UNIVERSITY OF SOUTHAMPTON

FACULTY OF SOCIAL AND HUMAN SCIENCES

School of Social Sciences


# Modelling under-nutrition in under-five children in Malawi


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# ABSTRACT

FACULTY OF SOCIAL AND HUMAN SCIENCES
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MODELLING CHILD UNDER-NUTRITION IN MALAWI

By Lana Clara Chikhungu

Despite numerous Government efforts to tackle the problem of child under-nutrition in Malawi, the levels of child under-nutrition remain high with stunting estimated at 47% and underweight at 12.7% . This thesis investigates whether the levels and patterns of stunting and underweight in Malawi have changed between the years 2000 and 2010 and if so how. It studies how feeding patterns and child immunisation affects child's nutritional status in Malawi and analyses the different pathways through which household and community level socio-economic factors affect a child's nutritional status in Malawi.

The Malawi Demographic and Health Survey (MDHS) data sets of 2000, 2004 and 2010 are used in the study of levels and patterns of child under-nutrition in Malawi whilst the 2004 MDHS is used to investigate how feeding patterns and child immunisation affect a child's nutritionals status in Malawi. The 2004 Malawi Integrated Household Survey data is merged with the 2004 Community level to analyse the pathways through which household and community level socio-economic factors affect child nutritional status in Malawi.

Results of this study show that children from communities that have a daily market are less likely to be stunted compared to children from communities without a daily market. Children from communities that trace their descendants through their father have a lower likelihood of stunting compared to children from communities that trace their descendants through the mother due to being of relatively higher economic status. The levels of stunting and underweight have gone down significantly from 54.1% and 21.4% respectively in the year 2000 to 47.1% and 12.7% respectively in 2010. However, the percentage of children that are stunted but not affected with other under-nutrition problems has hardly changed, estimated at 37.2% in 2000 and 36.2% in 2010.

Although generally female children are less likely to be stunted and less likely to be underweight, female children are more likely to be underweight as they get older. Contrary to what one would expect, children are more likely to be stunted during harvest time compared to the hunger season. Most of the children are fed food from the local grain, whilst in fact children aged between 7 to 36 months who consume food from animal sources are less likely to be undernourished. Children whose mothers are in possession of a child health card[1] are less likely to be underweight.

The Malawi Government should therefore intensify its efforts of encouraging mothers to attend under-five clinics, feed children that are undergoing weaning food from animal sources and should invest more in programmes that boost socio-economic status such as education and entrepreneurship skills.

[1] A child health card is a document where information on child immunisation, attendance to under-five clinics or contact with health services is recorded.

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# DECLARATION OF AUTHORSHIP

I, Lana Chikhungu, declare that the thesis entitled: "*Modelling Child Under-nutrition in Malawi*" and the work presented in it are my own and have been generated by me as the result of my own original research. I confirm that:

- this work was done wholly or mainly while in candidature for a research degree at this University;
- where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
- where I have consulted the published work of others, this is always clearly attributed;
- where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
- I have acknowledged all main sources of help;
- none of this work has been published before submission,

Signed:

Date:

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I would like to thank my husband Christopher for proof reading my thesis and supporting me throughout the period of study emotionally as well as untiringly looking after the children when I had to be away from home to finalise the thesis. I am grateful to my son Antonio and my daughter Wakisa for their understanding that I couldn’t be at home with them for most of the weekends and some evenings.

This thesis is dedicated to my mother Lusubilo who was a major source of encouragement. She passed away during the course of my studies.

# CHAPTER 1 : INTRODUCTION

## 1.1 Introduction

The problem of child under-nutrition continues to persist in Malawi regardless of numerous Government efforts to tackle it. Recent estimates indicate that 47% of children under the age of five are stunted whilst underweight and wasting are estimated at 13% and 4% respectively(National Statistical Office Malawi and MEASURE DHS, 2011) . The expected level of stunting, underweight and wasting for a well-nourished population is 2% (ORC Macro, 2006).
It is estimated that 34% of all deaths that occur before the age of five in Malawi are related to under-nutrition(ORC Macro, 2006). Tackling child under-nutrition in Malawi should therefore contribute to reducing the under-five mortality rate which is estimated at 92/1000 live births (WHO, 2012b).

The high stunting levels for under-five children in Malawi has led to the Malawi Government putting more emphasis on undertaking programmes that should tackle stunting in Malawi. Recently the Malawi Government launched a programme called Scaling Up Nutrition (SUN) 1000 special days which is a broad sensitisation programme calling all development partners to unite to end stunting by targeting resources to mothers and children in the first 1000 days of life beginning from pregnancy. Continued study of factors associated with stunting and underweight in Malawi is therefore pivotal if significant progress is to be made in reducing the levels of child stunting and underweight in Malawi to a level nearer to those expected for a well-nourished population. At the same time, there is need to monitor whether progress is being made in addressing the problem of child under-nutrition, by estimating child under-nutrition using estimates that are based on similar reference standards.

This chapter provides Malawi's geographic, historic and socio-economic background and background information relating to the problem of child under-nutrition globally and in Malawi. It describes the objectives of the thesis, the research hypotheses and research questions and it also provides the organisation and structure of the thesis.

## 1.2 Malawi's geographic, historic and socio-economic background

Malawi is a landlocked country that shares its boundaries with Zambia to the West, United Republic of Tanzania to the North and Northeast and Mozambique to the Southeast, South and Southwest as shown in Figure 1.1. It has a surface area of 118,484 square kilometres. Almost a quarter of Malawi's surface area is comprised of Lake Malawi, the third largest fresh water lake on the African continent. The population of the country is estimated at 13,077,160 (NSO-Malawi, 2008). Nearly 85% of the population reside in the rural areas where the main source of employment is subsistence farming. The population of Malawi is distributed as follows across its three regions: 13.1 % in the Northern region, 42.1% in the Central region and 44.8% in the Southern region.

Figure 1.1 Map of Malawi


Source: http://www.nationsonline.org/oneworld/map/malawi_map.htm

The predominant ethnicities in the Northern region are the Tumbuka, Tonga and Nkhonde. The Chewa are mainly found in the Central region whilst the Yao, Lomwe and Sena are mainly found in the Southern region. Communities in the Northern region predominantly practise a patrilineal system where descendants are traced through the father, whilst in the Central and Southern regions the majority of the communities practise a matrilineal system where descendants are traced through the mother. The three regions are further divided into 28 districts for administrative reasons and into 8 Agricultural Development Divisions (ADDs) for purposes of agricultural development.

Malawi became independent of the British protectorate in 1964 and gained its independence in 1966. For thirty years, the people of Malawi were ruled by one president and a single party system until 1994 when the Malawi Government adopted a multiparty system and elected a new president. Both the old government under the single party system and the parties that have ruled under the multiparty system have had problems of ensuring a stable economic growth. The introduction of Structural Adjustment Policies (SAPs) by the International Monetary Fund and the World Bank in the early 1980s which were introduced to improve failing economies in most of the developing countries resulted in the devaluation of the Malawi Kwacha, reduction of government spending, removal of agricultural subsidies and privatisation of some Government institutions. Such policies appear to have hampered the productivity of the agricultural sector in Malawi which had performed better in the 1970s with heavy state intervention (Chirwa *et al.*, 2008).

The agricultural sector is the backbone of the Malawi economy, it employs 85% of the labour force, contributes 83% of foreign exchange earnings and accounts for 39% of the Gross Domestic Product (GDP) (Chirwa *et al.*, 2008). The agricultural sector is dominated by smallholder farmers that mainly cultivate maize, the Malawian staple food, to meet their daily food requirements. The main cash crops are tea, sugar and tobacco. Farming in Malawi however, is mainly rain fed and therefore vulnerable to bad weather conditions and the availability of farm inputs such as fertiliser, seeds and insecticides is dependent on financial support from international lending organisations such as the International Monetary Fund or the World Bank. However, loans from these financial institutions are only provided on condition that the government implements specific policies i.e. cutting government spending which tend to have a negative impact on the poor in the short-term. The majority of Malawians are poor. It is estimated that 50.7% of the population are unable to meet their daily energy requirements (NSO-Malawi, 2012). Malawi's human development index[2] is low, ranked 171 out of the 187 countries (UNDP, 2011). The economic productivity of the country is also challenged by the high adult HIV prevalence estimated at 11% (NSO-Malawi and MEASURE DHS, 2011).

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[2] The human development index is a composite measure of a country's health status, education and income level

## 1.3 Child under-nutrition globally

Child under-nutrition is one of the major health problems facing developing countries. It is identified as an underlying contributor in one third of all child deaths globally (United-Nations, 2010). The under-five mortality rate in the developing regions is estimated at 72 per 1000 live births whilst in developed countries only 6 children per 1000 live births die before the age of five (United-Nations, 2010). Based on the analysis of 310 national nutrition surveys compiled in the WHO Global Database on Child Growth and Malnutrition, Caulfield *et al.* (2004) estimate that 52.5% of all reported deaths in under-five children were due to children being underweight. Wasting on its own is reported to be responsible for the death of 1.5 million children in the world every year (WHO, 2008). Tackling child under-nutrition would therefore greatly contribute to achieving the Millennium Development Goal Number Four of reducing the levels of under-five mortality in the developing regions by two thirds by 2015 as well as the Millennium Development Goal Number One of eradicating extreme poverty and hunger.

Stunting on the other hand represents past and chronic inadequacies in nutrition which is often due to debilitating cycles of illness, depressed appetite, insufficient food and inadequate care. Those who survive are affected by long term deficits in mental capacity and losses in stature (UNICEF, 2000). Many children affected by under-nutrition end up growing into adults with lower level intellectual skills than they would have if they were properly nourished in their childhood. A human capital study conducted between 2002 and 2004 designed to link nutrition intervention to adult human capital and economic productivity reports of the long-term effects of poor nutrition in childhood in Guatemala (Hoddinott *et al.*, 2008). The study found that a group of adult men who had been fed a nutrient dense supplement during the ages of 0 to 24 months earned higher wages compared to a group of adult men that had been fed a supplement with energy only also during the ages of 0 to 24 months. Studies linking childhood nutritional status and economic productivity in adulthood are rare in the sub-Saharan Africa. The only such study that this research came across is the South Africa cohort study. Findings of the study by Victora *et al.* (2008) based on data from a 1990 born South Africa urban cohort study combined with an analysis of longitudinal data from the Philippines, Jamaica, Peru, Indonesia and Brazil, revealed that stunting between 12 and 36 months of age predicted poor cognitive performance and /or lower school grades attained in middle childhood.

Table 1.1 shows the rates of under-nutrition in different developing regions. Africa has the highest rate of stunting estimated at 40.1% whilst the rates of underweight in Africa and Asia are similar at 22%. The levels of underweight and stunting in these regions are extremely high considering that the expected level of stunting and underweight for a well-nourished population is about 2% (ORC-Macro, 2006).

Table 1.1 Under-nutrition rates by region

| Region | % Stunted | % Underweight | % Wasted |
|---|---|---|---|
| Africa | 40.1 | 21.9 | 3.9 |
| Asia | 31.3 | 22.0 | 3.7 |
| Latin America | 16.1 | 4.8 | 0.6 |

Source: WHO, 2005

http://www.who.int/nutrition/topics/Lancetseries_Undernutrition1.pdf

## 1.4 Child under-nutrition in Malawi

Compared to its neighbouring countries, Malawi has the highest percentage of children aged less than five years that are stunted but has a lowest estimate for wasting and underweight as seen in Table 1.2. On the other hand Zimbabwe has the highest estimate for wasting but the lowest estimate for stunting.

Table 1.2 Under-nutrition rates for Malawi and its neighbouring countries

| **Country** | **Year** | **% Stunted** | **% Underweight** | **% Wasted** |
|---|---|---|---|---|
| Malawi | 2010 | 47.8 | 13.8 | 4.1 |
| Zambia | 2007 | 45.8 | 14.9 | 5.6 |
| Mozambique | 2008 | 43.7 | 18.3 | 4.2 |
| Tanzania | 2009/2010 | 42.5 | 16.2 | 4.9 |
| Zimbabwe | 2005/2006 | 35.8 | 14.0 | 7.3 |

Source: WHO Global Database on Child Growth and Malnutrition, 2012

http://www.who.int/nutgrowthdb/database/countries/en/

Micronutrient deficiencies are also high in Malawi. The 2009 Malawi National Micronutrient Survey estimates that 40.1% of under-five children and 29.9% of school aged children have a mild vitamin A deficiency, whilst the estimated percentages of iron deficiency are 61.5%, 23% and 32.4% in under-five, school aged and women respectively (Shawa, 2010).

A few national level studies have been conducted in Malawi on the determinants of child under-nutrition. A study by Chirwa and Ngalawa (2008) used a fixed effects model and found that child under-nutrition as measured by under-weight, stunting and wasting is more prevalent in children that fall sick regularly and that children who come from households with a mother/female household heads who are economically empowered, in terms of being in salaried employment or working in a family business, tend to be better nourished. Their study also found that a child's nutritional status worsens with age and that female children were better nourished compared to male children. The study also reported that drawing water from a well (protected or not) appeared to increase the likelihood of a child being wasted.

The importance of age in determining a child's nutritional status and the higher likelihood of under-nutrition amongst male children compared to female children is also reported in the study by Madise *et al.* (1999) that analysed heterogeneity of child nutritional status between households in six sub-Saharan countries including Malawi. This study found age of the child to be the most important factor influencing child nutritional status as measured by child's underweight status, with the nutritional status of children deteriorating very rapidly after birth and stabilising during the second year of life. The study by Madise *et al.* (1999) also reports of a significant clustering effect of underweight at household and community levels. The importance of community level factors in determining child nutritional status is echoed in the work of Griffiths *et al.* (2004), that studied under-nutrition in six sub-Saharan African countries and four Indian states.

Poor feeding practices such as early introduction of complementary foods are pretty common in Malawi according to findings of the studies by Madise and Mpoma (1997) and Espo *et al.* (2002). The study by Madise and Mpoma (1997) reports of poor nutritional status for children aged 12 months and over who were still breastfeeding. Nutrient intake is at the heart of a child's nutritional status. Whilst nutrient intake is partly influenced by a child's health status, the amount and kind of food taken by a child plays a greater role in the amount of nutrients that a child's body absorbs. The study by Madise and Mpoma (1997) also identified breastfeeding as an important factor apart from child health status and socio-economic status.
The fact that child under-nutrition affects many children in Malawi is well known by the Malawi government and its development partners. This is reflected in the numerous interventions that feature in the Malawi National Nutritional Policy and Strategic Plan of 2007 to 2012 to tackle the problem of under-nutrition (Republic-of-Malawi, 2009).

## 1.5 Objectives and research questions of the study

The objectives and research questions of this study are given in Table 1.3

Table 1.3 Research objectives and research questions

| Objectives | Research question |
|---|---|
| To establish if there has been significant changes to the levels and patterns of child stunting and child underweight in Malawi between the years 2000 and 2010. | Have the levels and patterns of child under-nutrition changed between 2000 and 2010 in Malawi, if so, how? |
| To study the feeding patterns that are associated with a better child nutritional status in Malawian children aged three years and below. | What kind of feeding patterns are associated with better nutritional status for children aged three years and below in Malawi? |
| To study the association between child immunisation and vitamin A supplements and child nutritional status in Malawi | Is child immunisation and vitamin A supplementation associated with child under-nutrition in Malawi? |
| To examine pathways through which household and community level socio-economic factors are associated with child nutritional status in Malawi. | What are the pathways through which household and community socio-economic status affects child nutritional status in Malawi? |
| To determine if stunting and underweight in Malawi vary across seasons | How does stunting and underweight in Malawi vary across seasons? |

## 1.6 Research Hypotheses

This study is being undertaken with the following hypothesis in mind:

- There haven't been any significant changes to the levels and patterns of child under-nutrition in Malawi over the past 10 years.
- Children that are fed according to appropriate feeding recommendations are better nourished than those that are not. Appropriate feeding is one of the important factors that are associated with a child's nutritional status.
- Child immunisation and vitamin A supplements have an important role in child nutritional status

- Apart from household socio-economic factors, community socio-economic factors are also influential to children's nutritional status more especially to stunting than underweight.
- The level of child stunting and child underweight in Malawi varies across seasons.

## 1.7 Organisation and structure of the thesis

This thesis has seven chapters. Chapter 2 provides a literature review on stunting and underweight. It starts by reviewing conceptual frame works and describing the conceptual frame work that has been adopted for this research. The literature review is done around the factors described in the conceptual framework. Data and methodology used in this thesis are explained in chapter 3. Chapter 4 presents the findings on determinants, of child under-nutrition in Malawi and the patterns and levels of child under-nutrition in Malawi between 2000 and 2010. This chapter looks at what the determinants of stunting and underweight in Malawi are and investigates if there has been a significant change in the patterns and levels of stunting and underweight in Malawi. Chapter five on household behavioural influences looks at the links between breastfeeding, immunisation, food consumed and child's nutritional status in Malawi. Chapter six is on household and community level socio-economic factors associated with stunting and underweight. Chapter seven discusses the findings of this thesis.

# CHAPTER 2 : LITERATURE REVIEW

## 2.1 Introduction

This chapter presents a critical review of some of the studies that have been conducted on the topic of child under-nutrition with a focus on stunting and under-weight as this is where the interests of this research are. Two conceptual frameworks that illustrate how several factors interact to contribute to a child's nutritional status, the UNICEF's conceptual framework on the causes of child malnutrition (UNICEF, 1998) and Millard's causal model of child mortality (Millard, 1994) are reviewed from which a conceptual framework guiding this research is adapted. The conceptual frame work guiding this research is given in section 2.3. General literature on the determinants of child under-nutrition with a special focus to developing countries is reviewed based on the conceptual framework shown in section 2.3. Apart from reviewing literature on the association of factors at child level, household level and community level and child under-nutrition, a review is also done on the role of different government policies and programmes undertaken at national level.

A list of some of the journal articles and other literature reviewed and summary of findings on each topic are given in appendices 1a to 1f. All literature reviewed is from the developing countries with the exception of one article from the USA. The review considered at least 44 research papers from sub-Saharan Africa and 20 from Malawi. The literature review also includes books and reports on specific nutrition related and development topics. The following search terms were used to search for articles: stunting in children, causes of stunting, stunting and underweight in children, child growth in developing countries, causes of underweight, child care practices and under-nutrition, underweight and/or stunting in sub-Saharan Africa, child under-nutrition in Malawi, stunting in Malawi, infant and young child feeding and child growth. Articles that were addressing a topic on an aspect that is given in the conceptual framework were included for review. When a search produced far too many results, only articles published between 2000 and 2010 were included. In cases where specific literature was sought for, search words on some specific aspects of nutrition were done such as; anaemia as a cause of under-nutrition, effect of childhood diarrhoea on nutrition, zinc and diarrhoea, vitamin A and diarrhoea through which relevant journal articles were identified. Whilst under-nutrition (stunting and underweight) is the focus of this research, several studies that have been reviewed have used the term malnutrition to imply under-nutrition since malnutrition is often associated with under-nutrition; a deficiency of energy or nutrients, however malnutrition also occurs as a result of over-nutrition due to an excess of nutrients (Smolin and Grosvenor, 2003). Malnutrition has therefore broader dimensions than under-nutrition.

## 2.2 Defining and measuring child under-nutrition

Child under-nutrition is often assessed through taking anthropometric measurements. The most common anthropometric measurements are weight for age, height for age and weight for height. To compute these measurements, data on children's age, sex, length/height and their weight is required. Weight for age, height for age and weight for height z scores are then computed based on a reference population (Cogill, 2003). A child is identified to be stunted (low height/length for age) if their height for age z score is below -2 standard deviations, underweight if the weight for age z score is below -2 standard deviations units whilst a weight for height z score of less than -2 standard deviation units measures wasting.

Other anthropometric measures include Mid Upper Arm Circumference (MUAC), sitting height to standing height ratio (cormic index) and many skin fold thickness measures (Cogill, 2003). The Mid Upper Arm Circumference is not a very popular measure of child under-nutrition amid criticisms of lack of sensitivity in identifying growth faltering in children under the age of six months, although it has been described as a better predictor of death in children than any other anthropometric indicator (Collins *et al.*, 2000). It is best used to monitor child growth in children aged between one and five years. A study by Shrestha *et al*. (1990) conducted in urban areas of Malawi reports of a good correlation between MUAC and weight for age, making MUAC a good alternative to weight for age for monitoring child growth in resource poor communities. The cormic index measures the proportion of sitting height from the total height, providing a ratio of relative trunk length. This varies a lot between and within populations and is not commonly used to monitor child growth. Measurements relating to skin-fold thickness estimate the percentage of body fat and are good for assessing obesity and thinness.

This study is based on under-nutrition as measured by weight for age and height for age z scores calculated using the 2006 WHO growth standards. The 2006 WHO growth standards, replaces the National Centre for Health Statistics/WHO Reference which was largely based on the growth of formula fed infants from the United States of America. The WHO Growth standards were constructed by the Multi-centre Growth Reference Study conducted between 1997 and 2003 based on data from 8500 children from Brazil, Ghana, India, Norway, Oman and USA representing widely different ethnic backgrounds and cultural settings (WHO, 2006).

The adoption of new WHO growth standards has implications for growth assessments and analysing trends of under-nutrition over time. A study comparing the WHO Child Growth Standards and the National Centre for Health Statistics (NCHS) that analysed data from Bangladesh, Dominican Republic, a pooled sample of infants from North America and Northern Europe found that healthy breast-fed infants appeared to falter from 2 months onwards on the NCHS reference, whilst underweight rates increased during the first six months and decreased thereafter when analysed based on the WHO Child Growth standards. For all ages stunting rates were higher on the WHO Growth standards compared to the NCHS reference (de Onis *et al.*, 2006) .

## 2.3 Determinants and causes of child under-nutrition

A child's nutritional status is determined by a combination of factors, some of which are closely associated with the child but many of them are indirectly linked to the child. Due to the complexity of the factors associated with a child's nutritional status, conceptual frameworks are often used to provide a better way of understanding how different factors interact to result in a child having a good or a poor nutritional status. Two conceptual frameworks; Millard's causal model of child mortality Figure 2.1 and the UNICEF conceptual framework on child nutritional status (UNICEF, 1998) Figure 2.2 that depict how different socio-economic factors in developing countries interplay to affect a child's nutritional status are reviewed in this section.

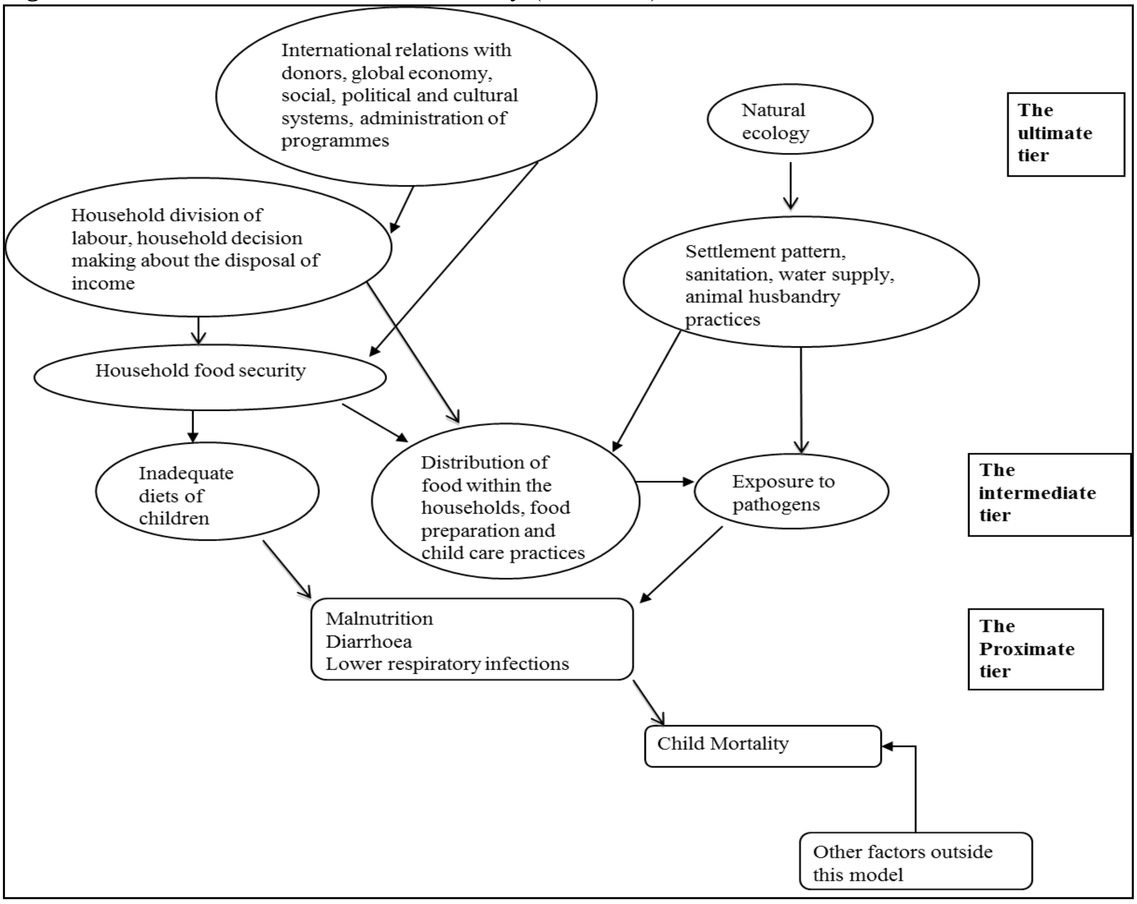
Millard's causal model of child mortality looks at the link between agricultural development and under-nutrition as well as other childhood illnesses. It is based on the premise that in many of the world's developing countries large segments of the population are engaged in farming and that child nutritional status is related to the characteristics of the agricultural system such as settlement patterns, cropping systems, household composition, division of labour, markets and pricing policy (Millard, 1994). In this model, the intermediate and ultimate tiers of the model are important determinants of a child's nutritional status and childhood illnesses such as diarrhoea and lower respiratory infections. The intermediate tier consists of behavioural patterns that increase the exposure to the proximate causes of child mortality. For example, in the framework, insufficient feeding of newly weaned children and their frequent exposure to infection is regarded as being responsible for poor child nutritional status. It is also reported that in some cultures there is a belief that children with diarrhoea should not be given food or water and as result children with diarrhoea end up with rapid dehydration and deteriorating nutritional status.

Interventions to deal with the problem of child malnutrition at the intermediate level have generally included nutrition education and child care training efforts, nutrition rehabilitation involving hospitalizations of malnourished children and intensive education of the mother (Millard, 1994). The outcome of nutrition education programmes is however very much dependent on the availability of resources such as food, money, time and labour. Evidence from a Tanzanian study on nutrition education programmes to tackle child malnutrition revealed that although such programmes helped mothers acquire knowledge in cooking, nutrition and child care, their children continued to revert to their malnutrition states (Howard, 1980). Howard (1987) concluded that the reason for this was that mothers were lacking resources in food, labour and spending money to put their knowledge to practice. Nutrition education may therefore be necessary but not sufficient in effecting changes to children's nutritional status.

Above the intermediate tier are factors that are influential in ensuring that households can access resources such as food, water and income. The availability of natural resources, settlement patterns, decision making about the disposal income, administration of programmes, social, political and cultural systems, international relations with donors, global economy all have a bearing as to whether households have better diets or not. Child care practices and the extent to which the children are exposed to pathogens are also indirectly responsible for a child's nutritional status. For example, a community's natural ecology influences their settlement pattern, sanitation, water supply and animal husbandry practices and these have a direct effect on food preparation and child care practices which in turn affect the likelihood of children getting exposed to pathogens.

On the other hand, the natural ecology also plays a role in determining the household's food security as the kind of crops that can be grown are dependent on the type of soil, terrain and the rainfall pattern although not indicated in this model. The model, however, does not recognise access to land as an important factor. Access to land may vary across households as opposed to settlement patterns that affect communities as a whole. The model rightly recognises the important role of political and cultural systems and administration of programmes in ensuring household food security. Regardless of how well-endowed a community may be with natural resources, government interventions through implementation of appropriate policies and programmes are vital in ensuring that households are accessing farm inputs such as fertilisers, chemicals as well as markets for their produce.

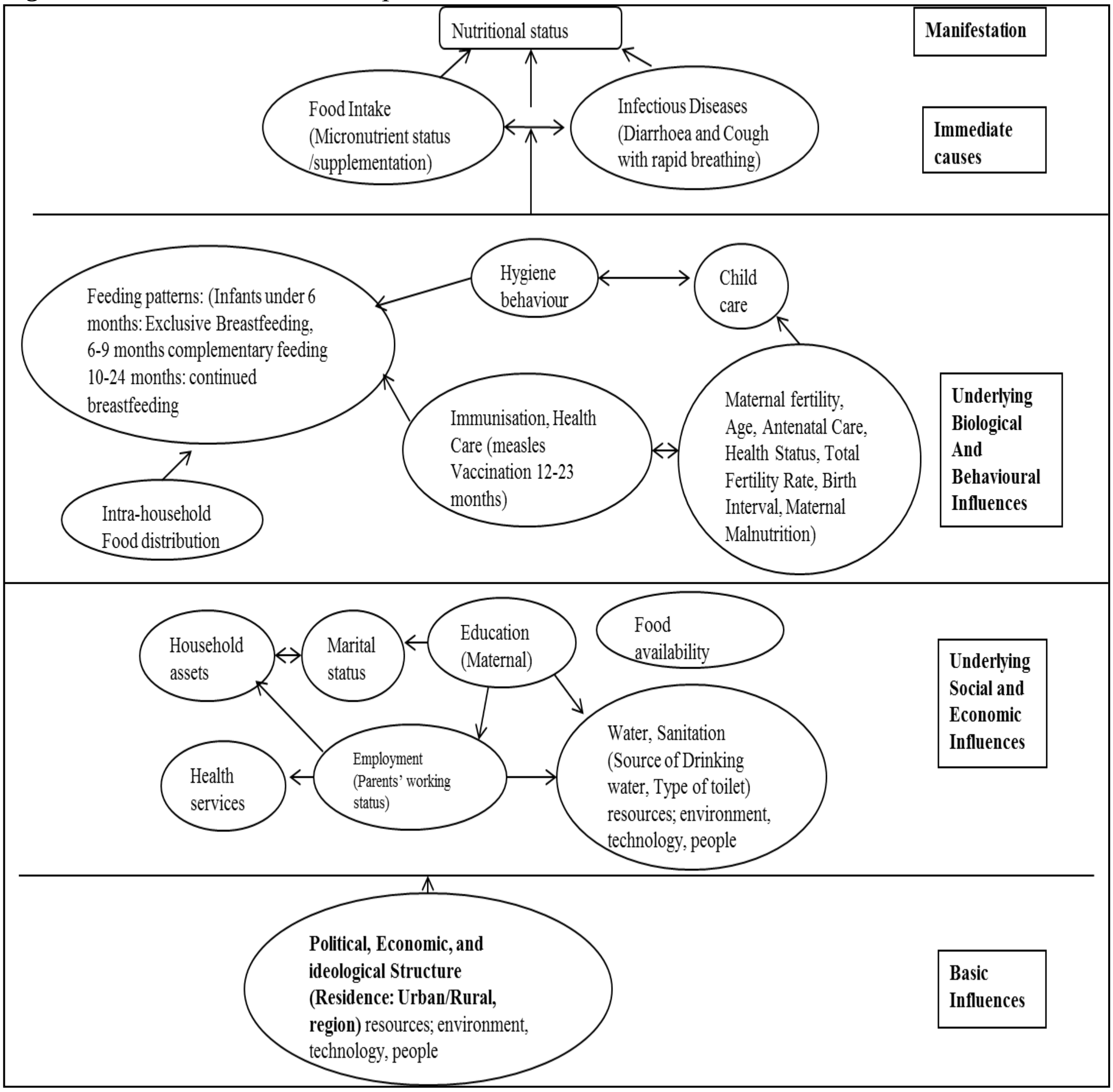
Figure 2.1 A causal model of child mortality (Millard's)




Millard, 1994, P.286

The UNICEF's conceptual framework on child nutritional status is illustrated in Figure 2.2. Directly associated to a child's nutritional status are food intake and infectious diseases. These factors are similar to factors that are given in the intermediate tier of Millard's causal model of child mortality. The interplay between inadequate food intake and illnesses is said to create a vicious circle, so that as an undernourished child whose resistance is compromised falls ill, the child's already poor nutritional status worsens.

Figure 2.2 The UNICEF's conceptual framework for nutritional status




Adapted from UNICEF's State of the World's Children, 1998

Following the immediate causes in the UNICEF's framework are the biological and behavioural influences such as maternal fertility, immunisations and feeding pattern. These factors are influenced by social and economic influences such as maternal education, sanitation and drinking water which are the next level up. The socio-economic factors are influenced by basic influences such as political, economic and ideological structure. These basic influences may be likened to the ultimate tier of causes of child survival in Millard's causal model of child mortality. They depict policy influence that determine the quantity and quality of resources, household food security but also determine the availability of health services, safe water and sanitation.

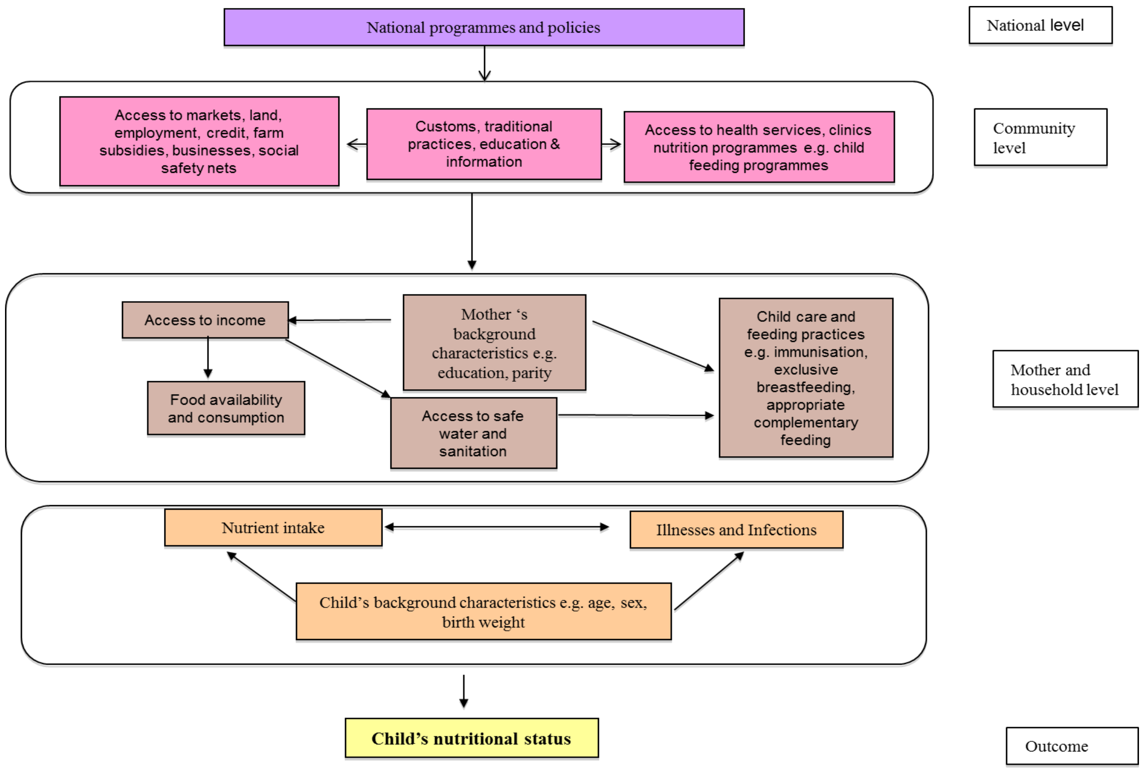
UNICEF's conceptual framework highlights factors that are linked to the mother and therefore puts the mother at the centre of a child's nutritional status whilst Millard's framework on the other hand is focused around how existing systems affect the environment to influence the distribution of food within households, food preparation and child care. Both frameworks recognise the importance of political, cultural, economic and social systems in promoting access and utilization of resources but Millard's framework also includes the role of the global economy and a country's international relations with its donors at this level.

The two frameworks show that factors determining a child's nutritional status exist at different levels, are multi-sectoral and inter-related. Though not explicit in the two frameworks, the different levels may be categorised as the child, household, community and national levels. Each level plays a part in a child's nutritional status. The frameworks depict a trickle-down effect of policies and programmes which when implemented appropriately are expected to improve the social and economic factors such as education level of the mother, employment, access to assets, access to nutritious food and then influence the behavioural practices such as child care practices and hygiene behaviour resulting in a better nutritional status of the child.

Both the UNICEF conceptual framework and
Millard's framework illustrate the direct relationship between adequate diets and nutritional status although they do not specifically include child feeding programmes. This is perhaps due to the fact that child feeding programmes are often implemented as short-term measures to help households affected by under-nutrition which often times is as a result of households experiencing poor harvests. However, the lack of progress in reducing under-nutrition in the Sub-Saharan region and the very little change to estimates of stunting and underweight in Malawi for the past decade has led to child feeding programmes becoming a permanent feature of addressing under-nutrition in poor countries like Malawi (United-Nations, 2010). For this reason, the conceptual framework used in this research includes child feeding programmes. This conceptual framework is shown in Figure 2.3. In this conceptual framework, factors associated with child under-nutrition are grouped in four different levels similar to the UNICEF's conceptual framework for nutritional status and Millard's with groups named as the child level, mother and household level, community level and national level in recognition of the different levels that play a part in a child's nutritional status. The child level has biological factors such as age and sex and non-biological factors such as child illnesses. At household level are economic factors such as education level of mother and father and access to income and behavioural factors such as child immunisation and feeding practices. The community level

recognises the importance of community amenities such as health clinics, markets, access to water as well customs and traditional practices. The national level is about policies and programmes that influence household food security but also implementation of programmes aimed at dealing with child under-nutrition. The factors associated with child under-nutrition described in the three conceptual frameworks bear similarities to the factors described in the analytical framework for the study of child survival in developing countries by Mosley and Chen (1984). Mosley and Chen's analytical framework of child survival is based on the premise that in an optimal setting, over 97% of new born infants can be expected to survive through the first five years of life and that the reduction in this survival probability in any society is due to the operation of social, economic, biological and environmental forces. In their analytical framework, growth faltering and mortality in children are the cumulative consequences of multiple disease processes. The socioeconomic determinants which include mother/father variables such as skills, education, health and time, household level variables such as income/wealth, water, preventive care, community variables such as ecological setting, health system institutionalised actions must operate through more basic proximate determinants. The proximate determinants include maternal factors e.g. age, parity, birth interval, environmental contamination, nutrient deficiency and personal illness control.

Figure 2.3 Conceptual framework for nutritional status used in this study



## 2.4 Child level factors associated with Nutritional Status

### 2.4.1 Nutrient intake and child nutritional status

Conceptual frameworks on child nutrition as illustrated in section 2.3 place nutrient intake and child illnesses as factors that are directly associated with a child's nutritional status. Nutrients are substances contained in food that are essential for growth, give the body energy to perform physical activities, repair the body after illness or injury, provide a general maintenance to the body and are needed for reproduction. Nutrients are classified into six classes; proteins, carbohydrates, lipids (fats and oils), water, vitamins and minerals. Carbohydrates, lipids and proteins are required by the body in large amounts whilst vitamins and minerals are required in small amounts (Smolin and Grosvenor, 2003). Consuming too much or too little of one or more nutrients can cause malnutrition. Consumption of food with the appropriate nutrients required by the body and in the correct amounts is the first important step in nourishing the body. However, the availability of such nutrients for use by the body may be hindered by the inability of the body to absorb and use such nutrients due to illnesses and infections.

**Protein and Energy**

Study findings on the effect of different nutrients on linear growth and weight gain are not consistent, mainly due to differences in study populations and study methodologies. In a study conducted about 30 years ago in New Guinea amongst Bundi[3] children aged between 5.5 and 15 years, changes to diet through the increase of number of meals but with no change to the composition of the food and inclusion of milk to the normal diet was found to improve linear growth, whilst consumption of margarine is reported to have only affected weight gain (Malcom, 1970) . The children studied were very stunted and on a diet of taro and sweet potatoes which are tubers with low protein content varying from 0.5 to 2%. There were four groups in the experiment, one group had their meals increased from three to five (22 children), another group was supplemented with skim milk powder (31 children) (skim milk has a higher content of protein), another group was given margarine only, whose energy values was equivalent to the skim milk powder (22 children) and another group of 22 children were the control group feeding on the normal diet. The supplementation programme was implemented for thirteen weeks. Compared to the group of children that ate the normal school meal, the group that had their quantity of food increased experienced an increase in their heights of 40%, and the children that were supplemented with skim milk increased their heights by 111% whilst those

[3] Bundi is a tribe from New Guinea that live in the highlands with an altitude of 1220 metres

that were supplemented with margarine grew less than the controls; those on just the normal diet. Weight gain was achieved and more rapidly so by the children that were fed margarine and skim milk. Malcolm (1970) concluded that the feeding experiments indicated that protein is a key factor in determining growth and that additional calories from fat just increase weight through the storage of redundant intake as subcutaneous fat. Whilst the effect on linear growth as a result of the increase in the number of meals and more especially due to the supplementation with skim milk is very impressive, the big percentage increase may be specific to the Bundi children due to their original poor day to day to diet. However, similar findings on the role of energy intake on growth are reported in a more recent study by Gibson *et al.* (2009) done in Ethiopia. Their study found that the median daily intakes of energy from complementary foods for stunted infants aged 6-8 months but not for older groups (9 to 23 months) were significantly lower than those of their un-stunted counterparts. The difference however, was not apparent when intakes were expressed per kilogram body weight. Similarly, a higher frequency of feeding is reported to be associated with linear growth in Ethiopia (Umeta *et al.*, 2003).

On the other hand, Martorell and Klein (1980) did not find any significant differences in changes to linear growth for undernourished children in Guatemala who were given supplements of good quality protein (Atole) which was a mixture of dry skim milk and cereal compared to those that were given supplemental energy alone (fresco) a non-protein beverage. In the majority of children, severe growth stunting occurred even when the energy intakes exceeded the FAO/WHO requirements and protein intakes were two to three times higher than the requirements. The research team concluded that perhaps the study population might have been lacking special micronutrients that are vital for growth. The findings on the role of the two macronutrients (energy and protein) on linear growth from these studies are therefore mixed. Whilst both energy and protein contribute to a better nutritional status of the child, their effect possibly varies according to how much low energy and protein levels were in the undernourished children before intervention. In some cases where undernourished children do not respond to protein and energy interventions it could be the case that such children could be lacking micro nutrients such as Zinc, Iron and Vitamin A which are also important for child growth as described in the following section.

**Minerals and vitamins**

Zinc, Iron and Vitamin A are the commonly reported micronutrients linked to children's nutritional status. Zinc and Iron are mainly derived from similar sources (animal sources of food) and as a result zinc and iron deficiencies tend to co-exist. From a medical/biological point of view, zinc is an essential nutrient in the body. Clinical features of severe zinc deficiency among others include growth retardation, impaired appetite and an increased susceptibility to infections (Howard, 1980). Iron and zinc are critical for normal growth, blood formation and neurological development during infancy (Krebs, 2000). Research findings on the role of zinc in the nutritional status of children are also varied.

There is some evidence in support of vitamin A supplementation improving anthropometric scores of undernourished children. In a study conducted in Sudan, Sedgh *et al.* (2000) examined the associations between dietary vitamin A intake, non-dietary factors and growth in 8174 Sudanese children aged 6 to 72 months who were stunted at the start of follow-up for a period of 18 months. Their study found that children that were in the highest quintile for consuming food containing vitamin A grew 13mm more in the study period than children in the lowest quintile, after controlling for age, sex, breastfeeding status and socioeconomic status of the child. The study also found that the relative risk of recovery from stunting associated with vitamin A intake was greater amongst children under the age of one year compared to children over three years. I suppose this could be because the vitamin A deficiency in the children under the age of one may be higher than the deficiency in the older children considering younger children are more likely to be facing nutritional challenges due to being introduced to new foods. Dietary intake of vitamin A in this study was measured by asking mothers about each child's consumption on the previous day, and as such may not be an accurate record of vitamin A consumption. The importance of vitamin A in child nutritional status is also supported by the findings of Berger *et al.* (2007) in Indonesia, whereby more children that had received vitamin A supplements had relatively better anthropometric scores compared to children that had not.

Whilst a few studies report on the effectiveness of vitamin A in improving anthropometric scores, other studies have reported that Vitamin A supplementation is useful in the improvement of the immune system for children and adults. In a Brazilian study by Lima *et al.* (2010), vitamin A supplementation was found to improve the immune system of children aged between two months and 9 years with length/height for age less than the median of the community which was -0.06. The study was done on 79 children, 39 received vitamin A and 40 received a placebo. After being followed up for a period of 36 months, the study found that the total intestinal parasitic, specifically from new infections were significantly lower in the vitamin A treatment group compared to the control group. This was accounted for entirely by significantly fewer giardia infections (a form of diarrhoea illness). By reducing infections, vitamin A may help in the absorption of other nutrients. Vitamin A supplementation has also been shown to reduce the number of episodes where the malaria causing parasite, plasmodium falciparum is at least 8000/μL as well as temperature equal or greater than 37.5 degrees celcius by 30%, (relative risk 0.70 (P value 0.0013) in Papua New Guinea (Shankar *et al.*, 1999), and to have improved the severity of measles and reduced the mortality in children with severe measles in a South African study (Hussey and Klein, 1990). Findings of a study by Sommer *et al.* (1986) in Indonesia suggest that vitamin A supplements given to vitamin A deficient population may decrease child mortality by as much as 34%.

### 2.4.2 Childhood illnesses and infections

A dual relationship exists between nutrient intake and childhood illnesses as shown in the conceptual framework for child nutritional status given in Figure 2.3 under section 2.3. Children with poor nutrient intake either due to lack of access to nutritious food or poor absorption are likely to have a reduced immune system and have an increased chance of catching illnesses as a result. On the other hand, childhood illnesses reduce children's nutrient uptake by reducing children's appetite, reducing the absorption of nutrients and increasing the loss of nutrients in their bowel movements. Children that do not recover from their illnesses get caught up in the vicious circle of poor health and poor nutrition and are therefore very weak to fight any new infections that they catch decreasing their chances of surviving from any new illnesses. Undernourished children are reported to have had longer durations of diarrhoea compared to well- nourished children in a study conducted in northern Nigeria (Tomkins, 1981). In this study the duration of diarrhoea was 33% longer for underweight children, 39% longer for stunted children and 79% longer for wasted children.

The dual relationship between nutrient intake and illnesses/infections shown in the conceptual framework for child nutrition entails that both aspects have to be dealt with simultaneously. It is a well-recognised fact that strategies to tackle under-nutrition have to go beyond food provision to maintaining good health status. Nutritional approaches that aim to break the vicious circle between under-nutrition and diarrhoea have been cited as the best approaches to dealing with the problem of under-nutrition (Guerrant *et al.*, 2008). These approaches repair the intestinal mucosa through provision of safe water, good sanitation, access to vaccines, supplementation with bowel nutrients and consumption of probiotics.

**Intestinal infections**

Apart from childhood diarrhoea, other common illnesses that affect children's nutrient intake are infections of the intestines such as Schistosoma mansoni, Cryptosporidium and Escherichia coli. Schistosomes are a kind of worms that live in the bloodstream of human beings and animals and often people are infected by exposure to water containing the infective larvae (I.A.R.C., 1994). There are three kinds of schistosomes; Schistosoma haematobium, Schistosoma mansoni and Schistosoma japonicum. A study in Brazil analysed the relationship between stunting, Schistosoma mansoni infection and dietary intake (Assis *et al.*, 2004) and found that Schistosoma mansoni infection and inadequate consumption of dietary lipids independent of each other were the most relevant factors for the high prevalence of stunting (22.1%) in this population. Whilst the prevalence of Schistosoma mansoni is pretty low in Malawi at 0.8% the estimate for the prevalence of schistosoma haematobium is quite high at 18.7% (Shawa, 2010). Other infections such as Cryptosporidium and Escherichia coli infections predispose affected children to growth shortfalls even without extreme levels of diarrhoea, and Escherichia coli infections also increase gut inflammation infections (Guerrant *et al.*, 2008). The prevalence of Cryptosporidium and Escherichia coli in Malawi is not known.

**Diarrhoea**

It is estimated that each year 2.5 billion cases of diarrhoea occur in under-five children in the World (UNICEF-WHO, 2009). More than half of these children are from Africa and Asia. Childhood diarrhoea is responsible for 16% of under-five children deaths in the world, (WHO, 2008). Numerous studies report an association between childhood diarrhoea and poor child nutritional status. In a study by Madise *et al.* (1999) involving six African countries, in all the six countries, children that had been ill with diarrhoea within two weeks of the survey had lower weight for age z scores compared to children that had not been ill with diarrhoea. Childhood diarrhoea incidences in Malawi follow a similar pattern to child under-nutrition, increasing with the age of the child and having sharp increases in the first year of life, peaking at about 8 to 12 months (Kandala *et al.*, 2006) whilst a recent study from rural Malawi by Weisz *et al.* (2011) reports that more days of diarrhoea were associated with decreases in height for age z scores, mid upper arm circumference z scores and weight for age z scores.

More evidence on the effect of childhood diarrhoea on child nutritional status comes from a multi-country analysis on the effects of diarrhoea on childhood stunting by Checkley *et al.* (2008). This study pooled longitudinal information from nine prospective studies from Bangladesh, Peru, Guinea-Bissau, Brazil and Ghana. The studies that were picked for analysis had participants from birth who were followed with regular anthropometric measurements and daily records for diarrhoeal surveillance. An aggregate socio-economic status variable was used to control for socio-economic status. Their study found that the effect of cumulative diarrhoeal incidence prior to 24 months on stunting at 24 months was similar among studies and that the adjusted odds of stunting at 24 months increased multiplicatively by a factor of 1.13 with a cumulative diarrhoeal incidence per five episodes of diarrhoea. Similarly the adjusted odds of stunting increased multiplicatively by a factor of 1.16 when the longitudinal prevalence of diarrhoea prior to 24 months increased by 5%. As such a greater burden of diarrhoea prior to 24 months of life was associated with a greater frequency of stunting at 24 months of age.

The positive association between child diarrhoea and child under-nutrition may influence one to conclude that under-nutrition may be overcome by reducing diarrhoea illnesses. However, a study conducted in Bangladesh assessing whether diarrhoea control programmes are likely to reduce childhood under-nutrition concluded that the effect of diarrhoea on growth is transient and that efforts to control diarrhoea are unlikely to improve children's nutritional status (Briend *et al.*, 1989). The study analysed diarrhoea incidences in 3-month intervals per child. Using information from 1772 3-month intervals, this study found that weight and linear growth were lower in intervals without diarrhoea but their comparison of weight and height gains in intervals during which diarrhoea occurred at the beginning or at the end showed that after non-bloody diarrhoea children caught up and that deficits in weight gain and linear growth were no longer apparent a few weeks later. It should be noted however that children with diarrhoea received oral rehydration therapy if diarrhoea occurred and were referred to a nearby hospital if they were seriously ill.

Whether children catch up or not in their weight gain or linear growth after a diarrhoea episode is probably a function of the duration or frequency of the diarrhoea and the treatment provided. A study in Serbia, a medium income country, did not find diarrhoea to be a significant associate of childhood under-nutrition (Janevic *et al.*, 2010). Since the link between childhood diarrhoea and child under-nutrition could be as a result of reduced nutrient intake through poor appetite and loss of nutrients in bowel movements, the lack of association between child diarrhoea and under-nutrition in the Serbian study could possibly indicate that diarrhoea illnesses affecting these children are either not severe or are of a short duration, and that perhaps children suffering from diarrhoea may still be getting adequate nutrition such that they are able to quickly replace the nutrients that they lose in bowel movements.

Good nutrition during diarrhoea episodes can indeed overcome potential weight losses often experienced by children during diarrhoea episodes as reported in a Gambian study by Hoare *et al.* (1996) in which dietary supplementation after acute diarrhoea is reported to have induced catch-up growth. Their study provided a high energy-protein supplement to 34 children aged between 4 to 22 months with weight loss after acute diarrhoea for a fortnight. In half of the children, supplementation was taken immediately after rehydration (early) whilst in the other half, supplementation started a fortnight after rehydration (late). Children that were supplemented early weighed significantly less than children that were supplemented late both on the day that they presented with diarrhoea and the day after rehydration. Children were rehydrated at a clinic and breastfeeding was encouraged to continue throughout the study. Children were given the supplement containing 50% more energy and 100% more protein than their usual diet every two hours from 07.30 to 19.30. The following vitamins and minerals; Vitamin A, Vitamin D, Vitamin C, Folate, Thiamine, Calcium, Iron and Zinc were added to the feeds to meet or exceed the recommended dietary intake for developing countries. Local fruits and honey were used as flavourings.

Although vomiting and diarrhoea increased during periods of supplementation in both groups, children continued to gain weight. The findings of the study show that intensive feeding with adequate uptake of nutrients during diarrhoea episodes can overcome the under-nutrition that is often associated with diarrhoea. However, one has to bear in mind that the children were thoroughly rehydrated at a clinic and the mothers were supervised by the study team. This kind of intensive feeding for children suffering diarrhoea may not be practical in the majority of children who suffer from diarrhoea but also have poor access to food contrary to the suggestion by Hoare *et al.* (1996). More practical strategies are likely to be the ones that prevent diarrhoea from taking place in the first place through good sanitation and consumption of locally available foods that are rich in nutrients such as zinc and vitamin A that have been shown to improve children's immune status in other studies.

**Fever**

Fever is a common illness amongst children and is often a symptom of malaria in malaria infected areas or some form of infections. In a community based study involving 2410 under-five children from South West Ethiopia, children who had malaria were 1.5 times more likely to be anaemic compared to children who had no malaria parasite 95% CI (1.1,2.0) (Deribew *et al.*, 2010). However the study did not find an association between malaria and under-nutrition. Similar findings are reported in a study by Crookston *et al.* (2010) conducted in Ghana where children experiencing anaemia had an increased likelihood of asymptomatic malaria, OR 4.15, CI (1.92,8.98). This study also did not find any association between stunting and malaria. The lack of association between malaria and under-nutrition possibly shows that all children whether undernourished or not are equally exposed to the malaria parasite, however well-nourished children may not be affected severely considering the previous evidence supporting the role of vitamin A in reducing malaria morbidity (Shankar *et al.*, 1999). However, a recent study from rural Malawi in children aged between 6 and 18 months found that more days of fever were associated with decreases in mid upper arm circumference z scores and weight for age z scores (Weisz *et al.*, 2011). Probably the cause of fever could have been some other infections and not malaria in this case.

