FOOD SAFETY INDICATORS IN HOUSEHOLD FOOD SECURITY IN THE RURALVHEMBE DISTRICT, LIMPOPO PROVINCE, SOUTH AFRICA

by

NESAMVUNI CN

BSc (Dietetics) (Oklahoma State University)

Master in Nutrition (University of the North)

Master of Health Profession Education (Maastricht University)

Thesis submitted in fulfilment of the requirements for the **Ph.D. (Nutrition)** degree in the

Faculty of Health Sciences

Department of Nutrition & Dietetics

at the

University of the Free State

July 2014

Promoter: Prof. A Dannhauser (Ph.D.)

Department of Nutrition & Dietetics

University of the Free State

Co-promoters: Prof. BC Viljoen (Ph.D.)

Department of Microbial, Biochemical and Food Biotechnology

University of the Free State

Biostatistician: Prof G Joubert (MSc)

Department of Biostatistics

University of the Free State

DECLARATION

I, **Cebisa Noxolo Nesamvuni,** declare that the thesis hereby handed in by me for the qualification **Ph.D. (Nutrition)** degree at the University of the Free State, is my own independent work and that I have not previously submitted the same work for a qualification at/in another University/faculty. I furthermore waive the copyright of the thesis in favour of the University of the Free State.

_____

CN Nesamvuni (PhD candidate)

_____

Date

Acknowledgements

My foremost gratitude goes to the creator of all, the God Almighty, my Abba Father! Through Him, The following people, units and institutions made the accomplishment of this work possible. *'Umntu ngumntu ngabantu'*:

- My promoter, Prof. André Dannhauser and my co-promoters, Prof Gina Joubert and Prof. Bennie Viljoen. I sincerely thank you for your guidance, patience and professionalism.
- My mentor, Prof. & Pastor Vhakoma vhoEdward A Nesamvuni.
- The School of Health Sciences staff members, University of Venda. Prof. Base L Khoza, the Dean at the school.
- Finance (Mr S Munyai and Miss T Ndou), Transport (Mr. H. Mushiana and staff) and Research (Dr. Sinah Sekhula) Departments, University of Venda.
- Netherlands Universities Foundation for International Cooperation (NUFFIC) and National Research Foundation (NRF) for financial assistance.
- Committed, passionate and diligent fieldworkers, Ellen Mashau, Brenda Baloyi, Sibongile Mabunda, Tshilidzi Ndou and Aluwani Godzwana
- People who contributed in shaping the content of this study, Mr. Emmanuel Radzilani, Dr. Edgar Musie, Prof. Hettie Schonfeldt, Ms. Sandy Mufamadi and Mr. Khuthadzo Ndwammbi.
- My friends, my colleagues from the Department of Nutrition, our students and Mrs. Madeleine Du Randt, office of the Dean, Faculty of Health Sciences, University of the Free State.
- Prof. PO Bessong, Mal-Ed project principal investigator, University of Venda and all collaborators and field workers, including members of the Nutrition team who left the project.
- Hilda Mapholi, Mathagu family and Azwinndini Bulannga for taking care of my children and my home when I could not, due to my studies.
- My family:
    - My God given gifts, my husband, Prof & Pastor Edward Azwihangwisi Nesamvuni and our precious children, Philelo and Phuluso.
    - Cloupas Mahopo (my son, mentee and left hand) together with his family whom have become one family with us.
    - Nesamvuni family - Mom Reginah Tshimangadzo, my brother Edgar (Dr), his wife (my sister) Tshisikhawe, and their wonderful children, Phathutshedzo and Shammah.
    - Manona family – Dad, Phindile Lungelo, Mom, Brenda Lindiwe and my brothers, Thandile, Duma, Lungelo and Zingisile.
    - Charis Missionary Church family - My Pastor and mom, Sophy Khorommbi and the entire CMC body.

'Above all wisdom men can display or provide, there is the author of life, Alpha and Omega.'

DEDICATION

"Nutrition security is a critical investment for economic growth. More important, there is considerable moral obligation to do so. Without such security, individuals are unable to fully exploit their full human potential and enjoy healthy and active lives."

Todd Benson, IFPRI

This work is dedicated to the struggle against food and nutrition insecurity in the 21st century and beyond. Jesus came for us all to have life, to have it more abundantly, **John 10:10 (NIV)**.

Striving for a brighter and a beautiful future: A picture taken during data collection in Thulamela Municipality, Vhembe District, Limpopo Province, South Africa, March 2011.

INDEX

CHAPTER 3: METHODOLOGY

CHAPTER 4: RESULTS

CHAPTER 5: DISCUSSION

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND SYMBOLS

ADA	American Dietetic Association
AHA, FS	Assuming Health for All in the Free State
AIDS	Acquired Immunodeficiency Syndrome
AI	Adequate Intake
ARI	Acute Respiratory Tract Infections
BMI	Body Mass Index
BMI/A	Body Mass Index-for-age
CDC	Centre for Disease Control
CGS	Child Growth Standards
CCHI	Community Child Hunger Identification Project
C. perfringens	*Clostridium perfringens*
cfu	Colony Forming Units
CGCSA	Consumer Goods Council of South Africa
CI	Confidence Interval
cm	Centimeter
d	Day
DALY	Disability adjusted life years
DoH, SA	Department of Health, South Africa
DRI	Dietary Reference Intake
DWAF	Department of Water Affairs and Rural Forestry
EAR	Estimated Average Requirements
E. coli	*Escherichia coli*
EER	Estimated Energy Requirement
Et al.	and others
FAM	Food Aid management
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organisation of the United Nations
Fax	Fascimile
FBDG	Food Based dietary guidelines
FFQ	Food Frequency Questionnaire
FGP	Food Guide Pyramid
FIVIMS	Food Insecurity and vulnerability Information and Mapping System

FNS	Food and Nutrition Security
FS	Food security
FSIS	Food Safety and Inspection Service
GHS	General Household Survey
g	Gram
H/A	Height-for-age
HACCP	Hazard Analysis critical control point
HFIAS	Household Food Insecurity Access Scale
HFS	Household Food Security
HH	Household
HIV	Human Immunodeficiency Virus
HPC	Heterotrophic Plate Count
hrs	Hours
HSRC	Human Sciences Research Council
ht^2	Height in metre squared
ICMSF	International Commission on Microbiological Specification for Foods
ID	Identification
IDP	Integrated Development Plan
IES	Income and Expenditure Survey
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IFSS	Integrated Food Security Strategy
INP	Integrated Nutrition Programme
kg	Kilogram
kJ	Kilojoules
km^2	Kilometer square
LSDF	Limpopo Spatial Development Framework Review
LFS	Labour Force Survey
L. monocytogenes	*Listeria monocytogenes*
Listeria	*Listeria monocytogenes*
m^2	meter squared
Mal-Ed	Malnutrition and Enteric Diseases
MDBSA	Municipal Demarcation Board of South Africa
MDGs	Millennium Development Goals

MGRS	Multicentre Growth Reference Study
ml	millilitre
m	Month
MRC	Medical Research Council
MUAC	Mid-upper arm circumference
n	Sample size
NCHS	National centre for Health Statistics
NFCS	National Food Consumption Survey
NFCS-FB-I	National Food Consumption Survey Fortification Baseline
NFSPs	National Food Security Programmes
NGO	Non-governmental Organisation
NHANES III	National Health and Nutrition Examination Survey
NLIS	Nutrition Landscape Information System
No.	Number
OHS	October Household Survey
OK	Okay (acceptable)
OR	Odds Ratio
p	Probability
PCA	Plate Count Agar
PEM	Protein Malnutrition Energy
PFBDG	Paediatric Food Based Dietary Guidelines
%TE	Percentage of Total Energy
R	Rands
RDA	Recommended Dietary Allowances
RDP	Rural Development Programme
SAFBDG	South African Food Based Dietary Guidelines
SAM	Severe Acute Malnutrition
SANS	South African National Standard
SAS	Statistical Analysis Software
SAVACG	South African Vitamin A Consultancy Group
SCN	United Nations System Standing Committee on Nutrition
SD	Standard Deviation
SPFS	Special Programme for Food Security
Spp	Species

StatsSA	Statistics, South Africa
TE	Total Energy
Tel.	Telephone
Thulamela	Thulamela Local Municipality
UFS	University of the Free State
UL	Tolerable Upper Intake Level
UK	United Kingdom
UNICEF	United Nation Children's Fund
UNU	United Nations University
US	United States of America
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
VRB-MUG agar	Violet Red Blue agar with 4-methylumbelliferyl-β-D-glucuronide
W/A	Weight-for-age
WFS	World Food Summit
W/H	Weight-for-height
WHO	World Health Organisation
Wt	Weight
XLD	Xylose Lysine Deoxycholate
&	And
B	Beta
^{0}C	Degrees Celsius
=	equal to
<	Less than
≤	Less or equal to
>	Greater than
≥	Greater or equal to
%	Percent

University of Venda

TO WHOM IT MAY CONCERN

EDITORIAL LETTER

This letter serves to confirm that I, Mr. ET Radzilani of the Management Foundation Department, University of Venda, have proofread a thesis entitled "Food safety indicators in household food security in the rural Vhembe district, Limpopo Province, South Africa." By CN Nesamvuni, University of the Free State.

Editorial services rendered focused on language and technical precision hence the following areas were identified and corrected with specific comments for client/candidate's attention:

- Concord errors
- Tautology
- Word order
- Semantics
- Confused words on the basis of homonyms
- Structural ambiguity
- Technical precision
- Punctuation

I hope you will find everything in order. Please contact me should you have any concerns.

ET Radzilani

.....

Date 15/June/2014

Mr. ET Radzilani

Contact No: 015 962 8013
Email Address: Thifhelimbilu.radzilani@univen.ac.za

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The concept of food security (FS) in general refers to the overall regional, national and the capacity of global supply to meet the population's energy and nutrients needs (Hahn, 2000:2; Lorenzana & Sanjur, 1999:687). Although on global aggregate considerable progress has been made on agricultural production, statistics of food insecurity in the world had remained persistently high. In practical terms, 826 million people in the world and 792 million in developing countries (about 18% of their population) could not have continued access to enough food to meet their minimum requirements for healthy and productive lives (De Haen & Thompson, 2003:376).

Slow global progress made towards the reduction of the number of food insecure people translates to the same pace in dealing with the burden of child malnutrition (Pinstrup-Andersen *et al.*, 2009:6). Food and Agriculture Organisation of the United Nations (FAO) (2001a:Online) estimates of undernourished people worldwide were ranging at 842 million from 1999 to 2001 and the majority (798 million) were from developing countries (Oniang'o, 2004:373). Menza (2004:Online) further mentioned that approximately 200 million children below the age of 5 years globally were stunted and more than 160 million severely underweight. The death rate of the children in this age group according to Caulfield *et al.* (2004a:195) was more than 10 million per year and 52.5% of such deaths were due to malnutrition. They further identified malnutrition as a leading cause of the global burden of diseases resulting in a loss of about 16% of all disability adjusted life years (DALY). FAO (2001a:Online) reported that the main cause of the widespread prevalence of underweight in children under 5 years of age is basically a combination of household food insecurity and inadequate food intake by mothers.

These malnutrition challenges still persist after a number of efforts taken globally to deal with the FS situation (Cleaver *et al.*, 2006:Online). For example, a Special Programme for FS (SPFS) launched by FAO in 1994 was directed at assisting countries to improve FS through establishment and continued support of National FS Programmes (NFSPs) (FAO, 2003a:Online). During the World Food Summit (WFS) in 1996, Heads of 185 countries and the European Community pledged to at least halve the number of undernourished people in

the developing world by the year 2015 (FAO, 2001:Online). The 5th report of the United Nations Systems Standing Committee on Nutrition (SCN) on the world nutrition situation (SCN, 2004:9) indicated some positive effects of such efforts although the progress rate was still slow. For instance, there was a decline in developing world undernourished population from 20% (816 million) in 1990 to 17% (777.2 million) in 1999. The trend has been seen through 2005 projections.

In spite of the reported progress in meeting Millennium Development Goals (MDGs) by certain developing countries such as Latin America and the Caribbean with Asia promising in meeting the set goals, the overall progress in Africa, especially Sub-Saharan region was found diverting further and further from the MDG's (SCN, 2004:7). Some African countries showed a decrease in underweight rates. The prevalence of underweight and wasting in African children less than 5 years of age was projected at 27% and 13.3% in 2005 respectively. Poverty rate increases coupled with high prevalence of human immunodeficiency virus and acquired immunodeficiency syndrome (HIV/AIDS) and persisting conflicts have been associated with these negative effects (SCN, 2004:7-8).

The paradox of a worsening malnutrition challenge amidst national FS exists also in South Africa. About 1.5 million South African children suffer from malnutrition (De Klerk *et al.*, 2004:25) despite being self-sufficient in food production (Steyn *et al.*, 2001:98**).** The prevalence of underweight children increased from 9.3% to 10.3% during the late 1990's while that of stunting of children aged 1 to 6 years raised from 22.9% in 1994 to 23.3% (De Klerk *et al.*, 2004:25). The children who were highly affected by stunting, according to the most recent national study, SANHANES-1 (Shisana *et al.* 2013:16), were the youngest ones aged 0 to 3 years from the rural areas. That could mean the raised prevalence among children 1 to 6 years old is mainly in children aged 0 to 3 compared to 4 to 6 year olds. Consequently, prospective studies looking at the anthropometric status of children 3 to 5 years old may find lower prevalence as compared to results reported by De Klerk *et al.* (2004:25). Machete (2004:Online) reported a large number (14 million) of South Africans who were still vulnerable to food insecurity. The report reflected 43% of households that suffered poverty and 42% of those were residing in rural areas (Machete, 2004:Online; De Klerk *et al.*, 2004:25; Rose & Charlton, 2002:386). In terms of hunger, Shisana *et al. (2013:16)* reported that 25% and 28.3% of South Africans experienced and were at risk of hunger respectively. The Limpopo Province in South Africa has been implicated as being prone to food insecurity

probably due to the fact that it is prominently rural. For instance, De Cock *et al.* (2013:Online) reported that 85.3% households in Limpopo Province experienced food insecurity with 53.1% severely food insecure. Thulamela Municipality food insecurity pattern is not far off from that of the province with 79.3% households having declared themselves food insecure and 50% severely food insecure.

Consistent and reliable FS assessments are necessary for reliable reporting, monitoring and evaluation as well as informing policies for efficient and effective targeting (for resource allocation) and interventions (Labadarios *et al*., 2007:259; Hendricks, 2005; Hoddinott, 1999:1,16). The assessments of FS are done at various levels using various complex indicators mostly comprising sets of measures due to the complicated multi-disciplinary nature of FS (FAO, 2008:Online; Gross *et al.*, 2000:9). Multiple measures also serve for various and diverse programmes (Bickel *et al*., 2000:2,8). The researcher has observed that in general, researchers tend to explore and explain FS from their background of expertise. Consequently, development and use of indicators is mostly informed by the background or the discipline of the researchers. Ultimately, other various user groups of FS indicators (governments, non-governmental organisations (NGOs), humanitarian organisation and local communities) select and use generated information according to their needs (Frankenberger, 1992:109). Nevertheless, commonly used indicators are based on food availability, accessibility and nutritional status. Nutritional status is used as an outcome indicator to evaluate whether food availability and accessibility were successfully achieved (Frankenberger, 1992:98).

The FS concept was eventually broadened and reformulated as food and nutrition security (FNS) to expand its focus beyond availability and accessibility of food to incorporate the nutritional aspects which ultimately translates to the well-being of individuals (Hahn, 2000:2). FNS includes aspects of caring, health services and healthy environments based on the fact that under-nutrition is directly caused by inadequate food intake and poor health status (Hahn, 2000:2,9; Gross *et al.*, 2000:2). In this study, FS and FNS concepts will be used interchangeably with the understanding that they both aim at addressing malnutrition.

The FNS conceptual framework (Figure 1.1) (Gross *et al*., 2000:5) shows stable food availability, stable food accessibility and stable food utilisation as identified key dimensions of household food security (HFS). Food availability means physical food constantly

obtainable from production, livestock, markets, trades and food aid (Gross *et al*., 2000:5; Hahn, 2000:3; Riely *et al*., 1999:12). Accessibility of food refers to the capability of a household to always get sufficient food for a productive life for all its members (Gross *et al*., 2000:5; Riely *et al*., 1999:12) through its resources including capital, assets, labour, knowledge, donations and purchases (Hahn, 2000:3; Gross *et al*., 2000:5). Food utilisation considers constant adequacy of food quantity and quality. Food quality includes dietary and microbial safety. All these dimensions are critical in their hierarchical order for individuals to meet their nutrient requirements and achieve satisfactory nutritional status (Tontisirin & Battacharjeel, 2003:382; Gross *et al*., 2000:5; Hahn, 2000:3).

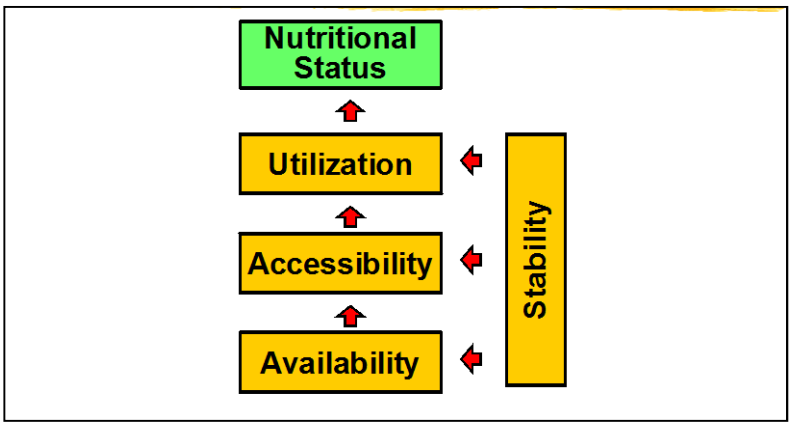


Figure 1.1. Food and Nutrition Security Conceptual Framework (Gross *et al*., 2000:5)

Food utilisation is often assessed through anthropometry and dietary consumption surveys (Hahn, 2000:5). Anthropometric and dietary consumption indicators supposedly reflect on how adequate the quantity and the quality of available and accessible food consumed is. In other words, these indicators test how well the investment on food availability and accessibility has fared in achieving FS. However, anthropometric status is also influenced by other factors including child care, environmental health and illnesses but often interpreted in terms of food availability and accessibility. Anthropometric results therefore bring incongruity between food availability and accessibility performance and FS achievement (Wolfe & Frongillo, 2000:2; Gross *et al*., 2000:7; Frankenberger, 1992:98). Hence, Frankenberger (1992:98) and Hoddinott (1999:2) assert that as much as availability and accessibility of food are necessary for improved nutritional status, they are not sufficient to ensure utilisation of nutrients by the body. Hahn (2000:4) states that one of the factors that influence utilisation critically is food safety.

Available literature (Unnevehr, 2003:Brief 1; Keenan *et al*., 2001:S49; Hoddinott, 1999:2) affirms that paying attention to food safety is an essential element in improving FS. Current food safety controls are accentuated in global food trade even though most food borne illness outbreaks occur at the household level (Taulo *et al.*, 2008:111; Unnevehr, 2003:Brief 1). The regulatory system and intervention strategies for ensuring safe food for human consumption do not consider household and individual levels but only focus on the national and regional levels (Kaferstein, 2003a:Brief 2) leaving food safety risks occurring in the kitchen not managed and controlled by legislation (Taulo, 2008:14-15). The role of food safety in meeting FS objectives is clearly reflected in the conceptualisation of FS (Gross *et al*., 2000:7; Frankenberger, 1992:98). Households and individuals can have adequate access to sufficient food but nutritional status of the children can remain poor because of consuming unsafe foods (Hoddinott, 1999:2). Unsafe foods refer to foods that are not fit for human consumption due to physical, microbial or chemical contamination. These hazardous agents can either cause food borne illnesses or make people fall victims of chronic diseases (Unnevehr, 2003:Brief 1). In this study, food safety will only refer to microbiological hazards. Food-borne diseases are amongst the most important underlying factors for malnutrition and indirectly for respiratory tract infections in developing countries. Repeated episodes of food-borne diseases over a period of time can lead to malnutrition with serious impact on the growth and immune systems of infants and children (Samuel *et al.*, 2008:44).

1.2 PROBLEM STATEMENT

The lack of food safety indicators in current measurements of HFS is viewed as presenting a huge gap in the progress of achieving FS (Keenan *et al*., 2001:S49; Hoddinott, 1999:2). The reporting on FS is still based on availability and accessibility of food in the context of many developing countries (Coates *et al.*, 2006:1447S) despite inclusion of food safety in the conceptualisation of FS concept. However, according to various researchers, a household should not only be declared food secure when it is able to have access to sufficient available food but also when its members can utilise the food for improved lives (Hahn, 2000:4; Hoddinott, 1999:2; Frankenberger, 1992:98). Intervention strategies tend to focus on agricultural production and other means that would increase household food access such as governmental social development grants and food aid from humanitarian organisations.

Figure 1.2 shows an adaptation of the Gross *et al*. (2000:5) FNS conceptual framework to operationalising food safety at household level. FNS conceptual framework indicates 4 hierarchical key dimensions of FS including food availability, food access, food utilisation (all stable) and the nutritional status. Figure 1.2 attempts to show how food safety might enhance FNS. Food utilisation block in Figure 1.2 depicts a point whereby the FS effect is compromised by lack of food safety to improve nutrition and health status. When unsafe food is consumed, the utilisation stage becomes compromised because nutrients get lost through possible diarrhoea and worm infestation. The implication is that even though food is available and accessible the body may still not obtain enough nutrients for good nutritional and health status due to ingestion of unsafe foods.

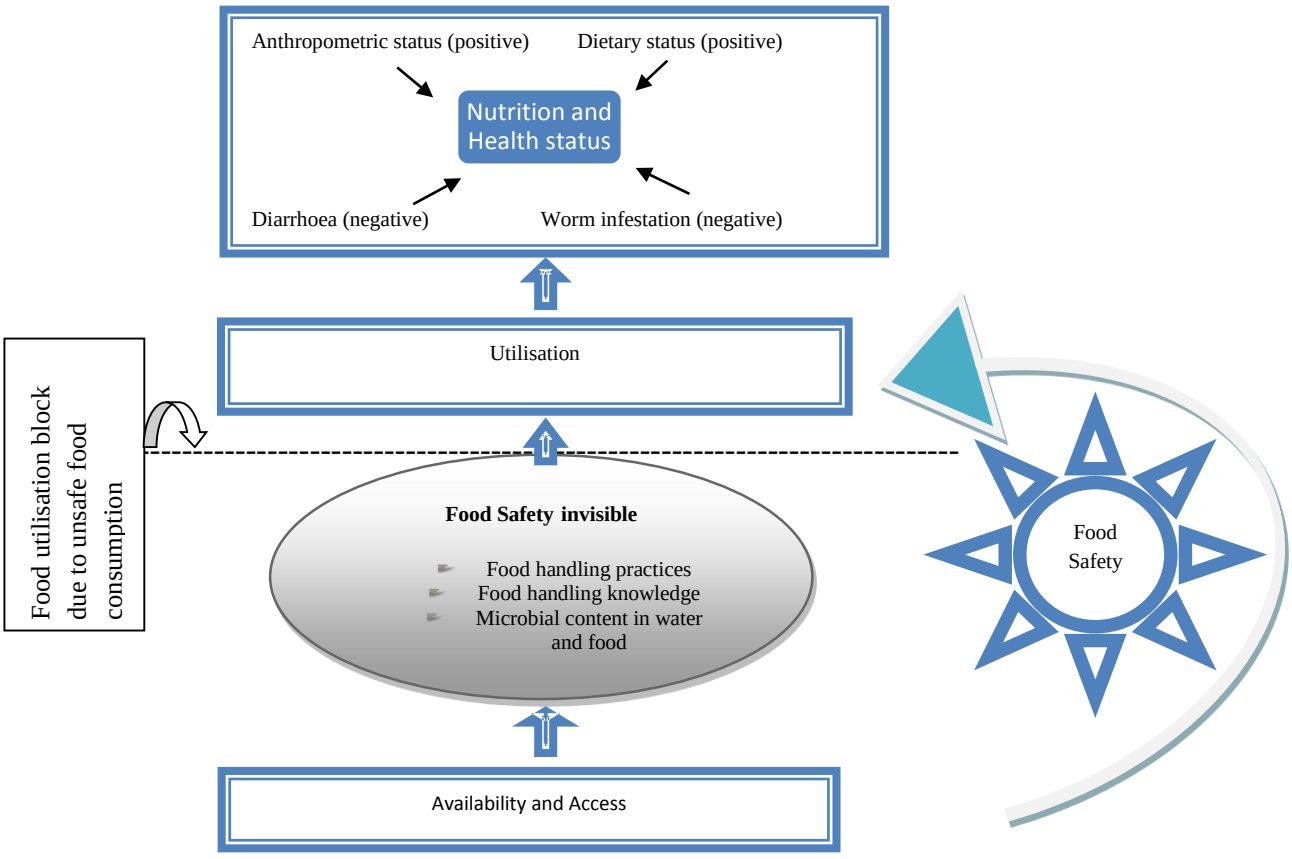


Figure 1.2. Food safety in HFS conceptual framework (adapted from Unnevehr, 2003:Brief 1; Kenaan *et al*., 2001:S49; Gross *et al*., 2000:5; Hoddinott, 1999:2)

In Venda, vulnerability to food safety risks is primarily due to poor sanitation and inadequate drinking water. The study conducted by Potgieter *et al*. (2005:152) revealed that the staple food *vhuswa,* a traditional maize meal porridge, consumed in Venda as well as water used for drinking and food preparation had faecal contamination that can cause diarrhoeal diseases.

Additionally, inadequate cooking and improper handling of cooking utensils were some of household food safety risks observed. Prevalence of *Salmonella* in water used for domestic and non-domestic purposes in rural communities of Vhembe region was reported in the water commission report (Potgieter, 2005:41-42). *Salmonella* was also isolated from raw vegetables, cabbages, tomatoes and onions suggesting water and food as vehicles of salmonellosis in such areas. Household food safety indicators measured in various studies include food handling practices, attitudes and knowledge of consumers with regards to proper food handling practices as well as microbial content in domestic water, food and environment (Redmond & Griffith, 2003:133; Baş *et al*., 2006:319; Taulo, 2008:33-44,65-66; Taulo *et al*., 2008:113-115; Bloomfield, 2007:3,5-6; Beumer & Kusumaningrum, 2003:299-300; Gilbert *et al*., 2007:307, 309-311; Jay *et al*., 1999:1285).

As available literature emphasises the importance of food safety in obtaining FNS, the current study was undertaken with the view to investigate possible food safety indicators that might possibly contribute towards improved assessment of HFS. The food safety variables chosen for this study were however limited to food handling practices, knowledge of caregivers related to proper food handling practices and microbial quality of consumed food and water due to feasibility and financial constraints of the study.

1.3 AIM OF THE STUDY AND OBJECTIVES

The aim of the study is to develop food safety indicators of HFS in rural Vhembe District, Limpopo Province, South Africa. The objectives are as follows:

1.3.1 To determine HFS in the households including:

1.3.1.1 Food availability and accessibility.

1.3.1.2 Household usual food consumption.

1.3.1.3 Nutritional and health status of children 3 to 5 years old.

1.3.2 To determine food safety including:

1.3.2.1 Food handling practices of the person who prepares food in the household.

1.3.2.2 Food handling knowledge of the person who prepares the food in the household.

1.3.2.3 Microbial quality of water consumed in households.

1.3.2.4 Microbial quality of water used for hand-washing before meals in households.

1.3.2.5 Microbial quality of foods consumed in households.

1.3.2.6 Microbial quality of left-over foods.

1.3.3 To determine the relationships between indicators of food safety and HFS.

1.3.4 To develop food safety indicators of rural HFS.

1.4 SIGNIFICANCE OF THE STUDY

This study pursues to develop food safety indicators that will increase the precision in the measurement of HFS. Food safety indicators might improve FS because food safety risks will be identified and acted upon and utilisation will be improved. Food safety indicators could be some of the keys in solving the problem of malnutrition. Furthermore, food safety intervention at household level could prove to be a much more cost effective means of reducing undernourishment in the households. Other benefits include redirecting research to focus on both FS and food safety at the same time rather than fragmentally. Knowledge on specific household food safety areas of concern will be identified thus rendering more directed and focused interventions. Such awareness may bring new insights towards improving nutritional status of children. Food safety indicators of HFS may be instrumental in awareness campaigns and food safety policies for behavioural change of individuals. Researchers may reach agreement on proper food safety measures that can be effectively incorporated into FS assessments to increase the association between FS and the nutritional status.

Presently, no study has been done indicating the extent to which food safety practices at home may compromise HFS. Such studies may stimulate urgency of research towards incorporation of food safety measures into the current FS measures. Furthermore, the devotion and efforts of legislature, industrial and public health authorities may not be effective if not matched with the consumer's food related practices (Taulo, 2008:13-14).

1.5 STRUCTURE OF THE THESIS

Chapter 1 gives an introduction of the study including the motivation, problem statement, aims and objectives, significance of the study as well as limitations of the study. Chapter 2 contains the literature review while Chapter 3 indicates the research methods. The results are described in Chapter 4 and discussed in Chapter 5, while Chapter 6 contains the conclusions and recommendations followed by the summary at the back of the Thesis.

1.6 LIMITATIONS OF THE STUDY

Biochemical nutritional assessment was not done due to technical reasons. The blood samples were collected from the children and sent to a laboratory, however, the laboratory did not follow proper procedures as stipulated in the protocol. Hence, the process was stopped and no results were available to use for this study. The decision to stop the process was taken to uphold the credibility of the study. The biochemical assessment would have strengthened the nutritional assessment of children by validating their dietary and anthropometric results, as it is the most sensitive and objective of all other nutritional assessment methods in detecting current nutrient deficits (Lee & Nieman, 2010:312). Nevertheless, two nutritional assessment methods (anthropometry and diet) were used. Most nutritional survey studies commonly use anthropometry and dietary methods when evaluating nutritional status of individuals (Hahn, 2000:5). Therefore, the results of the nutritional status of children used in this study could still meet the objectives of the study (objective 1.3.1.3).

The study may have been compromised because HIV/AIDS was not tested. HIV/AIDS impacts on all 4 key dimensions of HFS, availability, accessibility stability and utilisation (FAO, 2003b:Online). HIV/AIDS can decrease food production capacity, income and consumption of the household due to consequences of long illness. Long illness can also cause malnutrition of other family members who are not infected with HIV/AIDS (Loevinsohn & Gillepsie, 2003:20). Furthermore, HIV/AIDS can impose risks similar to those theoretically impacted by food safety on FS such as reduced immunity, increased infection and inadequate nutrient intake. This study intends to measure the relationship between food safety and FS in the households. In the presence of HIV/AIDS infections, poor nutritional status may be the result of HIV/AIDS rather than food safety. However, the food safety practices and microbial content of water and foods consumed were determined and therefore the presence of identified microbes and other sources of infections could be used to determine the cause of the infections.

Distribution inequalities (food not shared equally by family members) in the household were also not measured therefore inadequate intake by the children may erroneously be interpreted as food shortage. However, if inadequate food intake was observed for the children, it might still indicate that there is a problem of food access for the child in the household.

Coping strategies were not included as measures of HFS although Wolfe and Frongillo (2000:3,9) indicated that the use of experiences of food insecurity offer a valuable measure towards determination of HFS. On the contrary, they also warned that such measures may present with bias due to expectations of governmental support. Furthermore, such measures would neither strengthen nor weaken the case intended to be presented in this study of the inclusion of food safety indicators in HFS measurement. This study remained invaluable amidst the highlighted limitations above as the aims of the study could still be obtained.

2.1 INTRODUCTION

Food security is said to exist "when all people at all times have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life" (Food and Agriculture Organisation of the United Nations (FAO), 1996:Online; FAO, 2003a:Online; De Haen & Thompson, 2003:375). Conversely, when people live in absence of sufficient amounts of safe and nutritious food, food insecurity exists (De Haen & Thompson, 2003:375). However, observations of deficient food intakes by certain groups despite overall adequacy of national supply resulted in a shift of focus from the national to the household or individual FS level (Hahn, 2000:2; Lorenzana & Sanjur, 1999:687). The concept FNS emphasises the nutrition in FS as an important factor in achieving good health status. It is through optimal nutrition that food can provide all the essential nutrients and fibre in amounts sufficient to maintain a healthy body (Hammond, 2012:129). The World Health Organisation (WHO, 2003:Online) defines health as "a state of physical, mental and social well-being and not the mere absence of disease or infirmity".

Nutritional status of children is often assessed as an outcome indicator of FS (Hahn, 2000:5; Frakenberger, 1992:98). Nutritional status refers to a state of the body in terms of nutrition expressed as malnutrition when nutrients are inadequate. Malnutrition denotes either of the two states, undernutrition, that is when nutrients needed by the body are deficient or, overnutrition when nutrients exceed required amounts. Malnutrition has been shown to result from several factors that go beyond security of accessing food. Food safety appears in the literature as an area that can be explored with the potential to contribute positively towards FS achievement (Keenan *et al.*, 2005:S49; Unnevehr, 2003:Brief 1; Hoddinott, 1999:9).

Safe food refers to food free of environmental and microbial contaminants that can cause food and water borne infections, risk of chronic diseases or death (Unnevehr, 2003:Brief 1). Conversely, unsafe food would be food unfit for human consumption due to environmental contaminants and pathogens. Unsafe food poses a risk of causing food-borne infections. The food safety health risk ranges from short-term (food-borne infections) to long-term ill-health conditions (cancer, hypertension or coronary heart disease) (Dodd & Bayerl, 2012:235). Household food safety therefore will refer to protective measures such as food handling

practices from acquisition until consumption by the households, which guard against contaminants and pathogens. Household food safety in this study will also include acceptable microbial content levels in food and water consumed in the households.

Links between FS, health and nutritional status and food safety are well established (De Haen & Thompson, 2003:375). The Conceptual framework for this study (Figure 2.1) illustrates the relations between HFS, nutritional and health status and household food safety.

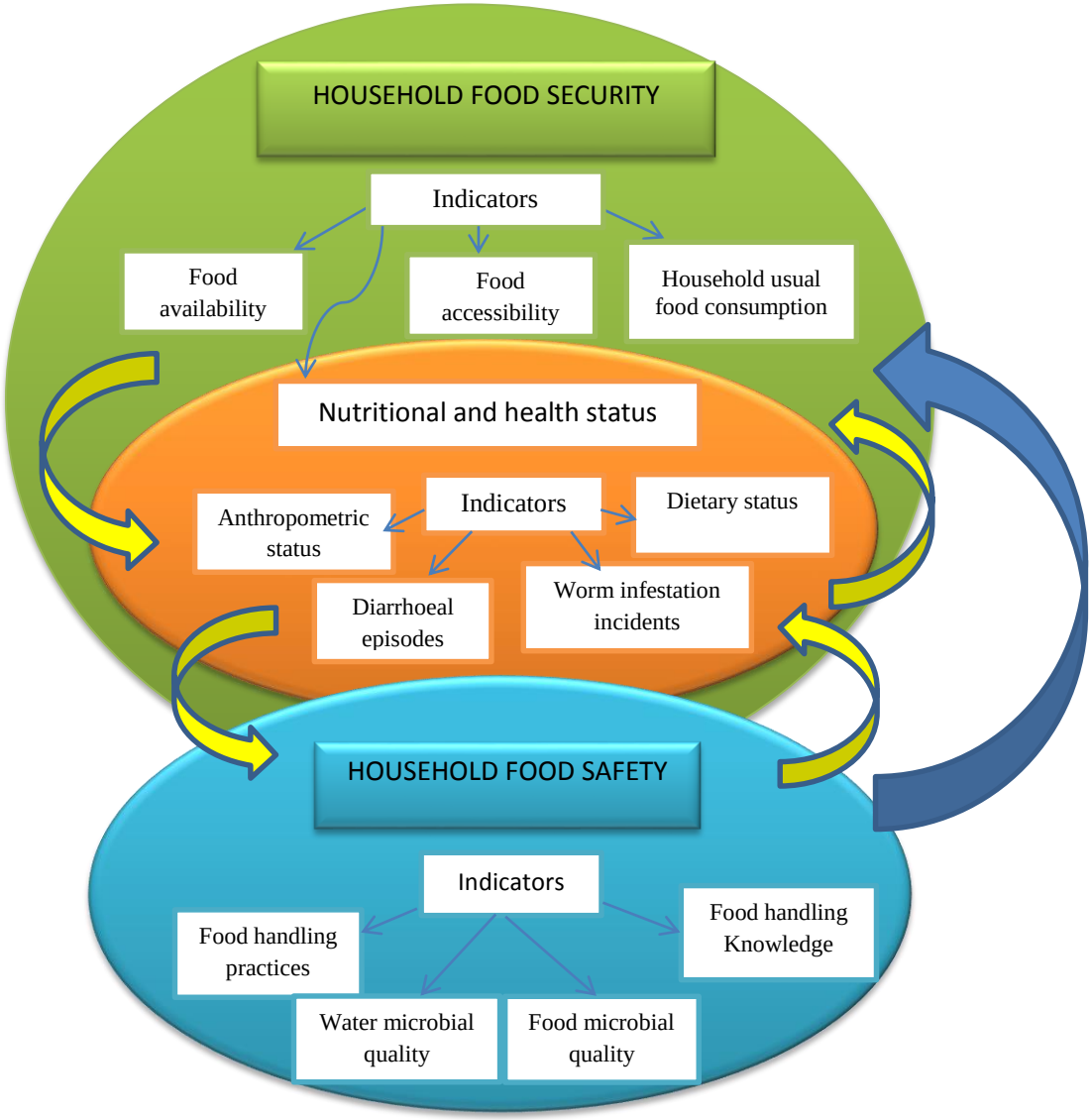


Figure 2.1. Conceptual framework indicating associations between household food security, nutritional and health status and household food safety (Caulfield *et al*., 2004b:551; De Haen & Thompson, 2003:375; Gross *et al*., 2000:5-7; United Nation Children's Fund (UNICEF), 1998:24)

The conceptual frameworks for FNS (Figure 1.1) and malnutrition (UNICEF, 1998:Online) (Figure 2.2) both portray nutritional status as the outcome of FS. Figure 1.1 shows what constitutes FS as well as malnutrition as its end result. Figure 2.2 on the other hand summarises the causes leading to malnutrition. It is clear that the achievement of HFS influences nutritional well-being and it becomes evident in the nutritional status of household members (Hahn, 2000:5).

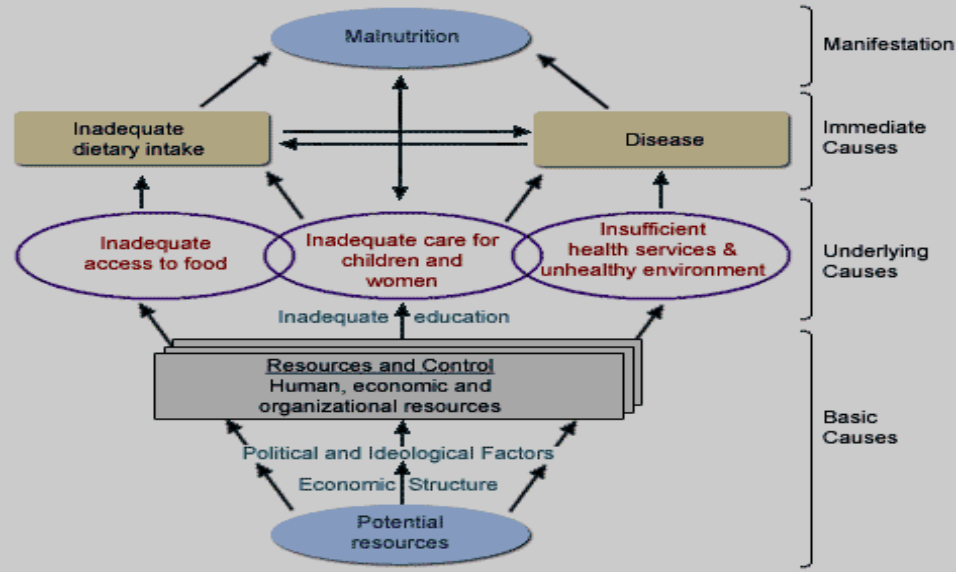


Figure 2.2 UNICEF conceptual framework of malnutrition (UNICEF, 1998:24)

Lack of household food access can lead to inadequate intake of nutrients and energy and ultimately undernutrition and infection cycle eventually resulting to morbidity and mortality (Psaki *et al.*, 2012:Online). Low food intake causes morbidity through weight loss, mal-absorption, compromised immunity and growth faltering and all these factors interfere with food intake and the cycle continues (De Klerk *et al.*, 2004:77). Furthermore, compromised health and nutritional status results in low productivity. Low productivity renders individuals incapable of working and earning enough to acquire sufficient resources for basic needs of life including food.

Scientists have known for some time that malnutrition and infection are connected (UNICEF, 1998:37). Literature shows that the ingestion of improperly handled food and unclean water can cause the same undernutrition and infection cycle as discussed above through food and water borne illnesses (Gulati, 2010:135-137; UNICEF, 1998:Online). Food and water borne illnesses are thus underlying factors of undernutrition. When food contaminated with

pathogens is consumed, nutrients are lost through diarrhoea and vomiting (Whitney & Rolfes, 2013:626; Dodd & Bayerl, 2012: 235; Vir, 2011:61) and therefore undermines FS. Diarrhoea can result in decreased dietary intake, loss of appetite, poor absorption and loss of nutrients in stools as well as decreased functioning of the immune function. Diarrhoea therefore interferes with utilisation of available food that the household has access to and if the situation persists it leads to chronic undernutrition (Yunus, 2011:275). Hence, the definition of FS stipulates that available and accessed food should be safe for human consumption implying that food safety is a prerequisite for FS.

Poor health and nutritional status pose infection risks due to reduced functioning of the immune system. On the other hand, intestinal parasites also cause poor growth and malnutrition (UNICEF, 1998:3). Poor health and nutritional status can be exacerbated in an environment with infectious diseases unless careful food safety precautions are put in place. Reinfections, especially when propelled by unsanitary conditions, can cause a vicious cycle. The interactions between HFS, nutrition and health status of children as well as household food safety are highlighted above. Indicators for HFS, nutritional and health status of children and household food safety will be investigated hereafter.

2.2 HOUSEHOLD FOOD SECURITY

HFS is the basic (micro) level where the degree of achievement in the progress of human development can be assessed (Hamelin *et al.*, 1999:527S & 528S). The focus shift of FS from the national (macro) and regional (meso) to the household (micro) level was instigated by observations of deficient food intakes by certain groups despite national supply sufficiency (Hahn, 2000:2; Lorenzana & Sanjur, 1999:687). It is clear however that HFS cannot be met if FS at the upper levels is not achieved. On the other hand HFS results can be used to describe the status of FS at regional and national levels. There are two schools of thoughts concerning the unit of analysis at household level (Maxwell, 2003:17). One school considers a household as a unit of analysis while the second school argues for the emphasis on individuals. The argument put forth by the second school is the consideration of intra-household issues which affect individuals. Intra-household issues include food distribution inequalities within the same household such as fathers' intake satisfaction before children and mothers can receive their meal portions as well as food intake adjustments by mothers in favour of their children.

Several factors associated with failure to achieve FS at household level led to the development of numerous indicators. Such factors include suboptimal nutritional status of individuals as well as consumption of microbiologically infected foods and water leading to infections and diseases. The development of FS indicators has basically been driven by what was known concerning the FS concept at that point in time (Frankenberger, 1992:80). Basing the development of FS indicators on in-depth understanding of the concept is crucial (Frankenberger, 1992:84). Conceptualisation most importantly assists in the development of efficient and effective indicators in meeting the objectives of FS. The challenge with regards to FS has been keeping up with the pace of the much elaborated progressive change in thinking due to the complexity and multi-dimensional nature of the concept (Hendricks, 2005:104; Food and Nutrition Technical Assistance (FANTA)/ Food Aid management (FAM), 2003:4). Wolfe and Frongillo (2000:2) however blame the lack of consensus of FS measurements on insufficient understanding of the concept and advocate for qualitative indicators. The WFS (1996) definition which includes aspects of access, sufficiency, safety and nutritional quality of food however appears comprehensive enough. Hoddinott (1999:2) and Keenan *et al.* (2001:S49) pinned the core of the problem with FS measurements to the omission of some factors already well understood as causal factors of food insecurity but not be incorporated in FS indicators. The discussion below reviews the development in the understanding of FS concept and consequent indicators used internationally and in South Africa.

2.2.1 Conceptualisation

Conceptualisation of FS evolved over the years from only embracing the supply point of view (Hendricks, 2005:103; Maxwell, 2003:13) to later realisation that there must be interaction of several factors for FS achievement (Rose & Charlton, 2002:383). The thinking evolution was appreciated by Frankenberger (1992:79) who viewed the emerging of FS as an obligation to think and act on bringing about development. Understanding FS gives direction on mandates, targeting, interventions and cost-effective use of resources (Hoddinott, 1999:1,16). Although the FS concept resurfaced strongly in the 1970s (Ayelew, nd.:Online), it is traced back to debates since the essay of Thomas Malthus in 1798 (Devereux, 2003:122; McCalla & Revoredo, 2001:Brief 71). The essay predicted the scarcity of food and famine due to the exponential population growth against arithmetical food production growth as time progresses. The concept therefore was conceived with foreseen severe food shortage relative to increasing human population, a pure food supply adequacy challenge. Adequate global food supply was thus seen as a solution for FS, meaning, the state of global FS would be

satisfied when food production is enough especially for countries that experienced food shortages (FAO, 2003a:Online; Van Zyl & Kirsten, 1992:170; International Fund for Agricultural Development (IFAD):Online; Ayalew:Online).

The development in FS conceptualisation over the years has been in line with the thinking and historical phases or events of the time (Hendricks 2005:103; Maxwell, 2003:13). Gross *et al.*(2000:3) mapped and depicted changing ideas and concerns about FS in 5 decades citing them as, food surplus (1940-50), food for development (1960s), food assurance (1970s), broadened FS (1980s) and freedom from hunger and malnutrition (1990s). The more the realisation of the multi-facet nature of FS, the more were the focus shifts producing numerous definitions. In the mid-1990s the more acceptable definition of FS was that of the 1992 United States Agency for International Development (USAID, 1992:Online) stating "when all people at all times have both physical and economic access to enough food to meet their dietary needs for a productive and healthy life". Maxwell (2003:14) indicated 3 focus shifts regarding the evolution of conceptualisation of FS. The first shift was the movement from the global and national level to that of household and the individual. The second shift was the movement from food first to livelihood perspective acknowledging that vulnerable households and individuals are incapable to be food secure without assets. The last shift involves the movement from objective to subjective indicators. The widely accepted definition hitherto is that of the FAO (1996:Online) that FS "exists when all people, at all times have physical and economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life."

Derived from this FAO (1996:Online) definition, the 4 key FS dimensions used to assess FS status of people are named as food availability, food access, utilisation and stability. The implication is that all 4 dimensions should be satisfied in order to declare FS achievement. However, availability and access to food as well as diet quality are the dimensions that can be measured (Benson & Shekar, 2006:Online). Indicators for food availability and those used in the determination of food accessibility often overlap (Frankenberger, 1992:85). Both food availability and food accessibility basically rely on the same factors (Boshoff & Kgaphola, 2006:14). However, some researchers (FAO, 2003a:25; Gross *et al.*, 2000:9; Riely *et al.*, 1999:12; Van Zyl & Kirsten, 1992:170; IFAD:Online; Ayalew:Online) distinguish the two by indicating that food availability is a FS dimension at aggregate levels rather than at a household level. The availability of sufficient food for all people is the responsibility of the

government and of the markets to make sure that food needed by households is available at reasonable prices and reachable in terms of distance (Van Zyl & Kirsten, 1992:170).

Nevertheless, food is said to be available when it is readily and sufficiently at the disposal of households and their inhabitants (Carletto *et al*., 2013:31; Gross *et al.*, 2000:5). The key word for availability of food is sufficiency for all individuals. Households acquire food through agricultural production, by purchasing the food from the markets or through endowments. Various production and supply factors include climatic conditions, production resources, distribution channels and community infrastructure (Boshoff & Kgaphola, 2006:13). Purchases and transfers also determine food availability (Gross *et al.*, 2000:7). Sayed (2006:6) further states that the quality of available food in terms of adequate nutrition, food safety, cultural and social acceptability determines the achievement of nutrition security. Other constraints towards availability of food include lack of agricultural knowledge, proper technologies and practices (USAID, 1992:Online).

Food access mainly assesses the income strength of the household both in monetary and various non-monetary values as well as prices (Hahn, 2000:3). Food access refers to the ability of household to procure, gather, produce adequate and appropriate food or through various channels of food transfers for all its members at all times (Gross *et al.*, 2000:5; FANTA, 2003:4). The FAO (2008:Online) also mentions bartering, wild food gathering, community support networks, gifts and theft as other means to access food. Gross *et al.* (2000:3) particularly states household resources (capital, labour and knowledge) and prices as determinants of household food access. Food access thus includes household's physical, economic, social and technological means to effectively utilise available resources to meet their FS needs (Sayed, 2006:6; Hahn, 2000:3). Physical access includes distance from markets to purchase food. Economic access refer to affordability of food prices, ability to buy or grow own. Social access refers to food that is culturally viewed as fit for human consumption. Social access addresses the "preferences" in FAO definition, meaning ability to access food communally and culturally accepted also accommodating religious beliefs and ethical values (Pinstrup-Andersen, 2009:6). Technological access refers to the ability of the household to operate cooking appliances in order to cook food.

Utilisation of food refers to either physical or biological use of available and accessed food. Physical utilisation includes good care, feeding practices, food processing, food storage,

diversity of diet and intra-household distribution of food (FAO, 2008a: Online; FANTA, 2003:5). Biological use refers to bioavailability of nutrients to the body (FAO, 2008a:Online; Gross *et al.*, 2000:5). Determinants of utilisation include nutritious and safe foods, adequate biological and social environments and proper health care (FAO, 2008a:Online). At individual levels anthropometry and consumption surveys are nutritional assessments commonly conducted to indicate utilisation of food (Hahn, 2000:5). Anthropometric status however is also influenced by other factors including child care, environmental health and illnesses therefore bringing the discrepancy between food availability and accessibility measures and the nutritional status which is meant to indicate the achievement of FS (Wolfe & Frongillo, 2000:2; Gross *et al.*, 2000:7; Frankenberger, 1992:98). Child care concerns include feeding practices and intra-household food allocation while environmental health and illnesses bring sanitation, food handling practices and quality of domestic water used for consumption into the picture. Nutritional assessments on the other hand are meant to detect whether households and individuals get adequate energy and nutrients from their food consumption. Usual household consumption and child usual dietary intake are commonly used in consumption survey methods. Food quality in terms of its nutritional value is assessed often omitting food preparation methods that could compromise the nutrient and biological quality of food.

Food stability impacts on all other 3 dimensions (Gross *et al.*, 2000:5). Stability refers to the sustainability of food availability, accessibility and utilisation over time for all people. Food stability also includes avoidance of spoilage and/or major losses during storage and processing of available food (Sayed, 2006:7). It also means the ability of the household to process food to the extension of shelf life of food for leaner seasons. Stability can be disturbed by natural disasters and political factors as well as social and economic standing.

As reflected by Maxwell's third focus shift (Maxwell, 2003:20), Wolfe and Frongillo (2000:2) insist that the FS concept goes beyond these mentioned dimensions and they advocate for the inclusion of qualitative and subjective assessments such as perceptions, worries and anxieties. Pinstrup-Andersen (2009:7) and Lemke *et al.* (2003:759,763) concur with this view claiming that such assessments give insights to the household behaviour. Pinstrup-Andersen (2009:7) still appreciates the importance of 4 dimensions but seeing them as an insufficient consideration. He states that if FS achievement is as defined by FAO in 1996 the matter should not end with ensured food access but how the households behave in terms of use and allocation

of available resources. For instance the households with sufficient resources may prioritise goods and services over food. Furthermore, food distribution may not ensure adequate amounts for all household members. In contrast, Rose and Charlton (2002:384) question the contextual relevance of qualitative assessments in developing countries stating that, developing countries are still battling with basics of food shortages. For them affective concerns are for the affluent countries. De Klerk *et al.* (2004:27) are equally cynical about subjective assessments stating that such data corroborates failure to secure relevant interventions. Hendricks (2005:104) also states that such results lead to discrepancies in the description of the FS magnitude especially when dealing with hunger and malnutrition. While Pinstrup-Andersen (2009:7) supports the subjective assessment he also warns against risks of deliberate misinformation provided by respondents who anticipate government support in subjective assessments. Despite the current debate of the form of assessments currently in use, gaps identified from the definition are still not considered.

With the view of all that is already known to date pertaining FS, there is still an on-going search of indicators that can capture all phenomena and enable reliable and credible food insecurity status. The only way of fighting and overcoming food insecurity is with the establishment of reliable measurements (Ballard, *et al.*, 2011:1). The following section will review currently used indicators internationally and in South Africa.

2.2.2 International indicators of household food security

The terminology associated with FS indicators is often unclear. Consequently, concepts that are otherwise different are used interchangeably due to their complications and uncertainties as well as FS multidimensional nature (Wolfe & Frongillo, 2000:2). Hence, definitions to clarify concepts here will be invaluable. Measures refer to raw measurements that on their own do not have meaning with respect to getting the intended information (Gibson, 2005: 7). Gibson (2005:7) points out the difference between indices, indicators and determinants. Indices refer to the combination of raw measurements used to make evaluation possible where applicable when compared with predetermined cut-off points, references or standards. Indicators refer to the interpretation read from the measurements and/or indices against standards to declare below, optimal or above condition. Determinants refer to variables that often indicate the presence of the condition of interest.

Numerous FS indicators are used globally to describe HFS by different agents for specific purposes that vary widely (Carletto *et al.*, 2013:31; FAO, 2008a:Online). Frakenberger (1992:82) owes the high progress of the development of indicators to much better conceptualisation of processes that causes food insecurity. Indicators help in targeting emergency projects, informing monitoring, evaluation and reporting, advocacy of certain key issues as well as policy and intervention (Carletto *et al.*, 2013:31; Hendricks, 2005; Hoddinott, 1999:1,16; Frankenberger, 1992:79). Use of multiple indicators is necessary because the FS problem embraces different sectors, such as agriculture, economy, environment, political, social, nutrition and health (Bickel *et al.*, 2000:2,8). They assist in capturing the full range of the area of interest, indicating combinations of food conditions at different stages of food insecurity severity. The FAO (2003a:Online), however warns that it becomes practical when focusing on narrower and simpler objectives guided by the primary goal of international action on FS which is to halve the number of hungry or undernourished by 2015.

The choice of indicators is informed by several factors such as the strengths or feasibility of the measures (quick and simple), ability to capture severity of FS and the capability of providing a multidimensional scale (Wolfe & Frongillo, 2000:4). FS measurement can also be very expensive (Hendriks, 2005:104) therefore associated cost can be another decision influencing factor. Indicators are basically categorised into process indicators and outcome indicators (Frankenberger, 1992:96). Process indicators reflect both food supply and food access whereas outcome indicators are used as proxies for food consumption. Outcome indicators are further grouped into direct and indirect indicators as well as the mixture of those (Frankenberger, 1992:96). FS outcomes are not quite correlated with process indicators (Hoddinott, 1999:1).