**Acute lower respiratory infections (Pneumonia)**

Acute lower respiratory infections/pneumonia causes more deaths amongst under-fives compared to diarrhoea, malaria, under-nutrition and neonatal problems. There is an overlap and interrelationship between child under-nutrition and acute respiratory illness whereby children that are under-nourished are prone to have acute respiratory infections. A Gambian study by West et *al.* (2008) reports that survival from hypoxemic pneumonia, a kind of pneumonia that causes deficiency of oxygen are more dependent on a child's nutritional status. Children with better nutritional status have a better lung capacity which increases a child's chance of survival.

### 2.4.3 Age

The age of the child is a major factor that influences how a child's nutritional status responds to the socio-economic environment that they are in. Studies on determinants of child under-nutrition conducted in several developing countries report child's age to be a significant determinant of child under-nutrition. Tharakan and Suchindran (1999) in their study conducted in Botswana found that stunting and underweight rates were lower for children aged less than one year compared to older children, whilst Garret and Ruel (1999) in their study conducted in Mozambique amongst children aged between 0 and 23 months report that children's nutritional status deteriorated at the rate of 0.13 z scores per month. A significant association between age of the child and weight for age z scores is also reported by Griffiths et *al.* (2004) in their study of under-nutrition in six African countries of Ghana, Nigeria, Zimbabwe, Malawi, Tanzania and Zambia and four Indian states of Uttar Pradesh, Maharashtra, Karnataka and Tamil Nadu. In all the studied populations weight for age z scores were significantly associated with the age of the child with a steepest decline in the weight for age z scores experienced between the ages of 6 and 12 months, the period when a child gets introduced to solid foods and other liquids apart from breast milk of formula milk. This period is sometimes referred to as the weaning period.

A child's weaning time is a particularly challenging time for mothers since during this time the baby gets introduced to new foods with different flavour and textures. It therefore takes some time for the baby to get used to new foods and start consuming adequate amounts increasing the likelihood of poor nutrient intake. A further challenge relates to ensuring that good hygiene practices are followed at a time when the child is becoming more mobile and starting to pick things up and putting them in their mouth increasing the chance of getting infections. The third challenge is to do with ensuring that the food that the baby is fed has all the nutrients to meet the demands of a growing baby. Whilst the nutrient composition of human milk may have some variation depending on mother's nutrition, this variation may not be as huge as the variation of nutrients in foods introduced to children during their weaning period. A mother's ability to properly wean their child therefore depends on whether they are aware of the appropriate weaning food and whether they can easily access the appropriate weaning food.

It is not surprising therefore that childhood under-nutrition rates rise sharply during the weaning stage. Two studies conducted in Malawi report that child under-nutrition worsens as the child grows older, stabilising at about two years of age (Chirwa and Ngalawa, 2008, Madise *et al.*, 1999). The study by Chirwa and Ngalawa (2008) used data from the Malawi Integrated Household Survey of 1998 and found that it is at the ages of 34 months for under-weight and 30 months for stunting that the proportion of children affected by under-nutrition start going down, depicting a curve-linear relationship between under-nutrition and the age of the child. Whilst the study by Madise et *al.* (1999) used Demographic and Health Survey data sets from Malawi, Tanzania, Zambia, Zimbabwe, Ghana and Nigeria and found that age of the child was the most important factor associated with a child's nutritional status and that the nutritional status of children deteriorated very rapidly after birth, stabilising during their second year of life. The stabilisation of under-nutrition rates from the age of two years onwards commonly reported in studies is possibly due to children developing a stronger immune system to fight infections as a result of increasing their food intake having adapted to the new diet as well as having grown bigger stomachs.

### 2.4.4 Sex

Several studies have reported an association between child's sex and child's nutritional status. In a study by Madise et *al.* (1999) that studied children aged 0 to 36 months in six sub-Saharan Africa countries, female children on average appeared to be better nourished than male children. A similar finding is reported by Chirwa and Ngalawa (2008) in Malawian children aged from 6 to 59 months. However, other studies have come up with different findings, Vella *et al.* (1992) using data from north west Uganda for children aged 0 to 59 months did not find any significant effect of the sex variable whilst better nutritional status for boys compared to girls is reported in a Kenyan study that used data from two rural districts on children aged 0 to 60 months (Ndiku *et* *al.*, 2011). Their study found that boys consistently had higher energy intakes than girls with indications that food allocation was biased towards boys. Girls were greatly undernourished compared to boys with stunting rates estimated at 51.7% for girls compared to 35.9 % for boys, underweight 32.1% for girls compared to 14.6% for boys, wasting 4.6% for girls compared to 1.2% for boys. Evidence of food allocation biased towards boys with associated poor anthropometric scores was also discovered amongst children under the age of five in a study by Chen *et al.* (1981) in Bangladesh and in Guatemala in children of a similar age group, (Frongillo and Bégin, 1993) . The study by Frongillo and Bégin (1993) controlled for many family and child variables that influence food intake as well as weight and stature due to differences in energy needs between boys and girls and found that the magnitude of bias amongst children aged between 2 to 5 years was 247 Kilojoules per day. The study by Chen *et al.* (1981) also found that health service utilisation was also biased towards boys.

Whilst there is some evidence of a biased food allocation in some of the studies that have reported better anthropometric scores for boys compared to girls, no reports have been identified of food allocation that is biased towards girls in places where girls are better nourished than boys. It appears that better nutritional status for girls compared to boys is common in sub-Saharan Africa as per the evidence from a study by Svedberg (1990) that showed that males of all ages were relatively shorter and lighter than females. There are suggestions that the gender differential in nutritional status favours women due to a biological difference in energy needs. The female body is estimated to be 15% more efficient than a male body when it comes to physical work and could be the reason why most studies find girls to have lower levels of under-nutrition compared to boys in populations that have poor access to food (Svedberg, 1990). Male children are also more prone to illnesses and face higher risk of dying in the early years compared to female children also due to biological reasons (Chen *et al.*, 1981). Due to the expected biological difference in the risk to illnesses between boys and girls as well as energy needs, findings that show girls to be better nourished than boys may therefore just be revealing the expected.

### 2.4.5 Birth weight

Weight of the child at birth is the third biological factor that affects a child's physical development. A few studies on the determinants of child under-nutrition have reported the existence of an association between child's nutritional status and their weight at birth. A study conducted in Ethiopia found that low birth weight (less than 1500g) is a significant predictor of stunting and underweight at one year and of underweight at six months Medhin *et al.* (2010). Similarly, a study by Datar and Jacknowitz (2009) in the United States of America amongst a nationally representative cohort of children followed up from birth born in 2001 showed that low birth weights (less than 1500g) and moderately low birth weights (between 1500g and 2499g) had large negative effects on mental development and growth at 9 months and 2 years of age. Results from within twin models with dizygotic twins that control for shared maternal, environmental and genetic factors showed much less effect of birth weight on mental or motor development but continued large effects on growth for the very low birth weight group. Children born with low weight are very unlikely to catch up with the growth of children born of normal weight even if they grow in a similar environment. Due to lack of data on birth weights in most developing countries, size at birth as reported by the mother has been used as a proxy for weight at birth in previous studies. Size at birth is reportedly a good proxy for weight at birth in large nationally representative surveys (Channon, 2011). Griffiths *et al.* (2004) in their study of six sub-Saharan countries and four Indian states reported earlier on, found size of child at birth to be an important predictor of low weight for age z score. Whilst mothers have no influence as far as the age and gender of the child is, there is potential for them to influence the size of the child at birth through better nutritional status during their childhood and more especially during pregnancy. The next section discusses past studies on the links between maternal nutritional status and child's nutritional status.

### 2.4.6 Birth order

A child's birth order may play a part in a child's well-being more especially in resource poor countries where as a result of limited access to resources such as food and income, households have to decide how food can be shared in the household. Children of the first birth order without a sibling or siblings, may be better off compared to children of a higher birth order with siblings as they do not have to compete for mother's care as well as food. A study from the Philippines suggests that as households get larger, the long term nutritional status for children of higher birth order may be at a disadvantage due to a reduction of households resources per capita (Horton, 1988). Similarly a higher likelihood of stunting amongst children of birth order 4 or higher compared to those of the first birth order has been reported in Cambodia by Hong and Mishra (2006) and Aerts *et al*. in Brazil (2004). On the other hand, one could argue that children of higher birth order could experience a better childhood compared to those of lower birth order as they are likely to be born into households that may be better off economically through parents having developed themselves over time i.e. through further education, promotion at work or business investments. Findings of a study by Mette and Pörtner (2004) appear to support this line of thought. Mette and Pörtner (2004) in their multivariate analysis study of birth order and the intra-household allocation of time and education in the Philippines which included fertility as an endogenous variable found that parents tend to favour the last-born children and that last-born children receive more education than their earlier-born siblings. Findings on the role of birth order on child nutritional status therefore do indicate a link between child nutritional status and child's birth order although there is a variation in the direction of the relationship due to differences in methodologies employed.

### 2.4.7 Birth interval

Whilst the association between birth order on a child's nutritional status is expected to be through influencing the decision making process of how resources should be allocated amongst siblings, birth interval may affect a child nutritional status through influencing the amount of time that a mother allocates for child care, the resources allocated to the children, as well as mother's health and nutritional status. Previous studies on the role of preceding birth interval on a child's nutritional status are varied possibly due to differences in the ages of children studied. A study by Madise and Mpoma (1997) found a significantly lower likelihood of underweight amongst children with a preceding birth interval of 48 months or more compared to those with a shorter preceding birth interval and first born children amongst children aged 12 to 59 months in Malawi. A positive association between longer preceding birth intervals and a child's nutritional status has also been reported by David *et al.* (2004). Shorter preceding birth intervals have also been linked to a higher risk of child/infant mortality in Malawi and in India (Samuel O.M, 1999, Whitworth and Stephenson, 2002). On the other hand Madise *et al.* (1999) reports of no significant difference in the underweight status between children with a preceding birth interval of 0 to 24 months and those with a preceding interval of more than 24 months amongst Malawian children aged between 1 to 35 months.

Findings on the relationship between succeeding birth interval and child nutritional status are also varied. A study by Madise and Mpoma(1997) conducted in Malawi reports of better underweight status for children who have a younger sibling in less than 24 months compared to those without a younger sibling whilst in other settings the age difference with a younger sibling has not been found to be associated with a child's nutritional status (David *et al.*, 2004). It is logical however to expect that the nutritional status of children should be affected more by their preceding birth interval and perhaps not their succeeding birth interval such that assuming two children from the same household, a short succeeding birth interval for an older child is in essence a short preceding birth interval for the succeeding child. As such, children with no younger siblings who happen to have short preceding birth intervals should have a higher likelihood of being undernourished than their older siblings, whilst children with a longer preceding interval should have a higher likelihood of being better nourished compared to those with a shorter preceding birth interval since they are born from mothers who have let their bodies recover and gain strength after a previous pregnancy.

## 2.5 Household level factors

### 2.5.1 Maternal nutritional status

Maternal health and maternal nutritional status before and during pregnancy does have a direct effect on the children's health and nutritional status by influencing the children's weight at birth. In a meta-analysis study of causes of low birth weight in developing countries, poor gestational nutrition has been cited as the second most important factor responsible for low birth weight, being of Black or Indian racial origin was first. Whilst in developed countries, the most important factor was cigarette smoking followed by gestational nutrition (Kramer, 1987). The estimate for low birth weight in developing countries is 16%, 18.3% in Asia and 14.3% in Africa (Black *et al.,* 2008).

Under-nutrition in newly born children in Malawi may be as a result of poor maternal nutrition status as per studies conducted in Malawi. In a study by Thakwalakwa *et al.* (2009) conducted in a rural district from Southern Malawi, new-borns were found to be on average 2.5 cm shorter and 510g lighter than children from the 2000 CDC reference population indicating that such children are already undernourished even before they are born. A study by Madise *et al.* (1999) found that the mean height for age z scores for children aged one month were negative in Malawi, Nigeria, Tanzania and Zambia indicating that stunting may be a problem in new born babies in these countries. The same study found a significant association between maternal weight for height and children's weight for age z scores showing that mothers who are heavier or taller are likely to have heavier or longer babies. The effect of maternal under-nutrition and maternal anaemia status on foetal growth has been studied by Mahajan *et al.* (2004) in India. Maternal under-nutrition was measured by a body mass index of lower than 17 and maternal anaemia was measured by a haemoglobin level of less than 11g/dL. Their study followed up 300 pregnant mothers who were attending an antenatal clinic at a government hospital in New Delhi. At birth, weight measurements revealed that the birth weight for both the neonates of under-nourished and anaemic mothers was significantly lower than the birth weight of children whose mothers were not under-nourished and not anaemic. The mean birth weight was further reduced if mothers were both under-nourished and anaemic.

The important link between maternal nutritional status and baby's birth weight is also revealed in a Gambian study that compared birth weights between children of mothers that were given a food supplement during their pregnancy and those that were not, during a food shortage season. Supplementation is reported to have been highly effective such that that babies that were born after mothers were supplemented, weighed 231g more (p value < 0.001) on average compared to those born during a similar food shortage period but without receiving any supplements (Prentice *et al.*, 1987). Studies also report of an association between mothers' nutritional status during pregnancy and their child nutritional status at six and 12 months in Ethiopia Medhin *et al.* (2010) and 12 months in Malawi (Espo *et al.*, 2002). Medhin *et al.* (2010) used Mid Upper Arm Circumference (MUAC) measurements of the mother when they were pregnant as a measure of mother nutritional status in a logistic and linear regression of predictors of infant under-nutrition and found that lower levels of mothers MUAC were associated with lower levels weight for age z scores. The study by Espo *et al.* (2002) found that at the age of 12 months children whose mothers had gained more than 200g per week during their pregnancy had a lower risk of stunting compared to children whose mothers gained less than 200g a week during their pregnancy. Mother's weight gained during pregnancy is therefore not only associated with better child birth weight but child nutritional status as they grow.

On another note, a child's birth weight and in some cases child survival may not only be influenced by mother nutritional status or weight gain during pregnancy but whether the mother is of short stature or not. Low maternal stature could be associated with a child's probability of dying, and a child's probability of being undernourished based on the findings from a study conducted in 54 low to middle income countries using DHS survey data sets from 1991 to 2008 by Ozaltin et *al.* (2010). The study found that in pooled adjusted models, a 1cm increase in height was associated with a 0.968 decreased relative risk in underweight, a 0.968 decreased relative risk in stunting and a decreased relative risk in wasting of 0.994. Compared with tallest mothers (height equal or greater than 160 cm) each lower height category had a substantially higher risk of their offspring being underweight and stunted with the risk being greatest for mothers shorter than 145cm. The nutritional and health status of mothers when they were a child themselves has an impact on their child's nutritional status reflecting the inter-generational link between mother and child's nutritional status. Short maternal stature is also reported to be associated with severe stunting in children aged 12 months in Malawi (Espo *et al.*, 2002).

Taking supplements during pregnancy is one way of maintaining good nutritional status. Whilst these supplements are vital for all mothers, HIV positive mothers need them more than HIV negative mothers. HIV/AIDS is an illness that greatly affects the nutritional status of those affected by it. Infected mothers if not treated with antiretroviral drugs, have a higher chance of transmitting HIV to their unborn child during pregnancy, delivery or during breastfeeding. Mother to child transmission rates without treatment with antiretroviral drugs during pregnancy, delivery and breastfeeding are estimated to be in the region of 15 to 45% (WHO, 2012c). It is estimated that every day 1,200 children become infected with HIV (UNICEF, 2010). Those infected with HIV have a higher likelihood of being ill due to a lowered immune system. Studies reveal the expected higher morbidity and higher under-nutrition amongst the HIV infected children compared to the HIV uninfected children (Bachou *et al.*, 2006, Lucas *et al.*, 1996, Padmapriyadarsini *et al.*, 2009). Apart from showing extremely high levels of under-nutrition amongst HIV infected children, the study by Padmapriyadarsini *et al.* (2009) conducted in South India also found the unusual situation where the underweight rate (63%) was higher than the stunting rate (58%) indicating a higher mortality risk for HIV infected children. On a positive note however, Vitamin A supplementation in HIV positive mothers has been shown to increase children's birth weight and improve children's anaemia status in a Malawian study (Kumwenda *et al.*, 2002). Their study involved 697 Human Immunodeficiency Virus (HIV) infected pregnant women. Women received a daily dose of iron folate, either alone or combined with vitamin A from 18-28 weeks gestation until delivery. After delivery, babies whose mothers had received vitamin A weighed heavier than those whose mothers had taken iron folate only and at six weeks the number of anaemic babies was significantly lower in the vitamin A group compared to the group that had received iron folate only. Iron supplementation on its own therefore, may not be adequate in improving the birth weight and anaemia status of babies born to mothers with a poor immune status.

The findings of the study by Kumwenda *et al.* (2002) show how much nutritional support is needed for HIV positive mothers to maintain their own health status and more so if they are pregnant. HIV positive mothers are more at risk of under-nutrition due to their lowered immune status. Two thirds of people with HIV are from sub-Saharan Africa where adult prevalence exceeds 25% in most of the countries (Uthman, 2008). A meta-analysis of 11 countries from the sub-Saharan region revealed that the overall prevalence of HIV related under-nutrition measured by body mass index <18.5 was 10.3% (Uthman, 2008). This means that HIV positive mothers coming from poorer backgrounds have a double risk of becoming under-nourished as most mothers have poor access to food, medicines and vitamins and also have a double risk of bearing low birth weight, anaemic and poor health status babies. Whilst breastfeeding is crucial for a child's nutritional status, a study by Magadi (2011) found that the benefit of breastfeeding was not evident amongst children whose mothers are infected with HIV in a study of DHS data from 18 countries from sub-Saharan Africa.

### 2.5.2 Mother education level

Education in general increases the chance of getting employed and earning a livelihood and also increases the awareness of good child care practices. A study on the role of maternal education in child health and nutritional status found that maternal education as measured by the number of years of schooling is a consistent positive associate of child's health status in general and nutritional status in particular in Ecuador (Larrea and Kawachi, 2005). Another study on nutritional effects of maternal work and child-care strategies in peri-urban Guatemala found that the percentage of family income earned by the mother was highly related to a child's anthropometric status showing the importance of control of resources and decision making in household welfare (Engle, 1991). This study found that once socio-economic status was taken into account, children whose mothers worked full time in paid employment had slightly higher weight for height z scores than children whose mothers were not in paid employment showing that economic benefits of paid employment may outweigh the benefits of not working to take care of the child. The importance of mother's economic status in children's nutritional status is also reported in a Malawian study by Chirwa and Ngalawa (2008) where children from households where the mother or female head of household was in a salaried employment had better nutritional status than children whose mothers were not. On another note, mother's education is reported to be a major influence on child feeding practices in Accra Ghana, more than household food availability and economic resources (Armar-Klemesu *et al.*, 2000). This shows that access to resources and awareness of good child care practices go hand in hand in influencing a child's nutritional status, and in circumstances where one factor appears more important than the other, it could be the case that there is a major imbalance of the two factors. More evidence of the influence of maternal education on child wellbeing measured by child immunisation and stunting is reported by Abuya *et al*. (2010) in their study conducted in Kenya. Children born to mothers with primary education were 2.17 times more likely to be fully immunised compared to those whose mothers lacked formal education ($P<0.001$) and the unadjusted results for nutrition revealed that children born to mothers with primary education had 94% lower odds of having stunted growth compared to children whose mothers had no primary education ($P <0.01$).

### 2.5.3 Maternal care

Whilst a child's nutritional status is mainly a result of what the child is fed and whether they get ill or not, what the child is fed, how they are fed and their chances of getting infection are influenced by their carer's child care practices. A child's mother is often the main care-giver. A multivariate analysis of risk factors for childhood under-nutrition amongst the Roma people in Serbia found that children that were ever left in the care of an older child were almost twice as likely to be stunted as those that were not (Janevic *et al.*, 2010). Similar findings are reported in a study conducted in urban Guatemala, where children cared for by preteen siblings had lower weights for heights compared to those looked after by adults even after controlling for socio-economic, demographic and work type variables (Engle, 1991). Considering that both studies controlled for other socio-demographic factors, this aspect signifies the importance of the existence of an adult in the care that a child receives.

However, high under-nutrition rates amongst orphaned children whose parents died from HIV related illnesses being looked after by the elderly is reported in a Ugandan study (Kikafunda and Namusoke, 2006). The underweight rate amongst the orphans was 47% whilst in the general population it was 23%. However, there is a higher chance that more of the orphaned children could be HIV positive considering the high mother to child HIV transmission rate discussed in section 2.5.1. The study however, did not control for the HIV status of children and their household's socio-economic status. HIV positive children have a higher chance of being under-nourished compared to HIV negative children due to a lowered immune system and older people might fail to take good care of the children they are looking after due to lack of resources. Contrary to this finding, a study in rural Gambia found that the reproductive status of the maternal grandmother influences child nutrition, with young children being taller in the presence of non–reproductive grandmothers than grandmothers who are still reproductively active. The study also found that the only kin to influence better nutritional status for children apart from their mothers was the maternal grandmother as reflected in higher survival probabilities in children living with their maternal grandmothers. Paternal grandmothers, male kin, including the father had negligible impact on child's nutritional status and child survival (Sear *et al.*, 2000).

On the other hand, being looked after by a non-biological mother regardless of age has been shown to significantly increase the risk of stunting amongst children from western Kenya after controlling for household socio-economic status (Bloss *et al.*, 2004). Similarly, the study by Sear *et al.* (2000) found that the death of the mother had a strong effect on child survival rates during the first two years of life. Children without mothers in the infant and toddler periods suffered risks of mortality 11 to 13 times greater than those whose mothers were still alive. Whilst lack of resources puts most children at risk of under-nutrition, lack of biological mother in some societies disadvantages the child even more since children have to be taken care of by people whose socio-economic status is further reduced by the additional responsibility. The care provided by biological mothers however does not only depend upon the mother's socio-economic status but also on the knowledge and awareness of good child care practices and their ability to put such knowledge into practice.

In developing countries, the care that mothers provide to children may vary across seasons with the demand increasing during periods of farming or harvesting. For example, Chen *et al.* (1979) and Huffman *et al.* (1980) report of a decline in breastfeeding frequency in rural Bangladesh during the periods when maternal activities increase i.e. harvesting and postharvest rice processing activities. However a study by Panter-Brick (1997) in Nepal found that despite an increase in women's agricultural workloads in the monsoon season compared to winter and spring, there was no significant difference in the nursing times which on average were 65 minutes per day amongst those aged between one to two years. The study by Panter-Brick (1997) however found that environmental changes from the winter to the monsoon seasons were reflected in significant losses of weight and lower weight-for-height z scores amongst children aged 0 to 35 months.

### 2.5.4 Paternal characteristics

A few multivariate analysis studies on the socio-economic determinants of child under-nutrition have found mother education to be an important factor of child under-nutrition but not father education (Wamani *et al.*, 2004), (Mukherjee *et al.*, 2008, Janevic *et al.*, 2010). An inter-country analysis using data from Asia, Latin America, Middle East and Africa that analysed the association of parental education on child health status as measured by a child's nutritional status, infant mortality rate and child mortality rate, found that maternal educational level is positively associated with a child's nutritional status and that the effect of father's education on infant and child mortality was about one half of that of mother's education (Cochrane *et al.*, 1982). However, the study made note of the fact that it is unclear how the effect of education on child health status resulted from improved knowledge and to what extent from higher income. A link between father's education and severe underweight status of the child is reported by Nahar *et al.* (2010).

Whilst the contribution of mother's education to the betterment of a child's nutritional status is possibly through the combination of better knowledge of appropriate child care practices and the likelihood of her being employed and earning the necessary income to support the household, a father's role may mainly be through income provision. It is possible therefore that once the analysis of under-nutrition controls for other socio-economic factors, the role of the father in supporting the nutritional status of his children may disappear making this a possible reason as to why many studies have not found father's education to be an important factor in child nutritional status. However, in societies that practice polygamous marriages, the father's role in food provision and more so in caring for the child is very limited. In such societies the household's wellbeing is almost wholly dependent on the mother's socio-economic status as revealed in the study by Hampshire *et al.* (2009) in Niger. Their study discovered that men and women from the polygamous Hausa tribe controlled separate budgets and there were substantial differences in mother's bargaining power reflected in their ability to secure resources for their children. For polygamous extended households, a mother's status depended on reproductive success; own family background and perceived sexual desirability. The study recommended amongst others increasing women's autonomy as a way of increasing their ability to secure crucial health and nutritional resources for their children.

### 2.5.5 Household wealth

Household wealth status as measured by either household assets or household income is often reported as a significant associate of a child's nutritional status. The link is very logical considering that access to food requires access to income which is necessary to either buy the food or grow it in the case of most subsistence farmers from developing countries. A household's access to resources is also pertinent to enable household members' access to medical/health services which are crucial for the maintenance of good health status. It is therefore no wonder that several studies have reported that wealthier households experience less child under-nutrition compared to poorer households (Janevic *et al.*, 2010), (Hong *et al.*, 2006), (Hong and Mishra, 2006). Since urban residence in most developing countries entails better access to services such as health centres, pharmacies, water, information, urban residence has been found to be highly associated with better children's nutritional status. Interestingly though, the level of welfare as measured by per capita consumption and expenditure was not statistically significant in a study of determinants of child nutrition in Malawi (Chirwa and Ngalawa, 2008). However, the study found that female headed households in salaried employment or with a family business were highly likely to have well-nourished children. This variable perhaps might have picked up the economic aspect associated with child nutritional status. The rich and poor divide is common across all developing countries whereby children from the poorest 20% households are three times more likely to be underweight compared to children from the richest 20% households and is worse in Asia where under-nutrition amongst the richest is estimated at 6% and 20% amongst the poorest (World-Bank, 2007).

The wealth status of a household appears to also influence how the HIV status of the mother impacts on child's nutritional status as reported in the study by Magadi (2011). Whilst the study by Magadi (2011) found a higher odds of being undernourished amongst children whose mothers were HIV positive, there was a wider gap between the predicted probabilities of children being underweight amongst children from poorer households which was (40%) for HIV positive mothers compared to all children (22%) and that of those in the richest category in which case, the predicted probability of being underweight amongst children whose mothers were HIV positive was 16% compared to all children 13%. This possibly indicates that economic status might be more influential to children's nutritional status than being HIV positive.

### 2.5.6 Access to water and sanitation

The importance of adequate safe water and good sanitation in child's health and nutrition cannot be overemphasized. Water is the most basic nutrient that needs to be consumed on a daily basis and quite regularly for proper functioning of the body but also to aid the digestion of other foods consumed. Yet the majority of households in the developing nations do not have access to safe and clean water. According to the 2006 estimates by the United Nations, the situation in the sub-Saharan region of Africa is such that 54% of rural households have an unimproved water source, 41% have other forms of improved drinking water source, only 5% have piped drinking water within their premises and 199 million people practice open defecation(United-Nations, 2008). Most mothers in developing nations fail to maintain good levels of hygiene practices when it comes to food preparation due to poor access to safe and clean water. It is estimated that nearly one billion people mostly from Africa and Asia live in water scarce conditions (United-Nations, 2008).

In Malawi it is estimated that 76% have sustainable safe drinking water and 60% have sustainable sanitation services. Having piped water within premises and a toilet facility has been shown to be associated with lower frequency of childhood diarrhoea episodes (Woldemicael, 2001, Osumanu, 2007) whilst a study by Chirwa and Ngalawa (2008) conducted in Malawi reports a higher likelihood of under-nutrition amongst children from households that draw water from a well (protected or not). Access to safe water and good sanitation promotes better child's nutritional status through the prevention of childhood illnesses and infections as shown in the conceptual framework guiding this study in section 2.3 Figure 2.3.

## 2.6 Community factors

### 2.6.1 Family systems, marriages and female headship

A family system may be defined as " a set of beliefs and norms, common practices and associated sanctions through which kinship and the rights and obligations of particular kin relationships are defined. Family systems typically define what it means to be related by blood, or descent and by marriage" page 160-161 (Mason, 2001). Two types of family systems are commonly practised across the world: the nuclear family system and the extended family system. The nuclear family refers to a family as being the mother, father, and their children whilst the extended family system extends the nuclear family to include grandmother, grandfather, uncle, aunt, cousins and other relations. The extended family system is commonly practiced in most of African and Asian societies and may further be classified as matrilineal or patrilineal. The main distinguishing factor between the matrilineal and patrilineal family systems is that in a matrilineal family system, the descendants are traced through the mother whilst in a patrilineal system the descendants are traced through the father. In Malawi the matrilineal system is commonly practised among the Chewa in the central region whilst the patrilineal system is dominant in the northern region. One characteristic of the Chewa family is that it gives considerable weight to the right of the mother even in marriage to remain united with her own kinsmen and to control with their help the offspring of her marriage (Phiri, 2009). The husband is expected to live in his wife's village and build a house there. On the other hand, in a patrilineal system, the wife lives in her husband's village. It is often the case that the mother in law to the wife, exert considerable influence in child care decision making process. For example paternal grandmothers are described as having a powerful and multifaceted role within the extended family in northern Malawi (Bezner Kerr *et al.*, 2008).

Mothers from matrilineal family systems should therefore be more autonomous compared to mothers from patrilineal family systems and such autonomy could have a positive effect in children's nutritional status. Doan and Bisharat (1990) report that little decision making power in young wives where the mother in law was present was associated with lower children weight for age z scores in Jordan. However, no significant difference in weight for age z scores is reported between children from families in which daughter in-law and mother in-law co reside in India (Griffiths *et al.*, 2002, Murthy *et al.*, 1985). On the other hand the higher women's autonomy amongst the matrilineal family systems has been associated with higher levels of divorce amongst matrilineal women compared to non-matrilineal women in Ghana (Takyi and Gyimah, 2007) and Mozambique (Carlos, 2004) leading to a relatively higher number of female headed households in communities that follow a matrilineal family system compared to communities that follow a patrilineal family system.

Buvinić and Gupta (1997) describes that female headed households are most likely to be poor because they often carry a higher dependency burden, they earn less than men on average such that the gender related gap contributes to the economic vulnerability of female headed households and that women who are heads of households and have no other female adult to fulfil home production and domestic roles have to face greater time and mobility constraints than male heads and other women do which can result to a preference for working fewer hours. It is reported that in Malawi, female farmers were inclined to limit their labour time in farm activities due to a heavy commitment to domestic chores (Chipande, 1987).

One characteristic of patrilineal family systems is the practising of polygamous marriages. In polygamous marriages it is expected that women may compete for husband's resources and that the first wife could be favoured resulting in her children being of better nutritional status compared to children of second, third or fourth wives. A study of the nutritional status of children from monogamous and polygamous families in Ghana found that children of monogamous mothers were significantly taller than children of second wives from polygamous marriages (Leroy *et al.,* 2008) whilst (Ojiako *et al.*, 2009) reports of a negative relationship between children's nutritional status and mother's position among wives married to the male head of household. However, Sichona (2001) did not find any association between mother's rank in a polygamous marriage and child's nutritional status amongst children aged under three years in Tanzania. The influence of polygamous marriages on child nutritional status across different settings is therefore varied.

### 2.6.2 Access to health services

As already shown in the conceptual framework of child nutrition in Figure 2.3, there is a lot of interaction between a child's uptake of nutrients and their health status. Whilst free health care is available in some parts in developing countries, to access good health services most people have to travel to urban areas and therefore need money for transport. The link between development, access to health services and better health status is very obvious; developed countries have more health facilities and better access to medical personnel and higher life expectancy compared to developing nations who have worse health statistics such as high maternal mortality rates, high infant mortality rates and high malnutrition rates. It is estimated that under-five mortality is fifteen times higher in lower income countries than in high income countries (World-Bank, 2007). In most countries where the Demographic and Health Survey is conducted, lower levels of under-nutrition are reported in urban areas compared to rural areas. Urban areas generally have better access to health facilities and medical care compared to rural areas. Haddad *et al.* (2003) suggests that changes to community and household infrastructure could contribute more to reducing child under-nutrition in developing countries compared to a country's income growth.

Poor health as shown by high infant mortality rates and maternal mortality rates as well as high severe under-nutrition rates are reported amongst the Adivasi people in Mahashtra in India living in the remote forest hilly areas (Bawdekar and Ladusingh, 2008). In such remote locations of developing countries, households mainly depend on health surveillance personnel that visit villages to inform them of ways of living hygienically and healthy as well as undertaking some medical treatments. The health surveillance assistants also undertake antenatal, postnatal and under-five clinics on some occasions. The limited access to under-five clinics entails that most under-five children do not get timely immunisations whilst some may not be immunised at all and their access to helpful immunisation campaigns in general and other campaigns such as vitamin A supplementation may be limited. Child immunisations are very crucial to improving children's immune systems for the prevention of illnesses and infections. Immunisation is described as a process whereby a child is made immune to an infectious disease through getting a vaccine (WHO, 2011). Having timely immunisation has been found to be protective towards stunting in under-five children in western Kenya (Bloss *et al.*, 2004).

### 2.6.3 Community socio-economic status

The importance of parental education in child health and nutritional status has already been discussed. It is however important to take note of the fact that access to education may vary across communities and as a result impact on the education status of parents across communities. Corsi *et al.*(2011) studied the importance of a shared environment in child nutritional status in Bangladesh and found that education level of the community emerged as the strongest community-level predictor of child height-for-age z scores. Similarly Larrea and Kawachi (2005) in their study conducted in Ecuador found that economic inequality at the provincial level had a statistically significant deleterious effect on stunting.

### 2.6.4 Feeding practices

The recommendation by the WHO is that infants should be exclusively breastfed within an hour of being born up to the first six months. At six months they should be introduced to complementary foods 2 to 3 times a day whilst continuing to be breastfed regularly. The food should have nutritional value similar to breast milk rich in protein, energy and micronutrients such as vitamin A, zinc, calcium, iron and folate. The food should be prepared hygienically, mashed and fed to the baby using clean utensils (WHO-FAO, 2002). The frequency and amount of food should be increased as the baby grows older 3 to 4 times a day for babies aged 9 to 11 months and five times for a 12 month old baby.

Cultural beliefs and customs are a major driving force of childcare and feeding practices that are followed by different societies. In most societies cultural beliefs and customs have been established over a long period of time due to lack of resources such as income, employment, occupation, food, and in case of women lack of contraception. Once established, the cultural beliefs continue to exist even in improved conditions. Hampshire *et al.* (2009) reports of customs in Niger where households distribute higher quality foods more formally with men being served first and getting the best, whilst children over the age of 1 year eat from a common plate where there is no control of who eats what and in what quantities. Their study also found poor infant feeding practices which included delayed initiation of breastfeeding, failure to give colostrum and early cessation of breastfeeding. Their survey estimated that only 35% of mothers initiated breastfeeding within the first three hours after birth whilst it was common practice to give regular water-based infusions of medicinal plants during the first 40 days of life. Most mothers ceased breastfeeding as a result of a new pregnancy. Mothers did not continue breastfeeding the moment they got pregnant because of the belief that the breastfeeding child is stealing milk from the unborn child. The report did not mention the existence of mother's awareness of exclusive breastfeeding.

Poor feeding practices are also reported in Malawi. Using the 1992 Malawi Demographic and Health Survey data, Madise and Mpoma(1997) report that 92.4% of children aged less than 4 months were given water, 49.4% solid or mushy food and 11.6% sugar water. Their study estimated that only 3% of Malawian children under the age of four months were exclusively breastfed. However, the estimate for exclusively breastfed children has since gone up, estimated at 45% from the 2000 Malawi Demographic Health Survey and 53% from the 2004 Malawi Demographic and Health Survey (NSO-Malawi and Macro-International, 2005). Regardless of the increase in the percentage of children that are exclusively breastfed at national level, there could be wide variations across the country with some parts having very low estimates and others much higher considering that the study by Vaahtera *et al.* (2001) in Lungwena area of Mangochi district in Malawi reports of estimated exclusive breastfeeding rates at 1,2,3 and 4 months of age as 19%, 8%, 2% and 0%. Their study showed that as many as 30% infants were receiving complementary porridges already during the first month of life. Infants being fed inappropriate complementary food in the form of chewed glutinous rice has been reported in a study conducted in Lao PDR (Barennes *et al.*, 2009) and pre-lacteal feeding is also reported amongst the Gonds and Bhills in rural Maharashtra an Indian state (Bawdekar and Ladusingh, 2008) and Uganda (Engebretsen *et al.*, 2008). Bawdekar and Ladusingh (2008) reports that mothers in these tribes do not feed breast milk to their new born until three days after delivery. Before then, the child is fed with either diluted honey or water either with soft cloth or by hand under extremely unhygienic conditions increasing the risk of infection even more.

Whilst the WHO recommends continued breastfeeding from 6 months up to 2 years of age, various studies report that breastfeeding beyond the age of twelve months is associated with poor nutritional status and poor health status (Mahgoub *et al.*, 2006) (Madise and Mpoma, 1997, Simondon *et al.*, 2001). The reason for this is not well established. Possible reasons may include the fact that mothers who cannot access nutritious food rely on breast milk as the main food for the baby, which in fact is not adequate to meet the nutritional requirements of the growing baby and that nutrients in breast milk decrease over time from the time the child is born. Research in Senegal by Simondon *et al.* (2001) however suggests reverse causality as another possible explanation for why low height for age z scores are associated with longer duration of breast-feeding. Their study analysed the association between linear growth and breastfeeding in the second and third year of life of 443 Senegalese children and found that both a greater prevalence of stunting and enhanced linear growth can be associated with a long duration of breast-feeding within the same population. They found that length increments were significantly greater in both the second and third year of life in children that were breastfed for longer durations and tended to be greater in breastfed than in weaned children in the second year of life and that height for age z scores at the age of three years were negatively associated with age at weaning before adjusting for age in infancy.

Based on this finding, analysis of the association between breastfeeding and anthropometric scores that do not take into account changes in linear growth may not find this positive effect of breastfeeding and improvement in nutritional status. Reverse causality was also a conclusion in a Peruvian study which found a negative association between breastfeeding and linear growth (Marquis *et al.*, 1997). The conclusion of this study was based on the finding that the risk of weaning decreased only when weight for age and dietary intake were low and diarrhoea morbidity was high. Another study however reports that the negative association between child nutritional status and breastfeeding is due to poor complementary feeding (Onyango *et al.*, 1998). It appears therefore that breastfeeding beyond twelve months may not be what is responsible for poor nutritional status but that mothers may breastfeed children that are of poor nutritional status for a longer duration compared to a child whose nutritional status is better whilst in other cases lack of adequate and nutritious food in children from poor socio-economic background entail that older children that are still breastfeeding do not get adequate nutrition.

On the other hand, infant formula which is enhanced with nutrients to cater for children of different ages is often the main food for an infant whose mother chooses not to breastfeed and may sometimes be viewed as a complementary food amongst children aged over 6 months. However, the efficacy of using infant formula and its influence on child nutritional status may vary from one population to another depending on socio-economic status. Nnyepi and Weatherspoon (2004) compared anthropometric indicators in children that were fed different complementary foods aged 3 to 36 months in Gabane, Botswana. Their study found that children that were given infant formula were more likely to have higher weight for age z scores and weight for height z scores compared to children that were fed sorghum porridge the most common complementary food in the population. Considering that the nutritional value of sorghum is largely limited to carbohydrate and therefore needs nutritional enhancement to cater for children's nutritional needs, it is most likely that children that were fed sorghum were getting lower nutrition compared to those that were fed infant formula as complementary food. The study reported that more of the children that were fed infant formula were children of working mothers. This aspect could also possibly contribute to the differences in anthropometric indicators between the infant formula fed children and sorghum fed children as the two groups of mothers are likely to have differences in education level, income and access to safe water, some of the factors that are important determinants of children's nutritional status. Nevertheless, considering that infant formulas are fortified with different nutrients they are more likely to provide better nutrition when good hygiene standards are followed. The efficacy of infant formula in providing good children's nutritional status is dependent on the ability of the mother to maintain good hygiene practices so as to avoid contaminating the baby's milk with germs. This is perhaps why; literature on the association between the use of infant formula and nutritional status presents different outcomes depending on the socio-economic status of mothers using infant formula.

If good hygiene is not observed, the efficacy of infant formulas in providing the required nutrients to children are jeopardised by the high likelihood of the child being affected by childhood diarrhoea which in turn results in poor nutrient uptake. Villalpando and López-Alarcón (2000) studied the growth of underprivileged infants in Mexico city from birth up to six months of age by their feeding status. Their study found that the incidence and prevalence of diarrhoea was greater in formula fed children than in breastfed children and that the overall growth performance was negatively associated with the number of episodes of diarrhoea but less negative in breastfed infants. All infants had a lower mean birth weight compared to the

NCHS reference but at the age of six months, for breast fed infants, the difference in weight disappeared whilst in contrast formula fed infants did not catch up but attained a significantly lower weight for age and length for age than the breastfed children.

The study by Villalpando and López-Alarcón (2000) confirms the undisputable fact that breast milk is the best food for babies. Children from developing countries often have poor access to safe water and do not have good sanitation and therefore benefit more from exclusive breastfeeding. Exclusive breastfeeding in the first six months of a baby's life does not only guarantee that the baby is getting the nutrients that are required to meet the needs of a growing body but also reduces the chance of the child getting contaminated with germs from poorly prepared food and feeding utensils and injuring the not fully developed intestines when fed bigger food particles. The benefits of exclusive breastfeeding outweigh breastfeeding that includes feeding the child with other foods. More recently a study using the WHO child growth standards in Eastern Uganda found that infants who had received pre-lacteal feeds had lower adjusted mean weight for length z score than those who had not, showing the importance of exclusive breastfeeding (Engebretsen *et al.*, 2008). Exclusive breastfeeding has also been found to have a protective effect towards childhood diarrhoea compared to mixed feeding in Malawi, (Kandala *et al.*, 2006).

Due to lack of affordability and hygiene issues surrounding the use of infant formulas and poor access to animal sources of food, most children in developing countries under the weaning age are fed the most commonly available staple food often made into porridge or a form that is soft enough for babies to swallow as reported in West Africa (Onofiok and Nnanyelugo, 1998) and Kenya (Onyango *et al.*, 1998). The porridges tend to be made from carbohydrates such as sorghum, maize, rice or potatoes with little content of protein, vitamins or minerals. The nutritional value of weaning foods may however be enhanced by formation of a weaning mixture comprised of any cereal or staple food and beans, peanuts and fish (Mosha and Vicent, 2004).

## 2.7 Macro-economy, food security, seasonality and child nutritional status

### 2.7.1 Macro economy

It is a well-established fact that national level economic status has an influence on a child's nutritional status. Countries with high per capita income tend to have lower levels of child under-nutrition (Haddad *et al.*, 2003) . Such kind of facts may appear to suggest that economic growth could be the answer to dealing with the child under-nutrition problem. However, evidence indicates that income growth is a necessary but not sufficient condition to influence significant reductions in child malnutrition. Using data from Egypt, Jamaica, Kenya, Kyrgyz Republic, Morocco, Mozambique, Nepal, Pakistan, Peru, Romania, South Africa and Vietnam, Haddad *et al.* (2003) found that sustained income growth of 2.5% per year could lead to a sizable reduction in under-nutrition in the next decade or so projected at around 27% by 2015 with no change to community and household infrastructure. Whilst allowing community and household infrastructure to change over time increased the effect of the growth by 34%. The estimated effect of income growth on child under-nutrition although pretty impressive, fell short of the Millennium Development goal of reducing the prevalence of underweight children by half by the year 2015. The study also found that only three out of the twelve countries had sustained economic growth of over 2.5% and that countries with worst under-nutrition rates such as Nepal, Pakistan and Vietnam did not meet the target of sustained economic growth of 2.5%.

This supports the recommendation by Alderman *et al.* (2006) that both income growth and program interventions are required to reduce child under-nutrition. Alderman *et al.* (2006) made such conclusions based on their findings of a study conducted in Tanzania that generally children from households of similar income levels differed in their nutritional status depending on whether they had access to nutritional interventions or not. There were more children stunted or underweight in households that had no access to nutritional interventions compared to those that had access to nutritional intervention.

Most households in the developing world are affected by hunger and starvation such that their main worry is their ability to access any form of food to fill their stomachs. In such households under-nutrition is rampant and the danger of dying from it is inevitable. The poverty rate (households living on less than 1.25 US dollars a day) is above 50% in the sub-Saharan region (United-Nations, 2008). Most of the household's poverty situation is as a result of poverty at the national level due to economies performing poorly. The developing countries' economies are highly affected by the performance of the global economy, national political problems such as conflict and war and policies and programmes that are implemented which are often a reflection of government's relationship with donors and lending agents. Changes to food prices may have an impact on child nutritional status more especially if households cannot afford nutritious food such as meat and fish. Animal sources of food are a good source of protein, energy, iron, zinc whose importance in nutrition have been described earlier on. They are also a good source of B vitamins that are essential for metabolism. The relationship between access to animal sources of food, non-grain foods and stunting has been studied in Indonesia, (Sari *et al.*, 2010). The study looked at household expenditures of different food items in the previous week and stunting levels amongst children aged 0 to 59 months and found that stunting was significantly associated with a lower proportion of total expenditure on animal foods, plant foods and total non-grain foods and a higher proportion of expenditure on grain foods. For most developing countries therefore, public interventions targeted at health and nutrition provide the immediate solution to tackling child under-nutrition and have done so in countries such as Sri Lanka and the Indian state of Kerala (Anand and Ravallion, 1993).

### 2.7.2 Food security and child under-nutrition

Ensuring food security at the national level is an important step towards improving children's nutritional status especially in countries that have very low food availability, (Smith and Haddad, 2001). Using panel data from 63 developing countries from the 1970s, Smith and Haddad found that national food availability had a statistically significant and strong impact on child nutrition. However, per capita food supplies had a declining marginal effect, being strong for countries with very low availability. Considering the huge number of countries studied, the importance of food security in child nutritional status appears to be well supported. Similarly, household food insecurity is reported to be associated with stunting and underweight among preschool children in Colombia in a dose-response way as food insecurity became more severe (Hackett *et al.*, 2009). On the other hand a lack of the relationship between national level food availability and household food security is reported by Misselhorn (2005) whilst other studies have reported a lack of a relationship between household food security and household's members' nutritional status (Messer, 1997), (Heaton *et al.*, 2005), (Young and Jaspars, 1995a). Whilst own food production ensures household food security in most rural households in developing countries, mixed findings are reported on the importance of own food production to child under-nutrition by Chirwa and Ngalawa (2008) in Malawi. Their study found own food production to be beneficial in reducing stunting but to contribute to the worsening of wasting, which the authors attribute to the measurement of the variable as it did not take into account the adequacy and quality of food.

### 2.7.3 Seasonality and child under-nutrition

Seasons play an important part in the availability of food in most developing countries that rely on rain fed agriculture. Periods after harvest are abundant with food whilst cropping and farming periods have less food. The seasonal variation in food availability may influence children's nutritional status. However a study by Ferro-luzzi *et al.* (2001) in Ethiopia did not establish an association between food availability and child nutritional status. The study by Ferro-luzzi *et al.* (2001) found that better weight for height z scores were registered in a period before harvest compared to a period after harvest, inconsistent with the pattern observed for adults where a higher Body Mass Index was reported in the season of plenty and a lower Body Mass Index in the lean season and could not be explained with dietary energy availability alone. Seasonality may also influence children's nutritional status through environmental changes i.e. poor sanitation during the rainy season which might increase the likelihood of children suffering from diarrhoea or malaria. Environmental changes from the winter to monsoon seasons in Nepal have been associated with losses in weight and lower weight for height z scores amongst 0 to 35 months old children (Panter-Brick, 1997). Similarly, a study conducted in Senegal by Simondon *et al.* (2001) found that increments in length, weight, arm circumference and triceps skinfold thickness were all significantly lower during the rainy season than during the dry season, whilst Rowland *et al*. (1977) in his study of Gambian children established a lower weight gain in children during the seasons greatly affected by gastroenteritis and malaria. It appears therefore seasonal morbidity may have a bigger role to play in seasonal variation in child nutrition compared to food availability.

## 2.8 Conclusion

This literature review has shown that it is indeed a combination of factors that work together to determine the nutritional status of a child. Implementing policies and programmes that help households to be food secure is an important first step towards supporting the nutrition of children, but some societies could be unaware of good child care practices that ensure that children are getting a good share of nutritious food available in their households. Although households with under-nourished children need nutrition interventions, the best long-term strategy to tackle child under-nutrition would be the one that ensures that all under-five children are accessing nutritious food as well as health services. An awareness of existing nutritional deficiencies in affected communities may provide an indication as to which nutrients are lacking in specific communities and would be the best way of identifying the kind of nutrition programmes that need to be implemented to tackle child under-nutrition. Since under-nutrition varies by age of child, age-group specific programme interventions might provide a cost effective way of tackling child under-nutrition. Whilst some of the previous studies undertaken in Malawi have analysed child under-nutrition by children's age group, such analysis have not explored the role immunisation, vitamin A supplementations and type of food consumed in child's nutritional status which have been studied in other sub-Saharan settings.

The findings of this literature review also support the fact that adequate uptake of nutrients may be hindered by infections such as diarrhoea and schistosoma and as such, improvement of access to safe water, good sanitation and health services are pertinent in ensuring good nutritional status. A lot of studies reveal the importance of household and community factors in child under-nutrition, however, not many have discussed the relative importance of household and community factors which is likely to be important for prioritisation of resources.  The measure of child under-nutrition used in previous studies conducted in Malawi that have explored correlation of child under-nutrition across households and communities is underweight and such the variation of stunting across households and communities has not been studied. Whilst previous studies conducted in Malawi report of significant variation in underweight across households and underweight, possible factors that may explain the community level variation have not been studied.

This review has only come across one study on the long-term effect of child under-nutrition in Africa through the work of Victora *et al.* (2008) , which possibly indicate that such studies are rare in this region.  The study of the long term effects of child under-nutrition in the African region is therefore limited to adolescences studied  by (Victora *et al.*, 2008).  Whilst some studies have analysed differences in child under-nutrition status across seasons in some sub-Saharan African countries none have done so in Malawi.

# CHAPTER 3 : DATA AND METHODOLOGY

## 3.1 Introduction

This chapter presents the data and methodology used to answer the research questions described in section 1.5. Five data sets have been used; three Malawi Demographic and Health Survey (MDHS) data sets of 2000, 2004 and 2010, the 2004 Malawi Integrated Household Survey (IHS 2) and the 2004 Malawi Community Level Survey. The three Malawi Demographic and Health Surveys data sets of 2000, 2004 and 2010 are used in the examination of changes to the levels and patterns of child under-nutrition. The three surveys collect similar information making it possible to merge them and make comparisons across the three time points. The 2004 MDHS data set is used to study the determinants of child under-nutrition in Malawi and to explore the association between child feeding, immunisation and child nutritional status.

The 2004 Malawi Integrated Household Survey (IHS 2) data is merged with the 2004 Malawi Community level survey data to assess the pathways through which household and community level socio-economic factors influence a child's nutritional status in Malawi. The IHS 2 data is rich with household socio-economic characteristics whilst the 2004 Community Level Survey has information on community facilities as well as community customs. Both the MDHS and the IHS 2 are conducted by the National Statistical Office of Malawi. Financial and technical assistance for the Malawi Demographic and Health Surveys is provided by Measure DHS which is funded by USAID (United States Agency for International Development) whilst the World Bank provides financial and technical assistance for IHS 2 and the Community Level Survey.

## 3.2 Survey designs

The Malawi Demographic and Health Surveys were designed based on a stratified two-stage cluster sampling design. A list of enumeration areas from the 1998 Malawi Population and Housing Census was used as sampling frame for the selection of enumeration areas (clusters) in the 2000 MDHS and 2004 MDHS whilst in the 2010 MDHS a listing of enumeration areas from the 2008 Malawi Population and Housing Census was used. The enumeration areas are the primary sampling units. These were randomly selected such that the information is representative at the regional level and by urban/rural residence in all the three data sets, but the 2010 MDHS data is also representative at the district level. All the three MDHSs oversampled districts from the northern region and urban areas to take into account the smaller population size. Sample weights are provided to correct for oversampling.

A complete list of households from the selected clusters provided the sampling frame for the selection of households. 13,220 households were selected for interviews in the 2000 MDHS, 15,091 in the 2004 MDHS and 27,307 in the 2010 MDHS. However, only a third of households from the 2010 MDHS were selected for children's anthropometric measurements, HIV testing and anaemia testing. Interviews were conducted to women of the reproductive age (15-49 years) in the selected households in all the three surveys. All the Malawi Demographic and Health Survey data sets are pretty similar in terms of information that was collected. Among others, information was collected on children's anthropometry aged 0 to 59 months, infant feeding practices, breastfeeding, vaccinations, nutritional status of mothers and children, succeeding and preceding birth interval, childhood illnesses and mortality, use of maternal and child health services, mother background statistics (age, education, religion etc.), reproductive history, HIV/AIDS-related knowledge and behaviours. The 2000 MDHS however does not have data on anaemia status of children aged 6 to 59 months.

The 2004 Malawi Integrated Household Survey (IHS 2) was designed based on a two-stage stratified sampling procedure. The country was first stratified into rural and urban strata. The urban strata included the four major urban areas which are Lilongwe, Blantyre, Mzuzu and the Municipality of Zomba. All other districts were considered as rural. The rural stratum were further divided into twenty six administrative districts (Likoma district was excluded because of difficulty to travel to the island). The total number of strata in the survey was 30. The first stage involved selecting enumeration areas for each stratum on the basis of probability proportional to size using the enumeration area listing from the 1998 Population and Housing Census. In the second stage, 20 households were randomly selected from each enumeration area resulting in 11,280 households selected for interviews. Sample weights are provided to correct for differences in the probability of selection. Interviews were conducted to household heads whilst mothers or guardians provided children's data.

The IHS 2 data amongst other aspects has information on household's food and non-food expenditure in the past week, household poverty status, health, participation in nutrition programmes, participation in under-five clinics, social safety nets and subjective assessment of wellbeing. The community level data includes physical and demographic characteristics, economic activities and agriculture. The data are also disaggregated by the 8 Agricultural Development Divisions (ADD) which were set up to promote agricultural development in specific fields depending on the dominant crops grown in a particular area. The 2004

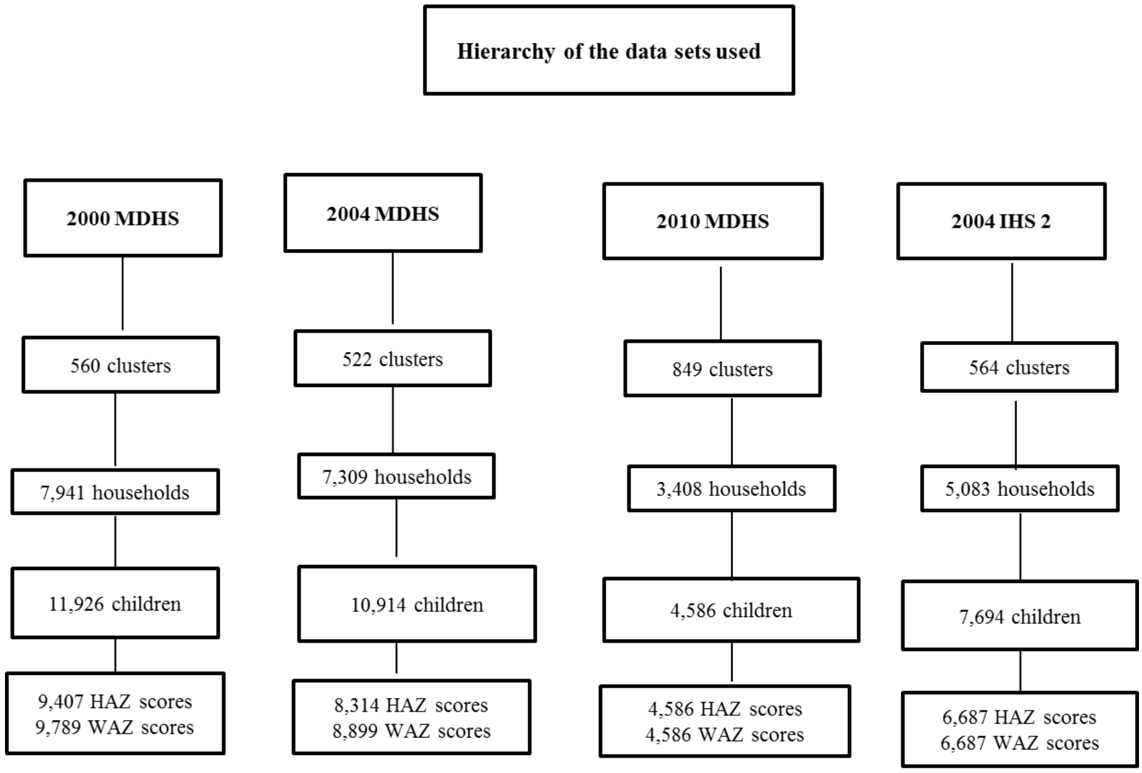
Community level data was sourced from most informed people in the community such as village headman and spouse, headmaster of a local school, agricultural field assistant, religious leaders, local merchants, health workers on access to basic services such as health clinics, availability of medical staff in the clinic, availability of an ADMARC[4], availability of a daily market, availability of a post office and availability of a telephone booth as well as ethnic background. A community in rural areas is defined as a village (group of households) or a group of villages within an enumeration area and in urban areas is defined as an urban location. The village/villages or urban location has boundaries which members of the community can recognise.

## 3.3 Data sets used

The data sets used are hierarchical as shown in Figure 3.1. At the very top there are clusters (groupings of households) also described as communities or enumeration areas from which households were selected. The clusters are the primary sampling units. Below the clusters are the households with children under the age of five. Below the households is the number of children under the age of five from each survey. At the lowest level is the number of children with weight for age z scores and height for age z scores. Due to lack of data on weights and heights and implausibility of some weight for age z scores and height for age z scores, the number of children with weight for age z scores and height for age z scores for the 2000 MDHS, 2004 MDHS and IHS 2 is lower than the number of children available in each data set. Details on how the z scores were computed are given in section 3.4.2. The 2000 MDHS has the largest number of children with height for age z scores and weight for age z scores whilst the 2010 MDHS has the smallest number.

[4] ADMARC market is the company that sells and buys agricultural produce from farmers in Malawi

Figure 3.1 Data sets used in this thesis




### 3.3.1 Data Quality

The height for age and weight for age z scores used in this analysis are all within the acceptable ranges and were computed using the 2006 WHO growth standards in all the analysis undertaken in this thesis. With the exception of data that required measurements and tests, all information in the MDHS data was reported by the mother. Information on child illnesses is based on the mother's understanding of the symptoms of particular illness and this could vary across settings i.e. diarrhoea. Generally the MDHS collect similar kind of information and the variables are named in the same way over time. This made it easier to merge the three MDHS data sets. However, the lack of data on anaemia status for children aged 6 to 59 months in the 2000 MDHS meant that trends in the anaemia status of children across the three time points of 2000, 2004 and 2010 could not be explored. The other data limitation on the MDHS data sets is that the data sets were collected at different time periods of the year as shown in Table 3.1. For this reason the comparison of the differences across the three time points has to take into account that seasonality may also have a role to play in the differences across the three time points.

Feeding information from the MDHS data sets is based on what the child was fed in the last 24 hours. Whilst this entails that the mother has a better recall on the food given to the child, the drawback is that food consumed before the 24 hours is missed. One challenge of pulling data sets relates to getting children from different data sets being identified as belonging to the same cluster due to similarities in cluster ID numbers. This was avoided by ensuring that each data had a range of cluster ID numbers that did not overlap with another data set. This, however, means that clusters that were randomly sampled in different surveys are identified as different whilst they could be the same geographically. Whilst such clusters may be the same geographically, developmental changes that occur over time i.e. infrastructural developments entail that they may in fact be different. For this reason, it is more reasonable to identify such clusters as different. Pooling three data sets increases the sample size and the chance of committing type 1 error. To reduce the chance of committing type 1 error, the significance level used to reject the null hypothesis of no association between the response variable and an explanatory variable is 0.01.

Data from the IHS 2 was collected throughout the year (March 2004 to March 2005) as shown in Table 3.1. This has an advantage in that it is possible to estimate stunting and underweight rates for Malawian children across different time periods of the year. However, the implications of this is that data on household expenditure on food which is based on the monetary value of what the household reported to have consumed in the last seven days, may not be comparable in households that were interviewed at different periods of the year. Major differences are expected between households that were interviewed in the hunger months (February to September) and those in the harvest season (August to March). To ensure comparability, all data on expenditure including that of expenditure on food is standardised separately for those interviewed in the period February to September and those interviewed from August to March. Once they are standardised, the data are then merged together.

Children's information from the IHS 2 was provided by mothers as well as guardians in situations where the mothers were not present. It is therefore possible that in situations where the guardians may have only been available temporarily the information provided may not be as accurate as that of MDHS. On the other hand, the fact that guardians and not just mothers were interviewed in the IHS 2 survey gives IHS 2 an advantage over the MDHS, since children data should include that of orphaned children as well, providing a more comprehensive picture of child under-nutrition in Malawi.

Table 3.1 Interview period for data sets used in this thesis

| Survey | Interview period | Season |
|---|---|---|
| 2000 MDHS | July to October | Hot and dry |
| 2004 MDHS | October to February | Hot and wet |
| 2010 MDHS | June to September | Hot and dry |
| IHS 2 | March 2004 to March 2005 | All seasons |
| 2004 Community level survey | March 2004 to March 2005 | All seasons |

There are differences between the MDHS data and the IHS 2 in how their surveys were conducted and in how their anthropometric measurements were taken. IHS 2 survey had a smaller sample size compared to MDHS data sets and therefore is more likely to have bigger standard errors than the MDHS. However, the MDHS oversampled some districts, the northern region and the urban areas. To weigh children, the MDHS used an electronic scale whilst the IHS 2 used a salter scale. The accuracy of measurements provided by a salter scale however very much depends on how the one taking them reads and records them since the readings are not given to the nearest decimal point as the electronic scale gives. The likelihood of rounding the measurements to the nearest figure may be high. The measurement of heights of children, however, was similar in the MDHS and the IHS 2. Both surveys used height boards from UNICEF (United Nations Children's Fund). MDHS anthropometric measurements were taken twice and an average used whilst in IHS 2 only one measurement was used. The MDHS used specifically trained personnel to undertake anthropometric measurements whilst the IHS 2 used enumerators.

Based on these differences, stunting and underweight estimates from the IHS 2 are more likely to be biased. Considering that the interest of this chapter is to understand household and community level factors associated with child under-nutrition, lower estimates for underweight and stunting may only affect the analysis by reducing the power of finding factors that are significantly associated with a child's underweight and stunting status, whilst higher estimates may increase the power. The IHS 2 estimates for stunting and underweight are lower compared to those of the 2004 MDHS and therefore the likely effect is that the statistical power for detecting significant factors would be lower. However, factors that emerge to be statistically significant based on the analysis of IHS 2 may also have emerged significant if the estimates of stunting and underweight were higher.

Another difference between the IHS2 and MDHS is that only children aged between 6 and 60 months had anthropometric measurements taken in the IHS 2 whilst the MDHS took anthropometric measurements for children aged form 0 to 59 months. For this reason there are more households with only one child in the IHS 2 compared to MDHS. To investigate further the extent of the differences between the IHS 2 and the MDHS, a comparison was made on how factors such as age, sex of child, urban/ rural residence and region are associated with stunting and underweight. The findings show that whilst there are differences on which variables are significant, the variables on sex, age, urban/ rural residence and region show a similar trend with the odds being higher for male children compared to female children, as children get older, for children from rural areas compared to children from urban areas and amongst children from the central region compared to children from the northern region. There is a difference however, in how the odds of underweight for children in the central region compare with those of children in the southern region between the MDHS and the IHS 2. The MDHS results show that the odds of underweight for children in the southern region are higher than those of children from the central region whilst IHS 2 shows that the odds of underweight are higher for children in the central region compared to children from the southern region. Considering the differences in how the weight measurements were taken between the MDHS and IHS 2, the underweight estimates on the odds ratio for the variable region have to be interpreted cautiously.

## 3.4 Methodology

### 3.4.1 Preliminary Analysis

The first step in data analysis involved exploring the data through obtaining graphs to determine patterns and trends. Cross tabulations and chi square tests were performed to identify variables that are significantly associated with a child's stunting and underweight status. The estimates are design weighted. There is evidence that children aged five or under are clustered within households in all the data sets as shown in the Table 3.2 indicating that there is need to account for correlation of stunting and underweight within households. As already pointed out, the percentage of households with one child in IHS 2 survey data is much higher than that of the 2004 MDHS probably due to the fact the IHS 2 took anthropometric assessments for children aged 6 to 60 months, this should reduce the likelihood of there being two children from the same household.

Table 3.2 Percentage of households with children aged five or under from each data set

| Survey | one child | two children | three children |
|---|---|---|---|
| IHS 2 | 76.0 | 22.1 | 1.9 |
| 2004 MDHS | 40.7 | 46.8 | 12.5 |
| Pooled data from the 2000, 2004 and 2010 MDHS | 37.8 | 47.8 | 14.4 |

### 3.4.2 Computation of height for age z scores and weight for age z scores

To compute height for age z scores and weight for age z scores, data on weights, heights, age and sex of the child was imported into Anthro software. Before importing the data into Anthro software, weights greater than 36kg or less than 0.9kg were set to missing and heights greater than 138cm or less than 38cm were set to missing due to implausibility, these were less that 0.5% for both weights and heights and in all the four data sets used, due to implausibility. Once the z scores were computed based on the 2006 WHO growth standards, any height for age z score greater than 6 or less than -6 was set to missing and any weight for age z scores greater than 5 or less than -6 was also set to missing following the WHO recommendations on plausible ranges for height for age and weight for age z scores. This was only the case for the 2000MDHS, 2004 MDHS and IHS 2. The height for age z scores that were set to missing ranged from 1% to 3.1% and that of weight for age z scores ranged from 0.2% to 0.4%. There were no implausible z scores in the 2010 MDHS data.

### 3.4.3 Variables analysed

**Dependent Variables**

The dependent variables for stunting and underweight are binary since both height for age z scores and weight for age z scores are not normally distributed in both the Malawi Demographic and Health Survey data sets and the IHS 2 data set. The histograms showing the distribution of the weight for age z scores and height for age z scores from the 2004 DHS data and the 2004 IHS2 data and the results of the Kolmogorov-Smirnov tests are given in appendices 4 to 9. Whilst the distributions generally appear symmetric, the Kolmogorov-Smirnov test results show that the height for age and weight for age z scores are not normally distributed (p value less than 0.05).

A child is identified to be stunted if their height for age Z score is less than -2 standard deviations. A value of 1 is assigned in this case and 0 otherwise.

A child is identified to be underweight if their weight for age Z score is less than -2 standard deviations. A value of 1 is assigned in this case and 0 otherwise.

**Independent variables**

The choice of independent variables for analysis is guided by the factors outlined in the conceptual framework which is described in chapter 2, section 2.3, Figure 2.3 which are also reviewed in the literature in chapter 2. However, the main basis for the choice of explanatory variables in each analysis chapter, are the research questions which are discussed in section 1.6. A detailed description of independent variables used in the analysis is given in the respective analysis chapters.

### 3.4.4 Multivariate Analysis

According to the conceptual framework for child nutritional status used in this study, there are many factors that have a role to play in a child's nutritional status. The factors are inter-linked and are at different levels. Based on the results of the preliminary analysis, variables that turn out to be statistically significant in the bivariate analysis are included in the multivariate analysis. Multivariate analysis is therefore employed to identify the factors that are associated with stunting and underweight after controlling for factors that were significantly associated with stunting and underweight in the bivariate analysis. All explanatory variables are entered simultaneously in the model and variables that are not significant are left out of the model. The significance level is 0.05 for all the analysis except the analysis that uses pooled data sets where the significance level is 0.01. Due to the hierarchical nature of the data sets used and the fact that a good percentage of households have more than one child, the next step in the multivariate analysis involves undertaking logistic multilevel modelling to analyse factors that are associated with stunting and underweight. Multilevel modelling ensures that estimates are robust i.e. in cases where there is significant variation at a particular level i.e. household or community, the fixed effects estimates are representative of the group level and not at the population level. Multilevel modelling is also useful in exploring how the inclusion or exclusion of specific variables affect the stunting and underweight variance at different levels and therefore provide an indication of which variables vary significantly across a particular level which is vital for making appropriate policy recommendations.

Both the household level variance and community level variance are explored in the study of the determinants of child under-nutrition in Malawi, the study on the levels and patterns of child under-nutrition in Malawi and the study of household and community socio-economic factors. The analysis of household behavioural factors however uses age group specific multivariate analysis and therefore it is only the community level variance that is explored. In cases where both the household and the community level variance are not significant, a design weighted model in Stata is used. Logistic multilevel modelling is performed either in Stata or MLwiN. MLwiN is a software that was specifically designed to analyse hierarchical data and is quick to run which is necessary when both the household level and community level variance need to be estimated. There were no significant differences in the variance estimates in the multilevel models obtained in Stata and those obtained in MLwiN.

MLwiN software however, has a limitation in that its' weighting techniques are not well developed to provide robust estimates for data of complex design like the ones used in this thesis. Ignoring survey design may lead to biased estimates and underestimation of standard errors in the analysis of child nutritional status as reported by Madise *et al.* (2003) in their study of five African countries. However, as observed by Madise *et al.* (2003) and Pfeffermann *et al*. (1998) inclusion of survey design variables as explanatory variables reduces the bias in the parameter estimates. The multivariate analysis undertaken in this thesis includes survey design variables such as region and residence as explanatory variables to reduce bias in estimates. Initial multivariate analysis is done in Stata accounting for survey design. This is done to make a comparison with estimates in MLwiN. The findings show that whilst there is a difference in the standard errors between Stata design weighted estimates and those in MLwiN at level one and community level, the differences in the standard errors is not so high as to change the significance levels of variables. Similar variables are significant or not significant in all the three models. An example of this kind of comparison based on the Stunting model using the IHS 2 data is shown in appendix 2.

**The modelling framework**

Since the response variable is binary, we are interested in the probability of success between 0 and 1. The child level model on stunting and underweight may be represented as follows:

$$g(\pi_i) = \beta_0 + \beta_{1i}x_{1i} + \ldots + \beta_{mi}x_{mi}$$

$$g(\pi_i) = log_e\left(\frac{\pi_i}{1-\pi_i}\right)$$

$\boldsymbol{\frac{\pi_i}{1-\pi_i}}$ = Odds of success

We use the logit link: $g(\pi_i)$ which is a function that models the probability that a child is stunted = 1 in the stunting model, and the probability that the child is underweight = 1 in the underweight model.

$\beta_0$ is the constant, $\beta_1$ to $\beta_m$ are coefficients for explanatory variables $x_1$ to $x_m$ for child i. The explanatory variables $x_1$ to $x_m$ may be factors directly related to the child like age and sex, factors related to the mother, father and household level as well as factors at the community level.

The model may be extended to include a level 2 to form the following random intercept model for child i within household j or community j;

$$log_e\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = \beta_{0j} + \beta_1 x_{1ij} + \cdots + \beta_m x_{mij}$$

Where $\beta_{0j} = \beta_0 + u_{0j}$

$\beta_0$ is the random intercept and $u_{0j}$ is the random effect at level 2. The random effect represents the variation of nutrition status for children from different communities. Similar to a standard logistic regression we can obtain average predicted probabilities for a child i within level 2 being stunted or being underweight using the formula:

$$\hat{\pi}_{ij} = \frac{exp(\hat{\beta}_0+\hat{\beta}_{1ij}+\cdots+\hat{\beta}_m x_{mij})}{1+ exp(\hat{\beta}_0+\hat{\beta}_{1ij}+\cdots+\hat{\beta}_m x_{mij})}$$

Assuming a three level model where level 2 is the household level and level 3 is the community level, the three level model may be represented as follows for a child i within household j in community k

$$log_e\left(\frac{\pi_{ijk}}{1-\pi_{ijk}}\right) = \beta_{0jk} + \beta_1 x_{1ijk} + \cdots + \beta_m x_{mijk}$$

Where $\beta_{0jk} = \beta_0 + v_{0k} + u_{0jk}$

$\beta_0$ is the random intercept, $v_{0k}$ is the random effect for community k and $u_{0jk}$ is the random effect for household j within community k.

Average predicted probabilities for a child i within household j in community k are obtained using the following formula:

$$\hat{\pi}_{ijk} = \frac{exp(\hat{\beta}_0+\hat{\beta}_{1ijk}+\cdots+\hat{\beta}_m x_{mijk})}{1+ exp(\hat{\beta}_0+\hat{\beta}_{1ijk}+\cdots+\hat{\beta}_m x_{mijk})}$$

The multilevel model may be extended to include a random coefficient at a level higher than the child level i.e. household or community where the variation of a group level factor is significantly different across households or communities. For child i within household j or community j, this is represented as follows:

$$log_e\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = \beta_{0j} + \beta_{1j}x_{1ij} + \cdots + \beta_m x_{mij}$$

Where $\beta_{0j} = \beta_0 + u_{0j}$

$\beta_{1j} = \beta_1 + u_{1j}$

$\beta_0$ is the random intercept and $u_{0j}$ is the random error at level 2

$\beta_1$ is the random coefficient and $u_{0j}$ is the random error at level 2

Models at level 2 or level 3 have a group-specific interpretation i.e. the interpretation of the coefficients is either at household level or community level.

Model results are presented as odds ratios. Predicted probabilities are also presented to show the variation of different factors by child's age.

# CHAPTER 4 : DETERMINANTS, LEVELS AND PATTERNS OF CHILD UNDER-NUTRITION IN MALAWI

## 4.1 Introduction

This chapter starts by investigating the determinants of stunting and underweight in Malawi using the 2004 Malawi Demographic and Health Survey (MDHS) in section 4.2 to explore more the factors that are associated with child under-nutrition in Malawi. Using the MDHS data sets of 2000, 2004 and 2010 it then examines whether or not the levels and patterns of child under-nutrition in Malawi have changed over time in section 4.3. The analysis undertaken in section 4.3, answers the question: have the levels and patterns of child under-nutrition in Malawi changed between the years 2000 and 2010? It is pertinent to investigate if there are significant changes in the levels of under-nutrition over time in Malawi to assess if programmes and policies that are implemented with the aim of tackling child under-nutrition in Malawi are moving in the right direction. Available statistics on child under-nutrition in Malawi over the period 2000 to 2010 are based on different reference/growth standards and therefore not comparable. The height for age z scores and weight for age scores for all the three data sets used in this analysis are based on the 2006 WHO growth standards. Initial analyses are done separately for each of the three data sets through obtaining figures and tables to explore the association between under-nutrition and different factors. Further analysis is based on a pooled data set. Pooling the data together makes it easier to analyse if differences in under-nutrition rates as well as differences in the factors associated with under-nutrition across the three years are statistically significant. The larger size of the pooled data also increases the chance of detecting more variables that are significantly associated with stunting and underweight and as such a significance level of 1% is used to determine variables that are significantly associated with stunting and underweight. To assess the importance of various factors in child under-nutrition and whether these have been changing, significant factors are interacted with year of interview.

## 4.2 Determinants of child under-nutrition in Malawi

The analysis undertaken in this section is guided by the conceptual framework for child under-nutrition which is shown in section 2.3 Figure 2.3. This conceptual framework recognises that factors that influence a child's nutritional status are at four levels; child level, mother and household level, community level and national level. At child level, factors such as child's illnesses, infections, nutrient intake and child's biological factors such as age, sex and birth weight play a very direct role in influencing a child's nutritional status. At mother and household level, access to resources such as income, food, safe water, sanitation, child care and feeding practices are important at influencing a child's nutrient intake and their health status and therefore have an indirect role in influencing a child's nutritional status. Community level factors such as customs and access to health facilities influence the household level factors whilst national level factors are important for influencing the implementation of programmes and policies that may be implemented at all levels to affect changes to children's nutritional status. The analysis undertaken in this chapter uses the 2004 Malawi Demographic Health Survey (MDHS) the details of which are described in chapter 3.

### 4.2.1 Independent variables analysed

Independent variables used in this section are described in Table 4.1.

Table 4.1 Description of independent variables

| |
|---|
| **Child characteristics** |
| Age: Age in months is standardized and is continuous. Age squared is also included to take into account of the non-linearity of the relationship between age and underweight and age and stunting. |
| Sex : 1 = Female and 0 = Male |
| Size at birth:<br>1= Very large<br>2= Larger than average<br>3= Average<br>4= Smaller than average<br>5= Very small |
| Health card: 1= Child has a health card,0=Child does not have a health card |
| Child's birth order<br>1=Birth order 1<br>2=Birth order 2<br>3=Birth order 3<br>4=Birth order 4 or 5<br>5= Birth 6 or higher |
| Illness variables: Illnesses related to having diarrhoea, fever, short rapid breaths and cough are analysed through the following variables:<br>1= child had diarrhoea, 0= child did not have diarrhoea.<br>1=child had fever, 0=child did not have fever,<br>1=child had short rapid breaths, 0=child did not have short rapid breaths<br>1=child had a cough, 0=child did not have a cough |
| Preceding birth interval<br>1= First births; 2=9 to 36 months; 3= Over 36 months |
| Younger sibling<br>0=No younger sibling,1=Have a younger sibling |
| **Other characteristics** |
| Residence : 1=Urban,0=Rural |
| Region: 1=Northern region,2=Central region,3=Southern region |
| Ethnicity<br>Chewa=1,Ngoni=2,Lomwe=3,Yao=4,Tumbuka,Tonga and Nkhonde=5, Sena and other=6. |

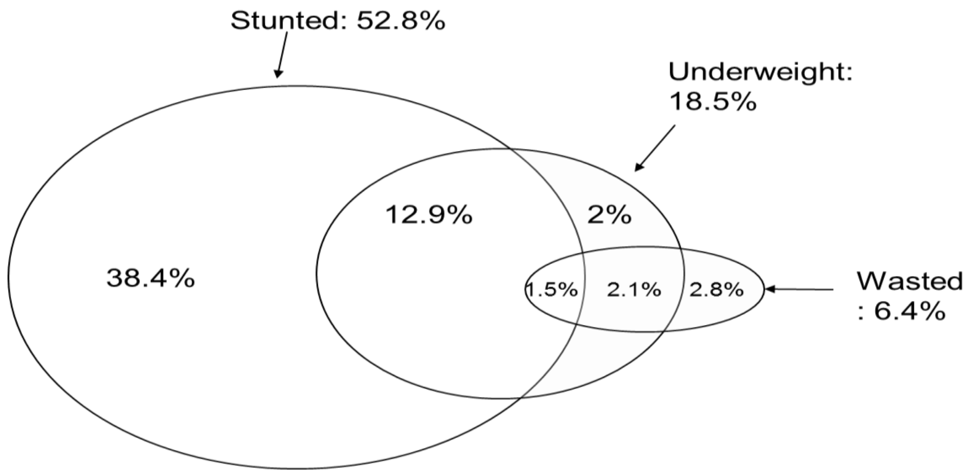
Table 4.1 continued, Description of independent variables

| Other characteristics |
|---|
| Mother education<br>0= Mother has no education<br>1=Mother has primary education<br>2=Mother has secondary education |
| Paternal education<br>0=Father has no education<br>1=Father has primary education<br>2=Father has secondary education |
| The wealth status variable has the following categories:<br>1=Poorest,2=Poorer,3=Average,4=Richer and 5=Richest. A description of how the wealth status variable was computed is given in appendix 3 |
| Number of children under the age of five<br>1 = One child<br>2 = Two children<br>3 = Three children or more |
| Number of children ever born<br>1= One or two children, 2 = Three of four children, 3= Five or more children |
| Mother's height is continuous. Heights of less than 73cm were set to missing due to being implausible and these comprised about 0.1% |
| Mother's weight is continuous. One case of mother's weight is 15.40Kg was set to missing due to implausibility |

### 4.2.2. Initial data exploration

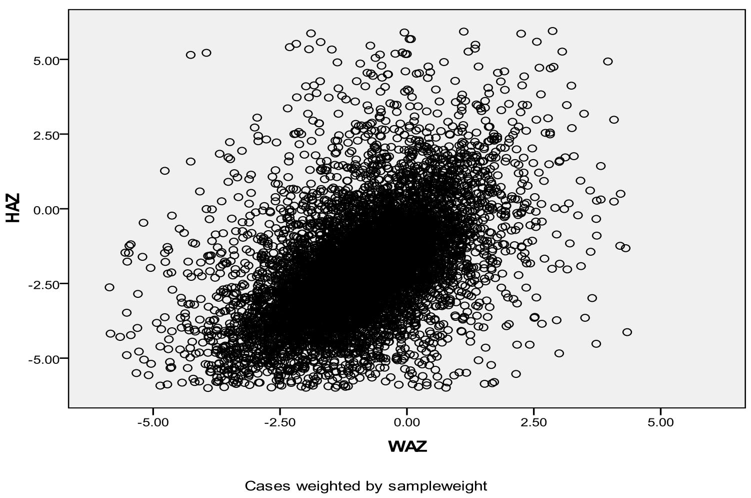
The estimate for children that are stunted is 52.8% which is higher than the rate based on the NCHS reference estimated at 48%, whilst the estimate for those that are underweight is 18.5 % which is lower than the estimate based on the NCHS reference estimated at 22%(NSO-Malawi and Macro-International, 2005). The estimate for children that are stunted but are not underweight and not wasted is 38.4% and those that are underweight but not stunted and not wasted is 2%. This shows that most children that are underweight are also stunted or wasted whilst there is a big proportion of children that are stunted but do not have other forms of undernutrition. The distribution of different types of undernutrtion are given in Figure 4.1.

Figure 4.1 Venn diagram showing under-nutrition rates of under-five Malawian children (2004 DHS data)




Although stunting (low height for age) and underweight (low weight for age) are measured differently, it is important to ascertain the correlation between the two so as to establish the extent to which factors associated with stunting and undereweight in Malawi may be similar. This is done through obtaining a scatter plot of weight for age z scores and height for age z as shown in Figure 4.2. The scatter plot indicates that children with a higher weight for age z score are more likely to also have a higher height for age z score. However, the correlation coefficient is 0.482 indicating that the positive linear relationship is not very strong. It is expected therefore that there should be some differences in factors associated with the two variables.

Figure 4.2 Plot of height for age and weight for age z scores (2004 DHS data)



### 4.2.3 The association between child's age, child's sex and stunting and underweight in Malawian under-five children

The relationship between age and sex of child and their stunting and underweight status is explored graphically in Figure 4.3 and Figure 4.4. The likelihood of stunting and the likelihood of underweight is higher amongst male children compared to female children amongst children aged between 0 to 24 months. There is little difference in the proportion of children stunted and the proportion of children underweight between male and female children amongst children aged 25 months or more.

From birth up to the age group of 19 to 24 months, the proportion of children stunted is increasing sharply. However, from the age of 24 months onwards, there is a general declining and stabilising trend in the proportion of children stunted. On the other hand the proportion of children underweight is increasing sharply for both male and female children in the first 12 months of life. Amongst female children the proportion underweight continues to increase througout all ages peaking in the oldest children.

Figure 4.3 Proportion of Malawian children stunted by age and gender (2004 DHS data)

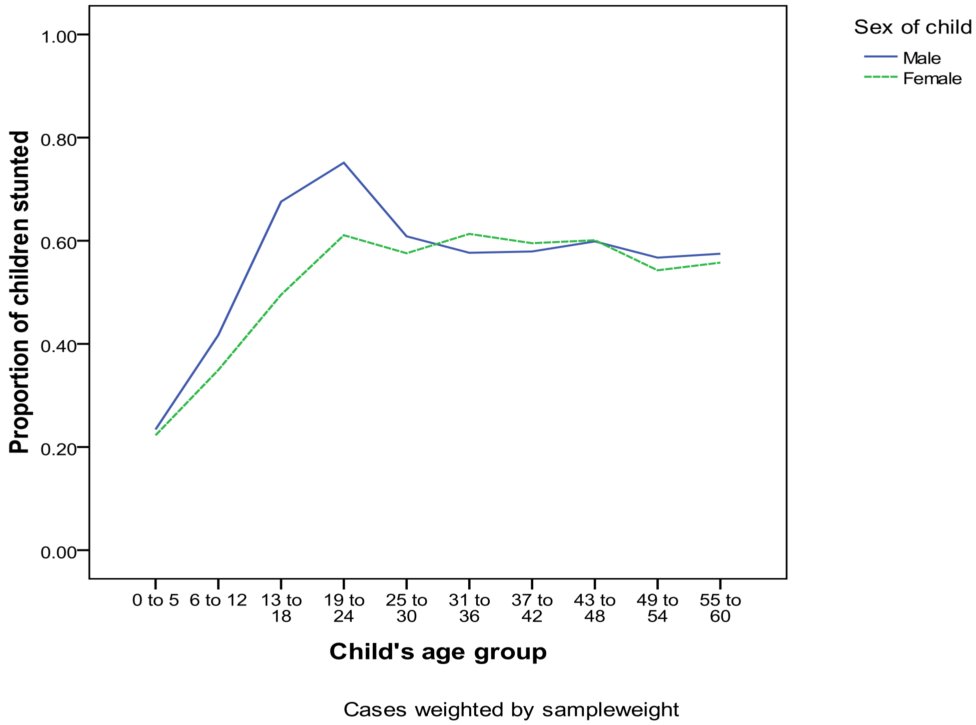
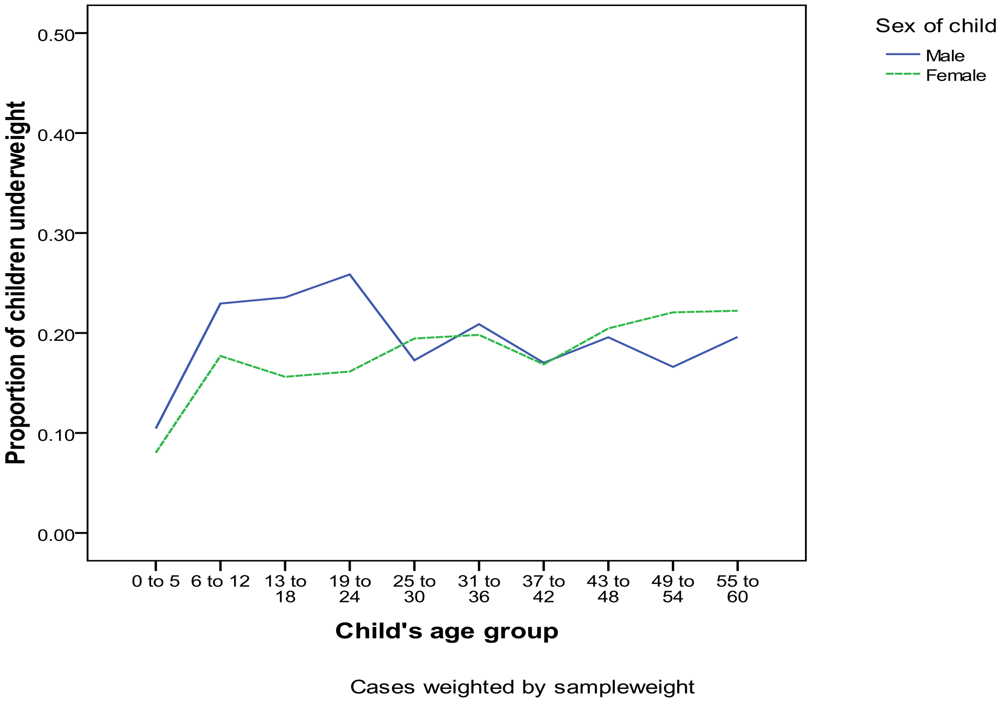


Figure 4.4 Proportion of Malawian children underweight by age and gender (2004 DHS data)




### 4.2.4 The association between child's age,child's residence and stunting and underweight in Malawian under-five children

Figure 4.5 shows the differences in the proportion of children stunted between urban and rural children by their age groups, and Figure 4.6 shows the differences in the proportion of children underweight for urban and rural children also by their age group. Whilst the proportion of children that are stunted and those that are underweight are consistently lower in urban areas compared to rural areas across all the age groups as shown in Figure 4.5 and Figure 4.6, the biggest urban/rural gap in the proportion of children that are stunted is amongst children aged between 25 and 48 months where the percentage of children that are stunted in urban areas is about 20% lower than that in the rural areas.

The gap in the proportion of children underweight between children from rural areas and those form urban areas is highest amongst children aged 13 to 36 months in which case the proportion of children underweight in rural areas is double that of urban areas. There is therefore a wider urban/rural gap in the proportion underweight compared to the proportion stunted.

Figure 4.5 Proportion of children stunted by age and residence (2004 DHS data)

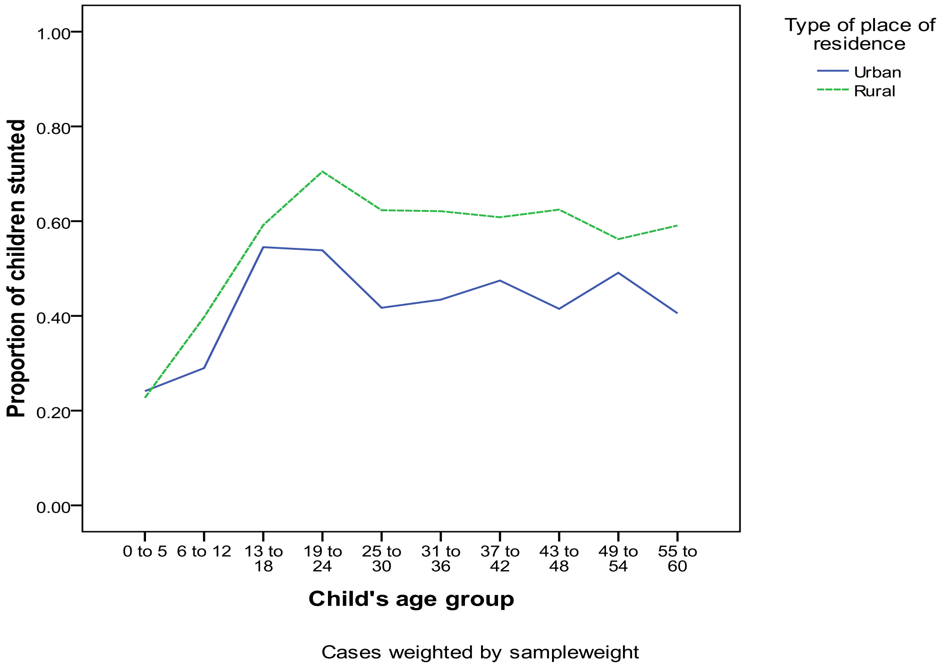
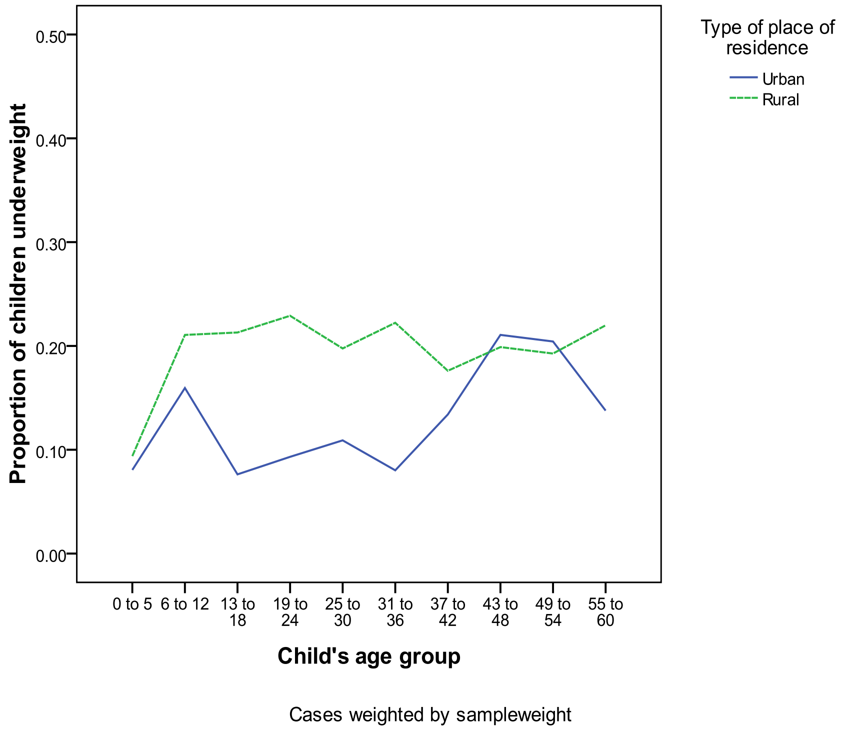



Figure 4.6 Proportion of children underweight by age and residence (2004 DHS data)



### 4.2.5 Maternal stature and child nutritional status

A recent study in 54 low income countries reports of an association between low maternal stature and a child's probability of being undernourished (Özaltin *et al.*, 2010). The association of child's stunting and mother's height and mother's weight and the association between child's underweight status and mother's height and mother's weight is investigated in Figures 4.7 to Figure 4.10. All figures portray that Mother's weight and mother's height show the expected negative linear association with a child's stunting status but also a child's underweight status.

Figure 4.7 Proportion of children stunted and mother's height (2004 DHS data)

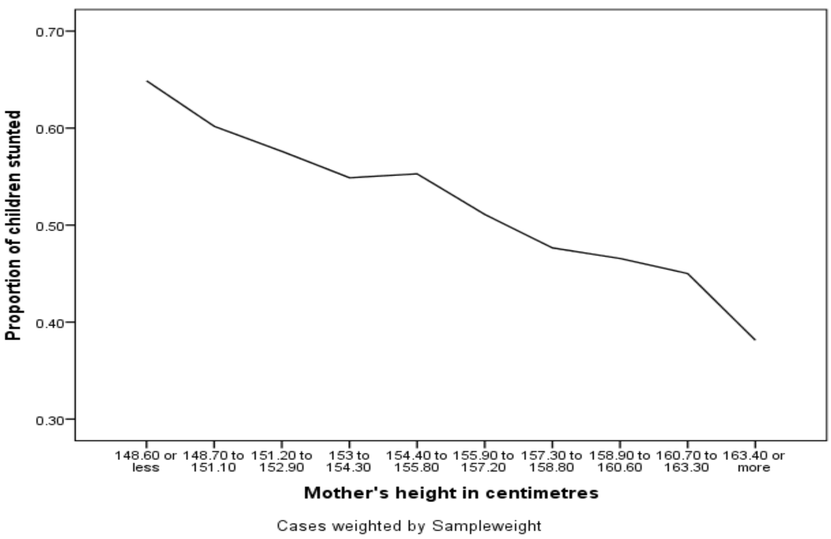



Figure 4.8 Proportion of children stunted and mother's weight (2004 DHS data)

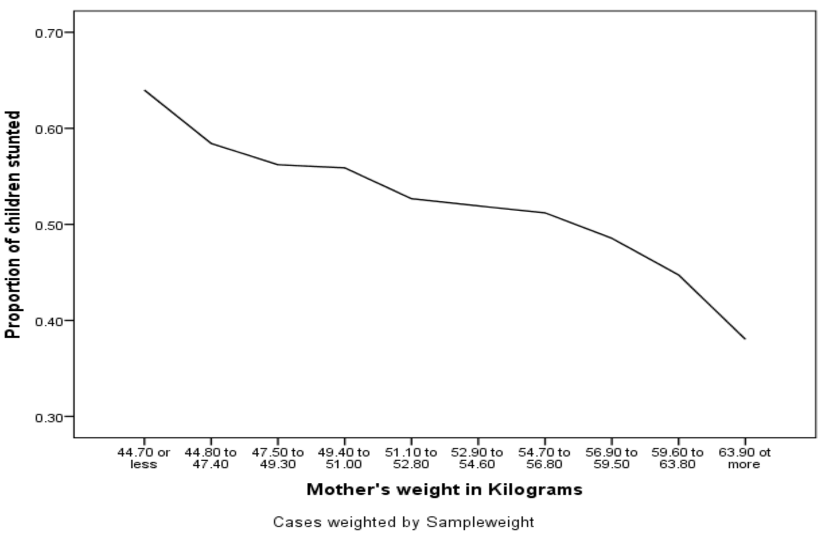


Figure 4.9 Proportion of children underweight and mother's weight (2004 DHS data)

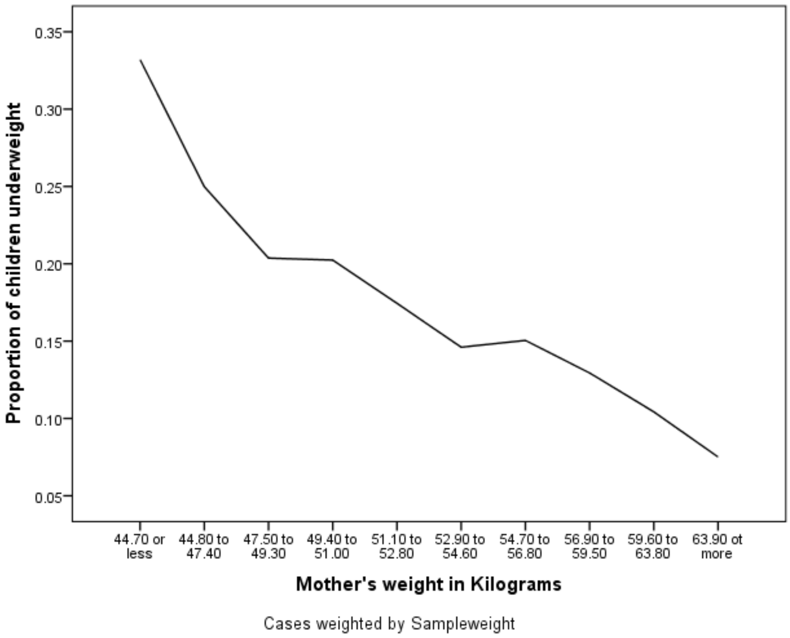



Figure 4.10 Proportion of children underweight and mother's height (2004 DHS data)

### 4.2.6 Childhood stunting and underweight in Malawian under-five children by background characteristics

The associations between child stunting and underweight and child's background are explored by undertaking a cross tabulation of the variables described in Table 4.1 and the variables on stunting and underweight. The results of this exploration are given in Table 4.2. The results show differences in the percentage of children stunted or underweight across these background characteristics. A chi square p value is given showing whether the difference is statistically significant or not. Variables with a p value of less than 0.05 are identified to be significantly associated with a child's stunting or underweight status. As expected, child's age, child's sex and size of child at birth are highly associated with both stunting and underweight. Whether the child has had diarrhoea or not in the last two weeks is also associated with both stunting and underweight but the variables on child having a cough and child having fever in the last two weeks are only associated with child's underweight status and not their stunting status. In contrast, the anaemia status of a child is only associated with stunting but not underweight. Socio-economic status variables such as wealth status, partner education and mother education are significantly associated with both child stunting and child underweight. Having a health card is significantly associated with a child's underweight status but not their stunting status. There is a significant association between a child's underweight and stunting status and their location as measured by region, residence and ethnicity.

Table 4.2 Percentage of children stunted and underweight by child, socio-economic and background factors (2004 DHS data)

| Variable | % Stunted | Chi Square P value | % Underweight | Chi Square P value | N | % |
|---|---|---|---|---|---|---|
| **Child characteristics** | | | | | | |
| Child's age group | | | | | | |
| 0 to 5 months | 22.8 | **<0.001** | 9.2 | **<0.001** | 1,121 | 11.7 |
| 6 to 12 months | 38.4 | | 20.4 | | 1,391 | 14.6 |
| 13 to 24 months | 62.9 | | 20.4 | | 2,173 | 22.7 |
| 25 to 36 months | 59.3 | | 19.4 | | 1,705 | 17.8 |
| 37 to 48 months | 59.3 | | 18.5 | | 1,627 | 17.0 |
| 49 to 60 months | 56.0 | | 20.1 | | 1,543 | 16.1 |
| Sex | | | | | | |
| Male | 55.2 | **<0.001** | 19.6 | **0.03** | 5,523 | 50.6 |
| Female | 50.5 | | 17.4 | | 5,391 | 49.4 |
| Diarrhoea status of child | | | | | | |
| Had diarrhoea | 57.5 | **<0.001** | 24.5 | **<0.001** | 2,212 | 22.8 |
| Did not have diarrhoea | 51.4 | | 16.7 | | 7,507 | 77.2 |

Table 4.2 continued, Percentage of children stunted and underweight by child, socio-economic and background factors (2004 DHS data)

| Variable | % Stunted | Chi Square P value | % Underweight | Chi Square P value | N | % |
|---|---|---|---|---|---|---|
| **Child characteristics** | | | | | | |
| Fever status | | | | | | |
| Had fever | 54.1 | 0.08 | 21.1 | **<0.001** | 3,702 | 38.2 |
| Did not have fever | 51.9 | | 16.9 | | 5,995 | 61.8 |
| Cough status of child | | | | | | |
| Had cough | 53.2 | 0.64 | 20.3 | **<0.01** | 3,798 | 39.1 |
| Did not have cough | 52.6 | | 17.4 | | 5,909 | 60.9 |
| Anaemia status | | | | | | |
| Anaemic | 55.9 | **<0.001** | 19.2 | 0.14 | 1,708 | 73.3 |
| Not anaemic | 45.7 | | 15.8 | | 621 | 26.7 |
| Size of child at birth | | | | | | |
| Very large | 48.6 | **<0.001** | 11.9 | **<0.001** | 1,029 | 9.7 |
| Larger than average | 50.1 | | 15.1 | | 2,625 | 24.8 |
| Average | 52.8 | | 17.7 | | 5,273 | 49.7 |
| Smaller than average | 59.8 | | 28.9 | | 1,275 | 12.0 |
| Very small | 57.0 | | 33.6 | | 406 | 3.8 |
| Has a health card | 52.9 | 0.62 | 17.8 | **<0.01** | 8,368 | 85.0 |
| No health card | 51.9 | | 22.6 | | 1,480 | 15.0 |
| Child's birth order | | | | | | |
| Birth order 1 | 52.9 | 0.21 | 17.8 | 0.11 | 2,469 | 22.6 |
| Birth order 2 | 50.3 | | 16.3 | | 2,230 | 20.4 |
| Birth order 3 | 52.4 | | 18.9 | | 1,755 | 16.1 |
| Birth order 5 or 5 | 54.5 | | 19.7 | | 2,418 | 22.2 |
| Birth order 6 or higher | 53.8 | | 20.0 | | 2,042 | 18.7 |
| Preceding birth interval | | | | | | |
| 0 | 53.1 | **0.02** | 17.9 | 0.72 | 2,490 | 22.8 |
| 9 to 36 months | 54.6 | | 18.9 | | 4,532 | 41.5 |
| Over 36 months | 50.6 | | 18.4 | | 3,892 | 35.7 |
| Younger sibling | | | | | | |
| No | 50.8 | **<0.001** | 18.8 | 0.40 | 7,439 | 68.2 |
| Yes | 57.9 | | 17.8 | | 3,475 | 31.8 |
| **Mother and household characteristics** | | | | | | |
| Maternal education | | | | | | |
| No education | 56.4 | **<0.001** | 22.4 | **<0.001** | 2,870 | 26.3 |
| Primary education | 53.4 | | 18.3 | | 6,967 | 63.8 |
| Secondary education | 40.2 | | 10.9 | | 1,077 | 9.9 |

Table 4.2 continued, Percentage of children stunted and underweight by child, socio-economic and background factors (2004 DHS data)

| Variable | % Stunted | Chi Square P value | % Underweight | Chi Square P value | N | % |
|---|---|---|---|---|---|---|
| Paternal education | | | | | | |
| No education | 57.0 | **<0.001** | 23.7 | **<0.001** | 1,694 | 15.8 |
| Primary education | 55.4 | | 19.1 | | 6,746 | 62.9 |
| Secondary education | 44.2 | | 13.5 | | 2,281 | 21.3 |
| Wealth status | | | | | | |
| Poorest | 57.6 | **<0.001** | 24.5 | **<0.001** | 1,945 | 18.0 |
| Poorer | 55.1 | | 20.4 | | 2,216 | 20.5 |
| Middle | 54.0 | | 19.0 | | 2,336 | 21.7 |
| Richer | 54.3 | | 17.3 | | 2,269 | 21.0 |
| Richest | 42.1 | | 11.3 | | 2,026 | 18.8 |
| Total number of children ever born | | | | | | |
| 1 to 2 children | 51.2 | 0.19 | 17.1 | 0.05 | 3,798 | 34.8 |
| 3 to 4 children | 53.1 | | 18.4 | | 3,573 | 32.7 |
| 5 or more | 54.3 | | 20.3 | | 3,543 | 32.5 |
| Number of children aged five or under | | | | | | |
| One child | 53.3 | 0.22 | 17.7 | 0.55 | 3,974 | 38.0 |
| Two children | 53.4 | | 18.9 | | 5,119 | 48.9 |
| Three or more children | 49.9 | | 19.0 | | 1,377 | 13.2 |
| Region | | | | | | |
| Northern | 46.1 | **<0.001** | 14.1 | **<0.01** | 1,349 | 12.4 |
| Central | 57.1 | | 18.4 | | 4,141 | 37.9 |
| Southern | 51.2 | | 19.8 | | 5,424 | 49.7 |
| Residence | | | | | | |
| Urban | 42.7 | **<0.001** | 12.4 | **<0.001** | 1,137 | 10.4 |
| Rural | 54.3 | | 19.4 | | 9,777 | 89.6 |
| Ethnicity | | | | | | |
| Chewa | 57.3 | **<0.001** | 19.5 | **<0.05** | 3,619 | 33.2 |
| Tumbuka, Nkhonde and Tonga | 46.8 | | 13.9 | | 1,306 | 12.0 |
| Lomwe | 50.6 | | 20.6 | | 2,008 | 18.4 |
| Ngoni | 53.9 | | 17.4 | | 998 | 9.2 |
| Yao | 52.2 | | 16.7 | | 1,796 | 16.5 |
| Sena and other | 49.4 | | 20.6 | | 1,186 | 10.9 |

### 4.2.7 Results of multivariate analysis on stunting and underweight

The determinants of child under-nutrition in Malawi are further explored by undertaking a multilevel logistic regression analysis for stunting and underweight controlling for child, household, socio-economic and location factors that were significant in the bivariate analysis presented in sections 4.2.3 to 4.2.6. Multilevel modelling is used to estimate the variation of stunting and underweight across households and communities so as to obtain robust estimates of the factors associated with underweight and stunting. Most of the factors that were significant in the bivariate analysis are also significant in the multivariate analysis as shown in Table 4.3. Factors that are not significantly associated with both stunting and underweight are not presented. The odds of stunting and the odds of underweight are significantly different across communities as shown in Table 4.4. The community level variance is larger and the T statistic is higher for stunting compared to the underweight model. The results of the fixed effect part of the model are therefore community specific (grouping of households). The household level variance was not significant for both stunting and underweight. Factors such as sex of the child, age, size of child at birth, residence, whether the child had diarrhoea or not, wealth status of the household, region, having a younger sibling, mother's height, mother's weight and residence are significantly associated with a child's stunting status, whilst a child underweight status is associated with nearly all factors that are associated with a child's stunting status but also partner education level, mother possessing a health card and whether a child had fever.

The odds of underweight are 17% lower for female children compared to male children, and the odds of stunting are 20% lower for female children compared to male children. The relationship between age and stunting and underweight is non-linear and this is illustrated in Figures 4.11 and 4.12. There is significant interaction between age of child and sex of child in underweight, the likelihood of underweight increases with age for female children but not for male children. Having diarrhoea is associated with both underweight and stunting, however, the effect is stronger for underweight with the odds of underweight being 41% higher for children that had diarrhoea in the two weeks before interviews compared to those that did not have diarrhoea, whilst the odds of stunting are 19% higher for children that had diarrhoea compared to children that did not have diarrhoea.

Children that had fever two weeks before interviews are 22% more likely to be underweight compared to children that did not have fever. Having a younger sibling is associated with better nutritional status for children, children that have a younger sibling have 28% lower odds of underweight and 19% lower odds of stunting compared to children that do not have a younger sibling. Children that are born of smaller than average size are more likely to be underweight and more likely to be stunted compared to children that were born of very large size. The odds of underweight are significantly higher amongst children without a child health card compared to children with a health card.

An increase of mother's weight by 1 Kg is associated with a decrease in the odds of underweight by 5% and the odds of stunting by 2%, whilst an increase in mother's height by 1cm is associated with a decrease in the odds of underweight by 1% and the odds of stunting by 3%. Children whose mother's partner has secondary education or higher have 25% lower odds of underweight compared to children whose mother's partner has no education. Children from the central region are more likely to be stunted compared to children from the northern region. The odds of stunting and underweight are higher amongst children from rural areas compared to children from urban areas.