Determinants of food insecurity as mentioned by FAO/WHO (1992:11) included higher number of dependents, younger aged household composition, lack of land-ownership and when income is particularly that of women. FAO/WHO (1992:11) further stipulated FS indicators considered in rural areas as food availability, prices of agricultural commodities and income.

Food availability indicators are used at aggregate level. With the use of balance sheets, national food energy available per capita per day and energy intake are measured and a single

cut-off point would give indication of population at risk of food insecurity (Perez-Escamilla & Segall-Correa, 2008:17). The disadvantages with food supply method are failure to identify households and individuals at risk of food insecurity as well as inability to assess dietary quality of the available food. These failures led to the shift towards household and individual measurements. Despite the focus shift, food availability is a definite necessity for HFS (Frankenberger, 1992:84). Nutrition surveillance programmes were also used with the belief that undernutrition will be signalling food deficiency at national level. Nutritional assessment results were however only indicating the manifestation of the problem but unable to pinpoint the cause.

Household production is measured by availability of agricultural resources including owning and use of land for food produce, agricultural knowledge and occurrence of natural disasters (Riely *et al.*, 1999:12). Whether the household is the food aid recipient also gives an indication that the household food has no sufficient food. Conversely, if the household participates in social responsibility by giving up food, that will signal FS in terms of quantity. Although the assessments of hunger and food inventory are not considered as food availability measurements probably because they are used at household level, they do provide indication of the presence of ready adequate food at household level (Fulkerson *et al.*, 2008:Online; Bickel *et al.*, 2000:8).

Questionnaire-based measures such as the hunger scale questionnaire also known as the food security scale, have been used to obtain information on experiences and behaviours that would indicate presence and severity of food insufficiency in households (Bickel *et al.*, 2000:8). Frongillo (1999:508) defining hunger as the extreme case of food insecurity, tested and proved that hunger and food security questionnaire-based measures [Radimer/Cornell, Community Child hunger identification Project (CCHIP) index and The United States of America National Health and Nutrition Examination Survey (NHANES III)] are valid for determining food insecurity and hunger in rural households. The household Food Insecurity Access Scale (HFIAS) and Household Hunger Scale were validated for cross-cultural and developing countries use respectively (Ballard *et al*., 2011:2) as the above mentioned ones were developed and used for Americans. Bickel *et al.* (2000:9) however indicates the shortfall of these scales as only addressing food sufficiency thus omitting other important dimensions of the phenomenon.

Food inventory is viewed as an efficient technique of assessing home food availability. Food inventory is associated with purchasing and expenditure habits of households. It identifies and measures food present in the household, grown or purchased or acquired otherwise, at the time of data collection (Fulkerson *et al.*, 2008:Online). An inventory of foods available in the households at a point in time gives a sense of foods afforded and types of food consumed or preferred by a family thereby giving indication of the likelihood of food and nutrition status of the household. In some cases such measurements are used during food critical times (food crisis). In certain cases, food inventory is used to assess food purchasing behaviour when comparing with the financial strength of the household. Disadvantages of this method include not considering food wastage and food consumed away from home. Moreover, researchers need to access the storage facilities when taking the inventory and respondents often view it as an invasion of privacy resulting in reduced cooperation. To deal with the privacy invasion challenge, Fulkerson *et al.* (2008) developed and validated an instrument that can be self-administered. However, such an instrument will be limited if respondents are not motivated and/or literate.

Indicators of food access include determination of number of people who live below the minimum poverty level (Sayed, 2006:9). Data used to identify vulnerable households with this regard is often from income and expenditure surveys as well as food price seasonality index. Income and Expenditure Survey (IES) measures ecological factors including household income and how it is used in terms of expending on food and non-food items and individual food access (Riely *et al.*, 1999:35). Food consumption surveys assess energy intake *per capita* per household and dietary diversity score. Purchasing behaviour like buying on credits, debts or loans also indicates the inability of the household to access sufficient food for all its members. Types of foods are also assessed in terms of social acceptability. Additionally, distance to markets is another indication of easy access to food supply.

Current understanding of the FS concept directs assessment of utilisation dimension to measurements of the nutritional and health status of individuals as well as their causes (Riely *et al.*, 1999:14). However, utilisation is currently measured by nutritional assessment in terms of dietary quality and intake as well as growth and development of children.

2.2.3 Indicators of household food security in South Africa

Upholding South Africa as a nationally food secure country (Steyn *et al.*, 2001:99) does not portray the true reflection of the severity of food insecurity suffered by multitudes of individuals in households. Analysis of balance sheets, upon which such reports are made, is silent about distribution dimension and household or individual access of food (Leroy *et al.*, 2001:5). In actual fact, South Africans, especially those residing in rural areas, have been reported to have quite a high prevalence of household food insecurity (Machete, 2004: Online; De Klerk *et al.*, 2004:25; Rose & Charlton, 2002:386). Determinants of food insecure or at risk households often include being in rural area, headed by an African, having low income and being a large family in size (Bonti-Ankomah, 2001:2; Rose & Charlton, 2002:386). The Human Sciences Research Council (HSRC) (2005:5) shows income as the main limiting factor to food access in rural areas due to low rates of employment. Hendricks (2005:116) reiterates the same notion of limited cash that it is even difficult to purchase staple food in rural areas.

Food security is a constitutional right in South Africa and has been a priority policy objective of the reconstruction and development programme (RDP) since1994 (Department of Agriculture, South Africa, 2002:Online). Since then the government reprioritised public spending to focus on improving FS conditions of historically disadvantaged people (Labadarios *et al.*, 2009:11). However, results have not been satisfactory because of implementation of many disjointed programmes by different departments of the government. Hence, the Integrated Food Security Strategy (IFSS) was decided upon and developed. IFSS is aimed at streamlining, harmonising and integrating diverse national FS programmes. Its vision is to "attain physical, social and economic access to sufficient, safe and nutritious food by all South Africans at all times to meet their dietary and food preferences for an active and healthy life" (Department of Health, South Africa (DoH, SA), 2002:4). One of the strategic objectives is to improve nutrition and food safety among the food insecure.

There are some empirical studies done on South African FS situation (Hendricks, 2005:109). Although all these studies concluded on high prevalence of food insecurity, their measurements were different owing to complexity of FS making it difficult to even compare them (Labadarios *et al.*, 2009:31; Hendricks, 2005:109; HSRC, 2005:5). Multiple disjointed methodological approaches used in the assessment of FS in South Africa and absence of national FS time series databases further aggravates the difficulty of analysing trends for

prompt and accurate intervention (Labadrios *et al.*, 2009:32; Hendricks, 2005:109). So far national FS survey reports present are extracts from other previously conducted national surveys with designs based on different objectives. Nevertheless, policy formulation process is done, currently based on Statistics South Africa (StatsSA) national studies including IES, General Household Survey (GHS), Labour Force Survey (LFS) and Community Survey (CS) (Du Toit *et al.*, 2011:Online). Labadarios *et al.* (2009:36) suggest using the same StatsSA existing surveys but with "new more comprehensive and purpose-specific approaches" for FS assessments. The latest national study on food security, South African National Health and Nutrition Examination Survey (SANHANES-1) however, reported the trend of national food security status from 1999 to 2008 based on previous national survey (Shisana *et al.*, 2013:147). The remaining challenge is that even with SANHANES-1 the objective of the study was not solely the assessment of FS but to define health and nutritional status of South Africans. Therefore, FS was just another variable used to explain the health and nutrition status of South Africans and the design of the study was not constructed for FS per se. De Cock *et al.* (2013:Online) explored social and economic aspects of FS in the rural Limpopo Province. They grouped social and economic determinants of FS into human capital, household income and location. Human capital determinants were household head (education and age) and family size including dependency ratio. De Cock *et al.* (2013:Online) however indicated that food production which seemed a strength for rural areas is not the case.

Table 2.1 presents some of the empirical FS studies undertaken to explain FS in South Africa. All these studies were conducted after 1990, a period of world mandate to eradicate hunger and malnutrition (Gross *et al.*, 2000:3). Although all these studies used more than one indicator, South African FS status is mainly explained in terms of food availability and food access. Food availability assessment at aggregate level is necessary to understand national situation as FS at lower levels would be impossible when food insecurity prevails nationally (Frankenberger, 1992:84). Steyn *et al.* (2001:98,99) used food balanced sheets to calculate and assess average energy, protein carbohydrates and fat available per capita in the country against recommended dietary intakes. They concluded that the country is food secure. Utilisation dimension of the study was reported to be limited by the omission of inter and intra-household food distribution (Steyn *et al.*, 2001:99). Bonti-Ankomah (2001:3-7) on the other hand used financial indicators from various surveys including October Household Survey (OHS), 1995 IES and 1997 Rural Survey to explain the ability of South Africans to access food. He concluded that many South Africans' food expenditure is unacceptably low

when compared to daily dietary requirements. When examining his definition (2001:2), it is clear that Bonti-Ankomah comprehends FS in terms of food sufficiency and access hence the selection of indicators.

Studies done in South Africa seem to have been influenced by the international pattern of conceptual evaluation in terms of movement from national to household and individual assessments. A shift from food supply to food access is also apparent. Although there is not yet complete shift towards the use of questionnaire-based measurements but they started to appear in the 21st century.

The Malnutrition and Enteric Diseases (Mal-Ed) global network study (Psaki *et al*., 2012:Online), the National Food Consumption Survey Fortification Baseline (NFCS-FB) (Labadarios *et al*., 2007) and National Food Consumption Survey (NFCS) (Labadarios *et al*., 2000) are the only studies so far that assessed FS using 3 dimensions even though food utilisation assessment was limited. Both NFCS studies included dietary quality and intake together with anthropometry to explain the utilisation dimension. Causes of nutritional status and health aspects were however not considered as recommended by Riely *et al.* (1999:14) for a full coverage of FS. While Psaki *et al*. (2012:Online) introduced the hygiene indicators and anthropometry to better explain utilisation, they did not look into the food consumption issues.

Table 2.1 Food security indicators used in South Africa

Publication year	Author(s) (Study)	Level of Assessment	Indicators	Dimension measured
2000	Labadarios *et al.* (NFCS)	• Household • Individual	• Hunger • Food Purchasing • Dietary • Anthropometry	• Food availability • Food access • Utilisation • Utilisation
2001	Steyn *et al.*	• National • Individual	• Food balance sheets • Energy intake	• Food availability • Utilisation
2001	Bonti-Ankomah	• National	• Poverty Level	• Food access
2001	Leroy *et al.*	• Individual	• Energy intake	• Utilisation
2002	Rose & Charlton	• Individual	• Food poverty • Energy intake	• Food availability • Utilisation
2002	Watkins and Makgetla	• National	• Farming Households • Expenditure	• Food availability • Food access
2003	De Swardt	Household	• Poverty levels Expenditure patterns	• Food availability Food access
2004	HSRC (Stats SA OHS)	Household	• Income • Affordability	• Food access • Food access
2005	De Klerk *et al.* (HSRC)	Household	• Anthropometry • Hunger	• Utilisation • Food availability

Table 2.1. (Continued) - Food security indicators used in South Africa

Publication year	Author(s) (Study)	Level of Assessment	Indicators	Dimension measured
2005	HSRC (Food Insecurity and vulnerability Information and Mapping System, FIVIMS)	• Household	• Ecological factors • Anthropometry • Health	• Food access • Utilisation
2005	Kruger *et al.*	• Household	• Ecological factors • Anthropometry	• Food access • Utilisation
2007	Labadarios *et al.* (NFCS-FB-I)	• Household • Individual	• Hunger • Food Purchasing • Dietary • Anthropometry	• Food availability • Food access • Utilisation • Utilisation
2012	Psaki *et al*. Mal-Ed Global Network	• Household • Individual	• Hunger • Socio-economic • Anthropometry • Hygiene	• Food availability • Food access • Utilisation • Utilisation
2013	De Cock *et al.*	• Household • Individual	• Hunger • Poverty • Expenditure patterns • Dietary • Energy intake	• Food availability • Food access • Food access • Utilisation • Utilisation
2013	Shisana *et al.* (SANHANES-1)	• Household • Individual	• Ecological factors • Hunger • Anthropometry • Dietary	• Food access • Food availability • Utilisation • utilisation

2.3 NUTRITIONAL AND HEALTH STATUS OF CHILDREN

Nutritional and health status of children improves when the FNS is achieved (Casey *et al.*, 2005:53; Hahn, 2000:5). Hence, nutritional and health statuses of children are considered as outcomes of FNS and thereby used indirectly in the measurements of HFS (Casey *et al.*, 2005:53; Hahn, 2000:5; Frankenberger, 1992:98). Both the FNS conceptual framework (Figure 1.1) and the UNICEF conceptual framework of child malnutrition (UNICEF, 1998:24) (Figure 2.2) clearly portray good nutritional status as the goal of FS. Good nutritional status would mean that the state of energy, protein stores, micronutrient status and metabolic functioning (physiological nourishment) is optimal (Hammond, 2012:129). Conversely, the state of failure to attain the good nutritional status is referred to as malnutrition. Malnutrition causes are more complex than insufficiency of food intake but include a wide spectrum from politics to personal diseases (International Food Policy Research Institute (IFPRI), 2000:73). Figure 2.2 summarises the hierarchical causes of child malnutrition in 3 levels, namely, basic, underlying and immediate causes (UNICEF, 1998:Online). These levels are corresponding to those of FNS conceptual framework (Figure

1.1), food availability, food accessibility and utilisation. The basic level states that the fundamental cause of malnutrition lies with political and economic systems (a level that determines national food availability) while the middle level (underlying causes) includes inadequate access of food (food accessibility), inadequate care for women and children, unhealthy environment, inadequate education and insufficient health services. The immediate causes (top level) are inadequate food intake and diseases as well as psychosocial care.

2.3.1 Nutritional Status

Nutritional status of people can be measured using 4 methods (Anthropometric, Biochemical, Clinical and Dietary assessments). These methods complement each other and use of just1method cannot give conclusive results. Use of two methods is often sufficient to get conclusive results. Biochemical methods however are the most objective, sensitive and reliable in validating the other methods (Lee & Nieman, 2010:312). The advantage of biochemical assessments is that nutrient deficits can be identified before they are evident with the use of other methods. For dietary intake assessments, biochemical methods assist in indicating recent intake. Their limitations are invasiveness and being expensive making it a last resort where finances are limited. Clinical assessments are usually done in clinical settings while anthropometric and dietary assessments are commonly used in nutritional surveys.

2.3.1.1 Anthropometric status of children

Human growth in the first 5 years of life is mainly influenced by nutrition, feeding practices, environment and care (WHO, 2008:Online). Anthropometric assessments are useful and most reliable in the detection of nutritional and health problems in children's growth and development both at individual and population levels (Lee & Nieman, 2010:161; Klasen, 2005:Online; Gibson, 2005:240; De Onis & Habicht, 1996:650). Anthropometry is the only feasible and non-invasive method applicable for body size and composition assessment globally (De Onis & Habicht, 1996:650; WHO, 1995:1). When used in conjunction with other nutritional assessment methods, anthropometric indicators assist in providing awareness about the nutritional status of the community (Lee & Nieman, 2010:161; Shetty, 2005:13). Although with anthropometric assessments the exact cause cannot be pinpointed, when used with the analysis of socio-economic information determinants of undernutrition can be inferred (Klasen, 2005:Online). Anthropometric assessment refers to 2 types of measurements for body size (or physical dimensions) and gross composition to assess the nutritional status

(Gibson, 2005:233; WHO, 1995:1). Measurements commonly taken are weight, height, and mid-upper-arm muscle circumference (MUAC) (Shah & Sachdev, 2011:116; Gibson, 2005:290). Weight and height measurements are mainly for body size assessments while MUAC measures body composition to assess the presence of protein-energy malnutrition (PEM) (Gibson, 2005:290). Measurements can only provide interpretation when two or more are combined to form indices (Gibson, 2005:233,240,253; WHO, 1995:7). Indices are used as indicators when compared to standards and references. Precise age is critical for interpretation of anthropometric measurements using age-specific reference data (Gibson, 2005:240, 254; WHO, 1995:8). Anthropometric methods and indicators for the interpretation of growth will be discussed respectively.

(i) Anthropometric indicators

The most frequently used anthropometric indicators amongst pre-school aged children include height-for-age (H/A), weight-for-height (W/H), weight-for-age (W/A) and body mass index-for-age (BMI/A) as well as mid-upper arm circumference (MUAC) (WHO, 2006:7). BMI can be influenced by variations in age, gender, ethnicity, climate and other factors (Klasen, 2005:Online).

(a) Height-for-age

A combination of height and age measurements forms an H/A index useful in assessing attained linear growth relative to age (WHO, 2008:3). A faltering of linear growth is known as shortness or stunting indicating less than expected height for age (Vir, 2011:52; Gibson, 2005:256). Stunting results from extended periods of inadequate food intake, poor dietary quality, increased morbidity or combination of these factors (WHO, 1995:181). Therefore, H/A reveals chronic nutritional and health status which is common in developing countries (Gibson, 2005:256). Genetics and ethnicity may however influence H/A. Stunting and genetic shortness are often differentiated with a population's prevalence of low H/A (WHO, 1995:165). If the prevalence is high then stunting is assumed and the opposite will be regarded as genetic shortness. Stunting is highest in the second and third years of life where it indicates 'having failed to grow' however it can be observed as early as 3 to 6 months and in such a case it shows a continuous process of 'failure to grow' (Gibson, 2005:256). Stunting suggests long-term factors such as chronic malnutrition especially severe acute malnutrition (SAM)

and frequent illness. The other consequences include reduced work capacity and adverse reproductive outcomes (in women) later in life that can result in intergenerational malnutrition cycle (WHO, 2010:1). A deficit in length takes some time to develop, so assessment of nutritional assessment based on length-for-age alone may underestimate malnutrition in infants in some settings. On the other hand, the difficulty of gaining optimum length in developing countries renders stunting a recommended "overall predictor of undernutrition than underweight" (Vir, 2011:52).

(b) Weight-for-height

Weight-for-height is useful in indicating the current effects on the nutritional status. It does so by determining whether weight is appropriate relative to height (Gibson, 2005:255). When W/H is low the condition is described as wasting, indicating the presence of SAM (Vir, 2011:52). Wasting is caused by deficits from the recent past in both tissue and fat mass due to conditions such as starvation, outbreaks of infectious diseases, severe disease or a combination of these factors. The high W/H on the other extreme reflects overweight. Overweight is the result of either gaining excess weight relative to height or failure to gain height in respect to weight (Gibson, 2005:255).

Weight-for-height is independent of age and therefore can be successfully used when age is not known (WHO, 2008:7). Wasting develops fast and can be reversed with prompt intervention (Gibson, 2005:255). Compared to H/A, it is more sensitive to changes in nutritional status. Seasonal, geographical and age differences in the prevalence of wasting occur and are usually associated with both variations in food supply and the prevalence of infectious diseases. Wasting prevalence is generally not as high as that of stunting in developing countries. Overweight remains the problem of the industrialised countries (Gibson, 2005:256). Poverty has also been shown to induce overweight in poor areas resulting in coexistence of stunting and overweight in the same area including the same household (WHO, 1995:1).

(c) Weight-for-age

Weight-for-age is the commonly used index that indicates body mass relative to chronological age (Gibson, 2005:254; WHO, 2008:5; WHO, 1995:170). When body mass with respect to age is low, the condition is called underweight or thinness when it is genetically influenced

(Shah & Sachdev, 2011:116). The causes of underweight could either be insufficient gain in weight relative to age or weight loss. Presence of underweight reflects both chronic and acute malnutrition and can be difficult to interpret (Shah & Sachdev, 2011:116; WHO, 2010:1). Caution should be taken not to draw incorrect conclusions concerning those short due to genetic reasons.

(d) Body mass index-for-age

The body mass index (BMI) refers to the ratio of weight to the square of height [wt(kilogram (kg))/ht^2 (meter squared, m^2)] (FAO, 2012:175; WHO, 1995: 9). BMI is increasingly used to assess body weight in adults, adolescents and children (Lee & Nieman, 2010:169,176,177; Gibson, 2005:2 45) but is not appropriate to explain body composition (Lee & Nieman, 2010:169,176,177). Body weight accounts for the total amount of protein, fat, water and bone mass in the body (Gibson, 2005:257). Body weight decreases in the presence of acute or chronic illness and in starvation. But in certain disease conditions as oedema, massive growth tumour or in cases of rapid weight loss by obese individuals, body weight assessment gets masked and therefore does not provide reliable results. Other circumstances where BMI can give false results include when a child has big muscles, head size and torso-to-leg ratio (Gibson, 2005:265).

The healthy weight of children is between $\geq 5^{th}$ and 85th percentile using 2006 WHO child growth standards. Children who fall below the 5th percentile are classified as underweight and above 85th percentile are overweight. Above 95th percentile however, they are regarded as obese. Obesity is the state where fat accumulation is excessive (Lee & Nieman, 2010:568).

(ii) Interpretation of growth indicators

The term indicator refers to the use of indices for interpretation and evaluation purposes (WHO, 1995:8; Gibson, 2005:240). Anthropometric indices can only have meaning when conveyed either as Z-scores, percentiles or percent of median which can then be used to compare a child or group of children with a reference population (WHO, 1995:7). In this section definition and use of Z-scores, percentiles, percent of median and reference data are highlighted.

(a) Z-scores

The Z-scores simply refer to standard deviation scores (WHO, 1995:7). In anthropometric interpretation, Z-scores become a deviation of individual's values from the corresponding age-specific median values of the reference population divided by the standard deviation for a population (Gibson, 2005:337). The mathematical expression is as follows (WHO, 1995:7):

$$\text{Z-score} = \frac{\text{(observed value)} - \text{(median reference value)}}{\text{standard deviation (SD) of reference population}}$$

From calculated Z-scores a normalised distribution for a population is generated. The acceptable range for the 3 growth indices (2.3.1.1) is -2 to +2 SD. Z-scores below -2 are considered stunted, wasted and weight deficient and above +2 overweight. Z-scores of > -3 SD signify severe cases. The cut-off points for public health concern are 20% for stunting, 5% for wasting and 10% for underweight (WHO, 1995:208). Use of Z-scores is preferred because it allows calculations of the mean and standard deviation for population-based applications. Z-scores are recommended in low income countries because they provide accurate calculations even in cases with indices below extreme percentiles of the reference data (Gibson, 2005:337).

(b) Percentiles

A percentile is a rank position that indicates a percentage of the group an individual score equals to or exceeds on a given reference distribution (WHO, 1995:7). For instance, a child's score that falls in the 10^{th} percentile would indicate having the same or a higher score than 10% of the reference population of children of the same age (WHO, 1995:7). Percentiles (3^{rd} or 5^{th} and 95^{th} or 97^{th}) are recommended to categorise 'unusually low', 'usual' and 'unusually high' observed anthropometric values of individuals in developed countries (Gibson, 2005: 21,336). Their easy interpretation makes them a preferred choice in clinical settings. The disadvantage however is an inability of calculating summary statistics such as means and standard deviations because the same interval of percentile values corresponds to different changes in absolute height or weight according to which part of the distribution is concerned (Gibson, 2005:336; WHO, 1995:7).

(c) Percent of median

Percent of median is the ratio of measured value in the individual for instance to the median value of the reference data for the same age or height expressed as a percentage (WHO: 1995:7). The main disadvantage of this system is the lack of exact correspondence with a fixed point of the distribution across age or height status. For example, depending on the child's age, 80% of the median W/A might be above or below -2 Z-scores; in terms of health, this would result in different classification of risk. In addition, typical cut-offs for percent of median are different for the different anthropometric indices; to approximate a cut-off of -2 Z-scores, the usual cut-off for low height-for-age is 90% and for low weight-for-height and low W/A 80%, of the median.

(d) Reference data

Reference data refer to reference or standard used to compare the indices obtained from the measured children in order to make nutritional status judgement (diagnosis) accordingly (WHO, 1995:176). Reference data is presented in the form of growth charts (growth curves). Growth charts, dating back as far as 1920s, are developed from large-scale-cross-sectional surveys done on presumably well-nourished and healthy kids (Lee & Nieman, 2010:165). Three editions of international reference data, namely, the National Centre for Health Statistics/World Health Organisation (NCHS/WHO) international Growth Reference, 2000 Centre for Disease Control (CDC) Growth Charts and the WHO new standard are explained below.

The NCHS/CDC growth charts were based on data collected between 1929 and 1975 from American children (WHO/UNICEF, 2009:3; WHO, 1995:227). The charts were recommended and adopted by WHO for international use for about 20 years (Shetty, 2005:7; WHO, 1995:227). In 1980s these charts were normalisation to include percentiles and Z-scores for interpretation of anthropometric indicators thus making them more accepted as international reference (WHO, 1995:227). The population used however, did not represent variability in ecological, geographical and biological factors and feeding mode was mainly infant formula (Vir, 2011:52; Kuczmarski *et al.*, 2000:2; WHO, 1995:227). In 1993 WHO pointed out even more limiting technical and biological challenges (Shetty, 2005:7; WHO, 1995:249). Suitability to describe the rapid and changing rate of growth in early infancy was in question as data was only collected in 3 months intervals (Vir, 2011:55). The statistical

methods used also had shortcomings. The fact that data was from two different sources also posed challenges aggravated by the use of different height measurements, length and stature (WHO, 1995:227). The reference was also silent on optimal growth as interpretation was only in terms of actual growth (Grummer-Strawn, 2002:2).

The 2000 CDC growth charts were later developed as a revised version of NCHS/WHO (Grummer-Strawn, 2002:2). Although indicators used and gender specificity were not altered, the population used was more nationally representative and the statistical methods used were also improved (Kuczmarski *et al.*, 2000:1). Among modifications made the CDC charts included BMI/A growth curves. BMI/A together with weight-for stature came with the 85th smoothed percentile. In addition all charts included 3rd and 97th smoothed percentiles. In spite of these modifications, CDC curves could only be used as a reference (actual growth) and not a standard (optimal growth).

The current set of curves, WHO Child Growth Standards (CGS), was developed for the purpose of creating a standard for a change. These standards are based on WHO Multicentre Growth Reference Study (MGRS) undertaken from 1997 to 2003 in response to limitations of NCHS/CDC curves (WHO, 2006:1). The MGRS data qualified to form a standard because data was collected from healthy children living in favourable conditions for their full genetic potential (Vir, 2011:55; WHO, 2006:1). Children from 6 countries involved were fed according to WHO recommendations and had non-smoking mothers (WHO, 2006:3; De Onis *et al.*, 2004).

2.3.1.2 Dietary status of children

Dietary status refers to the indication of whether the level of nutrients in the body is sufficient for optimal functioning and good health. Diet provides macronutrients, energy and micronutrients that are needed in proportional amounts for the proper functioning of the body. Types of food sources and amounts consumed in diets influence the dietary status of an individual. Macronutrients, carbohydrates, protein and fats are required in large amounts compared to micronutrients, vitamins and minerals.

Macronutrients, particularly carbohydrates and fats, provide our bodies with energy. However, excessive energy consumed from the diet leads to overnutrition (obesity) (Gibson, 2005:255), while restrained energy intake results in undernutrition [acute severe malnutrition (SAM)] (Vir, 2011:52). NFCS report indicates that 1 to 9 years children in rural areas including Limpopo Province had very low energy intakes (Steyn & Labadarios, 2000:226). NHANES-1 also indicated that although on average South Africans have high fat diet, people residing in rural areas have comparatively the lowest fat intake (Sishana *et al.*, 2013:171). Protein intake was generally high nationally exceeding the Recommended Dietary Allowances (RDA) of children less than 9 years old. Protein nutrition is complex therefore it also needs to be considered when diets are evaluated for quality. It is important to include complete protein in the diet. Complete protein provides all 9 essential amino acids in correct proportions as required for biological functioning of the human body (Gallagher, 2012:52). Animal protein is likely to provide complete protein but with plant protein sources, extra caution must be taken. Plant sources of protein need to be complemented, meaning, they need to be taken in such a way they provide different essential amino acids to make a complete protein. The recommended combination is inclusion of grains together with legumes (Gallagher, 2012:52; WHO/FAO/United Nations University (UNU), 2007:93). It is not compulsory however to take complementary protein sources in one meal but consuming them within a reasonable time apart (American Dietetic Association (ADA), 2009:1268; Young & Pellet, 1994:1209S). Global common micronutrient deficiencies of concern in children include that of vitamin A, folate, iron and zinc. In South Africa, Steyn and Labadarios (2000:247) reported several more (Vitamin B6, Vitamin C, riboflavin, niacin and calcium) that were consumed in approximately less than half of RDA by 50% of children. Vitamin C is important for infection resistance (Gallagher, 2012:88).

Dietary assessments are done to evaluate and ensure optimal dietary status (Lee & Nieman, 2010:69) particularly for children under 5 years of age because of their vulnerability and prompt nutritional status response to food and nutrient deprivation (Bowley *et al.*, 2007:282). Parents, guardians or caregivers act as informants during data collection however other people may also be interviewed to capture foods eaten away from home like school and friend's houses (Gibson, 2005:43; Wenhold *et al.*, 2008:447). Dietary assessments constitute a range of methods. Available methods best suitable to assess dietary status of young children are 24 hour recall, food records, food frequency questionnaire (FFQ) and diet history as well as

combinations of these methods. The summary of these methods including their strengths and weaknesses is given in Table 2.2. These dietary methods can be categorised into 2 groups, namely, daily food consumption and recalled food consumption methods (Lee & Nieman, 2010:73; Gibson, 2005:41). In daily food consumption method, data is collected through recalls and records and examples of techniques used for diet measurement are 24 hour recall and food record. Diet measurement basically provides types and quantities of foods consumed by an individual on a day. To obtain usual intakes of individuals, data is collected for more than one day (Gibson, 2005:41). Recalled food consumption method techniques on the other hand include, FFQ and diet history. Usual food and nutrient intake can be obtained using retrospective dietary assessment methods (Lee & Nieman, 2010:75).

The 24 hour recall is the method often used to assess daily food intake in nutritional surveys including longitudinal studies. The 24 hour recall is a meal-based dietary method characterised by a recall of the detailed previous day intake. A detailed description of foods and drinks consumed is reported during an interview including amount, cooking or preparation method, brand names and fat content where necessary. Amounts of foods and drinks consumed are estimated by a trained interviewer with the use of food models, household measures and in certain cases by use of photographs or charts. Food records are also meal based dietary method whereby the respondents keep a record of every food and drink that they consume for a day or up to 5 days. Respondents therefore need to have and know how to use food scales or household measures in order to accurately record intake at the point of consumption (Lee & Nieman, 2010:74). Food records are precise and provide full description of intake as recording takes place during each meal without relying on memory (Thompson & Subar, 2013:5,6; Lee & Nieman, 2010:73-75).

A FFQ is a tool with a list of food items whereby the respondent has to indicate how often (number of times per day, week, month or year) such a food item is usually consumed (Thompson and Subar, 2013:9; Lee & Nieman, 2010:76; Gibson, 2005:46-47). FFQ enables the assessment of either nutrients or energy or both (Lee & Nieman, 2010:76). Unlike 24 hour recall, FFQ requires little description of consumed food and drinks. It is only with quantitative FFQs where respondents are required to describe the consumption sizes or amounts consumed. Diet history is an extended form of a food record method in terms of content and

period (Gibson, 2005:45). It is however carried out in an interview as opposed to self-administration. It is usually used as a component of clinical assessment including ecological information, other health aspects like smoking, drinking, presence of nausea and vomiting as well as nutritional factors such as appetite (Lee & Nieman, 2010:347; Gibson, 2005:46). Dietary intake data is collected with the 24 hour recall or 3 day food record or both.

A Diet history is the only method that captures the seasonal changes efficiently and enables the assessment of meal patterns providing a broader scope of intake (Lee & Nieman, 2010:82). It captures both the usual intake and a typical diet. As with the 24 hour recall however, diet history relies on the memory of the respondent. Advantages of the 24 hour recall over the dietary history method includes, provision of more objective data, less time required for data collection and is less costly. FFQ is also inexpensive and can be self-administered without burdening the participant. Although it may fail to represent common foods or portion sizes consumed by a participant, usual intake data collected becomes more inclusive compared to that from food records.

Table 2.2 Available methods used in child dietary assessments

Technique	Type of assessment	Strengths	Weaknesses
24 hour recall	Daily food consumption	• Inexpensive, quick and easy to administer. • Based on short term memory and does not depend on the literacy level of the respondent. • Furnishes a lot of information on types of food consumed in a short time. • Not burdensome to the respondent.	• Requires a well-trained skilled interviewer. • Relies on memory, under- and over-reporting may occur. • Embarrassing foods (alcohol and desserts) and foods like condiments may be respectively deliberately or genuinely omitted rendering under estimation of energy intake.
24 hour recall	Daily food consumption	• Does not influence dietary choices.	• Data from a single day is seldom representative of usual intake. • Inability to address seasonal variation.

Table 2.2. (Continued) - Available methods used in child dietary assessments

Technique	Type of assessment	Strengths	Weaknesses
FFQ	Recalled food consumption	• Inexpensive and easy to administer. • Assesses long-term food intake. • Food intake inadequacies of any food group can be detected.	• Relies on memory. • Short-term dietary changes cannot be captured. • Food quantities may not be accurately reported.
FFQ	Recalled food consumption	• Memory is boosted by food list prompts. • May be more representative of the usual diet.	• Food list may be restricted. Calculations of food intakes may not be accurate. • Time-consuming • Combined foods may compromise intake of certain foods.
Diet history	Recalled food consumption	• Not burdensome to the respondent. • Ability to assess long term dietary habits. • Assesses usual nutrient intake. • Ability to detect seasonal changes. • Data on all nutrients can be obtained. • Can correlate well with biochemical measures.	• Interview process is long. • Requires a well-trained skilled interviewer. • Requires cooperative respondent with ability to recall usual diet. • Deliberate omission of unhealthy foods may occur. • Over-estimates of nutrient intakes may occur. • Coding is difficult.

Sources: Thompson and Subar (2013); Lee and Nieman (2010); Gibson (2005)

The 24 hour recall and food records are comparable in that they are both meal-based daily food consumption methods. Furthermore, they can both provide detailed food intake data. Food records however provide a more representative data on usual intake as they are collected over a number of days (Lee & Nieman, 2010:75). However, the 24 hour recall and FFQ are the commonly used dietary techniques in cross-sectional and intervention studies (Thompson & Subar, 2013: 20; Steyn & Labadarios, 2000:219). Feasibility in using the 24 hour recall and FFQ surpasses food record and diet history use. Both the 24 hour recall and FFQ are easy to administer with low participant burden and not limited by participant literacy (Lee & Nieman, 2010:73-75; Gibson, 2005:43). Moreover they do not alter usual diet as could be the case with recording. Recording also brings bias towards the illiterate making it a far less preferred method in developing countries (Thompson & Subar, 2013:6); Lee and Nieman, 2010: 75).

Dietary studies conducted in the Limpopo province of South Africa extensively used 24 hour recall in line with the global trend. It is the ability of the 24 hour recall to estimate nutrient intakes of population groups that make it widely used (FAO, 2004:9). The major short coming

of the 24 hour recall however is failure to measure usual intake with its single-use version. Repeated 24-hour recalls which can be used to measure usual intake require multiple dietary data collections, for example, collecting in 2 or 3 days but in non-consecutive evenly distributed days, including 1 or 2 week days and 1 week end day. Restricted resources may be a limitation however telephonic interviews may be done from 30% of the study sample. Accuracy of data collected with 24 hour recall can be improved by validating with FFQ (Hammond, 2012:140).

(i) Indicators of child dietary status

Dietary data collected from groups and individuals is evaluated for adequacy using dietary standards (Lee & Nieman, 2010:13; Gibson, 2005:197). There are a variety of available dietary standards and most of them were meant for diet planning however they are well used for dietary consumption assessment (Murray *et al.*, 2012:275; Lee & Nieman, 2010:13,14). The standards are either nutrient or food based. Nutrient-based standards are quantitative therefore allow use of reference tables for calculation of nutrient consumption. Food-based standards are qualitative, guidelines derived from health issues that are diet-related. Nutrient-based and food-based standards are highlighted.

Nutrient-based standards include Dietary Reference Intakes (DRIs) and Estimated Energy requirements (EER). DRIs comprise 4 reference intakes, namely, Estimated Average Reference (EAR), RDA, Adequate Intake (AI) and Tolerable Upper Intake Level (UL). Reference intakes can be used to assess nutrient intakes of individuals and groups with the exception of RDAs that can only be used for individuals. Adequate Intakes are observational and are used when there is no sufficient data for EAR and consequently RDAs. While EAR, RDA and AI indicate risk of nutrient deficiency, UL guards against excessive nutrient intakes. The recommendation is to use DRIs in conjunction with other nutritional methods for nutritional adequacy assessment as requirements for individuals vary even if they are in the same age group and gender. Furthermore, individuals do not have same nutrient intake every day. Nutrient-based recommendations were translated to food rather than nutrient based standards that can be understood easier by the public (Vorster, 2013:S5; Steyn *et al.*, 2006:66).

Food-based standards refer to guidelines aimed at assisting consumers in making healthy informed choices. Use of these guidelines increasingly takes precedence in both developing

and developed countries (Gibson, 2005:197). Such standards include the food guide pyramid, exchange lists and food based dietary guidelines.

(a) Food guide pyramid

Food guide pyramid (FGP) is a graphic form of communicating messages of healthy moderate eating that was developed by the United States Department of Agriculture (USDA) in 1988 (Lee & Nieman, 2010:52). Although several other countries developed their own food guide pyramids, South Africa did not. The USDA version is explained because it provides a clear guidance for a meal with a variety of foods, eating in moderation and proportionally. It portrays 5 food groups, namely, bread/cereal, vegetables, fruit, dairy products and protein-rich food. The groups are presented with suggested number of servings also enforced by the position of the particular group in the pyramid. For example, bread/cereal group is situated at the base of the pyramid suggesting that the meal's largest portion should come from this group. Conversely, foods at the tip of the pyramid should be consumed sparingly as they contain large amounts of fats, oils and sugars. A child FGP version released by USDA in 1999 was intended to assist parents in guiding food intakes of their 2 to 6 years old children. The health message remained the same as that for adults. The difference for children was the serving sizes and where possible the number of servings was a single value as opposed to ranges, based on the fact that nutrient requirements in that age group do not vary much.

FGP was revised and replaced by MyPyramid in 2005 mainly informed by 2005 Dietary Guidelines for Americans (Lee & Nieman, 2010:54). MyPyramid was developed with the intention to address American obesity problem while motivating and encouraging the users to make use of the guide system for informed healthy choices. MyPyramid also came with children's version excluding pre-school going age and younger. Child-friendly colourful graphics are used also depicting serving sizes that are specific to children. MyPyramid however, proved to be more complicated and sophisticated for the public as vertical presentation is not as clear as the previous horizontal one.

(b) Food exchange lists system

Food exchange list system is a method that was developed by the American Dietetic Association, American Diabetic Association and United States (US) Public Health service in

1950 for controlling energy intake in diabetic diets (Lee & Nieman, 2010:55; Hogbin & Hess, 2009:1209; Wheeler *et al*., 1996:1167). This method is best suited for approximation of energy and macronutrient consumption and further indicates the energy proportions from each macronutrient, fat, protein or carbohydrates (Lee & Nieman, 2010:55). Foods and beverages are arranged into 6 lists in this system according to their energy-nutrient contents. The lists include starch/grain, vegetable, fruit, meat (sub-lists include lean, medium fat and high fat), milk (with sub lists non-fat, low-fat and whole) and fat. All foods grouped together in a list basically provide the same amount (grams) of macronutrients and energy (kJ) per1portion size (Wheeler *et al*., 1996:1167). This arrangement allows free consumption of a variety of foods while controlling energy intake (Lee & Nieman, 2010:55).

(c) Food based dietary guidelines

Food based dietary guidelines (FBDG) are a useful nutrition educational tool in addressing global nutritional problems (FAO/WHO, 2004:Online). FBDGs refer to food-based instructive simple statements from scientific bodies that guide consumers on healthy eating habits with a mandate of addressing nutrition-related health problems (Vorster, 2013:S6; Lee & Nieman, 2010:36; Gibson, 2005:220). Collected dietary data can be assessed for optimal nutrition against the FBDG statements. FBDGs are most effective when informed by evidence-based nutritional challenges of that specific country however caution needs to be taken not to totally deviate from the international guidelines (Bourne *et al.*, 2007:244). South Africa responded to the 1996 international call in 1997 to develop population specific FBDGs. South African FBDGs were tailored to consider dietary changes and promote optimal nutrition of different groups of South Africans 5 years and older (Vorster, 2013:S6; Bourne *et al.*, 2007:240). Their underlying message is the promotion of diets low in fat, sugar and salt but high in fruits and vegetables with active lifestyle in line with the recommendations by DoH, SA (2003:Online). Most importantly was the further development for South African vulnerable groups including HIV/AIDS infected persons, the elderly, pregnant and lactating women as well as young children (Bourne *et al.*, 2007:241). Three age-based sets of FBDGs for children, less than 6 months, 6 to 12 months and1to 7 years, were developed.

(ii) Interpretation of food-based dietary standards

The section below attempts to explain how nutritional judgement of optimal or lack of diet adequacy is arrived at when using dietary assessment standards, FGP, exchange lists system and FBDG.

(a) Food guide pyramid

The FGP provides recommended servings in each of the 5 food groups. Collected dietary data is analysed in such a way that it reflects the number of servings consumed on average by a population and results are compared to the recommendations. Table 2.3 shows the recommended number of servings for young children. It would be likely to have nutrient and/or energy deficiencies if the food servings in respective food groups are below the given recommendations and vice versa. Intakes above the recommended servings may suggest over-nutrition.

Table 2.3 Recommended number of servings (USDA, 2009:Online)

Food group	Children 2-6 years old /day
Grain group	6 servings
Fruit group	2 servings
Vegetable group	3 servings
Meat group	2 servings
Milk group	2 servings
Fats and sweets	≤3 servings/day

(b) Food exchange list system

Food exchange list system enables the calculation of energy from consumed foods. The foods are grouped according to the respective lists and energy provided by each list is determined. Furthermore, energy sources are well traced as it becomes clear how much grams of protein, fats and carbohydrates were consumed. Energy conversions are then made to establish the kilojoules (kJ) provided by each category of macronutrient. Each gram (g) of protein and carbohydrates provides 17kJ while a fat gram gives 38kJ and that of alcohol where applicable provides 29kJ. Hints of whether the dietary intake is deficit or optima are derived from the use of recommended proportions of kJ from each macronutrient. Macronutrients in grams are expressed as a percent of total energy (%TE) intake. The conversion of grams of macronutrients to %TE is done by determining energy (kJ) using a factor of 17kJ/g of protein and of carbohydrate but 38kJ/g of fat. The energy from protein, carbohydrate and fat is added up to determine the total energy (TE). Then the energy contribution (%TE) made by each

macronutrient (carbohydrate, fat and protein) is obtained by dividing energy from each macronutrient by TE multiplied by 100. Whitney and Rolfes (2013:292) recommend that a diet per day has carbohydrate % TE of 45% to 65%, fat %TE of 20% to 35% and only protein %TE of 10% to 15%.

(c) Food based dietary guidelines

Steyn *et al.* (2006:67) evaluated whether foods and beverages consumed by South African children provide adequate macro and micro-nutrient intakes using food based dietary guidelines. They could describe the general pattern of minimal variety and low food consumption from most of the enlisted food groups. Health related guidelines for children in paediatric food based dietary guidelines (PFBDG), recommend physical activity (as with older age groups) and regular periodic clinic visits (Bourne *et al.*, 2013:241; Bowley *et al.*, 2007:287,288). The use of consumption related guidelines for young children for dietary interpretation is discussed below.

1) Encourage children to eat a variety of foods

Children who eat a variety of foods tend to continue with the practice to adulthood. This guideline can be used to judge if the diet of children has colourful fruits, dark green leafy vegetables and deep yellow vegetables in combination with foods rich in iron, such as lean meats and iron-fortified cereals.

2) Feed children 5 small meals a day

Number of meals used with other indicators gives indication of whether the child meets the expected food consumption. Traditionally, 3 small meals were emphasised however the current trend is 5 small meals per day due to the small stomach size of the child faced with high energy needs (Bowley *et al.*, 2007:283). This guideline also guards against energy rich empty nutrient foods such as sweets and crisps. Only certain dietary techniques will provide for the assessment of the number of meals with the possibility of quantities consumed per day including 24 hour recall, food record and diet history.

3) Make starchy foods the basis of a child's main meals

Evaluation of diet using this statement judges if diet has sufficient complex carbohydrates including porridge, bread, fruit and vegetables. This guideline is based on the recommendation that energy derived from consumed food should largely come from carbohydrates. Complex carbohydrates are both energy and nutrient dense foods providing more than just energy but importantly also nutrients which is not the case with simple carbohydrates (sugar, sweets and chocolates). Furthermore, complex carbohydrate foods can also be evaluated for added nutritional benefits often determined with whether they are refined or unrefined. Brown bread for example was found to provide more fibre, protein, as well as certain micronutrients like zinc compared to white bread (Steyn *et al.*, 2006:70).

4) Children need plenty of vegetables and fruit every day

High consumption of vegetables and fruit ensures sufficient intakes of micronutrients especially vitamins, A and C (Bowley *et al.*, 2007:285). Colours of vegetables and fruit such as, dark green, deep yellow orange and so on, also give an indication of the micronutrients that are supplied by the diet lack of which will indicate possible deficiency. Bowley *et al.* (2007:285) further caution against complete displacement of animal foods in favour of fruits and vegetables as malnutrition may result.

5) Children need to drink milk everyday

Milk is an important source of protein, energy and calcium and its intake is very critical in children (Bowley *et al.*, 2007:285). Poor consumption of milk will therefore indicate possible deficiency in those nutrients particularly calcium. Over-consumption of milk however will give indication of less consumption of other foods due to compromised appetite.

6) Children can eat chicken, fish, meat, eggs, beans, soya or peanut butter everyday

Protein rich food sources are found in many food groups including cereals and dairy. However, chicken fish meat and eggs provide complete, high quality protein including micronutrients such as zinc, iron and calcium as well as vitamins, A and B_{12} (Schonfeldt *et al.*, 2013:S66). This guideline therefore will help in establishing if the diet includes these foods if not the implication would be even if other protein sources are included in the diet they would be providing incomplete protein with decreased quantities of lysine and tryptophan, amino acids that cannot be made by the body. Beans, soya and peanut butter provide plant-derived protein but with nutritional benefit in that they are a good quality protein, affordable and some provide essential fatty acids (Venter *et al.*, 2013:S87).

7) If children have sweet treats or drinks, offer small amounts with meals

Added sugar in diets and foods containing a high content of sugar are not encouraged as they can lead to nutritional risks such as obesity and cardiovascular diseases (Temple & Steyn, 2013:S103). Therefore, the reported or observed evaluated diet will give an indication if the diet poses a nutritional risk or not. Judgement however should be balanced with total energy sources because if the diet lacks sufficient energy such foods may boost energy as long as they are not taken in excess (Bowley *et al.*, 2007:287). This guideline also acknowledges the problem of dental caries that can interfere with proper nutrition hence emphasis with "with meals". Sports drinks are not encouraged at all for children as they are not only high in sugar content but also contain high amounts of electrolytes.

8) Offer children clean safe water regularly

Diet assessment may include the judgement of inclusion of water as well as the type of water provided by the diet. The number of times that water is offered will reflect whether this guideline is met or not. There are now different kinds of water available. In general mineral water has high content of electrolytes and may have detrimental nutritional effect to children (Bowley *et al.*, 2007:287).

2.3.2 Health status

Health status refers to the indication of the presence or absence of illnesses, conditions and/or diseases. Awareness of the health status is, as other ecological factors, crucial in correct interpretation of nutritional assessment results (Gibson, 2005:5). Health together with adequate dietary intake are the immediate determinants of good nutrition and survival (UNICEF, 1997:3). There are a number of indicators used to determine health status of individuals including children. In children however, nutritional surveys in developing countries often focus on diarrhoea, acute respiratory tract infections (ARI) and worm infestation because they are common and are believed to contribute to the poor nutritional status of children (Yunus, 2011:276; Swart & Dhansay, 2008:419). Diarrhoea and worm infestation are greatly associated with poverty and unhygienic environments (Käferstein, 2003b:S162). ARI is also very common and fatal (Käferstein, 2003b:S163) but is likely to be induced by diarrhoea in such circumstances (Fischer Walker *et al.*, 2013:6).

Diarrhoea refers to frequent loose watery stools passed 3 or more times in a day (Decher & Krenitsky, 2012:613) but according to Yunus (2011:274) it is a sudden change of stool

consistency and its character matters than the number of stools passed. Poor sanitation, contamination of water and food as well as poor hygiene are implicated as sources of diarrhoea (Yunus, 2011:274; Swart & Dhansay, 2008:419). Diarrhoea can be life threatening due to excessive body fluids loss. Diarrhoea affects the nutritional status of affected individuals through 3 modes, lack of appetite, decreased absorption rate and increased nutrient requirements. Diarrhoea can adversely affect the linear growth in children (Kaferstein, 2003b:S163). The severe the diarrhoea the more the negative impact it has on the nutritional status (Weisz *et al.*, 2011:3). In their multi-country meta-analysis study, Checkely *et al.* (2008:823) concluded that the frequent occurrences of diarrhoea in children under 2 years of age resulted in stunting by the age of 2 years. Conversely, the degree of severity of undernutrition determines the nature of diarrhoea.

Parasite infection is another added burden common in developing countries where there is inadequate sanitation and high levels of poor hygiene (Käferstein, 2003:S162). Pre-school age children are prone to worm infestation as they are likely to play with soil. *Giardia lamblia, Ascaris lumbricoides* and *Trichuris tichiura* are amongst the common parasites often detected from children. *Giardia lamblia* causes a very common infection of the small intestine known as giardiasis (The Merck Manual of Medical Information, 1997:897). *Ascaris lumbricoides* and *Trichuris tichiura* are commonly known as intestinal roundworms resulting in infections called ascariasis and trichuriasis respectively (The Merck Manual of Medical Information, 1997:897). In South Africa there is a regular synchronised deworming programme as part of intestinal parasites management of integrated nutrition programme (INP) (DoH, SA, 2002:4). Furthermore, a policy on school based deworming programme has been developed and is being implemented. Below diarrhoea and worm infestation indicators in children are highlighted.

2.3.2.1 Diarrhoea indicators

Diarrhoea is established when 3 or more loose stools are passed in a day (Yunus, 2011:274; Swart & Dhansay, 2008:419). However, Yunus (2011:274) further states that it is the recent change in consistency and character of stools rather than the number of stools that is important. Duration of diarrhoea gives an indication of the severity of the condition. There are 3 diarrhoeal classifications, including acute, chronic and dysentery types of diarrhoea. Acute diarrhoea is mostly caused by infections and can last up to 14 days. Chronic diarrhoea

takes more than 14 days and is likely to develop from the complications of the acute diarrhoea. Malnutrition is mainly observed in this type. Dysentry is characterised by the presence of blood and abscess in the stools (Yunus, 2011:276). Dysentry including cholera and typhoid are diseases mainly associated with people from a low income class (Käferstein, 2003:S162).

2.3.2.2 Worm infestation indicators

Worm infestation is detected from clinical signs and symptoms. Location and sanitation also serve as indicators of the likelihood of being infected. In South Africa, Kirkby (1988:80) indicated that high incidences of worm infestation were in children from rural black settlements. In white areas deworming was less-cost effective because of proper housing, good water supply and good hygienic practices. Poor sanitation is a major determinant for intestinal parasites however *Trichuris trichiura* requires warm and moist climate of the tropical and subtropical regions where soil incubation of eggs can be favoured. Both Ascariasis and trichuriasis infections take place when food contaminated with eggs are swallowed. In both cases eggs are hatched in the small intestine. The difference is that with ascariasis the larvae also migrate to the lungs. Signs and symptoms of *Giardia lamblia, Ascaris lumbricoides* and *Trichuris trichiura* will be explained below.

(i) *Giardia lamblia*

Mild effects of giardiasis include nausea, flatulence, belching, abdominal cramps, voluminous foul smelling stools and diarrhoea (The Merck Manual of Medical Information, 1997:897). With severe infection, nutrient absorption gets impaired resulting in severe loss of weight. Confirmation of giardiasis is obtained through laboratory examinations of specimens such as stools and duodenum secretions. *Giardia* cysts have been isolated from various water plants in South Africa (Department of Water Affairs and Rural Forestry (DWAF), 1996:97). Infection can occur just from1*Giardia* cyst.

(ii) *Ascaris lumbricoides*

Lung infection induces fever, coughing and sneezing whereas intestinal infection abdominal causes cramps that could be accompanied by intestinal obstruction (The Merck Manual of Medical Information, 1997:897). Adult worm may also obstruct appendix biliary tract and pancreatic duct. These obstructions especially with severe infection lead to impaired nutrient absorption. Laboratory tests on stools vomit and blood can confirm the ascariasis infection. Lung infection may be detected by chest x-ray.

(iii) *Trichuris trichiura*

Symptoms of trichuriasis are only experienced on severe infection. Symptoms include abdominal cramps and diarrhoea. Persistent infection can result in intestinal bleeding, anaemia, weight loss and appendicitis (The Merck Manual of Medical Information, 1997:897). In rare cases a child may also suffer rectal prolapse. Microscopic examination of stools can detect eggs.

2.3.2.3 Interpretation of health status indicators

Interpretation of health status indicators is basically done using the clinical diagnosis coupled with laboratory tests. Indication would be presence or absence of the condition.

2.4 HOUSEHOLD FOOD SAFETY

Food safety has been a global issue of concern in the trade industry for a very long time (Taulo, 2008:13) although Unneverh (2003:Brief 1) pinpoints at the "current heightened" attention it is receiving. The revived concern can imply that the long lasting food safety challenges have not yet been resolved. Continuing to draw attention to only trade level of food safety may still fail to effectively deal with food safety challenges until control and management are considered at household level (Taulo, 2008:14; Angelillo *et al.*, 2001:162). There has been some indication that food borne incidences mainly occur in the households (De Jong *et al.*, 2008:615; Griffith & Worsfold, 1994:200).

Hazard Analysis Critical Control Point (HACCP) was established in 1960s (Griffith & Worsfold, 1994:201) at the trade level to ensure safety of food (Unneverh, 2003:Brief 1; Van Gerwen *et al.*, 1997: 1314; Griffith & Worsfold, 1994:201). Safety of foods was ensured identifying specific critical or hazardous points and put in place control measures. Each critical point gives an indication if food is safe for consumption. Where risk is suspected food is then discarded. Although hazard analysis critical control point (HACCP) application at household level has been advocated with stipulated control measures in the kitchen (Food Safety and Inspection Service (FSIS), 1998:Online; Griffith & Worsfold, 1994:203-205) there seem not have been much following on that trend. Critical points were identified as purchasing, storage, preparation, cooking, serving and handling of left-over foods (FSIS, 1998:Online; Griffith & Worsfold, 1994:203-205). What is already conceptualised with

regards to food safety risks and current indicators used to define food safety at household level will be highlighted hereafter.