Table 4.3 Determinants of stunting and underweight in Malawi, multilevel logistic regression results (2004 DHS data)

| Variable | Odds ratio underweight | 95% confidence interval | Odds ratio stunted | 95% Confidence interval |
|---|---|---|---|---|
| **Child characteristics** | | | | |
| Female | 0.83** | (0.73,0.93) | 0.80*** | (0.72,0.88) |
| Age[5] | 1.07 | (0.88,1.31) | 1.53*** | (1.31,1.79) |
| Age squared | 0.87*** | (0.81,0.93) | 0.63*** | (0.59,0.66) |
| Age*Female | 1.20** | (1.06,1.36) | 1.09 | (0.99,1.20) |
| Child had diarrhoea | 1.41*** | (1.22,1.62) | 1.19** | (1.06,1.35) |
| Child had fever | 1.22** | (1.07,1.38) | 1.07 | (0.96,1.19) |
| Has a younger sibling | 0.72*** | (0.60,0.85) | 0.81** | (0.71,0.94) |
| Child has a health card | 0.82* | (0.69,0.97) | 1.07 | (0.92,1.23) |
| | | | | |
| Size at birth: | | | | |
| Reference is very large | | | | |
| Larger than average | 1.25 | (0.97,1.60) | 1.04 | (0.87,1.24) |
| Average | 1.42** | (1.13,1.78) | 1.17 | (0.99,1.39) |
| Smaller than average | 2.37*** | (1.83,3.08) | 1.42** | (1.15,1.76) |
| Very Small | 2.96*** | (2.10,4.17) | 1.16 | (0.85,1.58) |
| | | | | |
| **Mother and household characteristics** | | | | |
| Mother's height in kilograms | 0.99 | (0.98,1.00)* | 0.966*** | (0.96,0.97) |
| Mother's weight in centimetres | 0.95 | (0.94,0.96)*** | 0.982*** | (0.98,0.99) |

*= P value <0.05 **=p value <0.01 ***=p value<0.001

[5] Age is standardised and is therefore unit less

Table 4.3 continued, Determinants of stunting and underweight in Malawi, multilevel logistic regression results (2004 DHS data)

| Variable | Odds ratio underweight | 95% confidence interval | Odds ratio stunted | 95% Confidence interval |
|---|---|---|---|---|
| Wealth status: Reference is poorest | | | | |
| Poorer | 0.86 | (0.72,1.04) | 0.90 | (0.77,1.06) |
| Middle | 0.86 | (0.71,1.04) | 0.87 | (0.74,1.03) |
| Richer | 0.82* | (0.68,0.99) | 0.93 | (0.79,1.09) |
| Richest | 0.60*** | (0.48,0.74) | 0.63*** | (0.53,0.75) |
| Partner education level: Reference is no education | | | | |
| Primary education | 0.84 | (0.72,0.99)* | 0.99 | (0.86,1.14) |
| Secondary education | 0.75 | (0.61,0.92)** | 0.88 | (0.74,1.04) |
| Wealth status: Reference is poorest | | | | |
| Poorer | 0.86 | (0.72,1.04) | 0.90 | (0.77,1.06) |
| Middle | 0.86 | (0.71,1.04) | 0.87 | (0.74,1.03) |
| Richer | 0.82* | (0.68,0.99) | 0.93 | (0.79,1.09) |
| Richest | 0.60*** | (0.48,0.74) | 0.63*** | (0.53,0.75) |
| **Location characteristics** | | | | |
| Region : Reference is Northern | | | | |
| Central | 1.12 | (0.89,1.41) | 1.46*** | (1.21,1.77) |
| Southern | 1.19 | (0.97,1.48) | 1.10 | (0.92,1.31) |
| Residence: Reference is urban | | | | |
| Rural | 1.46** | (1.13,1.89) | 1.47** | (1.21,1.79) |

*= P value <0.05 **=p value <0.01 ***=p value<0.001

Table 4.4 Results of the random part of the models on Underweight and Stunting (2004 DHS data)

| Level | Underweight model variance | Standard error | Stunting model variance | Standard error |
|---|---|---|---|---|
| Community | 0.083 | 0.035 | 0.111 | 0.027 |

The association between a child's underweight status and sex depends on the age of child as shown in Figure 4.12. Amongst children aged 48 months or less, male children have a higher likelihood of underweight compared to female children, whilst amongst children aged over 48 months female children are more likely to be underweight compared to male children. Figure 4.11 and Figure 4.12 also captures the non-linear relationship between both stunting and underweight and a child's age. Predicted probabilities of stunting are highest amongst children aged 36 months for both male and female children whilst predicted probabilities of underweight for male children peak in the age group 19 to 24 months and those of female children are highest amongst children aged 55 to 60 months. Whilst in general the odds of underweight are 17% lower for female children compared to male children and the odds of stunting are 20% lower for female children compared to male children, female are more likely to get undernourished as they get older, an increase in the age of female children by one standard deviation is associated with a 20% increase in the odds of being underweight.

Figure 4.11 Predicted probabilities of being stunted by sex and age in Malawian under-five children (2004 DHS data)

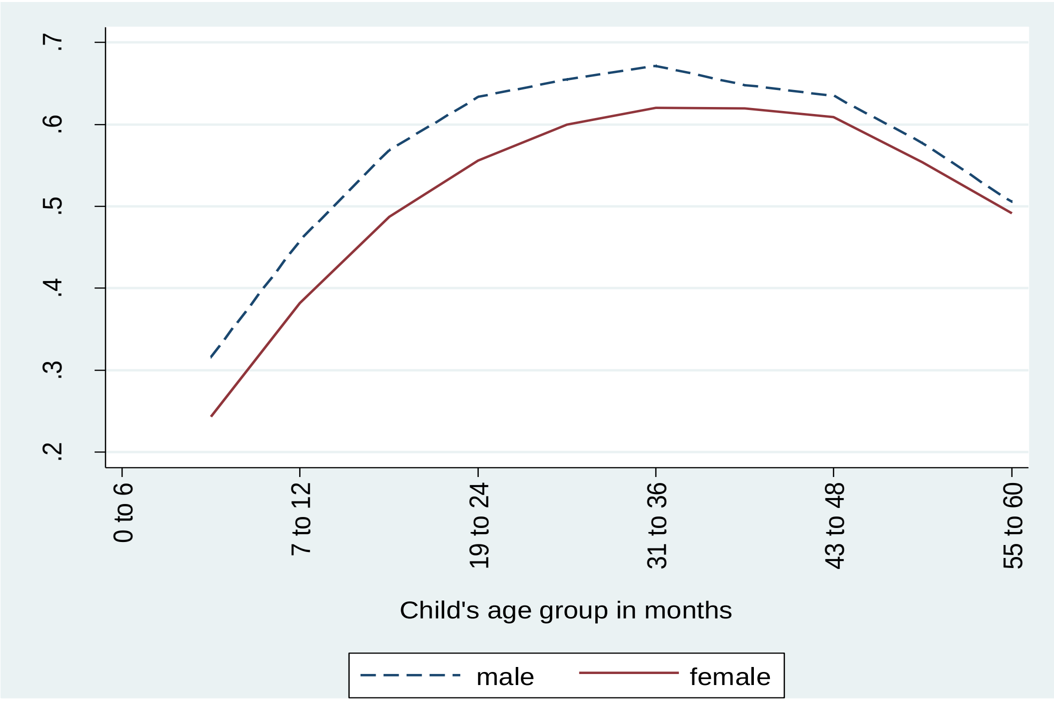
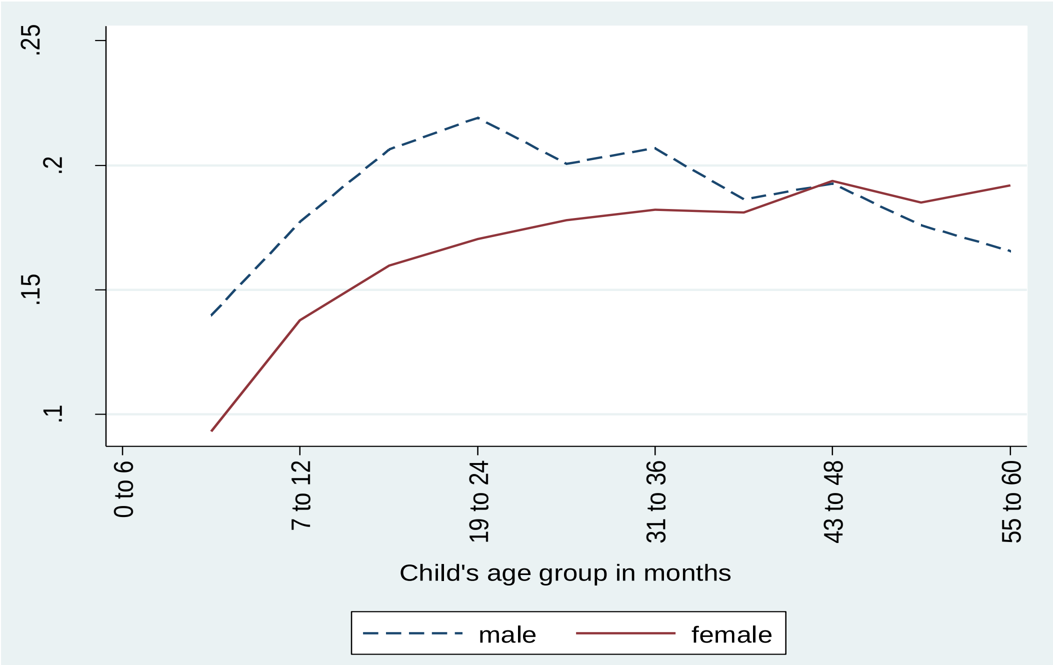


Figure 4.12 Predicted probabilities of underweight by sex and age in Malawian children (2004 DHS data)




## 4.3 Levels and patterns of child under-nutrition in Malawi

This section investigates if the levels and patterns of child under-nutrition have changed in the period 2000 to 2010 and if so, to what extent.

### 4.3.1 Under-nutrition rates for years 2000, 2004 and 2010

There is a declining trend in both underweight and stunting across the three time points. This is shown in Table 4.5. Underweight has declined by more percentage points compared to stunting (8.7% compared with 7%) whilst wasting declined by 2.9 percentage points. The difference in under-nutrition rates across the three time points is statistically significant (chi square p value <0.001). Table 4.5 also shows that the year 2010 has the lowest percentage of children that are overweight and that across the three time points the estimate for children that are overweight is less than 2% and therefore is within the expected level. The difference in the percentage of children overweight is statistically significant (chi square p value <0.05).

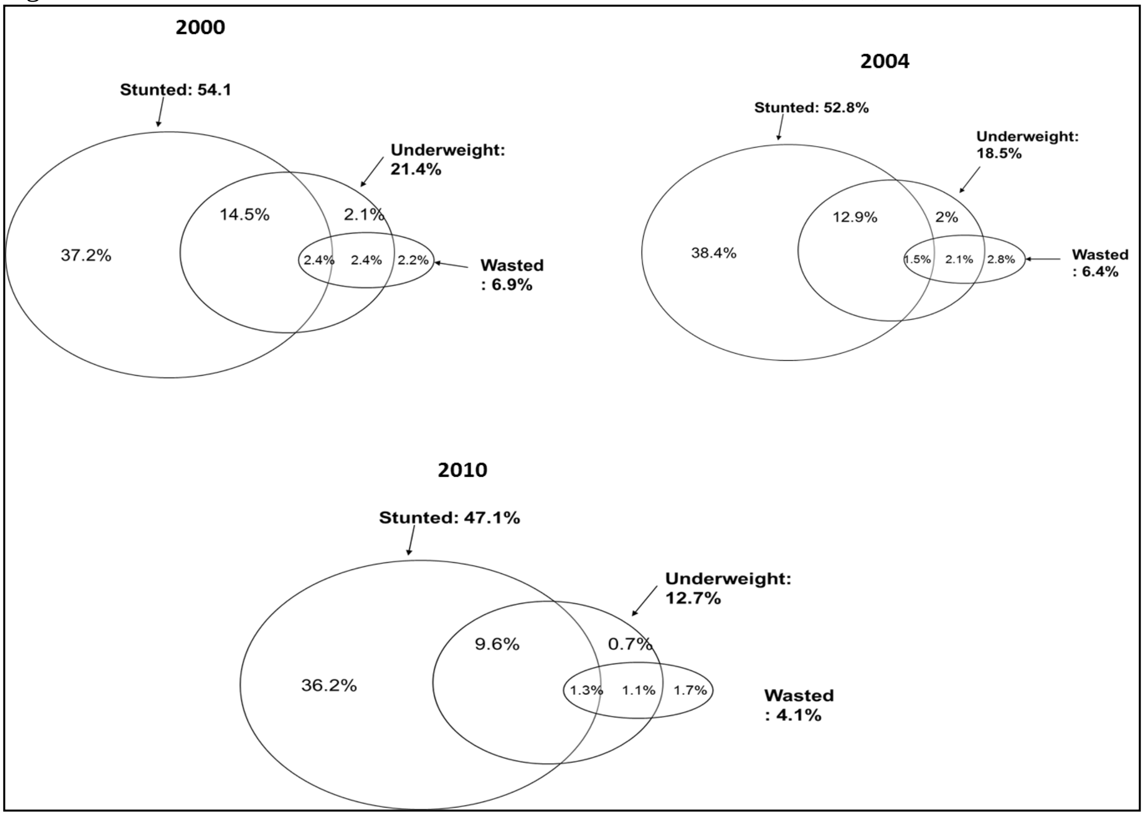
Table 4.5 Under-nutrition rates for Malawian children for years 2000, 2004 and 2010

| Year of survey | % Stunted | % Underweight | % wasted | % Overweight* |
|---|---|---|---|---|
| 2000 | 54.1 | 21.4 | 7.0 | 1.5 |
| 2004/2005 | 52.8 | 18.5 | 6.4 | 1.8 |
| 2010 | 47.1 | 12.7 | 4.1 | 1.1 |

*= children with a weight for age z score over 2 standard deviations

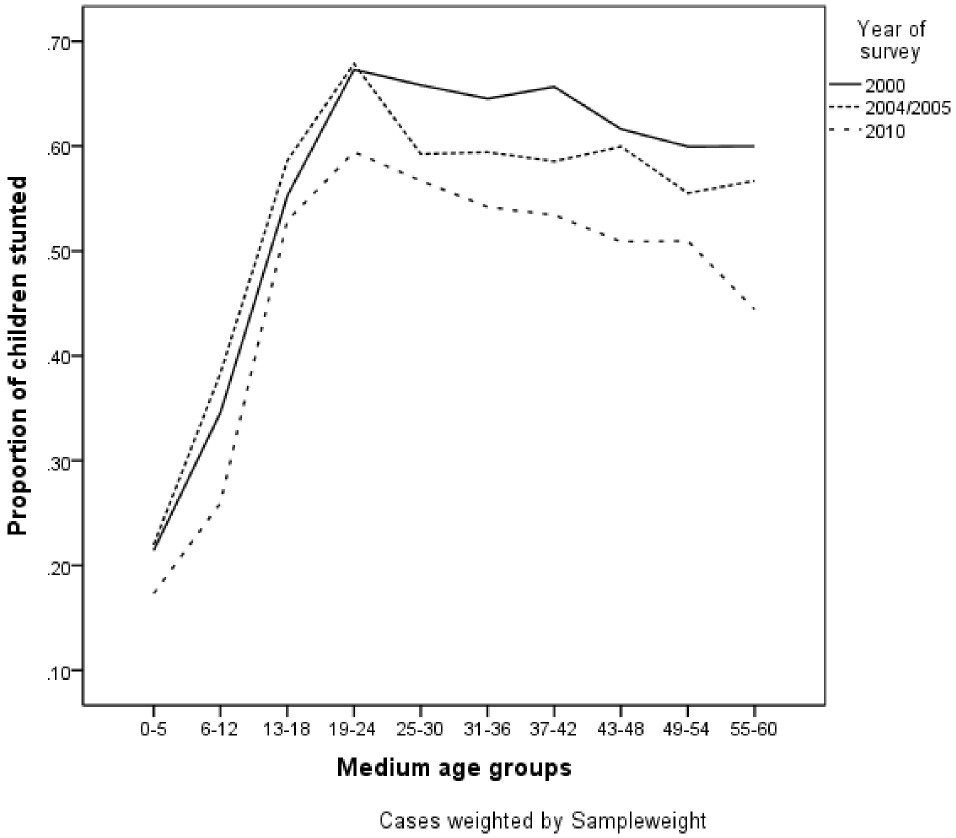
The three types of under-nutrition given in Table 4.5 are decomposed to show the percentage of children that are affected by one or a combination of two and three types of under-nutrition. This is shown in Figure 4.13. The figure shows that in all the three survey years, over two thirds of children that are underweight are also stunted. However, the percentage of children that are both stunted and underweight has been declining from 14.5% in 2000 to 12.9% in 2004 and to 9.6% in 2010. The percentage of children that are stunted but not affected by any other kind of under-nutrition appears to have slightly gone up in 2004 to 38.4% from 37.2% in 2000 and slightly declined in 2010 to 36.2% The percentage of children that are underweight but are not stunted or wasted is very small.

Figure 4.13 Under-nutrition status for Malawian under-five children, 2000, 2004 and 2010




A comparison of stunting across the three time points by age of the child is given in Figure 4.14. Generally the pattern is that the proportion of children stunted rise sharply in the first year of life, peaking in the age group 19 to 24 months after which the proportion of children stunted starts declining very slowly. The year 2010 has the lowest proportion of children stunted throughout all the age groups. From birth up to the age of 18 months the proportion of children stunted is slightly lower in the year 2000 compared to the year 2004, however this reverses from the age of 25 months and above. The biggest difference in the proportion of children stunted across the three interview years is amongst the children aged 25 months and above.

Figure 4.14 Proportion of Malawian children stunted by age and survey year (pooled data set)




The proportion of children underweight rises sharply in the first year of life in all the three survey years as shown in Figure 4.15. In 2000, underweight rates are highest in children aged 25 to 30 months, whilst in 2004, there does not appear to be a unique peak. In 2010 the peak of underweight rates is amongst those aged 13 to 18 months. Year 2010 has consistently the lowest underweight rates amongst all the age groups whilst the year 2000 has the highest underweight rates from birth up to 36 months.

Figure 4.15 Proportion of children underweight by age and survey year (pooled data set)

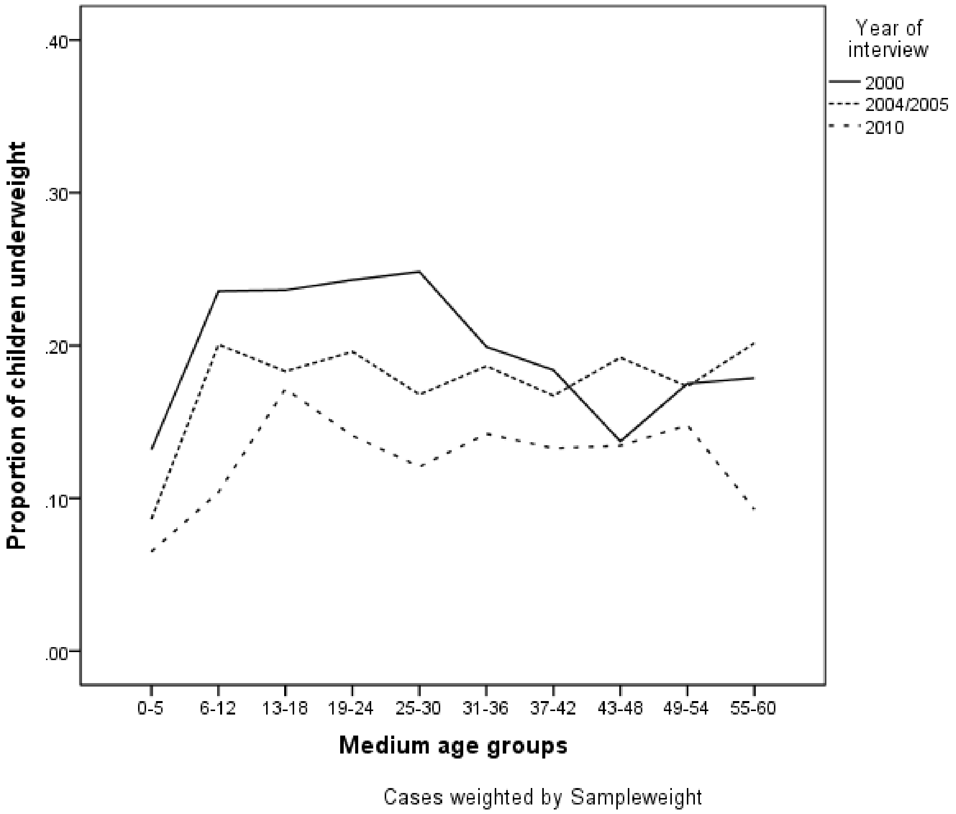
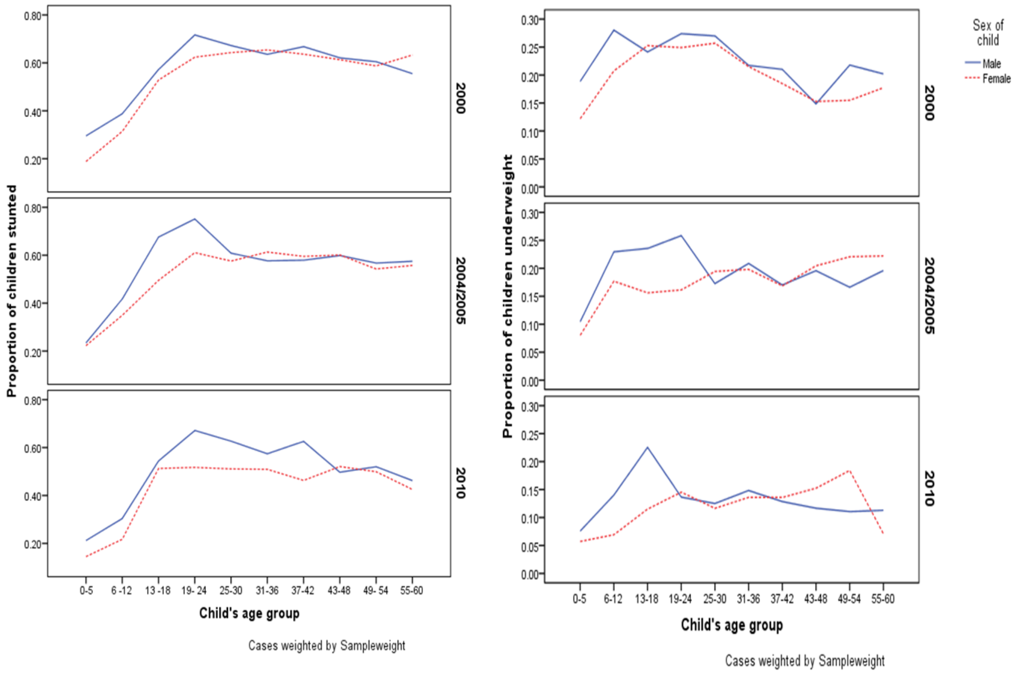



Figure 4.16 presents the proportion of children that are stunted and those that are underweight by age, sex and survey year. Male children are more likely to be stunted than female children in the first two years of life in all the three interview years. However in 2010, the proportion of male children that are stunted is persistently higher than the proportion of female children that are stunted from birth up to the age of 43 to 48 months. The difference in the proportion of children stunted between male and female children is bigger in 2004 and 2010 and smaller in 2000. Similarly, the proportions of male children that are underweight are higher than that of female children in the first two years of life in all the three survey years. However, the years 2004 and 2010 depict a somehow similar pattern of higher underweight proportions for female children than male children in the older age groups (from the age of three and half years in 2004 and from the age of three years in 2010). This pattern does not appear in the year 2000.

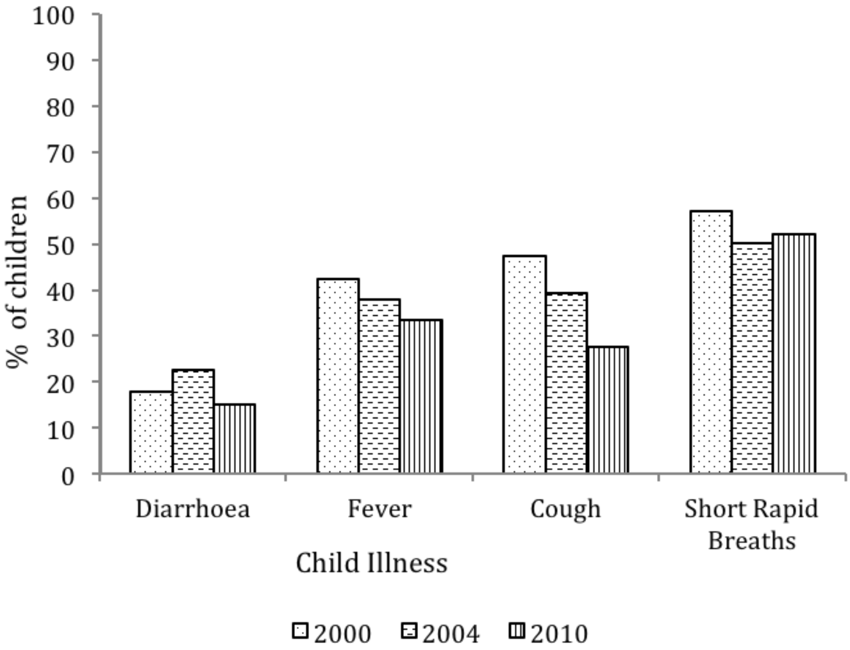
Figure 4.16 Proportion of children that are stunted and underweight by age, sex and survey year (pooled data set)




### 4.3.2 Comparison of morbidity, vaccination and feeding across 2000, 2004 and 2010

This section makes a comparison of morbidity, vaccination and feeding across the three survey years considering the important role played by these factors on a child's nutritional status as described in the literature review section. The morbidity comparison is shown in Figure 4.17, where the rates of four illnesses (diarrhoea, fever, cough and short rapid breaths) are shown. The year 2010 has the lowest levels of children that were affected by cough, fever and diarrhoea in the two weeks prior to interview. However, the percentage of children with short rapid breaths are higher in 2010 than those reported in 2004, although the difference is not statistically significant (P value = 0.356). The year 2000 has the highest proportion of children suffering from fever, cough and short rapid breaths, whilst diarrhoea levels are highest in 2004. The higher levels of diarrhoea in 2004 compared to 2000 may be due to the rainy season. However, in general, morbidity rates are lowest in 2010 and highest in 2000.

Figure 4.17 Percentage of children affected by illness two weeks prior to interview by survey year




(Chi square p value <0.001 )

Across the three survey years, a comparison is made on the percentage of children that were fully immunised (for children aged 12 to 59 months) but also the percentage of children that were reported to have received vitamin A supplements for children aged 6 months or more. The results are given in Table 4.6. A fully immunised child is one that has received BCG, DPT1, DPT2, DPT3, Polio 1, Polio 2, Polio 3 and Measles vaccine. It is expected that a child should have received all these vaccines by the time they are 12 months old. The year 2010 has the highest proportion of children that are reported to be fully immunised as well as those that are reported to have received vitamin A supplements. However, it is interesting to note that immunisation levels in 2004 were lower than those reported in 2000. The difference in the levels of immunisation and vitamin A supplementation across the three survey years is statistically significant (chi square p value <0.001).

Table 4.6 Full vaccination status for Malawian children aged between 12 and 59 months and vitamin A supplementation for children aged over 6 months (2000,2004 and 2010 DHS data sets)

| Immunisation status | 2000 % (N) | 2004 % (N) | 2010 %( N) |
|---|---|---|---|
| None at all | 3.1 (233) | 4.6 (325) | 3.2 (128) |
| Fully immunised | 73.4 (5,496) | 68.3 (4,859) | 78.6 (3,137) |
| Some immunisation but not a full set | 23.5 (1,756) | 27.1 (1,930) | 18.2 (728) |
| Vitamin A in the last six months | 71.2 (5,910) | 66.1(4,779) | 85.8(3,604) |

The WHO propagates exclusive breastfeeding of babies from birth up to the age of six months. Mothers are advised to feed their babies breast milk only at this age. It appears that such campaigns are working since the percentage of children that are exclusively breastfed has risen from 38.1% in 2000 to 57.1% in 2010 as shown in Table 4.7. The percentage of children that are exclusively breastfed shows an increasing trend from 2000 to 2004 and then 2004 to 2010. The difference in the percentage of children that were exclusively breastfed across the three survey years is statistically significant (chi square p value <0.001).

Table 4.7 Percentage of children aged 0 to 6 months under exclusive breastfeeding by age and year of survey (2000,2004 and 2010 DHS data sets)

| Age in months | 2000 %(N) | 2004 %(N) | 2010 %(N) |
|---|---|---|---|
| 0 | 84.7 (111) | 82.8 (116) | 90.7 (54) |
| 1 | 75.6 (242) | 67.3 (214) | 87.8 (98) |
| 2 | 55.1(243) | 66.8 (223) | 80.2 (96) |
| 3 | 42.0 (212) | 48.7 (197) | 84.6 (91) |
| 4 | 15.5 (238) | 34.9 (192) | 39.0 (77) |
| 5 | 9.2 (229) | 14.4 (174) | 23.0 (74) |
| 6 | 4.6 (216) | 4.8 (187) | 11.7 (120) |
| All | 38.1 (1491) | 45 (1301) | 57.1 (613) |

Apart from recommending exclusive breastfeeding for children aged six months or less, the WHO recommends introduction of solid foods to children aged six months with continued breastfeeding up to the age of two years. Figures 4.18, 4.19 and 4.20 present the percentage distribution of children that were exclusively breastfed in the ages 0 to 6 months, mixed fed or fed other food with no breast milk for those aged between 6 and 24 months for years 2000, 2004 and 2010 respectively. The figures also show the percentage of children that were never breastfed. Whilst the child's feeding pattern for the year 2000 shown in Figure 4.18 and that of the year 2004 shown in Figure 4.19 are pretty similar, there are some slight differences. The percentage of children that are exclusively breastfed is bigger in 2004 compared to 2000 reflecting the increase in mothers that reported to be exclusively breastfeeding their children in 2004. There is a very small percentage of children randomly spread across the ages of 0 to 24 months that reported to have never breastfed.

Figure 4.20 for the year 2010 feeding pattern depicts a major shift from the pattern shown for the years 2000 and 2004 with the percentage of children that were exclusively breastfed having increased highly. However, on another note, the percentage of children that were never breastfed is higher in 2010 (7.2%) compared to 2004 (5.6%) and the percentage of children that are consuming foods and liquids only amongst those aged between 6 and 12 months is also much higher in 2010 (16.5%) compared to 2000 (5%) and 2004 (4.5%). This shows that whilst good progress has been made in exclusive breastfeeding in 2010, continued breastfeeding after six months has gone down.

Figure 4.18 Child's feeding type by age of child in months, 2000 MDHS

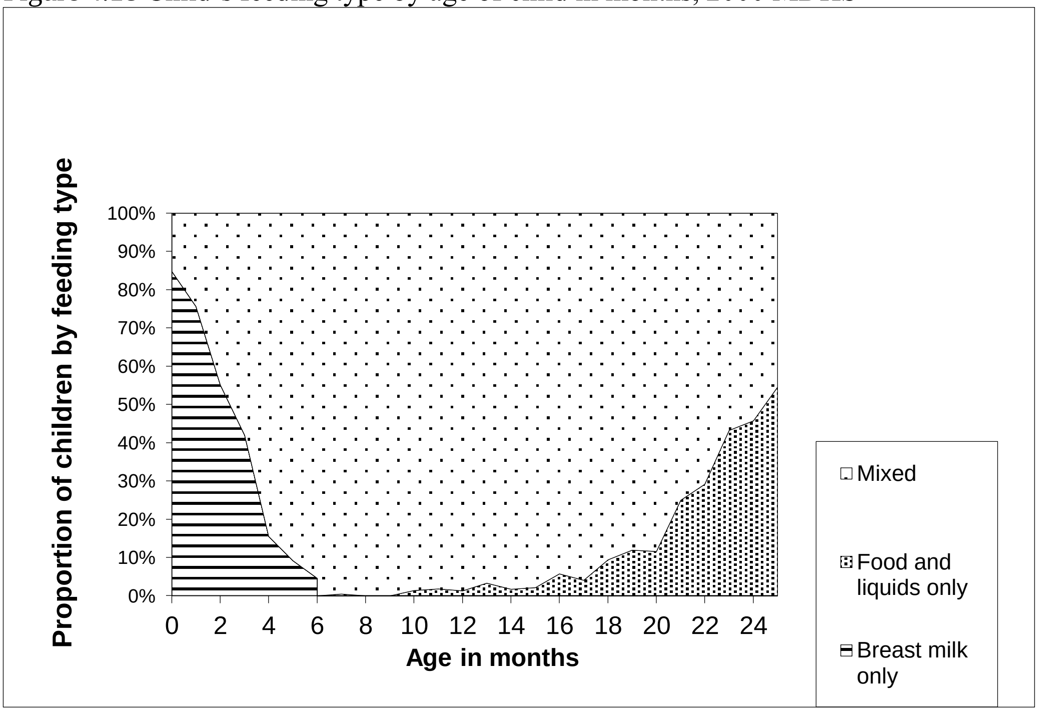


Figure 4.19 Child’s feeding type by age of child in months, 2004 MDHS

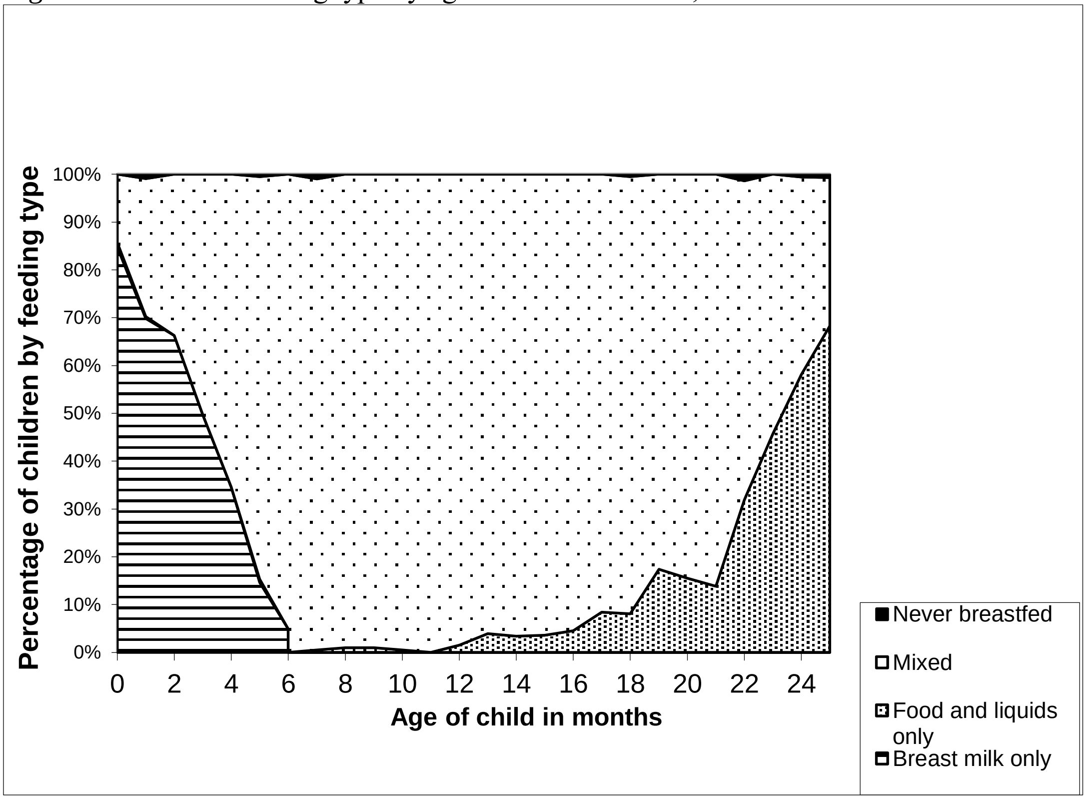



Figure 4.20 Child’s feeding type by age of child in months, 2010 MDHS

### 4.3.3 Source of water and use of toilet facility across 2000,2004 and 2010

Access to safe water is very crucial for ensuring good health which in turn influences better nutritional status. Environmental contamination is identified as one mechanism through which the probability of child survival is affected (Mosley-Chen, 1984) and there is an association between childhood diarrhoea and poor access to safe water (Osumanu, 2007) whilst other studies report that children that suffer from diarrhoea are likely to be undernourished (Griffiths *et al.*, 2004, Madise *et al.*, 1999). Lack of a toilet facility has also been linked to a higher likelihood of diarrhoea in children (Woldemicael, 2001). Differences in the percentage of households with access to safe water and those with a toilet facility are explored and shown in Table 4.8. Generally there is no big difference in the percentage of households using piped water between the year 2000 and 2010, although the percentage of households using piped water is lower in 2004 than in 2000. However the difference in the percentage of households with piped water compared to households without piped water across the three survey years is not statistically significant (p value 0.082). More households are using a borehole in 2010 compared to 2000, whilst the percentage of households using unprotected well water has gone down from 52.9% in 2000 to 28.4% in 2010. This shows a considerable increase in the percentage of households using safe water between the years 2000 and 2010.

Whilst in general the majority of households have a toilet facility in all the three survey years (over 80%), the percentage of households with a toilet facility has gone up from 81.6% in 2000 to 90% in 2010 showing an improvement in sanitation which is key to prevention of illnesses such as diarrhoea.

Table 4.8 Percentage of households accessing a particular type of source of water and those with a toilet facility (2000,2004 and 2010 DHS data sets)

| Survey year | Piped water | Borehole | Un protected water | Has a toilet |
|---|---|---|---|---|
| 2000 | 21.5 | 25.6 | 52.9 | 81.6 |
| 2004 | 17.1 | 43.4 | 39.5 | 83.3 |
| 2010 | 22.5 | 49.1 | 28.4 | 90.0 |

### 4.3.4 Bivariate analysis of factors associated with stunting and underweight

The bivariate analysis of different factors associated with stunting and underweight in the pooled data set are given in Table 4.9, statistical significance is set at 1% level due to the large sample size. There is a significant association between survey year and stunting and underweight status of a child. Most of the child and mother factors as well as location factors are significantly associated with a child’s stunting and underweight status. However, a few factors are not significantly associated with a child stunting status and these are: having a cough, having short rapid breaths, having a health card, total number of children ever born, child's birth order and number of children under the age of five. The only variable whose association with child underweight is not statistically significant is total number of children ever born ( p value = 0.017).

Table 4.9 Percentage of children stunted and underweight by child, household and location characteristics (pooled data from 2000, 2004 and 2010 MDHS data sets)

| Variable | % Stunted | Chi Square P value | % Underweight | Chi Square P value | N | % |
|---|---|---|---|---|---|---|
| Year of Survey | | <0.001 | | <0.001 | | |
| 2000 | 54.1 | | 21.4 | | 11,926 | 43.5 |
| 2004/2005 | 52.8 | | 18.5 | | 10,914 | 39.8 |
| 2010 | 47.1 | | 12.7 | | 4,586 | 16.7 |
| **Location characteristics** | | | | | | |
| Region | | <0.001 | | <0.001 | | |
| Northern | 45.9 | | 13.9 | | 4,073 | 14.9 |
| Central | 55.9 | | 19.5 | | 10,238 | 37.3 |
| Southern | 50.4 | | 19.0 | | 13,115 | 47.8 |
| Residence | | <0.001 | | <0.001 | | |
| Urban | 41.2 | | 12.2 | | 3,677 | 13.4 |
| Rural | 53.9 | | 19.6 | | 23,749 | 86.6 |
| Ethnicity | | <0.001 | | <0.001 | | |
| Chewa | 56.3 | | 19.8 | | 8,481 | 30.9 |
| Tumbuka, Nkhonde and Tonga | 45.1 | | 13.4 | | 3,741 | 13.7 |
| Lomwe | 50.3 | | 19.4 | | 4,862 | 17.7 |
| Ngoni | 53.2 | | 19.9 | | 3,214 | 11.7 |
| Yao | 49.5 | | 17.7 | | 4,090 | 14.9 |
| Sena and other | 50.8 | | 18.7 | | 3,028 | 11.0 |
| **Child characteristics** | | | | | | |
| Child's age group | | | | | | |
| 0 to 5 months | 22.6 | <0.001 | 11.9 | <0.001 | 2,730 | 11.3 |
| 6 to 12 months | 34.6 | | 20.4 | | 3,396 | 14.1 |
| 13 to 24 months | 60.8 | | 21.4 | | 5,357 | 22.2 |
| 25 to 36 months | 61.1 | | 20.2 | | 4,567 | 18.9 |
| 37 to 48 months | 59.7 | | 17.0 | | 4,399 | 18.2 |
| 49 to 60 months | 55.5 | | 17.8 | | 3,680 | 15.3 |
| Sex | | | | | | |
| Male | 54.8 | <0.001 | 19.9 | <0.001 | 13,747 | 50.1 |
| Female | 49.7 | | 17.4 | | 13,679 | 49.9 |

Table 4.9 continued, Percentage of children stunted and underweight by child, household and location characteristics (pooled data from 2000, 2004 and 2010 MDHS data sets)

| Variable | % Stunted | Chi Square P value | % Underweight | Chi Square P value | N | % |
|---|---|---|---|---|---|---|
| **Child characteristics** | | | | | | |
| Diarrhoea status of child | | | | | | |
| Had diarrhoea | 54.1 | 0.02 | 24.8 | <0.001 | 4,709 | 19.2 |
| Did not have diarrhoea | 51.7 | | 17.1 | | 19,774 | 80.8 |
| | | | | | | |
| Fever status | | | | | | |
| Had fever | 53.2 | 0.04 | 21.8 | <0.001 | 9,500 | 38.9 |
| Did not have fever | 51.5 | | 16.6 | | 14,955 | 61.1 |
| | | | | | | |
| Cough status | | | | | | |
| Had a cough | 52.2 | 0.95 | 20.0 | <0.001 | 9,880 | 40.4 |
| Did not have a cough | 52.1 | | 17.7 | | 14,560 | 59.6 |
| | | | | | | |
| Short rapid breaths (Srb) | | | | | | |
| Child had Srb | 52.3 | 0.81 | 21.7 | <0.001 | 5,216 | 52.9 |
| Child did not have Srb | 52.0 | | 17.9 | | 4,654 | 47.1 |
| | | | | | | |
| Health card | | | | | | |
| Child has a health card | 52.0 | 0.38 | 18.2 | <0.01 | 21,103 | 85.2 |
| No health card | 53.1 | | 21.0 | | 3,673 | 14.8 |
| | | | | | | |
| Size of child at birth | | | | | | |
| Very large | 47.6 | <0.001 | 11.3 | <0.001 | 2,600 | 9.7 |
| Larger than average | 46.5 | | 14.0 | | 6,000 | 22.3 |
| Average | 52.7 | | 18.6 | | 14,110 | 52.4 |
| Smaller than average | 61.8 | | 29.0 | | 3,180 | 11.8 |
| Very small | 60.4 | | 34.7 | | 1,042 | 3.9 |
| | | | | | | |
| Child’s birth order | | | | | | |
| Birth order 1 | 52.9 | 0.23 | 19.2 | 0.013 | 6,197 | 22.6 |
| Birth order 2 | 50.9 | | 16.8 | | 5,490 | 20.0 |
| Birth order 3 | 51.3 | | 18.2 | | 4,355 | 15.9 |
| Birth order 4 or 5 | 52.2 | | 18.8 | | 5,985 | 21.8 |
| Birth order 6 or higher | 53.4 | | 20.0 | | 5,399 | 19.7 |
| | | | | | | |
| Preceding birth interval | | | | | | |
| First births | 53.1 | <0.001 | 19.5 | <0.001 | 6,268 | 22.9 |
| 9 to 36 months | 54.5 | | 19.6 | | 12,003 | 43.8 |
| 37 or more | 48.7 | | 16.8 | | 9,155 | 33.4 |
| | | | | | | |
| Younger sibling | | | | | | |
| No | 49.2 | <0.001 | 18.9 | <0.01 | 18,485 | 68.3 |
| Yes | 58.6 | | 17.0 | | 8,565 | 31.7 |

Table 4.9 continued, Percentage of children stunted and underweight by child, household and location characteristics (pooled data from 2000, 2004 and 2010 MDHS data sets)

| Variable | % Stunted | Chi Square P value | % Underweight | Chi Square P value | N | % |
|---|---|---|---|---|---|---|
| **Household characteristics** | | | | | | |
| Partner education | | | | | | |
| No education | 57.6 | <0.001 | 23.7 | <0.001 | 3,908 | 14.5 |
| Primary education | 54.3 | | 19.2 | | 17,290 | 64.3 |
| Secondary or higher | 42.9 | | 13.5 | | 5,678 | 21.1 |
| Maternal education | | | | | | |
| No education | 57.2 | <0.001 | 22.4 | <0.001 | 7,187 | 26.2 |
| Primary education | 52.4 | | 18.4 | | 17,680 | 64.5 |
| Secondary or higher | 37.4 | | 9.6 | | 2,559 | 9.3 |
| Wealth status | | | | | | |
| Poorest | 59.4 | <0.001 | 24.2 | <0.001 | 3,748 | 13.8 |
| Poorer | 56.3 | | 22.6 | | 6,086 | 22.4 |
| Middle | 53.1 | | 18.7 | | 6,133 | 22.5 |
| Richer | 51.7 | | 17.2 | | 6,436 | 23.7 |
| Richest | 40.9 | | 11.2 | | 4,811 | 17.7 |
| Total number of children ever born | | | | | | |
| 1 to 2 children | 50.9 | 0.05 | 18.4 | 0.05 | 9,501 | 34.6 |
| 3 to 4 children | 52.7 | | 17.8 | | 8,747 | 31.9 |
| 5 or more children | 53.0 | | 19.6 | | 9,178 | 33.5 |
| Number of children aged five or under | | | | | | |
| One child | 51.7 | 0.66 | 17.9 | 0.11 | 9,939 | 37.8 |
| Two children | 52.5 | | 18.7 | | 12,555 | 47.8 |
| Three or more children | 52.1 | | 19.9 | | 3,775 | 14.4 |

### 4.3.5 Results of multilevel logistic regression

The multilevel logistic regression results are given in Table 4.10 and they show that the odds of underweight and the odds of stunting are significantly lower in 2010 compared to 2000 and that the odds of underweight are also significantly lower in 2004 compared to 2010. The likelihood of underweight is 36% lower amongst children in the 2010 survey compared to children in the 2000 survey and 17% lower in the 2004 survey compared to children in the 2000 survey. The pooled data analysis results show significant interactions in the following variables; age and sex for both the underweight and stunting models, age and having a younger sibling in the stunting model and age and year of survey in the underweight model. Interactions between survey year and factors such as having diarrhoea, having fever and wealth status were not significant. The interaction between age, sex and year of survey is not significant but is left in the model to control for the fact that the association between age and sex and child's nutritional status is different across the three survey years as shown in exploratory analysis in Figure 4.16. Differences in predicted probabilities by age, year of interview, sex and whether the child had a young sibling or not, are discussed in section 4.3.5.1.

As expected most factors that emerged as significant in the analysis of determinants of child stunting and child underweight in section 4.2 are also significant in the pooled data set i.e. age, sex, having diarrhoea, size at birth, having a younger sibling, mother height, mother weight, household wealth status, region and residence. Having fever is also only significantly associated with underweight. The direction of the relationship between these factors and stunting and underweight is the same as that is reported in section 4.2.7. Interestingly, both partner education and mother education are significantly associated with a child's stunting status in the pooled data analysis whilst in the analysis of the determinants of child under-nutrition only partner education was significantly associated with underweight status. The odds of stunting are 18% lower amongst children whose fathers have secondary education compared to children whose fathers have no education and they are 17% lower amongst children whose mothers have secondary education compared to children whose mothers have no education. The variable on possession of a health card is not significant in the pooled data analysis but was significant in the analysis of determinants of stunting and underweight based on the 2004 DHS data.

Table 4.10 Multilevel logistic regression results for stunting and underweight for Malawian children (pooled data for 2000, 2004 and 2010 MDHS data sets)

| Variable | Odds ratio underweight | 99% confidence interval | Odds ratio stunted | 99% confidence interval |
|---|---|---|---|---|
| Year of Interview | | | | |
| 2004 | **0.83** | **(0.73,0.94)** | 1.03 | (0.93,1.15) |
| 2010 | **0.64** | **(0.55,0.75)** | **0.77** | **(0.68,0.87)** |
| Child characteristics | | | | |
| Female | **0.78** | **(0.71,0.86)** | **0.77** | **(0.71,0.84)** |
| Age | 1.04 | (0.93,1.17) | **1.71** | **(1.56,1.89)** |
| Age squared | **0.82** | **(0.76,0.99)** | **0.59** | **(0.56,0.63)** |
| Age*Sex | **1.20** | **(1.07,1.35)** | **1.21** | **(1.07,1.37)** |
| Age*2004 | **1.24** | **(1.07,1.44)** | 0.95 | (0.84,1.07) |
| Age*2010 | 1.03 | (0.83,1.27) | 0.96 | (0.82,1.11) |
| Age*Sex*2004 | 1.02 | (0.82,1.28) | 0.89 | (0.75,1.07) |
| Age*Sex*2010 | 1.22 | (0.90,1.66) | 0.86 | (0.69,1.07) |

Table 4.10 continued, Multilevel logistic regression results for stunting and underweight for Malawian children (pooled data for 2000, 2004 and 2010 MDHS data sets)

| Variable | Odds ratio underweight | 99% confidence interval | Odds ratio stunted | 99% confidence interval |
|---|---|---|---|---|
| Child characteristics | | | | |
| Age*Having a younger sibling | 1.15 | (0.91,1.46) | **1.26** | **(1.06,1.51)** |
| Has a younger sibling | **0.68** | **(0.54,0.86)** | **0.70** | **(0.59,0.84)** |
| Child had diarrhoea | **1.36** | **(1.20,1.53)** | **1.13** | **(1.02,1.26)** |
| Child had fever | **1.19** | **(1.07,1.32)** | 1.03 | (0.94,1.12) |
| | | | | |
| Preceding birth interval | | | | |
| First births | 0.97 | (0.85,1.11) | 1.03 | (0.92,1.14) |
| 37 to 60 months | **0.81** | **(0.73,0.91)** | **0.83** | **(0.76,0.91)** |
| | | | | |
| Size at birth: Reference is very large | | | | |
| Larger than average | 1.23 | (1.00,1.53) | 1.02 | (0.88,1.18) |
| Average | **1.54** | **(1.27,1.87)** | **1.19** | **(1.04,1.36)** |
| Smaller than average | **2.59** | **(2.08,3.22)** | **1.19** | **(1.04,1.36)** |
| Very Small | **3.21** | **(2.42,4.26)** | **1.57** | **(1.22,2.01)** |
| Mother and household characteristics | | | | |
| Mother’s height in kilograms | **0.99** | **(0.98,0.994)** | **0.96** | **(0.957,0.97)** |
| Mother’s weight in centimetres | **0.95** | **(0.94,0.956)** | **0.98** | **(0.976,0.986)** |
| | | | | |
| Household wealth status | | | | |
| Poorer | 0.93 | (0.79,1.09) | **0.86** | **(0.75,0.99)** |
| Middle | **0.80** | **(0.68,0.95)** | **0.78** | **(0.68,0.89)** |
| Richer | **0.76** | **(0.65,0.90)** | **0.74** | **(0.64,0.85)** |
| Richest | **0.57** | **(0.47,0.70)** | **0.56** | **(0.48,0.66)** |
| | | | | |
| Mother education level: Reference is no education | | | | |
| Primary education | 0.96 | (0.85,1.08) | 0.95 | (0.86,1.05) |
| Secondary education or higher | 0.84 | (0.65,1.09) | **0.82** | **(0.68,0.99)** |
| | | | | |
| Partner education level: Reference is no education | | | | |
| Primary education | 0.92 | (0.80,1.06) | 0.94 | (0.83,1.06) |
| Secondary education | 0.84 | (0.69,1.01) | **0.85** | **(0.73,0.99)** |

Table 4.10 continued, Multilevel logistic regression results for stunting and underweight for Malawian children (pooled data for 2000, 2004 and 2010 MDHS data sets)

| Variable | Odds ratio underweight | 99% confidence interval | Odds ratio stunted | 99% confidence interval |
|---|---|---|---|---|
| Location characteristics | | | | |
| Region | | | | |
| Central | 1.39 | (1.17,1.66) | **1.40** | **(1.22,1.60)** |
| Southern | 1.31 | (1.10,1.56) | 1.10 | (0.96,1.25) |
| | | | | |
| Residence | | | | |
| Rural | **1.57** | **(1.29,1.89)** | **1.51** | **(1.31,1.73)** |

#### 4.3.5.1 Predicted probabilities of underweight and of stunting by survey year, sex and whether or not the child has a younger sibling

The predicted probabilities of stunting and underweight are significantly lower in 2010 compared to 2000 as shown in Figure 4.21 and Figure 4.22 respectively. The difference in the predicted probabilities of stunting for the year 2004 and those of the year 2000 is not statistically significant. There are some similarities in how a child's under-nutrition is related to their age across the three interview years. Predicted probabilities for stunting shown in Figure 4.21 are increasing sharply in the first three years of life in all the three interview years and then declining after. Predicted probabilities for underweight given in Figure 4.22 however, show a sharp increase only in the first year of life in all the three years. Predicted probabilities of stunting therefore continue to rise with the age of child for a longer period than predicted probabilities of underweight do and also vary more across the age groups than predicted probabilities of underweight in all the three interview years.