2.4.1 Conceptualisation of household food safety

Food safety refers to all measures taken to ensure that food is safe for human consumption (FAO/WHO, 2004:Online). Unhygienic environment and handling of food in and around the homes have been shown to be a risk factor for the spread of infectious diseases and consequently childhood diarrhoea (Takanashi *et al.*, 2009; De Jong *et al.*, 2008; UNICEF, 1997:3). In section 2.3.2, literature showed important associations between diarrhoea, ARI and undernutrition meaning that the effects of hygiene are far reaching in terms of mortality and morbidity of children (Bloomfield, 2007:1). Hence, food safety is also a major economic burden concern as is malnutrition and health (Jevšnik *et al.*, 2008:737). A meta-analysis study conducted by Stenberg *et al.* (2008:Online) disputed a notion that kitchen hygiene practices are an important child diarrhoeal risk factor in the developing countries. They did not find any association between kitchen hygiene practices and child diarrhoea in developing countries. Takanashi *et al.* (2009:609) could not find definite association between hand-washing and diarrhoea prevalence. Unicomb, (2009:600) blames lack of consensus in food safety measurements for these inconsistencies in research findings. Hereafter will be the review of household food safety indicators.

2.4.2 Review of the current use of food safety indicators

Food safety indicators at household level have been based on the idea that the food handlers are the key to prevention and control of food safety risks (Unusan, 2007:45; Angellilo *et al.*, 2001:162). Hence, food handling and hygienic practices including food handlers' food safety knowledge as well as their attitudes have been extensively studied (Jevšnik *et al.*, 2008; Unusan, 2007; Redmond & Griffith, 2004; Wilcock *et al*., 2004; Baş *et al.*, 2004; Angelillo *et al.*, 2001; Medeiros *et al.*, 2001a; Jay *et al.*, 1999; Altekruse *et al.*, 1999; Yang *et al.*, 1998; Raab & Woodburn, 1997). As mentioned above, the challenge with food safety indicators is use of multiple variables with no effort to consolidate them to obtain a standard. Food handling practices are operationalised differently in different studies, as "practices" is a composite term encompassing various actions. The same trend applies to knowledge and perception studies. It could be correctly argued that those studies were not impacted by such a limitation because they only meant to gather information for the identification of effective

preventive interventions (Angelillo *et al.*, 2001:162). The common finding in such studies is the lack of acceptable practices and the recommendation is always educational programmes (Jevšnik *et al.*, 2008:744; Unusan, 2007:46,50; Angelillo *et al.*, 2001:166). Paradoxically, measured knowledge of food handlers does not necessarily predict practices or behaviour (Baş *et al.*, 2006:320). Possibly, the limitation in education intervention approach is that the given knowledge is not contextualised but generalised. Bloomfield (2007:3) recognises the interdependency of various factors responsible for an overall food safety risk. For instance, food handlers may be failing to link their food handling practices with long lasting detrimental effects such as growth and development of the child. Redmond and Griffith (2004:312) suggested personal relevance in messages communicated during food safety education as in their study they found that food handlers perceived low personal risk during food preparation.

Jevšnik *et al*. (2008:738,743-744) sought "to investigate the actual level of food safety knowledge and relevant practices in food handling that are responsible for shaping the mind set of consumers at home". This intention could be interpreted as aiming at establishing definite standard of food safety indicators that would indicate presence or absence of food safety risk at home. Unfortunately, they were not conclusive on clear levels of food safety knowledge and food handling practices required. Such insight could have been invaluable in determining reliable indicators in domestic food safety measurements. The establishment of reliable food safety indicators could be useful in measurements of FS according to its conceptualisation, a concern highlighted in section 2.2. The following section attempts to describe the variables used in the literature to measure food safety in the households. Food handling practices, food handling knowledge and food handlers' attitudes as well as microbial quality examinations conducted will be reviewed.

2.4.2.1 Food handling practices

Gilbert *et al.* (2007:310) define unsafe household food handling practices as the behaviour of the food handler in the kitchen that causes or aggravates a food safety risk that could have been controlled or managed to avoid such a risk. Proper food handling practices are tested directly by investigating the behaviour of food handlers when handling food or indirectly by measuring food handlers' knowledge, attitudes and perceptions as well as microbial content in domestic water, food and environment (Taulo, 2008: 33-44,65-66; Taulo *et al.*, 2008:113-

115; Gilbert *et al.*, 2007: 307, 309-311; Baş *et al.*, 2006: 319; Redmond & Griffith, 2003:133; Bloomfield, 2007:3,5-6; Beumer & Kusumaningrum, 2003:299-300; Jay *et al.*, 1999:1285).

Several studies (Gilbert *et al.*, 2007:310; Bloomfield, 2007:2) have implicated lack or improper hand-washing of food handlers. Although hand-washing is often used as an indicator for food safety risk, there are other indicators measured including dishcloth handling, cooking methods, meat and poultry thawing practices (Bloomfield, 2007:2). Usually food handling practices data is collected quantitatively by means of a questionnaire where respondents are required to indicate their practices on predetermined factors (Takanashi *et al.*, 2009; Baş *et al.*, 2006:318; Angelillo *et al.*, 2001:162. A checklist is also used to indicate whether observed practices are hygienically acceptable or not. However, self-reported hygiene practices are usually overestimated ending up not reflecting the real practices (Gilbert *et al.*, 2007:311; Wilcock *et al.*, 2004:61). Redmond and Griffith (2003:159) uphold observational measurements as more reliable than self-reporting.

2.4.2.2 Food handling knowledge, attitudes and perceptions

Food handling knowledge, attitudes and perceptions are indirect measurements of food handling practices. Food handling knowledge by food handlers is imperative for an effective control of pathogens or their toxins in food (Unusan, 2007:45; Jevšnik *et al.*, 2008:744). Attitudes and perceptions are believed to influence change of behaviour (Wilcock *et al.*, 2004:61). Consequently, food handling knowledge, attitudes and/or perceptions are often tested together with the assessment of food handling practices in food safety studies (Unusan, 2007:46; Baş *et al.*, 2006:318; Angelillo *et al.*, 2001:162; Johnson *et al.*, 1998:745). Unusan (2007:49) found a relatively low level of knowledge compared to reported food handling practices thus supporting that food safety knowledge does not always ensure good food handling practices.

Knowledge questionnaires are used to ask questions about food safety practices including possible hazards posed by pathogens that often cause foodborne illnesses. The questionnaire is designed to meet the goal of the researchers but areas of concern include foodborne illnesses, personal hygiene, cross-contamination, high risk food groups, time-temperature relationship (Baş *et al.*, 2006:318). The number of variables tested also differs across the studies. For example, Unusan (2007:48) only reported familiarity with food borne illnesses as food safety knowledge while Baş *et al.* (2006:318) had a wider scope (4 areas) on food

safety test items. Johnson *et al.* (1998:745) tested the food safety knowledge of the elderly on refrigerator settings. Socio-demographic factors such as age, gender and location were indicated as possible determinant factors of food safety knowledge (Unusan, 2007:46).

2.4.2.3 Microbiological quality indicators

Microbial quality indicators refer to the indicators that point to the level of microbial load in water or food indicating level of safety for human consumption. Microbial contamination in the kitchen has greatly been indicated as the cause of food-borne diseases (Gilbert *et al.*, 2007:311). Lack of ready access to a safe water supply and proper sanitation causes faecal contamination of food and water and consequently diarrheal incidents (Trevett *et al.*, 2005:268; Clasen & Bastable, 2003:112,113). Hence, several studies examined samples of food and water for the presence and/or numerical occurrence of pathogens indicated in household food-borne incidences (Taulo, 2008; Potgieter *et al.*, 2005; Indrawattana *et al.*, 2011). Potgieter *et al.* (2005:152) showed food safety risks in food and water consumed at Venda households that posed diarrhoeal risks. More emphasis has been put in water as a vehicle of pathogens in food however food has been shown to be even more hazardous than water (Bloomfield, 2007:3). Taulo (2008) also tested hand-washing water while Mattick *et al.* (2003:843) indicated pathogenic risks in water used to wash-up after food preparation. Taulo (2008:4) described traditional hand-washing as a common practice in developing countries of Africa where hands are washed (in the same bowl) with cold water and without soap. Other household food safety indicators have been used in other studies. For instance, Mattick *et al.* (2003:843) as well as Hilton and Austin (2000:258) cultured dish towels implicating them as a source of microbial risk. Jagals *et al.* (2013:1235) isolated *Escherichia coli* (*E. coli)* from water containers.

There has been no consensus for microorganisms that are associated with safety risks (indicator organisms) for safe consumption as is the case with water across the globe. Therefore, different countries use different food standards. Water consensus was reached because water has been regarded as the only transmitter of pathogens. General indicators used for assessment of domestic water are total counts, total coliforms, faecal coliforms, *E. coli*, enterococci (faecal Streptococci in particular), *Clostridium perfringens* (*C. perfringens*) and bacteriophages (DWAF, 1996:78). Total counts refer to heterotrophic plate counts (HPC) which measures a general content of bacteria present without giving the total bacterial population (WHO, 2011:296; DWAF, 1996:83). Total coliform bacteria refer to aerobic and

facultative anaerobic, gram-negative and non-spore forming bacilli that are basically used to indicate general hygienic quality of water (WHO, 2011: 294; DWAF, 1996: 78). Total coliform bacteria are not useful as indicators of faecal contamination (WHO, 2011:295) but just indicate potential risk of faecal contamination (South African National Standards (SANS), 2011:7). Faecal coliforms on the other side are specific indicators for faecal contamination. *E. coli* bacteria are a highly specific faecal coliforms originating from human and other warm-blooded animals. Hence they are the most preferred indicators of faecal contamination (SANS, 2011:7). Enterococci, for example faecal Streptococci, are also indicators of faecal contamination but tend to be more resistant compared to coliform bacteria therefore useful in indicating persistent or long term pollution. *C. perfringens* is part of normal human and warm blooded animals intestinal flora therefore, is also used as a faecal contamination indicator (WHO, 2011:300). The distinctive advantage of *C. perfringens* is that it can indicate previous contamination due to its highly resistant spores to disinfection processes. Bacteriophages are bacterial viruses such as coliphages (bacterial viruses that infect *E. coli* and other related species) which also indicate faecal contamination (WHO, 2011:301; DWAF, 1996:89). Use of bacteriophages as microbiological indicators however has not been popular especially in South African laboratories DWAF, 1996:79).

2.4.3 Interpretation of food safety indicators

Interpretation of food handling practices, reported and observed as well as knowledge is presented below. Certain studies report the mean responses and frequencies of practices (Takanashi *et al.*, 2009:604-608; Jevšnik *et al.*, 2008: 738-743; Angelillo *et al.*, 2001:164) while other studies use scoring approach where it is indicated that below a particular cut-off score (e.g. <50%) the results indicate failure to meet the required or acceptable standard while scores at and above that cut-off score (e.g. ≥50%) will indicate acceptable practices (Baş *et al.*, 2006: 318-319) .

For microbial quality indicator organisms are used to detect safety for human consumption. Indicator organisms are stipulated in various water quality guidelines (WHO, 2011:294-303; SANS, 2011:7; Snyder, 2006:Online; DWAF, 1996:77-109). Table 2.4 and Table 2.5 show the standard cut-off points used for the microbial quality interpretation, indicating whether the pathogenic load in water or food per millilitre (ml) or g (respectively) is acceptable for human consumption. Any faecal contamination in the food or water chain is of health concern (Trevett *et al.*, 2005:259). When a numerical count of bacterial colony forming units (cfu) in

100ml of tested sample exceeds the cut-off point, it is indicative of health risk upon human consumption. The higher the concentration of cfu the greater the health risks (SANS, 2011:7). The measure of central tendency for bacterial counts is usually reported in terms of logarithmic distribution (DWAF 1996:79). The geometric mean in that case becomes the same as the median in principle therefore either can be used. Qualitative reporting (presence or absence) can also be done especially for organisms indicating faecal pollution as their mere presence is not acceptable.

Table 2.4 Cut-off points of indicator organisms

Indicator organism	Cut-off point (cfu/100ml or g)
Water	
Total count	≤100
Total coliforms	≤5
Faecal coliforms	0
E. coli	0
Streptococci	≤5
Food	
Salmonella	0
Liseria	0
Coliforms	≤5
E. coli	0

Sources: WHO (2011:294-303); SANS (2011:7); Potgieter *et al.* (2005:152); DWAF (1996:86-92)

2.5 SUMMARY

This chapter reviewed literature regarding the conceptualisation of FS, how it is measured currently including international and local measurement approaches. The focus of FS assessments evolved from macro (national measurements) to micro (household and individual measurement), a move that was thought to be effective in the reduction of malnutrition especially as observed in children under 5 years of age.

There are 4 dimensions of HFS including food availability, food accessibility, utilisation and malnutrition. Each dimension has its own determinants and measureable parameters. Methods used for each dimension in the literature and interpretation of results were also reviewed. There has been a debate about the effective way of measuring HFS resulting in the use of subjective (qualitative) measurements where households or individual report their experiences of food (in)security. It has been a concern that the measurements do not measure food safety that can very much play a role in inhibiting good nutrition or health despite food accessibility.

Nutritional and health status of children were also reviewed with emphasis on their conceptualisation and methods used to measure them including their interpretation. Nutritional surveys that examine the nutritional status of children especially in developing countries employ anthropometric, dietary and biochemical methods. For anthropometric methods growth indicators, stunting, wasting, underweight and BMI/A are mostly used and results are interpreted in terms of Z-scores.

Dietary methods are many and are categorised into nutrient and food based categories. The latter category is mostly used for the public including the food guides, dietary guidelines and exchange lists. All these methods were initially meant to help with meal planning but they are also used for evaluation of diets. Interpretation could be in terms of meeting the recommended number of servings consumed per day, diet matching the health statements from dietary guidelines or comparing energy consumption and its proportions as contributed by macronutrients in the diet.

For biochemical method, static tests are often done to particularly assess vitamin A, vitamin C and iron as these are micronutrients of concern in children less than 5 years of age. Health status of children associated with infection is usually assessed through upper tract respiratory infection, diarrhoea and worm infestation. Diarrhoea and worm infestation were further studied for measurement and their interpretation as they are associated with food safety.

Food safety literature also indicated conceptualisation of food safety and the methods used to measure food safety. As with FS, it has been of concern that much work to ensure food safety is at trade or supply level instead of concentrating at household level. However, there have been many studies that measured household food safety including handling practices, knowledge of food hazards, attitudes and perceptions of food safety. In some cases food and water samples are examined in the laboratory to check the microbial quality of food and water consumed. Microbial load is tested against standards that give an indication of whether there is safety in human consumption of those.

There are established associations between FS, nutritional and health status of children as well as food safety. Each variable affects the rest of variables. The global challenge in resolving health public concerns results from the difficulty to collate measurements due to their complexity and number of measurements even just for a single variable. This difficulty has been a limiting factor in operationalising the definition of FS during its measurements. Otherwise the definition of FS does capture all these variables (nutritional status, health status and food safety). The measurements so far lack food safety. Hence, some researchers advocate for the inclusion of food safety indicators in measurements of FS because interventions done based on FS results may overlook the presence or severity of poor utilisation of food resulting from unsafe food consumption.

3.1 INTRODUCTION

The aim of the study was to develop food safety indicators of HFS in rural Vhembe District, Limpopo Province, South Africa. In this chapter the ethical considerations, study design, study population, measurements, training of field workers, pilot study, procedures, statistical analysis and problems encountered will be described.

3.2 ETHICAL CONSIDERATIONS

The proposal was approved by the Ethics Committee of the Faculty of Health Sciences, University of Free State (ETOVS NR 73/2010). Requisition letters for approval to conduct the study at Vhembe District Thulamela municipality, were sent to the provincial Department of Health, Thulamela municipality and Tribal Authority offices in the study area. The content of the letters included the purpose of the study, objectives and procedures to be followed while conducting the study. Approval letters were obtained from DoH and Vhembe District Municipality offices (Appendices 1a & 1b respectively). The crèches in the study area were visited to request permission to conduct the study as they were planned to serve as meeting and recruitment places for the study as well as collecting data on the children such as anthropometric measurements. The study purpose, objectives and what was to be done at the crèches with regards to the study were explained to the crèche personnel. Letters of approval from the stakeholders mentioned above (Appendices 1a & 1b) were presented to the crèche personnel as evidence. Crèche personnel as well as tribal authorities consented orally and therefore there was no documentation. Five tribal authority offices required study proposal presentations in the presence of either tribal officials (2 cases) or the entire community (3 cases). In all presentations given, attendees (everybody) present were given an opportunity to ask questions, seek clarity or give a comment. The presentation was well received in all such meetings. Consent forms (Appendix 2), to obtain written confirmation from the respondents for participation in the study, were developed in English and translated into Tshivenda and Xitsonga languages. The forms included a section that explained in details the purpose and methods of the study. These consent forms were administered to the respondents and willing respondents were required to sign them. Decisions of the respondents whether to participate or not in the study were respected and confidentiality was kept. Respondents who wished to pull out of the study were kindly advised of the negative impact that the study may suffer but those who insisted their withdrawal (13%) were released without any form of intimidation

(Appendix 2). Assent forms for children (Appendix 3) were also administered. Children were also given an opportunity to make an informed decision whether they would feel comfortable partaking in the study. The study was explained to the children using lay language and pictures so that they could understand what was to happen. Permission was confirmed with thumb prints.

3.3 STUDY DESIGN

A quantitative cross-sectional study design was used.

3.4 STUDY POPULATION

3.4.1 Target population

The target population were households with a 3 to 5 years child residing in Thulamela Local Municipality (Thulamela) of the Vhembe District in the Limpopo Province.

3.4.2 Study area

The study was carried out in Thulamela one of the 4 local municipalities of Vhembe District in the Limpopo Province (Appendix 4a). Vhembe District is mainly rural (1.1% urban) covering 25 597km^2 in the northern part of the Province, sharing borders through the Limpopo river valley with Zimbabwe and Botswana in the north-west as well as Mozambique in the south-east through Kruger National Park (Statistics South Africa (StatsSA), 2011; Thulamela Integrated Development Plan (IDP) Review, 2008/2009). Demographics of the district indicate a population of 1 294 722 at 0.78% growth per annum, 335 226 households and an employment rate of 38.7%. The main commercial sectors in this district are agriculture, mining and tourism (StatsSA, 2011).

Thulamela (Appendix 4b) constitutes about 23% (5 843km^2) of the district geographic land. There are 2 towns within the municipality, Thohoyandou (one of the 3 main towns in the district) and Malamulele and therefore the communities at close proximity to these towns are rather developed compared to those that are far. Thohoyandou is the centre for political, administrative and commercial activities in the municipality Thulamela IDP (2012/2013:1). In 2011 the total population registered 618 462 in 2011 with annual growth rate of 0.62% and 156 594 households (StatsSA, 2011). In terms of population, Thulamela does not only have the largest number inhabitants amongst Vhembe District local municipalities but in Limpopo Province as a whole (Thulamela IDP, 2012/2013:1).

Figure 3.1 graphically presents the demographics of Thulamela against those of Vhembe district. In spite of its dense population, Thulamela only claims 19% of the district's geographic area. Limpopo Spatial Development Framework Review (LSDF, 2007:26) explains that in most cases where there are formal townships, the population is high because the townships compensate through economic use of the available land. The growth rate is extremely high, and is only 0.16% lower than that of the whole district. The unemployment rate (43.8%) exceeds that of the district (37.5%).

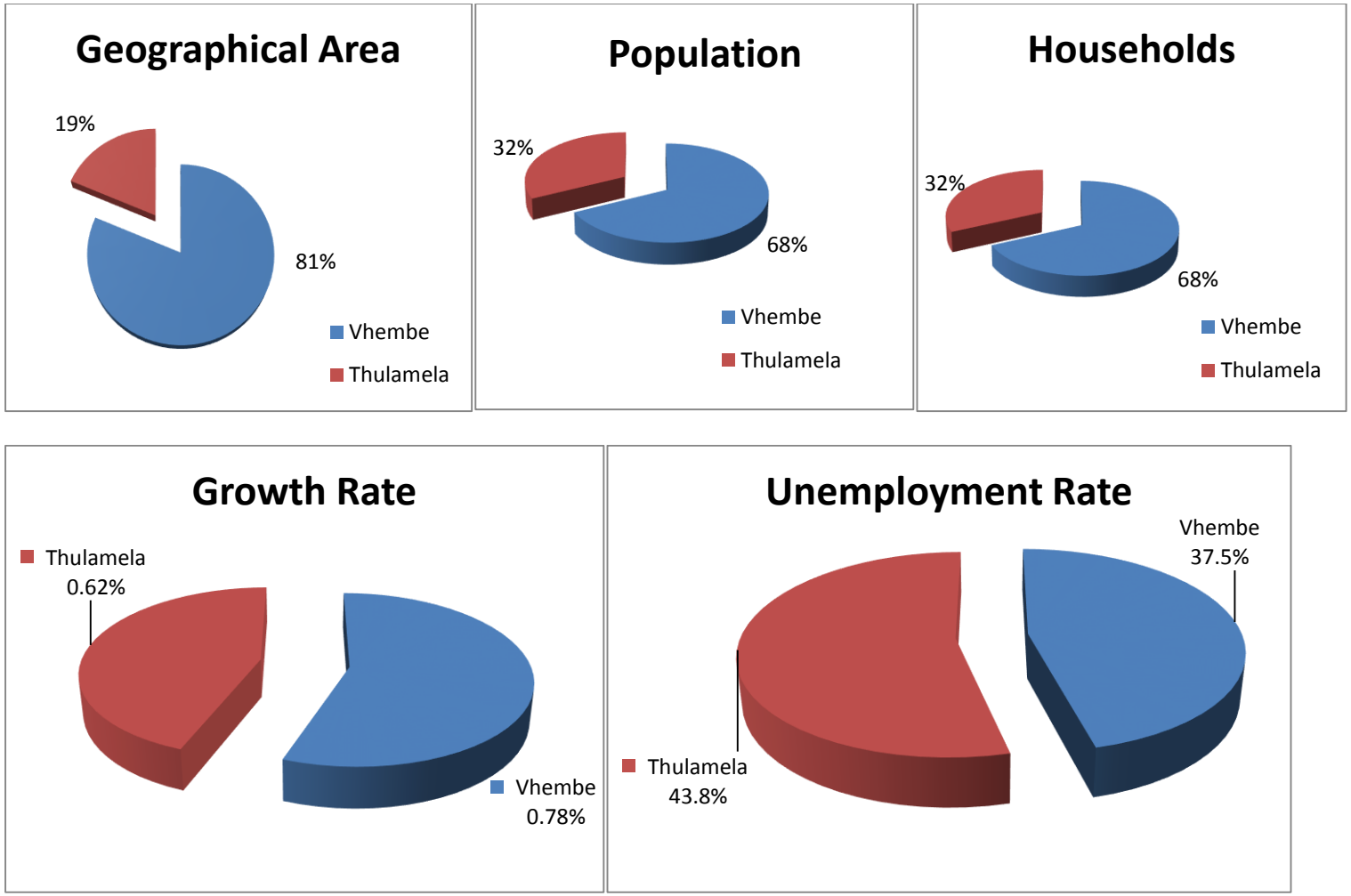


Figure 3.1 Graphical presentation of the demographics of Thulamela against that of Vhembe District with respect to geographic area, population, household number, growth and unemployment rate (StatsSA, 2012; Thulamela IDP review, 2008/2009; Thulamela IDP review, 2012/2013; LSDF, 2007).

3.4.3 Inclusion criteria

Households with at least one child aged 3 to 5 years and a caregiver were considered for inclusion in the study. The caregiver was any person from the age of 18 years including a mother who was responsible for food planning and preparation for the child. For the purpose of this study the caregiver was the respondent. Both the respondent and the head of the household (where different from the respondent) signed a consent form (Appendix 2) before the onset of data collection.

3.4.4 Sampling frame

Sampling frame is a list of elements from which the first stage of sampling occurs such as households or villages. The sampling frame in this study was the village level. There were 299 villages identified in Thulamela. A village is defined as a cluster of Thulamela households. Village names were obtained from the Municipal Demarcation Board of South Africa (MDBSA, 2007:Online).

3.4.5 Sample size calculation

The sample size for the household survey within Thulamela was determined using a standard statistical formula. The following formula was used to calculate sample size:

$$n = \frac{Z^2 * p(1-p)}{c^2}$$

where Z is standard normal variable associated with a given alpha value (e.g. $\alpha = 0.05$), p is the estimate of the proportion of population that belong to one of the two categories (for example, the YES and NO category), c is the confidence interval expressed as a decimal.

For the purpose of the current survey, an alpha of 5% or confidence interval of 95% was chosen. The p value was assumed to be 0.5 which is a worst case scenario and requires the maximum sample size. A $p = 0.5$ is recommended for sample size calculations. The confidence interval (expressed as a percentage) was chosen to be 5%. Using the formula above, the sample size (n) or number of households required to achieve the desired level of confidence for the current survey was 384. It should however be noted that a number of variables or characteristics of the households (such as total number and proportion of households owning land, total number

and proportion of households with an income, and so on) were considered in the current survey. Therefore, sample size in the current survey had to be considered an approximation rather than an exact number. The sample size of 384 was assumed to be valid to allow for using the sample statistics as unbiased estimates of population parameters and therefore appropriate for decision making. For practical purposes the figure of 384 was adjusted or rounded up to 400.

3.4.6 Sampling

Figure 3.2 shows the sampling plan of the study. There were 299 identified villages in Thulamela. A multi-stage sampling was done by the Department of Biostatistics of the University of Free State to select villages, 400 households for the survey and stool collection as well as 30% (guided by proportionate sampling to ensure inclusion of small villages while providing for possible attrition) of those selected households (120) for food and water sample collection. The first sampling stage was a random selection of 32 Thulamela villages (10%). A household represented the basic sampling unit in this survey. Proportional sampling (second sampling stage) was done to select study households where a number of households sampled per each village was determined by the size of the respective village.

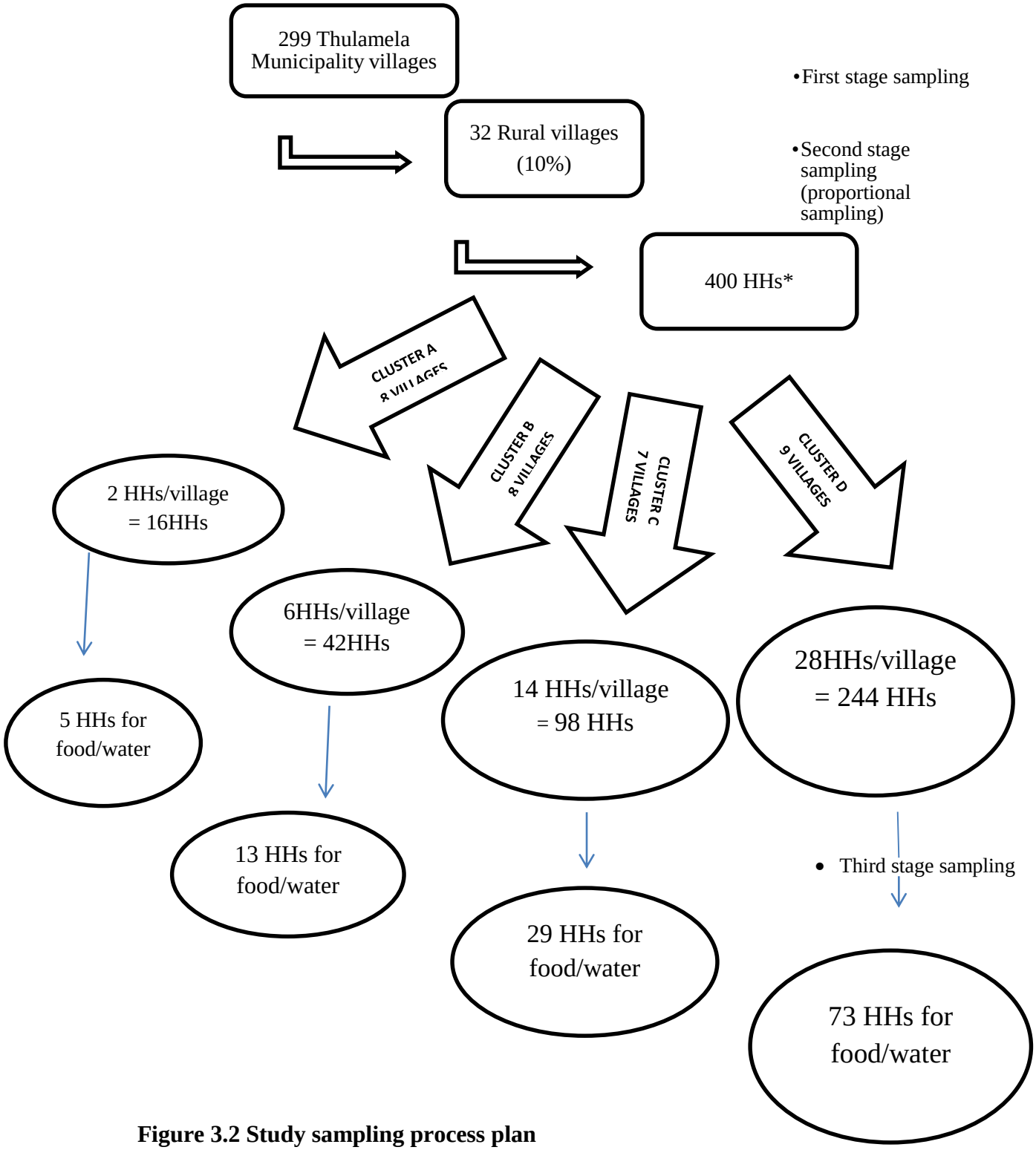


Figure 3.2 Study sampling process plan

*HHs refers to households

Villages were categorised into 4 clusters (A, B, C and D) for sampling purposes according to their sizes (Table 3.1). Village population and household numbers data was sourced from LSDF (2007:Online). Cluster A, comprised the smallest villages with populations ranging from 97 to 378. The number of households in cluster A ranged from 18 to 72. Cluster B had population range of 512 to 1253 with households numbering from 99 to 241. Cluster C's population was from 1329 to 2030 with households ranging from 255 to 389. The biggest villages with population range of 2532 to 9496 and household range of 486 to 1822 were under cluster D. The number of households sampled from clusters A, B, C and D were 2, 6, 14 and 28 respectively.

Table 3.1 Clustering of sampled villages

Village clusters	Number of sampled villages	Number of household sampled/village	Village population range	household range
A	8	2	97-378	18-72
B	8	6	512-1253	99-241
C	7	14	1329-2030	255-389
D	9	28	2532-9496	486-1822

Lwamondo was found to be a compound village registered as stand-alone together with its sub-villages (Thondoni from cluster A and Lwamondo, Makambe and Mutandani from cluster C) during village allocation. This discovery implied that Lwamondo alone would have a total sample of 44 households (A = 2 households; C = 14 x 3 households). Adjustments had to be made. Lwamondo then qualified as a cluster D village because the total number of households considering all the given names (721) corresponded with cluster D range. The number of households had to be reduced to 28 following the criteria used for the respective cluster to maintain the proportional sampling. Adjustments had to be done to reduce sampled households to 28 following the criteria used for the respective cluster to maintain the proportional sampling. This adjustment (44-28 =16 and 400-16 = 384) reduced the sample size from 400 to 384. The study villages were also reduced to 29 as 4 villages were now combined. The resultant figure for the total sample size after adjustments were made was 384 which was the same as the calculated sample size.

Third stage sampling was done to select 120 (30%) households for the collection of food and water samples. Proportional sampling was again used to determine the number of households

from which collection should be done per cluster of villages. Five (4.2%), 13 (10.8%), 29 (24.2%) and 73 (60.8%) households were considered from Clusters A, B, C and D respectively (Table 3.2).

Table 3.2 Number of sampled households per cluster of village for food and water samples

Village clusters	No. of sampled households	%
A	5	4.2
B	13	10.8
C	29	24.2
D	73	60.8

Recruitment of participating households was done in local crèches. Caregivers were invited to crèches. The study was explained and a simple random sampling approach was used to select the respondents and therefore the study households. Selected households were then later on visited for data collection. The respondent was a caregiver. Each time the respondent failed to give certain information with regards to household like in the case of the child-minder, the head of the household provided the required information. All children included in the study attended crèches. Where there was more than1child within the identified age group in a household and attending a crèche, simple random selection was used to select1of the children.

3.5 MEASUREMENTS

Operational definitions, techniques as well as validity and reliability will be described.

3.5.1 Operational definitions

The variables that were measured in this study included HFS, nutritional and health status of children as well as household food safety.

3.5.1.1 Household food security indicators

Household food security with respect to this study referred to objective and subjective availability and accessibility of food in the households as well as usual food consumption by households. Nutritional and health status of children will be regarded as indirect indication of HFS.

(i) Availability and accessibility of food in the households

Availability and accessibility of food in the households referred to quantitative HFS indicators including, home food production, household income, HFS support received, food purchasing behaviour, food available in the household and a qualitative indicator, a self-reported hunger prevalence (Table 3.3).

Home food production referred to land ownership, its use for food production and agricultural knowledge. Household income referred to source of income and estimated collective amount earned per month in the household. HFS support received referred to food aid donations from the government and non-governmental organisations (NGOs) as well as any other form or kind of assistance received elsewhere (like from the community or relatives). Food purchasing behaviour referred to the frequency of buying food, ability to afford socially acceptable foods (foods regarded by the community as proper for human consumption) and the form of buying such as credits, debts, loans and battering. Foods available in the households referred to foods that were in the possession of the households at the day of the data collection. Hunger prevalence referred to the hunger experiences of the household.

Table 3.3 Indicators of household food availability and accessibility

VARIABLE	INDICATOR
Home food production	• Land for home production • Use of land • Agricultural knowledge
Household income	• Source • Estimated amount earned per month
HFS support	• External resources received - Governmental and NGOs - Elsewhere (Community and relatives)
Purchasing behaviour	• Frequency of buying food • Social acceptability of foods that can be afforded • Form of food acquisition (Credits/debts/loans/ battering)
Food available in the households	• Foods available in the household at the day of data collection.
Hunger prevalence	• Hunger experiences

(ii) Usual household food consumption

Usual food consumption referred to the foods frequently consumed (at least once a month) in the households, according to 8 food groups, including starchy foods, protein rich foods, fruit, vegetables, milk and dairy, salt, sugar and fats/oils. Use of 8 food groups was adapted from the criterion used to determine food consumption score (FAO, 2008b:3). The foods available in the households were expressed in percentages, according to the food groups.

(iii) Nutritional and health status of children (3-5 years old)

(a) Nutritional status

Nutritional status referred to anthropometric and dietary status of children 3 to 5 years old.

1) Anthropometric status referred to the status of the children in terms of weight-for-age (wasting), height-for-age (stunting), weight- for-height (underweight) and Body Mass index for age (BMI-for- age) (overweight), according to the WHO standards (2006:Online) as stipulated in Table 3.4.

Table 3.4. Classification and Interpretation of Z-scores (WHO, 2006:Online)

Z-score	Classifications	Interpretation
Below -3 SD	Very low W/A; W/H; H/A	Severe underweight/ wasting/ stunting
Between below -2 SD and -3SD	Low W/A; W/H; H/A	Moderate underweight/ wasting/ stunting
Between -2SD and +2SD	Normal	Normal
Between above +2SD and +3SD	High W/A; W/H; H/A	High weight/ height
Above +3SD	Very high W/A; W/H; H/A	Very high weight/ height

2) Dietary status referred to dietary intake of children 3 to 5 years old, including usual daily energy and macronutrient intakes as well as usual daily food intake.

(i) Usual energy intake referred to the total energy intake in kJ, calculated from total daily protein (g), carbohydrate (g) and fat (g) intake. Usual daily macronutrient intake referred to the total intake of carbohydrates, proteins and fats according to food exchange system. Macronutrients in grams were expressed as a percent (%) of total energy intake. Usual macronutrient intakes less than recommended percentages were considered inadequate, an intake within the recommended percentages was considered adequate and an intake above the recommended percentage was considered high as indicated in Table 3.5.

Table 3.5. Macronutrient intake expressed as percentage (%) of total energy intake for children (Whitney & Rolfes, 2013:292)

Nutrient	Low	Within	High
Protein	<10%	10-15%	>15%
Carbohydrate	<45%	45-65%	>65%
Fat	<20%	20-35%	>35%

(ii) The usual food intake was expressed as the number of servings consumed from each group by children per day according to food guide pyramid (FGP) for young children (Table 3.6) (USDA, 2009:Online).

Table 3.6. Food consumption adequacy using FGP for young children (USDA, 2009:Online)

Food group	Children 2-6 years old /day
Grain group	6 servings
Fruit group	2 servings
Vegetable group	3 servings
Meat group	2 servings
Milk group	2 servings
Fats and sweets	≤3 servings/day

(b) Health status of children

Health status of children referred to the incidence of diarrhoea and worm infestation amongst children 3 to 5 years as reported by the respondents. Diarrhoea is defined as loose or watery stools passed 3 or more times in 24 hours day (Decher & Krenitsky, 2012:613) and sudden change in consistency of stools (Yunus, 2011:274). Presence of blood indicates the severity of the condition (dysentery) (Yunus, 2011:276). In this study diarrhoea referred to more than 3 loose stools passed in a 24-hour period. Worm infestation referred to number of times the child has been infested in the past 4 weeks as reported by the respondent as well as the presence of worms in stools as detected by microbiological assays.

3.5.1.2 Household food safety indicators

Household food safety indicators for this study referred to food handling practices, food handling knowledge, microbial quality of foods and water consumed in the household as well as microbial content of water used for communal hand-washing before meals.

(i) Appropriate food handling practices by a food preparer referred to hand-washing behaviour of the respondent, cleaning of preparation surfaces and eating utensils, storage and thawing methods of raw meat/poultry/fish, as well as handling practices of leftover foods. The

impact of each practice was determined by using a 5 point rating scale (1 = never to 5 = always) (Baş *et al.*, 2006:318).

(ii) Food handling knowledge of the food preparer referred to knowledge of food preparers on the importance of personal hygiene, kitchen environmental hygiene and food hygiene during food preparation as well as practices that can prevent food contamination and bacterial growth. Respondents were regarded knowledgeable if they obtained a score of 50% and above from the given test (Baş *et al.*, 2006:318).

(iii) Microbial content of water consumed in households referred to counts of coliforms, faecal coliforms and faecal Streptococci detected in water from sources (taps or tanks) and storage containers within the households. Minimum microbial count that was regarded safe was <100cfu/100ml, 5 cfu/100ml for coliforms and 0 cfu/100ml for faecal Streptococci and faecal coliforms (WHO, 2011:294-303; SANS, 2011:7; Snyder, 2006:Online; Potgieter *et al.*, 2005:153; DWAF, 1996:77-109).

(iv) Microbial quality of water used for hand-washing before meals referred to counts of coliforms, faecal coliforms and faecal Streptococci detected in water used by family members (communal bowl hand-washing water) to wash their hands before they eat. Minimum microbial count that was regarded safe was <100cfu/100ml, 5 cfu/100ml for coliforms and 0 cfu/100ml for faecal Streptococci and faecal coliforms (WHO, 2011:294-303; SANS, 2011:7; Taulo, 2008:36; Snyder, 2006:Online; Potgieter *et al.*, 2005:153; DWAF, 1996:77-109).

(v) Microbial quality of foods consumed in households referred to counts of *Salmonella, Listeria monocytogenes* (*L. monocytogenes*) (*Listeria*), coliforms and *E coli* detected in cooked animal protein rich food items and in *vhuswa*. Only *vhuswa* and accompanying animal protein source were collected from each household. Both fresh and left-over *vhuswa* were collected where available. Left-over was of interest because microbial count was expected to be high as it is often stored for 2 days at room temperature before consumption (Potgieter *et al.*, 2005:151). Other foods were excluded because reimbursement for the collected food and analysis could have been too expensive and therefore would have compromised the feasibility of the study. Food was regarded as safe when bacterial count of *Salmonella, L. monocytogenes,*

and *E. coli* is zero colony forming units (cfu/100g) (WHO, 2011:294-303; SANS, 2011:7; Snyder, 2006:Online; DWAF, 1996:77-109). Coliform bacteria count should not exceed 5cfu/100g.

(a) Animal protein rich foods were chosen because of being high risk foods likely to be consumed in the households.
(b) *Vhuswa* was selected because it is the main source of energy (staple food) and is the most frequently consumed food item in the diets of Vhavenda (Vorster *et al.*, 1994:9).
(c) Left-over *vhuswa* was selected because it is a common practice in the study area to eat it the following day (personal observation; Potgieter *et al*., 2005:151).

3.5.1.3 The contribution of food safety in household food security

The contribution of food safety on HFS referred to the impact of household food safety indicators on HFS. The impact referred to the association between HFS and food safety.

3.5.2 Techniques

The information was collected by means of an interview, using a structured interview schedule as well as anthropometrical and laboratory techniques.

3.5.2.1 Interview and interview schedule

The interview schedule consisted of questionnaires and data/record sheets that were completed during an interview with the respondent of each household. The questionnaires included closed and open ended questions and an observation checklist (Appendix 5). Five equally trained (Training manual – Appendix 6) field workers participated in all types of data collection. They visited the households, conducted interviews with the respondents and filled in the questionnaires themselves. The approach of field workers filling the questionnaires themselves was decided upon because of the anticipated literacy level of the respondents. The questionnaires were developed in English and were translated to Tshivenda and Xitsonga and back translated from Tshivenda and Xitsonga to English by two different people independently from University of Venda Dictionary Unit to ensure that translated questionnaires to the Tshivenda version had not lost intended meaning. Tshivenda, which is the local language, was used during interviews to ensure collection of accurate information. Responses were recorded in English.

The interview schedule consisted of the following10 questionnaires and data/record sheets:

Section 1: Socio-demographic questionnaire (Appendix 5 section 1) included general questions regarding the social characteristics of the respondent and the household that are associated with food and nutrition security.

Section 2: Food availability and access questionnaire (Appendix 5 section 2) was used to obtain data on availability and access of food in households. The questions were developed based on the literature (HSRC, 2006:4-14; Hahn, 2000:6; Labadarios *et al.*, 2000:492; Gross *et al.*, 2000:6; Frankenberger, 1992:89; FANTA, 2003:4). An expert in nutrition evaluated the questionnaire for content validity.

Section 3: A food inventory record sheet (Appendix 5 section 3) was used to collect data on available food present in households at the time of interviews. The form was adapted from the NFCS study (Labadarios *et al.*, 2000:969). Food inventory record sheet comprised a list of food items that were likely to be consumed in the study area. The researchers indicated which foods were available in the household, the place where they were stored and recorded their amounts in kilograms or litres. An expert in nutrition evaluated the questionnaire for content validity.

Section 4: An 8-item hunger scale questionnaire (Appendix 5 section 4) was adopted to measure hunger experienced in households (NFCS, 1999:637). NFCS (Gericke *et al.*, 2000:636-664) used this scale to assess hunger in South African children, therefore inclusive of the population in this study. Hunger prevalence responses were scored out of 8. In the absence of any "yes" answers, a 0 (zero) score was allocated and that implied everybody in the household was food secure. One to 4 "Yes" scores were interpreted as at risk while 5 to 8 "yes" scores meant food insecure.

Section 5: A food frequency questionnaire (FFQ) was used (Appendix 5 section 5) to determine usual dietary intake of Households and foods normally consumed in the area. The respondents were asked to indicate whether, the listed foods were consumed in their households, and if so how often. Frequency was recorded as per day, per week or per month accordingly. Foods usually consumed in the households were compared to the relevant statements from FBDG for South Africa (DoH, SA 2002:Online) (Appendix 7) to determine sufficiency in consumption of dietary quality foods in the households.

Section 6: A single 24 hour recall (Appendix 5 section 6) was used to collect data on dietary intake of the children. The 24 hour recall was used in combination with household FFQ in an attempt to improve the reliability of the information of the one 24 h reacall. Food models and kitchen utensils were used during data collection for amount consumed

estimation to increase the accuracy of portion sizes. Food exchange system was used for estimation of the number of servings and for calculation of dietary energy in foods consumed by children as collected by the 24 hour recall. The number of servings consumed by children per food group were compared with food guide pyramid for children to ascertain (in) adequate number of servings. The number of servings per food item consumed were derived from the food portion sizes reportedly consumed by children. Macronutrient intake of children was expressed as percentage of total energy intake, (in) adequacy was determined by comparing with recommended standards for children (Whiteny & Rolfes, 2013:292) (Appendix 8).

Section 7: Food handling practices questionnaire (Appendix 5 section 7) was used to collect data on food handling practices. The section had 2 parts (1 & 2). Part 1 comprised self-reporting on food handling practices while part 2 was an observation checklist on food handling practices. The questionnaire was developed based on literature regarding food hygiene and food handling practices (Taulo, 2008:9; Gilbert *et al.*, 2007:310-311; Beumer & Kusumaningrum, 2003:300; Jay *et al.*, 1999: 1285). An expert evaluated the instrument for content validity. For part 2, an observer (fieldworker) visited the household approximately 2 hours prior to lunch hour to observe food handling practices of the respondent guided by the checklist and ticked on the checklist appropriately.

Section 8: A food handling knowledge test questionnaire (Appendix 5 section 8) was used to assess the knowledge of respondents on food handling. Questions were formulated based on literature (Taulo, 2008:29; Baş *et al.*, 2006:318). Nutrition and microbiology experts evaluated the instrument for content validity. Eight negatively formed items (7, 8, 9, 11, 12, 16, 19 and 20) from 24 self-reporting food handling practices questions were reversed (1=4; 2=3; 3=2 and 4=1) to maintain the meaning of scoring 0-4 being never to always. Percentages were then calculated from the total of 96. Households with mean scores of and above 50% (score of 43) were regarded as having good or acceptable food handling practices while those with mean score below 50% were not practicing proper food handling. Appendix 9 shows the memorandum.

Section 9: Child health status questionnaire (Appendix 5 section 9) was developed by the researcher based on the objectives of the study. Literature on the effects of consuming infected food on child health status (Petri *et al.*, 2008:1279; Potgieter, 2005:Online; Potgieter *et al.*, 2005:21-50; Beumer and Kusumaningrum, 2003:300-301) informed the development of the questionnaire. Two health experts (nursing and nutrition) evaluated the instrument for content validity.

Section 10: Record sheets (Appendix 5 section 10) were developed for field workers to note the anthropometric measurements and the biological test results for the food and water samples type of stool sample as well as the presence of worm infestation.

3.5.2.2 Anthropometry

Anthropometric measurements, including weights and heights of children 3 to 5 years old, were taken by the same 5 trained fieldworkers who conducted interviews and the researcher. Standard weight and height measurements were used, according to Lee and Nieman (2010:165-168) as described below. A record sheet (Appendix 5 section 10) was used to capture readings. Dates of birth were taken from the children's Road to Health clinic cards.

(i) Weight Measurements

Weight measurements were taken with calibrated solar scales placed on a flat or level surface. Children stood on the middle of the scale with minimal clothing, bare foot and without touching anything.

(ii) Height Measurements

A calibrated stadiometer was used for height measurements. Each child stood on the stadiometer with bare feet, heels together, arms on sides, legs straight, shoulders relaxed and head in the Frankfort horizontal plane. Children were asked to inhale deeply just before the measurement was taken, hold the breath and maintain the straight posture.

Three measures to the nearest 0.01kg and 0.1centimetre (cm) for weight and height respectively were taken and the average of the nearest two was recorded in the form (Appendix 5 section 10A).

3.5.2.3 Biological sample

Biological tests were conducted on food, water and stools to determine microbial quality of food and water as well as worm infestation from the stools of the children. All 5 trained field workers collected the samples into separate cooler boxes according to the sample type (food, water or stool) and were transported kept on ice by an overnight courier to the University of Free State laboratory for analysis. Sample collection procedures and laboratory tests were followed as indicated in the protocol.

(i) Sample collection

Food samples of fresh porridge, left-over porridge and animal protein rich food were collected. Each household was requested to provide 150g to 200g of each of the required food sample. The samples were collected in sterile Ziploc bags by the field workers using ladles (or equivalent) used by food preparers and immediately placed in a cooler box with ice (4-10^{0}C). The temperature of porridge samples varied as they were collected at different times since preparation. Fresh porridge meant preparation was the same day of collection. Left-over porridge samples were from porridges prepared the previous day. Animal protein rich food was any type of food in that category available in the household. The collected samples were chicken, meat and eggs.

Water samples (≥100ml) from usually used sources (either pipe or a storage container) for consumption were collected from each household. Similarly, 100ml of water samples used for washing hands before meals were collected from bowls, commonly used for that purpose in the households, after members of the family washed their hands before meals. Water samples were collected using the household used jug or cup and poured into a sterile Ziploc bag which was doubly sealed and placed on ice in the cooler boxes (4-10^{0}C).

Stool samples (4-10g) were collected from children 3 to 5 years old for infestation assessment. Stool amount and consistency were recorded (Appendix 5 section 10E). Prior to collection the field worker wore disposable latex gloves. The stool sample was collected into a wide-mouthed sterile plastic container. In case of loose stools a plastic disposable transfer pipette for liquid stools was used. The collected specimen was put into a cooler box with ice (4-10^{0}C) until it was taken to a cold storage.

(ii) Laboratory tests

(a) Isolation and identification of bacteria from food and water samples

Food and water samples were collected from 114 Households. Total coliforms and *Salmonella spp* were indicators used to evaluate the microbial quality in food samples but for protein rich food *Salmonella* species (*spp*), *Listeria (L) monocytogenes (Listeria),* coliforms and *E. coli* were tested. Water quality was evaluated with total viable counts, total coliforms, faecal coliforms and Streptococci as indicators.

Table 3.7 shows selective agar used to enumerate presumptive pathogens and their identification. For the detection of *Salmonella spp* from food samples, a pre-enrichment broth, peptone water [Oxoid, Basingstoke, United Kingdom (UK)] was poured into a sterile Whirl Pak bag (Nasco, USA). Sterile metal thongs were used to position each sample in a sterile bag in such a way that it is entirely covered with the broth. Each sample was rubbed through the bag for 1 minute to suspend surface residue in the buffered peptone water (Oxoid). Tenfold dilution in buffered peptone water (Oxoid) was prepared. Sample (0.1 ml) was transferred to Rappaport-Vassiliadis Soya Peptone Broth (Oxoid) (Ogonowski *et al.*, 1984:250) and incubated at 42^0C for 24 hours. After incubation, the enrichment broth (0.1ml) was streaked on to Xylose lysine deoxycholate (XLD) agar and incubated at 37^0C for 24 hours for the isolation of *Salmonella spp*. Colonies that were big and red with black centres were identified and subjected to biochemical tests for confirmation.

For the detection of *Listeria*, similar procedures as with *Salmonella spp* were followed but instead of using buffered peptone water (Oxoid), the University of Vermont *Listeria* enrichment broth (Oxoid) supplemented with *Listeria* primary selective supplement enrichment (UVM I) (Oxoid) was used. A sample (0.1 ml) of the pre-enrichment broth after incubation was transferred into 10 ml Fraser Broth (Oxoid) supplemented with Fraser supplement (Oxoid) and incubated at 35°C for 24 h. The enrichment broth was streaked onto *Listeria* selective agar base (Oxford formulation) supplemented with *Listeria* selective supplement (Oxford formulation) (Oxoid) and incubated at 30°C for another 48 hours (Dykes *et al.*, 1994:521). Presumptive *Listeria* (isolates showing a dark brown colour change on the agar) were selected from plates and purified on Tryptone soya agar (Oxoid) with 0.3% yeast extract (Merck) (Dykes *et al.*, 1994:521). Presumptive isolates were then evaluated for tumbling motility at 20°C (International Commission on Microbiological Specification for Foods (ICMSF), 1990:Online). Colonies that showed tumbling motility were identified to species level as described by Skovgaard and Morgen (1988).

For total viable bacteria, similar procedures were followed as with the detection of *Samonella spp*. Spread plating was done onto Plate Count Agar (PCA) plates and incubated for 48hrs at 28^oC. Procedures for counting were performed as described above. For coliforms Violet Red Bile (VRB-MUG) Agar (Oxoid) was used and incubation was at 37^oC for 24 hours. For *E. coli*,

coliform colonies with deep red halos selected from VRB-MUG Agar (Oxoid) were confirmed as *E. coli* type 1 based on the IMViC test (Harrigan and McCance, 1966:94). Typical *E. coli* type 1 species were characterised by the Eijkman (+), indole (+), methyl red (+), Voges-Proskauer (-) and citrate (-) tests (Harrigan and McCance, 1966). Feacal *Streptoccocci* was cultured on KF-Streptococcus agar for 48 hours at 37^0C. Pink to red colonies were presumed feacal *Streptoccocci*.

Table 3.7. Selective agar used for the enumeration of the presumptive pathogens and the description of colonies of each pathogen

Microorganism	Selective agar	Description of colonies
Salmonella spp.	*XLD agar	Transparent, sometimes black-centered
L. monocytogenes	Rapid' L. Mono agar (Bio-rad, France)	Green- blue colonies
Total counts	PCA	White to yellow colonies
Coliforms	*VRB-Mug agar	Red to dark red
E. coli	*VRB-Mug agar	Pink to dark red colonies, fluorescence under UV
Fecal coliforms	MF-c agar	Blue colour at 45^OC
Streptoccocci	KF-Streptococcus agar	pink to red colonies

* Media from (Biolab, Germany)

(b) Identification of parasites in stool samples

A technician at the University of Free State, Medical Microbiology Department laboratory conducted the tests. Direct smear microscopic examinations of stool samples were done for detection of *Ascaris lumbricoides*, *Trichuris trichiura* and *Giardia lamblia* using normal saline (0.9% sodium chloride solution) (WHO, 1991:Online). Slides were examined at 10X and 40X objectives. Consistency and colour of stools including the observed presence of blood or mucus were noted.

3.5.3 Validity and reliability

Validity refers to the quality of instruments used in terms of appropriateness, meaningfulness, correctness and usefulness of the inferences made by the researcher (Fraenkel & Wallen, 2006:150). Leedy and Ormrod (2013:31) define validity as an extent to which the instrument measures what it is supposed to measure. Reliability refers to the consistency of results obtained irrespective of the change of the administrator or instrument intended to measure the same entity (Fraenkel & Wallen, 2006:157; Leedy & Ormrod, 2013:31).

3.5.3.1 Validity

Both internal and external validity were considered in the design of the study and during the execution of the research protocol. Development of the questionnaire was based on literature. Some sections of the questionnaire were adopted/adapted from other studies (Labadarios *et al.*, 2009; Food Insecurity and Vulnerability Information and Mapping (FIVIMS), 2005; Gericke *et al.*, 2000; Labadarios *et al.*, 2000; Assuming Health for All in the Free State (AHA FS), 2007; Malnutrition and Enteric Diseases Study (Mal-Ed), unpublished) conducted in the same or similar context. Experts in nutrition, nursing and microbiology fields evaluated the questionnaire for content validity. The questionnaire was translated to the local language in the Tshivenda dictionary unit, University of Venda. Back translation was done to test whether it would have same meaning as the original English version.