Figure 4.21 Predicted probabilities of stunting for Malawian children by age and survey years

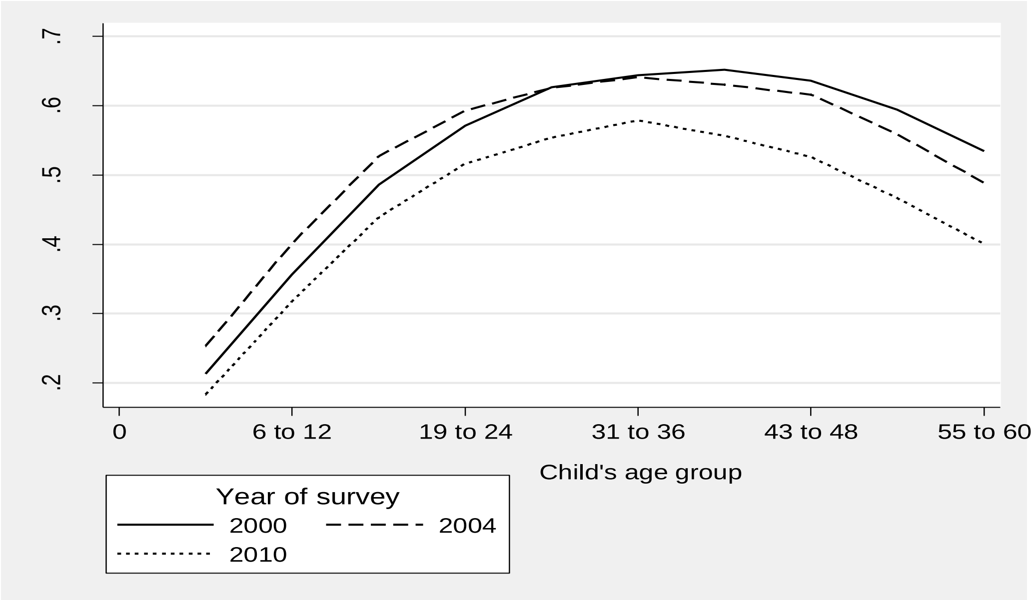
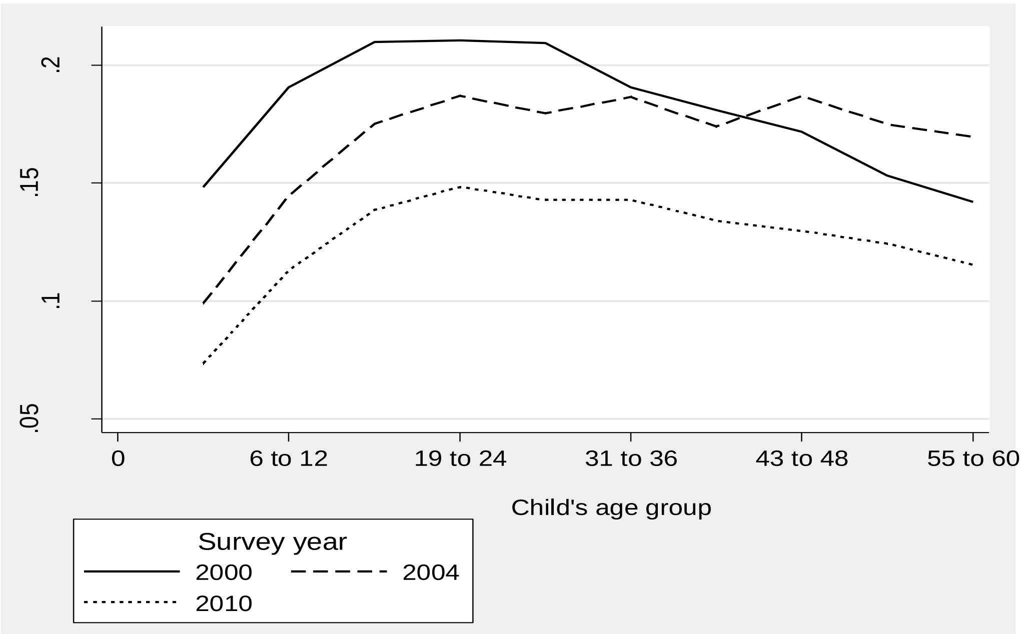



Figure 4.22 Predicted probabilities of underweight for Malawian children by age and survey year



Although female children have lower odds of being underweight and lower odds of being stunted compared to male children in general as shown in Figure 4.23 and Figure 4.24, the story is different amongst the older children especially in the case of underweight across the three survey years. Amongst children aged more than 36 months, predicted probabilities of underweight are either pretty similar for female and male children (year 2000) or higher for female children compared to male children in the years 2004 and 2010. The figure also illustrates that whilst male children's predicted probabilities of underweight are declining after the peak in all the three survey years, female children's predicted probabilities of underweight have an increasing trend throughout all the age groups in the years 2004 and 2010.This non decreasing trend of predicted probabilities of underweight amongst the older age groups of female children could be the explanation as to why the predicted probabilities of underweight are higher for female children compared to male children amongst children aged over three years in 2004 and 2010. On the other hand, the situation with stunting is different, the higher predicted probabilities for female children compared to male children amongst children aged over 36 months which exist in 2000 are not there in 2004 and 2010. The gap in predicted probabilities of stunting between male and female children across all ages appear to have grown wider in 2010.

Figure 4.23 Predicted probabilities of stunting for Malawian children by age, sex and survey year

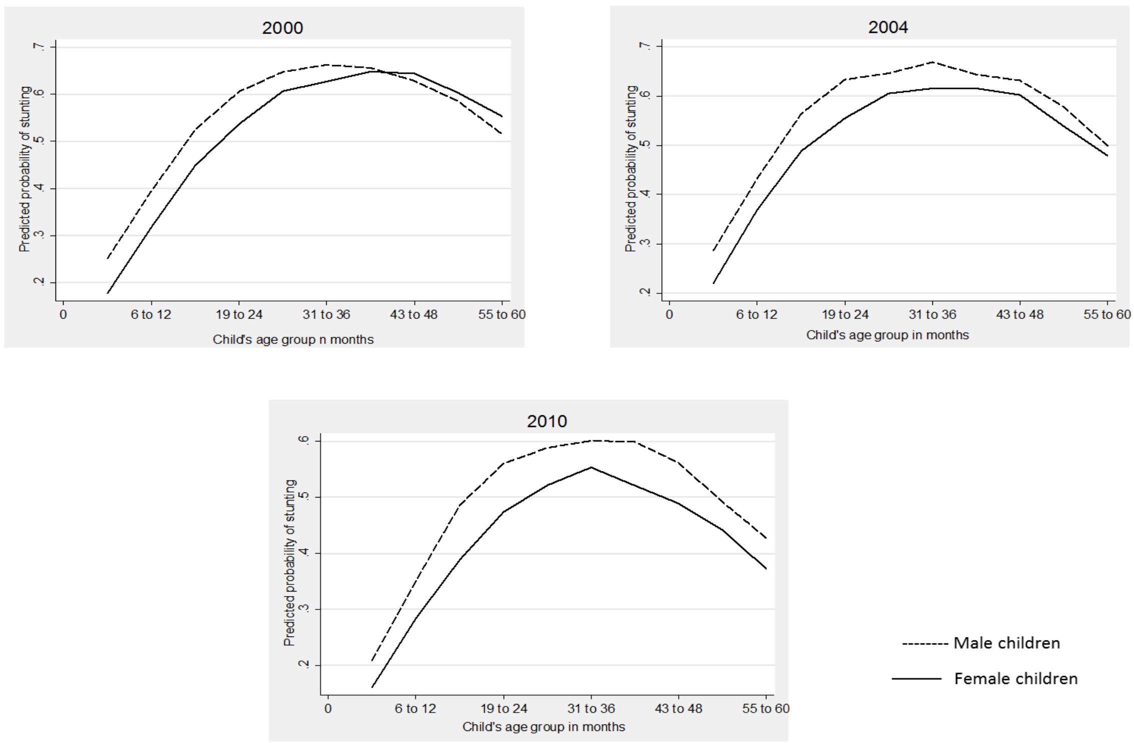
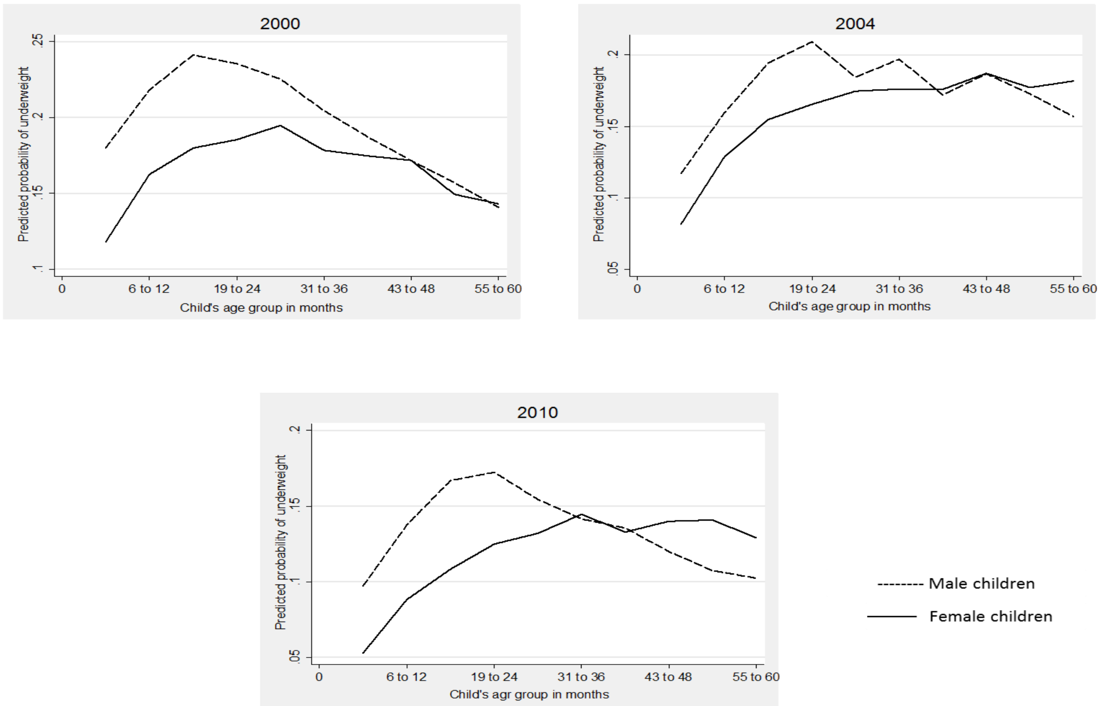
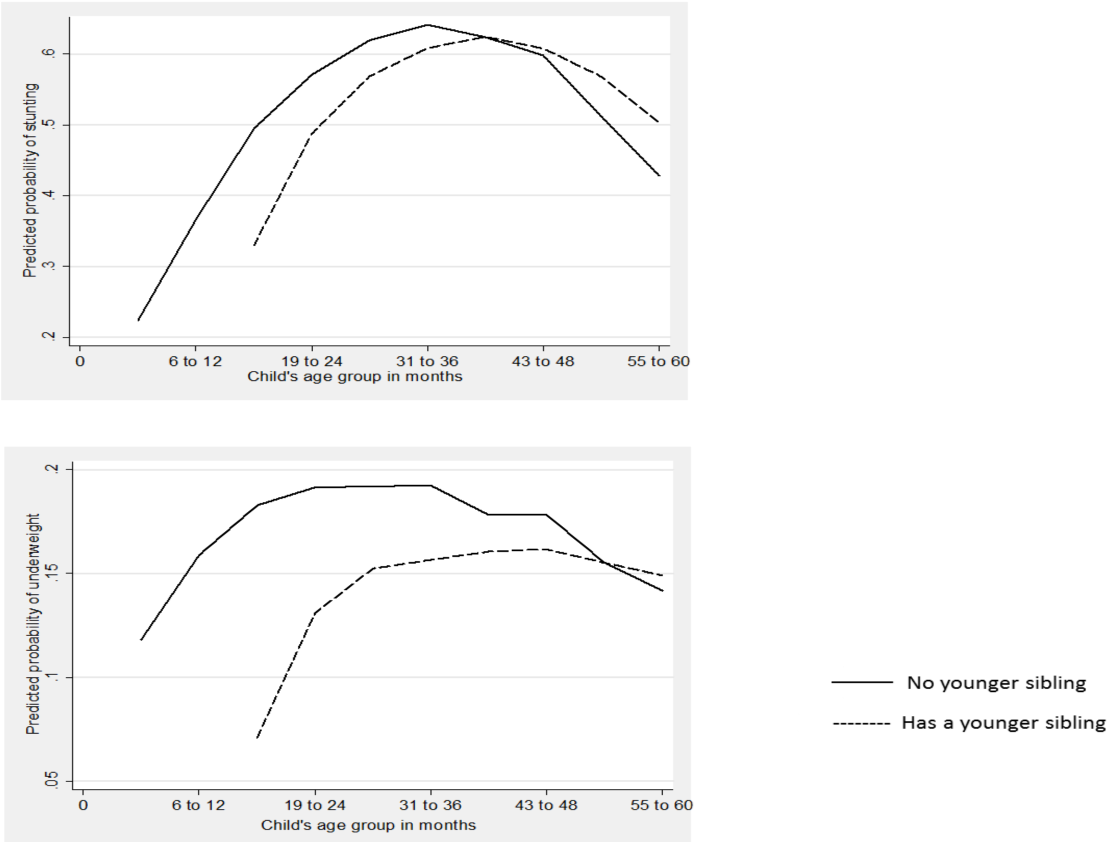


Figure 4.24 Predicted probabilities of underweight for Malawian children by age, sex and survey year




The relationship between having a younger sibling and a child's stunting status depends on the child's age as shown in Figure 4.25. For children aged three years or less, those without a younger sibling have a higher predicted probability of stunting compared to those with a younger sibling whilst for children aged three years or more, children with a younger sibling have lower predicted probability of stunting compared to children without a younger sibling.

Figure 4.25 Predicted probabilities of stunting and underweight by whether child has a younger sibling or not




There is a significant variation in the odds of a child being underweight and the odds of a child being stunted across communities (grouping of households) as shown in Table 4.12. The odds of stunting and underweight also vary significantly across households.

Table 4.11 Results of the random part of the models on underweight and stunting (pooled data set from 2000, 2004 and 2010)

| Level | Underweight Model Variance | Standard error | Stunting model variance | Standard error |
|---|---|---|---|---|
| Community | 0.098 | 0.023 | 0.075 | 0.016 |
| Household | 0.142 | 0.059 | 0.165 | 0.04 |

## 4.4 Discussion of findings

The analysis of levels of underweight and levels of stunting for Malawian children across the years 2000, 2004 and 2010 undertaken in this chapter, shows that the odds of stunting and the odds of underweight are significantly lower in 2010 compared to 2000 indicating an improvement in the nutritional status of children over the ten year period. Considering that there wasn't any significant interaction between the year of survey and the explanatory variables with the exception of age, it is reasonable to conclude that the reduction in under-nutrition rates across the three time points may be a result of a combination of several factors. The year 2010 has the lowest morbidity rates, the highest vaccination rates and the highest number of children that were exclusively breastfed compared to the other two years, all of which are very influential factors when it comes to a child's nutritional status and these factors could have contributed to the reduction in child under-nutrition rates. The analysis also shows that the percentage of households accessing safe water has gone up in 2010 whilst the percentage of households without a toilet facility has gone down. This finding signifies the importance of ensuring that all children receive immunisation, are exclusively breastfed, live in a safe and uncontaminated environment, which all together contribute to a better health and nutritional status of a child.

This analysis has also revealed that the majority of children that are underweight are also stunted but a bigger proportion of children that are stunted are not underweight or wasted. We also learn that the proportion of children that are stunted but not underweight or wasted has hardly changed between 2000 and 2010. Identification of groups of children that are stunted but not underweight or wasted could therefore be very crucial in tackling the problem of stunting in Malawi. It is possible that such children come from communities that consume diets lacking in micronutrients such as iron or zinc or perhaps live in environments infected with parasites such as bilharzia, schistosoma haematobium and mosquitoes. Interventions to tackle stunting in such a situation would therefore entail addressing specific needs for particular communities. It is often the case that nutrition interventions tend to be generic and may not address community specific needs. In such communities one would expected that that stunting may be passed from one generation to the other and could explain why a high proportion of children are stunted but not underweight or wasted. Maternal birth size was a significant predictor of child's birth size after adjusting for gestational age, sex of the child and other potential confounders in rural Guatemala (Ramakrishnan *et al.*, 1999). On the other hand Özaltin *et al.* (2010) found that in 54 low and middle income countries the risk of underweight and stunting was greatest for mothers shorter than 145cm.

The findings of this study are in line with findings from previous studies on the importance of child level factors such as age, sex, and size at birth, preceding birth interval, and child's health status in a child's nutritional status. The non-linear relationship between age of the child and a child's underweight status which we find in this study has been reported in other studies conducted in Malawi; (Griffiths *et al.*, 2004, Chirwa and Ngalawa, 2008, Madise *et al.*, 1999) whilst the non-linear relationship between age of child and their stunting is line with the findings of the study by Chirwa and Ngalawa (2008). The sharp rise in under-nutrition in the first year of life may be linked to the challenges of getting introduced to solid foods which may not be adequate to meet the nutritional demands of some children as children as shown in figures 4.18 to 4.20, but it is also the period when children become more mobile and are more likely to ill. The variation of under-nutrition by child's age is similar to how childhood diarrhoea varies across children's age, having sharp rises in the first year of life as reported in the study by Kandala *et al.* in Malawi (2006).

The higher likelihood of underweight and stunting amongst male children compared to female children has been reported by numerous studies previously, however, we learn from this study that the relationship between sex and child's nutritional status depends on the age of the child. Amongst children aged four years or over this difference either diminishes or reverses. The higher likelihood of underweight for female children compared to male children amongst children over three years of age is not there in 2000, smaller in 2004 and is biggest in 2010. This seems to suggest that the higher likelihood for underweight for female children amongst children aged over three years is a new phenomenon in Malawi. Previous studies have shown that in poor settings where female children are allocated less food compared to female children, female children have a higher likelihood of being undernourished (Frongillo and Bégin, 1993, Chen *et al.*, 1981, Ndiku *et al.*, 2011). It is not known if such practices exist or are emerging in Malawi.

Children of small size at birth are more likely to be underweight or stunted compared to those that were of larger size in support of previous findings in Malawi and from other settings (Griffiths *et al.*, 2004, Medhin *et al.*, 2010, Datar and Jacknowitz, 2009) and being ill with diarrhoea is associated with a higher likelihood of stunting and a higher likelihood of underweight(Madise *et al.*, 1999, Checkley *et al.*, 2008). This study also finds a significant association between having fever and a child's underweight status. Having fever is mostly associated with illness from malaria in Malawi although it is generally a symptom of being unwell.

A preceding birth interval of more than three years is associated with lower odds of stunting and lower odds of underweight compared to a preceding birth interval of 9 to 36 months in line with previous studies Madise and Mpoma (1997) David *et al.* (2004). Amongst children aged three years or less, those with a younger sibling have a lower likelihood of stunting compared to those that do not have a younger sibling, however, for children aged three years or more, those that have a younger sibling are more likely to be stunted compared to those without a younger sibling. It should be noted, however, that in this sample, children without a younger sibling are more likely to have an older sibling (81%) compared to those with a younger sibling (75%) p value <0.01 and as such the issue of siblings competing for scarce resources may be relevant to both those with a younger sibling and those without a younger sibling. However, these results appear to indicate that older children (over three years) are more likely to be neglected when they have a younger sibling than younger children (less than three years) with a younger sibling. These findings are in line findings of the study Madise and Mpoma(1997) conducted in Malawi.

Mother characteristics emerge to be very central in child's nutritional status. Mother's nutritional status is key to a child's nutritional status as seen by the significant association between a child's nutritional status and their mother's height and weight. The association between short maternal stature and stunting in children in Malawi has previously been reported(Espo *et al.*, 2002) and in 54 middle income countries (Özaltin *et al.*, 2010). This shows that poor nutrition status may be passed from one generation to another and therefore the eradication of child stunting and child underweight may take a long time to be fulfilled. Higher education level for the mother and father may contribute to better nutritional status of children through a combined effect of increasing child care knowledge as well as increasing their chances of getting a high earning job. Previous studies in Malawi have shown that children from households where the mother or female head of household was in a salaried employment had better nutritional status than children whose mother's weren't (Chirwa and Ngalawa, 2008) whilst the study by Abuya et *al.* (2010) in Kenya reports of a higher likelihood of immunisation amongst children of mothers with primary education compared to mothers who lack formal education. Similarly children from households that are wealthier are less likely to be stunted or underweight in line with previous studies (Janevic *et al.*, 2010, Hong and Mishra, 2006, Hong *et al.*, 2006). Considering that the wealth status variable used in this analysis is composed of environmental factors such as access to safe water and type of toilet, this finding also signifies the importance of access to safe water and good sanitation in ensuring better health and therefore better nutritional status for children. However in a way this is a limitation because it is not possible to provide clear possible recommendations as to the specific factors that may require intervention using this combined socio-economic status variable.

Location is another important factor in a child's nutritional status. Child under-nutrition varies significantly across the three regions, between urban and rural areas and across groupings of households in line with previous studies (Madise *et al.*, 1999, Chirwa and Ngalawa, 2008). The northern region has the lowest underweight and stunting rates whilst the central region has the highest stunting and underweight rates. Children from rural areas have a higher likelihood of being stunted and a higher likelihood of being underweight. These differences are probably due to the variation in the availability of services such as health clinics, schools, immunisation and access to safe water across different locations with mostly urban areas having better access than rural areas. Whilst such differences may in themselves have a direct role on a child's health and nutritional status, communities sharing a common environment such as customs and values of life, cultural practices, access to markets and types of food grown are also likely to have similar child care practices. The northern region has the highest percentage of mothers with primary education or higher (92%) the percentage for the central region is 72.8% and southern region is 70.5%. The northern region has the lowest percentage of children that reported to have had diarrhoea in the two weeks prior to the survey (12.9%). Figures for the central and southern region are 22.7% and 18.8% respectively. Educational level of the community is reported to have emerged as the strongest community level predictor children's height for age z scores in Bangladesh (Corsi *et al.*, 2011).

There is significant variation of stunting and underweight across households and across groupings of households (communities) in the pooled data set whilst the analysis based on the 2004 DHS data finds community level variance to be significant but not the household level variance. The higher household level variance compared to the community level variance found in the analysis of the pooled data is possibly as a result of greater variation in the households analysed. The multivariate analysis found that mother education and preceding birth interval are significant factors in the pooled data set but not in the 2004 DHS data. A higher clustering effect at household level compared to the community level has been reported in previous studies conducted in Malawi (Madise *et al.*, 1999, Griffiths *et al.*, 2004). Both the household and community level variance will be further explored in chapter 6 using different household and community level socio-economic factors. The next chapter explores the importance of household behavioural factors in a child's nutritional status.

# CHAPTER 5 : HOUSEHOLD BEHAVIOURAL FACTORS AND CHILD NUTRITIONAL STATUS IN MALAWI

## 5.1 Introduction

Factors such as nutrient intake, vaccination, morbidity, age and sex, are closely associated with a child's nutritional status as shown in the conceptual framework for nutritional status used in this study in Figure 2.3 of chapter 2. On the other hand household level factors such as education level of the mother and father and access to income play an important role of influencing appropriate nutrient intake, child immunisation and a child's health status. The findings from chapter four appear to suggest that the significant reduction in child underweight and child stunting between 2000 and 2010 could be as a result of reduction in child morbidity, increase in the number of children vaccinated and increase in the exclusively breastfed children. This chapter explores how household behavioural factors are associated with child's nutritional status by answering these two questions: is child immunisation and vitamin A supplementation associated with child under-nutrition in Malawi? what kind of feeding patterns are associated with better nutritional status for children in Malawi? The 2004 MDHS data set is used in this study.

## 5.2 Explanatory variables

Explanatory variables used in the analysis to answer the research questions described above are provided in Table 5.1 .

Table 5.1 Explanatory variables

| |
|---|
| Breastfeeding status is binary:<br>1 = breastfeeding<br>0 = not breastfeeding |
| Exclusive breastfeeding is binary and only applies to children aged six months or less:<br>1= child is exclusively breastfed<br>0= child is not exclusively breastfed |
| Times breastfed is binary<br>Children aged 6 months or less<br>1= child was breastfed 15 times or less<br>0 = child was breastfed 16 times or more<br>Children aged 7 to 18 months<br>1 = child was breastfed 13 times or less<br>0 = child was breastfed 14 times or more |
| Duration of breastfeeding is categorical for children aged 37 months or over<br>1 = One year or less<br>2= One to two years<br>3= Over two years |

Table 5.1 continued, Explanatory variables

| |
|---|
| Immunisation status is categorical<br>1 = Fully immunised<br>2 = At least one immunisation but not all<br>3 = No immunisation at all,<br>Only two categories are used in the multivariate analysis ( 1 and 2) |
| Feeding is categorical; for children aged 7 to 18 months<br>1 = Three food types<br>2 = One or two food types<br><br>For children aged 19 to 36 months<br>1= One or two food types only<br>2= Three food types<br>3= One or two food types and breast milk<br>4= Three food types and breast milk<br>5= Plain water or nothing |
| Consumption of a variety of food is continuous, obtained through a factor analysis of different foods consumed as described in section 5.4.2 |
| Number of times a child consumed food from animal sources, vitamin A rich foods, vitamin C rich foods, local grain and legumes is analysed using five variables relating to consumption of each type of food. The variables have three categories : 1= 0, 2 = Once, 3= Twice. Full description is given in section 5.4.2 |
| Receipt of vitamin A for children aged 6 months or more<br>1= a child received vitamin A in the last six months<br>0 = child did not receive vitamin A in the last six months |

## 5.3 The association between immunisation status and nutritional status for Malawian under-five children

Immunisations are important for improving children's immune status and ensuring better health. The Malawi Immunisation and Vitamin A supplementation schedule is shown in Table 5.2. With the exception of measles vaccination, all vaccinations are supposed to be given by the age of 14 weeks. By the age of 12 months, a child is expected to have received all the vaccinations. From the age of six months and every six months thereafter, children are given a vitamin A supplement. Table 5.3 shows the percentage of children vaccinated by the type of vaccine. The percentage of children vaccinated by the type of vaccine is quite impressive for most of the vaccines (77% and above), however less than half of the children have had Polio 0. This is pretty understandable considering that many babies are not born in hospitals in Malawi and that Polio 0 is only given up to two weeks from the time the baby is born. Excluding Polio 0, the estimate for children that are fully immunised is 68.6% as shown in Table 5.4. Just over a quarter of children aged between 12 and 59 months received at least one kind of vaccination but were not fully vaccinated.

Table 5.2 Malawi immunisation and vitamin A supplementation schedule (2004 MDHS data)

| Age | Vaccine |
|---|---|
| At birth or first contact | BCG |
| At birth up to two weeks | Polio 0 |
| At 6 weeks | Polio 1 and DPT+HebB+Hib 1 |
| At 10 weeks | Polio 2 and DPT+HepB+Hib 2 |
| At 14 weeks | Polio 3 and DPT+HebB+Hib 3 |
| At 10 months | Measles |
| At 6 months and every 6 months up to 59 months | Vitamin A |

Source : Malawi Immunisation Programme, Financial Sustainability Plan (2003)
http://www.gavialliance.org/resources/fsp_jan04_malawi.pdf

Table 5.3 Percentage of children vaccinated by vaccine type for under-five Malawian children aged 12 to 59 months (2004 MDHS data)

| Type of Vaccine | Percentage Vaccinated |
|---|---|
| BCG | 93.1 |
| Polio 0 | 39.5 |
| DPT1 | 94.6 |
| DPT2 | 91.0 |
| DPT3 | 84.0 |
| Polio1 | 94.5 |
| Polio2 | 90.5 |
| Polio3 | 77.2 |
| Measles | 86.3 |
| Vitamin A in the last six months | 65.6 |

Table 5.4 Full vaccination status for under-five Malawian children aged 12 to 59 months (2004 MDHS data)

| Vaccination status | Frequency | Percentage Vaccinated |
|---|---|---|
| None at all | 305 | 4.6 |
| Fully vaccinated | 4,926 | 68.6 |
| Some vaccinations but not a full set | 1,924 | 26.8 |
| Total | 7,155 | 100 |

The relationship between stunting, underweight and a child's immunisation status for children aged between 12 and 59 months is shown in Table 5.5. The percentage of children stunted and underweight is lowest amongst children that are fully immunised compared to those that are not fully immunised and those that had not had any immunisation at all. However, it is only a child's underweight status that is significantly associated with a child's immunisation status. Children that have not had any immunisation at all record the highest underweight rates.

Table 5.5 Percentage of children underweight and percentage stunted by Immunisation status for Malawian children aged 12 to 59 months (2004 MDHS data)

| Immunisation status | Count | % Stunted | Chi Square P value | Count | % Underweight | Chi Square P value |
|---|---|---|---|---|---|---|
| Fully immunised | 4316 | 58.5 | 0.263 | 4533 | 18.2 | **<0.001** |
| At least one | 1593 | 61.3 | | 1700 | 21.7 | |
| None | 264 | 60.2 | | 282 | 27.7 | |

The association between the percentage of children stunted and the percentage of children underweight and receiving vitamin A in the last six months amongst different age groups is shown in Table 5.6. Receiving vitamin A supplement appears not to have a significant effect on the likelihood of stunting amongst children of all age groups but amongst children aged 7 to 18 months there is a significant association between receiving vitamin A and a child's underweight status. The percentage of children that are underweight is lower amongst children that received vitamin A in the last six months compared those that did not receive vitamin A in the last six months.

Table 5.6 Percentage of children underweight and percentage stunted by whether the child received vitamin A or not for children aged between 6 and 59 months (2004 MDHS data)

| Child's age in months | Vitamin A | % Stunted | Chi square p value | % underweight | Chi square p value | Count |
|---|---|---|---|---|---|---|
| 7 to 18 | Received | 50.7 | 0.20 | 17.7 | **<0.001** | 1,737 |
| | Did not receive | 47.1 | | 26.2 | | 630 |
| 19 to 36 | Received | 61.6 | 0.14 | 19.5 | 0.38 | 1,995 |
| | Did not receive | 65.5 | | 21.4 | | 696 |
| 37 to 60 | Received | 58.7 | 0.23 | 19.1 | 0.30 | 1,613 |
| | Did not receive | 56.3 | | 17.2 | | 1,189 |

The association between a child's immunisation status and their underweight status is further explored in a multivariate analysis controlling for other factors as shown in Table 5.7. There is no significant association between child's immunisation status and their stunting and underweight status. The variable on child immunisation status used has two categories only (those that were fully immunised and those that were partially immunised) this is because only 4.6% of the children had no immunisation at all. Using the immunisation variable that includes children with no immunisation at all produces similar results. Factors that are significantly associated with stunting amongst these children are sex, size at birth, preceding birth interval, breastfeeding status, mother's weight, mother's height, household wealth status, residence and ethnicity. Significant factors in the underweight model are age, size at birth, having diarrhoea, having fever, having a younger sibling, breastfeeding status, household wealth status, mother's weight, and ethnicity.

Table 5.7 Multivariate analysis results for stunting and underweight for children aged 12 to 59 months (2004 MDHS data)

| Variable | Odds ratio underweight | 95% confidence interval | Odds ratio stunting | 95% confidence interval |
|---|---|---|---|---|
| Child characteristics | | | | |
| Age | **1.03** | **(1.02,1.04)** | 1.01 | (1.00,1.02) |
| Female | 0.94 | (0.79,1.11) | **0.70** | **(0.71,0.91)** |
| Size at birth: reference is very large | | | | |
| Larger than average | **1.43** | **(1.02,2.00)** | 1.05 | (0.82,1.33) |
| Average | **1.70** | **(1.24,2.32)** | 1.12 | (0.89,1.41) |
| Smaller than average | **2.86** | **(1.97,4.13)** | **1.50** | **(1.12,2.00)** |
| Very small | **3.53** | **(2.07,6.03)** | 1.45 | (0.95,2.21) |
| Had diarrhoea | **1.48** | **(1.20,1.81)** | 1.01 | (0.86,1.20) |
| Had fever | **1.22** | **(1.02,1.46)** | 1.11 | (0.96,1.27) |
| Has a health card | 0.82 | (0.63,1.07) | 1.14 | (0.93,1.40) |
| Preceding birth interval : reference is First births | | | | |
| 9 to 36 months | 1.18 | (0.93,1.48) | 1.06 | (0.88,1.27) |
| 37 months or more | 1.06 | (0.82,1.36) | **0.81** | **(0.67,0.98)** |
| Has a younger sibling | **0.73** | **(0.58,0.92)** | 0.85 | (0.72,1.01) |
| Child's vaccination status: reference is fully vaccinated | | | | |
| Partially vaccinated | 1.05 | (0.86,1.27) | 1.03 | (0.89,1.20) |
| Still breastfeeding | **1.64** | **(1.25,2.17)** | **1.33** | **(1.08,1.63)** |

Table 5.7 continued, Multivariate analysis results for stunting and underweight for children aged 12 to 59 months (2004 MDHS data)

| | Odds ratio underweight | 95% confidence interval | Odds ratio stunting | 95% confidence interval |
|---|---|---|---|---|
| **Household characteristics** | | | | |
| Mother education: reference is no education | | | | |
| Primary education | 0.97 | (0.79,1.19) | 1.11 | (0.95,1.31) |
| Secondary education | 0.83 | (0.56,1.24) | 0.88 | (0.66,1.18) |
| Wealth status: reference is poorest | | | | |
| Poorer | 0.87 | (0.67,1.14) | 0.85 | (0.68,1.07) |
| Average | **0.69** | **(0.54,0.89)** | **0.77** | **(0.61,0.95)** |
| Rich | 0.82 | (0.63,1.06) | 0.92 | (0.73,1.14) |
| Richest | **0.48** | **(0.36,0.65)** | **0.53** | **(0.42,0.67)** |
| Partner education: reference is no education | | | | |
| Primary education | 0.87 | (0.70,1.10) | 1.07 | (0.88,1.30) |
| Secondary education | 0.87 | (0.64,1.18) | 0.89 | (0.70,1.14) |
| Mother's height in centimetres | 0.98 | (0.96,1.00) | **0.97** | **(0.96,0.98)** |
| Mother’s weight in kilograms | **0.95** | **(0.94,0.97)** | **0.98** | **(0.97,0.99)** |
| **Location characteristics** | | | | |
| Rural | 1.34 | (0.96,1.88) | **1.61** | **(1.28,2.01)** |
| Region: Reference is Northern region | | | | |
| Central | 0.82 | (0.57,1.17) | 1.22 | (0.92,1.62) |
| Southern | 1.09 | (0.75,1.57) | 1.07 | (0.81,1.43) |
| Ethnicity: Reference is Chewa | | | | |
| Tumbuka, Tonga and Nkhonde | 0.79 | (0.54, 1.15) | 0.79 | (0.60,1.06) |
| Lomwe | 0.87 | (0.65, 1.17) | **0.70** | **(0.55,0.90)** |
| Ngoni | 1.01 | (0.73,1.41) | 0.87 | (0.69,1.10) |
| Yao | **0.70** | **(0.51,0.94)** | **0.75** | **(0.59,0.96)** |
| Sena and others | 0.93 | (0.67,1.29) | **0.76** | **(0.59,0.99)** |

## 5.4 Feeding and child’s nutritional status in Malawi

To assess the relationship between feeding and a child’s nutritional status, analysis of the association between what a child consumed in the last 24 hours and a child’s nutritional status is made. The analysis is based on variables on the number of times a child was fed a particular food. This is the only information available on consumption by the child. Consumption in the last 24 hours may not have a direct bearing on a child’s current weight or height, however, it could be a fair indicator of routine consumption within the household. The analysis is done by age groups, considering that child nutritional status varies by age as shown in chapter 4 and that the WHO feeding recommendations are different for children in different age groups. The WHO recommends that children should be exclusively breastfed in the first six months of life, and should be introduced to complementary foods 2 to 3 times a day at the age of six months whilst continuing to be breastfed regularly. The food should be nutritious similar to breast milk, rich in protein, energy and micronutrients such as vitamin A, zinc, calcium, iron and folate. The frequency and amount of food should be increased as the child grows older to 3 to 4 times a day for babies aged 9 to 11 months and five times for babies aged 12 months (WHO-FAO, 2002).

### 5.4.1 Breastfeeding analysis

All children aged between 0 to 18 months are breastfeeding whilst for children aged 19 months or more, some children have stopped breastfeeding. For this reason, breastfeeding analysis is undertaken in the following way across the different age groups: for children aged 6 months or less and those aged between 7 to 18 months, the relationship between the number of times a child is breastfed and stunting as well as underweight is explored. The number of times a child was breastfed is used to proxy quantity of milk consumed. For children aged 6 months or less, analysis is also made to see if there is a significant difference in the likelihood of stunting and underweight between children that are exclusively breastfed and those that are not exclusively breastfed. Exclusively breastfed children are children under the age of six months that are still breastfeeding who were not fed any other food or liquid in the last 24 hours.

Amongst children aged 19 to 36 months, since there is a good variation between those that are still breastfeeding and those that are not breastfeeding, the relationship between breastfeeding status (still breastfeeding or not) and stunting as well as underweight is analysed. For children aged 37 months and above, nearly all children are no longer breastfeeding therefore the association between the duration of breastfeeding (how long they were breastfed for) and their stunting and underweight status is analysed. The results of breastfeeding analysis are shown in Table 5.8.

Amongst children aged 6 months or less, the results show that there is no significant difference in the likelihood of stunting and the likelihood of underweight between children that were exclusively breastfed and those that were not exclusively breastfed. Similarly, there is no significant variation in the likelihood of stunting between children that were breastfed 15 times or less and those that were breastfed 16 times or more but the number of times that a child is breastfed is significantly associated with underweight (P value 0.01), children that were breastfed 16 times or more are more likely to be underweight compared to those that were breastfed 15 times or less. Considering that the number of times a child is breastfed could be associated with whether a child is ill or not, variables on whether the child was ill or not in the last two weeks are cross tabulated with the variable on number of times a child is breastfed. The chi square statistic is not significant for variables ‘Child had a cough’ and ‘Child had fever’ but is significant for the variable ‘Child had diarrhoea’. However, more children that had diarrhoea (65.9%) were breastfed fifteen times or less although the difference is not statistically significant.

The number of times a child is breastfed is also not an important factor in both stunting and underweight for children aged 7 to 18 months. However, breastfeeding status is a highly significant factor in both stunting and underweight for children aged between 19 to 36 months. Children that are still breast feeding are more likely to be stunted or underweight compared to children that are not breastfeeding. Slightly more male children are still breastfeeding in this age group but the difference is not statistically significant (36.45% versus 33.3%) p value 0.084. For children aged 37 months or over, duration of breastfeeding is a significant factor only for stunting and not for underweight, children that were breastfed between one to two years are less likely to be stunted compared to those that were breastfed for one year or less and those that were breastfed for more than two years. Children that are still breast feeding are filtered out for the analysis of children aged 37 months or over.

As far as consumption of food other than breast milk in the first three days (before milk began to flow) after birth, 92.7% of children were reported to have been given nothing apart from breast milk.

Table 5.8 Association between breastfeeding and child's stunting and underweight status (2004 MDHS data)

| Age of child in months | Breastfeeding Variable | % Stunted | Chi Square P Value | % Underweight | Chi Square P value | Count |
|---|---|---|---|---|---|---|
| =< 6 | Exclusively breastfed | 22.80 | 0.92 | 8.10 | 0.15 | 617 |
| | Not exclusively breastfed | 23.30 | | 11.20 | | 710 |
| | Number of times breastfed | | | | | |
| | Fifteen times or less | 24.40 | 0.31 | 7.80 | **0.01** | 833 |
| | Sixteen times or more | 21.10 | | 13.0 | | 481 |
| 7 to 18 | Number of times breastfed | | | | | |
| | Fifteen times or less | 49.4 | 0.42 | 20.20 | 0.901 | 1,575 |
| | Sixteen times or more | 51.9 | | 20.40 | | 717 |
| 19 to 36 | Still breastfeeding | 71.4 | **<0.001** | 27.9 | **<0.001** | 927 |
| | Not breastfeeding | 57.8 | | 15.6 | | 1,769 |
| >= 37 | Duration of breastfeeding | | | | | |
| | =< One year | 57.3 | **0.04** | 22.9 | 0.34 | 331 |
| | > One year or < two years | 55.4 | | 18.4 | | 1,868 |
| | Over two years | 62.1 | | 19.5 | | 928 |

### 5.4.2 Food consumption analysis

The association between food consumption and child nutritional status excludes children in the age group 6 months or less who are not expected to be fed food and those aged over 36 months due to missing data (over 36%) and is therefore only done for children aged 7 to 18 months and 19 to 36. The analysis is done in three ways:

(i) Analysing the relationship between consumption of a variety of foods and stunting and underweight. The feeding variable used in this analysis is based on undertaking a principle component analysis of the different foods that a child could have or have not consumed in the last 24 hours. The following food items were entered for factor analysis: animal milk, fruits, vegetables, legumes, local grain, mango, papaya, meat, fish, poultry, roots or tubers. The results of the principle component analysis showed that the first component had positive loadings on all food items indicating that a higher factor score is associated with a high consumption of a variety of foods. The first component is used in this analysis and is named as the 'diversity score'. The association between the diversity score and stunting and underweight are shown in Figure 5.1 and Figure 5.2

(ii) Number of times a child consumed a particular food type is analysed to assess the importance of consuming particular foods to a child's nutritional status. The food types are identified as to whether they are of animal origin (rich in protein, iron and zinc), Vitamin A rich, Vitamin C rich, Carbohydrates ( local grain) or Legumes as shown in Table 5.9.

Table 5.9 Food types

| Animal sources | Vitamin A | Vitamin C | Carbohydrates (Local grain) | Legumes |
|---|---|---|---|---|
| Meat<br>Fish<br>Poultry<br>Eggs | Mango<br>Papaya | Green leafy vegetables | Maize<br>Nsima[6]<br>Rice<br>Cassava | Beans<br>Peas<br>Groundnuts |

(iii) Analysis is also made of the association between the number of food groups consumed, whether they were breastfed or not and child's stunting and underweight status. This method explores the association between all consumption (breastfeeding and food consumption) that the child had in the last 24 hours prior to interviews being conducted. The food groups analysed are those commonly used in nutrition in terms of the major nutrients available in the food i.e. protein (meats and legumes), vitamins (fruits and vegetables) and energy giving/carbohydrates (local grain, oils, butter, sugary drinks) (Smolin and Grosvenor, 2003). If a child consumed one of the foods from each of the three food groups then they are identified to have consumed three food groups. Examples of the three food groupings analysed are shown in Table 5.10. The analysis on children aged 7 to 18 children is based on 96.2% of children who are all still breastfeeding and therefore the feeding variable has the following categories:

(a) child consumed one or two food types
(b) child consumed all three food types

[6] Nsima is Malawi's staple food cooked using maize/corn flour

For children aged 19 to 36 months there is a bigger variation on what the child was fed in the last 24 hours and therefore the feeding variable has five categories:

(a) child consumed one or two food types only

(b) child consumed three food types only

(c) child consumed one or two food types and breast milk

(d) child consumed three food groups and breast milk

(e) Child had plain water or nothing

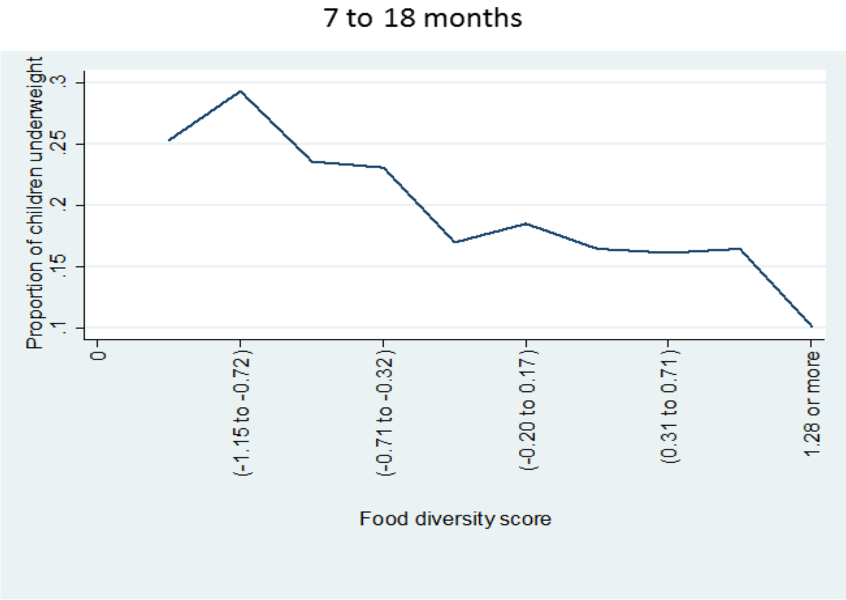
Table 5.10 Three food groups analysed

| Protein foods | Energy giving/Carbohydrates foods | Vitamin rich foods |
|---|---|---|
| Meat | Local grain | Green leafy vegetables |
| Fish | Bread | Mango |
| Poultry | Butter | Papaya |
| Eggs | Oil | Fruit juice |
| Legumes | Sugary drinks | Vegetables |
| Cheese | | Roots |
| Yoghurt | | Tubers |
| Milk | | |
| Baby formula | | |

### 5.4.3 Association between consumption of a variety of food and child nutritional status for Malawian children

Exploratory analysis of the association between consumption of a variety of food and a child's underweight and stunting status by age group is shown in Figure 5.1 and Figure 5.2 respectively. Generally, it is amongst children aged 7 to 18 months that there appears to be a negative linear relationship between consumption of a variety of food and their underweight status and that amongst children aged 19 to 36 months there appears a negative curve linear relationship between consumption of a variety of food and a child's stunting status.

Figure 5.1 Child's underweight and food diversity score by age group (2004 MDHS data)



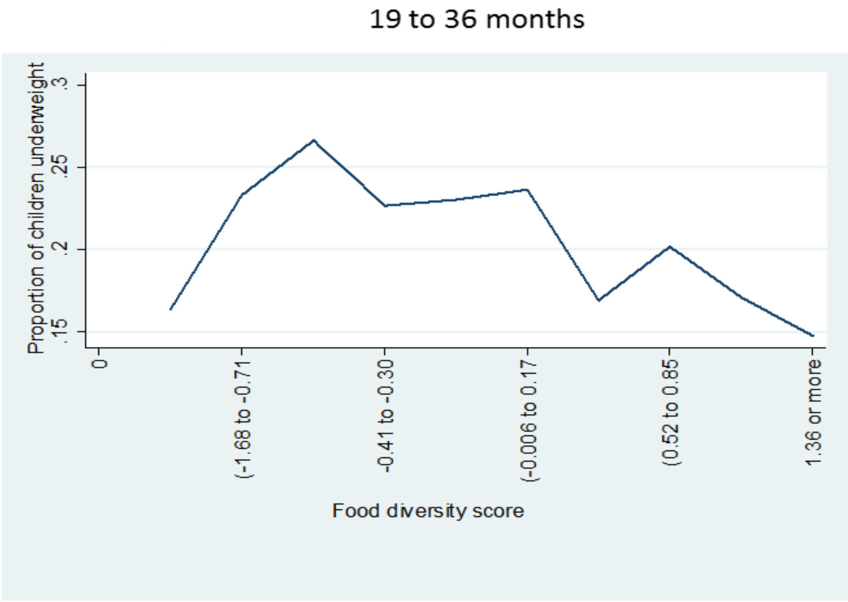
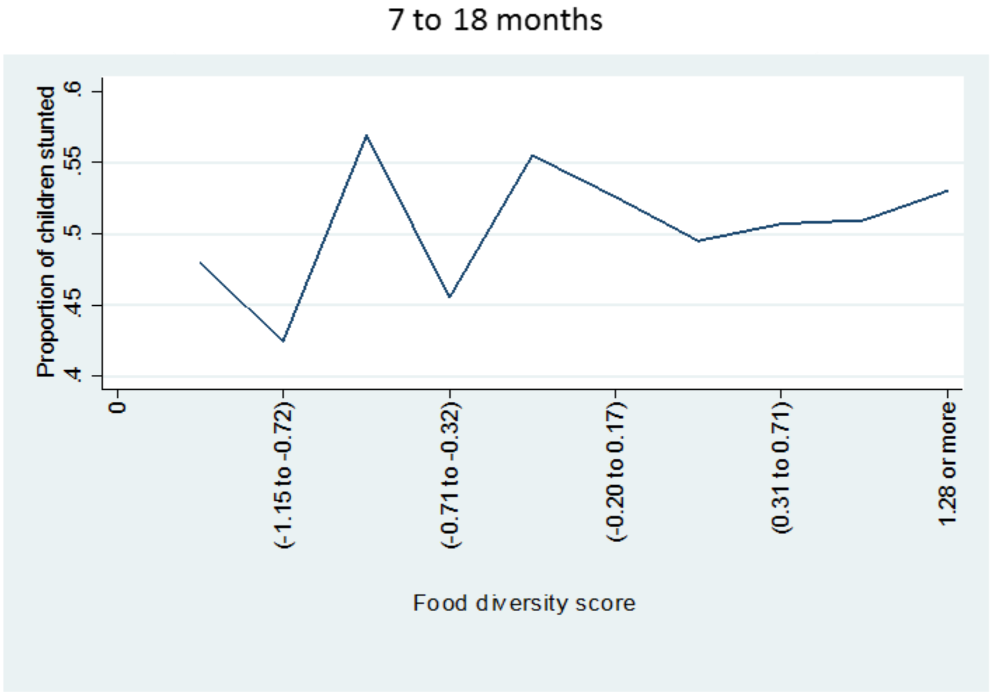
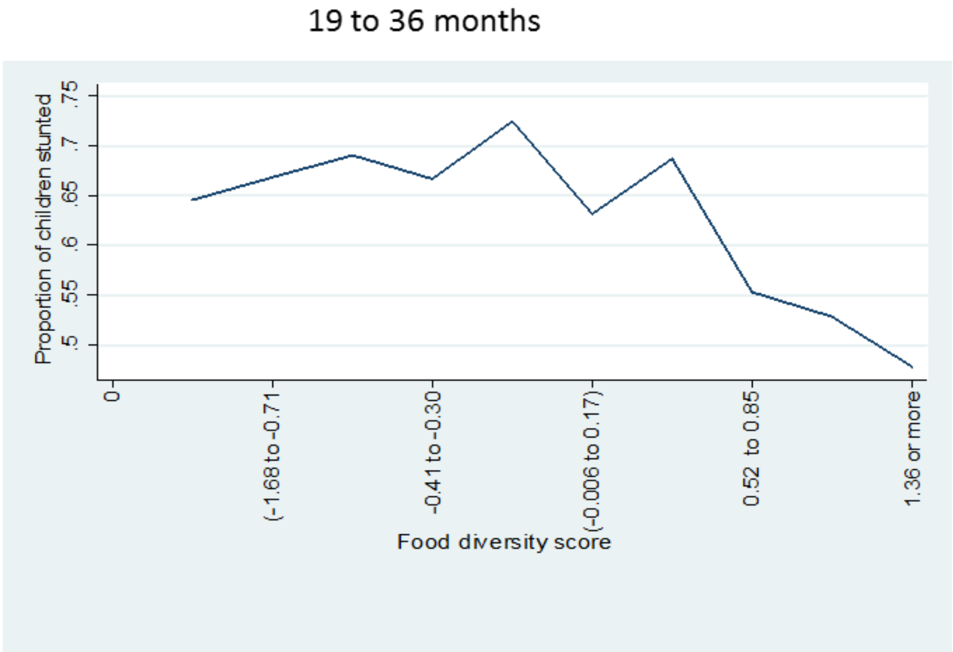



Figure 5.2 Child's stunting and food diversity score by age group (2004 MDHS data)



### 5.4.4 Association between the number of times a particular food was consumed and stunting and underweight status for Malawian children

Results of a chi square analysis for the association between stunting and underweight and the number of times a child consumed a particular food for children aged 7 to 18 months and those aged 19 to 36 months are shown in Tables 5.11 and 5.12 respectively. For children aged 7 to 18 months, the proportion of children underweight is significantly lower amongst those who consumed two foods from animal sources, mango/papaya or green leafy vegetables in the 24 hours prior to interviews being conducted compared to those that consumed these foods once or those that did not consume any at all, whilst for children aged 19 to 36 months, both the proportion underweight and the proportion stunted is lowest amongst children who consumed twice food from animal sources in the 24 hours before their mothers were interviewed compared to those that consumed them only once or those that did not consume any at all.

Table 5.11 Association between the number of times a child consumed a particular food and underweight and stunting for children aged 7 to 18 months (2004 MDHS data)

| Type of food eaten | Number of times food was consumed | % underweight | Chi square p value | % Stunted | Chi square p value | Count | % |
|---|---|---|---|---|---|---|---|
| Local grain | 0 | 22.1 | 0.59 | 45.1 | **0.03** | 274 | 11.6 |
| | 1 | 22.6 | | 43.7 | | 361 | 15.3 |
| | 2 | 19.9 | | 51.8 | | 1,732 | 73.2 |
| Food from animal sources | 0 | 23.0 | **<0.01** | 48.9 | 0.12 | 1,488 | 62.9 |
| | 1 | 19.4 | | 54.8 | | 479 | 20.2 |
| | 2 | 13.3 | | 46.5 | | 400 | 16.9 |
| Mango/papaya | 0 | 23.0 | **<0.01** | 49.1 | 0.78 | 1,409 | 59.5 |
| | 1 | 19.4 | | 49.7 | | 525 | 22.2 |
| | 2 | 14.3 | | 51.5 | | 433 | 18.3 |
| Green leafy vegetables | 0 | 24.2 | **0.014** | 46.5 | 0.13 | 902 | 38.1 |
| | 1 | 20.1 | | 50.6 | | 625 | 26.4 |
| | 2 | 17.1 | | 52.3 | | 840 | 35.5 |
| Legumes | 0 | 21.8 | 0.18 | 49.0 | 0.47 | 1,655 | 69.9 |
| | 1 | 17.0 | | 49.4 | | 471 | 19.9 |
| | 2 | 19.8 | | 54.1 | | 241 | 10.2 |

Table 5.12 Association between number of times a child consumed a particular food and underweight and stunting for children aged 19 to 36 months (2004 MDHS data)

| Type of food eaten | Number of times food was consumed | % Underweight | Chi square p value | % Stunted | Chi square p value | Count | % |
|---|---|---|---|---|---|---|---|
| Local grain | 0 | 17.2 | 0.09 | 63.6 | 0.510 | 385 | 14.8 |
| | 1 | 25.6 | | 66.5 | | 239 | 9.2 |
| | 2 | 20.0 | | 61.9 | | 1,970 | 75.9 |
| Food from animal sources | 0 | 21.5 | **0.019** | 65.4 | **<0.01** | 1,501 | 57.9 |
| | 1 | 21.5 | | 61.2 | | 570 | 30.0 |
| | 2 | 14.6 | | 55.7 | | 523 | 20.2 |
| Mango/papaya | 0 | 20.7 | 0.45 | 64.2 | 0.08 | 1,320 | 50.9 |
| | 1 | 21.2 | | 63.7 | | 576 | 22.2 |
| | 2 | 18.1 | | 58.5 | | 698 | 26.9 |
| Green leafy vegetables | 0 | 20.6 | 0.20 | 62.4 | 0.23 | 918 | 35.4 |
| | 1 | 22.6 | | 59.2 | | 603 | 23.2 |
| | 2 | 18.4 | | 64.4 | | 1,073 | 41.4 |
| Legumes | 0 | 21.4 | 0.07 | 63.2 | 0.28 | 1,721 | 66.3 |
| | 1 | 15.4 | | 58.7 | | 518 | 20.0 |
| | 2 | 20.8 | | 64.6 | | 355 | 13.7 |

### 5.4.5 Association between the number of food groups consumed, breastfeeding and child's nutritional status for Malawian children

Results of the analysis of the association between stunting and underweight and number of food groups a child consumed in the last 24 hours as well as their breastfeeding prior to their mother being interviewed as per the method described in part (iii) of section 5.3.2 are shown in Table 5.13. For children aged 7 to 18 months, the results show that the percentage of children that are underweight are significantly lower amongst children that consumed three food groups compared to those that consumed one or two food groups. However, there is no significant association between the number of food groups that a child consumed and their stunting status.

For children aged between 19 to 36 months there is a significant association between food consumption and a child's stunting and underweight status. Children that had three food types and no breast milk have the lowest levels of stunting and underweight whilst children that had one or two food types with breast milk have the highest levels of stunting and underweight.

One interesting finding is that the percentage of children stunted and those that are underweight is higher amongst children that had three food groups and breast milk compared to those that had three food groups only. This perhaps suggests that children who are breastfeeding in this age group may not be consuming adequate amounts of food. On the other hand, the percentage of children stunted and those underweight is much lower amongst children that had nothing or plain water only. It should be noted, however, that 80% of children that are in this category are aged over two years. Considering that at this age, children are more mobile, it is possible that the consumption information of these children is not accurate.