An attempt to validate the dietary intake of children collected with a single 24 hour recall was made. Foods reported to have been consumed by a child in the previous 24 hours were compared with foods reportedly consumed at home from household FFQ. Discrepancies were determined and noted. Discrepancies were cases whereby a child was reported to have eaten a food item that was never consumed at home.

3.5.3.2 Reliability

The design of the study considered several controls to ensure the reliability of the study. Data was collected cross-sectionally to minimise risks that could be introduced by multiple measurements over time. Although assessments were done by different people, training was provided to reduce errors that could be introduced by this practice. Furthermore, all assessments carried out were objective to avoid subjectivity or bias.

A representative sample was sought through use of sample frame work, calculation of sample size and multi-staged random sampling. Although possible attrition was taken into consideration and the calculated sample size (384) was increased to 400, at the end of the study 335 households remained in the study. Besides attrition, the number of respondents was also reduced by a misinformed number of villages in Thulamela hence adjustments had to be made reducing the targeted 400 households to 384 (see more details in section 3.4.6). Considering the reduced number of targeted households against the actual number which participated,

legitimate inferences can still be done. Multiple measurements done for each objective of this study also contribute towards high degree of reliability of results.

Reproducibility of the 24 hour recall for usual intake estimates of the children was compromised by doing a single 24 hour recall. A single 24 hour recall does not give true reflection of habitual intake but rather gives estimates of actual intake (Gibson, 2005: 130-131). Reproducibility is strengthened by increased number of measurements. In this study, apart from the 24 hour recall mentioned above, two other dietary assessments were done including food frequency and food inventory. The 24 hour recall was used together with household FFQ as an attempt to improve accuracy of usual intake estimates of children as stated by Hammond (2012:140). The household FFQ data confirmed the data of the 24 hour recall except for few cases. Those cases could have been influenced by the foods that were consumed by children at the crèches.

3.6 TRAINING OF FIELD WORKERS AND RESPONSIBILITIES OF THE RESEARCHER

3.6.1 Training of field workers

The field workers were trained by the researcher. Five nutrition graduates assisted in data collection as field workers. They all had experience in data collection for nutrition-related studies. The training manual (Appendix 6) compiled by the researcher was used in the training process. All field workers were trained for collection of all data that was needed for the study. Training was done for 2 weeks at the University of Venda. Thereafter, bi-weekly meetings for the first month after the commencement of data collection were held to discuss any field work challenges. Refresher training was offered every 2 months during the period of data collection (interviews). Practices on taking anthropometric measurements were conducted at the University model pre-school 4 times. Retraining for a particular field worker was done when data collected by a same fieldworker during revisits was not consistent.

3.6.2 The responsibilities of a researcher

The researcher was responsible for fieldworkers, instruments, data collection and ensuring quality of data. Specific duties of the researcher are highlighted below.

3.6.2.1 Field workers

The researcher recruited and trained field workers on how to fill in the questionnaires and record sheets as well as weighing children. The researcher also trained field workers on having respondents to consent and how to fill in the consent and assent forms.

3.6.2.2 Instruments

The researcher was responsible for the development of questionnaires, forms and record sheets that were needed for the study. Testing and amendment of instruments was also the responsibility of the researcher.

3.6.2.3 Data collection

The researcher had to ensure appointments with the respondents and respective officials and set up visiting schedules. Transportation of the field workers as well as collecting data with the field workers was the responsibility of the researcher. The researcher had to attend to all challenges encountered during data collection.

3.6.2.4 Quality assurance of the data

The researcher supervised field workers to ensure that they adhere to proper methods. The researcher checked the completion of questionnaires and forms the same day when coming from the field and ensured that any errors found are corrected within the reasonable time. Correct coding was also the responsibility of the researcher.

3.7 PILOT STUDY

Pilot study was done in 13 households at Mbilwi village, which was a similar context, to test the instrument for correctness and ease of understanding by the respondents and further train the research assistants in the use of the instrument (questionnaire) in the real setting. Mbilwi is a Thulamela municipality village that was not selected during the sample random of study villages. This means this village also stood a chance to be selected for this study.

There were 4 field workers at the time of pilot study. Each field worker visited 3 households and the researcher visited one household. Field workers and the researcher assembled in one point that could be regarded as the centre of the village. Each fieldworker went a different direction and entered the 5^{th} household. The researcher went with one field worker and visited

the first qualifying household while the field worker proceeded to the 5th household at home but were attending crèches. Some of the respondents (3) were not found in their homes and were followed at nearby schools where they were working as food vendors. Arrangements were made that when going home they go with a respective fieldworker for interviews. Response rate was 100%. The questions were well understood by the respondents. It was discovered at this time that caregivers are not necessarily women. This discovery helped adjustment of the main study criteria that formerly defined caregivers as women. Other outcomes of the pilot study included:

- Field workers themselves realising that they asked certain questions differently although respondents answered the questions well.
- Time taken to complete a questionnaire was on average 1 hour 30 minutes. This observation prompted a decision to add one more field worker to assist in data collection looking at the magnitude of the work and the remoteness of some of the study areas.
- Subsequently a 5th field worker, with nutrition degree as well, was recruited. The change helped in expediting the data collection process
- Training for the new field worker was offered by the researcher for 3 days. Thereafter the new field worker joined all the activities that were done by other field workers. Two days were dedicated for all field workers to practice more on their own to ensure that they understood and asked the questions the same. Anthropometric practice was done at the University of Venda model pre-school.
- Household sampling plan was the systematic random sampling however lack of structures in the villages encouraged the change to crèche recruitment. The change could have biased against the households with children of the age of interest who were attending crèche, although chances were very slim to find a child who was not attending crèche.
- The intention was to have three nutritional assessment methods, anthropometry, dietary (2 different methods) and biochemical. Biochemical assessments could not be proceeded with due to technical problems encountered in the laboratory. Although this deviation could have strengthened the study, the results of the two nutritional assessments that were done sufficed.
- Two 24 hour recalls were planned however a single collection was done due to remoteness of some villages (considering cost attached to the exercise) as well as comprehensiveness of the study. Travelling expenses threatened the budgeted because of

several unplanned multiple visits that had to be taken due to unforeseen reasons. Use of telephone was tried but could not work properly as there was no reception in most of the study area.

3.8 DATA COLLECTION PROCEDURES

Data collection procedures will be presented in this section including procedures followed when collecting data and deviations from the protocol.

All field workers and the researcher visited the same village(s) at the same time but each field worker collected data alone in at least 2 households per day of visit. In the case of small villages (where 2 or 4 households were required) more than one village would be visited at the same time. Prior to the household visit day, sampling and appointments were done from the crèche meetings where contact details of respondents were collected. Anthropometric measurements of children were taken on the day of crèche meeting because all children were there and the likelihood was not to find them at home during home visits due to crèche attendance. Respondents were again called on their phones to confirm the visit and get household directions.

On the day of household visits, field workers conducted interviews at the homes of the respondents. Interview schedules were filled by the field workers. For food inventory, fieldworkers requested to go to the kitchen with the respondent to record the foods available in the household. In certain cases respondents opted to bring the food to the field worker rather than the proposed way. That was admissible but fieldworkers had to probe to make sure they captured all available foods as much as possible although that could not be established.

The 5 field workers also observed food handling practices prior and during meal preparation guided by the checklist (Appendix 5, section 7) the same day interviews were done. Where food was not yet prepared the field workers requested that the preparation be done. Whenever the request was turned down (for example some respondents would indicate that they only cook for supper) time was rearranged except for places that were extremely far. In such cases the observations could not be carried out.

Upon arrival from the field, the fieldworkers checked and cleaned the data they collected. Once a week cross-checking was done whereby field workers checked each other's filled questionnaire and recorded all queries in the presence of the researcher. Agreed upon queries were attended by the respective field worker and corrected. Where error was found, the field worker had to go back to the household or to call the respondent depending on the nature of the error to redo the data collection.

Field workers were also responsible for biological sample collection. Although all households were visited for stool collection, food and water samples were collected at the same time but only from households sampled for that purpose (section 3.4.6). The researcher created schedules for sample collection visits. Such schedules were separate from the interview visits because the questionnaire was long and took almost an hour per household and field workers had to clean the data, mainly dietary, collected upon arrival at the researcher's office. Field workers also prepared samples for their transportation to the University of Free State after collection.

3.9 STATISTICAL ANALYSIS

After extensive checking of computerised data, all data was statistically analysed by the Department of Biostatistics, University of Free State using Statistical Analysis Software (SAS) version 9.2. Anthropometric data were analysed using WHO Anthro Plus (version 3.2.2). The 24 hour recall was analysed using the Food Finder III computer programme version 1.1.3 (South African Medical research Council (MRC), 2002). Continuous data was described using mean and standard deviations (symmetric distributions) or median, lower and upper quartiles (skew distributions) as well as minimum and maximum values. Frequencies and percentages were used to describe categorical data. Associations between variables were assessed using chi-squared tests or Fisher's exact tests in the case of small numbers. Food safety variables found to be significantly associated with specific HFS variables on univariate analysis were considered for inclusion in the logistic regression model, with stepwise selection of variables.

3.10 PROBLEMS ENCOUNTERED DURING THE STUDY

Five problems were encountered during the execution of the study namely location failure of a sampled village, household sampling, data collection difficulties and problems with the transportation of biological samples.

3.10.1 Failure to locate a sampled village

The first problem encountered was to locate Miluwana village which belonged to the sampling cluster D where 28 households had to be sampled. Replacement was done with Tshisaulu village which was selected by a random sampling from the same cluster.

3.10.2 Village sampling

Secondly was the incorrect identification of Lwamondo village as 4 villages, resultantly misleading calculation of total sample size. Adjustments had to be done (see details in section 3.3.5) reducing the total sample size from 400 to 384 households and cutting down on the number of households in Lwamondo from 44 to 28. These changes are not expected to affect the representation of the study population as 400 was an inflated figure nonetheless.

3.10.3 Household sampling

The third problem was about household sampling (second sampling stage). The protocol sampling design was to do systematic random sampling in villages to get households for participation. However, after preliminary studies, crèche recruitment was thought to be the best over household visits for recruitment for two reasons. Firstly, village structures were not easy to follow for sampling purposes. Most of the villages were not structured and stand numbers did not follow order, meaning two numbers next to each other were not necessarily in a chronological order, making systematic sampling difficult even when using a registration list from tribal authority offices. Secondly, in certain study areas, employment of caregivers or domestic workers was not a common practice, preschool children were taken care of at crèches when the parent(s) are at work and houses remained locked. Therefore availability of respondents at their homes would have been a challenge if recruitment was done from households. Probability sampling (simple random) was done in crèches as children were randomly selected in the presence of teachers and parents/caregivers. Parent/caregivers' contact details were obtained from crèches and they were contacted to make an appointment at

the crèches. The appointment was at the same time for all parents and caregivers. The explanation of the study and participant selection were done at the crèches.

Recruitment from crèches rather than households biased the children of the same age group who did not attend crèches. It was however quite a small proportion of children of this age group who do not attend crèches as crèche attendance is a requirement for school commencement nowadays. Negative effect on the reliability of the study was therefore not anticipated because the total sample size catered for attrition. The number of participated children was assumed to be still representative of the population.

Crèche recruitment exposed all possible respondents to the recruitment process which was fine, but the challenge was when some parents/caregivers did not understand why they were excluded from the study even after explaining why selection had to be done and sampling was done in their presence. 2 cases who could not be convinced otherwise were also included in the study to avoid strained relationship with the community. This addition disturbed the proportional sampling planned however it was not expected to negatively affect the reliability of the study instead to help in cases of attrition.

The other challenge with crèche attendance is the bias of dietary contribution on children nutritional and health status of children as it did not reflect only what children could access from the Households. All children attended crèches and had up to 2 meals from their respective crèches. Results of the study, the relationship between food security, nutritional and health status of children as well as food safety impact on the food security, could be confounded by crèche meals in two different ways. Firstly crèche meals could be boosting children' nutritional status while FS is very low at home. Secondly, improper food handling practices at crèche could negatively affect the nutritional and health status of children. Therefore the results of this study should be interpreted with caution.

3.10.4 Data collection difficulties

There were respondent-induced difficulties during data collection that led to both reduced number of respondents and missing data from others who did not withdraw from the study but

could not supply all required data. An interesting observation was made that Tshivenda speaking respondents were quite difficult to work with although they consented participating in the study compared to Xitsonga speaking respondents who were instead very much welcoming. Failure to collect all data in just one visit made matters worse as in subsequent visits some respondents decided to withdraw from the study. In cases of withdrawals the researcher visited the respondents and explained the importance of continuing being in the study but without coercion. Some respondents changed their minds while some could not be convinced. There were 37 respondents in total (9%) who withdrew from the study. Loss of respondents disturbs the planned sampling design especially if probability sampling was intended. The final sample size fell below (9%) the calculated sample size that would give optimum representation of the targeted population. The impact of this loss on the reliability of the results was minimised by the use of multiple measurements to collect data for all objectives.

Completing food inventories was not always well received. Some respondents were reluctant to open their food storage places. Fulkerson *et al.* (2008) stated that this challenge is due to respondents viewing the act as invasion of their privacy. Again an extra effort had to be made to explain the need to do so. Some preferred to bring food items to the fieldworkers and did not allow them in their food storage places. In such cases fieldworkers had to ensure that all foods present in the household were taken out. Probing was used to ask if a particular food item was not bought when purchasing groceries and whether such an item was finished or was still available. Ultimately food inventory was successfully done in all households.

The most difficult part of data collection was the stool collection and, to some extent, food sample collection. In some instances several (4-5) visits had to be made for stool collection and sometimes with no avail. This difficulty could have been induced by superstitious belief that make people reluctant to give bodily specimen in fear of being bewitched. The other contribution towards attrition and limited data collected was the mobility of children (7 cases). Four children, who were taken care of by their grandparents, left to join their parents in other provinces (mainly Gauteng). Eleven children were found to have visited other relatives at the time of data collection. One case was a hospitalised child and therefore stool sample could not be collected. There were 312 instead of 335 (93%) stool samples that were analysed. With food samples, in some instances we had to plead for the food preparation to be done and explain again the importance of conducting the study and therefore the importance of collecting the

food samples. Multiple visits had huge financial implications on the study but adequate useable samples were obtained.

3.10.5 Transportation of biological samples

Biological samples (food, water and stools) had to be transported to the University of Free State for laboratory analysis. The same overnight courier was used for all the transportation done. Packaging was reported by the laboratory personnel not to have secured all water samples well as some of the sample packages leaked. Consequently, some samples that were suspected to have been contaminated by leaked water had to be discarded adding loss to those that leaked. The faulty packaging therefore resulted in the reduction of water samples for analysis. The number of samples aimed at was 120 for each category, stored water, tap water and hand-washing water. The number of eventually analysed stored, tap and hand-washing water samples were 111(92.5%), 20 (17%), 114 (95%) respectively. The low number of tap water did not only result from packaging loss but also from the fact that most households did not have taps. Unfortunately it could not be traced how much loss for tap water but for stored water percentage loss was 7.5% while that of hand-washing was 5%. Tap water was eventually not considered for analysis. Loss of less than 10% of water was considered preferable to having contaminated water included in the analysis because that would have risked the credibility of results.

Thus, despite the problems encountered, adequate, reliable data could be collected to meet the objectives and aim of the study.

4.1 INTRODUCTION

The aim of this study was to develop food safety indicators in HFS in the rural Vhembe District, Limpopo Province, South Africa. The development of food safety indicators was to be achieved through measurements of HFS, nutritional and health status of the children (3-5 years of age) and household food safety as well as the effect of household food safety on the HFS. The results will be described in the following order: demographic and households' profile, HFS, household food safety, the relationship between household food safety and HFS, the relationship between household food safety indicators and the development of household food safety indicators in rural HFS.

4.2 DEMOGRAPHIC AND HOUSEHOLDS' PROFILE

The final targeted number of households (sample size) for this study was 384 instead of 400 (see section 3.8.2) and the response rate was 87% (335 of 384 households). The targeted number of households that were to provide biological samples was 30% of the sample size (115 of 335 households). The response rate for biological samples was 99% (114 of 115 households).

Table 4.1 shows the demographic profile of the caregivers. Caregivers will also be referred to as respondents in the text. The majority of the respondents (58.5%) were biological mothers of the children followed by grandmothers (26%). Of the 335 respondents, 57.3% were married and 26.9% were single. Most respondents (57%) were between the ages of 26 and 50 years, with about 22% younger than 26 years and 22% older than 50 years old. Most respondents (89%) had attended school with 36.4% up to grade 11, 12 or equivalent while only 6.3% obtained tertiary education. Many of the respondents (76.7%) were not employed.

Table 4.1 Demographic profile of caregivers (n=335)

Characteristic	n	%
Relationship of caregiver to child		
Mother	196	58.5
Sibling	9	2.7
Grandmother	87	26.0
Guardian	1	0.3
Child-minder	5	1.5
Father	4	1.2
Step-mother	1	0.3
Cousin	2	0.6
Aunt	30	8.9
Marital status		
Single	90	26.9
Married	192	57.3
Separated	13	3.9
Divorced	17	5.0
Widowed	23	6.9
Age (years)		
18 – 20	7	2.1
21 – 25	66	19.7
26 – 30	59	17.6
31 – 35	54	16.1
36 – 40	37	11.0
41 – 45	19	5.7
45 – 50	22	6.6
51 – 55	25	7.5
56 +	46	13.7
Highest level of formal education		
None	37	11.0
≤ grade 7	59	17.6
grade 8-10	96	28.7
Grade 11-12 or equivalent	122	36.4
Tertiary Education	21	6.3
Employment		
Working	78	23.3
Not working	257	76.7
Place of employment		
Self-employed	44	13.1
Private sector	19	5.7
Public sector	15	4.5

Table 4.2 indicates the profile of the households that participated in the study. The heads of the households were mainly one of the grandparents (58.2%) and fathers (35.2%). Most households (51.9%) had relatively small family sizes (≤5 members), followed by households with 6 to 7 members (27.7%) and more than 7 per household (16.9%). Most households (77.3%) had few (either1or 2) children between the ages 1 to 9 years of age. Most of the households (66.9%) had family members who were migrant workers (that is they worked far from home). There were either 1 (43.4%), 2 (14.7%), 3 (6.0%), 4 (1.5%) or more (1.2%) migrant workers per household. Some of the households (56.7%) were financially supported by migrant workers and mainly (40.3%) on a monthly basis.

Table 4.2 The households' profile (n=335)

Characteristic	n	%
Household head to child relation		
Grandfather	93	27.8
Grandmother	102	30.4
Father	118	35.2
Mother	13	3.9
Aunt	5	1.5
Uncle	4	1.2
Family size		
Two	8	2.4
Three	37	11.0
Four	54	16.1
Five	75	22.4
Six	45	13.4
Seven	48	14.3
Eight	29	8.7
Nine	14	4.2
Ten	13	3.9
More than ten	12	3.6
No. of children 1-9 years old		
One	141	42.1
Two	118	35.2
Three	46	13.7
Four	22	6.6
Five	5	1.5
Six	2	0.6
Seven	1	0.3
Are there migrant workers in the family?		
Yes	224	66.9
No	111	33.1
No. of family migrant workers (n=334)		
None	111	33.2
One	145	43.4
Two	49	14.7
Three	20	6.0
Four	5	1.5
Five and more	4	1.2
Financial support from family migrant workers		
Yes	190	56.7
No	145	43.3
Frequency of receiving money from the family migrant worker		
None	145	43.3
Once a year	3	0.9
Every few months	52	15.5
Monthly	135	40.3

4.3 HOUSEHOLD FOOD SECURITY

The results of household food availability and accessibility, a comparison of food availability and accessibility indicators, usual food consumption and the nutritional and health status of children will be described.

4.3.1 **Household food availability and accessibility**

The availability and accessibility of food will be explained by household food production, household income, HFS support received by households, purchasing behaviour, food available and occurrence of hunger in the households.

4.3.1.1 Household food production

Table 4.3 shows results of household food production. Almost all the households (97%) indicated that they owned land for food production. Of those who owned land, 98.8% used it for home vegetable gardens, while 41.8%, 30.2% and 1.2% used it as cultivated field, for keeping livestock and as orchards respectively. However, only 21.5% of these households had at least one family member with agricultural knowledge. There were many households (78.5%) that had no family member with formal agricultural education. Only 19.5% had some kind of formal agricultural education (13.9% high school and 5.6% tertiary levels). Some family members with agricultural knowledge (41.7%) learned to grow vegetables informally from experience of working in other houses' gardens.

Table 4.3 Household food production (n = 335)

Parameter	n	%
Land ownership for food production		
Yes	325	97.0
No	10	3.0
Type of land use (n =325)*		
Home garden	321	98.8
Orchard	4	1.2
Field for cultivation	136	41.8
Livestock production	98	30.2
Family member with agricultural knowledge		
Yes	72	21.5
No	263	78.5
Source of that agricultural training (n=72)		
No formal education	27	37.5
Formal education (High school level)	10	13.9
Formal education (tertiary level)	4	5.6
Experience from working in other houses' gardens	30	41.7
Greenery project training	1	1.2

*percentages do not amount to 100% because of multiple responses.

4.3.1.2 Household income

Household income is described in terms of the source and amount that the households received monthly. Table 4.4 shows that the national social development grant was the most common

source of household income (89%) followed by wages 41.2% and salaries 39.7%. Households that received wages or salaries additional to other sources were 246 (73.4%). Households that had no salary or wage as an income source were 89 (26.6%). Households that had salary only as an income source were 21(6.3%). Very few respondents sold their livestock (4.2%) and/or crops (3.6%) for income. The highest monthly household income of above R3000.00 was reported by 20.6% of the respondents. Many of the households (41.8%) had a monthly income range of R1000.00 to R2000.00, while 25.1% earned between R2000.00 and R3000.00 per month.

Table 4.4 Household income (n =335)

Parameter	n	%
Source of household income*		
Salary#	133	39.7
Wage#	138	41.2
Pension	127	37.9
National social development grant	298	89.0
Selling livestock	14	4.2
Selling crop produce	12	3.6
Range of monthly household income		
<R1000	42	12.5
≥R1000 – R2000	140	41.8
>R2000 – R3000	84	25.1
> R3000	69	20.6

*percentages do not amount to 100% because of multiple responses. # Households that had no salary or wage as source of income were 89 (26.6%). #Households with only salary or wage were 21 (6.3%).

4.3.1.3 HFS support received by households

HFS support received by households was in the form of donations. Table 4.5 indicates that only 16 households (4.8%) received donations. Donations refer to the help received by households from either government or non-governmental organisations (NGOs) to boost their HFS status. The majority of households (95.2%) were not receiving any of such benefits. However, some kind of help from other sources like the community or relatives was received by 105 households (31.3%), leaving 230 (68.7%) not receiving any kind of support at all. Of the 105 households (31.3%) which received some kind of support 58.1% received the support in the form of cash, 40.9% in the form of food and 1.0% received material needs.

Table 4.5 HFS support received by households (n =335)

Support received by households	n	%
Received donations*	16	4.8
No donations received	319	95.2
Any other source[#] of support received	105	31.3
No kind of support received	230	68.7
Form/kind of support received (n = 105)		
Cash	61	58.1
Food	43	40.9
Material needs	1	1.0

*Source of assistance could be governmental, humanitarian organisation/NGO.
[#] Any other source of assistance received could be from the community or relatives.

4.3.1.4 Household purchasing behaviour

Table 4.6 shows that the majority of the households (97.9%) could afford buying socially acceptable foods (foods regarded by the community as proper for human consumption). Although 2.1% indicated inability to afford socially acceptable foods, only 0.9% was actually consuming foods that were not socially acceptable.

All respondents indicated that they do get food from their home gardens. Home gardens are at the back of their yards or small plots that are used to grow small scale cereals mainly maize and vegetables such as tomatoes, cabbages, spinach and some wild vegetables. Other mostly used sources of food were local shops (99.1%), hawkers (64.5%) and fields (41.8%). Fields are relatively bigger plots away from the home and used for a bigger cultivation scale. Crops grown in these fields may not differ from those in the home gardens but those commonly grown in fields are maize and ground nuts. Home livestock was only owned by 2.4% and 0.3% benefited from community greenery projects launched by the government to improve FS. Livestock included cattle, goats and chickens.

Almost all households (99.7%) purchased food by cash. However, loans were also resorted to either from the shops (26.6%) or from other people (17.6%). Frequency of food purchasing was measured to establish affordability to buy food. Households buying food once a month or when the food is critically needed were interpreted as not affording to buy sufficient food for the household members and those that could buy food more than once as households affording to provide sufficient food. Most households (70.2%) could only buy food once per month or when food was critically necessary.

Table 4.6 Household purchasing behaviour (n = 335)

Parameter	n	%
Household affords buying food socially regarded edible for human consumption		
Yes	328	97.9
No	7	2.1
Household consume food not socially regarded proper for human consumption		
Yes	3	0.9
No	332	99.1
Source where food is acquired*		
Shops/spazas	332	99.1
Hawkers	216	64.5
Home gardens	335	100.0
Source where food is acquired*		
Fields	114	41.8
Home livestock production	8	2.4
Community greenery project	1	0.3
Method used for purchasing (acquiring) food*		
Money	334	99.7
Loans from other people	59	17.6
Loans from the market/shops	89	26.6
Bartering (exchanging assets for food)	2	0.6
Frequency of food purchase		
Once a month/when necessary	235	70.2
More than once a month	100	29.8
Food expenditure /month		
R51-R99	1	0.3
R100 – R500	120	35.8
R501 – R1000	167	49.9
> R1000	47	14.0

*percentages do not amount to 100% because of multiple responses.

4.3.1.5 Foods available in the household

A household food inventory was used to determine the foods available in the household at the time of data collection. The list of all food items that were available in the households is indicated in Appendix 8. Table 4.7 presents foods available in more than 30% of the households (top 22 foods) in descending order. All households (100%) had chicken heads, mangoes and litchis. Salt and maize meal were available in 99.7% and 99.1% of households respectively. Cooking oil, tea, sugar and crispy chips were available in 83% to 88.7% of the households. Some of the foods that could be regarded as basic, such as onion, bread, chicken and soup were only found in 51% to 69% of the households. The imitation fruit juice (squash) was in 45.1% of the households. Even fewer households had items like coffee/tea creamer (37.6%), wild green leafy vegetables (34%), butter (33.7%), chicken feet (32.2%), pawpaw (32.2%), eggs (30.5%) and legumes (30.2%).

Table 4.7 Foods available in 30% of the households in descending order

	Food item	n	%
1.	Chicken Heads	335	100.0
2.	Mangoes	335	100.0
3.	Litchis	335	100.0
4.	Salt	334	99.7
5.	Maize meal	332	99.1
6.	Cooking oil/fat	297	88.7
7.	Tea	291	86.9
8.	Sugar	280	83.6
9.	Crispy chips	278	83.0
10.	Onion	231	69.0
11.	Bread	226	67.5
12.	Tomatoes	189	56.4
13.	Chicken	176	52.5
14.	Soup	171	51.0
15.	Squash (imitation)drink	151	45.1
16.	Coffee/tea creamer (whitener)	126	37.6
17.	Wild green leafy vegetables	114	34.0
18.	Butter/Margarine	113	33.7
19.	Chicken feet	108	32.2
20.	Pawpaw	108	32.2
21.	Eggs	102	30.5
22.	Legumes	101	30.2

Figure 4.1 illustrates the total number of food groups (out of 8) available in all households. The average of the availability of food items from each food group in the households was calculated. All households (100%) had foods from the starch and sugar food groups available. The percentage of households with the other food groups available were as follows in the descending order: salt/salty foods (crispy chips and instant soup) (99.7%), vegetables (91.0%), fat/oils (90.8%) and protein rich foods (meat, chicken, fish and legumes) (89.3%). Just above half of the households (51.3%) had fruit while foods from the milk and dairy group were only available in 35.2% of the households. Most households that had fruit had seasonal fruits like mangoes, litchis and papaws from trees grown in their yards.

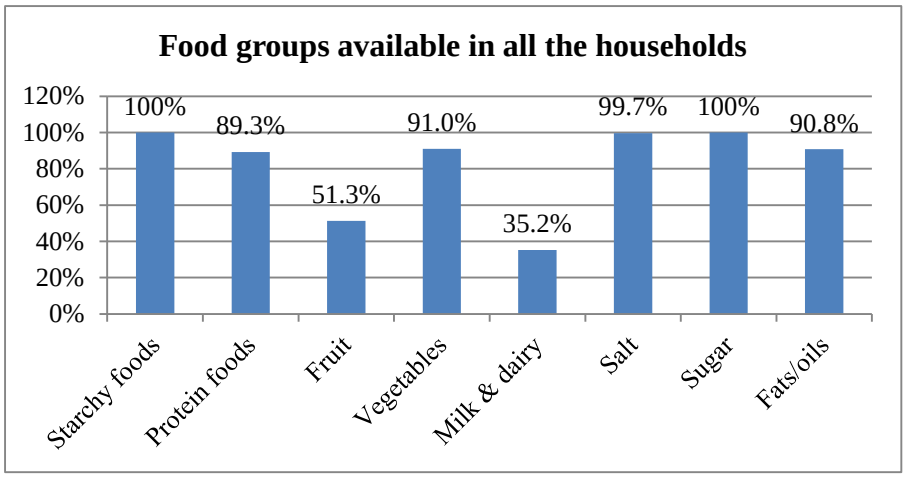


Figure 4.1 Food groups available in the households

4.3.1.6 Occurrence of hunger in the households

Table 4.8 presents results obtained from hunger scale measurements. The households were almost equally distributed amongst the three levels that describe their FS status: food secure (30.2 %); at risk of food insecurity (37%) and food insecure (32.8%).

Table 4.8 Occurrence of hunger in the households (n = 335)

Levels of food security	n	%
Food secure	101	30.2
At risk	124	37.0
Food insecure	110	32.8

4.3.2 Comparison of food availability and accessibility variables

Table 4.9 shows food availability and accessibility variables that were significantly different in secure, at risk and insecure households at $p<0.05$. According to Table 4.9 the salary, affordability of households to buy food and availability of protein, vegetables, milk and fat in the household, were associated with the FS status of households. Households with no salary were more insecure (38.1%) than households with salaried family members (24.8%). Of the households which could not afford buying often 37.0% were insecure compared to 20.9% of the households which could afford to buy as often as needed. Households with protein rich foods, vegetables, milk and fat available (28.8%, 30.2%, 24.6%, 30.3%) were less food insecure than households without these foods (66.8%, 60.0%, 37.3%, 58.1%). Significant difference between the secure, at risk and insecure households was strongest in households

with or without protein rich foods (p<0.0001). Availability of vegetables and fat in the households also showed a strong indication of FS status at p=0.004 and p=0.0031 respectively.

Table 4.9 Household food security variables significantly different in secure, at risk and insecure households

Food security variables	Hunger scale						P-value
	Secure		At risk		Insecure		
	n	%	n	%	n	%	
Salary							
Yes **(n=133)**	45	33.8	55	41.4	33	24.8	p=0.0400*
No **(n=202)**	56	27.7	69	34.2	77	38.1	
Household affordability measured with food buying frequency							
Cannot afford buying often **(n=100)**	67	28.5	81	34.5	87	37.0	p=0.0433*
Can afford buying as often as needed **(n=235)**	34	34.0	43	43.0	23	20.9	
Household with protein rich foods							
Yes **(n=299)**	100	33.4	113	37.8	86	28.8	p<0.0001***
No **(n=36)**	1	2.8	11	30.6	24	66.8	
Household with vegetables							
Yes **(n =305)**	96	31.5	117	38.4	92	30.2	p=0.0040**
No **(n=30**)	5	16.7	7	23.3	18	60.0	
Household with milk							
Yes **(n=118)**	44	37.3	45	38.1	29	24.6	p=0.0313*
No **(n=217)**	57	26.3	79	36.4	81	37.3	
Household with fat							
Yes **(n=304)**	98	32.2	114	37.5	92	30.3	p=0.0031**
No **(n=31)**	3	9.7	10	32.3	18	58.1	

*p<0.05; **p<0.005; ***p<0.0001

4.3.3 Household usual food consumption

Table 4.10 displays the frequency in descending order of food items consumed in the households. Listed food items are only those with a consumption frequency median of at least once monthly. *Vhuswa* prepared from fortified maize meal and salt and salty foods (such as stock, instant soup and crispy chips) were indicated as the most frequently consumed food items in the households. They were both eaten daily by at least 25% of the households. Both the median (50%) and the upper quartile (75%) show that *vhuswa* and salt and salty foods were consumed twice daily. Tea and sugar were the next food items frequently consumed (once every day by at least half of the households), followed by bread (with a median of 6 days a week). The next most frequently consumed food items were sugary foods such as imitation fruit juice (squash); sweets, chocolates, cakes, biscuits and soft drinks (consumed 6, 5 and 3 times in a week respectively by 75% of the households). Protein rich foods including eggs, chicken, heads and feet, fish as well as offal, were consumed at least every week by half of the households, however some households (less than 25%) did not consume eggs, offal and

legumes at all and had fish only 2 times in a month. Vegetables on the other hand were consumed at least every week. More than 75% of households had vegetables 4 times in a week, 50% ate vegetables 2 times in a week and less than 25% at once a week. The frequency of green leafy vegetable consumption was low, once every week by 75% of the households. Although the frequency median that described the use of margarine, oils and/or fats by the households was once a week, the upper quartile (75%) indicated use of these foods almost every day (5 times a week). Tea or coffee creamer however was used once daily by 75% of the households, 3 times a week by 50% and not consumed by 25% of the households.

Results of household usual consumption confirmed the results on the foods available in the households. The frequency of food intake in the households suggested a daily consumption of *vhuswa*, a protein rich food and *gwengwelele* (mixture of fried onion, tomato and instant soup) used as a 'stew'. Twice in a week vegetables would be added while fruit would be consumed once in a week.

Table 4.10 Frequency* of food consumption in the households

Food item	Consumption Frequency		
	Median#	Lower Quartile (25%)	Upper Quartile (75%)
Porridge (fortified maize meal)	Twice daily	Once daily	Twice daily
Salt/Stock/instant soup	Twice daily	Once daily	Twice daily
Tea	Once daily	Three times weekly	Once daily
Sugar	Once daily	five times weekly	Once daily
Bread	Six times weekly	Three times weekly	Once daily
Imitation fruit juice (squash)	Three times weekly	-	Six times weekly
Tea/coffee whitener	Three times weekly	-	Once daily
Eggs	Twice weekly	-	Three times weekly
Chicken	Twice weekly	Weekly	Three times weekly
Chicken heads & feet	Twice weekly	Weekly	Four times weekly
Vegetables	Twice weekly	Weekly	Four times weekly
Fish	Weekly€	Twice monthly	Twice weekly
Sweets/chocolates	Weekly	-	Three times weekly
Crispy chips	Weekly	-	Five times weekly
Cake/biscuits	Weekly	-	Five times weekly
Legumes	Weekly	-	Weekly
Fruit	Weekly	Twice monthly	Three times weekly
Margarine/oil/fat	Weekly	-	Five times weekly

Table 4.10 (Continued) - Frequency* of food consumption in the households

Food item	Consumption Frequency		
	Median[#]	Lower Quartile (25%)	Upper Quartile (75%)
Offal	Three times monthly	-	Weekly [¥]
Spinach	Three times monthly	-	Weekly
Soft drink	Twice monthly	Once monthly	Weekly
Wild green leafy vegetables	Twice monthly	-	Weekly

* Only foods with at least once monthly consumption frequency median are listed

[#] Median was used because distributions were asymmetrical

[€]Five days/week

[¥]Six days/week

Table 4.11 presents comparison of household usual consumption with recommendations from SAFBDG. The median household consumption of starchy foods was 2 times a day and compared well with the recommendation of making starchy food the basis of most meals. Fruits and vegetable consumption were less than SAFBDG recommendation as fruit and vegetables were not even consumed every day whereas the statement recommends plenty in a day. Milk, maas and yoghurt are recommended to be consumed everyday but Thulamela rural households were not even consuming these items monthly. Fat is recommended to be consumed sparingly and the households had a median frequency of weekly. Sugar and foods high in sugar were consumed once on daily basis.

Table 4.11 Comparison of household usual consumption with SAFBDG

SAFBDG	Household usual consumption	
	Median	Upper Quartile (75%)
1. Make starchy foods the basis of most meals	Twice daily	Twice daily
2. Eat plenty of fruit and vegetables everyday	3 - 4 times weekly*	4 times weekly
3. Eat dry beans, split peas, lentils and soya often	Once weekly	Weekly
4. Have milk, *maas* and yoghurt everyday	-	-
5. Fish, chicken lean meat or eggs can be eaten everyday	1-2 times weekly[#]	2 times weekly
6. Eat fat sparingly. Choose vegetable fats rather than hard fats[¥]	Once weekly	5 times weekly
7. Use sugar and food and drinks high in sugar sparingly	Once daily	Once daily

*Fruit 3 times weekly, vegetables 4 times weekly. [#]Some items once weekly and some 2 times weekly.
¥type of fat was not determined.

4.3.4 Nutritional and health status of children

Nutritional and health status of children will be described.

4.3.4.1 Anthropometric status

Anthropometric status of children will be presented in terms of H/A, W/H, W/A and BMI/A. Table 4.12 presents the Z-score classification and interpretation. More than 88% of children had adequate anthropometric nutritional status (± 2SD), according to the 4 indicators H/A (90.7%), W/H (88.3%), W/A (90.1%) and BMI/A (88.3%). Children with poor nutritional status (<-2SD) were mainly wasted (W/H < -2SD=9.9%) with 6.4% moderately wasted (<-2 to -3SD) and 3.5% severely wasted (<-3SD) and underweight (9.6%). Less than 8.7% of the children were stunted, with 7.8% moderately and 0.9% severely stunted. Very few children (2.1%) were overweight (1.2%) as measured by BMI/A.

Table 4.12 Z-score classification and interpretation of the anthropometric indicators (WHO, 2006:Online)

Z-score	Classifications	Interpretation	n = 335	%
H/A				
<-2SD		**Stunted**	**29**	**8.7**
< -3 SD	Very low H/A	Severely stunted	3	0.9
-3SD to <-2SD	Low H/A	Moderately stunted	26	7.8
≥-2		**Not stunted**	**306**	**91.3**
-2SD to +2SD	Normal	Normal	304	90.7
>+2SD to +3SD	High H/A	High height	1	0.3
>+3SD	Very high H/A	Very high height	1	0.3
W/H (n = 282)*				
<-2SD		**Wasted**	**28**	**9.9**
< -3 SD	Very low W/H	Severely wasted	10	3.5
-3SD to <-2SD	Low W/H	Moderately wasted	18	6.4
≥-2SD		**Not wasted**	**254**	**90.1**
-2SD to +2SD	Normal	Normal	249	88.3
>+2SD to +3SD	High W/H	Overweight	3	1.1
>+3SD	Very high W/H	Very overweight	2	0.7
W/A				
<-2SD		**Underweight**	**32**	**9.6**
< -3 SD	Very low W/A	Severely underweight	10	3.0
-3SD to <-2SD	Low W/A	Moderately underweight	22	6.6
Z-score	**Classifications**	**Interpretation**	**n = 335**	**%**
W/A				
<-2SD		**Underweight**	**32**	**9.6**
≥-2SD		**Not underweight**	**303**	**90.4**
-2SD to +2SD	Normal	Normal	302	90.1
>+2SD to +3SD	High W/A	Overweight	0	0.0
>+3SD	Very high W/A	Very overweight	1	0.3

Table 4.12 (Continued) - Z-score classification and interpretation of the anthropometric indicators (WHO, 2006:Online)

Z-score	Classifications	Interpretation	n = 335	%
BMI				
≤+2SD		**Not overweight**	**328**	**97.9**
< -3 SD	Very low H/A	Severely underweight	10	3.0
-3SD to <-2SD	Low H/A	Moderately underweight	22	6.6
-2SD to +2SD	Normal	Normal	296	88.3
>+2SD		**Overweight**	**7**	**2.1**
>+2SD to +3SD	High H/A	Overweight	4	1.2
>+3SD	Very high H/A	Very overweight	3	0.9

* Calculations were only done for cases below 61 months of age.

4.3.4.2 Dietary intake of children

The daily food intake of the children were analysed using the food groups and compared with the recommended number of servings according to the FGP, while the energy and macronutrient intake were determined using the food exchange system and the macronutrient intake were expressed as a percentage of total energy intake (%TE). Micronutrient intakes were estimated according to the food groups. Discrepancies between the 24 hour recall of children and household FFQ were determined to validate usual food intake of children.

(i) Usual daily food intake according to the FGP

Table 4.13 shows the usual food intakes of children as determined with the FGP for young children. The recommended number of daily servings according to FGP for young children were only met for the bread/cereal group and the meat and meat substitutes group. About 69.9% of the children were reported to consume the recommended 6 servings or more per day from the bread/cereal group. For the meat and meat substitutes group, 54.9% of the children consumed the recommended 2 or more servings per day. Almost all children had not met the daily recommended number of servings from the milk and milk products group (2 servings), or from the vegetable group (3 servings), or from the fruit group (2 servings) (99.4%, 97.6% and 94.6%) respectively. From the fat group 55.5% had the recommended less than 3 servings a day, while (44.5%) had more than 3 servings daily.

Table 4.13 Dietary intake of the children 3 to 5 years old compared to FGP* (n = 335)

Food group	FGP[#] standard	Below		Equal		Above	
		n	%	N	%	n	%
Milk and milk products	2	333	99.4	1	0.3	1	0.3
Bread/cereal	6	101	30.2	12	3.6	222	66.3
Meat & meat substitutes	2	151	45.1	52	15.5	132	39.4
Fruit	2	317	94.6	8	2.4	10	3.0
Vegetables	3	327	97.6	1	0.3	7	2.1
Fats/Oils/Sweets	<3	-	-	186	55.5	149	44.5

*Food guide pyramid for young children; [#]standard refers to recommended number of servings per child per day.

(ii) Energy and macronutrient consumption

Using Whitney and Rolfes (2013:292) recommendations of the percentage of total energy (%TE) intake that should be provided by macronutrients in the diets of the individuals, Table 4.14 shows the contribution of macronutrients to the total energy intake of the children. Both their carbohydrate (median = 72.2%) and protein (median = 18.9%) intakes were above the suggested ranges (Carbohydrates 45%-65% & Protein 10%-15% of TE respectively). On the contrary, the fat intake provided less than the suggested range (20% to 35%TE), as depicted by their median of 8.5% fat energy.

Table 4.14 Total energy intake provided by macronutrients and %TE in the diets of the children (Whitney & Rolfes, 2013:292)

Variable	n	Median	Lower Quartile (25%)	Upper Quartile (75%)	Minimum	Maximum
Carbohydrate (kJ)	335	2426.8	1759.5	3181.0	102.0	5308.1
Protein (kJ)	335	661.3	511.7	839.8	76.5	1819.7
Fat (kJ)	335	304.0	151.6	505.1	0.0	2128.4
Sum (kJ)	335	3434.1	2598.3	4353.5	844.0	7043.6
%Prot	335	18.9	16.5	21.9	9.1	39.3
%Fat	335	8.5	4.8	13.9	0.0	68.7
% Carbohydrate	335	72.2	64.1	77.6	3.4	90.6

*% TE means percentage of total energy.

Table 4.15 shows that the majority of children (81.5%) had protein and carbohydrate (71%) intakes that exceeded the suggested ranges for protein and carbohydrate energy, expressed as %TE. Of the children 18.2% consumed the suggested range of protein energy, while 26.6% of the children consumed carbohydrates within the suggested range for carbohydrate energy.

Table 4.15 Macronutrient intakes of the children against recommended %TE contribution (Whitney & Rolfes, 2013:292)

	Low		Within		High	
	n	%	n	%	n	%
Fat	303	90.5	28	8.4	4	1.2
Protein	1	0.3	61	18.2	273	81.5
Carbohydrate	8	2.4	89	26.6	238	71.0

(iii) Micronutrient intake

Table 4.16 indicates the consumption of fruit and vegetables in the diets of children and particularly the β-carotene and vitamin C rich sources. Fruit was poorly consumed in general and therefore most (> 89%) of the children were not getting β-carotene and vitamin C from fruit. However, vegetables were consumed by 86.6% children, most of which ate vitamin C rich sources. Only 17% consumed β-carotene rich vegetables and 1.2% children had vegetables that provided both β-carotene and vitamin C.

Table 4.16 Description of fruit and vegetables in the usual diet of children

Fruit/vegetables consumed	Yes		No	
	n	%	n	%
Fruit				
Any fruit in the diet	110	32.8	225	67.2
β-carotene rich sources	1	0.3	334	99.7
Vitamin C rich sources	36	10.7	299	89.3
Sources rich in both β-carotene and vitamin C	22	6.6	313	93.4
Vegetables				
Any vegetable in the diet	290	86.6	45	13.4
β-carotene rich sources	57	17.0	278	83.0
Vitamin C rich sources	288	86.0	47	14.0
Sources rich in both β-carotene and vitamin C	4	1.2	331	98.8

(iv) Discrepancies between reported dietary intake of children and foods consumed in the households

Table 4.17 presents the comparison of the usual diet of children, according to the 24 hour recall for the child with the FFQ results for the household. Foods reported from the single 24 hour recall were statistically tested against the foods reportedly frequently consumed in the households. There were very few discrepancies between the reported intakes of the children (24 hour recall) and foods frequently consumed at home. Some discrepancies were found in the reported intake from the milk (0.6%), fruit (26.6%) and vegetable (9.0%) food groups. Discrepancies were regarded as cases whereby a child was reported to have consumed food that was not consumed in the respective household. While milk and vegetable consumption

had less than 10% of discrepancies, fruit consumption had a concerning discrepancy indicating a possibility of children getting fruit from elsewhere. Fruit rich in β-carotene and vitamin C was discrepant only with 2.7% of children. Thus the 24 hour recall was taken as valid for the usual dietary intake of the children.

Table 4.17 Discrepancies between reported children diets (24 hour recall) and foods frequently consumed at home (FFQ)

Food group	Discrepancy			
	Yes		No	
	n	%	n	%
Milk	2	0.6	331	98.8
Meat	0	0.0	335	100.0
Bread/cereal	0	0.0	335	100.0
Fruit high in both β-carotene and vitamin C	9	2.7	326	97.3
Fruit (other)	80	23.9	255	76.1
Vegetable source of both β -carotene and vitamin C	30	9.0	305	91.0
Fats/oils	0	0.0	335	100.0
Sweets/sugar	0	0.0	335	100.0

4.3.4.3 The health status of the children

The health status of the children will be described using the diarrhoeal episodes and incidences of worm infestations. Recent past (past 24 hours), past 7 days or previous month gives reference from the day of data collection of this study through interviews.

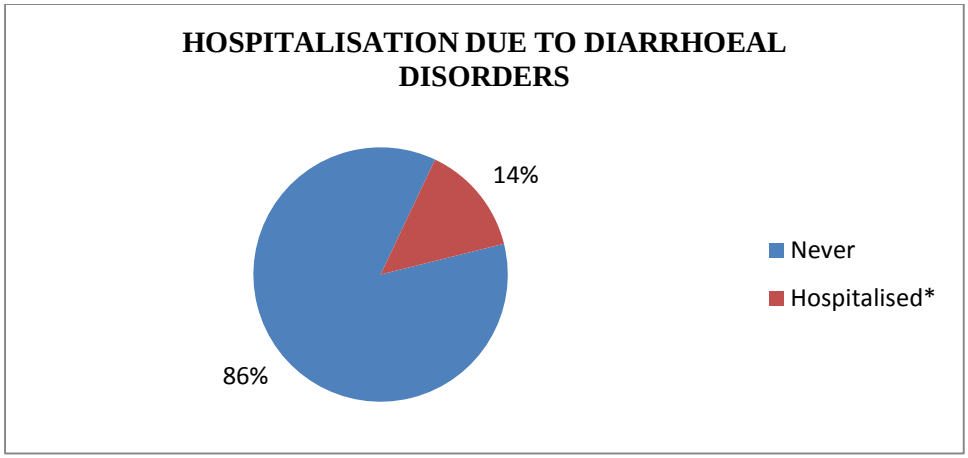
(i) Diarrhoeal episodes

Table 4.18 shows the frequency of diarrhoeal episode experienced by children in the past 24 hours, 7 days or previous month. In all instances there were less than 20% of children who had diarrhoeal episodes. In the recent past (past 24 hours) children passed loose stools once (0.9%), twice (0.3%) and 4 times (0.3%). The previous month had the highest diarrhoeal occurrences (19.1%) with varying stool forms and duration. Loose stools were passed by 14.1% for less than 3 days (7.2%), 3 to 7 days (6.6%) and by 0.3% for 8 days. Watery and bloody stools were also reported for 2.4% and 2.1% children respectively. Watery stools were experienced by 2.4% of cases where some had it just once (1.2%) and others between 3 to 5 days (1.2%). Bloody stools were reported to have occurred in the previous month of the study interviews in 2.1% (for less than 3 days by 1.2% and 3 to 6 days by 0.9%) of children. In the past 7 days diarrhoeal incidences were 8.1%. Loose, watery and bloody stools were reported by 6.3% (<3days in 3. 6% cases and 3 to 6 days in 2.7% cases), 1.2% (<3days in 0.3% cases and 3 to 4 days in 0.9% cases) and 0.6% (<3days) respectively.

Table 4.18 Frequency of diarrhoeal episodes in children (n = 335)

Period	Stool type	Frequency of episodes	n	%
Past 24 hours			**6**	**1.8**
	Loose	Once	3	0.9
		Twice	1	0.3
		Four times	1	0.3
	Watery	Once	1	0.3
Past 7 days			**27**	**8.1**
	Loose	< 3 days	12	3.6
		3-6 days	9	2.7
	Watery	< 3 days	1	0.3
		3-4 days	3	0.9
	Bloody	< 3 days	2	0.6
Past month			**64**	**19.1**
	Loose	< 3 days	24	7.2
		3-7 days	22	6.6
		8 days	1	0.3
	Watery	Once	5	1.2
		3-5 days	5	1.2
	Bloody	< 3 days	4	1.2
		3-6 days	3	0.9

Figure 4.2 presents the frequency by which children were hospitalised in their lifetime due to diarrhoeal disorders. There were only 14% of children who were hospitalised at least once in their lifetime due to diarrhoeal disorders. The hospital stay ranged from once (6.9%), twice (3.3%) to more than two times (3.9%).



*Children who had 1 (6.9%), 2 (3.3%) or more (3.9%) hospital admissions due to a diarrhoeal disorder.

Figure 4.2 Frequency of hospitalisation of children due to diarrhoeal disorders

(ii) Worm infestation incidences

Respondents were asked whether worms were ever seen in the stools of the children. Their responses were recorded as shown in Table 4.19. More than a third of the children (35.2%) had worms seen in their stools at least once in their lifetime. Frequencies were also indicated for the recent past including past 7 days (1.8%) and past month (5.1%).

Table 4.19 Reported worm detection in stools (n = 335)

Period	n	%
Ever occurred in life time	118	35.2
Past 7 days	6	1.8
Past month	18	5.1

Figure 4.3 shows that 9.9% of children were never dewormed but 74.2% were dewormed in the past year. Some of the children (13.5%) were dewormed in the previous month. Few children (1.5%) dewormed earlier in the year while even fewer children (0.9%) were dewormed the previous week.

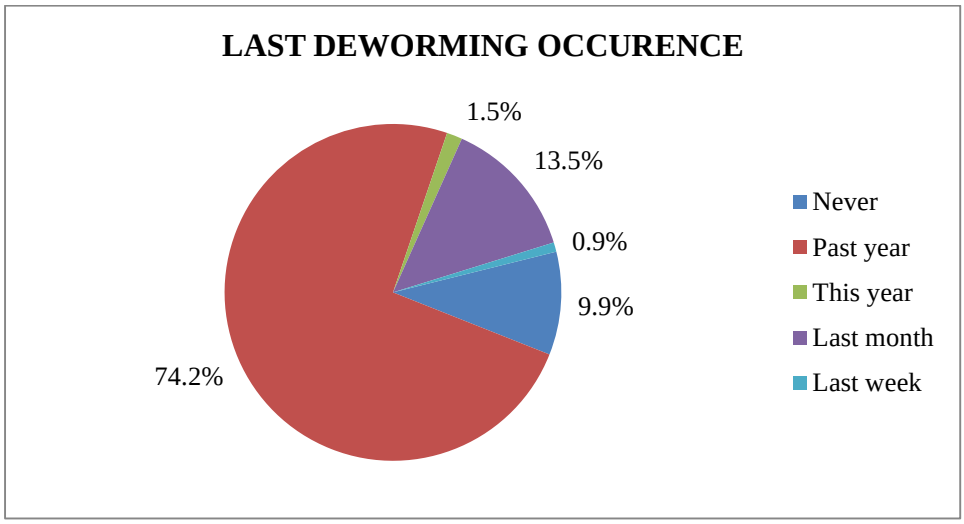


Figure 4.3. Last time children were dewormed

Samples of stools from the children were examined in the laboratory to detect presence of intestinal parasites, *Ascaris*, *Trichuris* and *Giardia lambia*. Table 4.20 indicates that *Ascaris* occurred in 1.2% cases, *Trichuris* in 1.9% and *Giardia lambia* in 5.6%. Just above 10% of samples had more than usual counts of bacteria and were therefore also recorded.

Table 4.20 Analytical detection of presence of worms in stool samples (n = 335)

Pathogen	n	%
Ascaris	4	1.2
Trichuris	6	1.9
Giardia lamblia	19	5.6
>bacteria*	34	10.5

*More than usual count of bacteria.

4.4 HOUSEHOLD FOOD SAFETY

Household food safety indicators included food handling practices and knowledge, microbial quality of foods and water used in the household.

4.4.1 Food handling practices and knowledge

Mean scores for self-reported and observed food handling practices and knowledge are shown in Table 4.21. Self-reported practices refer to responses that were obtained from the respondents when asked about their food handling practices whereas observed practices refer to observations made by the researchers during the food handling practice. Scores were obtained by calculating the number of good behaviour responses against the bad behavioural ones (Appendix 5 section 7). The mean score (56.4±7.4) of food handling knowledge obtained from self-reporting is higher than the observed mean score (47.1±20.3).

A memorandum for the assessment of knowledge on food handling (Appendix 10) was used to credit correct responses. The scoring for knowledge of respondents on food handling was obtained by calculating the number of correct or acceptable responses against the incorrect/unacceptable ones (Appendix 5 section 8 and Appendix 10). The mean score of food handling knowledge was 63.2±12.3.

Table 4.21 The mean (SD, min, max) of food handling practices and knowledge of food handling practices (n=335)

Component	Mean	SD[#]	Minimum	Maximum
Self-reported food handling practices	56.4	7.4	36.5	79.1
Observed food handling practices (n=334)*	47.1	20.3	0.0	100.0
Knowledge of food handling practices	63.2	12.3	37.5	93.8

*One missing value as observations could not be done in one household. [#]Standard deviation.

Table 4.22 presents results for scores obtained from caregivers with regards to reported and observed food handling practices as well as their food safety knowledge. More than 80% of the respondents had acceptable (≥50%) self-reported food handling practices (80.9%) and food safety knowledge (86%). However, only 45.5% of the respondents displayed an acceptable level of safe food handling practices when observed.

Table 4.22 Scores obtained by respondents for food handling variables

Food handling variable	n	%
Self-reported practices		
<50%	64	19.1
≥50%	271	80.9
Observed practices		
<50%	182	54.5
≥50%	152	45.5
Knowledge		
<50%	47	14.0
≥50%	288	86.0

4.4.2 Microbial quality of food and water used in the households

Source and storage form of the water used for domestic purposes in the households will be described. Microbial content of stored water, hand-washing water, porridge and protein rich foods will also be described.

4.4.2.1 Source and storage form of the water used for domestic purposes

The microbial quality of water used for domestic purposes by the households is described by the source, storage form and duration of its storage. Table 4.23 shows that most households (61.2%) accessed water for kitchen use from the communal (street) taps or their outside taps (26.9%). Other sources that were not so commonly used included the inside home tap (4.2%), fountains (4.2%), municipality water truck (0.3%) and river (0.6%). Some households had access to more than1source of water.

The majority of households (97.3%) stored water for varied number of days. Only 17% of households reported to store water for just1day. Others stored water for 2 (24.2%), 3 to 4 days (23.3%), 5 to 7 days (23.3%) and up to more than a month (9.6%).

Table 4.23 Source and storage form of water used in the households (n=335)

Water source and storage factor	n	%
Source		
Communal/street tap	205	61.2
Tap at home (outside)	90	26.9
Tap at home (inside)	14	4.2
Fountain	14	4.2
Municipality water truck	1	0.3
River	2	0.6
Communal & Fountain	8	2.4
Tap at home & borehole	1	0.3
Water stored at home		
Yes	326	97.3
No	9	2.7
Storage duration		
1 day	57	17.0
2 days	81	24.2
3 - 5 days	85	25.4
7 days	71	21.2
2 - 4 weeks	31	9.3
> 4 weeks	1	0.3

4.4.2.2 Microbial content of water and food used and consumed in the household

Table 4.24 gives an indication of the kind of bacterial contamination found in water and food used and consumed in the households. Total counts, total coliforms, faecal coliforms, Streptococci and *E. coli* were used as quality indicators for stored and hand-washing water. Total counts and coliform bacteria were found in more than 94% in both the stored and hand-washing water samples. Faecal bacteria were however found in less than half of the water samples (both stored and hand-washing water). Faecal coliforms were present in 42.5% of the stored water samples and 39.5% of the hand-washing water samples. *E. coli* were present in 38.9% of the stored water samples and 42.6% of the hand-washing water. Few stored water samples (8%) had Streptococci isolates compared to 22% of the hand-washing water samples.

Fresh and left over *vhuswa* were examined for the presence of *Salmonella* and coliforms. *Salmonella* was not detected in any tested *vhuswa* samples. Much more of the left over *vhuswa* samples (57%) had coliforms compared to fresh *vhuswa* samples (21.4%). Although coliforms were detected in 55.6% of the tested protein rich food samples, faecal contamination was also detected (*Salmonella:* 0.9%; *E. coli:* 26.6%). *Listeria* was not detected in protein rich foods.

Table 4.24 Qualitative assessment of water and food used and consumed in the households (n =114)

Samples/pathogens	No. of samples*	Positive		Negative	
		n	%	N	%
Stored water					
Total count	113	108	95.6	5	4.4
Faecal coliforms	113	48	42.5	65	57.2
Total coliforms	113	107	94.7	6	5.3
Streptococcus	112	9	8.0	103	92.0
E. coli	113	44	38.9	69	61.1
Hand-washing water					
Total count	114	113	99.1	1	0.9
Faecal coliforms	114	45	39.5	69	60.5
Total coliforms	114	108	94.7	6	5.3
Streptococcus	113	25	22.1	88	77.9
E. coli	114	52	45.6	62	54.4
Fresh porridge					
Salmonella	112	0	0.0	112	100.0
Coliforms	112	24	21.4	88	78.6
Left over porridge					
Salmonella	114	0	0.0	114	100.0
Coliforms	114	65	57.0	49	43.0
Protein source					
Salmonella	113	1	0.9	112	99.1
Listeria	113	0	0.0	113	100.0
Coliforms	113	63	55.6	50	44.3
E. coli	113	30	26.6	83	73.5

*Samples were not always 114 in number due to attrition.

Microbiological assessments were aimed for 30% of the 335 households that participated in this study. To guard against attrition 34% of households was targeted. Due to loss of samples during transportation only 32% of households had complete information on water and food samples. Table 4.25 indicates the microbial quality of food and water collected from households that had information about both *vhuswa* and protein rich food analysed. There were 108 households with complete information about food samples. Most of these households (75.9%) had at least1sample (either *vhuswa*, protein rich food or both) with bacterial loads above the safety limit. Contaminated *vhuswa* was found in 29.3% of the households while 15.8% had contaminated protein rich food. More than half of the households (54.9%) had bacterial contamination in both the *vhuswa* and protein samples.

Table 4.25 Households with bacterial contaminated food

Households with both *vhuswa* and protein information (n=108)	**n**	**%**
No bacteria in either *vhuswa* or protein	26	24.1
Bacteria in either *vhuswa*, protein or both	82	75.9
Bacteria in *vhuswa* only	24	29.3
Bacteria in protein only	13	15.8
Bacteria in both *vhuswa* and protein	45	54.9

Table 4.26 indicates the numerical values of pathogens in water ($100ml^{-1}$) and food ($100g^{-1}$) samples. Median, lower quartiles, upper quartiles, minimum and maximum values are reported. Unsafe contamination levels of total counts (>100cfu/100ml) and total coliforms (>5cfu/100ml) were observed in all water samples with total counts and coliforms. Hand-washing water had higher bacterial load compared to stored water. Nevertheless, there were few instances of faecal contamination (Streptococci) for both stored and hand-washing water with a median of 0cfu/100ml. The total count for the stored water had a median of $2.3x10^4$cfu/100ml and a maximum value of $3.2x10^8$cfu/100ml while the median of total coliforms was $5.6x10^4$cfu/100ml with a maximum value of $2.9x10^9$cfu/100ml. Hand-washing water had a median total count of $2.5x10^7$cfu/100ml with a maximum of $3.2x10^8$cfu/100ml and a median total coliforms count of $1.6x10^5$cfu/100ml with a maximum of $2.9x10^9$cfu/100ml.

Faecal contamination of food samples was low compared to what was observed in water samples in general. The fresh porridge samples with coliforms were few (21.4%, Table 4.24), the median, lower and upper quartiles were zero. The maximum value was however quite high at $4.3x10^5$cfu/100g. Left over porridge however had a high number of coliforms far exceeding cut off point of 5cfu/100g (median = $9x10^3$cfu/100g). The protein rich food sample with *Salmonella* contamination had a value of $3.0x10^2$cfu/100g. The *E. coli* median was also 0cfu/100g but the upper quartile (75%) and maximum values were$1x10^2$ cfu/100g and $1.4x10^5$ cfu/100g respectively.

Table 4.26 Quantitative assessment of water and food used and consumed in the households (n =114)

Samples/Bacteria	n	Median	Lower Quartile (25%)	Upper Quartile (75%)	Minimum	Maximum	Standard cfu/100ml or 100g
Stored water							
Total count	113	2.3×10^4	1.6×10^3	6.1×10^7	0	3.2×10^8	1×10^2
Total coliforms	113	5.6×10^4	1.1×10^1	1.2×10^4	0	2.9×10^7	0.5×10^1
Faecal coliforms	113	0	0	2.1×10^2	0	6.6×10^3	0
Streptococcus	112	0	0	0	0	1.5×10^5	0
Hand-washing water							
Total count	114	2.5×10^7	3.6×10^3	7.6×10^7	0	3.2×10^8	1×10^2
Total coliforms	114	1.6×10^5	1.2×10^4	9.8×10^5	0	2.9×10^9	0.5×10^1
Faecal coliforms	114	0	0	2.0×10^2	0	4.3×10^3	0
Streptococcus	113	0	0	0	0	3.7×10^5	0
Fresh Porridge							
Coliforms	112	0	0	0	0	4.3×10^5	0.5×10^1
Left over Porridge							
Coliforms	114	9×10^3	0	6.7×10^4	0	9.4×10^6	0.5×10^1
Protein source							
Salmonella	113	0	0	0	0	3×10^2	0
Coliforms	113	8×10^2	0	1.09×10^4	0	7.3×10^5	0.5×10^1
E. coli	114	0	0	1×10^2	0	1.4×10^5	0

Table 4.27 profiles the bacteria that were present in the protein rich food samples tested. Bacteria were distributed in 55.8% of protein rich food samples. The highest number of samples (33, 29.2%) had just coliforms. *E. coli* amongst coliforms was detected in 29 (25.7%) samples. The single protein rich food sample that had *Salmonella* detected (Table 4.25) presented with coliforms and *E. coli* as well.

Table 4.27 Profile of bacteria present in protein rich food

Bacterial profile in protein rich food	No. of protein rich food samples (n=113)			
	Yes		No	
	n	%	n	%
Coliforms only	33	29.2	80	70.8
Coliforms + *E. coli*	29	25.7	84	74.3
Coliforms + *E. coli* + *Salmonella*	1	0.9	112	99.1

4.5 RELATIONSHIP BETWEEN HOUSEHOLD FOOD SAFETY AND HOUSEHOLD FOOD SECURITY

Household food safety variables were tested to determine if they were significantly associated to HFS variables. Food safety variables were, food handling practices (self-reported and observed practices), food handling knowledge and microbial quality of water and food collected from the households. Household food security was measured objectively (food availability and accessibility), subjectively (self- reported hunger occurrence) and indirectly (nutritional and health status of children 3-5 years old). However households that were said to be food secure, at risk and insecure were determined subjectively. Objective HFS variables were tested to determine if they were significantly different in secure, at risk and food insecure households. Salary, affordability and presence of protein rich foods, vegetables, milk and fat were found significantly different as presented in Table 4.8. Associations that were found significant between each food safety variable and HFS variables will be reported hereafter. Household food security variables considered are objective and subjective variables found significantly associated with each other and variables used to describe the nutritional and health status of children (3-5 years old).

Table 4.28 presents the means of food handling practices and knowledge in food secure, at risk and in food insecure households. All households had acceptable level of food safety knowledge. Actually, knowledge ranked high ranging from 61% (insecure households) to 65.6% (secure households). Self-reported food handling practices scores, 57.6%, 57.1% and 54.4% for secure, at risk and insecure households respectively, were also acceptable. Nevertheless self-reported food handling practices scores were higher than the observed scores. While all self-reported scores were above 50%, observed scores were only above 50% in food secure households (score = 50.4%).

Table 4.28 The mean (SD, min, max) of food handling practices and knowledge in food secure, at risk and insecure households (n=335)

Food security	n	Food handling Variable	Mean	Std Dev	Min	Max
Secure	101	Self-reported practices	57.6	6.7	39.6	75.0
		Observed practices	50.4	18.0	11.1	90.0
		Knowledge	65.6	13.2	37.5	93.8
At risk	124	Self-reported practices	57.1	7.2	40.6	79.2
		Observed practices	46.5	22.3	0.0	90.9
		Knowledge	63.1	11.4	37.5	88.8
Insecure	110	Self-reported practices	54.4	7.9	36.5	75.0
		Observed practices	44.8	19.8	0.0	100.0
		Knowledge	61.0	12.0	37.5	92.5

Table 4.29 indicates that the self-reported food handling practices in the 3 categories of HFS were significantly different ($p<0.005$). Although all reported practices on average were acceptable, food handling practices in food secure households were better compared to those reported by food insecure households. The differences between pairwise groups however revealed that there was no significant difference between the food secure and at risk households ($p>0.05$). In other words, practices in food secure and at risk households were not different but practices in both of these categories differed significantly from those of food insecure households ($p<0.005$). In contrast, there was no significant difference ($p>0.05$) between the 3 categories of HFS in the households for observed food handling practices meaning from observations of food handling practices in all households, performance was the same on average.

Food handling knowledge comparatively differed significantly in food secure, at risk and insecure households ($p<0.05$). The pairwise comparisons however showed that difference was significant only between secure and insecure households ($p<0.05$). There was no significant difference between at risk households and secure households ($p>0.05$) as well as between at risk households and insecure households ($p>0.05$).

Table 4.29 Comparison of food safety parameters in food secure, at risk and insecure households (n = 335)

Food safety parameters/Food security categories	Self-reported food handling (p =0.0024*)			Observed food handling (p =0.1246)	Food handling knowledge (p =0.0254*)		
	Secure	At risk	Insecure		Secure	At risk	Insecure
Secure		0.6162	0.0018**			0.1363	0.0091*
At risk	0.6162		0.0061*		0.1363		0.1687
Insecure	0.0018**	0.0061*			0.0091*	0.1687	

*p<0.05; **p<0.005

Table 4.30 indicates that food handling practices and knowledge were associated significantly with kinds of foods available in the households including, protein rich foods and milk. Milk available in the household was strongly associated with observed food handling practices (p<0.0001). Protein rich foods on the other hand were significantly associated with self-reported food handling practices (p<0.05), observed food handling (p<0.0001) and food handling knowledge (p<0.05).

Table 4.30 Association between food handling and food availability and accessibility indicators that were significantly different in secure, at risk and food insecure households (n=335)

Food handling variable		Household food availability and accessibility variables			
		Protein rich food available		Milk available	
		Yes	No	Yes	No
Score for self-reported food handling practice					
<50% (**n=64**)	n	52	12	16	48
	%	81.2	18.8	25.0	75
≥50% (**n=271**)	n	247	24	102	169
	%	91.1	8.9	37.6	62.4
p-value		*p*=0.0215*		*p*=0.0569	
Score for observed food handling practice (n=334)					
<50% (**n=182**)	n	157	25	44	138
	%	86.3	13.7	24.2	75.8
≥50% (**n=152**)	n	142	10	73	79
	%	93.4	6.6	48.0	52.0
p-value		*p*=0.0334*		*p*<0.0001***	
Score for food handling knowledge					
<50% (**n=47**)	n	38	9	13	34
	%	80.9	19.1	27.7	72.3
≥50% (**n=288**)	n	261	27	105	183
	%	27	9.4	36.5	63.5
p-value		*p*=0.0448*		*p*=0.2416	

**p*<0.05; ***p*<0.005; ****p*<0.0001

None of the food handling variables was significantly associated with anthropometric status variables of the children (3-5 years of age). Significant association was only found between

self-reported food handling practices and worm infestation (p<0.05) (Table 4.31). Although there were too many caregivers who scored high in food handling practices than those who scored less than 50% (n of the 2 groups has a huge difference), most children who once had worms detected from their stools were seen a little more (76.6%) on the households with caregivers who scored less than 50% compared to those who scored 50% and above (62%).

Table 4.31 Association between health status of a child (3-5 years old) with self-reported food handling practices (n=334)

Health status variable	Self-reported food handling practices				*p*-value
	<50% (n =64)		≥50% (n=271)		
	n	%	n	%	
Diarrhoeal episode					
Never hospitalised	57	89.1	231	85.2	*P*=0.4284
Once hospitalised	7	10.9	40	14.8	
Worm infestation					
Never detected	15	23.4	103	38.0	*P*=0.0282*
Once detected	49	76.6	168	62.0	

*p<0.05

Table 4.32 shows significant association between microbial quality of water (stored and hand-washing) and food samples and food availability and accessibility indicators. With regards to food contamination, there was no significant association between contaminated *vhuswa* and HFS indicators. However significant association was found between protein rich foods contaminated with *E. coli* and the availability of vegetables in the households (p<0.05). Most households that had vegetables seemed to have more *E. coli* contamination in their protein rich foods.

Table 4.32 Association between microbial quality of water and food samples and food availability and accessibility indicators

Household food safety variable	Household food availability and accessibility variables							
	Salary				Vegetables available			
	Yes		No		Yes		No	
Hand-washing water contaminated with Streptococci (n=113)								
	n=41	**%**	**n=72**	**%**	**n=106**	**%**	**n=7**	**%**
Yes	10	24.4	15	20.8	21	19.8	4	57.1
No	31	75.6	57	79.2	85	80.2	3	42.9
***p*-value**	*p*=0.6614				*p*=0.0212*			
Contaminated protein source with *E. coli* (n=113)								
	n=41	**%**	**n=72**	**%**	**n=7**	**%**	**n=106**	**%**
Yes	11	26.8	19	26.4	5	71.4	25	23.6
No	30	73.2	53	73.6	2	28.6	81	76.4
***p*-value**	*p*=0.9593				*p*=0.0055*			

*p<0.05

Table 4.33 presents significant associations of microbial quality of water and food collected from the households with the anthropometric status of the children (3-5 years old). Almost all households had water samples with risky microbial contamination and coliforms. Risky microbial contamination refers to any detected contamination that was at unacceptable levels of bacterial load. Therefore there were very few households to compare with. Hence, results need to be interpreted with caution. Stored water with any risky microbial contamination and coliforms were significantly associated with the underweight anthropometric status of children (p<0.05). There were more underweight children who had infected samples collected from their homes than normal children. This is a pattern observed in all associations reported hereafter. Underweight children were also associated with various contamination in hand-washing water including coliforms (p=0.0095) and Streptococci (p=0.0225) as well as with contaminated protein rich foods. Presence of Streptococci in hand-washing water was however strongly associated with underweight children (p=0.0005). Stunted children were only implicated with detected contaminated left over porridge collected from their households (p=0.0423).

Table 4.33 Water and food microbial quality significantly associated with anthropometric status of children (3-5 years old)

Anthropometric status	**Microbial quality of water and food**				***p*-value**
	Absent		**Present**		
	n	**%**	**n**	**%**	
Underweight	**Any risky microbial contamination in stored water (n=112)**				
≥-2 (n=102)	4	3.9	98	96.1	p=0.0312*
<-2 (n=10)	2	20.0	8	80.0	
Underweight	**Coliforms > 5cfu/100ml in stored water (n=113)**				
≥-2 (n=103)	4	3.9	99	96.1	p=0.0300*
<-2 (n=10)	2	20.0	8	80.0	
Underweight	**Any risky microbial contamination in hand-washing water (n=113)**				
≥-2 (n=105)	4	3.8	101	96.2	p=0.0100*
<-2 (n=8)	2	25.0	6	75.0	
Underweight	**Coliforms > 5cfu/100ml in hand-washing water (n=114)**				
≥-2 (n=106)	4	3.8	102	96.2	p=0.0095*
<-2 (n=8)	2	25.0	6	75.0	
Underweight	**Presence of Streptococci in hand-washing water (n=113)**				
≥-2 (n=103)	84	81.6	19	18.5	p=0.0225*
<-2 (n=10)	4	40.0	6	60.0	
Wasting	**Presence of Streptococci in hand-washing water (n=113)**				
≥-2 (n=90)	72	80.0	18	20.0	p=0.0005***
<-2 (n=8)	2	25.0	6	75.0	
Stunting	**Coliforms > 5cfu/100ml in left over porridge (n=114)**				
≥-2 n=(101)	40	39.6	61	69.2	p=0.0423*
<-2 n=(13)	9	60.4	4	30.8	

Table 4.33 (Continued) Water and food microbial quality significantly associated with anthropometric status of children (3-5 years old)

Anthropometric status	Microbial quality of water and food				*p*-value
	Absent		Present		
	n	%	n	%	
Underweight	**Any risky microbial contamination in protein rich foods (n=113)**				
≥-2 (n=130)	49	47.6	54	52.4	*p*=0.0224*
<-2 n (n=10)	1	10.0	9	90.0	
Underweight	**Coliforms > 5cfu/100ml in protein rich foods (n=113)**				
≥-2 (n=103)	49	47.6	54	52.4	*p*=0.0224*
<-2 (n=10)	1	10.0	9	90.0	

*p<0.05; **p<0.005; ***p<0.0001

Table 4.34 presents results of the associations between microbial quality of water and food and health status of children (3-5 years of age). Stored water presented with faecal coliforms and *E. coli* as well as left over *vhuswa* contaminated with coliforms were associated with diarrhoeal episodes that led to the hospitalisation of children (all at p<0.05). Again most children were never hospitalised andt the few who were once hospitalised had few cases of contaminated water and food detected in their households.

Table 4.34 Water and food microbial quality significantly associated with health status of children (3-5 years old)

Child health status	Microbial quality of water and food				*p*-value
	Absent		Present		
	n	%	n	%	
Diarrhoeal episode	**Presence of faecal coliforms in stored water (n=113)**				
Never hospitalised (n=100)	53	53.0	47	47.0	*p*=0.0070*
Once hospitalised (n=13)	12	92.3	1	7.7	
Diarrhoeal episode	**Presence of *E. coli* in stored water (n=113)**				
Never hospitalised (n=100)	57	57.0	43	43.0	*p*=0.0140*
Once hospitalised (n=13)	12	92.3	1	7.7	
Diarrhoeal episode	**Coliforms > 5cfu/100ml in left over porridge (n=114)**				
Never hospitalised (n=101)	40	39.6	61	60.4	*p*=0.0423*
Once hospitalised (n=13)	9	69.2	4	30.8	

*p<0.05

Relationships between household food safety and HFS indicators were established. Food handling practices and knowledge in secure and at risk households were not significantly different. Observed food handling practices seemed a more credible food handling indicator

compared to other food handling indicators. Food handling practices could also indicate worm infestation in children 3-5 years of age. Contaminated hand-washing water seemed to be more implicated than either stored water or protein rich food. Presence of Streptococci in water especially in hand-washing water was associated with several HFS variables. Being underweight was significantly associated with several water and food cases. Consumption of left over porridge had a relationship with stunting.

Associations with food handling indicators differed from those of water and food associations. Availability of protein rich foods and milk were associated with food handling practices. In the case of water and food, associations were observed with getting salary, and having vegetables in the household. Furthermore, there were no links between anthropometric statuses of children with food handling practices but anthropometric status of children was associated with water and food. And the opposite was true for the worm infestation. These findings necessitated the determination of food handling variables and variables for microbial quality of water and food that are significantly associated. The next section will be reporting on the household food safety variables significantly associated with each other.

4.6 RELATIONSHIP BETWEEN HOUSEHOLD FOOD SAFETY INDICATORS

The relationships between various food safety variables were determined. There was no significant association between food handling practices and food handling knowledge. Table 4.35 shows the significant association between food handling practices ($p<0.05$). There is 95% chance that either of the food handling methods would give similar results.

Table 4.35 Association between self-reported and observed food handling practices (n=334)

	Self-reported food handling practices				*p*-value
	≥50%		<50%		
	n	%	n	%	
Observed food handling practices					
≥50% (n=152)	133	87.5	19	12.5	*P*=0.0066*
<50% (n=182)	44	24.2	138	75.8	

*$p<0.05$

Table 4.36 indicates that self-reported food handling practices were associated with faecal coliforms as well as Streptococci in hand-washing water. The Streptococci in hand-washing water was highly associated with food handling compared to faecal coliforms.

Table 4.36 Association between self-reported food handling practices and microbial quality of water

	Self-reported food handling practices				*p*-value
	≥50%		<50%		
	n	%	n	%	
Faecal coliforms in hand-washing water					
Yes **(n=45)**	33	73.3	12	26.7	*P*=0.0101*
No **(n=69)**	63	91.3	6	8.7	
Streptococci in hand-washing water					
Yes **(n=25)**	16	64.0	9	36.0	*P*=0.0009***
No **(n=88)**	80	90.9	8	9.1	

*p<0.05; **p<0.005; ***p<0.0001

Table 4.37 gives an indication that a risky microbial contamination in stored water would likely mean that contamination is mostly from coliforms (p<0.0001). All tested samples (n=112) that had risky contamination had coliforms (>5cfu/100ml). Results also show that presence of a risky contamination constitutes at a lesser extent the presence of faecal coliforms and *E. coli* (p=0.0292 and p=0.0428 respectively). The other indication is that where there are faecal coliforms in stored water, Streptococci and *E. coli* are also likely to be present (p=0.0036 and p<0.0001 respectively). Chances to have *E. coli* exceed chances of having Streptococci.

Table 4.37 Association between different kinds of contamination found in stored water

Microbial contamination description in stored water	Microbial quality of stored water				*p*-value
	Yes		No		
	n	%	n	%	
Any microbial contamination in stored water (n=112)					
Coliforms >5cfu/100ml in stored water					
Yes **(n=106)**	106	100.0	0	0.0	p<0.0001***
No **(n=6)**	0	0.0	6	100.0	
Faecal coliforms in stored water					
Yes **(n=48)**	48	100.0	0	0.0	p=0.0292*
No **(n=64)**	58	90.6	6	9.4	
***E. coli* in stored water**					
Yes **(n=44)**	44	100.0	0	0.0	p=0.0428*
No **(n=68)**	62	91.2	6	8.8	
Faecal coliforms in stored water (n=112)					
Coliforms >5cfu/100ml in stored water					
Yes **(n=107)**	48	44.9	59	55.1	p<0.0305*
No **(n=6)**	0	0.0	6	100.0	
Streptococci in stored water					
Yes **(n=9)**	8	88.9	1	11.1	p<0.0036**
No **(n=103)**	40	38.8	63	61.2	
***E. coli* in stored water**					
Yes **(n=44)**	39	88.6	5	11.4	p<0.0001***
No **(n=68)**	9	13.0	60	87.0	

*p<0.05; **p<0.005; ***p<0.0001

Table 4.38 indicates significant association between microbial quality of stored and hand-washing water. The presence of any risky contamination in stored water is strongly related with a risky contamination in hand-washing water (p<0.0001) with mostly coliforms (p<0.0001). Faecal coliforms and E coli are also likely to occur at p<0.0366 and p<0.0193 respectively. The implication of these results is that the quality of stored water is similar to that of hand-washing water.

Table 4.38 Association between contaminations in stored water and hand-washing water

Microbial contamination description in hand-washing water	**Any microbial contamination in stored water**				***p*-value**
	Yes		**No**		
	n	**%**	**n**	**%**	
Any risky microbial contamination in hand-washing water (n=107)					
Yes **(n=101)**	98	97.0	3	3.0	p<0.0001***
No **(n=6)**	3	50.0	3	50.0	
Coliforms > 5cfu/100ml in hand-washing water					
Yes **(n=102)**	99	97.1	3	2.9	p<0.0001***
No **(n=6)**	3	50.0	3	50.0	
Faecal coliforms in hand-washing water (n=108)					
Yes **(n=44)**	44	100.0	0	0.0	p<0.0366*
No **(n=64)**	58	90.6	6	9.4	
***E. coli* in hand-washing water (n=108)**					
Yes **(n=50)**	50	100.0	0	0.0	p<0.0193*
No **(n=58)**	52	89.7	6	10.3	

*p<0.05; **p<0.005; ***p<0.0001

Table 4.39 shows the association between various microbial loads in contaminated hand-washing water. The pattern resembles that of the stored water. Associated microbes in a risky contamination of hand-washing water include coliforms (p<0.0001), faecal coliforms (p<0.0406) and *E. coli* (p<0.0201). The presence of Streptococci in hand-washing water indicates the likelihood of getting *E. coli* contamination (p=0.0031).

Table 4.39 Association between different kinds of contamination found in hand-washing water

Microbial contamination description in hand-washing water	**Microbial quality of hand-washing water**				***p*-value**
	Yes		**No**		
	n	**%**	**n**	**%**	
Any microbial contamination in hand-washing water					
Coliforms in hand-washing water					
Yes **(n=107)**	107	100.0	0	0.0	p<0.0001***
No **(n=6)**	0	0.0	6	0.0	
Faecal coliforms in hand-washing water					

Yes **(n=45)**	45	100.0	0	0.0	p<0.0406*
No **(n=68)**	62	91.2	6	8.8	

Table 4.39 (Continued) Association between different kinds of contamination found in hand-washing water

Microbial contamination description in hand-washing water	**Microbial quality of hand-washing water**				***p*-value**
	Yes		**No**		
	n	**%**	**n**	**%**	
***E. coli* in hand-washing water**					
Yes **(n=52)**	52	100.0	0	0.0	p<0.0201*
No **(n=61)**	6	9.8	55	90.2	
Streptococci in hand-washing water					
***E. coli* in hand-washing water**					
Yes **(n=52)**	18	34.6	34	65.4	p=0.0031**
No **(n=61)**	7	11.5	54	88.5	

*p<0.05; **p<0.005; ***p<0.0001

There was no significant association observed between water microbial quality and fresh porridge. Table 4.40 presents the significant association found between the microbial quality of water and left over porridge. Left over porridge contaminated with coliforms (>5cfu/100ml) is likely to have the microbial pattern seen in stored and contaminated hand-washing water involving coliforms, faecal coliforms and *E. coli*. *E. coli* contamination in stored water was the most strongly associated water contamination with left over porridge presenting with coliform (>5cfu/100ml) (p=0.0017).

Table 4.40 Association between microbial quality of water and microbial quality of left over porridge

Microbial contamination description in water	**Coliforms in left over porridge**				***p*-value**
	Yes		**No**		
	n	**%**	**n**	**%**	
Risky contamination in stored water					
Yes **(n=104)**	60	57.7	44	42.3	p=0.0493*
No **(n=6)**	1	16.7	5	83.3	
Stored water contaminated with coliforms					
Yes **(n=105)**	61	98.4	44	41.9	p=0.0469*
No **(n=6)**	1	16.7	5	83.3	
Stored water contaminated with faecal coliforms					
Yes **(n=47)**	32	68.1	15	31.9	p=0.0262*
No **(n=64)**	30	46.9	34	53.1	
Stored water contaminated with *E. coli*					
Yes **(n=43)**	32	74.4	11	25.6	p=0.0017**
No **(n=68)**	30	44.1	38	55.9	
Hand-washing water contaminated with faecal coliforms					
Yes **(n=45)**	31	68.9	14	31.1	p=0.0119*
No **(n=63)**	28	44.4	35	55.6	
Hand-washing water contaminated with *E. coli*					
Yes **(n=50)**	34	68.0	16	32.0	p=0.0096*
No **(n=58)**	25	43.1	33	56.9	

*p<0.05; **p<0.005; ***p<0.0001

Table 4.41 shows that fresh porridge that is contaminated with coliforms is associated with the protein rich foods contaminated with *E. coli* ($p<0.0362$). Coliform contamination in left over porridge however indicates possible risky contamination of protein rich foods ($p=0.0013$) and most probably with coliforms exceeding 5cfu/100g ($p=0.0013$). Contamination of protein rich foods is likely to be coliforms ($p<0.0001$) and *E. coli* ($p<0.0001$).

Contamination of fresh and left over porridge indicates a likely contamination of protein rich foods. Although fresh and left over porridges seemed to indicate different kinds of contamination, protein rich food contamination indicates that any risky contamination is likely to include coliforms ($p<0.0001$) and *E. coli* ($p<0.0001$), a contamination that is suggested by both kinds of porridges.

Table 4.41 Association between microbial quality of food and microbial quality protein rich foods

Microbial contamination description in protein rich food	**Microbial quality in food**				***p*-value**
	Yes		**No**		
	n	**%**	**n**	**%**	
Coliforms in fresh porridge (n=110)					
***E. coli* contamination in protein rich foods**					
Yes**(n=29)**	10	34.5	19	65.5	$p=0.0362$*
No **(n=81)**	13	16.0	68	84.0	
Coliforms in left over porridge (n=111)					
Any risky microbial contamination in protein rich foods					
Yes **(n=61)**	43	70.5	18	29.5	$p=0.0013$**
No **(n=50)**	20	40.0	30	60.0	
Coliforms >5cfu/100g in protein rich foods					
Yes **(n=61)**	43	70.5	18	29.5	$p=0.0013$**
No **(n=50)**	20	40.0	30	60.0	
Coliforms in protein rich food (n=113)					
Any risky microbial contamination in protein rich foods					
Yes **(n=63)**	63	100.0	0	0.0	$p=0.0001$***
No **(n=50)**	0	0.0	50	100.0	
***E. Coli* in protein rich food (n=113)**					
Any microbial contamination in protein rich foods					
Yes **(n=63)**	30	47.6	33	52.4	$p<0.0001$***
No **(n=50)**	0	0.0	50	100.0	
Coliforms>5cfu/100g in protein rich foods					
Yes **(n=63)**	30	47.6	33	52.4	$p<0.0001$***
No **(n=50)**	0	0.0	50	100.0	

*$p<0.05$; **$p<0.005$; ***$p<0.0001$

The above presented results seem to suggest that food handling practices are related to microbial quality of hand-washing water. Hand-washing water will be likely to be contaminated with faecal coliforms and Streptococci if food handling practices are poor. Hand-

washing water contaminated with faecal coliforms is associated with risky contamination in both stored and hand-washing water. In addition, Streptococci present in hand-washing water is associated with the presence of *E. coli* in hand-washing water. It could be deduced then that microbial quality of both stored and hand-washing water seems to indicate a poor microbial quality of left over porridge which in turn indicates poor microbial quality of protein rich foods. Furthermore, presence of *E. coli* in protein rich foods indicates a chance of getting coliforms (>5cfu/100ml) even in fresh porridge.

A logistic regression model was used to determine household food safety indicators that would remain significantly associated with HFS. Table 4.42 indicates odds ratio (OR) results. The odds of households with good observed food handling practices being food secure households were 1.78 (95% CI: 1.11-2.85) times the odds of households with poor observed food handling practices. The odds of households with good food handling practices to have protein rich foods and milk were respectively 2.26 (95% CI: 1.05-4.87) and 2.90 (95% CI: 1.82-4.61) times the odds of households with poor observed food handling practices.

Table 4.42 The **odds of household food security characteristics in households with compared with households with poor observed food handling practices**

household food security characteristics	Odds Ratio	95% Confidence Interval	*p*-value
Food secure households	1.78	1.11-2.85	p=0.0107*
Households with protein rich foods	2.26	1.05-4.87	p=0.0334*
Households with milk	2.90	1.82-4.61	p<0.0001***

*p<0.05; ***p<0.0001

4.7 HOUSEHOLD FOOD SAFETY INDICATORS IN RURAL HOUSEHOLD FOOD SECURITY

This section will indicate the process used to derive food safety indicators that could be used in the measurement of rural HFS. Five step by step reduction process was followed in order to remain with food safety indicators mostly associated with HFS. Figure 4.4 shows the process of the derivation of food safety indicators proposed for use in rural HFS (Unnevehr, 2003:Brief 1; Kenaan *et al*., 2001:S49; Gross *et al*., 2000:7; Frankenberger, 1992:98, Hoddinott, 1999:2).

Step 1

The first step was to measure HFS. Household food security was measured using a variety of conventional methods. Conventional methods included direct and indirect methods. Direct methods used quantitative and qualitative indicators to measure food availability and accessibility. Quantitative indicators measured household food production, household income, external support received, purchasing behaviour, food inventory and household usual consumption. Qualitative indicators measured self-reported household food (in) security status. Indirect method measured anthropometric status of children (3-5 years old), hospitalisation of children due to diarrhoeal episodes and the incidents of worm infestations.

Step 2

Reduction of HFS indicators occurred through the variables that were not significantly different. Frequency distribution indicated variations for all the indicators used. Indicators that showed little or no variation amongst households could not be analysed further so they were omitted resulting in a reduced number of HFS indicators that were to be analysed further.

Step 3

Significant associations between HFS indicators were determined. This step left food security status (hunger occurrence), salary, affordability and availability of protein rich foods, vegetables, milk and fat in the households as considered HFS indicators for further analysis.

Step 4

Significant associations between household food safety indicators and HFS from step 3 were determined.

Step 5

All the FHS variables found significantly associated with household food safety variables were fitted in a logistic regression model with stepwise selection of variables. Food secure households and availability of protein rich foods and milk were significantly associated with good food handling practices.

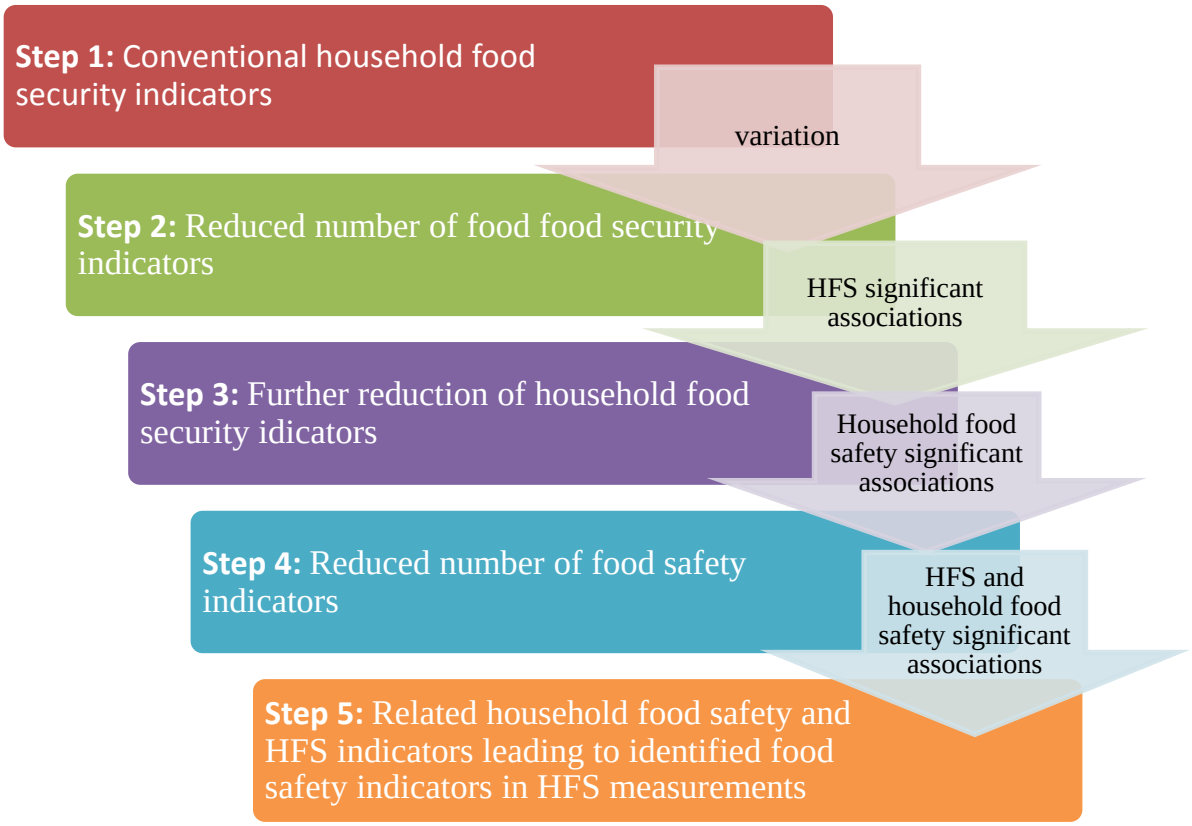


Figure 4.4 Process used in the derivation of food safety indicators proposed for use in HFS measurements

Figure 4.5 shows the results of the reduction process used to derived food safety indicators for a rural setting. The 5 step by step analyses led to the finding that poor observed food handling practices of in the households possibly indicates a food safety risk.

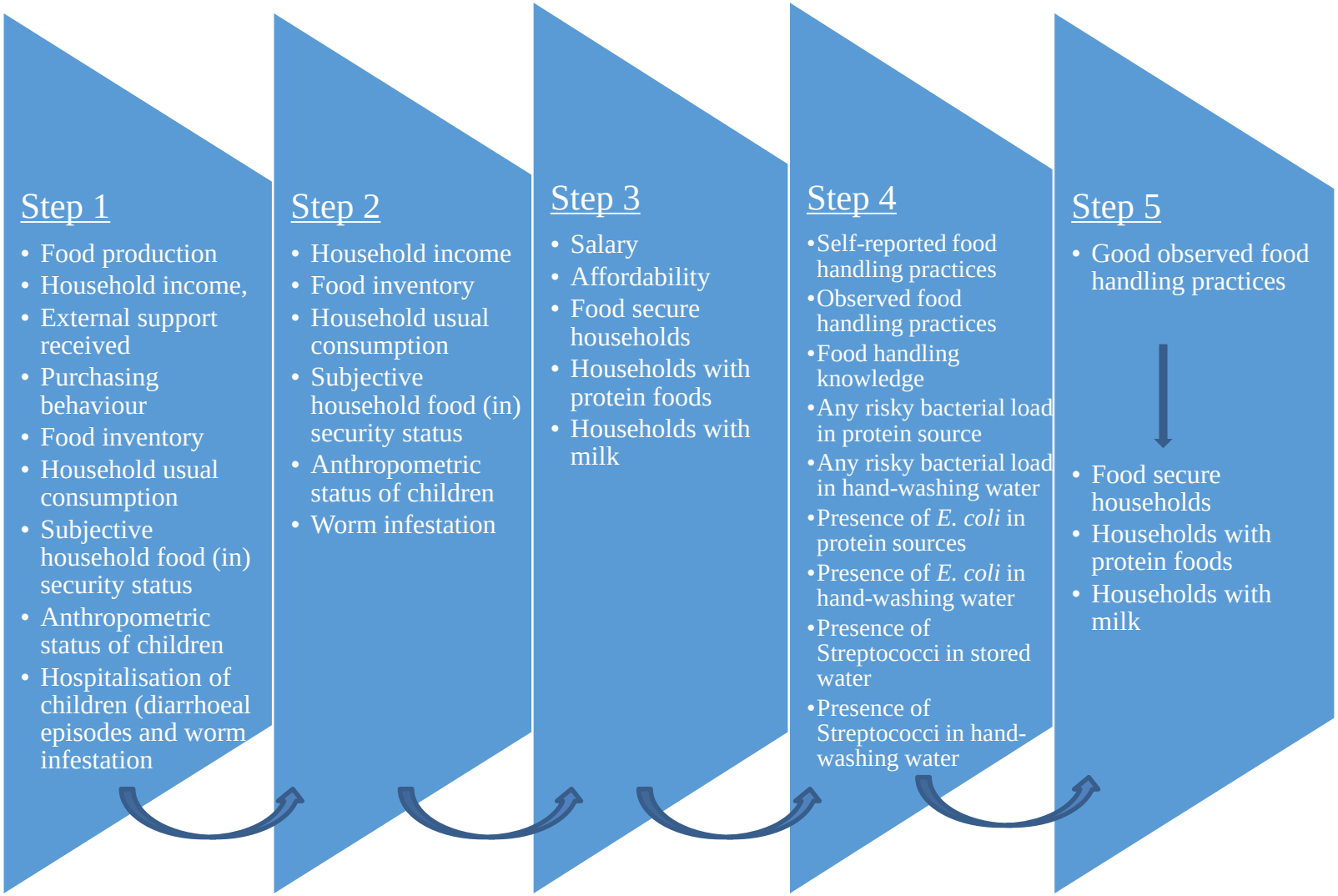


Figure 4.5 Results of the indicator reduction process in the development of food safety indicators

5.1 INTRODUCTION

The results on the attempt of the development of food safety indicators that can be used in the measurements of HFS in a rural setting will be discussed in this chapter. The most important observations regarding HFS, household food safety and the relationship between household food safety and HFS, as well as the development of food safety indicators of rural HFS will be discussed. Where possible, the results will be compared to other studies.

The sample of the study comprised 335 households from 29 villages of Thulamela municipality, Vhembe District. Each participating household had1child 3 to 5 years of age included in the study and a caregiver as a respondent. Water and food samples were collected from 34% of households.

5.2 THE LIMITATION OF THE STUDY

Although a single 24 hour recall was coupled with household FFQ, uncertainty of results was still observed. There were foods that were indicated in the diet of children but were never used in their respective households. Implication could be that the used method of determining the usual diet of children was compromised by foods that children ate away from home. However, results of the study are not expected to be affected because there were very few discrepancies observed between intake reported from the 24 hour recall and foods that were present in the households.

The possibility of under-reporting of high fat foods could be the limitation of the study. However, other studies also indicate a relative low fat intake in the rural areas (Shisana *et al*., 2013:171; Steyn & Labadarios, 2000:226). Crispy chips and coffee creamers were amongst top foods available in the households. Furthermore, it was discovered that some regularly used foods (*gwengwelele*) had fat added during preparation. However, the amounts consumed seemed to be minimal with chips reported to be eaten by children once a week (median).

Provision of false information by respondents is always a foreseen shortcoming of the data collection when using interviews due to various reasons including the anticipation to receive assistance (Pinstrup-Andersen, 2009:7). For instance, over-reporting food handling practices

as cautioned in the literature (Gilbert *et al.*, 2007:311; Baş *et al.*, 2006:320; Wilcock *et al.*, 2004:61) may have occurred as results shown that observed food handling practices had low score compared to self-reported practices score. However this shortcoming assisted with the insight that respondents may have knowledge but still do not use it in practice.

The results obtained for *vhuswa* contamination may have been influenced by the holding time (the interval between preparation and consumption) as this was not controlled in this study. However, the results are supported by the study conducted by Potgieter *et al.* (2005:152) that had controlled this aspect and was done in the same study area.

5.3 HOUSEHOLD FOOD SECURITY

Household food security was described by demographic and household characteristics that had an impact on HFS, the availability and accessibility of foods in the households, the usual household food consumption and indirectly by nutritional and health status of children (3-5 years old). The section will conclude with a comparison of the HFS indicators and a short summary.

5.3.1 Demographic and households characteristics

Household characteristics are important determinants of food security, nutritional and health statuses (Gibson, 2005:7). Rural setting was targeted for this study because literature indicates that food insecurity is likely in households situated in rural areas (Bonti-Ankomah, 2001:2; Rose & Charlton, 2002:386). However, the profile of households in the present study, included being grandparent-headed (58.2%), caregivers being mothers (58.5%), small sized families (51.9%) and 77.3% with few (1 or 2) children 1 to 9 years old children, and in this regard did not show determinants of food insecurity such as younger age headed households, large family sizes and many young dependent children as stated by De Cock *et al.* (2013:Online) and FAO/WHO (1992:11). As households in this study had few family members (2-5), the available food that could be accessed by the households was shared by few people thereby favouring the state of food security. Furthermore, about 40% of the households had other members of the family who were living away from home and who were giving them financial support. The age group that is very demanding financially in several ways (food, school, clothing, health and the like) are children less than 9 years old. Having a high number of children from this age group

in one household would serve as a determinant of food insecurity status. As rural South Africans have a history of compound families, the shift observed in this study towards smaller family sizes indicates a social transition that could likely benefit the households towards achieving food security.

On the contrary, the characteristics of caregivers in this study, including their low educational levels and unemployment status, were not suggesting strengthening of food security in the households. For instance, low level of education was also implicated by De Cock *et al.* (2013:Online) as one of the limiting human capital factors in achieving HFS. Furthermore, low income could be attributed to unemployment. The Human Science Research Council (2005:5) indicated that low income is a main factor that makes it difficult to access food in rural areas. Although it is a positive attribute for children to be looked after by their mothers, the characteristics of caregivers, such as low levels of education (82.7%) and unemployment (76.7%) in this study might have been compromising the chances of the households to access sufficient foods thereby possibly negatively affecting achievement of HFS.

5.3.2 Household food availability and accessibility

Important factors determining access to food are ownership of land, coupled with household resources (capital, labour and knowledge) and prices (Gross *et al.*, 2000:3,5; FANTA, 2003:4). Almost all households in this study had land that was used for gardening and field cultivation. However, household members had very limited agricultural knowledge and according to USAID (1992:Online), agricultural knowledge is one of the constraints towards availability of food. Some households used their land for livestock farming but this was not a popular practice therefore, livestock was not widely used for food shortage alleviation. Home production has its own challenges including climatic conditions, production resources, distribution channels and community infrastructure (Boshoff & Kgaphola, 2006:13; Riely *et al.*, 1999:12; USAID, 1992:Online). Therefore, land ownership does not really determine sustainable food access by the households. This observation is similar to the findings by De Cock *et al.* (2013:Online) indicating that household food production did not seem to influence food security in the study done in Limpopo province. In South Africa, community greenery projects and home gardening have been promoted as one way of fighting food insecurity however in this study greenery project training was not common, implicating non-participation in such government strategies. The reasons for not participating were beyond the scope of this study. It can be deduced that the land owned by the households was not used to its maximum potential to assist achieving

and maintaining food security. Food production is likely not contributing much towards FS of the households in this study.

Household income and expenditure are common indicators used to indicate the potential of households to buy sufficient foods (De Cock *et al.*, 2013:Online; HSRC, 2005:5; Riely *et al.*, 1999:35; FAO/WHO,1992:11). Low income has been reported as a concern in South Africa mainly in rural areas (Machete, 2004:Online; De Klerk *et al.*, 2004:25; Rose & Charlton, 2002:386). Hendricks (2005:116) noted even difficulty in purchasing staple food in South African rural areas. Limpopo was reported as the province that accessed child support grants (84%) more than any other province in South Africa (Kruger *et al.*, 2007:27). In line with these reports, results of this study suggest that households survived mainly through the national governmental social grants. National governmental social grants may not be regarded as a stable source of income as new governmental administration may decide not to continue with the same policy. However, there were three other different streams of household income besides employment, grants and pension. There were households that received monthly income support from their migrant family members (40.3%), others made loans to buy food (44.2%) and 61 households received financial assistance from the community members or their relatives (61/335, 18.2%). It was not determined whether the informal assistance was on loaning basis as well. Accepting loans could be working towards food insecurity however, as loaning further puts a strain on the FS status through expected pay back with quite a very high interest in certain instances.

The specific amount of money that could be available per individual in the household could not be determined in this study because of collecting categorical household income data. Nevertheless, the measuring of the cash flow of household without determining expenditure behaviour could also be misleading as money could have been committed in other non-food necessities (education, electricity, clothes and the like) or even on unnecessary destructive behaviours like buying alcohol. Hence, purchasing behaviour is usually measured to ascertain the proportion of money used for food. In this study, purchasing behaviour was measured but the amount spent on buying food was not determined. Loaning to buy food and receiving income from community members and relatives suggest households that were either food insecure or at risk.

Households that received external support (cash, food or any other material), either governmental social support or humanitarian relief from other organisations, assistance from the community members or individuals, are regarded as incapable of accessing sufficient food therefore, vulnerable to food insecurity (Riely *et al.*, 1999:12). Most households in this study were not recipients of governmental or NGOs support to alleviate food insecurity. Instead, 31% of the households depended on community members and their relatives for money and food. It was not clear why households in this study opted to be assisted informally rather than formally. Possibly, they were not aware of the processes to access governmental or non-governmental support or they associated the formal support with being stigmatised. Informal assistance might aggravate the difficulty of accessing food by these households if assistance is on loaning basis as they would have to pay back and in most cases with interest. The results of this study seem to indicate that almost one third of households were either food insecure or at risk hence they resorted to external assistance.

The ability of households to purchase food determines household food access (Gross *et al.*, 2000:7; Riely *et al.*, 1999:35). In this study cash was reportedly the main mode used to acquire food. However, almost 1 in 5 households loaned the money to buy and some households got food from the markets on credit. These results also suggest difficulty of the households in acquiring food. In addition, households bought food from the local informal shops (*Spaza* shops) and hawkers. Prices at the *Spaza* shops are often higher compared to supermarkets but expense could have been balanced by saving in transport and time. Hawkers on the other hand usually sell fresh produce from the nearby farms and therefore at relatively low prices. Distance to market places also determines accessibility of food (Sayed, 2006:6; Hahn, 2000:3). In the case of these households, food was accessible in terms of a shorter distance to be travelled to obtain food but, prices, as a determinant of food access as well (Gross *et al.*, 2000:3) could have been limiting HFS. Food prices have been escalating lately due to inflation therefore, even relatively low priced food sold by the hawkers might not have been affordable to many households.

Frequency of buying per month was used to test affordability of the households to buy their necessities. Households could only afford buying once in a month. Alternatively they would just buy the critically needed item at a time. However, they were not too stranded to an extent

that they could resort to foods that were otherwise not eaten (regarded as food) in their communities. Other food acquisition strategies were used as discussed above. Purchasing behaviour therefore suggests prevalence of food insecure or at risk households as both source and means of acquiring food indicated high costs. There were various ways that could be used to access food by the households mentioned by FAO (2008:5) including bartering, wild food gathering, community support networks, gifts and theft. There were few households that indicated bartering. Wild food gathering might not be regarded as a coping strategy for food security as it forms part of historical cultural practice in the study area. It was not clear from the results whether the assistance offered by the community referred to community support networks or it was in another form. Income and expenditure practices of the households indicate potential of vulnerability and/or insecurity.

Determining readily available foods at the disposal of households helps to verify capability of households to access food, type and sufficiency of that food as well as nutritional quality of the food afforded (Carletto *et al*., 2013:31; Fulkerson *et al.*, 2008:Online; Sayed, 2006:9; *Gross et al.*, 2000:5). Sufficiency of available food in the households was not determined. Foods that were available in the households were mostly basic foods possibly due to financial constraints. All households had chicken heads, litchis and mangoes. Chicken heads are an inexpensive source of protein. Litchis and mangoes were in season at time of conducting the study. The possibility was that households were getting these fruits from trees within the homesteads or buying locally at a cheaper price. Other available foods in most households were still basics including salt, maize meal, cooking oil, tea and sugar. Steyn and Labadarios (2000:245) reported maize porridge, brown bread, sugar, tea and milk as most commonly consumed foods in South Africa.

The combination of protein rich source, fruit and fortified cereals was good but could do better with more variation of colours from vegetables as well (Bourne *et al.*, 2013:241; Bowley *et al.*, 2007:287, 288). The food items that were beyond basic bracket were crisp chips possibly for children. Together with coffee creamers crisp chips were the only energy dense foods, not contributing to micronutrients in the top 22 foods found in the households. Available protein in less than a third of households included eggs, chicken feet and legumes. Most available vegetables were tomatoes and onions. Wild green vegetables were only available in just above one third of the households. Lack of green leafy vegetables in most households may be the

result of a nutrition transition (urbanisation). The other possible cause is that these vegetables are no longer gathered from the fields as was done in the past but they are also sold now in the markets. Milk and dairy foods were not available even in 30% of households instead tea/coffee creamer/whitener was common implying their replacement of milk therefore compromising adequate nutrient intake. Contrary to these results, full cream milk was however indicated as one of the top 5 foods commonly consumed in the NFCS study and less of tea/coffee creamer was used (Steyn & Labadarios, 2000:27). High prices of milk and dairy products could be the contributing factor in the use of tea/coffee creamer/whitener by the households.

The picture of foods found in the households looks better when reported in terms of food groups compared to individual items. A food-based approach has been suggested over nutrient-based as it is easily understood by consumers (Vorster, 2013:S5; Steyn *et al.*, 2006:66). Food groups available in the households were determined by calculating on average the presence of food items per food groups in all households. Starchy foods and sugar and/or foods rich in sugar were present in all households. Salt, fats/oils, vegetables and protein food groups were available in the households. Milk and fruit however were still shown to be food groups that were scanty in the households.