Table 5.13 Percentage of children underweight and percentage stunted by age group and feeding type (2004 MDHS data)

| Age of child in months | Feeding variable | % Stunted | Chi square P value | % Underweight | Chi square P value | Count | % |
|---|---|---|---|---|---|---|---|
| 7 to 18 | Three food groups | 51.2 | 0.52 | 18.1 | **0.01** | 1,148 | 50.4 |
| | One or two food groups | 49.3 | | 23.4 | | 1,128 | 49.6 |
| 19 to 36 | Three food types only | **54.0** | <0.001 | 14.1 | **<0.001** | 891 | 34.7 |
| | One or two food types only | 62.7 | | 18.5 | | 512 | 20.0 |
| | Three food types and breast milk | 68.0 | | 25.5 | | 566 | 22.1 |
| | One or two food types and breast milk | 75.7 | | 31.4 | | 339 | 13.2 |
| | Nothing or plain water | 59.9 | | 14.8 | | 258 | 10.1 |

## 5.5 Age-group specific multivariate analysis

Age-group specific multivariate analysis is undertaken for the age groups; six months or less, seven to eighteen months and nineteen to thirty six months to analyse the importance of feeding and other factors to a child's stunting and underweight status. The feeding variables included in the multivariate analysis are based on the variables described in part (i) and (ii) of section 5.4.2. Multivariate analysis was also undertaken based on the variables described in part (iii) of section 5.4.2, however these were not significant. The results of this modelling are therefore not presented. The results of the multivariate analysis for each age group are shown in Table 5.14 for the underweight model and in Table 5.15 for the stunting model. Table 5.16 presents results of the random parts of the underweight model for children aged less than 6 months or less and the stunting model for children aged 19 to 36 months where the community variance was significant. The variance across communities for underweight amongst children aged 6 months is 1.56 (0.52,4.69), whilst the variance across communities for stunting amongst children aged 19 to 36 months is 0.15 (0.05,0.44). As such there is greater variation of underweight across communities in children aged 6 months or less compared to the variation in stunting amongst children aged 19 to 36 months. The results for these two models are therefore community specific.

In the age group 6 months or less, the variable on number of times a child was breastfed is significantly associated with a child's underweight status. Children that were breastfed 16 times or more are more likely to be underweight compared to children that were breastfed 15 times or less. The variables on consumption of a variety of foods and number of times a child was given food from animal sources are significantly associated with a child's underweight status in the age group 7 to 18 months and a child's stunting status in the age group 19 to 36 months. An increase in the food diversity score by one unit is associated with a reduction of the odds of underweight by 21% amongst children aged 7 to 18 months and a reduction in the odds of stunting by 14% amongst children aged 19 to 36 months. There is a big difference in the odds of underweight amongst children that consumed food from animal sources twice in 24 hours prior to interviews compared to those that did not consume any food from animal sources amongst those aged 7 to 18 months. The odds of underweight are 47% lower amongst children that consumed food from animal sources twice in the last 24 hours compared to those that did not consume food from animal sources. Amongst children aged 19 to 36 months, the odds of stunting are 23% lower for children that consumed food from animal sources twice in the last 24 hours compared to those that did not consume food from animal sources.

Possession of a child health card is only significantly associated with a child's underweight status amongst those aged 7 to 18 months and those aged 19 to 36 months. Children whose mothers have a child health card are less likely to be underweight. Similarly, having diarrhoea is only a significant factor for underweight amongst children aged 7 to 18 months and those aged 19 to 36 months and for stunting amongst children aged 19 to 36 months. It should be noted however that although having diarrhoea is not significantly associated with a child's underweight status amongst children aged six months or less, the odds of underweight are lower amongst children that had diarrhoea. On the other hand mother's weight is significantly associated with child's underweight status across all age groups, and mother's height is significantly associated with child's stunting status across all age groups. An increase in the height of the mother by 1 cm is associated with a reduction in the odds of stunting of 4% for children aged 6 months or less and those aged between 19 and 36 months and 2% for children aged between 7 to 18 months. Whilst across all ages an increase in the weight of the mother by 1 Kg is associated with a reduction in the odds of being underweight of 6%. Amongst children aged 6 months or less, the odds of underweight are significantly higher for children of Lomwe ethnicity compared to children of Chewa ethnicity, whilst amongst children aged 7 to 18 months, children of Yao ethnicity have significantly lower odds of underweight compared to children of Chewa ethnicity. Amongst children aged 6 months or less, children of Sena ethnicity are less likely to be stunted compared to children of Chewa ethnicity.

Table 5.14 Results of the age group multivariate analysis for underweight (Odds ratio (CI)) (2004 MDHS data)

| Variables | 6 months or less | 7 to 18 months | 19 to 36 months |
|---|---|---|---|
| Child characteristics | | | |
| Size at birth : Reference is very large | | | |
| Larger than average | 2.34 (0.65,8.41) | 1.72 (0.89,3.32) | 1.05 (0.62,1.80) |
| Average | 2.28 (0.68,7.65) | 1.94 (1.05,3.57)* | 1.59 (0.95,2.64) |
| Smaller than average | 5.88 (1.54,22.44)* | 3.60 (1.85,7.02)*** | 3.36 (1.95, 5.77)*** |
| Very small | 7.31 (1.57,34.05)* | 4.77 (1.92,11.86)** | 3.02 (1.33,6.89)* |
| Female | 0.69 (0.39,1.21) | 0.67 (0.50,0.88)** | 0.80 (0.60,1.05) |
| Age | 1.26 (1.05,1.52)* | 0.99 (0.95,1.04) | 1.06 (1.03,1.10)** |
| Mother has a child Health card | 0.86 (0.39,1.90) | 0.58 (0.34,0.99)* | 0.67 (0.46,0.98)* |
| Had Diarrhoea | 0.71 (0.31,1.60) | 1.36 (1.01,1.83)* | 1.54 (1.14,2.09)** |
| Had Fever | 1.43 (0.78,2.59) | 1.10 (0.81,1.49) | 1.52 (1.15,2.00)** |
| Child was breastfed 16 times or more | 2.20 (1.24,3.93)** | - | - |

*= p value ,0.05, **=p value <0.01, ***=p value <0.001

Table 5.14 continued, Results of the age group multivariate analysis for underweight (Odds ratio (CI)) (2004 MDHS data)

| Variables | =< 6 months (N= 1327) | 7 to 18 months (N= 2,367) | 19 to 36 months (N= 2,696) |
|---|---|---|---|
| Child had Vitamin A | - | 0.79 (0.59,1.06) | 1.02 (0.76,1.36) |
| Still breastfeeding | - | - | 2.35 (1.62,3.40)*** |
| Consumption of a variety of food | - | 0.79 (0.66,0.94)** | 1.02 (0.88,1.17) |
| No. of times animal foods were consumed Reference is 0 | | | |
| Once | - | 1.03 (0.71,1.49) | 1.17 (0.87,1.59) |
| Twice | - | 0.53 (0.36,0.78)** | 0.85 (0.61,1.20) |
| Household characteristics | | | |
| Wealth status: Reference is poorest | | | |
| Below average | 0.62 (0.25,1.55) | 0.90 (0.59,1.38) | 0.79 (0.52,1.19) |
| Average | 0.93 (0.40,2.16) | 0.84 (0.52,1.32) | 0.50 (0.34,0.74)** |
| Above average | 0.93 (0.39,2.23) | 0.98 (0.61,1.56) | 0.61 (0.40,0.94)* |
| Wealthiest | 1.04 (0.38,2.85) | 0.53 (0.30,0.94) | 0.36 (0.22,0.59)*** |
| Partner education: Reference is no education | | | |
| Primary education | 1.20 (0.52,2.77) | 0.68 (0.46,0.99)* | 0.82 (0.58,1.15) |
| Secondary education | 1.37 (0.51,3.66) | 0.59 (0.35,0.98)* | 0.99 (0.65,1.53) |
| Mother's weight | 0.94 (0.90,0.98)** | 0.94 (0.92,0.96)*** | 0.94 (0.92,0.96)*** |
| Location characteristics | | | |
| Residence: Reference is urban | | | |
| Rural | 1.10 (0.34,3.60) | 1.34 (0.76,2.37) | 2.69 (1.67,4.34)*** |
| Region: Reference is Northern | | | |
| Central | 2.18 (0.51,9.26) | 1.63 (0.86,3.09) | 0.66 (0.39,1.11) |
| Southern | 1.19 (0.27,5.21) | 2.28 (1.18,4.43)* | 0.91 (0.55,1.49) |
| Ethnicity: Reference is Chewa | | | |
| Tumbuka, Tonga and Nkhonde | 2.54 (0.64,10.02) | 1.21 (0.63,2.31) | 0.91 (0.52,1.60) |
| Lomwe | 7.12(2.24,22.61)** | 0.69 (0.40,1.17) | 1.04 (0.64,1.68) |
| Ngoni | 3.21 (1.01,10.19) | 0.81 (0.46,1.44) | 1.33 (0.79,2.23) |
| Yao | 2.39 (0.79,7.16) | 0.52 (0.30,0.90)* | 1.14 (0.71,1.85) |
| Sena and other | 3.14 (0.98,10.04) | 0.94 (0.54,1.63) | 1.24 (0.77,1.99) |

*= p value ,0.05, **=p value <0.01, ***=p value <0.001

Table 5.15 Results of the age group multivariate analysis for stunting (Odds ratio (CI)) (2004 MDHS data)

| Variables | =< 6 months (N= 1327) | 7 to 18 months (N= 2,367) | 19 to 36 months (N= 2,696) |
|---|---|---|---|
| Child characteristics | | | |
| Size at birth : Reference is very large | | | |
| Larger than average | 2.06 (0.88,4.79) | 1.21 (0.74,1.98) | 0.91 (0.64,1.29) |
| Average | 3.75(1.74,8.10)** | 1.41 (0.88,2.25) | 0.99 (0.71,1.37) |
| Smaller than average | 3.5 (1.42,8.6)** | 2.11 (1.20,3.73)* | 1.26 (0.83,1.92) |
| Very small | 3.34 (1.14,9.8)* | 1.86 (1.00,3.45) | 0.76 (0.42,1.39) |
| Female | 0.98 (0.68,1.40) | 0.58 (0.47,0.72)*** | 0.80 (0.66,0.97)* |
| Age | 1.07 (0.96,1.21) | 1.14 (1.11,1.18)*** | 1.00 (0.98,1.03) |
| Had Diarrhoea | 0.84 (0.50,1.41) | 1.17 (0.91,1.50) | 1.34 (1.06,1.69)* |
| Exclusively breastfed | 1.04 (0.69, 1.57) | - | - |
| Still breastfeeding | - | - | 1.60 (1.24, 2.06)*** |
| Consumption of a variety of food | - | 0.99 (0.87,1.11) | 0.86 (0.78,0.95)** |
| No. of times food from animal sources were consumed Reference is 0 | | | |
| Once | - | 1.18 (0.89,1.56) | 0.86 (0.67, 1.09) |
| Twice | - | 0.77 (0.57,1.02) | 0.77 (0.60, 0.98)* |
| **Household characteristics** | | | |
| Wealth status: Reference is poorest | | | |
| Below average | 1.19 (0.68,2.07) | 0.71 (0.48,1.03) | 0.76 (0.55,1.07) |
| Average | 1.31 (0.76,2.26) | 0.90 (0.62,1.29) | 0.68 (0.50,0.93)* |
| Above average | 0.85 (0.49,1.47) | 0.91 (0.64,1.31) | 0.92 (0.67,1.27) |
| Wealthiest | 1.39 (0.73,2.65) | 0.60 (0.40,0.89)* | 0.46 (0.33,0.64)*** |
| Mother's height | 0.96 (0.93,1.00)* | 0.98 (0.96,0.99)* | 0.96 (0.95,0.98)*** |
| Mother's weight | 0.99 (0.96,1.02) | 0.99 (0.98,1.01) | 0.98 (0.97,0.99)** |

*= p value <0.05, **=p value <0.01, ***=p value <0.001

Table l5.15 continued, Results of the age group multivariate analysis for stunting (Odds ratio (CI)) (2004 MDHS data)

| Variables | =<6 months (N= 1327) | 7 to 18 months (N= 2,367) | 19 to 36 months (N= 2,696) |
|---|---|---|---|
| Residence: Reference is urban | | | |
| Rural | 0.85 (0.41,1.75) | 1.34 (0.91, 1.96) | 2.06 (1.49,2.85)** |
| | | | |
| Region: Reference is Northern | | | |
| Central | 2.03 (0.74,5.58) | 1.59 (0.96,2.62) | 1.33 (0.85,2.10) |
| Southern | 2.73 (1.03,7.22)* | 1.20 (0.73, 1.97) | 1.08 (0.68,1.71) |
| | | | |
| Ethnicity: Reference is Chewa | | | |
| Tumbuka, Tonga and Nkhonde | 1.04 (0.42,2.59) | 1.37 (0.82,2.30) | 0.93 (0.59,1.47) |
| Lomwe | 0.70 (0.32,1.51) | 0.87 (0.57,1.32) | 0.92 (0.64,1.32) |
| Ngoni | 0.77 (0.39,1.51) | 0.96 (0.68,1.37) | 0.91 (0.63,1.31) |
| Yao | 0.54 (0.27,1.09) | 1.16 (0.75,1.78) | 0.90 (0.63,1.28) |
| Sena and other | 0.39 (0.17,0.91)* | 0.92 (0.61,1.38) | 1.07 (0.72,1.61) |

*= p value <0.05, **=p value <0.01, ***=p value <0.001

Table 5.16 Results of the random part of the models on underweight (children aged 6 months or less) and stunting (children aged 19 to 36 months) at Cluster level (2004 MDHS data)

| Model | Variance | 95% Confidence interval | Chi Square Statistic | P value |
|---|---|---|---|---|
| Aged 6 months or less (underweight) | 1.56 | (0.52,4.69) | 6.99 | 0.004 |
| Aged 19 to 36 months (stunting) | 0.15 | (0.05,0.44) | 4.29 | 0.02 |

## 5.6 Discussion of findings

The findings of this chapter show that household behavioural factors such as breastfeeding, complementary feeding, and vaccination, possession of a health card by mother and vitamin A supplementation play an important role in a child's nutritional status.

One interesting finding of this chapter relates to the significant association between the number of times a child was breastfed and their underweight status. Since children that were fed less times (15 times or less) are less likely to be underweight compared to those that were fed more times (16 times or more) this perhaps suggests that children that are fed less number of times could be feeding for a longer time and consuming more milk compared to those that were fed more times. The WHO recommendation on frequency of breastfeeding is that a child should be breastfed on demand (WHO, 2012a), this is because how much or how long a baby feeds very much depends on their age and size. Nevertheless, breastfeeding of more than fifteen times appears to be on the higher side and may suggest that babies may be put/latched on the breast for a short time just for comfort.

The lack of significant association between a child's nutritional status and whether they were exclusively breastfed or not is possibly as a result of the methodology used for identifying those that were exclusively breastfed or not. It is possible that children that were identified as exclusively breastfed are not really under exclusive breastfeeding since due to data limitation feeding information is only available for the last 24 hours. Feeding information based on a longer period is more appropriate as far as studying the association between feeding and child health is concerned. A study by Raisler *et al.* (1999) reports of a dose response relationship between breastfeeding and child illness in the United States based on information of the ratio of breast-feedings to other foods for the first six months of the baby's life. The lower odds of underweight amongst children with diarrhoea for children aged 6 months or less although not significant is indicative of how adequate feeding can offset nutritional losses during diarrhoea episodes. It is likely that children with diarrhoea are breastfed more than they would normally if they did not have diarrhoea and as a result registering lower odds of underweight. Weight gain is reported amongst Gambian children who continued to vomit and experience diarrhoea whilst being fed a nutrient rich supplement (Hoare *et al.*, 1996) .

The results in this chapter show that full immunisation for children aged over 12 months and vitamin A supplementation amongst children aged 7 to 18 months are associated with a child's underweight in the bivariate analysis, however both full immunisation and vitamin A supplementation are not significant in the multivariate analysis. This is perhaps because behavioural factors operate through socio-economic factors such as wealth status, residence, ethnicity and access to safe water which emerge as significant factors in the multivariate analysis. Previous studies that have reported of an association between a child's vaccination status and their nutritional status in Kenya (Adeladza, 2009) and Zambia (Zondag *et al.*, 1992) have been based on bivariate analysis. A recent Malawian study at national level reports of no association between receipt of vitamin A and a child's nutritional status based on a multivariate analysis (Kazembe and Katundu, 2010). Regardless of the lack of association between child nutritional status and whether they received vitamin A or not in the multivariate analysis, the finding that it is only amongst children aged between 7 and 18 months where there is a significant bivariate association between receiving vitamin A and a child's underweight status shows that the effect of vitamin A supplementation to a child may be age dependent. A randomised study in Ecuador that looked at the association between receiving vitamin A and child's diarrhoea status amongst children aged 6 to 36 months found that it was only amongst children aged 18 to 23 months where the risk of severe diarrhoea was lower in the supplemented children compared to the un supplemented (Sempértegui *et al.*, 1999).

We also learn from the analysis undertaken in this chapter that in Malawi, not many children consume food from animal sources and food rich in vitamin A, but many children consume food made from the local grain. The results of the analysis of the association between food consumption and child nutritional status, however, indicate that consumption of food from animal sources and consumption of a wide variety of food (illustrated through a higher diversity score) may contribute to better nutritional status for Malawian children. Foods from animal sources are rich in nutrients such as protein, energy, iron and zinc and because of this, zinc and iron deficiencies tend to co-exist. In Malawi, iron deficiency is estimated at 50.9% amongst children under the age of five whilst iron deficiency anaemia is estimated at 30.6% (Malawi-Government, 2009) . There are no estimates of zinc deficiencies, however, one would expect high deficiencies of zinc amongst Malawian children due to low consumption of food from animal sources as well as high consumption of maize which is said to contain high levels of phytates that inhibit the absorption of zinc in animals and humans (Sandström and Lönnerdal, 1989). The association between consumption of vitamin A rich foods and a child's nutritional status found in this study is similar to findings of a Sudanese study that reports of greater growth experiences amongst children in the highest quintile for consuming food containing vitamin A compared to children that were in the lowest quintile, and that the relative risk of recovery from stunting associated with vitamin A intake was greater amongst the children under the age of one year compared to children over three years . It appears, therefore, that consumption of vitamin A rich foods as well as taking of vitamin A supplements may be more effective amongst children undergoing weaning than other age groups.

The result of higher likelihood of underweight and stunting amongst children aged 19 to 36 months that were still breastfeeding is in line with previous studies(Simondon *et al.*, 2001, Madise and Mpoma, 1997, Marquis *et al.*, 1997, Huffman *et al.*, 1980, Fawzi *et al.*, 1998). These studies all report of poorer nutritional status amongst children aged over 12 months that were still breastfeeding compared to those that were not. Most of the studies suggest that reverse causality is the explanation in that mothers continue to breastfeed if their child is of poor nutritional status. Whilst this could be true, it appears that most mothers who continue to breastfeed are more likely to not offer adequate and appropriate complementary food. Fawzi *et al.*(1998) suggests that an inverse association between prolonged breastfeeding and child growth amongst Sudanese children may be explained by poorer complementary feeding among breastfed children compared to weaned children based on the finding that children from poorer households and whose parents were illiterate were more likely to have less adequate complementary feeding. This could be the case amongst the children aged 19 to 36 months in this study, since there is a significant difference in the percentage of children that are still breastfeeding by mother's education level. The highest percentage of children that are still breastfeeding is amongst mothers with no education (40.1%) followed by mothers with primary education (32.9%) and its lowest amongst mothers with secondary or higher education ( 29.6%) p value $<0.01$. The analysis of the association between stunting and underweight and type of feeding presented in Table 5.12 shows that in the age group 19 to 36 months, the percentage of children underweight and the percentage of children stunted is higher amongst children that had breast milk as well as three food groups 24 hours before interview compared to children that had three food groups without any breast milk suggesting that children that consume food as well as breast milk may not be getting adequate quantities of food.

The urban/rural differential in child nutritional status is only significant amongst children aged 19 to 36 months. Most of the children in this age group are not breastfeeding (65.6%) and therefore consuming different kinds of food offered to them by their parents and it is also amongst this age group where children that are still breastfeeding are more likely to be underweight or stunted compared to those that aren't. Provision of adequate and appropriate complementary foods is more challenging for parents from rural areas who on average are of low economic status compared to those from urban areas and expectedly there is a significant difference in the percentage of children that consumed food from animal sources amongst children from rural areas (18%) compared to children from urban areas (36.7 %) p value <0.001.

Findings also suggest that children of Sena and Yao ethnic background may be better nourished probably due to having better access to fish through living near Lake Malawi and the Shire River respectively. Considering that food from animal sources are rich in nutrients, mothers of children of Yao and Sena ethnic background are likely to be better nourished compared to mothers of children from the Chewa ethnic background who predominantly rely on maize and beans and as such their better nutritious status could be passed on to their babies during pregnancy and through breastfeeding for children aged 6 months or less, whilst children aged between 7 to 18 months who are undergoing weaning may be consuming more nutritious food compared to children of Chewa ethnic background.

The findings of this chapter show that a household's wealth status is an important associate of child's nutritional status. However, since the wealth status variable used in the analysis is computed through combining economic and environmental variable, it is difficult to isolate the relative roles of environmental and economic factors in influencing a child's nutritional status. The next chapter investigates the pathways through which household and community socio-economic factors may influence a child's nutritional status through undertaking analysis of various environmental and socio-economic factors.

# CHAPTER 6 : HOUSEHOLD AND COMMUNITY SOCIO-ECONOMIC INFLUENCES ON CHILD NUTRITIONAL STATUS IN MALAWI

## 6.1 Introduction

This chapter aims to explore further the pathways through which household socio-economic status and community context influence a child's nutritional status in Malawi. Most studies on risk factors for child nutritional status tend to focus on household socio-economic factors possibly because household factors appear to be more closely linked to a child than community factors. Policy and programme implementation on child nutrition in most developing countries also tend to place more emphasis on mother and household level factors than community level factors. For example, the Malawi Government's nutrition interventions as outlined in the Malawi National Nutritional Policy and Strategic Plan (2007 -2012) relate to educating mothers on good child care and feeding practices but also implementation of programmes that prevent micro nutrient disorders through supplementation of nutrients such as vitamin A, iron and iodine, de-worming of children, school feeding programmes and special feeding programmes for the seriously undernourished. The Malawi National Nutritional Policy and Strategic Plan (2007 -2012) identifies communities/villages as channels for getting information from the national/district level to households and mothers. However, the conceptual framework for nutritional status used in this study as well as other conceptual frameworks on child nutritional status and child survival (Millard, 1994), (UNICEF, 1998) (Mosley and Chen, 1984), recognise that apart from household factors, community factors i.e. access to health facilities, markets and customs play an important role in influencing a child's nutritional and/or health status. Household and community infrastructural development has been identified as a more efficient avenue of tackling child under-nutrition in developing countries compared to economic growth (Haddad *et al.*, 2003).

Considering that past studies in child under-nutrition in Malawi report of clustering of child's underweight status within communities as well as households (Griffiths *et al.*, 2004, Madise *et al.*, 1999) to properly tackle the problem of child under-nutrition in Malawi, we need to also understand the linkages between community level factors and child under-nutrition but more their role relative to household level factors. The analysis undertaken in chapter 4 on determinants of child under-nutrition using the 2004 Malawi Demographic Health Survey found that stunting also varies across communities. The analysis further revealed that there was more unexplained variation of stunting across communities than underweight. This chapter links data on community facilities with data on household and child characteristics to answer the questions:

(i) What are the pathways through which household and community socio-economic status affect child nutritional status in Malawi?

(ii) How does stunting and underweight in Malawi vary across seasons?

By doing so, this chapter enhances our understanding of how household and community level factors are associated with a child's nutritional status in Malawi. Taking advantage of the availability of data by Agricultural Development Divisions (ADDs), this chapter also analyses the variability of child stunting and child underweight across the ADDs and explores how food availability and morbidity across the season may impact on child stunting and underweight. Such findings may contribute towards the formulation of more efficient policy recommendations to tackle the problem of child under-nutrition in Malawi.

## 6.2 Preliminary analysis

### 6.2.1 Stunting and Underweight estimates

The estimates for stunting and underweight from the 2004 Malawi Integrated Household survey (IHS 2) are 50.1% and 12.7% respectively. Both estimates are lower than those obtained from the 2004 Malawi Demographic and Health survey (MDHS) which are 52.7% and 18.5% for stunting and underweight respectively. Since the surveys were conducted differently, further investigation is undertaken to see if the difference is statistically significant or not. A comparison is made of stunting and underweight estimates between children from the two surveys of similar ages (aged between 6 and 59 months) and whose anthropometric measurements were undertaken during the same period (October and February). The results show that the difference in the estimates for stunting and underweight between the two surveys is statistically significant as shown in Table 6.1. The estimate for stunting from the IHS 2 is 45.1% whilst that of the 2004 MDHS is 56.3%, the estimate for underweight from the IHS 2 is 10.1% whilst that of 2004 MDHS is 19.7%. Differences in how anthropometric measurements were taken between the 2004 MDHS and the IHS 2 explained in section 3.2.2 may have possibly contributed to the significant difference in the estimates for stunting and underweight from the two surveys.

Table 6.1 Differences in the percentage stunted and the percentage underweight between IHS 2 and 2004 MDHS amongst children aged 6 to 59 months

| Survey data | % Stunted (CI) | Number of children | % Underweight (CI) | Number of children |
|---|---|---|---|---|
| 2004 IHS 2 data (October 2004 to February 2005) | 45.1 (41.9,48.3) | 2,032 | 10.1 (8.6,11.7) | 2,032 |
| 2004 DHS data (October 2004 to February 2005) | 56.3 (54.7,57.8) | 7,262 | 19.7 (18.5,20.9) | 7,692 |

Most of the households in the sample have one child under the age of five (76.0%) however 22.1% households have two children under the age of five and 1.9% have three children under the age of five. For this reason the analysis employs multilevel modelling techniques to take into account both the household and community level variation.

### 6.2.2 Annual household food expenditure by month of interview

One interesting feature of IHS 2 data is that it was collected throughout the year. This allows for an exploration of differences of child under-nutrition across the year. An initial exploration of annual household food expenditure[1] across the year shows that household annual food expenditure is significantly higher in the months of March to August compared to the months of September to February. This is shown in Figure 6.1. Annual household expenditure on food is standardised considering that expenditure on food may vary between the cropping season (November to March) and the harvest season (April to August). The exploration of annual household food expenditure by months of interview based on standardised food expenditures shown in Figure 6.2 also shows that annual household food expenditure is higher from March to August compared with the period of September to February. The association between period of interview (March to august) and (April to August) and child's nutritional status is investigated in the bivariate analysis in section 6.4 and the multivariate analysis in section 6.9.

[1] Annual household food expenditure is the monetary value of what the household consumed in the past 7 days of the interview day in Malawi Kwacha. It includes consumption from own production, purchases, as well as gifts and other sources.

Figure 6.1 Annual household food expenditure by month of interview (IHS 2 data)

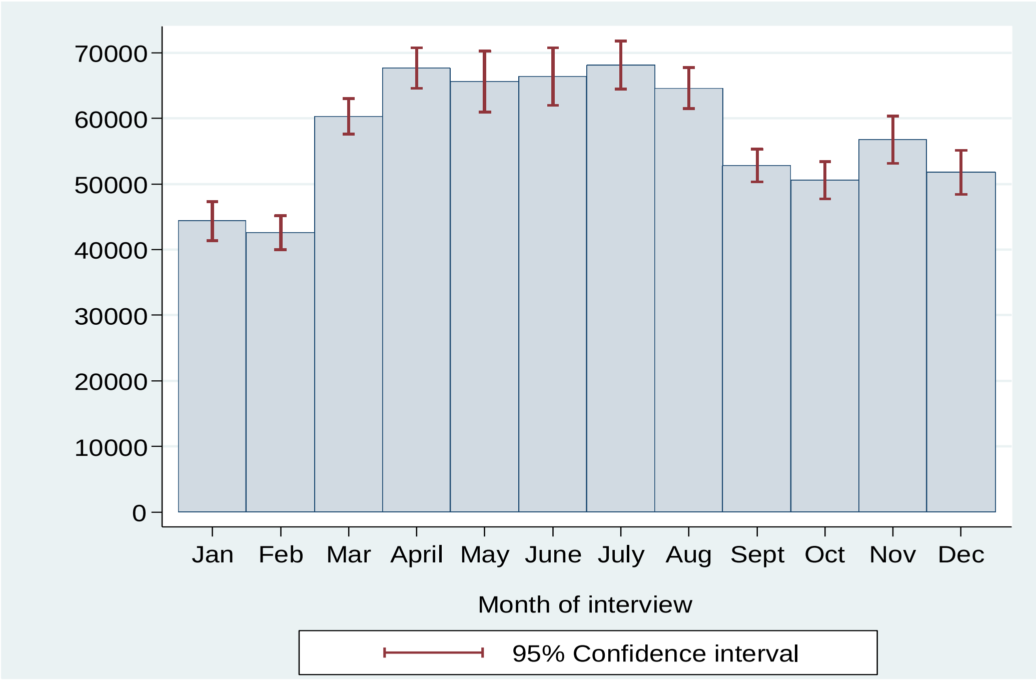
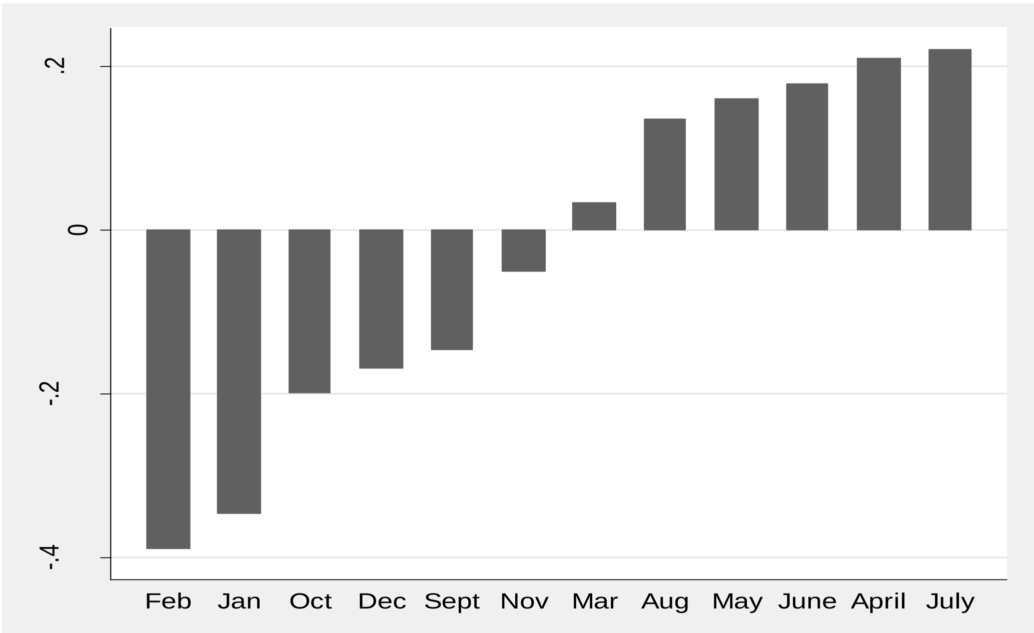



Figure 6.2 Mean annual food expenditure Z score by month of interview (IHS 2 data)



## 6.3 Variables analysed

### Independent Variables

Independent variables explored in this chapter are based on the conceptual framework for child nutritional status used in this study which is given in chapter 2, section 2.3, Figure 2.3. Both household and community socio-economic variables are explored. These are described in Table 6.2.

Table 6.2 Explanatory variables

| |
|---|
| Age: Age in months is continuous and is standardized. Age squared is also included to take into account of the non-linearity of the relationship between age and underweight and age and stunting. |
| Sex : 1 = Female and 0 = Male |
| Child was ill =1,Child was not ill = 0 |
| Household poverty status: 1=poor,0= Not poor |
| Qualification of the household head<br>0= Has no education<br>1=Has primary school certificate<br>2=Has junior secondary certificate or higher |
| Household Sanitation: This variable is computed through adding together the variable on availability of toilet and protected source of water.<br>0 = Do not have both a toilet and a protected water source<br>1 = Has a toilet and a protected water source |
| Housing: This variable is computed through adding the variables on type of roofing and type of floor.<br>0= No permanent roof and no improved floor<br>1= Has permanent roof and improved floor |
| Proportion with access to safe water<br>1= Proportion in community with access to protected water is less 0.73<br>2= Proportion in community with access to protected water is 0.73 or more |
| Community housing<br>1= Proportion in community with permanent roof and improved floor is less than 0.25<br>2=Proportion in community with permanent roof and improved floor is more than 0.25 |
| Household annual food expenditure: Has four categories which are quartiles obtained separately for households interviewed from March to August and those interviewed from September to February to take into account differences in food availability and inflation across the year: 1=First (lowest),2=Second,3=Third,4=Fourth (highest). This is only used for bivariate analysis.<br><br>For the modelling, a continuous annual household food expenditure is used based on standardised annual household food expenditure obtained separately for households interviewed in the period March to August and those interviewed from September to February also to take into account differences in food availability and inflation across the year. |
| Benefitted from free maize distribution: 1=Yes,2=No |

Table 6. 2 Explanatory variables continued.

| |
|---|
| Household experience of shocks<br>This variable is based on factor scores obtained after undertaking a factor analysis of variables on household's experience of different shocks given in appendix 14.<br><br>The relationship between household experience of shocks and child stunting and child underweight is shown in appendix 15.<br><br>Due to there not being a clear pattern in the relationship between the factor scores and child's stunting and underweight, the variable is categorised into three categories:<br><br>1=Low, 2=Medium, 3=High, |
| Community facilities<br>0= No facility<br>1= At least one facility<br>A community facility is either a post office, a health clinic or a telephone booth |
| ADMARC market available: 1=Yes, 0=No |
| Ethnicity: This variable describes how members of the community trace their descendants.<br>1 = Through the father<br>2 = Through the mother<br>A third category of those that trace their descendants through both their mother and father was set to missing due to relatively being small in size (4.8%) and comprising of relatively more households from urban areas (44%) compared to those that trace through their father (12%) and through the mother (7%) |
| Residence<br>1= Rural, 0= Urban |
| Region<br>1=Northern region<br>2=Central region<br>3=Southern region |
| Period of interview<br>1=September to February; 2=March to August |

## 6.4 Under-nutrition by month of interview

This section explores the variation of under-nutrition across the year. It is expected that under-nutrition should vary across the year since availability of food also varies across the year and because child illnesses may differ across different seasons. In Malawi, periods soon after harvest which is around March/April have abundant food whilst from November to March there is severe shortage of food. This is supported by analysis shown in Figure 6.1 and Figure 6.2 in section 6.2.2. Analysis of child stunting and child underweight by month of interview, shows that the proportion of children stunted is significantly lower in January and February compared to all other months, however, the variation in the proportion of children underweight across the interview months is not statistically significant (Figure 6.3 and 6.4). A comparison of monthly stunting and underweight levels between IHS 2 and 2004 DHS is shown in appendix 16 for the four months of October, November, December and January in which data is available for both the surveys. The two surveys agree in their being no significant difference in underweight across the four months and both surveys show a similar pattern of lower underweight levels in January and December and slightly higher levels in October and November. With regard to stunting levels, the IHS 2 shows significantly lower stunting levels in January whilst the 2004 DHS shows that there is no significant difference in stunting levels across the four months although the rates are highest in November compared to the other three months.

Figure 6.3 Proportion of children stunted by month of interview (IHS 2 data)

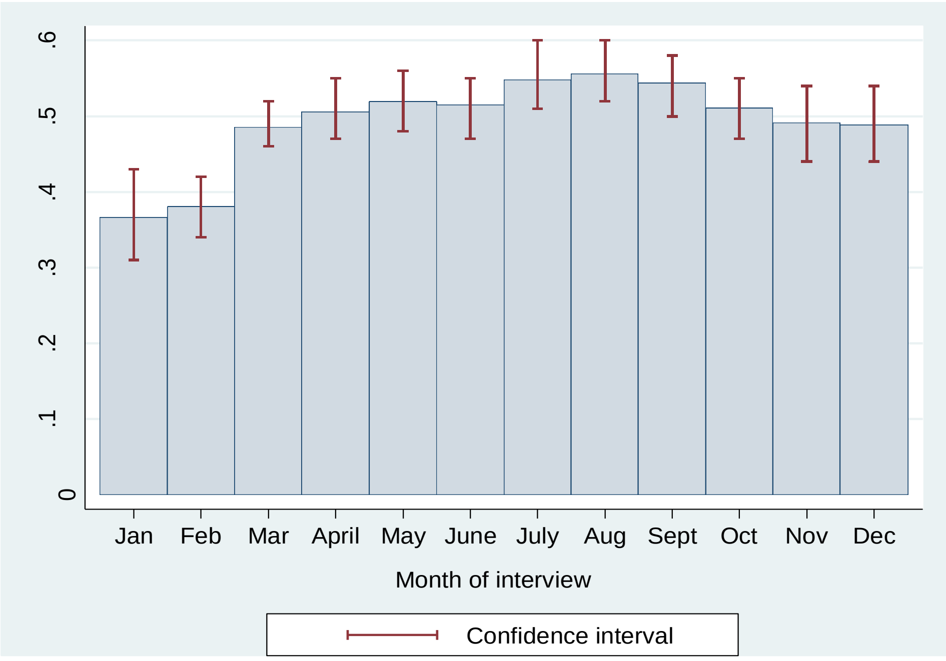
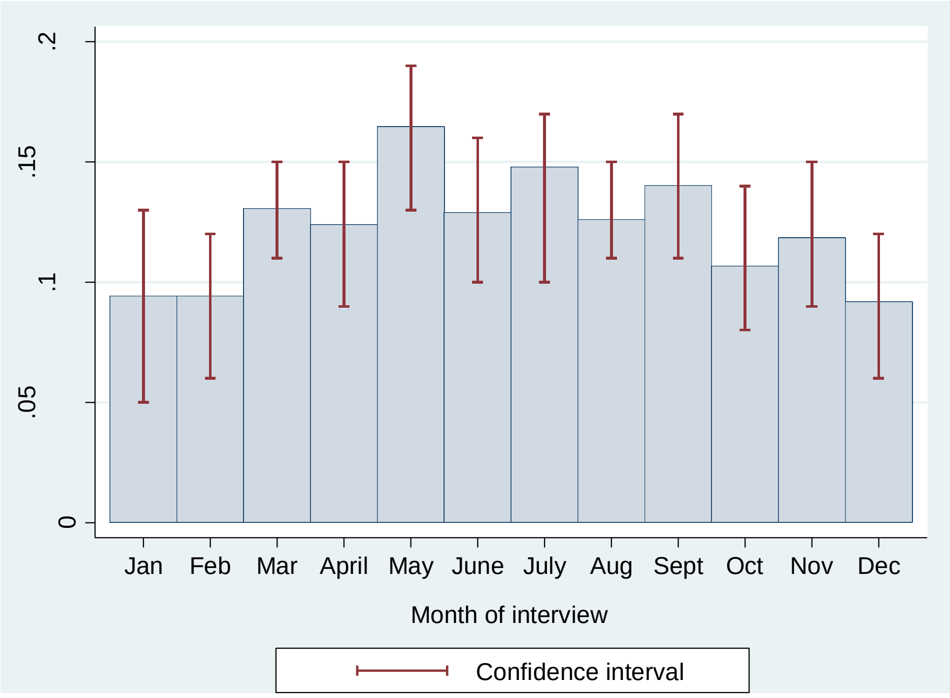
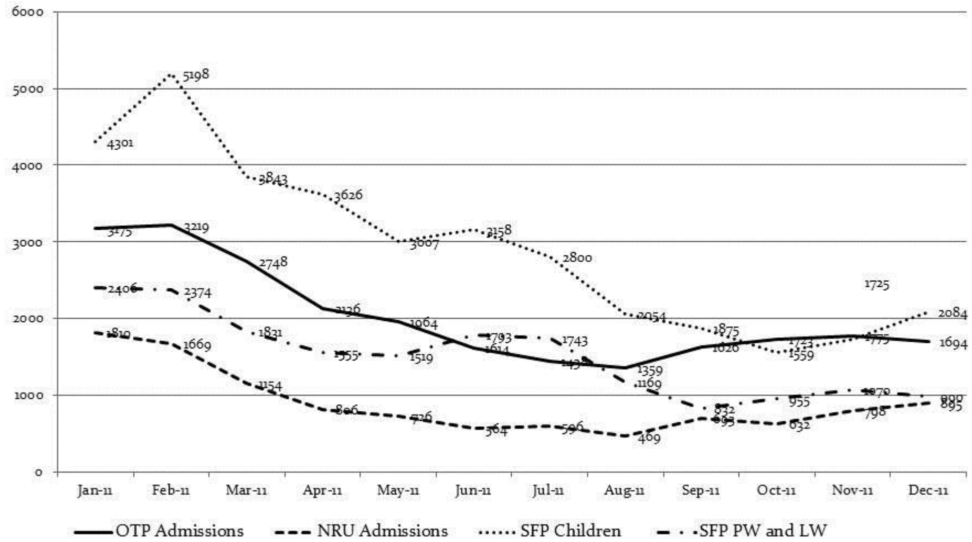


Figure 6.4 Proportion of children underweight by month of interview (IHS 2 data)




The patterns of under-nutrition across the interview months observed in Figure 6.3 and Figure 6.4 are not consistent with seasonal food availability in Malawi and what is shown in Figure 6.1 and Figure 6.2 on household annual food expenditure across the year. Household annual food expenditure is highest in the households that were interviewed from March to August and lowest in those interviewed in the months from September to February. However, based on anecdotal evidence with Dr Kalimbira, a human nutrition lecturer at Bunda College of Agriculture in Malawi, the pattern of severe under-nutrition requiring admissions does follow the trend of food availability shown in Figure 6.1 and Figure 6.2. Dr Kalimbira mentioned that as part of practical lessons for a human nutrition course which he teaches, it is hard to find enough undernourished children in hospitals during the period after harvest, whilst it is very easy to get them in the months of January and February. Dr Kalimbira's statement is supported by statistics from the Nutrition unit of the Ministry of Agriculture on admissions for severely undernourished children shown in a Figure 6.5. The figure also shows that the highest number of children on supplementary feeding programme in 2011 is in the months of January and February. The fact that more undernourished children are hospitalised in the hunger months and not during the harvest time could also explain the lower stunting and underweight rates experienced during this period, since those severely undernourished are at hospital when the household interviews were conducted. Whilst the high numbers of children participating in the supplementary feeding in January and February, could contribute to lower levels of stunting and underweight.

Figure 6.5 Admissions of severely undernourished children in Malawi (2011)




OTP: Outpatient Therapeutic Programme
NRU: Nutrition Rehabilitation Unit
SFP Children: Supplementary Feeding Programme for children
SFP PW and LW : Supplementary Feeding Programme for pregnant women and lactating women
**Source: Nutrition Unit: Malawi Government Ministry of Agriculture and Food Security**

## 6.5 Morbidity by month of interview

Considering the important association between morbidity and child undernutrition and the fact that child undernutrition and child morbidity might vary across seasons, this section analyses how child illnesses in general vary across the interview months. The bivariate analysis between child illness and undernutrition is discussed in section 6.7. Child illness varies across seasons and the proportion of children with illness is significantly higher in April compared to the rest of the months as shown in Figure 6.6. On average, the months of April to June have the highest percentage of children ill compared to the other three quarters as shown in Table 6.3 (p value <0.01). Child illnesses include illnesses from diarrhoea, lower respiratory infections, fever, stomachache and upper respiratory infections. Based on Table 6.3 on average, the period of high child illness is within the same period with high stunting and high underweight rates (March to August) as shown in Figure 6.3 and Figure 6.4 respectively. The seasonal pattern in illnesesses from malaria and pneumonia based on hospital administrative data presented in appendix 17 is similar to the one shown in Figure 6.6.

Figure 6.6 Proportion of children ill by month of interview (IHS 2 data)

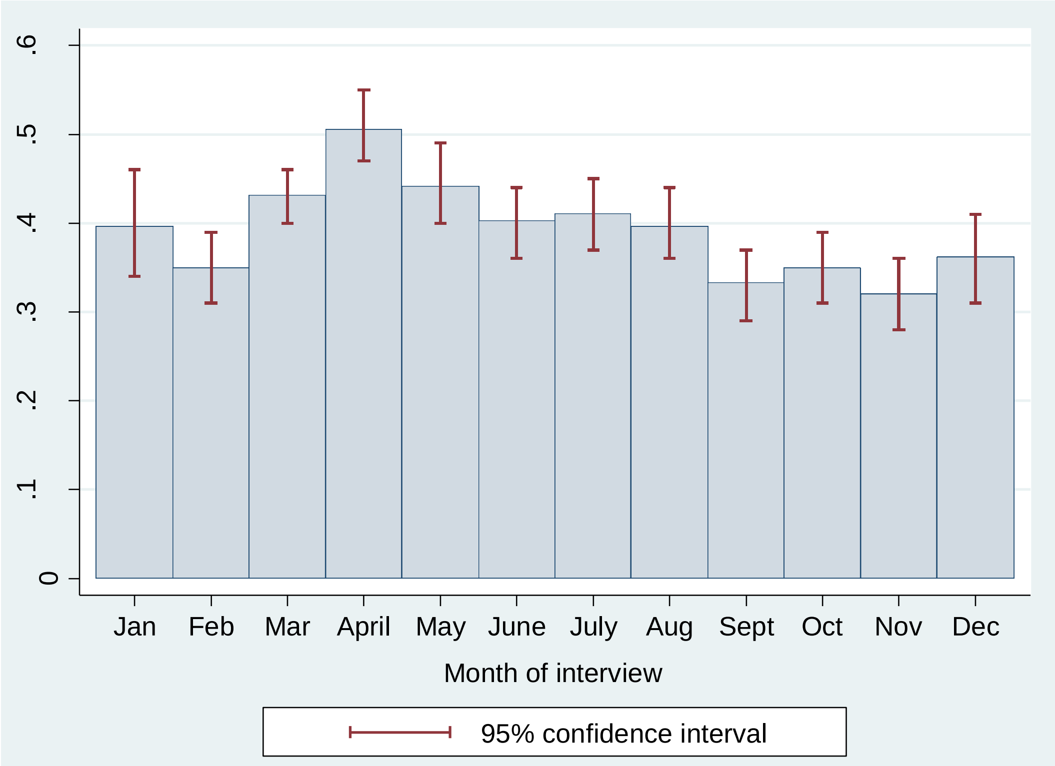



Table 6.3 Morbidity across different time periods (IHS 2 data)

| Period of interview (season) | Diarrhoea | Fever | Lower respiratory infections | All child illnesses |
|---|---|---|---|---|
| January to March (Hot wet) | 5.7 | 18.7 | 5.4 | 40.8 |
| April to June (Cold dry) | 4.9 | **19.5** | 6.6 | **44.8** |
| July to September (Cool dry) | 5.7 | 12.0 | **8.3** | 37.3 |
| October to December (Hot wet season ) | **8.9** | 12.7 | 3.9 | 34.1 |

P value <0.01

## 6.6 Under-nutrition by Agricultural Development Division

The Agricultural Development Divisions (ADDs) in Malawi were set up to promote agricultural development in specific fields depending on the dominant crops grown in the area. There are 8 ADDs in Malawi and they vary in terms of number of districts that are within each ADD as shown in Table 6.4. Blantyre ADD has the most districts whilst Salima, Karonga and Shire Valley have the least number of districts.

Table 6.4 Number of districts and region for each ADD (IHS 2 data)

| ADD | Number of districts | Region |
|---|---|---|
| Blantyre | 7 | Southern |
| Machinga | 4 | Southern |
| Kasungu | 4 | Central |
| Mzuzu | 4 | Northern |
| Lilongwe | 3 | Central |
| Salima | 2 | Central |
| Karonga | 2 | Northern |
| Shire Valley | 2 | Southern |

Crops grown are either cash crops such as tobacco, cotton, coffee and tea or food crops such as maize, Irish potatoes and beans. The type of crops grown and the quantity produced may have an influence on the availability of food or income which are vital for maintenance of good nutrition. Table 6.5 shows that estimates for stunting and underweight are significantly lower in Salima ADD compared to all other ADDs. Lilongwe and Kasungu ADD has a significantly high percentage of children that are stunted compared to the rest of the ADDs whilst the percentage of children underweight is significantly higher in Lilongwe ADD compared to Salima, Shire Valley, Karonga and Machinga ADDs. The 4 ADDs with the least under-nutrition percentages are those that have a good proximity to Lake Malawi and Shire River, possibly indicating that access to fish which is a good source of protein could be contributing to the relatively lower levels of stunting and underweight. It should be noted as well from Table 6.5 that Lilongwe and Kasungu ADDs have a lower percentage of households with safe water compared to Shire valley and Salima ADDs and relatively higher percentage of children that reported to be ill. These two factors are important in influencing child nutritional status according to literature. On the other hand Lilongwe and Kasungu ADDs have the lowest percentage of poor households[1]. Figure 6.7 shows that these two ADDs are amongst the ADDs with the highest mean household annual food expenditure. This could be due to the fact that Lilongwe and Kasungu are the major producers of maize the staple food of Malawi and the

[1] Poor households are those below the poverty line. The poverty line is defined as the expenditure required to meet the minimum calorific requirement for energy needs plus some minimum non- food expenditure

main source of energy. According to the 2011/2012 crop estimates from the Malawi Ministry of Agriculture, Kasungu and Lilongwe ADDs have produced 50% of all cereals in Malawi (Malawi-Government, 2012). However, cereals are not a good source of protein, vitamins and minerals which many studies have shown to be important for better nutritional status. On the other hand, there aren't major differences in the proportion of expenditure on food across the ADDs, as seen from Figure 6.8 although Kasungu, Lilongwe and Blantyre on average have the lowest proportion of food expenditure compared to the rest of the ADDs.

Table 6.5 Percentage of children stunted, underweight, ill, households with safe water, and households that are poor by Agricultural Development Division (ADD), with 95% Confidence Interval(CI)

| Region | ADD | % Stunted(CI) | % Underweight(CI) | % of children Ill (CI) | % of hhds[1] with safe water (CI) | % of hhds poor(CI) |
|---|---|---|---|---|---|---|
| Central | Salima | 30 (25,35) | 6 (3,9) | 36 (30,42) | 74 (68,80) | 56 (50,62) |
| Northern | Karonga | 44 (38,50) | 10 (7,13) | 29 (24,34) | 69 (63,75) | 67 (62,72) |
| Southern | Machinga | 46 (43,49) | 11 (9,13) | 39 (36,42) | 73 (70,76) | 69 (66,72) |
| Southern | Shire Valley | 47 (42,52) | 10 (7,13) | 38 (34,42) | 75 (70,80) | 70 (66,74) |
| Southern | Blantyre | 50 (47,53) | 13 (11,15) | 35 (32,38) | 79 (76,82) | 58 (55,61) |
| Northern | Mzuzu | 49 (45,53) | 12 (10,14) | 41 (38,44) | 65 (61,69) | 53 (49,57) |
| Central | Lilongwe | 56 (53,59) | 16 (14,18) | 44 (41,47) | 60 (57,63) | 43 (40,46) |
| Central | Kasungu | 58 (55,61) | 13 (11,15) | 45 (41,48) | 49 (45,53) | 42 (39,45) |

[1] hhds is short form for households

Figure 6.7 Mean annual household food expenditure by ADD (IHS 2 data)

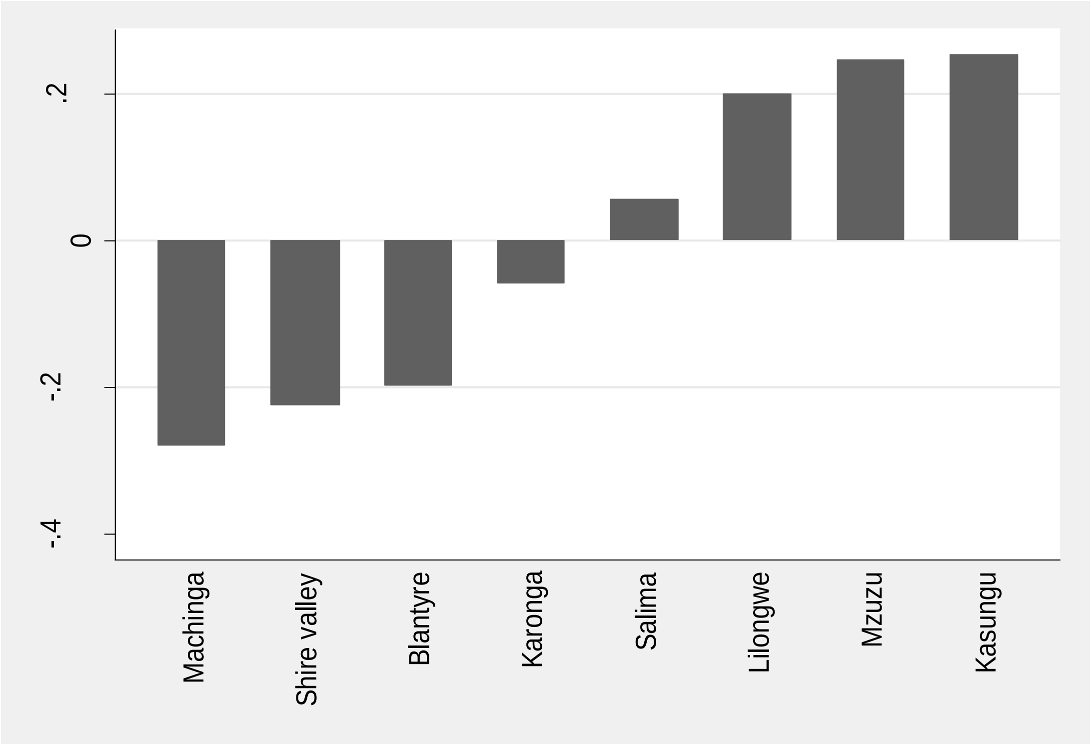
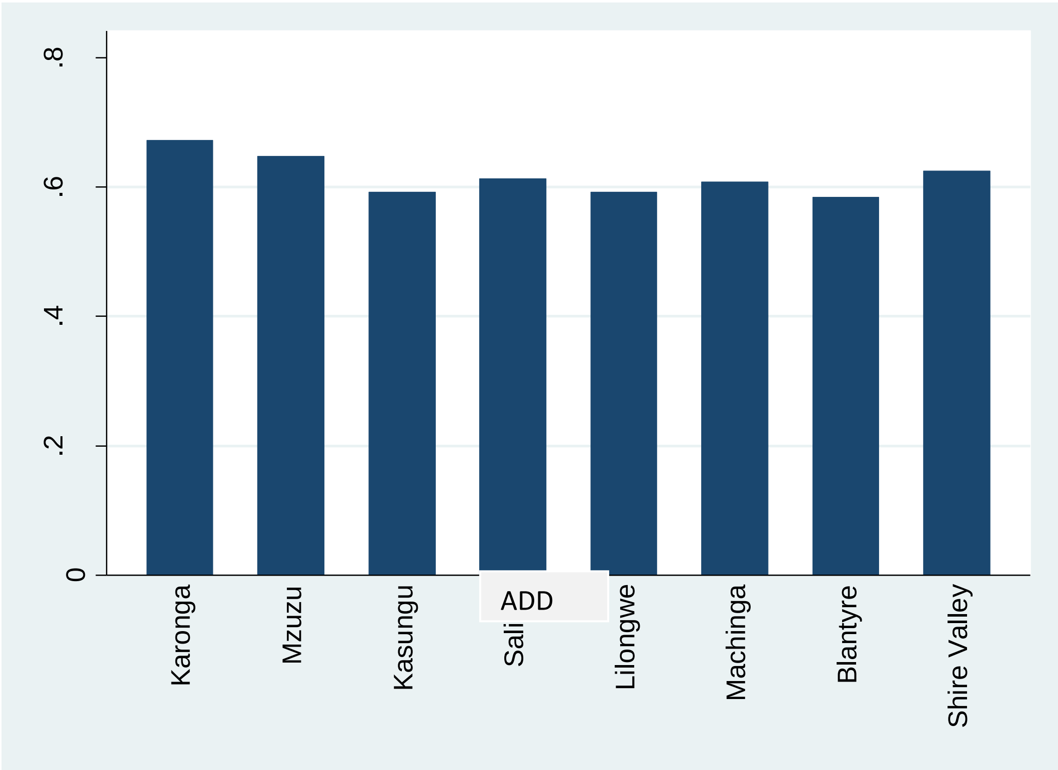



Figure 6.8 Proportion of household's expenditure on food by ADD (IHS 2 data)



## 6.7 Bivariate analysis of underweight and stunting and child and household factors

### 6.7.1 Association between stunting and underweight with child and household level factors

Table 6.6 shows factors associated with stunting and underweight at child and household level. Sex, availability of a toilet and protected source of water, quality of housing and education qualification of the household head are significantly associated with both stunting and underweight. Other factors are only associated with a child's stunting status but not their underweight status such as household poverty status, benefitting from free maize distribution, household's experience of shocks and region whilst child illness is only associated with a child's underweight status and not their stunting status. Children from households that have a lower shock score are more likely to be stunted compared to children from households that have a higher shock score.