Hunger occurrence was tested using the Community Childhood Hunger Identification Project (CCHIP) index (Welher *et al.*, 1992) to determine food secure, at risk or food insecure households as was done in South African national studies including, NFCS (Gericke *et al.*, 2000:637) and SANHANES-1 (Shisana *et al.*, 2013:147). The NFCS Provincial (Limpopo) results indicated the prevalence of hunger at 63%. The SANHANES-1 also indicated the severity of food insecurity and vulnerability of South Africans in rural areas including Limpopo province. Hunger prevalence in the formal and informal rural was reported at 28.8% and 37% respectively while prevalence of at risk was 20.3% and 32.8% respectively. Limpopo province was one of the two provinces with the highest prevalence of food insecurity above 30%. In this study, 32.8% of households experienced hunger, 37% were at risk and 30.2% were food secure. Therefore, food insecurity in Thulamela is about half of what was reported of the province from 1999 national survey results (Gericke *et al.*, 2000:641). The credibility of subjective measurement tools such as hunger scale questionnaire and household food insecurity access scale (HFIAS) are strengthened through associations with other variables used to determine HFS. Gericke *et al.* (2000:641) used the hunger scale questionnaire data in combination with other information such as nutritional status of the children, food purchasing, and foods that

were available in the households for the integrity of their food security results. Shisana *et al.* (2013) also had similar variables but added health variables. In a more recent study by De Cock *et al.* (2013:Online) in Limpopo province, the household food insecurity that was assessed with HFIAS was even higher at 85.3% than the 32.8% found in this study. However, their Thulamela results showed a little less prevalence of food insecurity (20.7%) than the results of the present study.

In line with other South African studies done in rural areas (Hendricks, 2005:109; Machete, 2004:Online; De Klerk *et al.*, 2004:25; Rose & Charlton, 2002:386), all indicators used in this study (food production, household income, external support received, purchasing behaviour, occurrence of hunger and food that was found available in the households) point to the fact that food insecurity was prevalent in the rural households of Thulamela Municipality, Vhembe District in Limpopo province. Limpopo province has been one of the highly affected areas in those studies. Almost all households in the present study could manage to access basic foods but could at least satisfy hunger in one third of the households. Moreover, the means of accessing the available food appeared to be threatening the stability of food security as they included informal dependency (relying on other people) and buying food on credits. Stability affects food availability and accessibility as well as utilisation (Gross *et al.*, 2000:5).

5.3.3 Household usual food consumption

Household usual food consumption was measured to determine utilisation of available foods in the households. Households consumed energy rich foods, *vhuswa* and bread (almost, 6 times/week), on a daily basis. Porridge was consumed twice per day. Compared to SAFBDG (Vorster, 2013:S28) seemingly the households were able to meet the guideline on starchy foods. Plate proportion of starchy foods was not determined in this study to establish the guideline, "making the basis of most meals." Starchy foods are staple sources (sole energy sources and are relatively cheap) therefore it is likely that when consumed they are consumed in large quantities. Furthermore, De Cock *et al.* (2013:Online) showed that in Limpopo province the norm is to have 2 to 3 meals a day. Therefore, if the households in this study indeed had 2 to 3 meals per day, it could be assumed that in 2 meals starchy food would be included thus making starchy foods the basis of most meals. The maize meal used in most households was fortified, meaning households were rather buying maize meal than growing their own maize, confirming the report by Hendricks (2005:116) that staple food is bought in rural areas. Consumption of fortified foods boosts the micronutrient status of individuals.

Households were therefore not only getting energy from their staple food but also micronutrients.

Protein sources that were consumed at least once every week by most of the households were of animal origin. Therefore households consumed complete protein. It could be deduced therefore that households were at least able to get all 9 essential amino acids in correct proportions for the biological functioning of the family members (Gallagher, 2012:52). Protein of a lesser biological value was obtained daily from *vhuswa* and bread as was determined by exchange list system. Protein from foods of plant origin does not provide complete protein in the diet unless complemented with other foods such as legumes for example according to Gallagher (2012:52 and WHO/FAO/United Nations University (UNU) (2007:93). Legumes provide added nutritional benefits with dietary fibre, low fat with no saturated fats but rich in polyunsaturated fatty acids (Venter *et al.*, 2013:S36). Legumes are a cheap source of protein but the results of this study showed that legumes were consumed once weekly, contrary to the 5th guideline of SAFBDG that encourages consumption of legumes regularly (Venter *et al.*, 2013:S36). Regular consumption of legumes could provide good quality protein that would complement staple food consumption in the households. However, consumption of legumes in South Africa appears to be low compared to other countries (Venter *et al.*, 2013:S42). Low consumption of legumes could be due to cultural practices, preferences, time required to prepare them or regarding them as low status foods as well as lack of nutritional knowledge. Protein consumption also provides micronutrients in a diet. Fruit and vegetables that are the main food sources of vast number of micronutrients were poorly consumed. Micronutrient adequacy of household consumption was however not determined. Although fat was amongst most available food items in the households, FFQ results showed that it was not a constant energy source as consumption was just once in a week and amounts consumed could have been small. Low fat intake in rural areas has been reported by Shisana *et al.* (2013:171) as well. These results should however be viewed with caution as there could be under-reporting of fat intake by the respondents.

Household generally had basic meals of *vhuswa* (fresh and/or left over porridge), inexpensive but high quality protein food and *gwengwelele* (onion and tomato 'stew'). *Gwengwelele* has added fat (cooking oil), onion, tomatoes and instant soup. The amount of fat added in gwengwelele is little therefore it may not contribute much to the dietary fat intake. Vegetables

as a side dish and fruits were poorly consumed. Therefore, practically the typical meal provided starchy food (2 times/day), protein (daily), vegetables (once/week) and fat (once/week) as well as salt (2 times/day). Deducing from the frequency of consumptions, it seems the starchy food and protein sources were consumed sufficiently (meeting the recommended amounts) and it was the opposite for the vegetables and fruits. The milk and dairy intake in the households was low. There were no dairy foods or calcium–fortified foods like soya, and fruit juices in the top 22 foods found in the households. These findings are in line with the national available data in South Africa. Some of the recorded reasons for low milk and dairy consumption are cultural, economic and sensory factors as well as the lack of knowledge about the nutritive value of milk and dairy products (Vorster *et al.*, 2013). Based on these findings, it can be concluded that the usual diet of households was not sufficient for adequate nutritional status of household members.

5.3.4 Nutritional and health status of children

The anthropometric nutritional status of most children in the study was adequate. Furthermore, there were very few cases of overweight (2.1%). Nevertheless, prevalence for wasting (9.9%), underweight (9.6%) and stunting (7.8%) were observed. Wasting was a significant public health concern (>5% cut-off point). Underweight was not far off below 10% cut-off point. All national studies conducted have always reported stunting as the worse malnutrition problem and wasting as the least. Wasting indicates a recent nutritional problem. Anthropometric assessments do not indicate the exact cause of deficits unless they are used together with socio-economic information (Klasen, 2005:Online). In this study wasting prevalence of children could have been the result of instability of household food access. Although the nutritional status of children in this study showed a satisfactory anthropometric status, the prevalence wasting (9.9%), underweight (9.6%) and stunting (7.8%) were higher than recommended for an ideal situation. The ideal recommendation is to have less than 2.3% of children in a population falling below the cut off points of anthropometric status indicators (WHO, 1995:199).

Dietary status of children younger than 5 years was used to assess the household status as the young children respond faster to food and nutrient deprivation than older household members (Bowley *et al.*, 2007:282). The usual daily food intake of children in the present study compared well with foods consumed in the households indicating a restricted diet high in

starchy foods and protein rich foods of animal origin, medium in vegetables but low in fruits and very poor in milk and dairy foods. Protein was mainly contributed by *vhuswa*, bread and chicken. Steyn *et al.* (2006:72) reported similar results except for the contribution of milk that was found in their study. Steyn *et al.* (2006:72) used the NFCS data to investigate foods and beverages consumed by South African children. Their study indicated minimal variety and low food consumption from most of food groups listed on FBDGs particularly in black population. The results from the SANHANES-1 study (Shisana *et al.*, 2013:12) still found that diets in rural areas have low diversity. Consumption of variety of foods is addressed by the first PFBDG (Bowley *et al.*, 2007: 282) as a recommendation for dietary intake of children. High intake of protein rich foods by all South African children was reported in the NFCS report by Steyn and Labadarios (2000:226). In the present study however, most children did not exceed the recommended servings for fat. Fat available and consumed in the household was cooking oil and chips. The possibility is that cooking oil was used only in small amounts when cooking or there was under-reporting of chips consumption by the caregivers. Indeed there were no deep fried foods indicated in the usual consumption of the households. Furthermore, Shisana *et al.* (2013) indicated that fat intakes reduced with age except for the elderly that consumed lesser amounts than that consumed by children. Recommended number of servings consumed by children was only met with starchy foods and almost half of the children had appropriate servings for meat and meat substitutes.

Despite food insecurity suggested by all other indicators used in this study, most children in this study were consuming sufficient energy for their daily requirements. However, the sources of energy were not contributing towards TE as recommended. Energy intake of children was mainly contributed by carbohydrates and protein. Intake from both of these macronutrients exceeded the recommended 45%-65% and 10%-15% towards TE respectively while fat fell below the recommended %TE. Food intake of children in this study showed that they consumed more complex than simple carbohydrates. Complex carbohydrates are more valued than simple carbohydrates (sugar, sweets and chocolates) as they provide more than just energy but also nutrients (Steyn *et al.*, 2006:70). The results of this study are different from NFCS report that indicated very low energy intakes of 1 to 9 years old children in rural areas including Limpopo Province (Steyn & Labadarios, 2000:226).

Possible sources of micronutrients in the diets of children in this study were starchy food, meat and meat substitutes, vegetables and fruit. Vegetable and fruit consumption was examined

particularly for their contribution of vitamin C and β-carotene in the daily diets of children. Vitamin C and β-carotene were amongst the micronutrients that were reported as poorly consumed by South African children (Steyn & Labadarios, 2006:247). Similarly, results of this study showed that fruit was generally poorly consumed by children and the children who could get fruits still did not consume fruits that are rich in these micronutrients. Vegetables on the other side were consumed by most children although 94.6% did not meet 3 servings per day as recommended in the FGP (USDA, 2009: Online). Most vegetables that were consumed by children were rich in vitamin C but poor in β-carotene. Poor intake of milk has been reported as a norm in rural areas of South Africa. Low calcium intake put the children in the study at risk of poor bone density which can affect them later in life and possibly missing the benefit of the regulation of body weight (Lucas *et al.*, 2012:389). Calcium was reported by Steyn and Labadarios (2000:247) as one of the minerals of concern in South Africa that are consumed in approximately less than half of RDA by 50% of children.

Validation of the 24 hour recall with the household FFQ revealed that the children were consuming fruit they got from elsewhere. Children who participated in this study attended different crèches. Discrepant foods that were seen between the two measurements were possibly due to what the children consumed in their respective crèches. Some of the children who could not receive fruit, milk and vegetables at home could get them at crèche. A huge discrepancy was found with fruit consumption, as many children consumed fruit but their respective households did not have them. Many of the crèches were providing children with fruit. However, the kinds of fruit provided at the crèches were neither rich sources of vitamin C nor β-carotene. Very few children had the advantage of getting milk from their crèches, therefore, it could be assumed that milk was not a popular/affordable food item in whole study area.

Dietary assessment of children done in this study revealed that the usual diet of children enabled them to meet their daily energy requirements but mainly from carbohydrates and protein, however, the protein was mainly contributed by foods of plant origin (starchy foods and some vegetables) and therefore of low quality. Fat intake of children was low. Although excessive fat intake is indicative of adverse health conditions such as obesity however fat is still required for physiologic purposes in our bodies. Therefore, very low fat diet is not recommended. The quality of fat (consuming fats concentrated with polyunsaturated than

saturated fatty acids is advisable). The overall diet quality was probably low due to a lack of milk, fruit and a variety of daily vegetables.

Although diarrhoea is reported as one of the major causes of death in children under 5 years old, it may not be presenting as a problem of concern in this study. Few children (<20%) had diarrhoea in their lifetime at different periods. Severe diarrhoea that led to hospitalisation was experienced by 14% of children which does not correspond with the report made by Potgieter *et al.* (2005:152) that *vhuswa* and water consumed in Venda may pose diarrhoea risks due to faecal contamination. It could be argued that reporting on diarrhoea in the children could not be trusted as respondents had to recall the incidences and memory tends to fail resulting in under-reporting. However, hospitalisation, being a significant event in a child's life, may not fade in memory as diarrhoeal episodes therefore we are inclined to believe that the reporting of episodes was not so far from the truth.

On the contrary a higher number of children (35.2%) had worm infestation experiences that occurred within the previous month. Wasting therefore could not have been influenced by these incidences. Results of stool examination confirmed the reported results. Bacteria were more in numbers that exceeded normal counts while worms were found in very few children. The low worm infestation rate in this study was probably also due to the national deworming programme. The deworming in the study area is done every 6 month incorporated into the child growth monitoring schedule of the child (Mahani, 2014: Personal communication).

5.3.5 Comparison of HFS indicators

Comparison of HFS indicators will include a comparison between objective and subjective food availability and accessibility indicators as well as direct HFS indicators (food availability and accessibility indicators and usual household food consumption) and indirect HFS indicators (nutritional and health status of children aged 3-5 years).

(i) Comparison between objective (food production, household income, purchasing behaviour, external support received by households and foods available in the households) and subjective (self-reported hunger prevalence) food availability and accessibility indicators.

The probability of getting similar results with various indicators used was tested using the results of the hunger scale (indicating the categories: secure, at risk and food insecure). Interestingly, the results of the subjective measurement with the hunger scale compared well with the other HFS indicators including food available in the household (a highly objective measure). Salary, affordability and availability of specific foods confirmed the results of the hunger scale. Households that had protein rich foods, vegetables and milk were more food secure compared to households that did not have those foods. On the contrary, affordability indicated that households which could afford buying food as needed were more food insecure than those that could not afford. Perhaps those households were mainly committing more of their money to non-food items as opposed to food. This observation conflicts with the report made by Kruger *et al.* (2007:30) stating that households in South Africa spent proportionally to their income (approximately 40% of household income) on food. However, Pinstrup-Andersen (2009:7) did indicate the possibility that households with sufficient resources may prioritise goods and services over food. Hence he believed that it is important to measure behaviour subjectively in the households as part of food security assessment.

Adding insight to the contrasting views that led to much debate on the use of the subjective assessments, results of this study indicate that subjective measurements may be capable of measuring two dimensions of HFS, food availability and accessibility. Subjective assessments measure FS from household experiences, behaviours and perceptions and so on using tools like hunger scale questionnaire and household food insecurity access scale to mention few. Pinstrup-Andersen (2009:7) feared that respondents will provide false information with the anticipation to receive assistance. The proponents (Pinstrup-Andersen, 2009:7; Lemke *et al.*, 2003:759,763; Wolfe & Frongillo, 2000:2) for the use of subjective measurements advocate for their inclusion in the list of already existing FS measurements while the opponents of this idea (Hendricks, 2005:104; Rose and Charlton, 2002:384; De Klerk *et al.*, 2004:27) find subjective measurements irrelevant especially in poverty stricken areas. Frongillo (1999:508) had validated and proved that these measures can measure food insecurity and the hungry. Ballard *et al*. (2011:2) also confirmed their valid use even cross-culturally and in developing countries.

(ii) Comparison between direct (food availability and accessibility indicators and usual household food consumption) and indirect household food security indicators (nutritional and health status of children aged 3-5 years).

In this study nutritional status of children aged 3 to 5 years of age was determined for the same purpose of using results indirectly to explain food security status of households studied. HFS indicators suggested a high prevalence (66.7%) of households that were not food secure. The usual dietary intake of the children in this study suggested sufficient energy intake and could be interpreted as food secure if food security is based on only food availability and accessibility indicators. The households in this study maintained the traditional low fat diet with the exception of chips and coffee creamers. Low fat diet is recommended as it protects against chronic diseases of lifestyle. Discrepancies often found between food accessibility measures and the nutritional status of children in other studies (FAO, 2008a: Online; FANTA, 2003:5; Gross *et al.*, 2000:7; Wolfe & Frongillo, 2000:2; Frankenberger, 1992:98) were not apparent in this study. Dietary intake of children resembles that of the households except for comparatively increased intake of fruit. The dietary intake of most of the children protected them against undernutrition because it provided sufficient energy, however their micronutrient intake could be inadequate. This finding compares well with their anthropometric status which was found to be normal in most of the children (>88%).

Diarrhoea is known to have a significant impact on the nutritional status of children in developing countries (Yunus, 2011:276; Swart & Dhansay, 2008:418; Checkley *et al.*,2008: 823; Kaferstein, 2003b:S162). However, diarrhoea and worm infestation in this study were not significantly associated therefore, they did not seem to have played a role in influencing food insecurity in the households. The presence of abnormal counts of bacteria in the stools of children were, however, a cause for concern.

5.4 HOUSEHOLD FOOD SAFETY

Household food safety results will be discussed with regards to food handling practices and knowledge, as well as the microbial quality of foods and water used in the household.

5.4.1 Food handling practices and knowledge of handling practices

According to the literature, food handlers have been identified as the major food safety risk factor, mainly because their practices were associated with child diarrhoea (Takanashi *et al.*,

2009: 606; Bloomfield, 2007:2; Gilbert *et al.*, 2007:310; Jevšnik *et al.*, 2008:744; Unusan, 2007:45,50; Angellilo *et al.*, 2001:162,166).

In this study 80.9% of the caregivers reported that they handled food safely when preparing food, however good food handling practices were observed in only 45.5% of the respondents. This incongruity between self-reported and observed practices suggested that caregivers were knowledgeable of proper practices but were just not practising them accordingly. It is a common observation that respondents overestimate self-reported food handling practices thereby not reflecting the real practices (Gilbert *et al.*, 2007:311; Baş *et al.*, 2006:320; Wilcock *et al.*, 2004:61). Observational measurements present more realistic practices compared to self-reported practices (Redmond & Griffith, 2003:159). The mean score of self-reported food handling practices in this study was low (56.4%), and was even lower (47.1%) for observed practices. The implication therefore is that even though the results show that most caregivers in this study had handled food safely (scored ≥50%), the food handling practices in the households are a concern, and could probably have contributed to diarrhoeal disorders in the children.

Food handling practices can also be measured indirectly by measuring the knowledge of food handling practices. Unusan, (2007:45) and Jevšnik *et al.* (2008:744) indicated that food handling knowledge of food handlers at the consumer level is crucial for food safety control. Many caregivers (86%) in this study presented with good food handling knowledge, with also a relatively high (63.2%) mean score. Contrary to these results, Unusan (2007:49) reported a low level of knowledge compared to reported food handling practices. The difference between these two sets of results could be in the application of the knowledge regarding the test items. Otherwise it may not be explainable how food handlers managed to practice what they do not know. Unusan (2007:48) for example, only tested familiarity with food borne illnesses as opposed to food handling practices meaning the two measurements were evaluating two different factors.

The difference between the scores of food handling practices and knowledge confirms that knowledge is not a credible measure of food handling practices and behaviour. However, educational programmes are seen as a possible effective intervention to ensure safe food

consumption at home (Jevšnik *et al.*, 2008:744; Unusan, 2007:46,50; Angelillo *et al.*, 2001:166; Medeiros *et al.*, 2001b:108). The current study points to beyond just giving education. It probably showed that a different approach in giving education should be considered. Other researches (Bloomfield, 2007:3; Redmond and Griffith, 2004:312) have suggested possible ways to modify the current approach of education. For example, Bloomfield (2007:3) thinks contextualisation of presented knowledge to the food handlers may encourage their use of acquired knowledge. In the same line of thinking, Redmond and Griffith (2004:312) propose use of personal relevant messages because food handlers often distance themselves from food safety risks and cannot attach their practices particularly to the health risks of the children. Brennan *et al.* (2007:417) identified personal traits that influence unacceptable food handling practices despite being aware of the risk. Observation of food handling practices appears to be the most credible indicator of food handling practices in the households when compared to self-reported practices and knowledge. Socio-demographic factors such as age, gender and location were indicated as possible determinant factors of food safety knowledge (Unusan, 2007:46).

5.4.2 Microbiological quality of food and water used in the households

The source and storage of water used for consumption in the households as well as microbial content of stored water, hand-washing water, *vhuswa* and protein rich foods collected from the households will be considered. Microbial content was only tested from 34% of 335 households that participated in the study. Households that had complete information on both *vhuswa* and protein rich foods were 108 (32%) therefore above the targeted 30%.

Results on source and storage of water used for domestic purposes indicated that most households obtained water for their kitchen consumption from communal taps. The source itself was likely to be credible however food safety risk was introduced when water had to be collected in containers and stored. However, pathogenic *E. coli* is increasingly found from stored water even when sourced from basic clean water suppliers (Jagals *et al.*, 2013:1235). Their results linked the presence of *E. coli* to human handling during collection and storing of water. The duration of storage may increase the food safety risk. The common practice in the study households was keeping the water up to one week.

Microbial content of water used in the household will be discussed in terms of total counts, coliforms, faecal coliforms, Streptococci and *E. coli*. Total counts and coliforms were identified in almost all tested samples of water thus indicating poor general hygienic quality of water (WHO, 2011: 294; DWAF, 1996: 78). The number of stored and hand-washing water samples with coliforms were equal which may indicate that there was no form of treatment (disinfection) done to water used for hand-washing. Although several other studies (Jagals *et al.*, 2013:1235; Taulo, 2008:4; Mattick *et al.*, 2003:843) that tested water for domestic use also found poor water quality, these other studies tested water in isolation unlike in this study where stored water quality was compared with that of communal hand-washing. Faecal coliforms were mostly found in stored water but the number of water samples that had *E. coli* and Streptococci were higher in hand-washing water samples. This observation suggests that there were other faecal coliforms present in water samples that were not isolated in this study. However the presence of *E. coli* is sufficient to indicate food safety risks in water (SANS, 2011:7). Actually the presence of any faecal coliform renders water unfit for human consumption (Trevett *et al.*, 2005:259). There were few Streptococci infected water samples for both stored (8%) and hand-washing (22.1%). The presence of Streptococci in water is indicative of resistant infection (SANS, 2011:7). These results could suggest that the containers used to store water are cleaned and disinfected possibly periodically alternatively the storage duration was short enough to prevent accumulation of bacteria. The higher number of hand-washing water samples with pathogens can suggest infection of water during hand-washing.

Microbial content of food consumed in the household will be discussed in terms of coliforms, faecal coliforms, *Salmonella*, *Listeria* and *E. coli*. Food samples, *vhuswa* and protein rich foods, were tested for coliforms, *Salmonella* and *Listeria*. Fresh *vhuswa* samples refer to samples that were collected on the day of preparation while left over *vhuswa* samples were prepared the day before collection. Protein rich foods were additionally tested for the presence of *E. coli*. *Salmonella* and *Listeria* were not detected in any of the food samples tested. Coliforms were found in samples of left over *vhuswa* (57%) slightly higher than the number of protein rich foods (55.6%) but quite a comparatively low number of infected fresh *vhuswa* samples (21.4%). Protein foods are believed to be high risk foods for microbial contamination and bacterial growth because they present a conducive environment for the physiological functioning of the microorganisms (Brown, 2011:78). Left over *vhuswa* however appeared slightly more susceptible to microbial contamination in this study compared to protein foods. The lesser number of contaminated fresh *vhuswa* may be explained by other factors like

temperature of food at the time of collection than food handling practices. Taulo (2008) also found microbial load below the infective dose in similar food in Malawi that was collected for analysis at high temperatures. The importance of these findings is that immediate consumption could be preventive towards bacterial infection. The interval between food preparation and time of consumption were not measured in this study. Therefore it was unclear if increased number of fresh *vhuswa* samples were infected at the time of consumption. *E. coli* was also detected in 26.6% of protein rich foods. Results of this study suggested that water was a greater risk for microbial infection than food. The results of this study are different from the results reported by Potgieter (2005:41-42) and Potgieter *et al.* 2005:152) who detected *Salmonella* in *vhuswa,* in studies conducted in the same study area as this present study (same district but different municipalities). Potgieter (2005:41-42) indicated isolation of *Salmonella* from raw vegetables which could be due to water contamination. The researcher speculates that another possible reason for the difference in results could be the positive effect of behavioural change in food handling that could have resulted after an intervention that resulted from the earlier results. The common indicator used in all samples in this study, coliforms, was found in more water samples (94.7%) than food samples. Most households had both *vhuswa* and protein rich foods that were infected. In the other households it was the *vhuswa* that was infected rather than the protein rich foods.

Causes for concern with regards to the microbial quality of water and food in the households have already been detected with the quantitative assessment above. The results of the qualitative assessment indicated that the quality of the water especially the hand-washing water was poor, which was similar to results of Taulo (2008:6). Numerical values of microbial load were indicative of whether safety limits were exceeded. An observation made was that the more infected the samples were, the higher the bacterial load in those samples. A high bacterial load is associated with increased health risks (SANS, 2011:7). Generally, water samples had higher microbial loads compared to food samples in this study, contrary to Bloomfield (2007:3) who stated that food poses a greater food safety risk than water. Again, hand-washing water presented with higher microbial loads than stored water in the present study. According to Taulo (2008:15), hand-washing water is one of the transmission routes of pathogens to food. In the present study, the pattern showed the same tendency with food sources as *vhuswa* had higher microbial loads. Taulo *et al.* (2008:114) also reported similar food (maize flour porridge) as the most contaminated food item compared to foods tested within the same category. Total counts for infected water samples exceeded safety limits in the present study

and coliforms were also beyond the safety limits. The faecal coliforms infected 25% (upper quartile = 10^2cfu/100ml) of both tested stored and hand-washing water samples. However, Streptococci infected less than 25% (upper quartile = zero cfu/100ml or g) in both water and food samples. It would be interesting to determine if location was a determinant factor of infection. Unfortunately, that investigation was beyond the scope of this study. Profiling of pathogen loading per sample of protein rich foods indicated that all protein rich samples had coliforms. *E. coli* were detected in almost half of those infected samples. Of interest was1sample that had coliforms, *E. coli* and *Salmonella*. The results of this study have shown that although water had higher microbial load than food, both water and food had the potential to transmit pathogens similar to claims made by Bloomfield (2007:3), but contrary to the old belief that water is the only transmitter, as stated in sources such as DWAF (1996:78). In this regard, Taulo (2008:13-14) stated that water was possibly thought to be the only food safety hazard to consumers because of stringent rules and programmes put in place for food control but then was only applied at trade level.

This study suggests that the observed food handling practices and microbial quality of hand-washing water as well as handling practices of *vhuswa* are probably usable food safety indicators in measuring household food safety risks.

5.5 RELATIONSHIP BETWEEN HOUSEHOLD FOOD SAFETY AND HOUSEHOLD FOOD SECURITY

Despite incongruence commonly found between the level of food handling knowledge and food handling practice (Unusan, 2007:49; Baş *et al.*, 2006:320) food handling knowledge, including other subjective measures such as attitudes and perceptions, assessments are still used as an indirect measure of household food handling practices (Taulo, 2008: 33-44,65-66; Taulo *et al.*, 2008:113-115; Gilbert *et al.*, 2007: 307, 309-311; Baş *et al.*, 2006: 319; Redmond & Griffith, 2003:133; Bloomfield, 2007:3,5-6; Beumer & Kusumaningrum, 2003:299-300; Jay *et al.*, 1999:1285). This study confirmed that food handling knowledge may not be reflective of practices followed during food preparation in the households. The problem with studies that assess food handling knowledge (Jevšnik *et al.*, 2008:744; Unusan, 2007:46,50; Angelillo *et al.*, 2001:166) is their recommendation of educational programmes. Yet, educational programmes have not quite proved to be always effective. Hence, researchers in the household

food safety domain (Bloomfield, 2007:3; Redmond and Griffith, 2004:312) have been suggesting new avenues in educational programmes like considering the context of the content taught so that learners are able to relate it with their daily encounters. Self-reported and observed food handling practices were found associated despite the earlier finding of over-reporting of respondents. The researcher is convinced that observational measurements are more reliable than self-reporting as confirmed in the literature (Gilbert *et al.*, 2007:311; Wilcock *et al.*, 2004:61; Remond & Griffith, 2003:159).

Food handlers are critical in the prevention and control of food safety risks in the kitchen (Unusan, 2007:45; Angellilo *et al.*, 2001:162). Food handling practices were associated with the availability of protein rich foods in the households including milk. Protein rich foods are more susceptible to increased microbial growth when not handled safely. There were no associations between anthropometric status and diarrhoeal incidences of 3 to 5 years old children and food handling practices. Agustina *et al.*, (2013:Online) indicated that food handling practices were more associated with the younger age group (<2 years) in low socioeconomic urban areas of Indonesia. The present study showed an association between handling practices and worm infestation. In this study, self-reported food handling practices were associated with the contamination of hand-washing water. Most respondents who practiced food handling in an acceptable way had less contaminated hand-washing water thereby confirming that food handling practices may be a proper household food safety indicator. The most prominent contamination in both stored and hand-washing water samples was total counts and coliforms that exceeded the safety limits (>1000cfu/ml and>5cfu/100ml respectively. Coliforms were just an indication of generally poor hygienic quality of water domestically used in Thulamela households (WHO, 2011: 294; DWAF, 1996: 78). The high concentrations of these microorganisms spelled health risks of bigger magnitudes (SANS, 2011:7). The specific pathogens that were targeted for isolation including faecal coliforms, Streptococci and *E. coli* appeared not to have affected most tested samples as much as total counts and coliforms. These results could indicate that stored water was further contaminated at or after the point of collection. But then numerous counts of heterotrophic plate (Total counts) and coliforms should be indicative of the presence of other bacteria that were not isolated in this study. Faecal contamination was found in both stored (faecal coliforms) and hand-washing water (Streptococci and *E. coli*) posing a health concern (Trevett *et al.*, 2005:259). However, the presence of coliforms in stored water was associated with the

presence of *E. coli,* faecal coliforms and Streptococci (order following descending magnitude). In the study conducted by Jagals *et al.* (2013:1235) *E. coli* was isolated from water containers. It could not be established if faecal coliforms found in stored water in the present study were related to location or not because that would have more implications on the health of children in the affected areas. Poor microbial quality of water supply with faecal contamination in particular results in diarrhoeal incidents (Trevett *et al.*, 2005:268; Clasen & Bastable, 2003:112,113). In this study, poor microbial water quality was shown to be related to underweight status of children.

Stored water contamination influenced hand-washing bacterial profile although bacterial load of hand-washing was higher for Streptococci and *E. coli* possibly from contamination caused by communal hand-washing. Poor microbial quality of both stored and hand-washing water seemed to have affected left over *vhuswa* than the fresh one. However *vhuswa* contamination irrespective of the kind was associated with risky contaminated protein rich foods. Food safety risks in food and water consumed in the households of Venda were reported by Potgieter *et al.* (2005:152) raising a concern of diarrhoeal incidences in children. In this present study, reported incidences of diarrhoeal episodes in children (3-5 years of age) were few but there were significant associations between poor microbial quality of water and hospitalisation of children due to diarrhoea. Seasonal variations in these different studies may explain the difference.

The relationships between HFS and household food safety indicators and relationships amongst household food safety indicators probably indicated that there was an interaction between HFS indicators and food handling practices, polluted stored and hand-washing water as well as contamination found in food as depicted in Figure 5.1. This study tested stored and hand-washing water but other studies showed possibility of detecting food safety risks in the kitchen by using other indicators such as dish cloths (Mattick *et al*., 2003:843; Hilton & Austin, 2000:258) or water used for 'wash-up' (Taulo, 2008: 31; Mattick *et al*., 2003:843).

5.6 DEVELOPMENT OF FOOD SAFETY INDICATORS IN RURAL HOUSEHOLD FOOD SECURITY

Research indicates that food safety indicators are critical in the rural HFS because they can be used to identify the magnitude of food safety related problems for proper nutritional interventions (Unnevehr, 2003:Brief 1; Kenaan *et al*., 2001:S49; Gross *et al*., 2000:7;

Frankenberger, 1992:98, Hoddinott, 1999:2). This study attempted to develop food safety indicators proposed for use in the measurements of rural HFS in Thulamela. The developed indicators can help as stated in the literature like any other indicators in informing intervention, monitoring, evaluation and reporting as well as policy (Carletto *et al.*, 2013:31; Hendricks, 2005; Hoddinott, 1999:1,16; Frankenberger, 1992:79). Food safety is equally important for improvement of human health as food security and malnutrition (Gross *et al*., 2000:7; Frankenberger, 1992:98), therefore, failure to measure it hinders progress in the efforts to reduce food insecurity and malnutrition.

Literature has shown food safety as a missing link in the quest to eradicate food insecurity (Kenaan *et al*., 2001:S49; Hoddinott, 1999:2). Derived food safety indicators for Thulamela rural households were found to be observed food handling pracices. The implication would be when a household presents with good food handling practices that would imply a food secure household. Alternatively, when food handling practices are bad that would be an indication of food insecure household. According to Taulo (2008: 33-44,65-66) and Taulo *et al.* (2008:113-115) food handling practices are very much influenced by the microbial quality of water used in the households. Similarly, the results of this study indicated a strong association between self-reported food handling practices and the presence of faecal coliforms and *E.coli* in hand-washing water. Self-reported and observed food handling practices were not significantly different. Therefore, it could be deduced that the poor quality of hand-washing water would affect the observed food handling practices the same way as self-reported food handling practices. Both hand-washing and stored water presented with poor microbial quality. Furthermore, the results of this study showed that any risky contamination found in stored water would indicate a poor microbial quality of hand-washing water. Hence, this study would extrapolate and implicate stored water, the practice of communal hand-washing and food handling practices as indicators of HFS in rural households of Thulamela. These indicators are easy and quick to use and expected to enable measurement of household food safety during assessments of HFS status. The other advantage of the developed food safety indicators is that they are few in number therefore manageable and cost effective.

Available household food safety measures have been receiving the same criticism as with HFS measures including lack of consensus, inability to compare studies and consequently the struggle in applying effective interventions. There have been several uncoordinated indicators used in the measurements of household food safety including food handling practices, attitudes,

knowledge, microbial content in domestic water, food and environment (Redmond & Griffith, 2003:133; Baş *et al*., 2006:319; Taulo, 2008:33-44,65-66; Taulo *et al*., 2008:113-115; Bloomfield, 2007:3,5-6; Beumer & Kusumaningrum, 2003:299-300; Gilbert *et al*., 2007:307, 309-311; Jay *et al*., 1999:1285). Hand-washing used to be seen as the sole food handling indicator of the food safety risk control but there are now other indicators used including dishcloth handling, cooking methods, meat and poultry thawing practices (Bloomfield, 2007:2).

Several suggestions to curb food safety challenges in the households include offering food safety education (Jevšnik *et al.*, 2008:744; Unusan, 2007:46,50; Angelillo *et al.*, 2001:166) and use of HACCP (FSIS, 1998:Online; Griffith & Worsfold, 1994:203-205). Educating food handlers about food safety issues was not associated with food handling practices in this study and other studies (Unusan, 2007:49; Baş *et al.*, 2006:320) therefore it appears a poor strategy for the reduction of food safety risks in the kitchen for now (Unusan, 2007:49; Baş *et al*., 2006:320). It is the researcher's view that HACCP application is sophisticated for the rural kitchen use considering increased low literacy level and kitchen equipment available therefore it may not be well received at that level. However interventions that would be needed after food safety measurements with the proposed indicators would appear relevant. Furthermore, critical hazard points identified in the kitchen include purchasing, storage, preparation, cooking, serving and handling of left-over foods. The list of identified control points is too long compared to three identified by this study.

Water used and consumed in the rural households of Thulamela was identified as a food safety risk, a finding similar to earlier studies conducted in Venda (Potgieter, 2005:41-42; Potgieter *et al*., 2005:152). Although these studies including the present study also implicated *vhuswa* as a critical food safety risk, the current study showed a higher bacterial contamination in water than in food and identified water as the source of contamination of food. Trevett *et al.* (2005:259) reported faecal contamination in stored (faecal coliforms) and hand-washing water (Streptococci and *E. coli*), results similar to the results of this current study. Furthermore, Jagals *et al.* (2013:1235) also isolated *E. coli* from water containers indicating poor microbial quality of stored water thus supporting the findings in this present study.

Findings on food handling practices in this study were supported by literature. Self-reported food handling practices tend to be over-reported and food handling knowledge as mentioned above is not a good indicator of food handling practices (Unusan, 2007:49; Baş *et al.*, 2006:320). However, a significant relationship was found between self-reported and observed food handling practices in this study suggesting that self-reported practices can be successfully used.

Two of three indicators developed in this study put the food preparer in the household at the centre of food safety risks. The acceptable score for observed food handling practices were obtained by 45% of the respondents (main food preparers in the households). Furthermore, hand-washing faecal contamination was associated with the food handling practices in this study. The literature states that food handlers are a key to prevention and control of food safety risks (Unusan, 2007:45; Angellilo *et al.*, 2001:162).

Conclusion and recommendations drawn from the findings of this study will be highlighted below.

6.1 CONCLUSION

Household food security was measured objectively, subjectively (self-reporting) and indirectly by assessing nutritional and health status of children (3-5 years old). All indicators used showed a prevalence of food insecurity. Using the hunger scale, food insecurity was reported in 67% of the households. Foods available in the households and usual household food consumption suggested that most households followed a basic high starch, low fat diet that lacked variety. The protein intake was probably adequate. Consumption of fruit and vegetables as well as that of milk and dairy products was below the SAFBDG recommendations combined with the lack of variety in the diet suggested an inadequate consumption of micronutrients.

Anthropometric status of many children (>88%) was adequate however, wasting prevalence was of public concern (9.9%). The prevalence of underweight (9.6%) and stunting (7.8%) were below the WHO cut off points (<10% and <20% of the population). The usual dietary intake of most children was adequate in terms of energy, carbohydrates, fat and protein intake but inadequate in terms of micronutrients. The implication could be that households managed to access food (to satisfy hunger) but the quality of food compromised the utilisation dimension of food security. Usual dietary intake of children resembled what was available and consumed in the households except for fruit consumption that seemed to be consumed by children at the crèches. Children met the recommended number of servings for the grain and meat groups. The kinds of fruit and vegetables that they could consume were poor in β-carotene but high in vitamin C. Therefore, the diet of children suggested insufficient intake of micronutrient.

Health status was apparently good. Reported diarrhoeal episodes were relatively low (<20%) while worm infestation was high (35.2%). However, these results did not seem to have affected the anthropometric status of children (3-5 years old). Hospitalisation cases due to diarrhoeal disorders were also few (14%) and laboratory examination of stools detected very few worm

infestations (*Ascaris* (1.2%), *Trichuris* (1.9%) and *Giardia lambia* (5.6%) in children. Low incidences of worm infestations could be due to the national deworming programme.

Observed food handling practices appeared more reliable than self-reported scores but the two indicators were found significantly related. Although the respondents got good scores (mean= 86%) in the handling knowledge test, the observed food handling scores (mean=45%) indicated poor food handling practices which is of concern.

Both water and food were found to be possible routes for pathogen transmission to food consumed in the households. Stored and hand-washing water were greater risks for microbial infection compared to food. A high bacterial load water contamination was mostly with total counts and coliforms. Faecal coliforms were mostly found in stored water while *E. coli* and Streptococci were higher in hand-washing water. The implication is that the water used and consumed in the households had faecal pollution. Furthermore, there is a possibility of other bacteria present in the water that were not tested in this study. Streptococci water contamination was very low and mostly introduced by hand-washing indicating possible short periodic cleaning of the water storage containers or short duration of water storage. Hand-washing water was more contaminated than the stored water implying that communal washing increased the degradation of poor quality of stored water. Both *vhuswa* and protein rich foods also presented with high loads of total counts and coliforms but tested negatively for *Salmonella* and *Listeria*. Left over *vhuswa* appeared the most food safety risky foods than protein rich foods and fresh *vhuswa*.

The process used in the development of household food safety indicators led to the following findings. Food handling practices were similar in food secure and at risk households. Food handling practices were linked to protein rich foods and milk available in the households and there was no significant relationship between food handling practices and anthropometric status of children (3-5 years of age). An association between food handling practices and worm infestation in children (3-5 years old) however, was indicated. Households with vegetables and fat were associated with faecal contaminated water and food. Vegetable availability in the households was related to Streptococci contamination in hand-washing water and *E. coli* contaminated protein rich foods whereas fat availability was linked to Streptococci

contamination in stored and hand-washing water. Contamination of water and food in the households was associated with underweight children (3-5 years old). Diarrhoeal episodes were linked to poor microbial quality of stored water and left over *vhuswa*.

Relationships amongst household food safety indicators indicated association between self-reported and observed food handling practices. Significant links between poor food handling practices and poor microbial quality of hand-washing water were observed. These findings would imply therefore that hand-washing water played a role in worm infestation of children and underweight status of children. Contamination in hand-washing water was influenced by stored water and the hand-washing process. Hand-washing water could then be also playing a role in diarrhoeal episodes and poor microbial quality of left over *vhuswa*.

Based on the above mentioned findings, food handling practices and microbial quality of hand-washing water were then found to be possible food safety indicators that could be used in HFS measurements. Stored water as the main source of water used in the households, including use during food handling and for hand-washing, could also be considered as one of the household food safety indicators to be used in measuring HFS. Figure 6.1 illustrates the logic followed that led to the conclusion of possible food safety indicators for use in rural HFS. It may not be feasible though to include assessment of microbial quality in HFS measurements therefore possibility of observational studies on hand-washing practices could be explored.

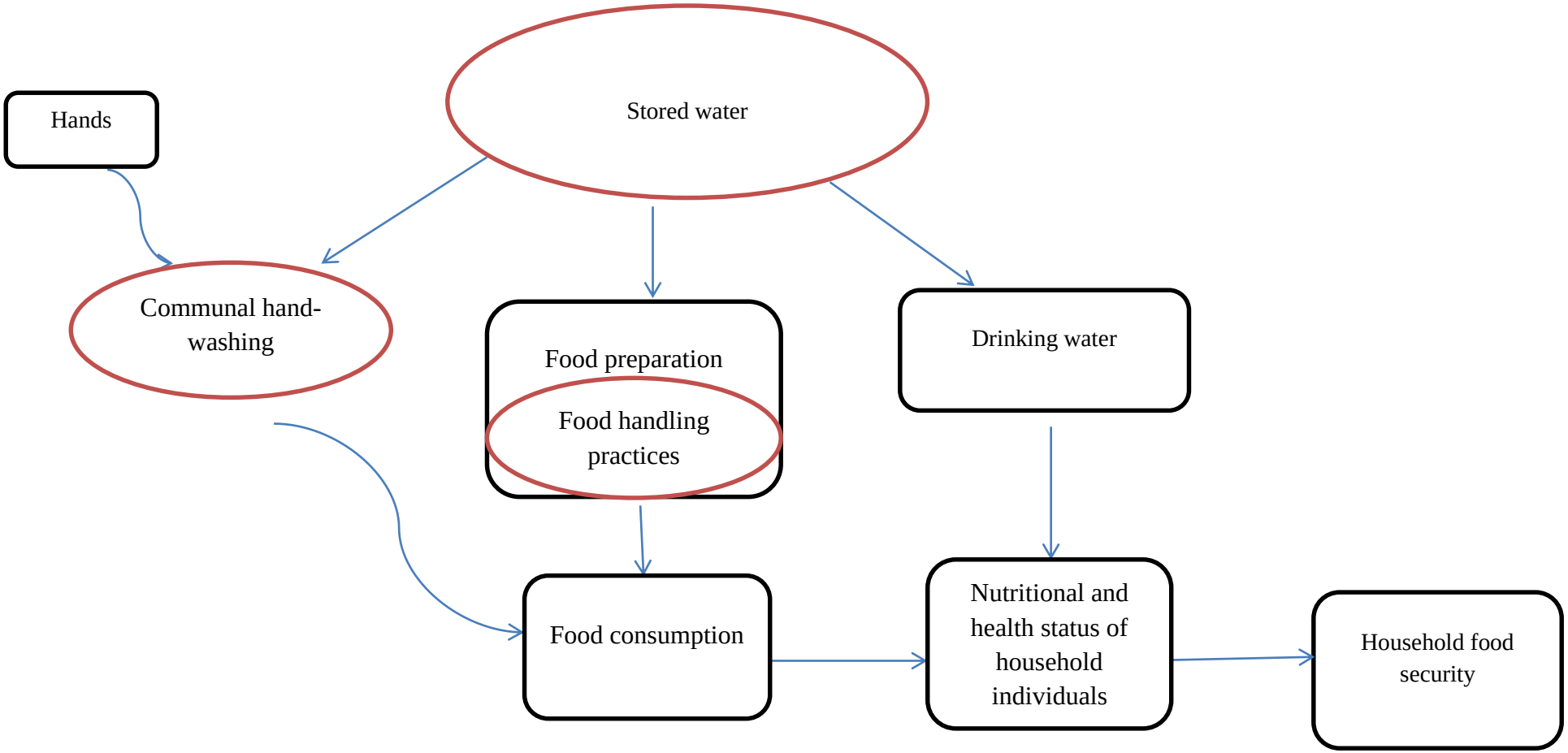


Figure 6.1. A diagram showing possible food safety influence in rural household food security measurements

Proposed areas of household food safety assessment during household food security measurements.

6.2 RECOMMENDATIONS

Recommendations for practice include use of subjective measurements for the two dimensions of HFS (availability and accessibility), supporting some researchers who have been advocating for their use (Pinstrup-Andersen, 2009:7; Lemke *et al.*, 2003:759,763; Wolfe & Frongillo, 2000:2). Findings from the present study indicated that HFS subjective indicators are capable of measuring household food availability and accessibility comparatively with the commonly used objective methods with additional assessments of salary and affordability of households to buy sufficient food per month as well as availability of protein rich foods, vegetables, milk and fat. Such measurements will be beneficial in the FS measurements because they are feasible, cost effective and quick assessments. As supported by literature (Gross *et al.*, 2000:7; Wolfe & Frongillo, 2000:2; Frankenberger, 1992:98) that indirect methods of measuring HFS, nutritional and health assessments are not always associated with food security, it may be advisable to omit them in the measurements of rural HFS.

Furthermore, food availability and accessibility in the studied community could be improved with sustainable economic support through job creation and education opportunities so that they may have sustainable salaries. It is recommended that nutrition education be offered to assist households in accessing and consuming variety of foods with inclusion of fruit, vegetables and milk.

Food safety variables recommended for use in measuring HFS include: household use of stored water, communal hand-washing practices and observed (over self-reported or knowledge) food handling practices. Taking cognisance of this recommendation will also help cut on many food safety assessments done thus saving time and costs.

Food safety education should be designed in such a way that it targets areas of household food safety risks and it be given contextually. Hand-washing, when handling food and before meals, is critical and desirable however, the communal hand-washing practice seems to be a transmitter of bacteria to food instead of protecting food (Taulo, 2008:15). The following guidelines for food safety education are recommended:

(i) It is recommended that households be taught safe ways of washing hands.

(ii) Households that store water used for hand-washing and consumption should be encouraged on keeping the water storage containers clean and avoiding long storage duration.
(iii) Beyond the water treatment done at meso and macro levels, the efforts can be extended to micro level where households are empowered to do disinfection processes of water in their households.
(iv) Encouraging households to avoid consumption of left over *vhuswa* for reduction on consumption of contaminated food. Households can be encouraged to consume all prepared food within a reasonable time period (not exceeding 4 hours) after preparation.

The newly developed food safety indicators (use of stored water in the households, communal hand-washing and food handling practices) proposed for rural HFS are recommended for capturing utilisation dimension of food security definition. Basing food safety and nutrition campaigns on these indicators is recommended for possible improvement in child nutritional and health status. It is recommended that food safety indicators be included in the measurements of HFS as suggested in the literature (Keenan *et al.*, 2001:S49; Hoddinott, 1999:2) for proper identification of food insecure households according to FAO (1996:Online) definition of food security and for effective intervention and monitoring programmes.

This study confirmed the association between HFS and food safety and revealed specific areas of concern in rural household food safety. Therefore, further research that focuses on both food security and food safety is encouraged in order to get true reflections of households and individuals who are failing to achieve not only food accessibility but food security in totality including nutrition security.

Food safety and nutrition related policy developers should take cognisance of the rural household food safety indicators herewith proposed to inform policies aimed at improving human health.

Recommended future research in relation to the findings of this study is the low faecal microbial load isolated from both water and food in this study. The studies conducted in Venda (a term that was used to describe where Tshivenda speaking people reside in South during the old regime), where Thulamela is situated, indicated a high faecal

contamination in water and food. It is also recommended that investigations of whether location and seasonal variations for specimen (food and water) collection could be determinants factor of infection be done.

It appears that the development of the household food safety indicators included in this study will probably benefit the efforts made in the struggle against food insecurity and malnutrition. Although this study focused on a small, seemingly homogenous, rural setting, it seems to be addressing the identified gap of lack of food safety indicators in HFS measurements. It is therefore recommended, that these indicators be evaluated and be included in the measuring of rural households.

6.3 THE NOVELTY OF THE STUDY

The study successfully developed food safety indicators that could be used in rural HFS measurements, a concern that has been shown by Keenan et al. (2001:S49) and Hoddinott (1999:2). Furthermore, specific rural household food safety areas of concern were determined therefore promotion of household food safety can be achieved with specific and low cost interventions. Food safety indicators developed are easy, quick and practical to measure. Thus, they will neither burden the researcher nor the respondents. Inclusion of these food safety measurements in HFS is expected to increase precision in the measurements of HFS therefore, contributing towards effectiveness of intervention strategies aimed at reducing food insecurity in rural areas and ultimately reducing malnutrition. The researcher believes that this study will open interesting research debates regarding food safety and food security thus redirecting research to focus on both of these critical spheres together at the same time as opposed to current research that studies them fragmentally.

REFERENCES

ADA, do see American Dietetic Association

American Dietetic Association. 2009. Position of the American Dietetic Association: Vegetarian diets. Journal of American Dietetic Association, 109:1266-1282.

Agustina R, Sari TP, Satroamidjodjo S, Feskens EJM and Kok FJ. 2013. Association of food-hygiene practices and diarrhea prevalence among Indonesian young children from low socioeconomic urban areas. Public Health, 13:977. [Online] available from http://www.biocentral.com [Accessed January 21st 2014]

AHA, do see Assuming health for all in the Free State

Assuming health for all in the Free State. 2007. Interdepartmental research project. University of Free State. A KXPO Research Project: KXP (Philippolis, Trompsburg and Springfontein).

Altekruse SF, Yang S, Timbo B and Angulo FJ. 1999. A multi-state survey of consumer food-handling and food consumption practices. American Journal of Preventive Medicine, 16(3):216-221.

Angelillo IF, Foresta MR, Scozzafava C and Pavia M. 2001. Consumers and foodborne diseases: Knowledge, attitudes and reported behaviour in one region of Italy. International Journal of Food Microbiology, 64: 161-166.

Ayelew M. nd. What is food security and famine and hunger? [Online]. Available from: http://www.brad.ac.uk [Accessed December 14th, 2005]

Ballard T, Coates J, Swindale A and Deitchler M. 2011. Household hunger scale: Indicator definition and measurement guide. Washington, DC:FANTA-2 Bridge, FHI 360.

Bas M, Ersun AS and Kivanc G. 2006. The evaluation of food hygiene knowledge, attitudes and practices of food handlers' in food businesses in Turkey. Food Control, 17: 317-322.

Benson T and Shekar M. 2006. Trends and issues in child undernutrition In Disease and Mortality in sub-Saharan Africa. Ed by Jamison DT, Feachem RG, Makgoba MW, et al. 2nd edition Washington DC: world Bank.

Beumer RR and Kusumaningrum H. 2003. Kitchen hygiene in daily life. International Biodeterioration & Biodegradation, 51: 299-302.

Bickel G, Nord M, Price C, Hamilton W and Cook J. 2000. Guide to measuring household food security: Measuring food security in the United States. [Online]. Available from: http://www.fns.usda.gov [Accessed January 31st, 2005]

Bloomfield SF. 2007. Focus on home hygiene in developing countries. A paper presented at the global sustainable health conference, Bonn.

Bonti-Ankomah S. 2001. Addressing food insecurity in South Africa. The national institute for economic policy. Paper presented at the SARPN conference on land reform and poverty alleviation in southern Africa, Pretoria.

Boshoff E and KgapholaM. 2006. Availability, access and utilisation of food in rural communities: A conceptual framework, In Fundamentals of nutrition security in rural development. Ed. By Schonfeldt H. Graduate readings, 3:13-23.

Bourne LT, Marais D and Love P. 2007. The process followed in the development of the paediatric food-based dietary guidelines for South Africa. Maternal & Child Nutrition, 3: 239–250.

Bourne LT, Pillme N, Sambo M and Behr A. 2013. Food hygiene and sanitation in infants and young children: a paediatric food based dietary guideline. South African Journal of Clinical Nutrition, 26(3)(supplement):S156-S163.

Bowley NA, Pentz-Klyts MA, Bourne LT and Marino LV. 2007. Feeding the 1 to 7-year-old child. A support paper for the South African paediatric food based dietary guidelines. Maternal and Child Nutrition, 3:281-291.

Brennan M, McCarthy and Ritson C. 2007. Why do consumers deviate from best microbiological food safety advice? An examination of 'high-risk' consumers on the island of Ireland. Appetite, 49:405-418.

Brown A. 2011. Understanding food: Principles and preparation. 4th ed., International edition. Wadsworth, Cengage Learning. USA.

Carletto C, Zezza A and Banerjee R. 2013. Towards better measurement of household food security: Harmonizing indicators and the role of household surveys. Global food Security, 2:30-40.

Casey PH, Szeko KL, Robbins JM, Connell C, Gossett JM and Simpson PM. 2005. Child health-related quality of life and household food security. Archives of Pediatrics and Adolescent Medicine, 159(1):51-56.

Caulfield LE, De Onis M, Blossner M and Black RE. 2004a. Undernutrition as underlying cause of child deaths associated with diarrhea, pneumonia, malaria and measles. American Journal of Clinical Nutrition, 80:193-198.

Caulfield LE, Richard SA, Rivera JA, Musgrove P and Black RE. 2004b. Stunting, wasting and micronutrient deficiency disorders, In Disease control priorities in developing countries. [Online]. Available from: http://files.dep2.org [Accessed December 12th, 2006]

Checkley W, Buckley G, Gilman RH, Assis AM, Guerrant RL, Morris SS, MØlbak K, Valentiner-Branth P, Lenata CF, Black RE and the childhood malnutrition and infection network. 2008. Multi-country analysis of the effects of diarrhoea on childhood stunting. International Journal of Epidemiology, 37:816-830.

Clasen TF and Bastable A. 2003. Faecal contamination of drinking water during collection and household storage: the need to extend protection to the point of use. Journal of Water and Health, 1(3): 109-115.

Cleaver K, Okidegbe N and De Nys E. 2006. Agriculture and rural development: Hunger and malnutrition. World Bank seminar series: Global issues facing humanity The World Bank. [Online]. Available from: http://www.siteresources.worldbank.org [Accessed December 9th, 2009]

Coates J, Frongillo EA, Rogers BL, Webb P, Wilde PE and Houser R. 2006. Commonalities in the experience of household food insecurity across cultures: What are measures missing? Journal of Nutrition, 136:1438-1448.