Figure 6.9 and Figure 6.10 present the relationship between household annual food expenditure and child stunting and child underweight respectively. Both figures show that on average, annual household food expenditure is negatively associated with the proportion of children who are stunted or underweight and that the relationship is approximately linear.

Table 6.6 Stunting and underweight rates by child and household characteristics for under-five Malawian children (IHS 2 data)

| Variable | % Stunted | Chi square p value | % Underweight | Chi square p value | N | % |
|---|---|---|---|---|---|---|
| Sex | | | | | | |
| Male | 52.5 | <0.01 | 14.5 | <0.01 | 3,279 | 49.0 |
| Female | 47.6 | | 11.0 | | 3,408 | 51.0 |
| Child's health status | | | | | | |
| Child was ill | 50.5 | 0.58 | 14.0 | 0.03 | 2,661 | 39.8 |
| Child was not ill | 49.8 | | 11.9 | | 4,026 | 60.2 |
| Household Sanitation | | | | | | |
| Does not have both a toilet and a protected water source | 55.1 | <0.001 | 14.3 | <0.001 | 2,088 | 42.2 |
| Has both a toilet and a protected water source | 48.5 | | 10.6 | | 2,856 | 57.8 |
| Housing | | | | | | |
| Has permanent roof and improved floor | 41.8 | <0.001 | 7.0 | <0.001 | 812 | 18.1 |
| No permanent roof and improved floor | 53.5 | | 13.6 | | 3,686 | 81.9 |

Table 6.6 continued Stunting and underweight rates by household socio-economic characteristics for under-five Malawian children (IHS 2 data)

| Variable | % Stunted | Chi Square P value | % Underweight | Chi square P value | N | % |
|---|---|---|---|---|---|---|
| Poverty status | | | | | | |
| Poor | 51.1 | 0.04 | 13.4 | 0.08 | 3,710 | 55.5 |
| Non poor | 48.3 | | 11.8 | | 2,977 | 44.5 |
| Education qualification of household head | | | | | | |
| No qualification | 53.2 | <0.01 | 13.3 | <0.01 | 3,693 | 74.2 |
| Primary school certificate | 48.2 | | 9.9 | | 570 | 11.6 |
| Junior secondary school certificate or higher | 43.2 | | 7.7 | | 715 | 14.4 |
| Benefitted from free maize distribution in the past three years | | | | | | |
| Yes | 53.0 | 0.02 | 13.0 | 0.66 | 1,727 | 25.8 |
| No | 49.0 | | 12.6 | | 4,958 | 74.2 |
| Factor score on household experience of shocks[1] | | | | | | |
| Low | 54.0 | <0.01 | 13.9 | 0.29 | 2,004 | 31.7 |
| Medium | 49.0 | | 12.0 | | 1,996 | 31.5 |
| High | 48.4 | | 12.5 | | 2,330 | 36.8 |
| Region | | | | | | |
| Northern | 47.9 | <0.01 | 11.7 | 0.18 | 1,093 | 16.3 |
| Central | 53.2 | | 13.7 | | 2,645 | 39.6 |
| Southern | 47.7 | | 12.0 | | 2,949 | 44.1 |
| Residence | | | | | | |
| Urban | 46.6 | 0.21 | 11.3 | 0.33 | 713 | 10.7 |
| Rural | 50.4 | | 12.8 | | 5,974 | 89.3 |

[1] This is obtained through a factors analysis of variables on whether or not the household experienced different shocks given in appendix 14. The association between household experience of shocks and child underweight and child stunting are illustrated in appendix 15

Figure 6.9 Proportion of children stunted by household annual food expenditure (IHS 2 data)

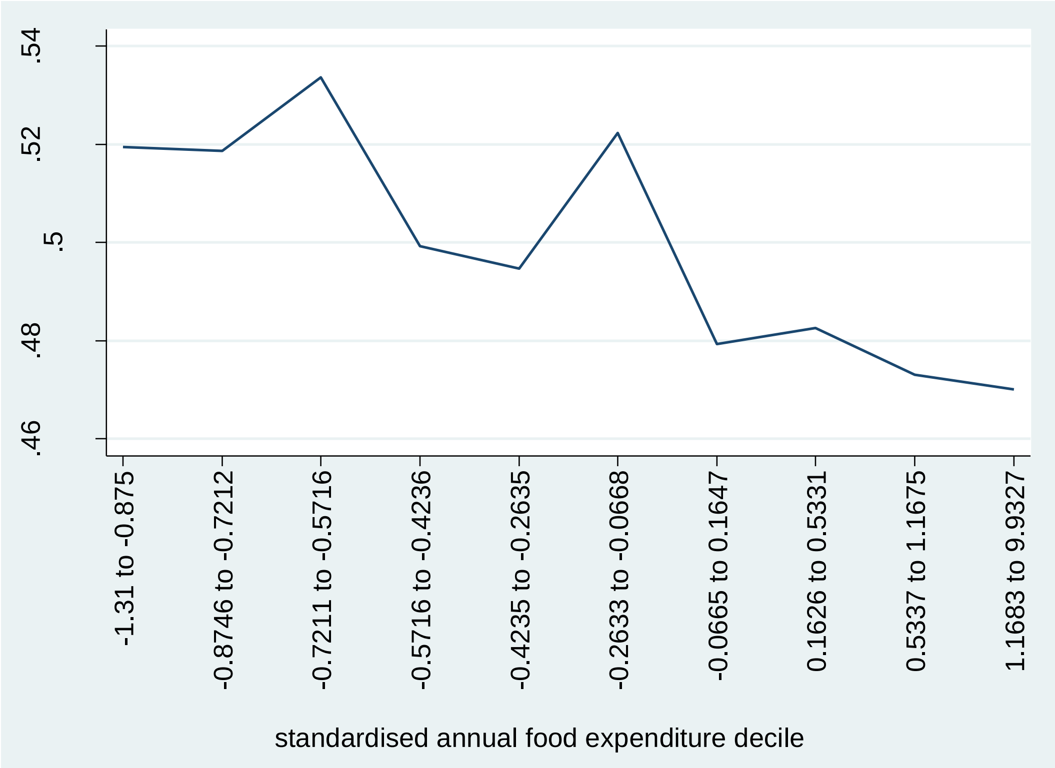
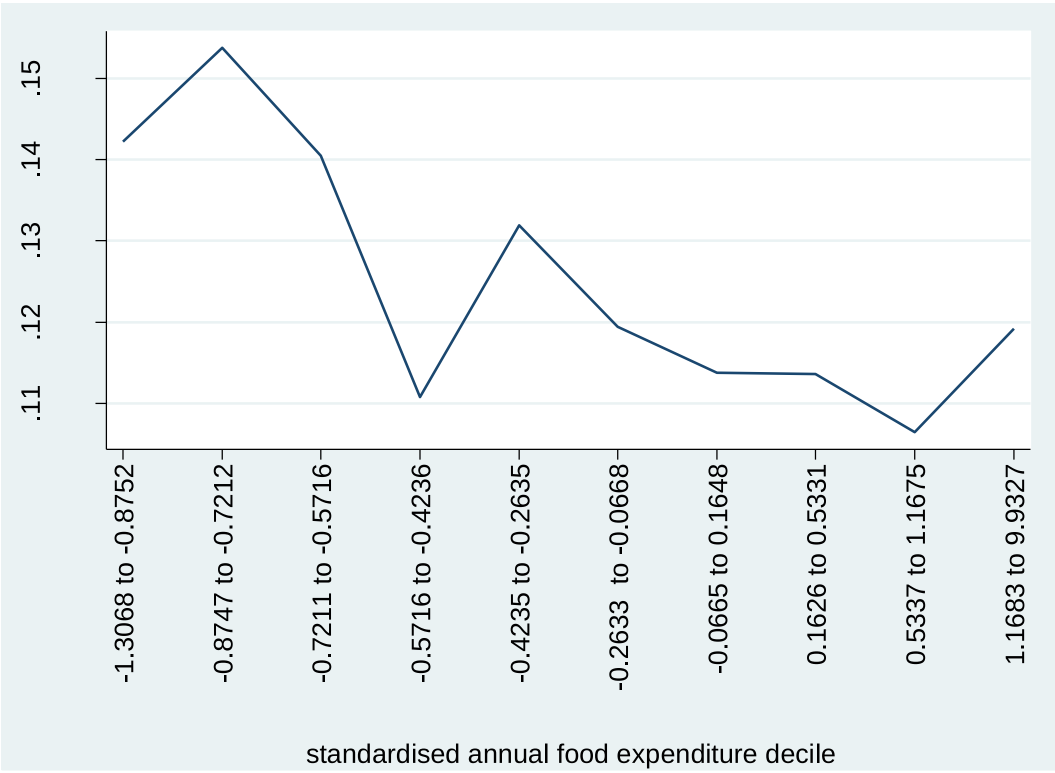



Figure 6.10 Proportion of children underweight by household annual food expenditure (IHS 2 data)



### 6.7.3 Association between stunting and underweight and community level factors

The bivariate relationship between community variables and a child's stunting and underweight status is shown in Table 6.7. There is a significant association between availability of an ADMARC and both child stunting and underweight status. The variables on proportion of households with access to safe water, ethnicity and availability of a daily market are only associated with a child's stunting status and not their underweight status. Availability of community facilities such as a health clinic, post office and telephone booth is not associated with a child's stunting nor their underweight status. Figure 6.11 and Figure 6.12 show that the relationship between the proportion of households with access to safe water and child stunting and underweight is not linear. Other community factors that were explored but turned out not to be associated with stunting and underweight are proportion of households with permanent roof and improved floor and proportion of households with a toilet and access to safe water.

Table 6.7 Percentage of Malawian children stunted and underweight by community socio-economic characteristics (IHS 2 data)

| Variable | % Stunted | Chi square p value | % Underweight | Chi Square p value | N | % |
|---|---|---|---|---|---|---|
| Availability of community facilities[1] | | | | | | |
| No facility | 51.4 | 0.06 | 12.8 | 0.71 | 3,780 | 56.6 |
| At least one facility | 48.2 | | 12.5 | | 2,899 | 43.4 |
| ADMARC | | | | | | |
| Yes | 46.2 | 0.03 | 10.4 | 0.03 | 1,116 | 16.7 |
| No | 50.8 | | 13.1 | | 5,571 | 83.3 |
| Daily market | | | | | | |
| Yes | 44.9 | <0.001 | 11.0 | 0.07 | 1,863 | 27.9 |
| No | 51.9 | | 13.3 | | 4,824 | 72.1 |
| Ethnicity (how the community trace their descendants) | | | | | | |
| Through the father | 47.2 | 0.04 | 11.4 | 0.12 | 2,146 | 33.7 |
| Through the mother | 51.3 | | 13.1 | | 4,218 | 66.3 |
| Proportion of households with protected water source | | | | | | |
| 0.73 or less | 51.5 | ` | 11.3 | 0.07 | 4,744 | 70.9 |
| More than 0.73 | 46.6 | | 13.3 | | 1,943 | 29.1 |

[1] The Community facilities variable is obtained through combining three variables on availability of a health clinic, post office and a telephone booth

Figure 6.11 Proportion of households with safe water in a community and child stunting (IHS 2 data)

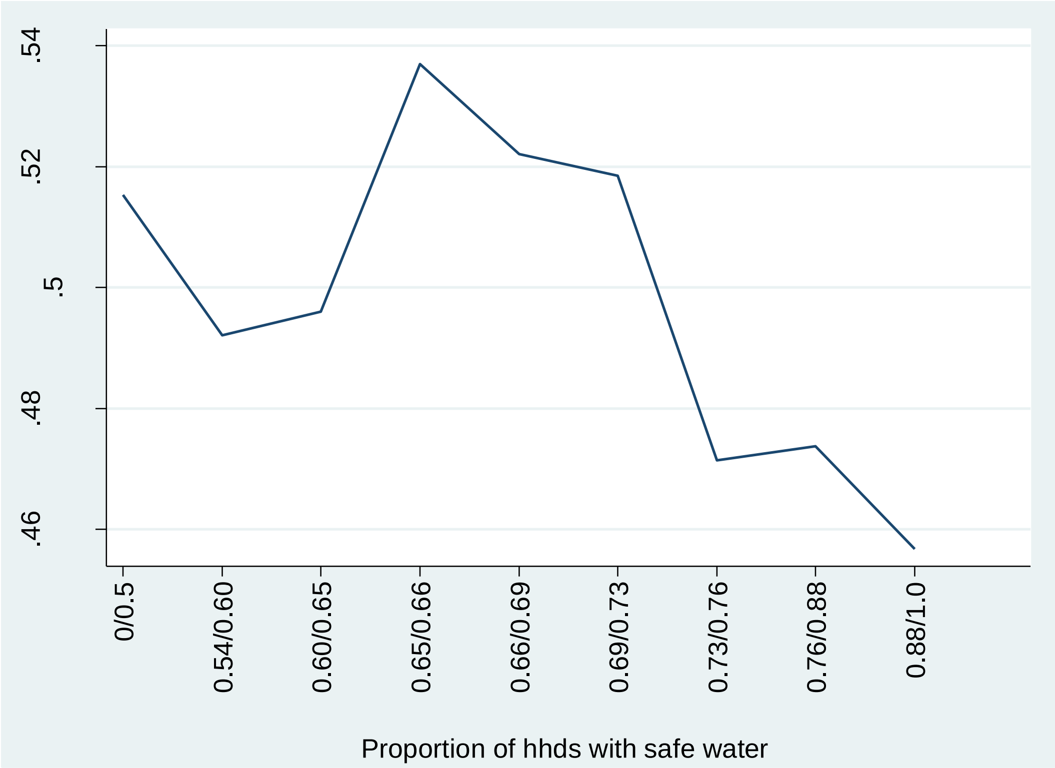
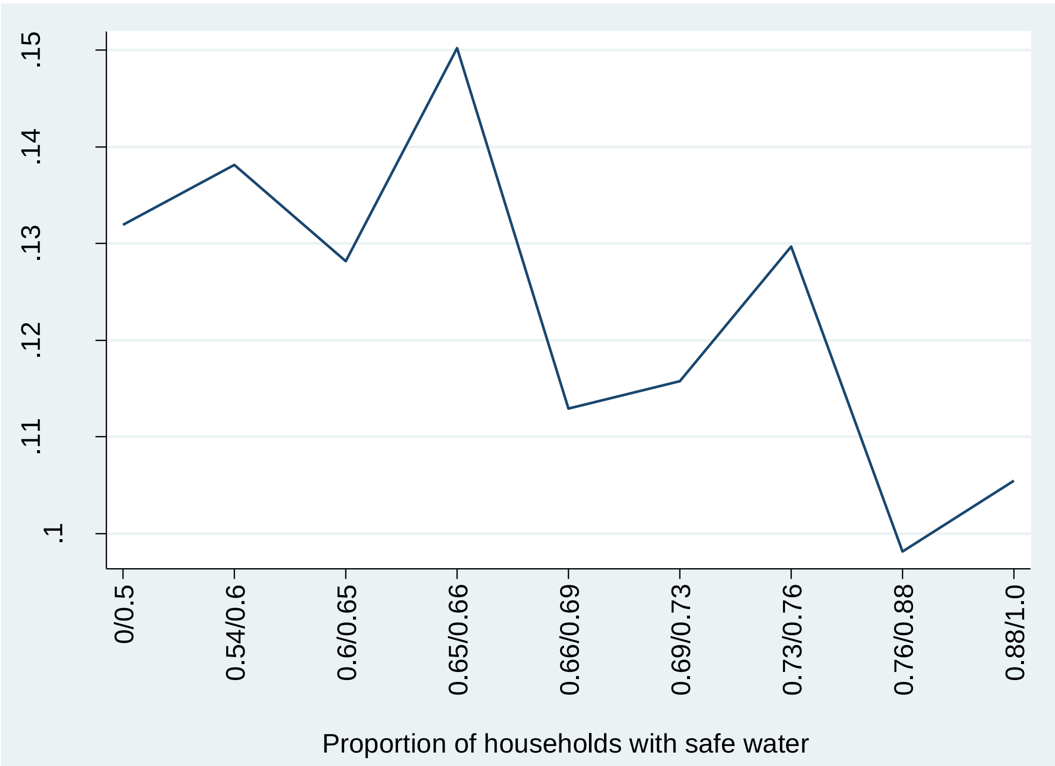



Figure 6.12 Proportion of households with safe water in a community and child underweight (IHS 2 data)



## 6.8 Variation of height for age z scores and weight for age z scores across households and communities

There is a lot of variation in the height for age z scores and weight for age z scores across households and communities, with height for age z scores showing more variation across households and communities compared to weight for age z scores as shown in Table 6.8 . Table 6.9 shows the average weight and average height of under-five children. Graphical illustration of the variation in weight for age z scores and height for age z scores across households and across communities is provided in appendices 10 to 13.

Table 6.8 Mean weight for age and height for age z scores across households and communities (IHS 2 data)

| Variable | Mean | Standard deviation |
|---|---|---|
| Weight for age z score (Households) | -0.83 | 0.93 |
| Weight for age z score (Community) | -0.83 | 0.20 |
| Height for age z score (Households) | -1.99 | 1.29 |
| Height for age z score (Community) | -1.99 | 0.30 |

Table 6.9 Weight and heights across households and communities (IHS 2 data)

| Variable | Mean | Standard deviation |
|---|---|---|
| Weight (Households) | 11.96Kg | 2.18Kg |
| Weight (Community) | 11.96Kg | 0.43Kg |
| Height (Households) | 84.06cm | 8.06cm |
| Height (Community) | 84.06cm | 1.56cm |

## 6.9 Multivariate analysis of household and community level socio-economic risk factors for child undernutrition.

Based on the exploratory analysis presented in sections 6.4, 6.7 and 6.8 multivariate analysis is undertaken to identify household and community level socio-economic factors that are significantly associated with a child stunting and underweight. A fixed effect model is used for underweight because there is no significant variance of underweight across housheolds and communities. On the other hand there is significant variance of stunting across community levels and therefore a variance component model is used. The results of the multivariate analysis for stunting model are given in Table 6.10 whilst the multivariate analysis results for the underweight model are shown in Table 6.11. Results from the two tables show that at the household level, quality of housing is a significant influencing factor for both a child's stunting and underweight status. This factor is particulary more important to a child's underweight status compared to a child's stunting status. The odds of being underweight amongst children from households that have a permanent roof and improved floor are 51% lower than the odds for children from households that do not have both an improved floor and permanent roof whilst the likelihood of stunting amongst children from households with an improved floor and permanent roof is 28% lower compared to children from households that do not have a permanent roof and improved floor. Household food expenditure is only significantly associated with a child's stunting status. A one unit increase in the household's mean z score of food expenditure is associated with a reduction in the odds of stunting by 14%. The variable on sanitation (access to safe water and availability of a toilet) is only significant in the stunting model. Children from housheolds that have a toilet and access to safe water are 14% less likely to be stunted compared to children from households that do not have both a toilet and protected water source. It is interesting to find that the housheold sanitation variable is not a significant factor in the underweight model. This may be because household sanitation influences a child's likelihood of being ill, and child illness already emerges as an important factor in the underweight model.

At community level it is ethnicity and availability of a daily market that are significantly associated with a child's stunting status. Children from communities that trace their descendants through the mother have a 32% higher likelihood of being stunted compared to children from communities that trace their descendants through their father and children from communities that have a daily market have a 18% lower likelihood of being stunted compared to children from communities that do not have a daily market. The lack of significant association between child stunting and the variable on proportion of households with access to safe water in the multivariate analysis is perhaps due to the fact that the variable on household sanitation may outweigh the importance of community level access to water. It should be noted, that if the household sanitation variable is excluded from the model, the variable on proportion of households in the community with access to safe water is significantly associated with a child's stunting status. The decision to leave the household sanitation variable in the model instead of the variable on proportion of households with access to safe water was based on the fact that the variable on household improved the fitness of the model better. This is perhaps because it is comprised of two factors, access to safe water and availability of a toilet. Period of interview is also only significantly associated with stunting. Children from households that were interviewed between September and February have a 20% lower odds of being stunted compared to children from households that were interviewed in the months of March to August.

Table 6.10 Multivariate analysis results for stunting model (IHS 2 data)

| Variable | Odds ratio stunting | 95% Confidence interval |
|---|---|---|
| Child characetristics | | |
| Female | 0.81*** | (0.71,0.92) |
| Age | 1.31*** | (1.22,1.40) |
| Agesquared | 0.70*** | (0.65,0.75) |
| | | |
| Household characteristics | | |
| Has a toilet and protected water source | 0.86* | (0.75,0.99) |
| Household annual food expenditure | 0.86*** | (0.80,0.93) |
| Has a permanent roof and improved floor | 0.72** | (0.60,0.88) |
| | | |
| Community characteristics | | |
| Community has a daily market | 0.82* | (0.71,0.96) |
| | | |
| Ethnicity: reference is descendants are traced through father | | |
| Descendants traced through mother | 1.32** | (1.11,1.58) |
| | | |
| Period of interview (September to February) | 0.80*** | (0.70,0.91) |
| | | |
| Central region | 0.95 | (0.75,1.20) |
| Southern region | 0.77* | (0.61,0.98) |

*= p value <0.05 **=p value <0.01 ***=p value<0.001

Table 6.11 Multivariate analysis results for the underweight model (IHS 2 data)

| Variable | Odds ratio underweight | 95% Confidence interval |
|---|---|---|
| Child characetristics | | |
| Child was ill | 1.23 | (1.01,1.50)* |
| Female | 0.80 | (0.65,0.97)* |
| | | |
| Household characteristics | | |
| Has a permanent roof and improved floor | 0.49 | (0.36,0.66) *** |

*= p value <0.05 **=p value <0.01 ***=p value<0.001

There is signicant variance in stunting across communities before and after adding child, household and community variables. The addition of child and household level variables reduces the variance from 0.069 to 0.056, and the variance further reduces to 0.051 when the variable on the daily market is added to the mode. This probably indicates that the availability of a daily market varies across communities. On the other hand the inclusion of the ethnicity variable to the model is associated with a higher community level variance of 0.062, which suggets little variance across communities in their ethnicity. The standard deviation for the community effect on child stunting is 0.239. The base odds of a child being stunted is 1.95. Therefore the odds for a child who lives in a community with a random effect of + 1 standard deviation of being stunted is 2.48 and the odds of a child who lives in a community with a random effect of -1 standard deviation of being stunted is 1.54.

Table 6.12 Results of the random part of the stunting model at community level (IHS 2 data)

| Level | Stunting model variance | Standard error | Base odds of child being stunted |
|---|---|---|---|
| Null model (no variables included) | **0.069** | **0.020** | |
| Only child and household level variables included (model 1) | **0.056** | **0.022** | |
| Model 1 + Daily market | **0.051** | **0.021** | |
| Model 1 + Ethnicity | **0.062** | **0.024** | |
| Model 1 + Daily market + Ethnicity | **0.057** | **0.023** | **1.95** |

## 6.10 Discussion of findings

This chapter has studied different pathways through which household and community socio-economic status influences child nutritional status in Malawi and has found that economic and environmental factors are significantly associated with a child's nutritional status at the household level and that socio-economic factors may have a significant role to play for child's nutritional status at the community level.

At the household level, children from houses with a permanent roof and an improved floor are less likely to be underweight and less likely to be stunted compared to children from households that do not have a permanent roof or an improved floor. Houses with a permanent roof are less likely to leak and therefore have less chance of having stagnant water that breeds mosquitoes and other germs or parasites that cause illness. There is a significant difference in the percentage of children that were ill in the last two weeks between children from households that have a permanent roof and an improved floor between (30.3%) and those from households that do not have both a permanent roof and an improved floor (39.4%) p value $< 0.001$, indicating that bad housing conditions could be contributing to children's poor nutritional status through increasing children's likelihood of being ill.

Children from communities that trace their descendants through their father have lower odds of stunting compared to children from communities that trace their descendants through their mother. Customarily fathers in communities that trace their descendants through the mother are obliged to provide financial assistance to their sisters' children, which is not the case with fathers from communities that trace their descendants through the father. This custom could result in lower commitment from fathers in such communities in providing for their own children as they are likely to expect uncles of their children to provide for their children rather than themselves. Due to data limitation, it is not possible to analyse if there is a significant difference in the contributions of fathers as far as caring for their children between those from communities that trace their descendants through the father and those that trace their descendants through the mother. However, Table 6.13 shows that communities that trace their descendants through the father appear to be better off economically compared to communities that trace their descendant through their mother as shown by the lower percentage of household heads with no qualification, having a higher mean annual expenditure on food and more likely to be married. It appears therefore, that it is poor economic status that puts communities that trace their descendants through their mother at a disadvantage. The fact that heads of household heads from these communities are less likely to be married entails that most households in these communities may only have one person providing for the house, such that the parent may have to divide their time between caring for the children and earning for their household.

Table 6.13 Differences in socio-economic factors by how communities trace their descendants

| Variable | Through the father | Through the mother | P value |
|---|---|---|---|
| % of household heads with no qualification | 66.8% | 80.2% | <0.001 |
| Mean z score on annual expenditure on food | 0.1040 | -0.0865 | <0.001 |
| % household heads that are not married[12] | 12.4 | 16.1% | <0.01 |

Although the variable on ' how communities trace their descendants' is significantly associated with stunting and underweight, there is little variation of this variable across communities whilst on the other hand the variable on the availability of a daily market does vary across communities. This finding shows that the difference in stunting levels across communities is partly explained by the availability of a daily market. A daily market is important as far as ensuring access to food and other household amenities such as washing powder, bathing soap, mosquito nets which are essential for maintenance of better living conditions. It provides an opportunity for households to transform their goods into cash which they can then use to prophase other household amenities and services i.e. paying transport to access better health services. Those selling in the daily markets are likely to be members of the same community and therefore availability of a daily market is in itself a sign of better socio-economic status of a community. The availability on ADMARC market is only important in the bivariate analysis. Considering that an ADMARC market is purely for the sale of agricultural produce which occurs seasonally, its contribution to household and community socio-economic status may not as significant as that of a daily market. Previous studies in Malawi have reported significant variation of underweight across communities (Griffiths *et al.*, 2004, Madise *et al.*, 1999). This study finds that the significant variation in stunting across communities in Malawi is partly explained by differences in socio-economic status across communities as a result of availability or unavailability of a daily market.

The lack of an association between the variable on proportion of households with access to safe water and a child's nutritional status in the multivariate analysis could be due to the fact that the household level variable on access to safe water and a toilet over powers the effect of the community variable on access to safe water. This is expected since the community level

[12] Those not married include the never married, divorced, separated and widowed

variable on proportion of households with access to safe water is only an aggregation of the household variable on access to safe water and the household level variable on access to safe water and a toilet has two factors included in it. The strong association between access to safe water and child stunting, however, is further shown in the analysis of child under-nutrition across the Agricultural Development Divisions. The two Agricultural Development Divisions (ADDS) that have the highest percentage of children that are stunted, Lilongwe and Kasungu, also happen to have a relatively lower percentage of households with safe water 60% and 49% respectively compared to Salima ADD which has the least percentage of children stunted and has 74% of households with safe water.

The findings of lower stunting levels amongst children from households that were interviewed in the hunger period (September to February) compared to those from households that were interviewed in the harvest season (March to August) suggest a negative association between food availability at household level and child under-nutrition status. One explanation of this unexpected relationship is that there is a lag between a child suffering from hunger and being affected by under-nutrition as a result. This is considering that stunting is as a result of chronic under-nutrition. Another explanation could be that although food availability varies across the year, food consumed by children does not really vary across the year to an extent of influencing a child's nutritional status, and that perhaps other factors such as child illness that also vary across the year are more influential than food availability. This explanation appears to be supported by the pattern shown in Figure 6.5 which shows that on average child illness are higher in the months of March to August estimated at 42.8% compared to 34.8% for the months of September to February ($p$ value $< 0.01$). The lack of association between seasonal food availability and child nutritional status has been reported in an Ethiopian study by Ferro-luzzi *et al.* (2001). On the other hand the study found that the pattern of weight for height z scores was consistent with the diarrhoea pattern. The role of infection and illness across seasons and its association with child nutritional status has also been reported by Rowland *et al.* (1977) in the Gambian children. However, the findings by Huffman et *al*. (2012) in rural Bangladesh suggest that poor nutritional status for children during and after harvest time could be due to reduced child care time. Whilst the seasonal trend in the number of hospital admissions for severely undernourished children and the number of children participating in supplementary feeding programme shown in Figure 6.5 is a reflection of food availability at the household level, the trend in hospital admissions and participation in supplementary feeding might also be a reflection of the availability of time from parents to take care of their children. Season is reported to be the only variable most closely associated with child growth in Senegal (Simondon *et al.*, 2001). The study by Simondon *et al.* (2001) found that increments in length, weight, arm circumference and triceps skinfold thickness were all significantly lower during the rainy season than during the dry season

Previous studies have also reported the importance of household socio-economic status as measured by household wealth status in a child's stunting and underweight status. This study, however, shows that pathways through which socio-economic status influences a child's nutritional status in Malawi are both economic and environmental in nature and they include household expenditure on food, housing conditions specifically quality of roofing and quality of floor, source of drinking water and availability of a toilet. Economic factors such as household expenditure on food and availability of a daily market are associated with stunting but not underweight status, whilst environmental factors such quality of housing and sanitation (access to safe drinking water and availability of toilet facilities) are associated with both underweight and stunting. The significant association between ethnicity and child's stunting and child's underweight is also more likely due to differences in economic status across communities of different ethnicities. The next chapter provides a discussion of all study findings in line with the research hypothesis outlined in section 1.6.

# CHAPTER 7 : DISCUSSION

## 7.1 Introduction

Numerous studies have been conducted in Malawi and in developing countries on the correlates of child under-nutrition. This thesis has investigated if there has been significant changes in the levels and patterns of child under-nutrition in Malawi in the years 2000 to 2010 using the 2006 WHO growth standards, it has explored the role of household behavioural influences on child's nutritional status by analysing the associations between child feeding, vaccinations and child nutritional status and has studied the pathways through which household and community level socio-economic status affects child under-nutrition in Malawi. Both stunting and underweight have been modelled bringing to light the linkages and differences of underweight and stunting but also enabling the identification of factors that are important for both short term and long term under-nutrition in Malawi.

This chapter discusses all the study findings. The discussion is done along the lines of the research hypothesis. This chapter also identifies possible areas for future research, makes policy recommendations and provides a conclusion.

## 7.2 Study findings

### 7.2.1 Levels and patterns of child under-nutrition in Malawi between 2000 and 2010.

Contrary to the hypothesis that the levels and patterns of child under-nutrition between 2000 and 2010 have not changed, the results of this study show that there has been a significant reduction of both the levels of underweight and stunting for children under the age of five between this time period. The comparison between these two time periods is reasonable and reliable considering that the height for age z scores and weight for age z scores used in the analysis of the three data sets were all based on the 2006 WHO growth standards. Stunting estimates are higher based on the 2006 WHO growth standards compared to those based on the NCHS reference whilst underweight estimates are lower compared to those based NCHS reference. Higher estimates for stunting based on the 2006 WHO growth estimates compared to those based on the NCHS reference and lower estimates for underweight compared to those based on the NCHS reference have also been reported in other locations outside the sub-Saharan Africa (de Onis *et al.*, 2006) and in rural Malawi (Prost *et al.*, 2008).

It should also be noted that Malawi experienced surplus harvests in the 2006/2007 cropping season which Denning *et al.* (2009) attributes to the intensive agricultural subsidy programme.

Whilst improvements in the food security situation in Malawi starting from the 2006/2007 cropping season could have played a part in the reduction of under-nutrition levels, a bigger contribution may have come from a combination of health related factors such as reduction in morbidity rates, increase in the number of children vaccinated, and increase in the number of children that were exclusively breastfed between 2000 and 2012 as shown in chapter 4. On another note however, the percentage of children that are stunted but not affected by other forms of under-nutrition i.e. underweight and wasting has only reduced slightly over the ten year period having only gone down by 1% from 37.2% in 2000 to 36.2% in 2010. This shows lack of progress in reducing stunting per say.

This study also finds that the pattern of child under-nutrition across children's age groups has remained the same over this time period with a sharp increase of stunting and underweight rates in the first year of life and stabilisation around the ages of two to three years as reported in previous studies conducted in Malawi and the sub-Saharan Africa (Chirwa and Ngalawa, 2008, Griffiths *et al.*, 2004, Madise *et al.*, 1999). The analysis of the variation of stunting and underweight by age group and sex reveals that although on average the likelihood of stunting and the likelihood of underweight is higher in males compared to females in all the three survey years in line with previous studies (Chirwa and Ngalawa, 2008, Madise *et al.*, 1999), significant differences in underweight between male and female children only exist amongst children aged less 24 months. This is the time when children are introduced to solids, have to receive all their vaccinations, become more mobile and more prone to illnesses. This indicates that the weaning time is more challenging for male children compared to female children in Malawi which may be attributed to biological differences as explained by Svedberg (1990) and Chen (1981).

### 7.2.2 Feeding patterns and child under-nutrition in Malawi

The findings of this study indicate that the percentage of children that are exclusively breastfed in Malawi has increased over time estimated at 53.4% in 2010 compared to 45% in 2004 and 38.1% in 2000 (p value $<0.001$). This shows good progress in the exclusive breastfeeding policy promoted by the WHO. This study did not find any significant differences in stunting and underweight rates for children that were exclusively breastfed and those that were not exclusively breastfed which could be as a result of not properly identifying the exclusively breastfed children. Not many studies have investigated the association between exclusive breastfeeding and child nutritional status probably due to data challenges. One study in this line is by Engebretsen et al. (2008) in eastern Uganda amongst children aged 0 to 11 months that reports a higher likelihood of lower weight for length z scores for children that were given pre-lacteal feeds compared to those that weren't. Whilst data limitation may have played a part in the lack of significance in the relationship between exclusive breast feeding and a child underweight and stunting status found in this study, the findings on the relationship between the number of times a child was breastfed and child underweight amongst children aged 6 months or less vindicate the role of breastfeeding in child under-nutrition in general.

Consumption of animal source foods is significantly associated with a child's underweight amongst children aged 7 to 18 months and with stunting amongst children aged 19 to 36 months possibly because the initial effect of poor nutritional status may be impairing a child's appetite and this may quickly affect a child's weight whilst the effect on their height may only occur after a longer period of time. Foods from animal sources are rich in nutrients. Not only are they a source of protein and energy, they are also a source of iron and zinc. Iron and zinc are said to be critical for normal growth, blood formation and neurological development in infancy(Krebs, 2000) whilst severe zinc deficiency may cause growth retardation, impaired appetite and increased susceptibility to infections (WHO-FAO, 2002). Whilst lack of consumption of food from animal sources may lead to poor intake of zinc for most Malawian children, the high consumption of local grain which is mostly maize could be hindering the absorption of any zinc consumed as per the findings of Manary et al. (2002) further lowering zinc nutrient levels in Malawian children.

This study has found a significant bivariate relationship between consumption of vitamin A rich foods (mango and papaya) and a child's underweight status amongst children aged 7 to 18 months. The relationship between consumption of vitamin A rich foods in child's nutritional status has been reported in Sudan (Sedgh et al., 2000) where greater growth experiences are reported amongst children in the highest quintile for consuming food containing vitamin A compared to children in the lowest quintile and the relative recovery from stunting associated with vitamin A intake was greater amongst children aged less than one year compared to children aged over three years. Although consumption of vitamin A food is not significant in the multivariate analysis, this finding signifies the higher nutritional demands for children in the weaning age.

Children that are still breastfeeding at the age of over 12 months are more likely to by stunted and more likely to be underweight similar to findings from previous studies (Simondon *et al.*, 2001, Madise and Mpoma, 1997, Marquis *et al.*, 1997, Huffman *et al.*, 1980, Fawzi *et al.*, 1998) Poor complementary feeding amongst the breastfed compared to the weaned may explain the negative association between breastfeeding and child nutritional status according to the study findings of Fawzi *et al.* (1998). Appropriate complementary feeding begins at the age of 6 months, when children should stop exclusive breastfeeding. They however need to continue breastfeeding whilst getting introduced to other nutritious foods to meet the demands of their growing body. The low consumption of food from animal sources and vitamin A rich foods and the higher consumption of carbohydrate based food from the local grain indicates that poor nutrient intake may be responsible for the high stunting and underweight rates in Malawian children.

### 7.2.3 Immunisation, Vitamin A supplementation and child nutritional status

This study has found that there has been a significant increase in the percentage of children that are fully immunised from 73.4% in 2000 to 78.6% in 2010 and the percentage of children receiving vitamin A supplements is much higher in 2010 (85.8%) compared to 2000 (71.2%). This is a step in the right direction, however, the percentage of children that were fully immunised in 2004 is lower than that of 2000 showing that the level of immunisation coverage can fluctuate from one year to another. The reason why the level of immunisation went down in 2004 is not clear at the moment, however, identifying what could have been responsible for the drop may go a long way in ensuring that immunisation levels are steadily on the increase.

The relationship between underweight and child immunisation status however, is only significant in the bivariate analysis. Similarly, vitamin A supplementation is only associated with a child underweight status in the bivariate analysis amongst children aged 7 to 18 months. This is perhaps due to the fact the multivariate analysis includes other socio-economic factors that may influence the likelihood of mothers immunising their children or ensuring that their children get vitamin A supplements i.e. household wealth status, urban/rural residence and mother education level. Higher immunisation rates amongst mothers with primary education compared to mothers without any formal education have been reported in Kenya (Abuya *et al.*, 2010). Some studies reported of an association between full immunisation and child nutritional status based on bivariate analysis studies (Zondag *et al.*, 1992, Adeladza, 2009). On the other hand, Bloss *et al*. (2004) found that having up to date immunisation was protective towards stunting after controlling for socio-economic status of households. By using a variable on up to date immunisation as opposed to full immunisation which this study and other studies have used, the study by Bloss *et al.* (2004) analysed the role of immunisation amongst all children under the age of five years. Considering that child illnesses and under-nutrition rises sharply between the age of six and twelve months, the lack of inclusion of children under the age of one year in the analysis of the role of child immunisation in child nutritional status undertaken in this study may have limited the analysis of the role of immunisation in child nutritional status in Malawi. The lack of significance of the variables on immunisation and receipt of vitamin A supplements in the multivariate analysis may also be explained by the fact that multivariate analysis includes the variable on possession of child health card which is significantly associated with child underweight.  This variable  may have picked up the effect of child immunisation and vitamin A supplements considering that mothers with a child health card are more likely to be attending health services and therefore more likely to immunise their children or ensure that their children receive vitamin A supplements.

The lack of association between receiving vitamin A supplements and child nutritional status has previously been reported in Malawi (Kazembe and Katundu, 2010) whilst one study conducted in Indonesia reports of relatively better anthropometric scores in children that had received supplements compared to those that had  not (Berger *et al.*, 2007).  There are quite a few studies however, that report of an association between receipt of vitamin A supplements and improvement of the immune status or reduction of morbidity (Lima *et al.*, 2010, Shankar *et al.*, 1999, Hussey and Klein, 1990, Sempértegui *et al.*, 1999) suggesting that the link between vitamin A and child nutritional status is through reduction of morbidity.  It is therefore not surprising that an association between receiving vitamin A supplement and child underweight was only found in the bivariate analysis of these two variables amongst children aged between 7 to 18 months where the likelihood of illness is much higher. Interestingly though, Sempértegui (1999) reports of an association between receiving vitamin A and child's diarrhoea only amongst children aged 18 to 23 months in his study of children aged 6 to 36 months in Ecuador. This shows that the age dependent effect of vitamin A on child immune status may vary across locations.

The percentage of mothers possessing a child health card has remained consistently high at 84.8 % in 2000, 85.0% in 2004 and 85.2% in 2010 showing a positive trend in children's access of health services.  More mothers from urban areas have a child health card (88.9%) compared to mothers from rural areas (83.1%) p value < 0.001 and more educated mothers have a health card compared to those with no education.  The percentage of mothers with secondary education or higher that possess a health card is 90.4%, for those with primary education its 85.1% and for those with no education its 78% p value <0.001.   The relationship between mother possessing a health card and a child nutritional status may therefore be indirect through the fact that mothers that possess a child health card are more likely to be of a higher socio-economic status or direct in that mothers who have a child health card are more likely to be attending under-five clinics where they get advice on child care and better management of child illnesses as well as exclusive breastfeeding.

### 7.2.4 Household and community level socio-economic influences and child nutritional status in Malawi

The findings of this thesis show that economic status is influential in child nutritional status at both the household and the community level. An increase in the mean household annual food expenditure is associated with a reduction in the odds of stunting and households that are categorised as richest have lower odds of stunting and lower odds of underweight compared to households that are identified as poorest. Children from communities that have a daily market are less likely to be stunted and underweight compared to children from communities that do not have a daily market. Children from communities that trace their descendants through their mother have a higher likelihood of underweight and a higher likelihood of stunted compared to children from communities that trace their descendants through their father. Average household annual food expenditure and number of household heads with a qualification is lower in communities that trace their descendants through the mother compared to communities that trace their descendants through their father. Access to animal source foods requires one to have money and most of the households in Malawi are poor and therefore may not afford foods from animal sources. Rural areas are on average poorer than urban areas. A comparison between the rural areas and urban areas shows that 45.8% of children in the age group of 7 to 18 months from urban areas consumed foods from animal sources at least once in the 24 hours prior to interviews whilst the percentage from rural areas is 34.1% (p value 0.003). Poor economic status may therefore partly explain children's poor nutritional status in Malawi. The association between socio-economic status and child nutritional status has reported in previous studies in Malawi (Madise and Mpoma, 1997, Madise *et al.*, 1999, Chirwa and Ngalawa, 2008) and in other settings (Janevic *et al.*, 2010, Bloss *et al.*, 2004, Hong *et al.*, 2006, Hong and Mishra, 2006).

The significant relationship between household food expenditure and child stunting found in this study shows that what the household consumes trickles down to the children. As shown earlier on, children from urban areas that are on average richer, consume more foods from animal sources compared to children from rural areas that are poorer on average. However, it also means that mothers from households that have higher food expenditure may have a better nutritional status compared to mothers from households that spend less on food by having a good weight in relation to their age. Good nutritional status in childhood may also have an impact on adult's height. This study has found that mother's weight and mother's height are important associates of underweight and stunting respectively across all ages indicating that the influence of mother's nutritional status goes beyond determining a child's size at birth to determining a child's height and weight as they grow regardless of environmental or socio-economic factors. The importance of mother's height and mother's weight in child nutritional status has been reported in various studies (Özaltin et al., 2010, Espo et al., 2002).

Stunting and underweight significantly varies across the three regions of Malawi which is a result similar to previous studies (Chirwa and Ngalawa, 2008, Madise and Mpoma, 1997, Madise *et al.*, 1999). However, this study found that differences in the likelihood of stunting and the likelihood of underweight across the three regions depend on the age group of children and whether the modelling takes into account community level factors. Findings from the MDHS pooled data sets of 2000, 2004 and 2010 show that children from the northern region have a lower likelihood of underweight and a lower likelihood of stunting compared to children from the central region. However based on the 2004 MDHS data for children aged 0 to 6 months, there is no significant difference in the stunting and underweight status between children from the northern region and those from the central region but children from the southern region have significantly higher odds of stunting compared to children from the northern region. Amongst children aged 7 to 18 months, children from the southern region have a higher likelihood of stunting compared to children from the northern region. There are no significant differences in the likelihood of stunting and the likelihood of underweight across the three regions amongst children aged 19 to 36 months. This may imply that children from the southern region may be highly affected by the challenges of weaning compared to those from the northern region.

On the other hand, findings from chapter six based on the analysis that controls for community factors show that in general the odds of stunting are actually lower in the southern region compared to the northern region and that there is no significant difference in the odds of stunting and the odds of underweight between children from the northern region and those from the central region. Since the majority of communities from the northern region trace their descendants through the father, and the odds of underweight and that of stunting are lower amongst communities that trace their descendants through the father compared to communities that trace their descendants through their mother, perhaps this finding depicts that the lower odds of stunting and underweight amongst children from the northern region are largely as a result of the economic advantage that is associated with communities in the northern region tracing their descendants through their father as explained in section 6.10.

The two community factors that are significantly associated with child stunting and underweight are socio-economic i.e. availability of a daily market and how the community trace their descendants (considering that it has been observed in section 6.10 that there is significant difference in the economic status of communities that trace their descendants through their mother and those that trace their descendants through their father). Whilst it is expected that availability of community facilities such as a health facility should be associated with a better nutritional status for children, this study does not find availability of community facilities to play an important role in child's nutritional status in Malawi. This is probably because there could be cases where health facilities may not have adequate medical facilities i.e. no medicine, no laboratory and inadequate staff in which case, when such facilities are required, community members may have to travel to places where adequate facilities are available. It is therefore no wonder that existence of a daily market in a community emerges as the most significant community factor. Previous studies report of significant variation of under-nutrition across households and communities in Malawi and other settings (Madise and Mpoma, 1997, Madise *et al.*, 1999, Griffiths *et al.*, 2004, Pongou *et al.*, 2006) but not many studies have analysed community level factors associated with child nutritional status. The study by Pongou *et al.* (2006) reports that community environment was a significant factor associated with child nutritional status in Cameroon.

The analysis of association between community socio-economic factors and child under-nutrition in Malawi shows that the inclusion of the variable on the existence of a daily market in the community level model reduces the variance of stunting across communities. This appears to suggest that a daily market is an important factor as far as the variation of stunting across communities. Daily market is also an important factor as far as predicting the likelihood of stunting across communities. On the other hand whilst ethnicity is a significant predictor of stunting across communities, its inclusion in the model increases the community level variance. This is perhaps because ethnicity may influence child care practices in many ways i.e. environment, economic which vary a lot across communities.

### 7.2.5 Seasonality and child under-nutrition in Malawi

We learn from this study that whilst there is a significant variation in child stunting across seasons in Malawi, child stunting rates are significantly higher in the period after harvest (March to August) compared to the lean cropping months of September to February. On the other hand although underweight rates follow a pattern similar to that of stunting rates, the difference in underweight rates across seasons is not significant. The finding of higher stunting rates in the period after harvesting is very interesting as it shows that seasonal household food availability may not be an important factor in child stunting. This finding is similar to a previous study in Ethiopia (Ferro-luzzi *et al.*, 2001). No study has analysed the relationship between season and child under-nutrition in Malawi. The seasonal variation in stunting found in this study appears to follow the trend in child illnesses with stunting levels being significantly higher in periods where on average child illness is significantly higher (March to August) compared to the period where child illness is significantly lower (September to February) in line with previous studies (Panter-Brick, 1997, Rowland *et al.*, 1977, Simondon *et al.*, 2001).

The finding that the period of the year with higher annual food expenditure (March to August) has higher odds of stunting compared to the period with lower mean annual food expenditure (September to August) has probably got more to do with the fact that the high annual food expenditure during the harvest time is associated with a higher consumption of foods from crops such as maize, beans, and potatoes. These may not be that important in a child's nutritional status based on the findings of the importance of consuming foods from animal sources and a variety of food to a child's nutritional status. This finding ties in with the finding that the two ADDs that have the highest underweight and stunting rates also happen to have the highest mean annual food expenditure. Although it is expected that after harvest time households should have more money after selling their produce and therefore more able to purchase food from animal sources compared to the lean months, it is possible that since animal source foods are expensive, once they are accessed the quantities might not be adequate for each member of the household. Expenditure on animal source foods however may not be expected to vary a lot through the year, and may form a bigger proportion of expenditure of food for households that can afford to buy animal source foods such that it could be a major contributory factor in the difference in the stunting levels of those that spend more on food compared to those that spend less on food.

The seasonal analysis of under-nutrition and its association with seasonal food expenditure has also brought to light the fact that poor child care may play a part in poor child nutritional status observed during the harvest time. During harvest time parents have to spend long hours harvesting and processing crops and may as a result spend relatively less time to take care of their children compared to the hunger season. During the field work that was conducted in June 2012, it was mentioned by one of the officers working on the Community Management of Acute Malnutrition (Mrs Mphatso Mapemba) that it is common for parents from Kasungu district to deliberately miss attendance of hospital appointments for their undernourished child during the busy tobacco harvesting period. Children may therefore not necessarily benefit from better household food security during the harvesting periods. Whilst it is expected that under-nutrition rates should be higher in the lean months, parents' willingness to be hospitalised considering they may not have much to do at home may also be a contributory factor to the higher number of admissions shown in Figure 6.5. A study on breastfeeding patterns in rural Bangladesh reports of a seasonal trend in suckling time with mothers reducing suckling time during the harvest season(Huffman *et al.*, 1980). The absence of severely undernourished children from households during the survey period and the high numbers of children participating in supplementary feeding programme may have contributed to the significantly lower stunting levels in the period of September to February shown in this study.

## 7.3 Future research

Data limitations explained in section 3.3.1 may have played a part in the lack of significance of some factors that were analysed in this study. Future studies may improve on the analysis undertaken in this study through the use of more accurate and reliable data as well as through the collection of fresh data.

Identification of the exclusively breastfed children and the non exclusively breastfed children can be better based on a question that asks the mother if the child is exclusively breastfed or not which can be easily incorporated in future MDHS questionaires. Such information would be more accurate than basing it on consumption in the last 24 hours. The other option would be use of diaries where mothers would record what a child consumed for at least a period of two weeks. This however would only be practical for smaller surveys.

Quantity of milk consumed whilst breastfeeding is an important factor in child nutritional status and the only way of measuring quantity from the data used in this study is through assuming that children that were breast fed a lower number of times were fed for longer and therefore consumed more compared to children that were breastfed for a higher number of times. It is perhaps the best possible way of estimating amount consumed in a large national level survey. Future smaller scale surveys could attempt to estimate the amount of time the mother actually spend suckling their child which would be a better measure of quantity consumed.

Most children aged 7 to 18 months are mostly consuming local grain foods as oppossed to the nutritions animal source foods and vitamin A rich foods. This may be due to poverty but lack of awareness could play a part as well. Considering that consumption of animal source foods and consumption of a wider variety of foods is associated with child underweight amongst children aged 7 to 18 months and with stunting amongst children aged 19 to 36 months, future work could explore further how mothers decide what food they offer to their children during the weaning time taking into account availability of such foods.

Analysis of levels and patterns of child undernutrition and associated factors in 2000, 2004 and 2010 shows that immunisation levels and the perecentage of children receiving vitamin A supplements were lower in 2004 compared to 2000. Future research could investigate records related to the implementation and management of the immunisation programme to iron out what was responsible for the drop in immunisation levels and the percentage of children receiving vitamin A supplements in 2004. Such information would feed into the preparation of future immunisation programmes and ensure that there is continued increase in the number of children that are immunised and those that are receiving vitamin A supplements.

The analysis of the 2004 Malawi Demographic and Health Survey data shows that amongst children aged 36 months or more, the likelihood of underweight is higher for female children compared to male children but the difference is not statistically significant. Considering that a similar pattern appears in the findings of the analysis of the 2010 Malawi Demographic and Health Survey but with a wider gap, future studies should continue to explore whether amongst children aged 36 months or more the difference in the likelihood of underweight between male and female children is significant or not. Continued study of this issue would be important to clarify if there is need for investigations of how food and child care are allocated between male and female children in Malawi.

One important community factor associated with child underweight and child stunting relates to how communities trace their descendants. The anaysis suggests that mean annual household food expenditure z score is significantly higher in households from communities that trace their descendants through the father compared to households from communities that trace their descendants through their mother. It also shows that more heads of households from communities that trace their descendants through the father have a qualification compared to heads of households from communities that trace their descendants through their mother. This shows that communities that trace their descendants through their father have better economic status compared to communities that trace their descendants through their mother and that may be what is responsible for better nutritional status of children from communities that trace their descendants through the father compared to children that trace their descendants through the father. However, customs and traditional practices amongst communities that trace their descendant through the mother oblige men regardless of their marital status and whether they have children or not to support children of their sisters in their day to day needs such as education, clothing, food etc. It is, however, not known to what extent such customs are followed in communities that trace their descendants through their mother and if so, how fathers from such communities decide how much to allocate to their sisters' children vis a vis their own children. Future work can investigate the inter and intra household allocation of resources amongst households from communities that trace their descendants through their mother to establish to what extent such practices exist in Malawi and their implication for household welfare and children's nutritional status.

The community level variables analysed in this study are mainly economic and their inclusion in the model does not affect the level of variation in child stunting. The analysis undertaken in this study therefore may have not fully explored factors that are responsible for the differences in stunting across communities. Possible future work along these lines could investigate the association between environmental related illnesses such as bilharzia and schistosoma haematobium and child underweight and stunting status at the community level. Schistoma mansoni infection is reported to have been one of the most relevant factors for the high prevalence of stunting in Brazil (Assis *et al.*, 2004). Similarly, further investigation may be made on the association between child stunting and their anaemia status since the exploratory analysis undertaken in chapter 4 found that children with anaemia have a significantly higher likelihood of stunting compared to those without anaemia whilst the association between child underweight status and their anaemia status was not significant. Poor nutrient intake through reduced intake of iron rich foods e.g. food from animal sources and infections with parasites may contribute to anaemia.

## 7.4 Policy recommendations

Good progress has been made in the implementation of health programmes such as child immunisation, vitamin A supplementation, exclusive breastfeeding, improving access to safe water and sanitation programmes. Such good advances may have contributed to the reduction in underweight and stunting levels between 2000 and 2010. More work however needs to be done to ensure 100% coverage for full immunisation, safe water and use of a toilet. Little progress has been made in the reducing the number of children that are stunted but are not affected by underweight or wasting, more research therefore is required to identfy the characteritics of children in this group.

One of the strategies for reducing under-nutrition in Malawi is promotion of optimal feeding practices for children aged 6 to 24 months through giving approriate complementary feeds. Mothers are advised to feed children a variety of foods from the six food groups of protein, fats, carbohydrtaes, vegetables, fruits and legumes. This is an appropriate policy for Malawian children considering that this study has found that consumption of a wider variety of food is associated with better weight for age z scores amongst children aged 7 to 18 months and with better height for age z scores amongst children aged 19 to 36 months. However, this study has also found that consumption of food from animal sources is also associated with better weight for age z scores for children aged 7 to 18 months and better height for age z scores for children aged 19 to 36 months.  Focusing on encouraging mothers to feed weaning children food from animal sources might be a more straight forward message for mothers to follow and therefore could be more efffective in  tackling child undernutrtion in Malawi.

The seasonal trend in hospital admissions for severely undernourished children participating in supplementary feeding programem  in Malawi shows that there is more attendance in the nutritional rehabilitation unit and a higher participation in the supplementary feeding programme  in the hunger months of January and Februray and lower  attendance during the harvest period of March to August.   However, this pattern may not be a good reflection of the trend in child nutrtional status in Malawi considering that parents might shy away from attending hospital appointments during the harvest time as a result of being busy with their harvest work.  The community outreach programme which is implemented by the Ministry of health should be intensified during the harvest time to carter for children whose parents may give priority to their harvest work rather than caring for their children.

One strategy to improve the health status of Malawian children is to ensure bettter housing conditions.  Houses with a permanent roof and improved floor ensures a clean environment and do not promote infestation of parasites.  However, most of the households can not afford better housing conditions due to poverty.  The  only way to achieve better housing conditions in the long term would be for the Malawi Governmnet to continue with investing in education especially the kind that provides entrepreneurship skills to boost the economic  status of housholds in Malawi.

This study has shown that children from communities that have a daily market are less likely to be stunted compared to children from communities that do not have a daily market, a finding which emphasizes the importance of economic status in child nutritional status. Communities should be encouraged to set up markets as this encouarges establishment of businesses which do not only improve the community's economic status but also ensures availability of food and other houshold items.

Household heads from communities that trace their descendants through their mother are less qualified  compared to household heads from communities that trace their descendants through their father which could be contributing to lower nutritional status for children in these communities.  These communities should be targeted with campaigns that encourage parents to send their children to school which is important for better economic status in future but also may increase awareness in good child care practices.

## 7.5 Conclusion

There has been a significant reduction in the levels of stunting and underweight in Malawi between the years 2000 and 2010 although the levels remain high. On the other hand, the percentage of children that are stunted but are not underweight nor wasted, has hardly changed indicating little progress in tackling stunting per say. The likelihood of stunting and underweight is higher for male children compared to female children amongst those aged 24 months or less whilst for children aged more than 24 months the differences in stunting and underweight are not significant.

The percentage of children that are exclusively breastfed has gone up between the years 2000 and 2010. However, challenges exist as far as complementary feeding is concerned. Most children of the weaning age feed on carbohydrate rich local grain as opposed to nutrient rich foods from fruits and animal sources. The significant association between consumption of food from animal sources and child nutritional status suggest that an increase in the number of children consuming animal source foods may significantly contribute to the reduction of underweight and stunting in Malawi.

Child immunisation rates and number of children receiving vitamin A is pretty high in Malawi. A significant association between child underweight and their immunisation status as well as receiving vitamin A however only appears in the bivariate analysis possibly because such factors operate through socio-economic factors which are significant associates of stunting and underweight in the multivariate analysis. The fact that the association between vitamin A and child underweight is only significant amongst children aged 7 to 18 months suggests that vitamin A supplementation in Malawi may be most effective amongst this age group compared to all other age groups.

Stunting is significantly associated with household food expenditure and community socio-economic status in Malawi. Communities that trace their descendants through the father are better off socio-economically compared to communities that trace their descendants through the mother and this may explain why children from communities that trace their descendants through the father are less likely to be stunted compared to children from communities that trace their descendants through the mother. A daily market is an important factor that explains the variation of stunting across communities in Malawi.

Child stunting varies significantly across seasons in Malawi, however the seasonal pattern of stunting is similar to that of childhood illnesses but not that of food availability. Stunting levels are significantly higher in the months of March to August and lower in the months of September to February.  Apart from change of weather explaining the higher child illness in the period of March to August, reduced maternal care during the busy harvesting period may also contribute to poor child nutritional status in this period.

# APPENDICES

Appendix 1a Table of Literature Review: Child level factors (Nutrient Intake)

| **Journals searched** | **Year of Publication and study areas** | **Author** | **Methodology and sample size** |
|---|---|---|---|
| | 2003, General nutrition issues | Smolin and Grosvenor | |
| **European Journal of Clinical Nutrition** | 1980 | Martorell and Klein | Small scale randomised study |
| **The Journal of Nutrition** | 2000, Sudan Vitamin A | Sedgh *et al.* | randomised study involving 8174 children |
| " | 2003,Ethiopia,zinc | Umeta *et al.* | Survey on two rural districts |
| " | 2007, Indonesia, vitamin A | Berger *et al.* | Comparison of beneficiaries and those who did not benefit |
| " | 2000 | Krebs | Literature review |
| Journal of Pediatric Gastroenterology and Nutrition | 2010, Brazil | Lima *et al.* | A Prospective randomized, double-blind, placebo-controlled Trial |
| The Lancet | 1999, Papua New Guinea | Shankar et al. | Randomised double blind, Placebo controlled |
| " | 1986, Indonesia | Sommer *et al.* | Randomised trial involving 450 villages |
| **Maternal and Child Nutrition** | 2009,Ethiopia | Gibson *et al.* | Convenience sample of 100 infants |
| **British Journal of Nutrition** | 1970, New Guinea, role of energy and protein | Malcolm *et al.* | Small scale randomised study |
| **Report of a joint FAO/WHO expert consultation** | 2002 | WHO and FAO | |
| **British Journal of Ophthalmology** | 2003, Ethiopia | Kello and Gilbert | Eye examination to pupils attending ten primary schools for the visually handicapped |

**Summary of findings**: Whilst macro nutrients such as protein and energy and micronutrients such as vitamin A and zinc are essential for body repair and growth, there is inconsistency across studies as to the effectiveness of vitamin A and zinc in improving the nutritional status of undernourished children perhaps because in most of the studies, the intervention may have been undertaken in children not really deficient in zinc or vitamin A.

On the other hand interventions relating to iron supplementation are consistently positive. Interventions involving a large set of vitamins and minerals might be a solution for undernourished children in cases where the nutrients lacking are not known

Appendix 1b Table of Literature Review: Child level factors (Illnesses)

| Journals searched | Year of Publication and study areas | Author | Methodology and sample size |
|---|---|---|---|
| **Nutrition Reviews** | 2008 | Guerrant | |
| **British Journal of Nutrition** | 1996 | Hoare *et al.* | |
| **Report** | 2009 | Unicef-WHO | |
| **Nutrition Journal** | 2011, Malawi | Weisz *et al.* | |
| **International Journal of Epidemiology** | 2008, Countries studied: Bangladesh, Peru, Guinea Bissau, Brazil and Ghana | Checkley *et al.* | Multi-country analysis of longitudinal information of nine prospective studies on childhood diarrhoea and stunting |
| **European Journal of Clinical Nutrition** | 2009, South Africa | Chahagan *et al.* | Rural South Africa |
| " | 2004, Brazil | Assis *et al.* | Small scale randomised study |
| **BMC Public Health** | 2010, Serbia | Janevic *et al.* | National level cross sectional data (1192 children) |
| **South African Journal of Economics** | 2008, Malawi | Chirwa and Ngalawa | Cross sectional data |
| " | 1996 Cote d'Ivoire | Lucas *et al.* | Necropsy results on 78 HIV infected children and 77 un infected children |
| **The Lancet** | 1989, Bangladesh | Briend *et al.* | Longitudinal study |
| " | 1981, Nigeria | Tomkins | Cross sectional study |
| **Books** | 1981,1982 | Sommer | |
| **PLoS One** | 2010, Ethiopia | Deribew *et al.* | Cross sectional study involving 2410 children |
| **Malaria Journal** | 2010, Ghana | Crooksten *et al.* | Descriptive cross sectional study on 214 children |
| **Social Science and Medicine** | 2006, Malawi | N.B. Kandala *et al.* | National level cross sectional data |
| **Seminar presentation** | 2010, Malawi | Shawa | National level cross sectional study |
| **Report** | 1994 | International Agency for Research on Cancer | Global summaries and evaluations |
| **Population Development Studies: a journal of Development** | 1999, six sub- Saharan African countries | Madise *et al.* | National level cross sectional data, multivariate analysis, multilevel modelling |
| **Summary of findings**: Most of the studies indicate that childhood illnesses are significantly associated with stunting and underweight. Studies showing the association between stunting and diarrhoea are longitudinal. There is some suggestion that zinc supplementation may be important in reducing child morbidity and may have a role in reducing stunting. | | | |

Appendix 1c Table of Literature Review: Child level factors (Biological factors)

| Journals searched | Year of publication and study areas | Author | Methodology and sample size |
|---|---|---|---|
| **Population and Development Review** | 1981, Rural Bangladesh | Chen *et al.* | Dietary surveys |
| **Bulletin of the World Health Organisation** | 1992, North West Uganda | Vella *et al.* | Cross sectional data on 1178 children, multivariate analysis |
| **Population Development Studies : a Journal of Development** | 1999, Malawi | Madise *et al.* | National level cross sectional data, multivariate analysis, multilevel modelling |
| **South African Journal of Economics** | 2008, Malawi | Chirwa and Ngalawa | National level cross sectional data |
| **European Journal of Clinical Nutrition** | 2011, Kenya | Ndiku *et al.* | Cross sectional study in two Kenyan districts |
| **Malawi Medical Journal** | 2009, Rural Malawi | Thakwalakwa *et al.* | 767 children, longitudinal study |
| **Maternal and Child Health Journal** | 2009,USA | Datar and Jacknowitz | Longitudinal nationally representative data |
| **Nutrition Research** | 1999, Botswana | Thakaran and Suchidran | National level, cross sectional data, multivariate analysis |
| **BMC Psychiatry** | 2010a Ethiopia | Medhin *et al.* | Descriptive, Longitudinal analysis based on 1065 women from a demographic surveillance site |
| **International Food Policy Research Institute publication** | 1999, Mozambique | Garret and Ruel | National level cross sectional data, multivariate analysis |
| **Health and Place** | 2004, Six African countries and Four Indian States | Griffiths *et al.* | Multilevel comparison of DHS data from six African countries and four Indian States |
| **Journal of Development Studies** | 1990, 20 sub-Saharan African countries | Svedberg | Descriptive, Comparative, Literature review |
| **BMC Public Health** | 2010b, Ethiopia | Medhin *et al.* | Descriptive, Longitudinal analysis based on 1065 women from a demographic surveillance site |
| **Summary of findings**: Age and Sex of the child are highly associated with a child's nutritional status. There is evidence of discrimination against female children in food allocation in some Asian countries, however in most sub-Saharan countries female children appear to be better off than male children in their nutritional status due to a biological advantage. Weight at birth is also an important biological factor influencing a child's nutritional status. Better birth weight can be improved in most children from developing countries by improving maternal nutritious status during pregnancy. | | | |

Appendix 1d Table of Literature Review Household level factors

| Journal | Year of publication and study areas | Author | Methodology and sample size |
|---|---|---|---|
| **BMC Public Health** | 2010, Serbia | Javenic *et al.* | Cross-sectional national level data, multivariate analysis |
| " | 2010b, Ethiopia | Medhin *et al.* | Longitudinal descriptive study of 1065 women |
| **American Journal of Clinical Nutrition** | 2006, Uganda, Rakai district | Kikafunda and Namusoke | Small cross sectional comparative study on 100 caretakers of orphaned children |
| " | 1987, Gambia | Prentice *et al.* | Retrospective control |
| **Social Science and Medicine** | 2005, Ecuador | Larrea and Kawachi | Cross-sectional study, multivariate analysis |
| **Maternal Child Health Journal** | 2010, Kenya | Abuya *et al.* | Cross-sectional study, multivariate analysis |
| **BMC Psychiatry** | 2010a, Ethiopia | Medhin *et al.* | Longitudinal study of 1065 women |
| **The Lancet** | 2008, global and regional analysis | Black *et al.* | Literature Review (global and regional analysis) |
| **Malawi Medical Journal** | 2009, rural district from Southern Malawi | Thakwalakwa *et al.* | Longitudinal study of 767 women |
| **Population Studies: a Journal of Development** | 1999, six African countries | Madise *et al.* | National level cross-sectional DHS data from six African countries |
| **The Journal of American Medical Association** | 2010, 54 low to middle income countries | Ozaltin *et al.* | Analysis of 109 DHS data sets from 54 low to middle income countries |
| **Endocrine Research** | 2004, India | Mahajan *et al.* | Longitudinal study of 300 pregnant women attending an antenatal clinic |
| **Clinical Infectious Diseases** | 2002, Malawi | Kumwenda *et al.* | Controlled Clinical Trial |
| **BMC Public Health** | 2008, 11 countries from the sub-Saharan Africa | Uthman | Meta-analysis of DHS data from 11 sub-Saharan countries |
| **Tropical Medicine and International Health** | 2011, 18 countries from the sub-Saharan Africa | Magadi | DHS data from 18 sub-Saharan countries, multilevel logistic regression |
| **Health Policy and Education** | 1982, inter country | Cochrane *et al.* | Literature Review |
| **Disasters** | 2009, Niger | Hampshire *et al.* | Qualitative study from two districts |

Appendix 1d Table of Literature Review Household level factors continued

| Journal | Year of publication and study areas | Author | Methodology and sample size |
|---|---|---|---|
| **Food and Nutrition Bulletin** | 1997, Malawi | Madise and Mpoma | National level cross-sectional data, multivariate analysis |
| **Bulletin of the World Health Organisation** | 1987, Developing countries | Kramer | Meta-analysis |
| **South African Journal of economics** | 2008, Malawi | Chirwa and Ngalawa | Cross sectional data, regression modelling |
| **Acta Paediatrica** | 2002, Malawi | Espo *et al.* | Prospective cohort study of 613 singleton infants |
| " | 2006, Cambodia | Hong and Mishra | Binary and multinomial logistic regressions on national level cross sectional data |
| **International Journal of Equity in Health** | 2004, Uganda | Wamani *et al.* | Regression modelling on cross sectional data |
| " | 2006, Bangladesh | Hong *et al.* | Multivariate logistic regression on cross sectional data |
| **Medical Journal of armed Forces** | 2008, India | Mukherjee *et al.* | Cross sectional study for children in the army school |
| **Journal of Nutrition** | 2000, Ghana | Armar-Klemesu *et al.* | Cross sectional data from Accra, multivariate analysis |
| **Child development** | 1991, Guatemala | Engle | Bivariate analysis on data for 293 working women |
| **Journal of Tropical Paediatrics** | 2004, Kenya | Bloss *et al.* | A cross-sectional survey among 121 adults and 175 children in three villages of one district |
| **Proceeding of the Royal Society: Biological Sciences** | 2000, Gambia | Sear *et al.* | Longitudinal data |
| **International journal of paediatrics** | 2009, South India | Padmapriyadarsini *et al.* | |
| **British Medical Journal** | 1996, Cote d'Ivoire | Lucas *et al.* | |
| **Nutrition Journal** | 2006, Uganda | Bachaou *et al.* | Hospital based |
| **Summary of findings:** Household factors such as maternal education and maternal health status are very important to a child's nutritional status. Maternal education has the combined effect of affecting changes to income of the household as well as increasing the awareness of better childcare practices. Father education on the other hand seems to be important largely in increasing the household's wealth status. Maternal health status is important during pregnancy to ensure better birth weights for children as well as after birth for the child's better care. Household wealth status does explain children's nutritional status even in middle income countries such as Serbia | | | |

Appendix 1e Table of Literature Review: Community level factors

| Journal | Year of publication and study areas | Author | Methodology and sample size |
|---|---|---|---|
| **Report** | 2008 | United Nations | Analysis of national level data sets |
| **Danish Journal of Geography** | 2007, Ghana | Osumanu | Cross-sectional data of Tamale Metropolitan Area, multivariate analysis |
| **Health Population and Nutrition** | 2001, Eritrea | Woldemicael | National level, multivariate analysis |
| **Report** | 2007 | World Bank | Analysis of national level data sets |
| **Journal of Biosocial Science** | 2008, Mahashtra, India | Bawdekar and Ladusingh | District level data, multilevel modelling |
| **Disasters** | 2009, Niger | Hampshire *et al* | Qualitative study |
| **Report** | 2002 | WHO-FAO | Expert panel consultations |
| **American Journal of Clinical Nutrition** | 2001, Senegal | Simondon *et al* | Longitudinal study of 443 children |
| **BMC Public Health** | Eastern Uganda, 2008 | Engebretsen *et al.* | Cross-sectional data, multivariate analysis |
| **Maternal and Child Health** | 2010, Western Uganda | Jilcot *et al* | Descriptive statistics and qualitative study |
| **The Journal of Nutrition** | 2010, Haiti | Donegan *et al* | Comparative program evaluation |
| **Journal of Nutrition** | 2010,Mexico | Leroy *et al* | Program evaluation, double difference regression |
| “ | Northeast Brazil | Morris *et al* | Program evaluation based on 5823 households |
| “ | 2000, Mexico | Villalpando and Lopez | Longitudinal study of 170 healthy infants |
| **Food and Nutrition Bulletin** | 1997, Malawi | Madise and Mpoma | National level |
| **African Journal of Food Agriculture Nutrition and Development** | 2004,Botswana | Nnyepi and Weatherspoon,2004 | 132 children attending a welfare clinic in Gabane village |
| **International Journal of Food Sciences and Nutrition** | 2004,Tanzania | Mosha and Vicent | Experimental study |

Appendix 1e Table of Literature Review: Community level factors continued

| Journal | Year of publication and study areas | Author | Methodology and sample size |
|---|---|---|---|
| **WHO website** | 2011 | WHO | |
| **Report** | 2005, Malawi | NSO Malawi and Macro International | Cross sectional |
| | 2004, Kenya | Bloss *et al.* | A cross sectional survey among 121 adults and 175 children in three villages of one district |
| **Social Science and Medicine** | 2006, Malawi | N.B. kandala *et al.* | National level |
| " | 2005, Ecuador | Larrea and Kawachi | National level cross sectional study |
| **Public Health Nutrition** | 2010, Bangladesh | Corsi *et al.* | National level cross sectional study |
| **International Journal of Epidemiology** | 1997, Peru | Marquis *et al.* | Longitudinal data based on 134 children |
| **Acta Paediatrica** | 2001, Malawi | Vaahtera *et al.* | Cohort study of 720 new born children from a rural district in Malawi |
| **European Journal of Clinical Nutrition** | 2009, Lao PDR | Bareness *et al.* | Cross sectional study on pairs of mother and children in the capital city Vientiane |
| **African Journal of Food Agriculture Nutrition and Development** | 2006, Botswana | Maghoub *et al.* | Cross sectional national level study |
| **Summary of findings:** Facilities such as safe water and health services are very vital for good health status and yet very few households and communities in developing countries are able to access them which gives them a high risk of getting infections and suffering from illnesses such as diarrhoea. Remote communities are often affected by poor health status due to poor access to these vital facilities. Customs and traditional practices are often times influenced by the availability of resources and tend to affect child feeding practices. Improved access to health services and safe water may play a part in changing some practices that are detrimental to children's health status | | | |

Appendix 1f Table of Literature Review: Macro factors

| Journal | Year of publication and study areas | Author | Methodology and sample size |
|---|---|---|---|
| **World Bank Economic Review** | 2003 | Haddad *et al.* | Data from Egypt, Jamaica, Kenya, Kyrgyz Republic, Morocco, Mozambique, Nepal, Pakistan, Peru, Romania, South Africa and Vietnam |
| **Economics and Human Biology** | 2006, Tanzania | Alderman *et al.* | Four round panel data set from North western Tanzania |
| **Report** | 2008 | United Nations | National level data sets |
| **Agricultural Economics** | 2001 | Smith and Haddad | Panel data from 63 developing countries |
| PLoS Biology | 2009, Malawi | Denning *et al.* | Review of administrative records and literature |
| **Journal of Paediatric Gastroentorogy and Nutrition** | 2004, Malawi | Maleta *et al* | 61 underweight and stunted children, randomised trial |
| **Maternal and Child Health** | 2010, Western Uganda | Jilcot *et al.* | Descriptive statistics and qualitative study |
| **The Journal of Nutrition** | 2010, Haiti | Donegan *et al* | Comparative program evaluation |
| " | 2010, Indonesia | Sari *et al.* | |
| **Journal of Nutrition** | 2010,Mexico | Leroy *et al* | Program evaluation, double difference regression |
| **American Journal of public Health** | 2009, Colombia | Hacket *et al.* | Cross sectional household survey w |
| **Global Environmental change: Human and Policy Dimensions** | 2005, Southern Africa | Misselhorn | 49 local-level case studies on vulnerability to household food insecurity data from Sothern Africa |
| **Social Science and Medicine** | 1997, India, Nepal, Madagascar, Mexico, and Peru, | Messer | Ethnographic studies in |
| **Social Science and Medicine** | 2005, 42 countries in Latin America, Africa, and Asia. | Heaton | Cross national analysis of DHS surveys |
| **Disasters** | 1995a, Darfur Sudan | Young and Jaspers | Darfur Sudan |
| **Journal of Economic Perspectives** | 1993 | Anand and Ravallion | Literature Review |
| **South African Journal of economics** | 2008, Malawi | Chirwa and Ngalawa | Cross sectional data, regression modelling |

**Summary of findings:** Since most of the developing countries are dependent on agriculture for their well-being, good economic policies are needed to ensure that households are food secure. However food security may not be enough in dealing with under-nutrition in some communities due to the severity of under-nutrition in which case nutrition programmes could be more effective. Larger scale programmes benefitting all children that have a potential of getting undernourished would be more effective in treating and preventing under-nutrition.

Appendix 2 Comparison of T statistics for the Stunting model (IHS 2data): between design weighted logistic regression models and standard logistic regression models

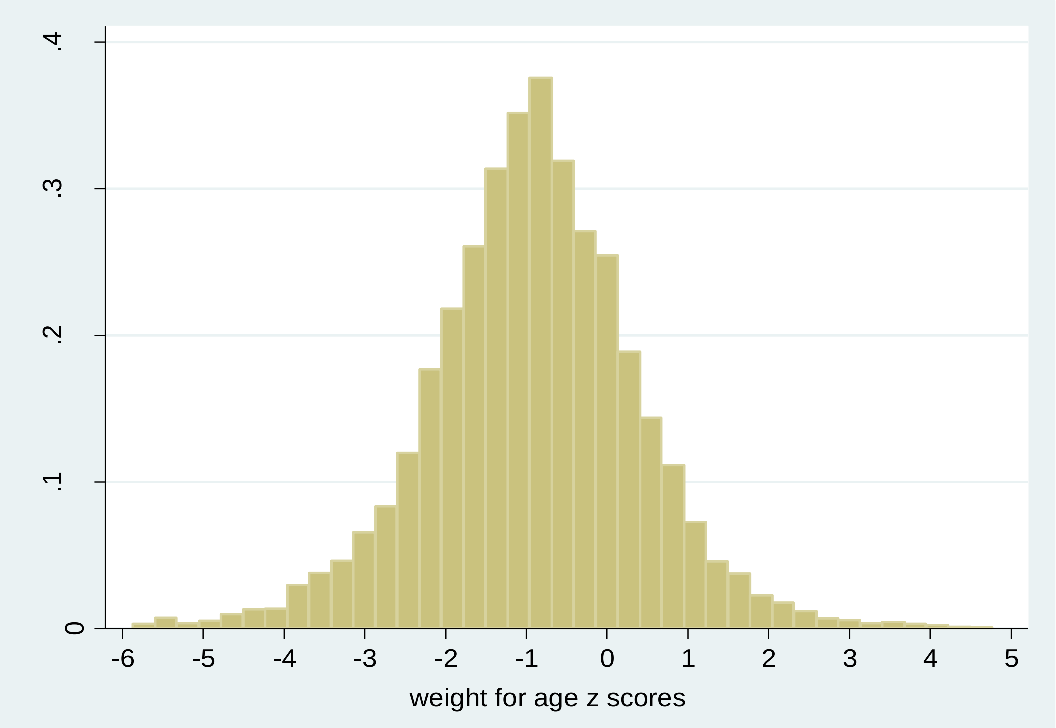
| | MLwiN Single Level | Stata design Weighted Single level | MLwiN Community Level |
|---|---|---|---|
| Sex | -3.40 | -2.92 | -3.33 |
| Age | 7.63 | 7.66 | 7.69 |
| Age squared | -9.53 | -8.51 | -9.50 |
| Period of interview | -3.59 | -2.70 | -3.34 |
| Food expenditure | -3.76 | -3.58 | -3.79 |
| Housing | -3.06 | -3.44 | -2.99 |
| Sanitation | -2.37 | -2.40 | -2.16 |
| Descendants | 3.38 | 3.14 | 3.08 |
| Daily market | 2.67 | 2.08 | -2.42 |
| Region2 | -0.74 | -0.94 | -0.44 |
| Region3 | -2.22 | -2.14 | -2.10 |
| Residence | 0.11 | -0.94 | 0.41 |

Appendix 3 Description of how wealth status variable was computed

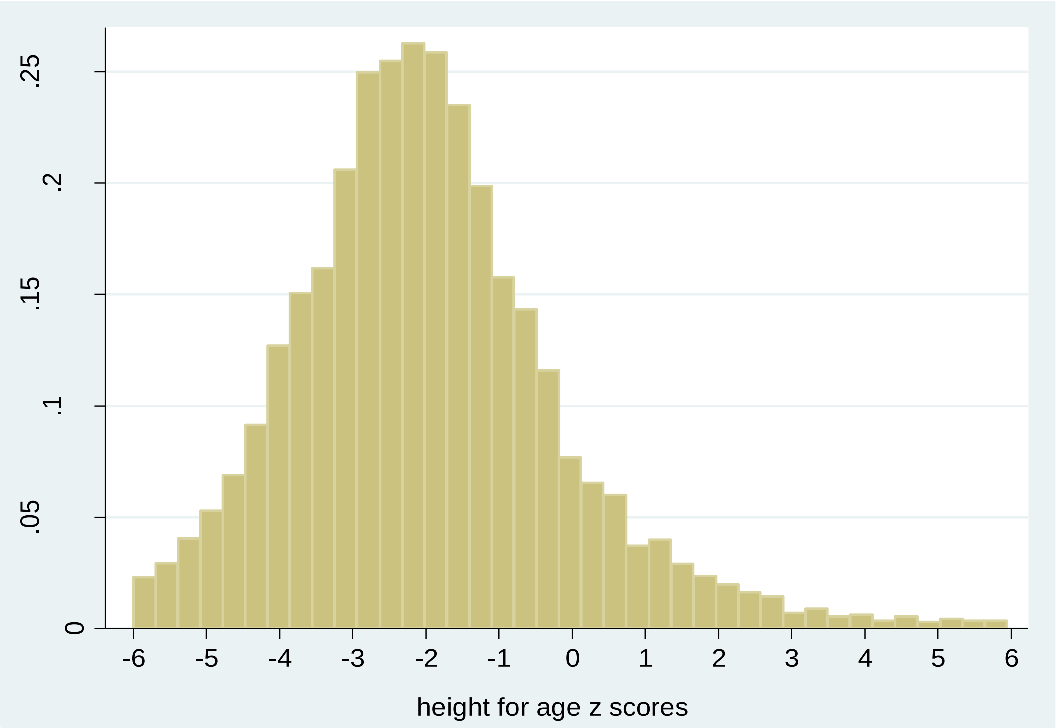
The wealth status variable is computed by obtaining wealth quintiles separately for Rural and Urban and merging the two files together after. Wealth quintiles are obtained by first undertaking a factor analysis of the following variables; type of toilet facility, ownership of a bike, type of floor material, ownership of livestock, source of drinking water, number of sleeping rooms, ownership of a fridge, ownership of a table with chairs, ownership of a radio.

The urban areas had more assets used in the formulation of the wealth quintile compared to rural areas as in most cases over 95% of households in rural areas did not own a particular asset or used a particular resource. Once the factor analysis was undertaken, factor scores were used to obtain quintiles. The wealth quintiles are the basis of the five categories of the wealth status variable

Appendix 4 Histogram of weight for age z scores from the 2004 DHS data




Appendix 5 Histogram of height for age z scores from the 2004 DHS data

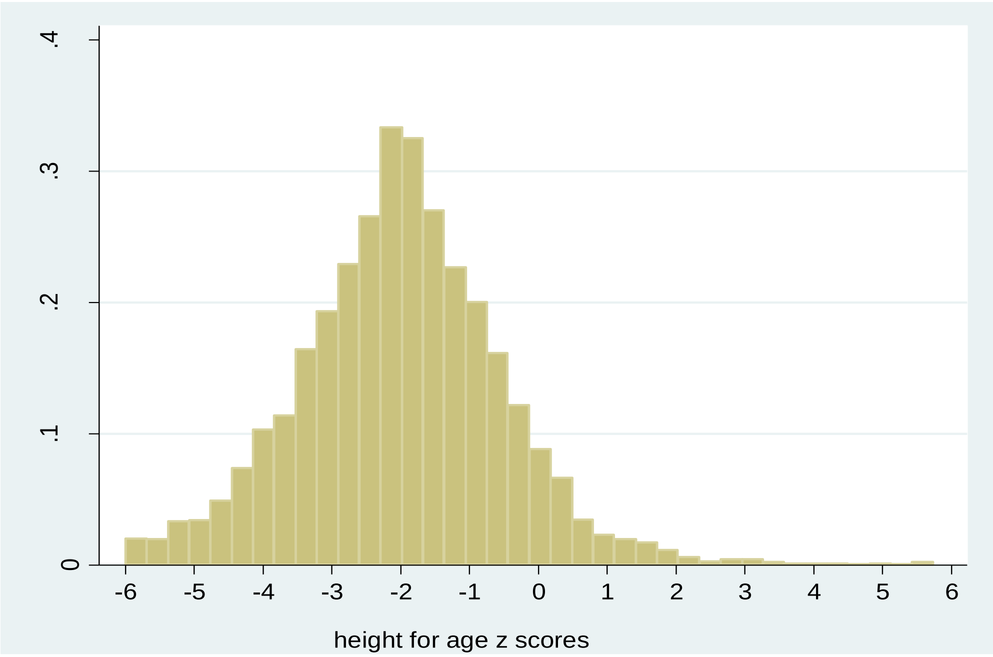


Appendix 6 Statistical test of the normality of the height for age z scores and weight for age z scores from the 2004 DHS data

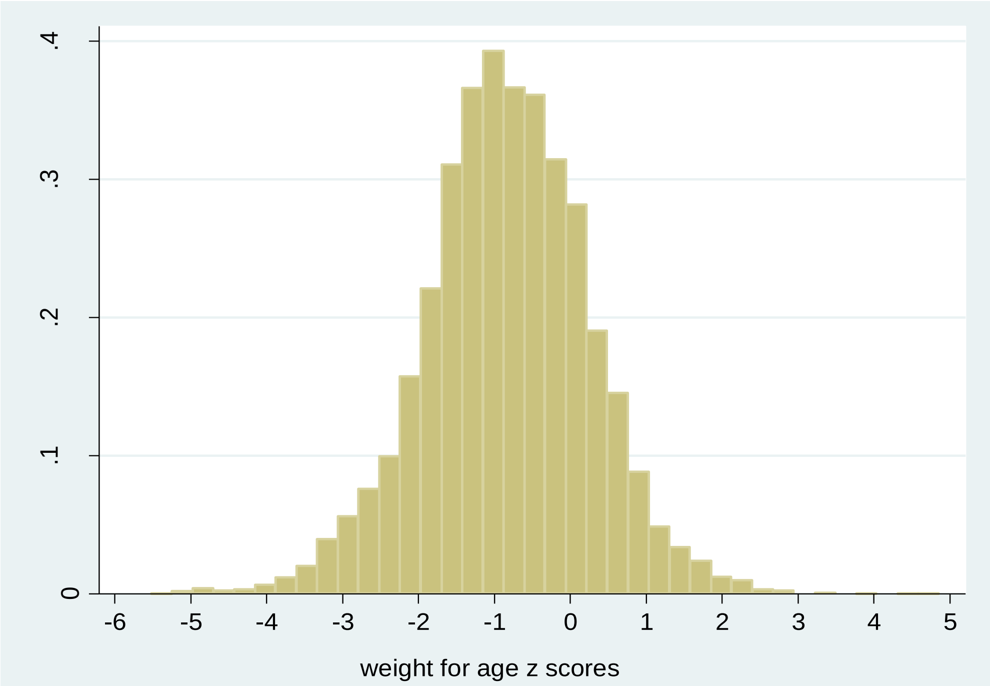
```
One-sample Kolmogorov-Smirnov test against theoretical distribution
           normprob((haz-hazmean)/hazstd)

 Smaller group        D       P-value  Corrected
 ----------------------------------------------
 haz:                 0.0562    0.000
 Cumulative:         -0.0206    0.001
 Combined K-S:        0.0562    0.000      0.000
```

```
One-sample Kolmogorov-Smirnov test against theoretical distribution
           normprob((waz-wazmean)/wazstd)

 Smaller group        D       P-value  Corrected
 ----------------------------------------------
 waz:                 0.0248    0.000
 Cumulative:         -0.0323    0.000
 Combined K-S:        0.0323    0.000      0.000
```

Appendix 7 Histogram for height for age z scores from 2004 IHS2 data



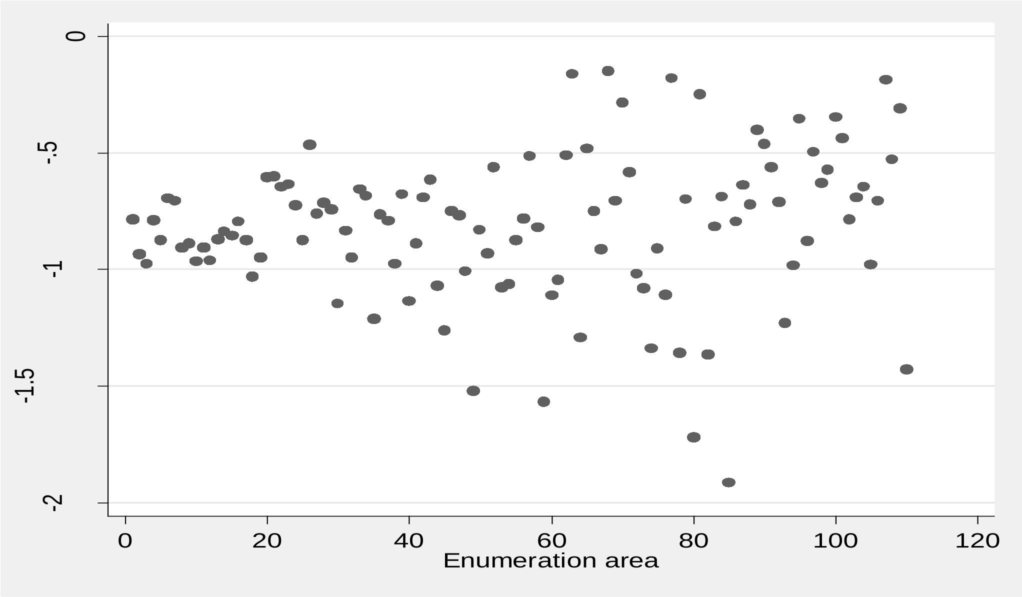
Appendix 8 Histogram for weight for age z scores from 2004 IHS2 data



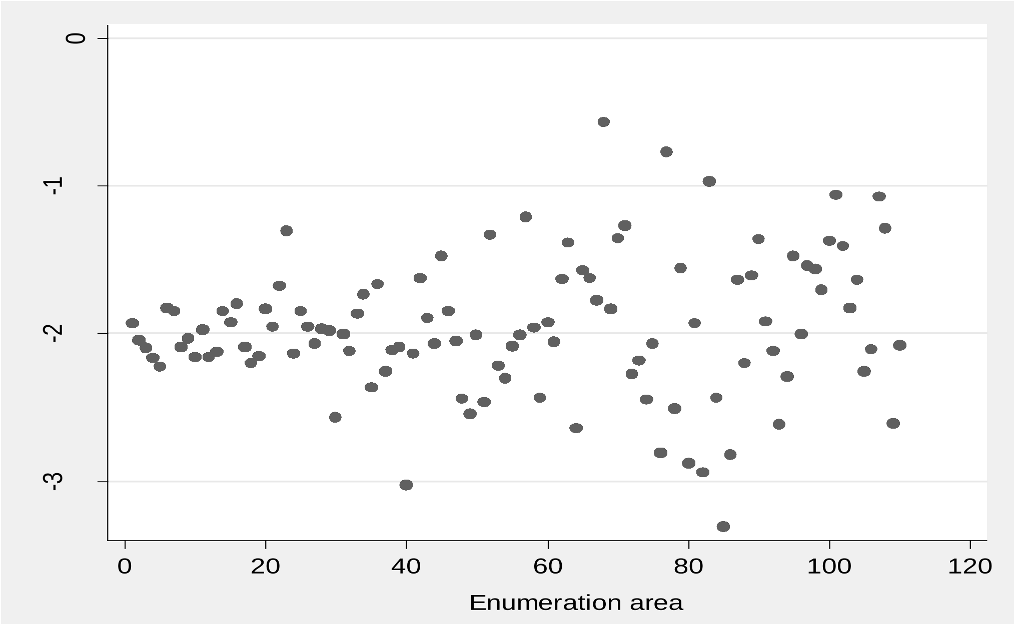

Appendix 9 Statistical test of the normality of the height for age z scores and weight for age z scores from 2004 IHS2 data

```
. ksmirnov haz = normprob((haz-hazmean)/hazstd)

One-sample Kolmogorov-Smirnov test against theoretical distribution
           normprob((haz-hazmean)/hazstd)

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 haz:                0.0307    0.000
 Cumulative:        -0.0247    0.000
 Combined K-S:       0.0307    0.000      0.000



One-sample Kolmogorov-Smirnov test against theoretical distribution
           normprob((waz-wazmean)/wazstd)

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 waz:                0.0159    0.035
 Cumulative:        -0.0233    0.001
 Combined K-S:       0.0233    0.001      0.001
```

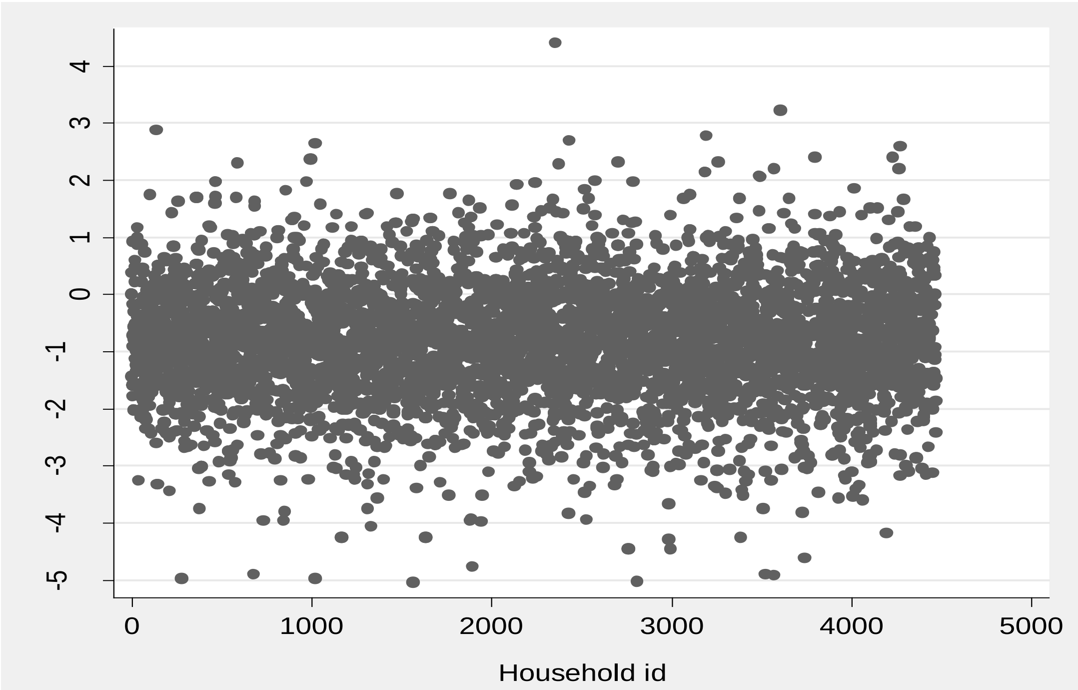
Appendix 10 Mean weight for age z scores across communities



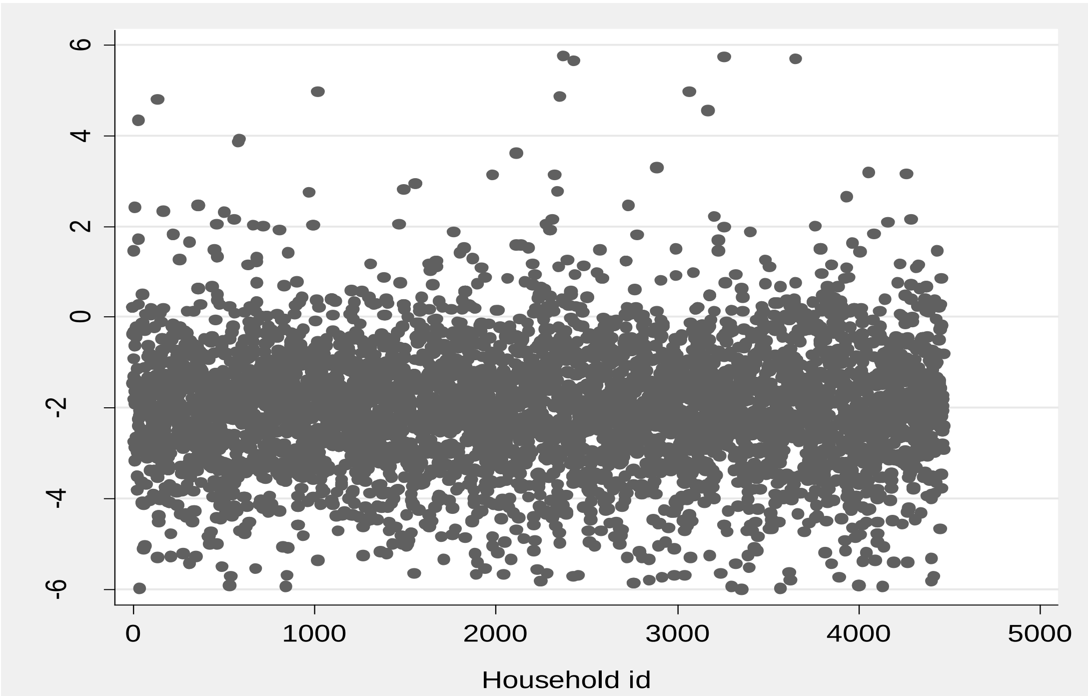

Appendix 11 Mean height for age z scores across communities



Appendix 12 Mean weight for age z scores across households



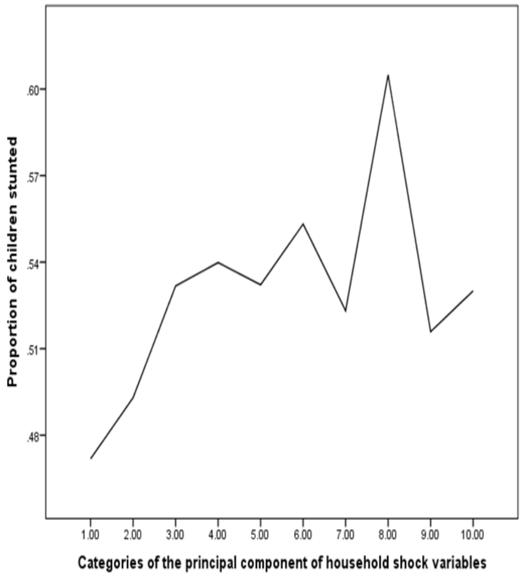

Appendix 13 Mean height for age z scores across households

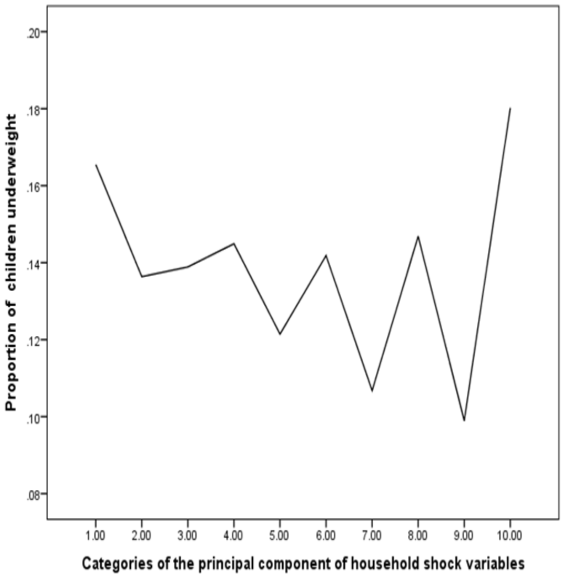


Appendix 14 Stunting and underweight rates by household experience of shocks in the past five years

| Variable | % Stunted | Chi square p value | % Underweight | Chi square p value | N |
|---|---|---|---|---|---|
| **Household experience of shocks in the past five years** | | | | | |
| Low crop yield | 51.2 | **0.013** | 13.0 | 0.32 | 4,309 |
| Not experienced | 47.9 | | 12.1 | | 2,375 |
| Crop disease | 52.8 | **0.01** | 13.3 | 0.43 | 1,718 |
| Not experienced | 49.1 | | 12.5 | | 4,967 |
| Business failure | 52.9 | **<0.01** | 14.1 | **0.05** | 1,832 |
| Not experienced | 49.0 | | 12.2 | | 4,854 |
| Large fall in sale prices for crops | 53.1 | **<0.01** | 13.1 | 0.43 | 2,809 |
| Not experienced | 47.8 | | 12.4 | | 3,877 |
| Household member illness | 50.9 | 0.21 | 13.6 | **0.04** | 3,468 |
| Not experienced | 49.3 | | 11.8 | | 3,217 |
| Birth | 52.8 | **0.03** | 13.3 | 0.45 | 1,452 |
| Not experienced | 49.4 | | 12.5 | | 5,234 |
| Household break up | 56.9 | **<0.01** | 15.0 | **0.04** | 760 |
| No | 49.1 | | 12.4 | | 5,925 |
| Damaged dwelling | 56.1 | **<0.01** | 14.0 | 0.26 | 743 |
| No | 49.3 | | 12.5 | | 5,941 |

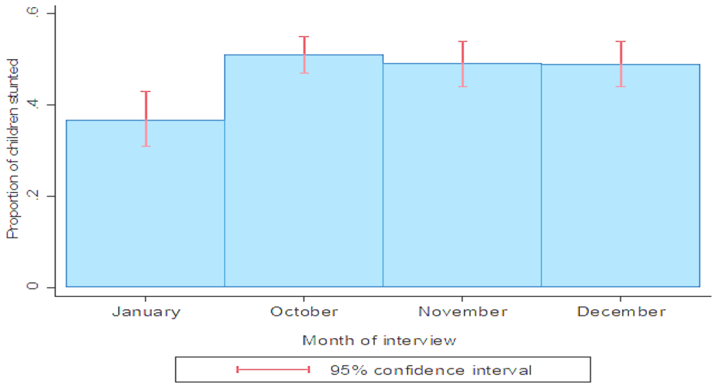
Appendix 15 Proportion stunted and proportion underweight by household experience of shocks



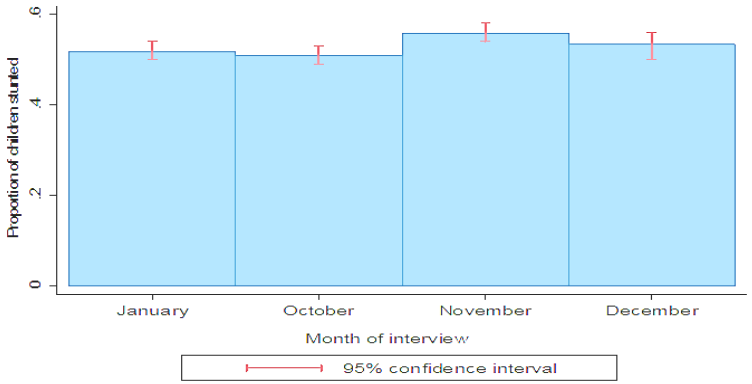



Appendix 16 Monthly comparisons of stunting and underweight between the 2004 I HS data and 2004 DHS data

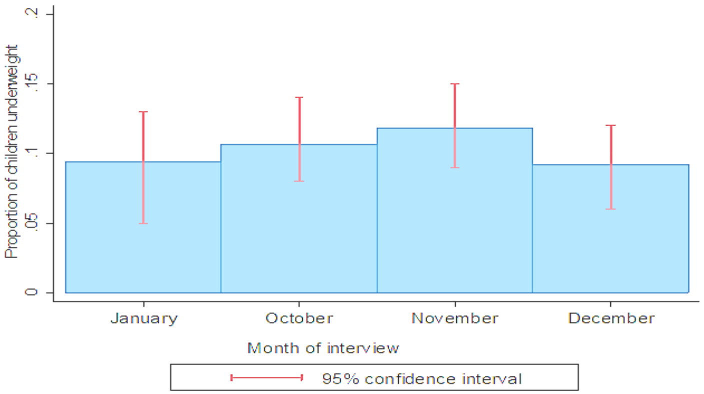
Proportion of children stunted by month of interview
( I HS 2004)



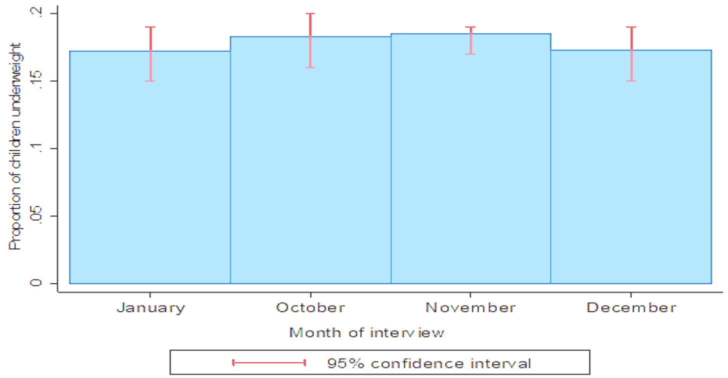

Proportion of children stunted by month of interview
(DHS 2004)



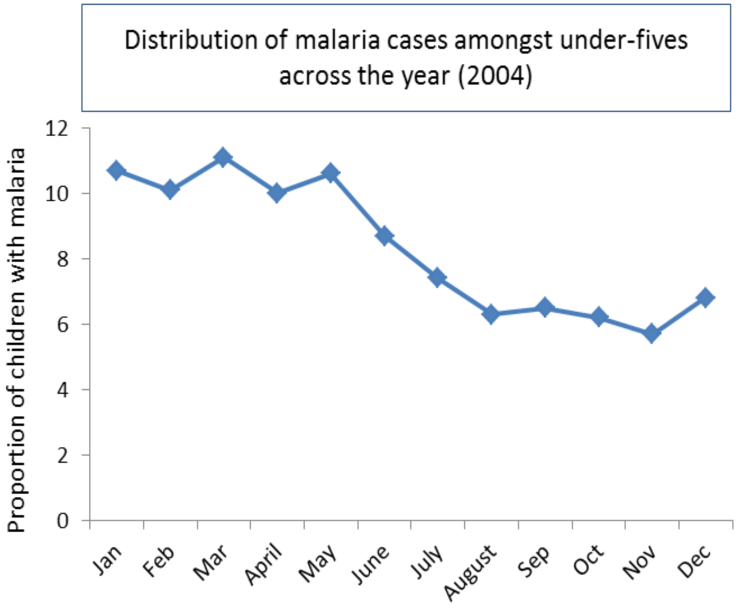

Proportion of children underweight by month of interview
(I HS 2004)

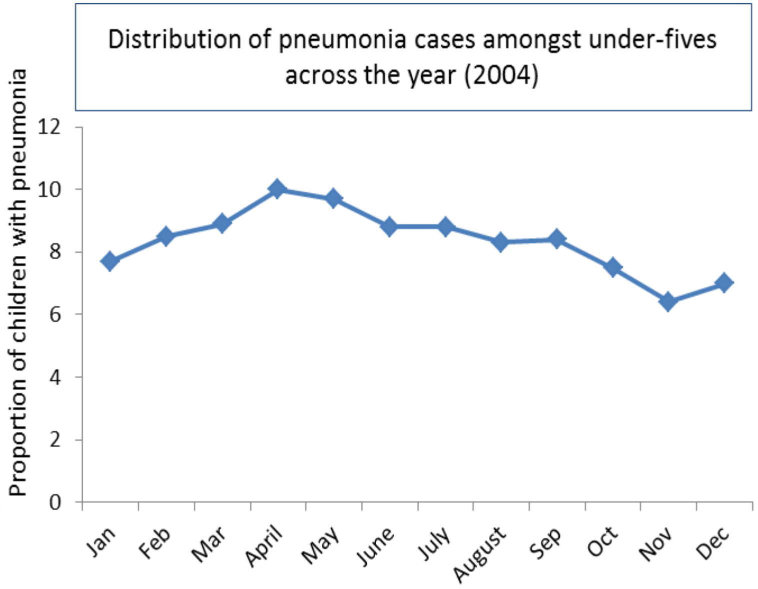



Proportion of children underweight by month of interview
(DHS 2004)



Appendix 17 Distribution of malaria and pneumonia cases across the year 2004




Source: Malawi Government Community Health Sciences Unit hospital based data

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