Decher N and Krenitsky JS. 2012. Medical nutrition therapy for lower gastrointestinal tract disorders In Krause's food, and the nutrition care process. Ed. by Mahan LK, Escott-Stump S & Raymond JL. 13th ed. Elsevier Saunders: St Louis, Missouri: 610-644.

De Cock N, D'Haese M, Vink N, Van Rooyen CJ, Staelens L, Schonfeldt HC and D'Haese L. 2013. Food security in rural areas of Limpopo province South Africa. [Online] Available from: http://www.link.springer.com [Accessed July 7th, 2013]

De Haen H and Thompson B. 2003. Food Security in a world without borders, In Modern aspects of nutrition. Present Knowledge and future perspectives. Ed by Elmadfa I, Anklam E & Konig JS. Proceedings of the 17th international congress of Nutrition, Vienna, Austria. Forum Nutrition, Basel, Karger, 56: 375-379.

De Jong AEI, Verhoeff-Bakkenes L, Nauta MJ and De Jonge R. 2008. Cross-contamination in the kitchen: effect of hygiene measures. Journal of Applied Microbiology, 105:615-624.

De Klerk M, Drimie S, Aliber M, Mini S, Mokoena R, Randela R, Modiselle S, Roberts B, Vogel C, De Swardt C and Kirsten J. 2004. Food security in South Africa: Key policy issues for the medium term. Human Science Research Council, Pretoria.

De Onis M and Habicht J. 1996. Anthropometric reference data for international use: recommendations from a World Health Organisation Expert Committee. American Journal of Clinical Nutrition, 64: 650-658.

De Onis M, Garza C, Victora CG, Onyang, AW, Frongillo EA and Martines J. 2004. The WHO Multicentre Growth Reference Study: Planning, study design, and methodology. Food & Nutrition Bulletin, 25, (Supplement 1), 15S-26S(12).

Department of Agriculture, South Africa. 2003. Integrated Food Security Strategy, [Online] Available from http://www.sarp.org.za [Accessed December 3rd, 2005]

De Swardt C. 2003. Food security in South Africa. [Online] Available from: http://www.sarp.org.za [Accessed May 14th, 2013]

Devereux S. 2003. Famine in Africa, In Food security in Sub-Saharan Africa. Ed by Devereux S & Maxwell S. South Africa: University of Natal Press:116-148.

Dodd J and Bayerl C. 2012. Behavioral-environmental: The individual in the community, In In Krause's food, and the nutrition care process. Ed. by Mahan LK, 0.

DoH,SA, do see Department of Health, South Africa.
Department of Health, South Africa. 2002. Integrated nutrition programme: A foundation for life, 3.

DWAF, do see Department of Water Affairs and Forestry
Department of Water Affairs and Forestry. 1996. South African water quality guidelines. Volume 1: Domestic water use. 2nd ed, Pretoria, South Africa.

Dykes GA, Geomaras I, Papathanasopoulus MA and Von Holy A. 1994. Plasmid profiles of *Listeria* species associated with poultry processing. Food Microbiology, 11(6):519-523.

Escott-Stump S & Raymond JL. 13th ed. Elsevier Saunders: St Louis, Missouri. 229-25.

FANTA/FAM, do see Food and Nutrition Technical Assistance and Food Aid Management.
Food and Nutrition Technical Assistance and Food Aid Management. 2003. Food access indicator review. Washington, DC.: Food and Nutrition Technical Assistance, Academy for educational Development.

FAO, do see Food and Agriculture Organisation of the United Nations.
Food and Agriculture Organisation of the United Nations. 1992. Monitoring access to food and household food security. FAO Committee on World Food Security, 17th session, Rome. [Online]. Available from: http://www.fao.org [Accessed January 13th, 2005]

Food and Agriculture Organisation of the United Nations. 1996. The sixth world survey. [Online]. Available from: http://www.fao.org [Accessed January 13th, 2005]

Food and Agriculture Organisation of the United Nations. 2001a. The World Food Summit goal and the millennium development goals. Committee on world food security, twenty-seventh session, Rome 28 May-1 June 2001. [Online]. Available from: http://wwwfao.org [Accessed February 18th, 2005]

Food and Agriculture Organisation of the United Nations. 2001b. The impact of HIV/AIDS on food security. Committee on World Food Security, twenty-seventh session, Rome. [Online]. Available from: http://www.fao.org [Accessed March 15th, 2013]

Food and Agriculture Organisation of the United Nations. 2001c. The World Food Summit: Five years later. [Online]. Available from: http://www.un.org [Accessed February 18st, 2009]

Food and Agriculture Organisation of the United Nations. 2003a. The special programme. [Online]. Available from: http://www.fao.org [Accessed March 21st, 2014]

Food and Agriculture Organisation of the United Nations. 2003b. Food security: Concepts and measurements, In Trade reforms and food security: Conceptualising linkages. FAO Corporate Document Repository. [Online]. Available from: http://www.fao.org [Accessed January 31st, 2006]

Food and Agriculture Organisation of the United Nations. 2004. Uses of food consumption and anthropometric survey in the Caribbean: How to transform data into decision-making tool. Available from: http://www.fao.org [Accessed January 31st, 2012]

Food and Agriculture Organisation of the United Nations. 2008a. Food security concepts and frameworks. EC-FAO Food security information for action programme. [Online]. Available from: http://www.fao.org [Accessed January 31st, 2012]

Food and Agriculture Organisation of the United Nations. 2008b. Measures of food consumption. Interagency workshop report, World Food Programme, Rome.

Food and Agriculture Organisation of the United Nations. 2012. The state of food insecurity in the world 2012. [Online]. Available from: http://www.fao.org [Accessed February 7th, 2013]

FAO/WHO, do see Food and Agriculture Organisation of the United Nations and World Health Organisation

Food and Agriculture Organisation of the United Nations and World Health Organisation. 1992. Improving household food security. Theme paper No. 1. International conference on nutrition: Major issues for nutrition strategies. [Online]. Available from: http://www.fao.org [Accessed January 13th, 2005]

Food and Agriculture Organisation of the United Nations and World Health Organisation. 2004. Technical consultation on national food-based dietary guidelines. Available from: http://www.fao.org [Accessed January 31st, 2012]

Fischer Walker CL, Perin J, Katz J, Tielsch JM and Black RE. 2013. Diarrhea as a risk factor for acute lower respiratory tract infections among young children in low income settings. Journal of Global Health, 3(1):1-8.

FIVIMS, do see Food Insecurity and Vulnerable Information and Mapping Systems
Food Insecurity and Vulnerable Information and Mapping Systems. [Online] Available from: http://www.fivims.net [Accessed February 17th, 2005]

Fraenkel JR and Wallen NE. 2006. How to design and evaluate research in education. Sixth edition. The McGraw Hill Companies, Inc. New York: 149-186.

Frankenberger TR. 1992. Indicators and data collection methods for assessing household food security. Household food Security: Concepts, indicators, Measurements. A Technical Review. New York: UNICEF: 73-134.

Frongillo EA. 1999. Validation of measures of food insecurity and hunger. Journal of Nutrition, 129:506-509.

FSIS, do see Food Safety and Inspection Service.
Food Safety and Inspection Service. 1998. Basics for handling food safety [Online]. Available from: http://www.fsis.usda.gov [Accessed October 7th, 2005]

Fulkerson J, Nelson MC, Lytle L, Moe S, Heitzler C and Pasch KE. 2008. The validation of a home food inventory. International Journal of Behavioural Nutrition and Physical Activity, 5:55.

Gallagher ML. 2012. Intake: The nutrients and their metabolism, In Krause's food, and the nutrition care process. Ed. by Mahan LK, Escott-Stump S & Raymond JL. 13th ed. Elsevier Saunders: St Louis, Missouri: 32-128.

Gericke G, Labadarios D and Nel JH. 2000. Hunger scale questionnaire: A measure of hunger, In The national food consumption survey (NFCS): Children aged 1-9 years South Africa, 1999. Ed. By. Labadarios D. Department of Health, Pretoria.

Gibson RS. 2005. Principles of nutritional assessment. 2nd edition. USA: Oxford University Press, Inc.

Gilbert SE, Whyte R, Bayne G, Paulin SM, Lake RJ and Van der Logt P. 2007. Survey of domestic food handling practices in New Zealand. International Journal of Food Microbiology, 117:306-311.

Griffith CJ and Worsfold D. 1994. Application of HACCP to food preparation practices in domestic kitchens. Food Control, 5(3): 200-2004.

Gross R, Schoeneberger H and Pfeifer HP. 2000. The 4 dimensions of food and nutrition security: Definition and concepts. FAO: Inwent [Online], 1-17. Available from: http://www.emeraldinsight.com [Accessed January 6th, 2007]

Grummer-Strawn LM. 2002. The use of NCHS and CDC growth charts in nutritional assessment of young infants. A white paper: Prepared for the Food Advisory Committee on infant formula, Food and drug administration: 1-22.

Gulati JK. 2010. Child malnutrition; Trends and issues. Anthropologist, 12(2):131-140.

Hahn H. 2000. Conceptual framework of food and nutrition security. FAO: Inwent1-15.

Hamelin A, Habicht J and Beaudry M.1999. Food Insecurity: Consequences for the household and broader social implications. American Society for Nutritional Sciences, 129:525S-528S. Available from: http://www.nutrition.org [Accessed March 20th, 2013]

Hammond K. 2012. Analysis of the diet, In Krause's food, and the nutrition care process. Ed. by Mahan LK, Escott-Stump S & Raymond JL. 13th ed. Elsevier Saunders: St Louis, Missouri:129-143.

Harrigan WF and McCance ME. 1966. Laboratory methods in microbiology. Academic press, University of Michigan.

Hendricks SL. 2005. The challenges facing empirical estimation of household food (in)security in South Africa. Development Bank of Southern Africa, 22 (1):103-120.

Hilton AC and Austin E. 2000. The kitchen dishcloth as a source of and vehicle for foodborne pathogens in a domestic setting. International Journal of Environmental Health Research, 10:257-261.

Hoddinott J. 1999. Operationalizing household food security in development projects: An introduction. International Food Policy Research Institute. Technical guide 1. Food consumption and nutrition division, Washington DC, USA.

Hogbin MB and Hess MA. 2009. Public confusion over food portions and servings. Journal of the American Dietetic Association, 99(10):1209-1212.

HSRC, do see Human Science Research Council.
Human Science Research Council. 2005. Report on survey in Sekhukhuni to pilot the development of a food insecurity and vulnerability modelling system (FIVIMS) for South Africa. [Online] Available from: http://www.agis.agric.za [Accessed April 20th, 2005]

Human Science Research Council. 2006. Food Insecurity and Vulnerability Information and Mapping System: Livelihood survey in Sekhukhuni district. Questionnaire: 1-20.

ICMSF, do see International Commission on Microbiological Specification for Foods
ICMSF. 1990. [online] Available from: http://www.icmsf.org [Accessed July 9th, 2012]

IFAD, do see International Fund for Agricultural Development
IFAD. Food security: A conceptual framework [Online]. Available from: http://www.ifad.org [Accessed February 25th, 2013]

IFPRI, do see International Food Policy Research Institute
IFPRI, 2000. Overcoming child malnutrition in developing countries: Past achievements and future choices. 2020 Vision for food, agriculture and environment. Discussion paper 30.

Indrawattana N, Nibaddhasobon T, Sookrung N, Chongsa-nguan M, Tungtrongchitr A, Makino S, Tungyong W and Chaicumpa W. 2011. Prevalence of *Listeria monocytogenes* in raw meats marketed in Bangkok and characterisation of the isolates by phenotypic and molecular methods. Journal of Health, Population and Nutrition, 29(1):26-38.

Jagals P. Barnard TG, Mokeana M, Ashbolt N and Roser DJ. 2013. Pathogenic Escherichia coli in rural container wasters. Water Science and Technology,67(6):1230-1237.

Jay LS, Comar D and Govenlock LD. 1999. A video study of Australian domestic food handling practices. Abstract. Journal of Food Protection, 62(11):1285-1296.
Jevšnik M, Hlebec V and Raspor P. 2008. Consumers' awareness of food safety from shopping to eating. Food Control, 19: 737-745.

Johnson AE, Donkin AJM, Morgan K, Lilley JM, Neale RJ, Page RM and Silburn R. 1998. Food safety knowledge and practice among elderly people living at home. Journal of Epidemiology in Community Health, 52(745-748).

Käferstein FK. 2003a. Food safety in food security and food trade: Food safety as a public health issue for developing countries. International Food Policy Research Institute. 2020 Focus 10, Brief 2.

Käferstein F. 2003b. Foodborne diseases in developing countries: aetiology, epidemiology and strategies for prevention. International Journal of Environmental Health Research,13:S161-S168.

Keenan DP, Olson, C & Hersey, JC. 2001. Measures of Food Insecurity/Security. Journal of Nutrition Education, 33(S1): S49-S58.

Kirkby RE. 1988. Intestinal worm infestation in white primary school children in Umkomaas. South African Journal of Family Practice, 9:78-81.

Klasen S. 2005. Anthropometric survey methods. Available from: http://www.fao.org [Accessed July12th, 2013]

Kruger A, Lemke S, Phometsi M, Van't Riet, Pienaar AE and Kotze G. 2005. Poverty and household food security of black South African farm workers: the legacy of social inequalities. Public Health Nutrition, 9 (7): 830-836.

Kruger HS, Swart R, Labadarios D, Dannhauser A and Nel JH. 2007. Anthropometric status, In The National food consumption survey: Fortification baseline (NFCS-FB) South Africa, 2005. Ed. By. Labadarios. Department of Health: 121-160.

Kuczmarski RJ, Ogden C, Flegal KM, Guo SS, Wei R, Mei Z, Curtin, Roche AF and Johnson CL. 2000. CDC growth charts: United States. Advanced data from vital health statistics, 314:1-28.

Labadarios D, Steyn NP, Maunder E, MacIntyre U, Gericke G, Swart R, Huskisson J, Dannhauser A, Vorster HH, Nesamvuni AE and Nel JH. 2000. The National food Consumption Survey (NFCS) South Africa, 1999. Public Health Nutrition, 8(5): 533-543.

Labadarios D, Swart R, Maunder EMW, Kruger HS, Gericke GJ, Kuzwayo PMN, Ntsie PR, Steyn NP, Schloss I, Dhansay MA, Jooste PL, Dannhauser A, Nel JH and Molefe D and Kotze TJvW. 2007. Executive summary of the National Food

Consumption Survey Fortification Baseline (NFCS-FB-I): South Africa, 2000. South African Journal of Clinical Nutrition, 21 (3) (Suppl 2): 245-300.

Labadarios D, Davids YD, Mchiza Z and Weir-Smith G. 2009. The assessment of food insecurity in South Africa. Human Science Research Council. [Online] Available from: http://www.npconline.co.za [Accessed February 4th, 2009]

Lee R and Nieman D. 2010. Nutritional assessment. 5th ed. New York: McGraw Hill Companies, Inc.

Leedy PD and Ormord JE. 2013. Practical Research, Planning and Design. 10th ed. Canada: Pearson Education Ltd.

Lemke S, Vorster HH, Jansen van Rensburg NS and Ziche J. 2003. Empowered women, social networks and the contribution of qualitative research: broadening our understanding of underlying causes for food and nutrition insecurity. Public Health Nutrition, 6(8):759-764.

Leroy JLJP, Van Rooyen J, D'Huaese L and De Winter A. 2001. A quantitative determination of the food security status of rural farming households in the Northern Province of South Africa. Development Southern Africa, 18(1):5-17.

Loevinsohn M and Gillepsie S. 2003. HIV/AIDS, food security, and rural livelihoods: Understanding and responding. International Food policy Research Institute. Washington, DC: 1-69.

Lorenzana PA and Sanjur D. 1999. Abbreviated measures of food sufficiency validly estimate the food security level of poor household: measuring household food security. Journal of Nutrition, 129:687-692.

LSDF, do see Limpopo Province Spatial Development Framework
Limpopo Spatial Development Framework. 2007. [Online] Available from: http://www.ruraldevelopment.gov.za [Accessed on August 16th 2008]

Lucas BL, Feucht BN, Ogata BN.2012. Nutrition in childhood. In Krause's food, and the nutrition care process. Ed. by Mahan LK, Escott-Stump S & Raymond JL. 13th ed. Elsevier Saunders: St Louis, Missouri: 389-409.

Machete C. 2004. Agriculture and poverty in South Africa: can agriculture reduce poverty? Paper presented at the overcoming underdevelopment conference held in Pretoria, 28-29 October 2004. Southern African Regional Poverty Network [Online]. Available from: http://www.sarpn.org.za [Accessed May 1st, 2005]

Mahani TO. 2014. Personal communication. Professional and Operational Manager Nurse. Vhembe District.

MAL-ED, do see, Malnutrition and enteric diseases project.

Malnutrition and enteric diseases project. (Unpublished). Etiology, Risk Factors and Interactions of Enteric Infections and Malnutrition and the Consequences for Child Health and Development: Birth Cohort Studies. Manual of Procedures.

Mattick K, Durham K, Hendrix M, Slander J, Griffith C, Sen M and Humphrey T. 2003. The microbiological quality of washing-up water and the environment in domestic and commercial kitchens. Journal of Applied Microbiology, 94:842-848.

Maxwell S. 2003. The evolution of thinking about food security, In Food security in Sub-Saharan Africa. Ed by Devereux S & Maxwell S. South Africa: University of Natal Press: 13-31.

McCalla AF and Revoredo CL. 2001. Prospects for global food security: A critical appraisal of past projections and predictions. 2020 Brief No. 71 [online]. Available from: http://www.ifpri.org [Accessed March 7th, 2005]

MDBSA, do see: Municipal Demarcation Board of South Africa

Municipal Demarcation Board of South Africa. 2007. [Online]. Available from: http://www.demarcation.org.za [Accessed January 11th, 2009]

Medeiros LC, Kendall P, Hillers V, Chen G and Mascola D. 2001a. Identification and classification of consumer food-handling behaviors for food safety education. Journal of the American Dietetic Association, 101(11):1326-1339.

Medeiros LC, Hillers VN, Kendall PA and Mason A. 2001b. Food safety education: What should we be teaching to consumers? Journal of Nutrition Education, 33:108-113.

Menza V. 2004. Targeting for nutrition improvement. FAO Corporate Document Reposisotory [Online]. Available from: http://www.fao.org [Accessed December 8th, 2009]

Murray DH, Holben DH and Raymond JL. 2012. Food and nutrition delivery: Planning the diet with cultural competency, In Krause's food, and the nutrition care process. Ed. by Mahan LK, Escott-Stump S & Raymond JL. 13th ed. Elsevier Saunders: St Louis, Missouri: 274-290.

Ogonowski K, Barnard M and Glesecke W. 1984. Bacteriological findings regarding the hygienic safety of poultry litter intended as an ingredient of feeds for ruminants. Onderstepoort Journal of Veterinary Research, 51: 249–252.

Oniang'o, RK. 2004. Nutritional challenges of the 21st century. In Modern aspect of nutrition. Present knowledge and future perspective. Ed by Elmadfa I, Anklam E & Konig JS. Proceedings of the 17th international congress of Nutrition, Vienna, Austria. Forum Nutrition, Basel, Karger, 56:373-375.

Pérez-Escamilla R and Segall-Corréa. 2008. Food insecurity measurements and indicators. Brazilian Journal of Nutrition, 21(Supplemento):15s-26s.

Petri WA, Miller M, Binder, Levine MM, Dillingham R and Guerrant RL. 2008. Enteric infections, diarrhea, and their impact on function and development. The Journal of Clinical Investigation, 188(4):1277-1290.

Pinstrup-Andersen P, Padya-Lorch R and Rosegrant MW. 2009. Global food security, In The unfinished agenda. [online]. Available from: http://www.mtnforum.org [Accessed December 5th, 2012]

Pinstrup-Andersen P. 2009. Food security: Definition and measurement. Food security,1:5-7.

Potgieter N, Obi CL, Bessong PO, Igumbor EO, Samie A and Nengobela R. 2005. Bacterial contamination of *vhuswa*-A local weaning food and stored drinking water in impoverished households in the Venda region of South Africa. Journal of Health, Population and Nutrition, 23(2):150-155.

Potgieter N. 2005. Molecular epidemiology of clinical and environmental *Salmonella* isolates and their antibiograms in rural Venda communities in the Limpopo Province, South Africa, In Origin, fate and clinical relevance of water-borne pathogens present in surface waters. Ed. by Venter SN. Water Research Commission Report: 21-50.

Psaki S, Bhutta ZA, Ahmed T, Amhed S, Bessong P, Islam M and MAL-ED Network Investigators. 2012. Household food access and child malnutrition: results from eight-country MAL-ED study. Population Health Metrics [Online], 10(24):1-11. Available from: http://www.populationhealthmetrics.com [Accessed December 5th, 2012]

Raab CA and Woodburn MJ.1997. Changing risk perceptions and food-handling practices of Oregon household food preparers. Journal of Consumer Studies and Home Economics, 21(2):117-130.

Redmond EC, and Griffith CJ. 2003. Consumer food handling in the home: A review of food safety studies. Journal of Food Protection, Abstract: 66 (1): 130-162.
Redmond EC, and Griffith CJ. 2004. Consumer perceptions of food safety risk, control and responsibility. Appetite,43:309-313.

Riely F, Mock N, Cogill, Bailey L and Kenefick E. 1999. Food security indicators and framework for use in the monitoring and evaluation of food aid programs. FANTA/

FAM. [Online] Available from: http://www.fantaproject.org [Accessed September 10th, 2005]

Rose D and Charlton KE. 2002. Prevalence of household food poverty in South Africa: results from a large, nationally representative survey. Public Health Nutrition. 5(3):383 – 389.

Samuel FO, Cole AH and Oldewage-Theron WH. 2008. Undernutrition and household environmental quality among urban and rural children in Nigeria. Pakistan Journal of Nutrition, 7(1):44-49.

SANS, do see South African National Standard
South African National Standard. 2011. Drinking water. Part 1: microbiological, physical, aesthetic and chemical determinants. SABS standards division, Pretoria, South Africa.

Sayed N. 2006. Household nutrition security in rural communities, In Fundamentals of nutrition security in rural development. Ed. By Schonfeldt H. Graduate readings, 3:1-12.

Schonfeldt HC, Pretorious B and Hall N. 2013. "Fish, chicken, lean meat and eggs can be eaten daily" a food-based dietary guideline for South Africa. South African Journal of Clinical Nutrition, 26(3)(Supplement):S66-S76.

SCN, do see Standing Committee Nutrition.
Standing Committee on Nutrition, 2004. Nutrition for improved developed outcomes, 5th report on the world nutrition situation. [online]. Available from: http://www.unscn.org [Accessed October 20th, 2007]

Shah D and Sachdev HPS. 2011. Measuring under-nutrition and over-nutrition in children, In Public Health nutrition in developing countries, Part 1, Ed by Sheila Chander Vir. Woodhead Publishing India, New Delhi.

Shetty P. 2005. Measures of nutritional status from anthropometric data. FAO Keynote paper, Rome, Italy. [Online]. Available from: http://www.fao.org [Accessed July12th, 2013]

Shisana O, Labadarios D, Rehle T, Simbayi L, Zuma K,Dhansay A, Reddy P, Parker W, Hoosain E, Naidoo P, Hongoro C, MchizaZ, Steyn NP, Dwane N, Makoae M, Maluleke T, Ramlagan S, Zungu N, Evans MG, Jacobs L, Faber M, & SANHANES-1 Team. (2013). South African National Health and Nutrition Examination Survey (SANHANES-1). Cape Town: HSRC Press.

Skovgaard N and Morgan C. 1988. Detection of *Listeria* spp. in faeces from animals, in feeds, and in raw foods of animal origin. International Journal of Microbiology, 6(3):229-242.

Snyder OP. 2006. Some food borne illness agents: Characteristics and confirmation, [Online]. Available from: http://www.hi-tm.com [Accessed November 27th, 2009]

StatsSA, do see Statistics South Africa
Statistics South Africa. 2012. General household survey. Statistics South Africa, Pretoria.

Stenberg A, Macdonald C and Hunter PR. 2008. How effective is good domestic kitchen hygiene at reducing diarrhoeal disease in developed countries? A systematic review and reanalysis of the UK IID study. Public Health, 8(71). [Online]. Available from: http://www.biomedcentral.com [Accessed October 10th, 2013]

Steyn NP and Labadarios D. 2000. Dietary intake: 24 hour recall method, In The national food consumption survey (NFCS): Children aged 1-9 years South Africa, 1999. Ed. By. Labadarios D. Department of Health, Pretoria:218-249.

Steyn NP, Abercrombie R and Labadarios D. 2001. Food security: An update for health professionals. South African Journal of Clinical Nutrition, 14(3): 98-102.

Steyn NP, Maunder EMW, Labadarios D and Nel JH. 2006. Foods and beverages that make significant contributions to macro- and micronutrient intakes of children in South Africa – do they meet the food-based dietary guidelines? South African Journal of Clinical Nutrition, 19(2):66-76.

Swart R and Dhansay A. 2008. Nutrition in infants and preschool children, In Community nutrition textbook for South Africans: A rights based approach, Ed by Steyn NP and Temple N, Chronic Diseases of lifestyle unit, South African Medical Research Council.

Takanashi K, Chonan Y, Quyen DT, Khan NC, Poudel KC and Jimba M. 2009. Survey of food-hygiene practices at home and childhood in Hanoi, Vietnam. Journal of Health, Population and Nutrition, 27(5):602-611.

Taulo S, Wetlesen A, Abrahamsen R, Kululanga G, Mkakossya R and Grimason A. 2008. Microbiological hazard identification and exposure assessment of food prepared and served in rural households of Lugwena, Malawi. International Journal of Food Microbiology, 125:111-116.

Taulo S. 2008. Microbiological risk assessment of household's food and water in a rural community. A case study in Lugwena, Malawi. Philosophiae Doctor Thesis, Norwegian University of Life Sciences.

Temple N and Steyn NP. 2013. Sugar and health: A food based dietary guidelines for South Africa. South African Journal of Clinical Nutrition, 26(3):S100-S104.
The Merck Manual of Medical information. 1997. Ed. by Berkow R, Beers MH & Fletcher AJ. Home ed. Merk research Laboratories.

Thompson FE and Subar AF. 2013. Dietary assessment methodology, In Nutrition in the prevention and treatment of disease. Ed. By. Coulston AM, Boushey CJ and Feruzzi MG. 3nd ed. Esevier Inc.

Thulamela IDP, do see Thulamela Integrated Development Plan Review

Thulamela Integrated Development Plan Review. 2008/2009. [Online]. Available from http://www.thulamela.gov.za [Accessed July 15th 2010]

Thulamela Integrated Development Plan Review. 2012/2013. [Online]. Available from http://www.thulamela.gov.za [Accessed February 11th 2014]

Tontisirin K and BattaHScharjeel L. 2003. Food security and nutrition-a household perspective, In Modern aspects of nutrition. Present Knowledge and future perspectives. Ed by Elmadfa I, Anklam E & Konig JS. Proceedings of the 17th International Congress of Nutrition, Vienna, Austria. Forum Nutrition, Basel, Karger, 56:382-383.

Trevett AF, Carter RC and Tyrell SF. 2005. The importance of domestic water quality management in the context of faecal oral disease transmission. Journal of Water and Health, 3(3):259-270.

UNICEF, do see United Nation's Children Fund.
United Nation's Children Fund. 1997. The care initiative: Assessment, analysis and action to improve care for nutrition, In care and nutrition: Concepts and measurements. Ed. By. Engle PL, Menon, P and Haddad L. International food policy research institute, Washington DC.

United Nation's Children Fund. 1998. The state of the world's children 1998. Oxford University Press, New York.

Unicomb LE. 2009. Food safety: Pathogen transmission routes, hygiene practices and prevention. Journal of Health, Population and Nutrition, 27(5):599-601.

Unnevehr LJ. 2003. Food safety in food security and food trade: Overview. International Food Policy Research Institute. 2020 Focus 10, Brief 1.

USAID, do see United States Agency for International Development

United States Agency for International Development. 1992. Policy determination: Definition of food security. [Online]. Available from: http://www.usaid.com [Accessed October 3rd, 2005]

USDA, do see United States Department of Agriculture.

United States Department of Agriculture. 2009. Food guide pyramid for young children. [Online]. Available from: http://www.cnpp.usda.gov [Accessed May 8th, 2010]

Unusan N. 2007 Consumer food safety knowledge and practices in the home in Turkey. Food Control, 18:45-51.

Van Gerwen SJC, de Wit JC, Notermans S and Zwietering MH. 1997. An identification procedure for foodborne microbial hazards. International Journal of Food Microbiology, 38:1-15.

Van Zyl J. and Kirsten J. 1992. Food security in South Africa. Agrekon, 31(4):170-184.

Venter CS, Vorster HH, Ochse R and Swart R. 2013. "Eat dry beans, split peas, lentils and soya regularly": a food-based dietary guideline for South Africa. South African Journal of Clinical Nutrition, 26(3)(Supplement):S36-S45.

Vir SC. 2011. Underntrition in children In Public Health nutrition in developing countries, Part 1, Ed by Sheila Chander Vir. Woodhead Publishing India, New Delhi.

Vorster HH. 2013. "Make starchy foods part of most meals": a food-based dietary guideline for South Africa. South African Journal of Clinical Nutrition, 26(3)(Supplement):S28-S35.

Vorster HH, Venter CS, Menssink E, Van Standen DA, Labadarios D, Strydom AJC, Silvis N, Gericke GJ and Walker ARP. 1994. Adequate nutritional status despite restricted dietary variety in adult rural Vendas. South African Journal of Clinical Nutrition, 7(2):3-16.

Watkins E and Makgetla. 2002. South Africa's food security crisis. [Online] Available from: http://www.sarpn.org [Accessed April 24th 2009]

Weisz A, Meuli G, Thakwalakwa C, Trehan, Maleta K and Manary M. 2011. The duration of diarrea and fever is associated with growth faltering in rural Malawian children aged 6-18 months. Nutrition Journal, 10(25). [Online]. Available from: http://www.nutritionj.com [Accessed January 21st, 2014]

Wehler CA, Scott RI and Anderson JJ. 1992. The community childhood hunger identification project: a model hunger - Demonstration project in Seattle, Washington. Journal of Nutrition Education, 4(1):29S-35S.

Wenhold F, Kruger S and Muehlhoff E. 2008. Nutrition for school-age children and adolescents In Community nutrition textbook for South Africans: A rights based approach, Ed by Steyn NP and Temple N, Chronic Diseases of lifestyle unit, South African Medical Research Council.

Wheeler M, Franz MJ, Madelyn L, Holler H, Cronmiller N, Delahaty MS, Harold H and Barrier P. 1996. Macronutrient and energy database for the 1995 exchange lists for meal planning: A rationale for clinical practice decision. Journal of the American Dietetic Association, 96(11): 1167-1171.

Whitney EN & Rolfes SR. 2013. Understanding Nutrition. 13th edition. Halfway House. Wadsworth.

WHO, see World Health Organisation

World Health Organisation. 1991. Basic laboratory methods in medical parasitology. Parasitology – Laboratory manuals. ISBN 92 4 154410 4 (NLM Classification: WC 25). World Health Organisation. Geneva.

World Health Organisation. 1995. Physical status: The use and interpretation of anthropometry. Report of a WHO Expert Committee. WHO Technical Report Series 854. Geneva.

World Health Organisation. 2003. WHO definition of health. Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19-22 June, 1946 (Official Records of the World Health Organization, 2:100).

World Health Organisation. Multicentre Growth Reference Study Group. 2006. WHO Child Growth Standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development. WHO, Geneva. [Online] Available from: http://www.who.int [Accessed April 27th, 2013]

World Health Organisation. 2008. Training course on child growth assessment. ISBN 92 4 159507 8 (NLM classification: WS 103). WHO, Geneva.

World Health Organisation. 2010. Nutrition Landscape Information System (NLIS). Country profile indicators: Interpretation guide. ISBN 978 92 4 159995 5 (NLM classification: QU 145). WHO, Geneva.

World Health Organisation. 2011. Guidelines for drinking water quality. 4th ed. ISBN 978 92 4 154815 1 (NLM classification: WA 675). WHO, Geneva.

WHO/FAO/University of United Nations (UNU), do see World Health Organisation, Food and Agriculture Organisation of the United Nations and University of United Nations

World Health Organisation, Food and Agriculture Organisation of the United Nations and University of United Nations. 2007. Protein and amino acid requirements in human nutrition. Report of a Joint WHO/FAO/UNU Expert Consultation. Technical

Report Series 935. [Online]. Available from: http://whqlibdoc.who.int [Accessed April 27th, 2013]

WHO/UNICEF, do see World Health Organisation and United Nation's Children Fund.

World Health Organisation and United Nation's Children Fund. 2009. WHO child growth standards and the identification of severe acute malnutrition in infants and children. A joint statement by World Health Organisation and United Nation's Children Fund. ISBN 978 92 4 159816 3 (NLM classification: WS 103). WHO, Geneva. [Online] Available from: http://www.who.int [Accessed April 27th, 2013]

Wilcock A, Pun M, Khanona J and aung M. 2004. Consumer attitudes, knowledge and behaviour: a review of food safety issues. Trends in Food Science and Technology, 15:56-66.

Wolfe WS and Frongillo EA. 2000. Building household food security measurements tools from the ground up. Food and Nutrition Technical Assistance Project: Academy for Educational Development. Washington DC.

Yang S, Leff MG, McTague D, Horvath KA, Jackson-Thompson J, Murayi T, Boeselager GK, Melnik TA, Gildemaster MC, Ridings DL Altekruse SF and Angulo FJ. 1998. Multistate surveillance for food handling, preparation and consumption behaviors associated with foodborne diseases: 1995 and 1996 BRFSS food safety questions, 47(SS-4):33-54.

Young VR and Pellet PL. 1994. Plant proteins in relation to human protein and amino acid nutrition. American Journal of Clinical Nutrition, 59(Suppl):1203S-1212S.

Yunus S. 2011. Diarrhoea and nutrition, In Public Health nutrition in developing countries, Part 1, Ed by Sheila Chander Vir. Woodhead Publishing India, New Delhi:274-291.

APPENDICES

APPENDIX 1

FOOD SAFETY INDICATORS IN HOUSEHOLD FOOD SECURITY IN THE RURAL VHEMBE DISTRICT

Permission Letters

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF HEALTH AND SOCIAL DEVELOPMENT

Enquiries: Ramalivhana NJ/Malomane EL

Ref: 4/2/2

1 September, 2010
Ms CN Nesamvuni
PO BOX 6796
THOHOYANDOU
0950

"Food safety indieters in household food security in the rural Vhembe District in Limpopo Province, South Africa"

Permission is hereby granted Ms CN Nesamvuni to conduct a study as mentioned above in , Limpopo Province of South Africa

- The Department of Health and Social Development will expect a copy of the completed research for its own resource centre after completion of the study.
- The researcher is expected to avoid disrupting services in the course of his study
- The Researcher/s should be prepared to assist in interpretation and implementation of the recommendations where possible
- The Institution management where the study is being conducted should be made aware of this,
- A copy of the permission letter can be forwarded to Management of the Institutions concerned

HEAD OF DEPARTMENT
HEALTH AND SOCIAL DEVELOPMENT
LIMPOPO PROVINCE

Received by MS Maphutle 05/11/2010

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

VHEMBE DISTRICT MUNICIPALITY

PRIVATE BAG X5006, THOHOYANDOU, 0950
TEL: 015 960 2000, FAX: 015 962 1017
Website: www.vhembe.gov.za

Ref : VDM 16/20/R
Enq : Madima N.S.

To : Nesamvuni C.N.

From : Community Services Department

Date : 06 August 2010

SUBJECT: REQUEST TO CONDUCT RESEARCH IN VHEMBE DISTRICT

1. Your letter dated 12 July 2010 has reference
2. Vhembe District Municipality has no objection in your request to conduct research in the district
3. Kindly refer your letter of request to the Department of Health and Social Development (Vhembe District) as another stakeholder for Nutrition Services.
4. Hoping that you will find this in order.

MUNICIPAL MANAGER

16/08/2010
DATE

APPENDIX 2

FOOD SAFETY INDICATORS IN HOUSEHOLD FOOD SECURITY IN THE RURAL VHEMBE DISTRICT

Consent form

Greeting: Receive warm greetings from Cebisa Nesamvuni, a PhD candidate in Nutrition**,** University of the Free State. With me I have a research team comprising of study promoter, Professor A Dannhauser, co-promoters, Professors BC Viljoen and G. Joubert, all from the University of the Free State, four field workers and two professional nurses. We will be very grateful for your willingness to participate in this study.

This study intends to contribute towards the health and nutrition of children. The information you will be providing us will be used for the purposes of this study. Confidentiality will be kept. Reporting will be on findings of the study not on individual information.

It is very important that you participate in this study because your participation can help us to get good results that can be used in trying to solve problems of malnutrition and its related death cases of children not only in Vhembe district but in our country and other countries as well. This means that you will have contributed to the future well-being of children. However, you are free not to participate if you choose to do so. If you choose to participate and along the way during the course of the study you wish to withdraw, you are also free to do so although that will disadvantage the study by reducing the chances of getting true results. There will not be any judgement or penalties charged on you.

Introduction: We are conducting this study to learn about food safety practices at home that can possibly affect the nutrition of children even when food is available and accessible. This study will help in identifying specific areas of food safety practices at our homes that need attention of the government, health professionals and people like you who are preparing food for children at home. Finally we will develop tools that can assist in detecting whether we are able to get maximum nutrients and good health from the food we have and eat in our homes.

Invitation to participate: We are inviting you to participate in this study. We would also like the participation of (one of) your child(ren) between the ages 3-5 years.

What the study involves: This study requires that we ask you questions about food available at your home, how you acquire your food and the food usually eaten at home and specifically by the study child. We will also request to see the available food in your cupboards and refrigerators where applicable on the day your home will be visited. Other questions will seek to know about hunger experiences at your home as well as diarrhoeal episodes and worm

infestations that the child has ever experienced. Because the study seeks to understand the contribution of food safety in food security we would also ask you questions on food handling during preparation. We will observe how you do things in your kitchen and it is very important that you feel free and do things the way you are used to and give honest answers as much as possible. This is not to judge you but it will help us to understand how you do things in your kitchen. You may be possibly visited more than once to make sure that the information collected is correct.

Measurements of weight and height of children, blood and stool samples will be taken once from the study child.

Blood sample (5-10ml) will be drawn from the child to test whether the child has less, enough or too much vitamin A and iron in the body. Vitamin A and iron are nutrients that we get from the food that we eat. The blood tests will be done in the laboratory. The laboratory staff members will sterilise the remaining blood after testing by steam and pour it off into sewer drains.

Samples food, *vhuswa* and meat or any equivalent, that you eat at home as well as samples of water that are used at home for consumption and hand-washing before meals will be requested for analysis.

Risks of being involved in this study: There are no foreseen risks that you can encounter by participating in this study. However, the child may feel a little discomfort when blood is being drawn. Samples of food, water and stools will be also required to investigate the presence of microorganisms that could hinder nutritional and health status of children.

Benefits of being in the study: You will be commended on recommended food safety practices and advised on recommended practices in the case of those that can be detrimental to health. You will also be informed of the results of this study.

Voluntary participation: Your participation in this study is voluntary meaning you can refuse to participate or withdraw anytime without any penalty or loss. We would however advise that you complete the study because the benefits of this study can be realised only if true representation of results could be put together.

Reimbursements: Foods that you will donate for the study will be reimbursed in the form of food parcels.

Remuneration and Expected Payment: Your contribution to this study is very important and will help in solving nutrition related problems of children in the future but you will not be paid

for participating in this study. Also, you will not be expected to pay any money for being part of this study.

Confidentiality: Efforts will be made to keep personal information confidential. Coding will be used to keep anonymity.

Permission sought: The proposal of this study was evaluated by a panel of experts in the University of Free State. Permission to conduct this study was granted by ethical committee, University of Free State, Department of Health, Limpopo Province, Vhembe District Municipality office and by the chief of your village.

Selection and pilot: The number of rural villages in Vhembe district was sought and 32 of them were randomly selected meaning each village had a chance to be chosen. Out of 32 villages we again selected randomly 400 households and your household was one of those selected. The chosen household should have at least one child of 3 to 5 years of age and a mother or a caregiver over 18 years of age. If the mother of the child is found and happens to be below the age of 18 years, she is considered but if it is a caregiver then the household will not participate. When the selected household does not meet these criteria, the next immediate household to the right-hand side is considered. The questions that will be asked were tested before to make sure that you will understand them. This was done by engaging with some of the community members. We ask them questions as we will be doing during the study then asked them if the questions were clear, they helped in the final version of the questionnaires. From the pilot we also managed to understand on average how much time you can give us in your household to get all the information that we need because it is important to us that you remain comfortable throughout the duration of this study.

Time frame: Information, weight and height measurements of the child, food, water and stools will be collected once by a fieldworker with the exception of questions on the dietary intake of the child that will be done twice, two weeks apart. The blood sample will also be collected once by a professional nurse. But because there is a lot of information that we need, we may take more than one day to collect it. Again because we want to be sure that the information that we collect is correct, the researcher will also come and repeat the same things that would be done by the field worker to check if the fieldworker is doing a proper job. Not all household will be visited by the researcher for this purpose, meaning your household may have this visit or may not have it. Households will be randomly selected.

What will happen to the findings: The findings of this study will be disseminated for other professionals and researchers to know and use them for the improvement of human life. Results will be published in scientific journals with anonymity meaning you will not be identified.

Contact details of researcher:

Name of contact person: CN Nesamvuni

Phone numbers: 0829247424 (cell) /+2715 962 8653 (Office)

Phone number of Secretariat of the Ethics Committee of the Faculty of Health Sciences, UFS: 051 405 2812 (in case you have complaints or problems with the study).

CONSENT TO PARTICIPATE IN RESEARCH

You have been asked to participate in a research study. You have been informed about the study by _____

You have been informed about any available compensation or medical treatment if injury occurs as a result of study-related procedures.

You may contact Nesamvuni CN (082 924 7424 or 015 962 8653) at any time if you have questions about the research or if you are injured as a result of the research.

You may contact the Secretariat of the Ethics Committee of the Faculty of Health Sciences, UFS at telephone number (051) 4052812 if you have questions about your rights as a research subject.

Your participation in this research is voluntary, and you will not be penalised or lose benefits if you refuse to participate or decide to terminate participation.

If you agree to participate, you will be given a signed copy of this document as well as the participation information sheet, which is a written summary of the research.

The research study, including the above information has been verbally described to me. I understand what my involvement in the study means and I voluntarily agree to participate.

_____	_____
Signature of respondent	Date
_____	_____
Signature of household head	Date
_____	_____
Signature of witness	Date

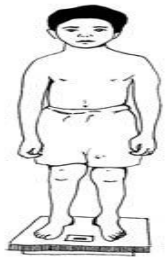
APPENDIX 3

FOOD SAFETY INDICATORS IN HOUSEHOLD FOOD SECURITY IN THE RURAL VHEMBE DISTRICT

Child Assent form

Hello! I am Cebisa Nesamvuni with me I have Ellen Mashau, Brenda Baloyi, Sibongile Mabunda, Tshilidzi Ndou and Aluwani Godzwana. We are here to ask you to help us get some answers for a study being done by the University of the Free State. We are doing this study to see if we can help reduce suffering of children from food and water related sicknesses.

This study will need to have you measured. We will measure your weight



and height.

We will also take your stools and blood once. This will take about 15 minutes to do. We will also ask your mother or caregiver about the food you eat and what she does when preparing your food.

We have asked your parent(s) or caregiver whether it is OK for you to participate, but now we want to see if it is OK with you.

All the information we collect will be kept secret and you don't have to share any of your answers in the questionnaire with anybody else. We will not use your name so everything will remain private.

By nodding your head you are showing that you understand what you are being told and what is going to be happening. If there is anything that you do not understand you can ask as many questions as you like. If you agree to take part in this study you will be asked to have your thumb coloured with ink then you place your thumb with ink on the form. You can also ask questions later if you cannot think of them now. Even though you agree now to take part in this study you can always tell when you want to stop.

ASSENT TO PARTICIPATE IN RESEARCH

You have been asked to participate in a research study. You have been told about this study by _____

You can only take part in this study if you want to and you are comfortable with it. If you do not feel like taking part it is OK you will not be punished for not agreeing.

If you agree to take part, you will nod your head. Then you will be asked to allow us to put ink in your thumb and then you put your thumb on the form to show that you agree.

What will be happening in the study was verbally explained to me and I understand what will be done by me and to me.

_____

Thumb Print Date

_____ _____

Signature of household head Date

_____ _____

Signature of Researcher/Fieldworker Date

APPENDIX 4

FOOD SAFETY INDICATORS IN HOUSEHOLD FOOD SECURITY IN THE RURAL VHEMBE DISTRICT

Maps

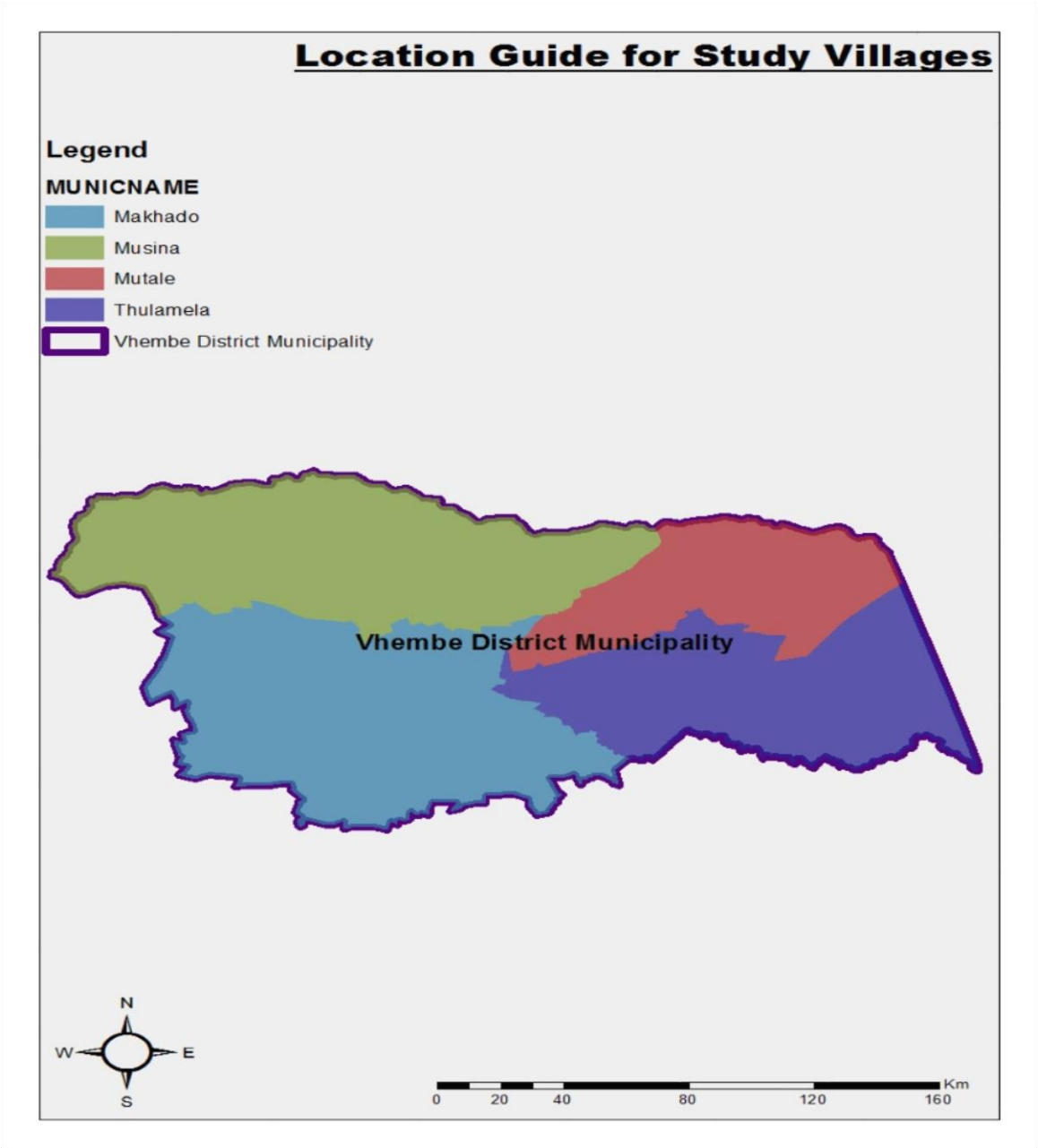


Figure 4a. A map showing Vhembe District

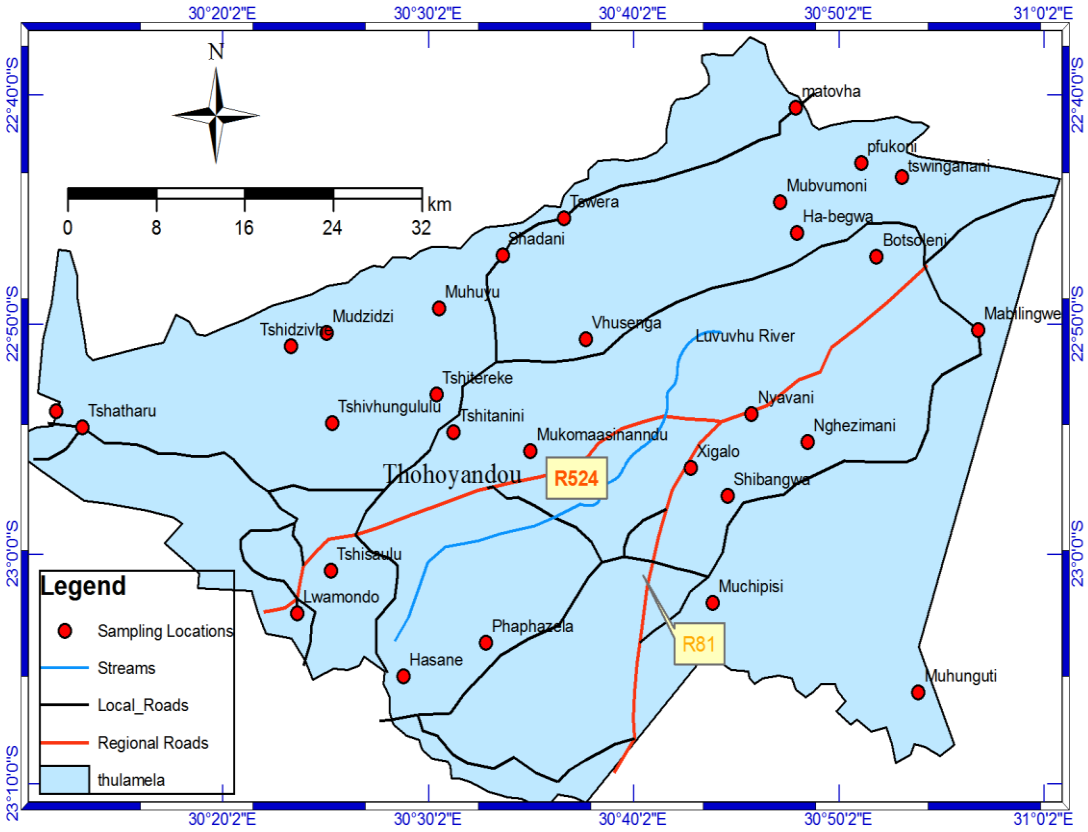


Figure 4b. A map showing study villages in Thulamela Local Municipality

APPENDIX 5

FOOD SAFETY INDICATORS IN HOUSEHOLD FOOD SECURITY IN THE RURAL VHEMBE DISTRICT

Interview Schedule

SECTION 1: SOCIO-DEMOGRAPHIC INFORMATION

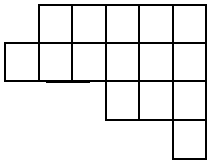
Good morning/afternoon/evening

My name is …….....
I am very pleased that you agreed to partake in this study. Your time, information and co-operation are invaluable to this study. Thank you.

Note to interviewers: The respondent in this section is a person responsible for food preparation for the child. In the event that the respondent cannot give answers, the head of the house will serve as an informant.

Instruction: Please fill in or tick where necessary in the tables below appropriately. Where the question is not relevant, e.g. follow up questions that are not applicable, tick on "Not Applicable". **Please make sure all questions are attended to.**

Child Code			
Date	dd:	mm:	yy:
Household code			
Interviewer ID			



1-5
6-11
12-14
15

Respondent's details:

1. Respondent's relation to the child	Mother	1
	Sibling	2
	Grandmother	3
	Guardian	4
	Child-minder/caregiver	5
	Other	6
Please specify		

16

2. Marital status	Single	1
	Married	2
	Separated	3
	Divorced	4
	Widowed	5

17

3. Relation of the head of the household to the child	Grandfather	
	Grandmother	
	Father	
	Mother	
	Sibling	
	Other	
Please specify		

18

4. Age	20 – 30	1
	31 – 40	2
	41 – 50	3
	51 – 60	4
	61 +	5

19

5. Highest level of formal education	None	1
	< grade 7	2
	grade 7 -10	3
	Grade 11-12 or equivalent	4
	Tertiary Education	5

20

6. Are you working?	Yes	1
	No	2

21

7. If working, whe you wor 22	Self-employed	1
	Private sector	2
	Public sector	3
	Other	4
Please specify		

Household Details:

7. The number of people currently staying with you in this household is.....

23-24

8. The number of children (1-9 years old) currently staying in this household is.....

25-26

9. Do you have any household family member(s) who work away from home (migrant workers)?	Yes	1
	No	2

27

10. The number of household/family members are working away from home is.....

28

11. Where is/are the household or family member (s) working?	Same district	1
	Same province	2
	Another province	3
	International	4
	Not Applicable	5

29-32

12. Does your household receive money from family member(s) who work away from home (migrant workers)?	Yes	1
	No	2

33

13. If yes, how often does your household receive the money?	Once a year	1
	Every few months	2
	Monthly	3
	Not Applicable	4

34

14. Indicate the type of toilet you have.	None	1
	Communal	2
	Bucket system	3
	Latrines	4
	Water flush	5

35

SECTION 2: FOOD AVAILABILITY AND ACCESS QUESTIONNAIRE

15. Does your household own land for home production?	Yes	1
	No	2

36

16. If yes, what is the land exactly used for?	Garden/small plot	1
	Orchard	2
	Field for cultivation	3
	To keep livestock in	4
	Other	5
Please specify		

37-41

17. Is there any member(s) of this household with agricultural knowledge used in food production for family consumption?	Yes	1
	No	2

42

18. Where was agricultural knowledge acquired from?	Informal education	1
	Formal education (High school level)	2
	Formal education (tertiary level)	3
	Experience from working in other house gardens	4
	Other	5
Please specify		

43-47

19. The household income is by:	Salary	1	48-53
	Wage	2	
	Pension	3	
	Grant	4	
	Selling livestock	5	
	Selling crop production	6	

20. The range of household income per month is:	<R1000	1	54
	R1000 – R2000	2	
	R2001 – R3000	3	
	> R3000	4	

21. Household food sources are (where you acquire your food):	Shops/spazas	1	55-60
	Hawkers	2	
	Home gardens	3	
	Fields	4	
	Farms	5	
	Other	6	
Please Specify			

22. The estimated amount used to purchase/buy food per month is:	< R50	1	61
	R51-R99	2	
	R100 – R500	3	
	R501 – R1000	4	
	> R1000	5	

23. Do you consider foods that your household can afford to buy socially acceptable?	Yes	1	62
	No	2	

24. If not, why do you think the food that your household can afford to buy is not socially acceptable?.....
.....
.....

25. How did your household buy food in the past four weeks? You r household used..... to buy food.	Money	1	63-67
	Credits (e.g. food stamps)	2	
	Loans from other people (relatives, neighbours etc.)	3	
	Loans from the market/shops	4	
	(Battering exchanging assets for food)	5	

26. Does your household get any other resources from other people?	Yes	1	68
	No	2	

27. If yes, the resources that your household get are:	Transfers	1
	Donations	2
	Both	3
	Other	4
Please specify		

69

28. What kind of other resources your household gets from other people?	None	1
	Cash	2
	Food	3
	Material needs	4
	Other	5
Please specify		

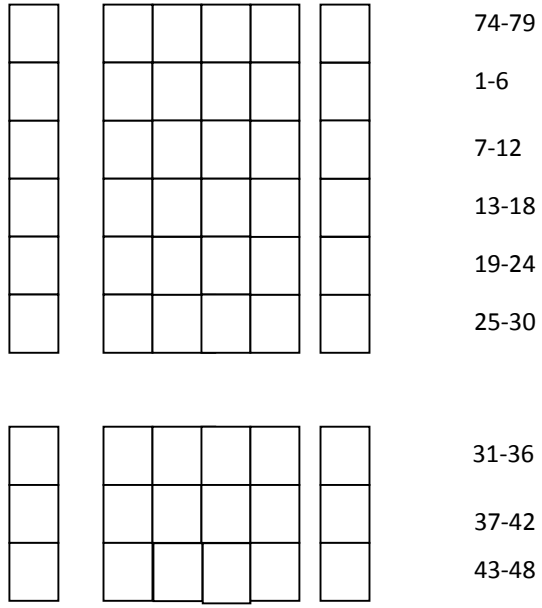
70-73

SECTION 3: FOOD INVENTORY RECORD SHEET

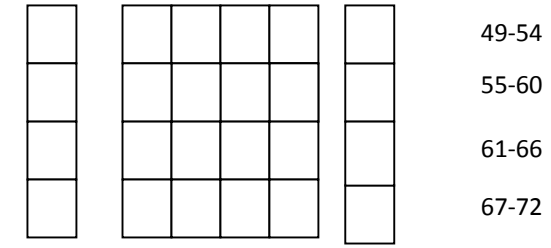
Storage Place Codes:

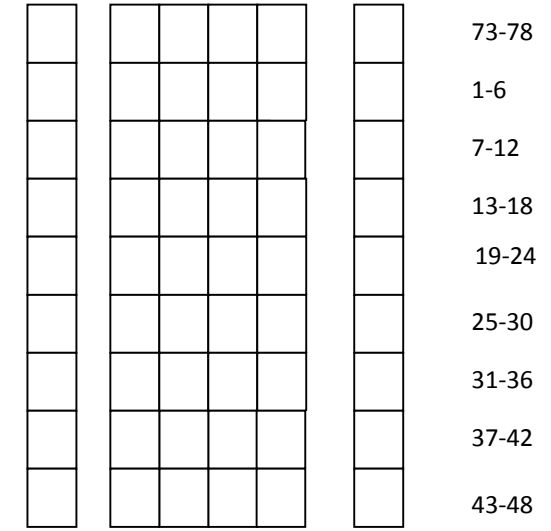
Room temp.	Refrigeration	Freezer
1	2	3

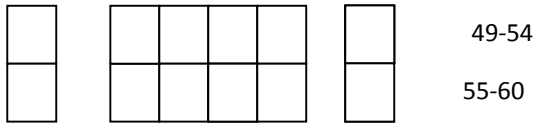
FOOD GROUP	FOOD	Yes 1	No 2	AMOUNT (Kg/ml)	STORAGE PLACE		
					1	2	3
Cereal/Bread	1. Breakfast cereals						
	2. Maize meal						
	3. Bread						
	4. Rolls						
	5. Pasta						
	6. Other, specify:						
Meat/meat alternatives	7. Eggs						
	8. Legumes						
	9. Chicken						



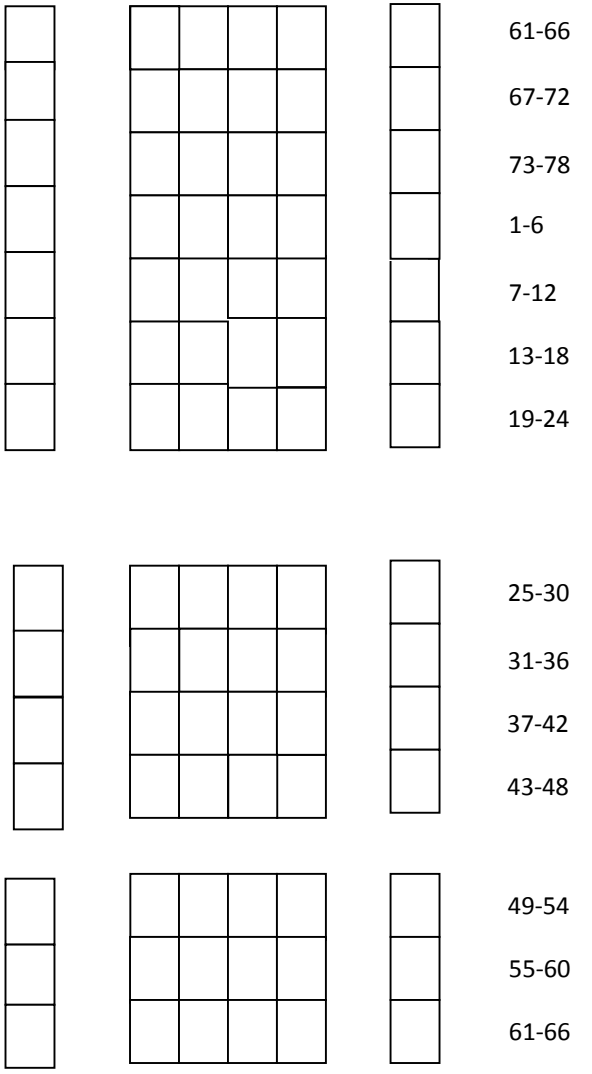
	10. Red meat				
	11. Mopani worms				
	12. Insects				
	13. Other, specify:				
Fruits	14. Avocado				
	15. Paw-paw				
	16. Mangoes				
	17. Litches				
	18. Banana				
	19. Apples				
	20. Oranges				
	21. Naartjies				
	22. Indigenous fruit,(specify)				
	23. Other, specify:				
Vegetables	24. Spinach				
	25. Cabbage				



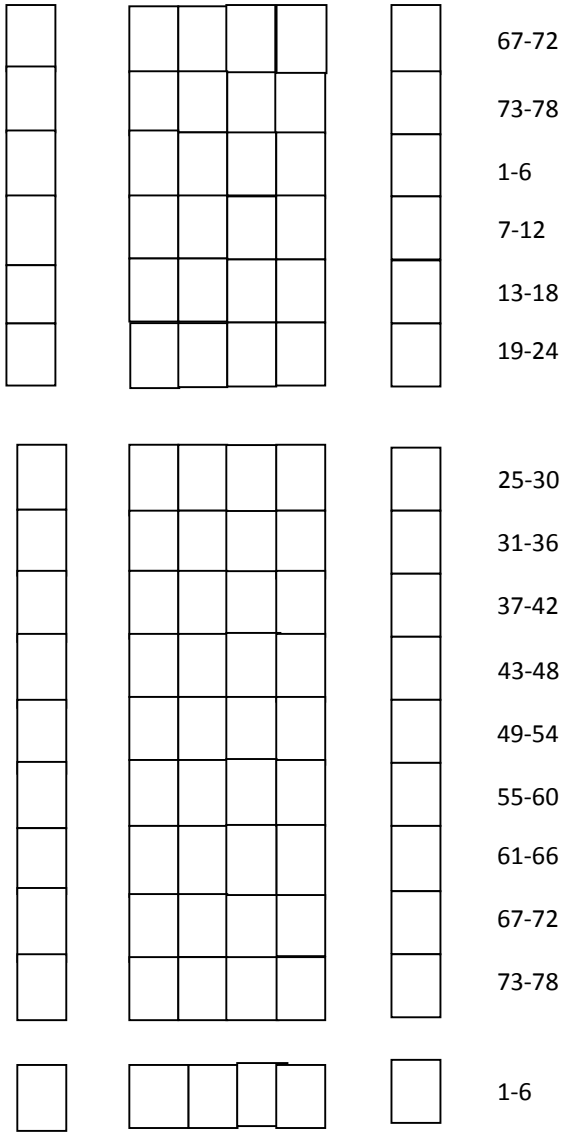




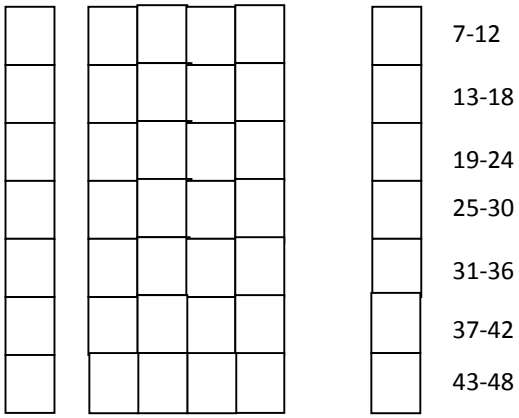
	26. Indigenous green leafy vegetables (*Muroho*)				
	27. Pumpkin				
	28. Beetroot				
	29. Potatoes				
	30. Onion				
	31. Sweet potato				
	32. Carrot				
	33. Other, specify:				
Milk/dairy products	34. Milk				
	35. Cheese				
	36. Yoghurt				
	37. Other, specify:				
Beverages	38. Tea				
	39. Coffee				
	40. Cool drink				



	41. 100% fruit juice				
	42. < 100% fruit juice				
	43. Dairy fruit mix drink				
	44. Squash drink				
	45. Alcoholic drinks				
	46. Other, specify:				
Fatty/sweet/salty foods (miscellaneous)	47. Sweets/chocolates				
	48. Biscuits				
	49. Scones				
	50. Cakes				
	51. Popcorn				
	52. Cool drinks				
	53. Ice cream				
	54. Desserts				
	55. Chips snacks				
	56. Other, specify:				
Other foods	57. Salt				



	58. Soup				
	59. Butter/margarine				
	60. Peanut butter				
	61. Cooking oil/ fats				
	62. Desserts				
	63. Coffee/tea creamer				
	64. Other, specify:				



SECTION 4: HUNGER SCALE

Hunger items	**YES 1**	**NO 2**	
Food uncertainty component			
1. Does your household ever run out of money to buy food?			☐ 49-51
1a Has it happened in the past 30 days?			☐
1b Has it happened 5 or more days in the past 30 days?			☐
• ***Qualitative component***			
2. Do you ever rely on limited number of food to feed your child because you are running out of money to buy food?			☐ 52-54
2a Has it happened in the past 30 days?			☐
2b Has it happened 5 or more days in the past 30 days?			☐
• **Individual level insecurity** • ***Quantitative component***			
3. Do you ever cut the size of meal or skip any because there is not enough food in the house?			☐ 55-57
3a Has it happened in the past 30 days?			☐
3b Has it happened 5 or more days in the past 30 days?			☐
4. Do you ever eat less than you should because there is not enough money for food?			☐ 58-60
4a Has it happened in the past 30 days?			☐
4b Has it happened 5 or more days in the past 30 days?			☐
• **Child hunger** • ***Quantitative component***			
5. Do your children ever eat less than you feel he/she should because there is not enough money for food?			☐ 61-63
5a Has it happened in the past 30 days?			☐
5b Has it happened 5 or more days in the past 30 days?			☐
6. Do your children ever say he/she is hungry because there is not enough in the house?			☐ 64-66
6a Has it happened in the past 30 days?			☐
6b Has it happened 5 or more days in the past 30 days?			☐
7. Do you ever cut the size of your child's meal or do he/she ever skip the meals because there is not enough money to buy food?			☐ 67-69
			☐
			☐

7a Has it happened in the past 30 days?		
7b Has it happened 5 or more days in the past 30 days?		
8. Do any of your children ever go to bed hungry because there is not enough money to buy food?		
8a Has it happened in the past 30 days?		
8b Has it happened 5 or more days in the past 30 days?		

70-72

SECTION 5: FOOD FREQUENCY QUESTIONNAIRE FOR HOUSEHOLDS

Food frequency questionnaire Number of times per day, per week or per month (only use one option). If food is not consumed fill in N/A.

Food	**/day**	**/week**	**/month**	
Sweets/ chocolates……..				73-78
Chips (crisp)……..				1-6
Cake/ biscuits……				7-12
Cool drinks…….				13-18
Cremora……				19-24
Coffee…….				25-30
Tea……..				31-36
Sugar……..				37-42
Full-cream milk…….				43-48
Low fat/ skim milk……				49-54
Eggs……				55-60
Peanut butter…….				61-66
Soya mince/ legumes (baked beans, dried beans/peas, lentils)….....				67-72
Chicken……				73-78
Red meat……				1-6
Fish……				7-12

Bread……								13-18
Porridge, cooked……..								19-24
Cereal (eg. Corn flakes/ Pronutro)…….								25-30
Samp/ mielie rice……..								31-36
Margarine/ oil/ fat…….								37-42
Fruit juice……..								43-48
Fruit……								49-54
Vegetables……								55-60
Salt/ stock/ Royco……								61-66
Alcohol …….								67-72

SECTION 6: 24 HR RECALL (of usual intake of the child)

24 hour usual food and fluid intake

Food/Drinks and amounts	Amount	Milk & milk products	Meat & alternatives	Bread , cereals & Legumes	Fruit	Vegetable A	Vegetable B	Fats & oils	Sweets/Sugar
Breakfast and midmorning									
Lunch and mid afternoon									
Supper and late night									
Total:									

SECTION 7: FOOD HANDLING PRACTICES OF CAREGIVERS/MOTHERS

Part I: Self-Reporting Practices

A. Hand-washing behaviour

1. Do you wash your hands before handling food?	Never	1
	Rarely	2
	Sometimes	3
	Often	4
	Always	5

26

2. Do you wash your hands after handling food?	Never	1
	Rarely	2
	Sometimes	3
	Often	4
	Always	5

27

3. Do you wash your hands after using the toilet?	Never	1
	Rarely	2
	Sometimes	3
	Often	4
	Always	5

28

4. Do you wash your hands after touching hair, face nose/mouth while handling food?	Never	1
	Rarely	2
	Sometimes	3
	Often	4
	Always	5

29

5. When you wash your hands do you use soap?	Never	1
	Rarely	2
	Sometimes	3
	Often	4
	Always	5

30

6. When you wash your hands do you use warm water?	Never	1
	Rarely	2
	Sometimes	3
	Often	4
	Always	5

31

7. When you dry your hands do you use dish towel?	Never	1
	Rarely	2
	Sometimes	3
	Often	4
	Always	5

32

B. Food preparation surfaces and utensils

8. Do you use a wooden cutting board when cutting meat/chicken/fish?	Never	1
	Rarely	2
	Sometimes	3
	Often	4
	Always	5

33

9. Do you wash preparation surfaces/utensils with clean warm soapy water after handling raw meat/chicken/fish?	Never	1	34
	Rarely	2	
	Sometimes	3	
	Often	4	
	Always	5	

10. Do you use the same preparation surface /utensils used to cut meat for vegetables without washing with warm soapy water in between?	Never	1	35
	Rarely	2	
	Sometimes	3	
	Often	4	
	Always	5	

C. Meat/chicken/fish storage

11. Do you store raw meat/chicken/fish at room temperature for more than four hours?	Never	1	36
	Rarely	2	
	Sometimes	3	
	Often	4	
	Always	5	

12. When you store raw meat/chicken/fish for more than one day do you put it in the refrigerator?	Never	1	
	Rarely	2	
	Sometimes	3	
	Often	4	
	Always	5	

13. When you store raw meat/chicken/fish for more than one day do you put it in the freezer?	Never	1	
	Rarely	2	
	Sometimes	3	
	Often	4	
	Always	5	

14. When you store raw meat/chicken/fish for more than one day do you put it in the freezer in serving portions?	Never	1	
	Rarely	2	
	Sometimes	3	
	Often	4	
	Always	5	

D. Meat/chicken/fish thawing

15. When you want to cook a frozen meat/chicken/fish do you leave it to thaw at room temperature/ in the sun?	Never	1	40
	Rarely	2	
	Sometimes	3	
	Often	4	
	Always	5	

16. When you want to cook a frozen meat/chicken/fish do you use a microwave to thaw it?	Never	1	41
	Rarely	2	
	Sometimes	3	
	Often	4	
	Always	5	

17. When you want to cook a frozen meat/chicken/fish do you leave it to thaw in cold tap running water?	Never	1	42
	Rarely	2	
	Sometimes	3	
	Often	4	
	Always	5	

18. When you want to cook a frozen meat/chicken/fish do you leave it to thaw in a bowl with cold standing water without changing it in 30 minutes intervals?	Never	1	43
	Rarely	2	
	Sometimes	3	
	Often	4	
	Always	5	

E. Handling of leftover food

19. Do you store leftover foods at room temperature overnight?	Never	1	44
	Rarely	2	
	Sometimes	3	
	Often	4	
	Always	5	

20. Do you store leftover foods for more than one day?	Never	1	45
	Rarely	2	
	Sometimes	3	
	Often	4	
	Always	5	

21. Do you store leftover foods in the refrigerator?	Never	1	46
	Rarely	2	
	Sometimes	3	
	Often	4	
	Always	5	

22. Do you store leftover foods in the freezer?	Never	1	47
	Rarely	2	
	Sometimes	3	
	Often	4	
	Always	5	

23. Do you reheat (cook again) leftover foods before they are eaten?	Never	1	48
	Rarely	2	
	Sometimes	3	
	Often	4	
	Always	5	

Part II Food Handling Practices Observation Checklist

Observed practice	Yes 1	No 2	Not observed* 3	
1. Hands are washed with soap and clean water before handling food.				49
2. Hands are washed with soap and clean water after handling food.				50
3. Hands are washed with soap and clean water before feeding the child.				51
4. Food preparation surfaces are cleaned with soapy water.				52
5. Knife is washed with warm soapy water after using in meat/chicken/fish.				53 54
6. Same utensils are used from one food item to the other without washing in between.				55
7. Food is eaten immediately after cooking.				56
8. household has a functioning refrigerator				57
9. Leftover food is cooked before eaten.				58
10. Dish towels are kept clean				

*There was no opportunity to observe this aspect.

SECTION 8: FOOD HANDLING KNOWLEDGE TESTQUESTIONNAIRE

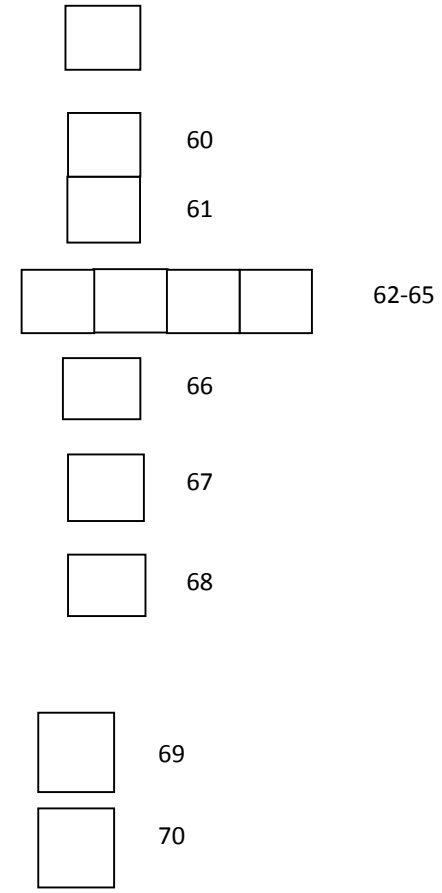
Questions/Answers

Personal Hygiene

1. Why is it important to wash hands before handling food? ----------
   ----
2. What is the proper way of washing hands? ----------
   ----
3. Why do we need to cut nails short when handling foods? ----------
   ----
4. List four critical times we need to wash our hands when preparing food? ----------
   ----
   ----
5. How can food prepared by someone with hand sores, cuts and/or boils cause sickness? ----------
   ----
   ----
6. What do we do with hand sores, cuts and boils before we can touch food? ----------
   ----
   ----
7. Why is it important **not** to handle food when we are sick? ----------
   ----

Kitchen environmental hygiene

8. What is the proper way of washing plates and eating utensils? ----------
   ----
   ----
9. What do we do to food preparation surfaces before we prepare food? ----------
   ----



---

10. Why is it important to clean/wash preparation surfaces and eating utensils with warm soapy water before using them? ---

---

11. Why is it important to clean/wash preparation surfaces and eating utensils with warm soapy water after using them? ---

---

12. Why is it important to keep away pests, pets and insects from the kitchen? ---

---

---

13. Why is it important to empty dustbins in the kitchen regularly? ---

---

Food hygiene

14. Why is it important to store food such as meat, milk and cooked food at low temperatures (in the refrigerator)? ---

---

---

15. Why is it important **not** to use same surfaces and knife used to cut meat for cutting vegetables without washing them first with warm soapy water? ---

---

---

16. Why is it important **not** to thaw meat/chicken/fish at room temperature? ---

---

---

17. Why is it important to cook food to well done stage? ---

---

18. What is the best way of keeping food after cooking if is not eaten immediately? ---

---

71

72

73

74

75

76

77

78

79

---

19. Why is it important to keep food covered? ----------

---

20. What is the best way of storing cooked food that will be eaten after two or more days? ----------
---

80

1

SECTION 9: CHILD HEALTH STATUS QUESTIONNAIRE

1. Has -------- (child's name) been hospitalised because of abdominal problems before?	Never	1
	Once	2
	Twice	3
	More than twice	4

☐ 2

2. Has -------- (child's name) been hospitalised because of diarrhoeal disorders before?	Never	1
	Once	2
	Twice	3
	More than twice	4

☐ 3

3. When was the last time -------- (child's name) been in a deworming programme?	Never	1
	In the past three days	2
	Last week	3
	Last month	4
	Past year(s)	5

☐ 4

4. Have worms been detected?	YES	1
	NO	2

☐ 5

Instruction: Below please indicate **how many times** has ---------- (child's name) experienced the following health disorders in the given time intervals. All spaces must be filled with numbers, 0 (zero) will indicate that the child has not experienced the disorder.

Health Disorder	**Past 24 hrs** 1	**Past 7 days** 2	**Last month** 3	
5. Too much appetite				☐☐☐ 9-11
6. Loss of appetite				☐☐☐ 12-14
7. Abdominal cramps/pains				☐☐☐ 15-17
8. Vomiting				☐☐☐ 6-8
9. Diarrhoea (loose stools)				☐☐☐ 18-20
10. Diarrhoea (watery stools)				☐☐☐ 21-23
11. Worms in stools				☐☐☐ 24-26
12. Bloody stools				☐☐☐ 27-29

SECTION 10: RECORD SHEETS

A. Child's Anthropometric Measurements

1. Date of birth	d	d	m	M	Y	y

30-35

2. Sex	Male	1
	Female	2

36

3. Birth weight (kg)			.		

37-41

4. Birth height (cm)				.	

42-46

5. Current weight (kg)	1. ……..
	2. …….

47-51

6. Current height (cm)	1. ……..
	2. …….

52-56

B. Child's Blood Samples Measurements

7. Vitamin A blood level (µg/dl)	
8. Haemoglobin (g/dl)	
9. Serum Ferritin (µg/l)	

57-59
60-63
64-66

C. Food samples

Food Item	**Alternative/Type of food (Specify)**	**Pathogen Count (CFU)**		
		Salmonella 1	*Lysteria* 2	*E.coli* 3
1. Chicken				
2. Freshly cooked*Vhuswa*				
3. Leftover *Vhuswa*				

67-78
1-12
13-24

D. Water Samples

Water Type	Pathogen Count (CFU)		
	Total Coliforms 1	Feacal coliforms 2	Faecal Streptococci 3
4. Household water source			
5. Storage container			
6. Hand-washing			

25-36

37-48

49-54

E. Stool Sample

7. Amount (g) of stool collected.....

55-56

8. Consistency of stool

9. Formed Stool	1
10. Loose stool	2

57

F. Worm Infestation

Worm infestation	Present 1	Absent 2
11. Ascaris lubricoides		
12. Trichuris trichiura		
13. Giardia		
14. Other (please specify)		

58

59

60

61

APPENDIX 6

FOOD SAFETY INDICATORS IN HOUSEHOLD FOOD SECURITY IN THE RURAL VHEMBE DISTRICT

Training manual for field workers

Foreword:

Dear Field worker

Thank you for agreeing to take part in this study as a field worker. Your enthusiasm and commitment is acknowledged and appreciated as it adds value to the quality of this study. Please feel free to share any inputs you may have during the course of this study as you also have nutrition background.

Below are procedures compiled to assist during this training and the entire course of data collection as to try to minimise any biases that could be brought by collection of data by different people. The training is a measure taken to add to our confidence that the information obtained through this study is reliable and can be trusted. Please refer to the manual throughout the duration of data collection.

I hope we will have a fulfilling experience as we will be trying to contribute towards the gift of life, improved nutrition.

God bless you,

CN Nesamvuni

SAMPLE SELECTION

As a field worker you will be informed of villages to be visited but you have to identify households to be included in the study as guided below.

In the village select a household randomly and define a systematic path to follow (you will be given a systematic number to identify the number of households you should skip before entering one) until you reach the given number of households selected for that village. For example if there are 120 households and you need 10 households you will enter every 5^{th} household from your randomly identified first household considering the systematic path you have defined.

Upon entering a household, friendly greet the people present, introduce yourself briefly including the study and explain that you are part of the team that is conducting this research. Determine whether there is a child in the age group of 3-5 years eating and sleeping at least four days a week in the household. If such a child is there ask to speak to the head of the house or an immediate person (for example if the head is the father and is not there then you can ask for the mother or the next person). Explain the purpose of the study using the provided information document (appendix 2). Ask for permission to have the household (person responsible for planning and preparing meals at home and a child) to participate in the study. If permission is granted get the consent by asking the person to participate in the study to sign the provided consent form (appendix 2).

In the case where there is no child qualifying for the study, go to the next immediate household in your right-hand side until you one with child of that age group and an eligible respondent. If there is more than one household with qualifying children determine select one through random sampling. Also if there is more than one qualifying child in the same household randomly select one.

Age in this study refers to completed years of life. For example, children three years of age include children from 36months to 47 months. However children older than 60 months will not be eligible for this study. In the case the date of birth is not known, check the road to health card, if that option is not helpful then the household will be disregarded. Note however if only the year is known the child will be included and therefore the household can participate.

2. CONSENT

Allow the head of the household (or a suitable relevant person) to read the informed consent. Allow him/her to ask any questions regarding the study and answer politely and honestly. Once everything has been agreed upon, ask them to complete and sign the informed consent.

3. CONDUCTING INTERVIEWS

3.1. Interview schedule

The interview schedule you are provided with is a multi-questionnaire with observation schedule and record sheets. There are ten sections, namely, socio-demographic characteristics; access and availability of food; food inventory record sheet; hunger scale questionnaire; food frequency questionnaire; 24 hr recall form; food handling practices (Part I: Self-reporting practices; Part II: observation checklist); food handling knowledge test questionnaire; child health status questionnaire and record sheets (anthropometry; blood samples; food samples; water samples; stool samples and worm infestation). You are required to follow the order of these sections during interviews.

Most questions need ticking however at times you will need or be given an explanation. Record all conversations you have with respondents in the note book clearly marked with the date, village, household and the question referred to.

Thereafter, take anthropometric measurements two times per each child and record the results accordingly. Should the readings be too different from each other take the third measurement and record the closest two.

3.2 Interview Skills

You need to apply the following guidelines when conducting interviews:

3.2.1 Start by introducing yourself. Explain briefly that you are conducting a research study and that her house was randomly selected for this purpose. Explain that you will ask for important information on food and food safety practices in her home as well as information on one of the children in the house. This process will also involve taking measurements of the child.

3.2.2 Explain the consent form, answer all raised questions and request the food planner and preparer to sign the consent form.

3.2.3 Assure of confidentiality of the information she gives and the importance of providing honest answers.

3.2.4 It is important that you ask questions in the order that they appear on the interview schedule. Ask the questions as they are written on the questionnaire trying to keep the tone of your voice the same for each interviewee cautious not to lead her to give you the answer that you expect. When it is necessary (when the question is not understood) you will have to reword the question.

3.2.5 Keep control of the interview. Do not hurry the interviewee. Allow her to think.

3.2.6 Make sure that you have completed all the questions on the interview schedule and record sheet.

3.3 Techniques used for anthropometric measurements during interviews

3.3.1 Weight

Place the solar scale on a flat surface and zero it by using a known weight every day before getting started with interviews to ensure accuracy of the scale. Solar scale will be used to take the weight of children. The children will be weighed twice with bare feet and light clothing. Each weight score will be numerically recorded in the questionnaire to the nearest 0.01kg (Lee and Nieman, 2010:167) later on an average will be calculated and recorded accordingly.

3.3.2 Height

The height will be measured using Panamedic 2m tape measure mounted on the wall. The child will be asked to stand against the wall without shoes, heals close together with their base touching the wall, hands kept straight on sides looking straight (Lee and Nieman, 2010:165). Height will be taken twice. Each height score will be numerically recorded in the questionnaire to the nearest 0.1cm (Lee and Nieman, 2010:165). The average will be calculated and recorded.

3.3.3 Instruments and equipment needed during interviews

- Interview schedule
- Solar scale
- Stadiometer
- Pens
- Note book

4 Techniques for blood sample drawing (for Professional nurses only)

4.1 Always make sure you put on non-powdered gloves and avoid touching your hair or skin because they may contaminate the blood specimen and therefore will interfere with analysis.

4.2 Clean well around the intended venepuncture area with alcohol soaked cotton wool ball and allow it to dry.

4.3 Do the venepuncture avoiding contact with the needle insertion point.

4.4 Apply Topla, a local anastasia in the area.

4.5 Use butterfly needle technique for blood collection**.** Butterfly needle technique is used because the veins of hand collapse easily if the vacuum tube technique is used (Mulder, 1999:297). This technique is more suitable for small, narrow and short vein as those in the hand and forearm, as the needle is short and sharp.

4.6 Place 5 to 10ml of blood into plain vacuum tubes.

4.7 Do not exceed two attempts to draw blood from a child. Failure to get blood from those attempts will be recorded as a missing value.

4.8 Write clearly on the labels using block letters. Write the time and date of sampling on the tube labels.

4.9 All blood samples drawn must be placed in the cooler box within two hours from the time the blood sample was drawn.

4.10 Syringes and needles must be properly disposed in the waste disposal container after use.

5 Techniques for sampling food, water and stools

5.1 Food

5.1.1 Request samples of food (*vhuswa* and an available animal protein source, meat/poultry or fish including the previous day left over foods, *vhuswa* and/or animal protein).

5.1.2 Use the spoon used to serve the food onto the plate to collect 150g – 200g food samples.

5.1.3 Collect food samples to separate sterile bags.

5.1.4 Store in cooler box with ice packs at 6-10^{0}C until transported to the laboratory.

5.2 Request samples of water (100ml) from the household source (tap or tank) used for household consumption

5.2.1 Collect water from the household source (100ml) and storage containers (100ml) using cups used in the household. Transfer the water to separate 100ml Colilert bottles and label each bottle accordingly.

5.2.2 Store in cooler box with ice packs at 4-10^{0}C until transported to the laboratory.

5.2.3 Request for sample of water used for washing hands before meals

5.2.4 Collect the water that the family used to wash their hands just before meals to 100ml Colilert bottle.

5.2.5 Store in cooler box with ice packs at 4-10^{0}C until transported to the laboratory.

5.3 Request a sample of the child stool

5.3.1 Wear a disposable latex glove before handling the child stool.

5.3.2 Collect 4-10g stool specimen into a wide-mouthed plastic container. In case of loose stools a plastic disposable transfer pipette for liquid stools will be used.
Put the collected specimen into a Cary Blair transport medium with cold packs until it is taken to the laboratory within 2 hours of production.

APPENDIX 7

FOOD SAFETY INDICATORS IN HOUSEHOLD FOOD SECURITY IN THE VHEMBE DISTRICT

Food Based Dietary Guidelines for South Africans

Table 7a. Food Based Dietary guidelines for South Africans

SOUTH AFRICAN FOOD BASED DIETARY GUIDELINES

1. Enjoy a variety of foods.
2. Be active.
3. Make starchy foods the basis of most meals.
4. Eat plenty of vegetables and fruits every day.
5. Eat dry beans, peas, lentils and soy regularly.
6. Chicken, fish, milk, meat or eggs can be eaten daily.
7. Eat fats sparingly.
8. Use salt sparingly.
9. Drink lots of clean, safe water.
10. If you drink alcohol, drink sensibly.
11. Use food and drinks containing sugar sparingly and not between meals.

Source: South African Journal of Clinical Nutrition, 14(3). 2001

APPENDIX 8

FOOD SAFETY INDICATORS IN HOUSEHOLD FOOD SECURITY IN THE VHEMBE DISTRICT

Tools used for the analysis of data obtained from the 24 hour recall

Table 7a. Evaluation of dietary intake according to Food Guide Pyramid (FGP)

Food Groups	Quantity	Interpretation of number of exchanges compared to *FGP recommendations: Below (1)	Within (2)	Above (3)	
Milk and milk products					5
Meat and meat alternatives					6
Fruits					7
Vegetables					8
Bread, cereal & legumes					9
Fats and oils					10
Sweets/sugar					11

***Food Guide Pyramid (FGP) (USDA, 2009: Online)**

Table 7b. Serving recommendations according to the Food Guide Pyramid for children

FOOD GROUP	NUMBER OF SERVINGS
Bread, cereal & legumes	6
Meat and alternatives	2
Milk and milk products	2
Fruit	2
Vegetables	3
*Fats and oils & sweets	Use sparingly (≤ 3 servings)

* ≥ 4 servings of fats and oils and sweets are considered high.

Table 7c. Calculation of dietary energy and macronutrient intake of children using the exchange lists

	Number	Energy	Protein	CHO	Fat
Milk and milk products		530	8	12	5
Meat and meat alternatives		315	7		5
Bread and cereal & Legumes		285	3	15	
Fruit β-carotene		250		15	
Fruit vit C		250		15	
Fruit other		250		15	
Vegetables B		150	2	7	
Fats and oils		190			5

Sweets/Sugar		170		10	
TOTAL					

Based on the American Dietetic Association Standard for Exchange Lists (Wheeler *et al*., 1996)

Calculated estimated total values for:

Carbohydrate (g)	_____						12-14
Protein (g)	_____						15-17
Fat (g)	_____						18-20
Energy (kJ)	_____						21-25

Table 7d. Macronutrient intake expressed as percentage (%) of total energy intake for children (Whitney & Rolfes, 2005:180)

Nutrient	**Low**	**Within**	**High**
Protein	<10%	10-15%	>15%
Carbohydrate	<45%	45-65%	>65%
Fat	<20%	20-35%	>35%

Table 7e. Guide for estimation of the number of servings consumed

Grain group	Fruit group	Meat group
1 slice of bread	1 piece of fruit or melon wedge	30g cooked lean
1/2 cup of cooked rice or pasta	1/2 cup of juice	meat, poultry or fish
1/2 cup of cooked porridge	1/2 cup of canned fruit	1 egg
1/2 cup of ready-to eat cereal	1/2 cup of dried fruit	1/2 cup of cooked
1/3 cup samp		dried beans
		2 tablespoons of
		peanut butter (add one fat
		exchange)
Vegetable group	**Milk group**	**Fats and sweets**
1/2 cup of chopped raw or cooked vegetables	1 cup of milk or 1/2 cup yoghurt	2 teaspoons sugar
1 cup of raw leafy vegetables	30g of cheese	2 hardboiled sweets
		10ml of mayonnaise
		5ml oil, 10ml margarine
		(medium fat)

APPENDIX 9

FOOD SAFETY INDICATORS IN HOUSEHOLD FOOD SECURITY IN THE RURAL VHEMBE DISTRICT

Food handling knowledge test memorandum

Each item is worth 1 point. Total maximum score = 23

Personal hygiene

21. Why is it important to wash hands before handling food?
    - To avoid passing bacteria from our hands to food. There are many bacteria (germs) carried by our hands because we use hands to touch so many different things including parts of our bodies.
22. What is the proper way of washing hands?
    - Use clean warm soapy water.
    - Wash hands thoroughly by making lather with soap and also wash in between fingers.
23. Why do we need to cut nails short when handling foods?
    - Long nails harbour many bacteria and may pass to food.
24. List four critical times we need to wash our hands when preparing food
    - Before touching food/ preparing food
    - After touching food/preparing food
    - After using toilet
    - After changing child's nappies/assist a child in the toilet
    - After handling raw meat/chicken/fish
    - After coughing/sneezing
    - After handling dirt/refuse
25. How can food prepared by someone with hand sores, cuts and/or boils cause sickness?
    - Most of the time hand sores, cuts and/or boils have many bacteria that can pass to food.
26. What do we do with hand sores, cuts and boils before we can touch food?
    - We clean and cover them with a moisture proof dressing
27. Why is it important not to handle food when we are sick?
    - Bacteria (germs) in our bodies may pass to the food.

Kitchen environmental hygiene

28. What is the proper way of washing plates and eating utensils?
    - Wash plates and eating utensils with clean warm soapy water
29. What do we do to food preparation surface before we prepare food?
    - We clean/wash with clean warm soapy water
30. Why is it important to clean/wash preparation surfaces and eating utensils with warm soapy water before using them?
    - Bacteria are found everywhere therefore all surfaces and utensils have bacteria.
31. Why is it important to clean/wash preparation surfaces and eating utensils with warm soapy water after using them?

- Food that we prepare has bacteria that pass to the surfaces and utensils that come into contact with.

32. Why is it important to keep away pests, pets and insects from the kitchen?
    - To protect food from getting bacteria from them.
33. Why is it important to empty dustbins in the kitchens regularly?
    - Food waste attracts pest, pests and insects that carry many bacteria with them.

Food hygiene

34. Why is it important to store food such as meat, milk and cooked food at low temperatures (in the refrigerator)?
    - Bacteria do not like low temperatures (Growth is not conducive)
    - These are foods that bacteria like(susceptible to microbial growth)
35. Why is it important **not** to use same surfaces and knife used to cut meat for cutting vegetables without washing them first with warm soapy water?
    - Bacteria from meat may transfer to vegetables
    - Meat is cooked at much higher temperatures than vegetables so bacteria in meat are likely to be destroyed than those in vegetables.
36. Why is it important **not** to thaw meat/chicken/fish at room temperature?
    - To prevent bacterial growth. Bacteria grow fast and multiply at room temperature.
37. Why is it important to cook food to well-done stage?
    - To ensure that harmful microorganisms are destroyed/killed.
38. What is the best way of keeping food after cooking if is not eaten immediately?
    - Food should be allowed to cool then be stored in low temperatures (in the refrigerator).
39. Why is it important to keep food covered?
    - To avoid pests and insects from contacting the food as they will pass some harmful microorganisms to the food.
40. What is the best way of storing cooked food that will be eaten after two or more days?
    - Food should be stored in much lower temperatures (in the freezer)

Score range 0-23 points

APPENDIX 10

FOOD SAFETY INDICATORS IN HOUSEHOLD FOOD SECURITY IN THE VHEMBE DISTRICT

List of available food items in the households the day of data collection

Table 10.1. Foods available in households in descending order

Food item	N	%
Chicken Heads	335	100
Mangoes	335	100
Litchis	335	100
Salt	334	99.7
Maize meal	332	99.1
Cooking oil/fat	297	88.7
Tea	291	86.9
Sugar	280	83.6
Chips (snacks)	278	83.0
Onion	231	69.0
Bread	226	67.5
Tomatoes	189	56.4
Chicken	176	52.5
Soup	171	51.0
Squash (imitation)drink	151	45.1
Coffee/tea creamer (whitener)	126	37.6
Indigenous greens	114	34.0
Butter/Margarine	113	33.7
Chicken feet	108	32.2
Pawpaw	108	32.2
Eggs	102	30.5
Legumes	101	30.2
Rice	89	26.6
Biscuits	84	25.1
Milk	78	23.3
Potatoes	77	23.0
Fish frozen	76	22.8
Cabbage	74	22.1
Desserts	72	21.5
Spinach	70	20.9
Beetroot	62	18.5
Breakfast cereals (uncooked)	59	17.6
Pasta	58	17.3
Cool drink	56	16.7
Sweets/chocolates	54	16.1
Red meat	49	14.6
Chicken offal	48	14.4
Banana	47	14.0
Oranges	47	51.1
Yoghurt	47	14.0
Tomato sauce	44	13.1
Mayonnaise	44	13.1
Peanut Butter	43	12.8
Fish canned	42	12.6
Apples	41	12.2
Coffee	41	12.2

Food item	N	%
Carrot	39	11.6
Curry	36	10.8
Boere Wors	33	9.9
Chicken heads & feet	33	9.9
Sweet potato	29	8.7
Jam	28	8.4
Pumpkin	27	8.1
Dairy fruit mix	21	6.3
Maltabella/Mabella	14	4.2
Polony	14	4.2
Ice cream	14	4.2
Desserts	14	4.2
Spices	13	3.9
Green pepper	11	3.3
Samp	10	3.0
Mopani worms	10	3.0
Lemon	9	2.7
Beef offal	8	2.4
Popcorn	8	2.4
Avocado	7	2.1
Atchaar	7	2.1
100% fruit juice	6	1.8
Raspberry	5	1.2
Rolls	4	1.2
Mageu	4	1.2
Dried vegetables (traditional)	4	1.2
Scones	4	1.2
Insects	3	0.9
Cheese	3	0.9
Cakes	3	0.9
Vienna	2	0.6
corned meat	2	0.6
Minced meat	2	0.6
Pork	2	0.6
Indigenous fruits	2	0.6
Peaches	2	0.6
Mixed vegetables	2	0.6
<100% fruit juice	2	0.6
Mielies (Corn)	1	0.3
Vetkoek	1	0.3
Russian	1	0.3
Biltong	1	0.3
Mutton/Lamb	1	0.3
Naartjies	1	0.3
Pineapple	1	0.3
Lettuce	1	0.3
Alcoholic drinks	1	0.3
Beef cubes	1	0.3
Chicken cubes	1	0.3
Pie	1	0.3
Chutney	1	0.3
Vinegar	1	0.3

Summary of the study

Available literature emphasises the importance of food safety in obtaining coordinated and conceptually informed results of food security, with the view to improve intervention programmes to achieve progress in obtaining food security in households. The study was undertaken intending to investigate possible food safety indicators that might possibly contribute towards improved assessment of household food security (HFS) in the rural Vhembe District, Limpopo Province, South Africa. The objectives were to determine HFS and household food safety, as well as the relationship between HFS and food safety, and to develop food safety indicators of HFS.

A cross-sectional study was undertaken. Twenty nine villages were randomly selected from the total number of 299 villages in Thulamela local municipality in the Vhembe District. For proportional sampling of households from the selected villages 4 village clusters were created according to their population sizes. Households were randomly selected from villages. The final randomly selected sample consisted of 335 households with at least 1 child (3-5 years of age) and a caregiver. The caregiver could be the mother of the child or any caregiver over the age of 18 years of age who was mostly responsible for food preparation in the household.

A structured interview schedule was used, consisting of questionnaires and data/record sheets that were completed during an interview with the respondent of each household. A socio-demographic questionnaire; food availability and access questionnaire; a food inventory; an 8-item hunger scale; a food frequency questionnaire; a food handling practices questionnaire; and a food handling knowledge test; a 24 hour recall and child health status questionnaire; as well as record sheets were included. Five repeatedly trained (for consistency) field workers (all Nutritionists) collected all types of data. Weight and height status were determined and laboratory techniques were used to determine microbiological content of the water and food samples (114 of 335 of households: 34%) and worm content of stool samples (from all 335 children 3-5 years of age). Data was analysed using statistical analysis software (SAS) version 9.2. Frequencies and percentages were used to describe categorical data. Continuous data (symmetric distributions) were expressed using means and standard deviations while medians, lower and upper quartiles as well as minimum and maximum values were used to describe skewed continuous data. Anthropometric data was summarised using Z-scores. Chi-square tests or Fisher's exact tests in case of small numbers were used to determine associations

between the indicators of household food safety and HFS. A statistical reduction process was used to develop the householf food safety indicators that can be used in rural HFS assessments.

Household food insecurity was indicated by all indicators used, as well as the socio-demographic indicators. Salary, affordability and the presence of protein rich foods, vegetables, milk and fat were significantly related to the household food security status as indicated by the hunger scale. The levels of food security were evenly distributed among the households: food insecure (32.8%), at risk (37%) and food secure (30.2%) households. However, the anthropometric indicators showed that most children (>88%) had an acceptable weight/height status. The dietary intake of the children suggested sufficient energy intake with probable low intake of micronutrients especially β-carotene. Furthermore, the diet seemed to lack variety, with inadequate intake of fruits, vegetables, milk and dairy products. The health status of the children was apparently good as shown by the less than 20% of children with diarrhoeal episodes and 35.2% with reported worm infestations. Stool examination results also showed few cases of children with worm infestation, *Ascaris* (1.2%), *Trichuris* (1.9%) and *Giardia lambia* (5.6%).

In general, caregivers had acceptable scores of self-reported food handling practices and knowledge. Water and food used in the households were both likely to pose a food safety risk in the households respectively. Poor microbial quality was detected in more than 94% of water and 75.9% food samples. Hand-washing water had higher bacterial load than stored water. Both stored and hand-washing water had food safety risk levels of total counts (median = 2.3×10^4 & 2.5×10^5 respectively) and coliforms (median = 5.6×10^4 & 1.6×10^5 respectively). Salmonella and Listeria tested negative on food samples however, coliforms exceeded the safety limits. The presence of *E. coli* in protein rich foods suggested a faecal pollution.

Food handling practices and knowledge were not significantly different in food secure and at risk households but were significantly different in the food insecure households. Self-reported and observed food handling practices did not differ. Availability of protein rich foods including milk in the households was linked to food handling practices, while a significant association was observed between worm infestation in children 3 to 5 years and food handling practices.

The microbial quality of stored water was significantly associated with that of hand-washing water. Both stored and hand-washing water were significantly linked with poor microbial

quality of left over *vhuswa* (maize meal porridge) but had no association with fresh *vhuswa*. Poor microbial quality of fresh and left over *vhuswa* were significantly related to contaminated protein rich foods.

A step by step analysis was done during the development process of food safety indicators, in which indicators that did not show significant associations and did not show sufficient variation were eliminated. In the final step the indicators of household food safety to be included in measuring of HFS in rural households were identified.

The food safety indicators identified by this study and recommended for use in measuring rural HFS, include use of stored water, communal hand-washing practices and observed food handling practices. It is recommended that these indicators be evaluated and included in the measuring of rural HFS.

Keywords: Household food security, household food safety, food availability, food accessibility, hunger scale, anthropometric status, health status, 24 hour recall, stored water, hand-washing water, food handling practices, microbial quality.

Opsoming

Beskikbare literatuur beklemtoon die belangrikheid van voedselveiligheid in die verkryging van gekoördineerde en betekenisvolle resultate van voedsel - en voedingsekuriteit. Sodoende kan intervensieprogramme verbeter word en vordering in die verkryging van voedselsekerheid in huishoudings bewerkstellig word. Die studie is onderneem met die doel om moontlike indikatore van voedselveiligheid te ondersoek wat moontlik kan bydra tot verbeterde bepaling van huishoudelike voedselsekerheid (HVS) in die plattelandse Vhembe distrik, Limpopo Provinsie, Suid Afrika. Die sub-doelwitte was om HVS en huishoudelike voedselveiligheid, asook die verwantskap tussen indikatore van HVS en voedselveiligheid te bepaal en om voedselveiligheidindikatore van HVS te ontwikkel.

'n Dwarssnit studie is onderneem. Van die 299 klein statte in die Thulamela munisipaliteit van die Vhembe Distrik is 29 ewekansig gekies. Van die 29 gekose klein statte is 4 trosse van klein statte volgens elk se bevolkingsgrootte gevorm. Sodoende is huishoudings in verhouding en ewekansig uit die gekose klein statte gekies. Die finale ewekansige steekproef het 335 huishoudings met ten minste een kind (3-5 jaar) en 'n oppasser ingesluit. Die oppasser kon die ma van die kind of enige ander oppasser bo 18 jaar wees wat die meeste verantwoordelik was vir die voedselbereiding in die huishouding.

'n Gestruktureerde onderhoudskedule is gebruik, bestaande uit vraelyste en data/rekord kaarte wat tydens 'n onderhoud met die respondent van elke huishouding voltooi is. 'n Sosiodemografiese vraelys; 'n voedselbeskikbaarheid en – toeganklikheid vraelys; 'n voedselinventaris; 'n agt-item hongerskaal; 'n voedselfrekwensie vraelys; 'n voedselhanteringspraktyke vraelys en 'n voedselhanteringskennis toets; 'n 24 uur herroep en 'n kindergesondheidststus vraelys; asook rekordkaarte is ingesluit. Vyf herhaaldelik opgeleide (vir ooreenstemmigheid) veldwerkers (almal voedingkundiges) het al die data versamel. Massa en lengte status is bepaal en laboratoriumtegnieke is gebruik om die mikrobiologiese inhoud van die water- en voedselmonsters (114 van 335 huishoudings: 34%), en die teenwoordigheid van wurms in die stoelgangmonsters (van 100% van die kinders 3-5 jaar) te bepaal. Die statistiese analise sagteware (SAS), weergawe 9.2 is gebruik om die data te verwerk. Frekwensies en verspreidings is gebruik om die kategoriese data te beskryf. Gemiddeldes en standaardsafwykings is gebruik om simetries verspreide kontinu data is beskryf, terwyl

mediane, laer en hoër kwartiele, asook minimum en maksimum waardes gebruik is om niesimetries verspreide kontinu data te beskryf. Antropometriese data is opgesom deur van Z-tellings gebrui te maak. Kruistabelle, of die Fisher'se eksakte toets in geval van klein getalle, is gebruik om die verwantskappe tussen indikatore van huishoudelike voeselveiligheid en HVS te bepaal. 'n Statistiese reduksieproses is gebruik om die huishoudelike voedselveiligheidindikatore wat in plattelandse huishoudings gebruik kan word, te ontwikkel.

Huishoudelike voedselonsekerheid is deur al die indikatore aangedui, asook deur die sosiodemografiese indikatore. Salaris, bekostigbaarheid en die teenwoordigheid van proteïenryke voedsel, groente, melk en vet het betekenisvol met die status van HVS, soos bepaal met die hongerskaal verband gehou. Die grade van voedselsekerheid was eweredig tussen die huishoudings versprei: voedselonseker (32,8%), risiko (37.0%), voedselseker (30.2%). Volgens die antropometriese indikatore het meeste (>88%) van die kinders egter 'n aanvaarbare massa/lengte status gehad. Die dieet van die kinders het 'n toereikende energie-inname getoon met waarskynlike lae inname van mikrovoedingstowwe, veral ß-karoteen. Verder het die dieet het 'n gebrek aan variase getoon en ontoereikende inname van, vrugte, groente, melk en melkprodukte. Die gesondheidstatus van die kinders was skynbaar goed soos aangetoon deur die minder as 20% van die kinders met diarree episodes en 35.5% met gerapporteerde wurmbesmetting. Stoelganondersoeke het egter net 'n paar gevalle van wurmbesmetting getoon, Ascaris (1.2%), Trichuris (1.9%) en Gardia lambia (5.6%).

Oor die algemeen het die versorgers 'n aanvaarbare telling vir selfrapporteerde voedselhanteringspraktyke gehad. Die water en voedsel wat in die huishoudings gebruik is, het beide waarskynlik 'n voedselveilgheidsrisiko ingehou. 'n Swak mikrobiologiese kwaliteit is in meer as 94% van die water- en 75.9% van die voedselmonsters opgespoor. Die water wat vir die was van hande gebuik is het 'n hoë mikrobiologiese lading gehad as die gestoorde water. Beide die gestoorde- en die handewaswater het vlakke wat 'n voedselveiligheid risiko inhou gehad, ten opsigte van totale tellings (medium = 2.3×10^4 & 2.5×10^5 repektiewelik) en *coliforme* (medium = 5.6×10^4 & 1.6×10^5). Hoewel *Salmonelle* en *Listeria* negatief op die voedselmonsters getoets het, het *coliforme* die veiligheisvlakke oorskrei. Die teenwoordigheid van E. coli in proteïenryke voedsel suggereer 'n fekale besmetting.

Voedselhanteringspraktyke en – kennis was nie betekenisvol verskillend in die voedselseker en risiko huishoudings nie, maar betekenisvol verskillend in die voedselonseker huishoudings.

Selfrapporteerde en waargeneemde voedselhanteringspraktyke het nie verskil nie. Die beskikbaarheid van proteïeryke voedsel, insluitend melk, het betekenisvol verband gehou met voedselhanteringspraktyke, terwyl die voedselhanteringspraktyke betekenisvol met die wurmbesmetting in die kinders (3-5 jaar) verband gehou.

Die mikrobiologiese kwaliteit van die gestoorde water het betekenisvol verband gehou met die van handewaswater. Beide die gestoorde en handewaswater het betekenisvol verband gehou met die swak mikrobiologiese kwaliteit van die oorskiet *vhuswa* (mielmeelpap) maar nie met vars *vhuswa* nie. Die swak mikrobiologiese kwaliteit van beide vars en oorskiet *vhuswa* het betekenisvol verband gehou met besmette proteïenryke voedsel.

‘n Stap vir stap analise is tydens die ontwikkeling van die indikatore vir voedselveiligheid gedoen, waartydens indikatore wat nie betekenisvolle verbande getoon het en nie voldoende variasie getoon het nie uitgeskakel is. In die finale stap is die huishoudelike indikatore van voedselveilig vir insluiting in die bepaling van voeselsekerheid in plattelandse huishouding identifiseer.

Die indikatore vir voedselveiligheid wat in hierdie studie identifiseer is en aanbeveel word vir insluiting in die bepaling van plattelandse HVS, sluit in die gebruik van gestoorde water, gemeenskaplike handewas praktyke en waargenome voedselhanteringspraktyke. Dit word aanbeveel dat hierdie indikatore evalueer en ingesluit word in die bepaling van HVS in plattelandse huishoudings.

Sleutelwoorde: Huishoudelike voedlsekerheid, huishoudelike voedselveiligheid, voedselbeskikbaarheid, voedselbekombaarheid, hongerskaal, antropometriese status, 24-uur herroep, gesondheidstatus, gestoorde water, handewaswater, voedselhanteringspraktyke, mikrobiese kwaliteit.