London School of Economics and Political Science

Double or Divergent? Stuntingoverweightness among Children and the 'Burden' of Malnutrition: A study of Albania

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Declaration

I certify that the thesis I have presented for examination for the MPhil/PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

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Abstract

Today, researchers and policy makers alike are increasingly concerned about the "double burden of malnutrition" in low and middle income countries (LMICs). This 'double burden' is understood to be the coexistence of under- and overnutrition within one population. The definition of a 'double burden' relies upon the existence of chronic undernutrition among children (indicated by stunting – where children are shorter than expected for their age) and the existence of overnutrition in children or adults (child overweightness as indicated by a greater weight than expected for a given height and adult overweightness/obesity as indicated by a greater weight than height^2).

However, research has failed to consider that children can be concurrently stunted **and** overweight – known here as 'stuntingoverweightness'. In failing to consider stuntingoverweightness, the prevalence of stunting and overweightness among children has been overestimated at the population level. Stuntedoverweight children have been 'double counted' – once as stunted and once as overweight. This has severe implications for our understanding of malnutrition in LMICs today. The polarisation of malnutrition among children of under- and overnutrition has been exaggerated and a whole group of children have become hidden – the stuntedoverweight.

This research addresses this issue. Recalculating stunting and overweightness prevalence accounting for stuntingoverweightness this research shows that, today in LMICs, up to 10.42% of children under-five are stuntedoverweight – yet no policies or programmes exist to understand the determinants of stuntingoverweightness, its effects or how to alleviate them. An individual level analysis of Albania shows stuntedoverweight children are a separate socioeconomic group and should thus be targeted for interventions separately from their stunted and overweight peers. Furthermore, failing to recognise stuntingoverweightness has led to overestimations of the burden of stunting by up to 88.54% (in Albania) and of overweight by up to 295.26% (in Benin) and skewing our understanding of the 'burden of malnutrition' in LMICs.

The thesis shows that for nutritional strategies to be effective – research needs to consider the diverse burden of malnutrition observed in LMICs today.

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To my family and friends - I may have started this but I certainly would never have finished it without you.

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Glossary

Altered Trajectory: *the Altered Trajectory refers to the specific pathway argued to result in a double burden of malnutrition or a double burden of child malnutrition (FAO 2006), key features of this pathway include rapid socioeconomic development, globalisation and urbanisation*

Body Mass Index: *indicator used to define over- or underweight based on relative mass for height, where BMI = weight(kg)/height(m^2) for adults -underweight = <18.5, healthy weight = 18.5–24.9, overweight = 25–29.9, obesity = ≥30*

Double Burden of Child Malnutrition: *where burdens of both under- and overnutrition are found within under-fives of a population*

Double Burden of Malnutrition: *where burdens of both under- and overnutrition are found within one population*

Epidemiologic Transition: *proposed by Omran (1971) The epidemiological transition theory explores the long-term shifts in mortality and disease patterns within populations*

Intrauterine Growth Retardation: *suboptimal growth of foetus in the womb*

Low Birth Weight: *<2500g at birth, indicating intrauterine growth retardation or prematurity, N.B.: Very Low Birth-weight, <1500g at birth; Extremely Low Birth-weight <1000g at birth*

Malnutrition: *Literally 'bad nutrition'*

Nutritional Insult(s): *Any form of malnutrition impacting upon the health of an individual*

Nutritional Profile(s): *The overall picture of a particular populations nutrition burdens*

Nutrition Transition(s): *the Nutrition Transition is a theory proposed by Popkin (1993), which outlines changing trends in nutrition and diet and the factors that drive these changes. Nutrition Transitions refers to the proposition of this thesis that there is more than one type of Nutrition Transition experienced by populations*

Obesity: *for an adult, a BMI>30*

Overnutrition: *a positive nutrient balance leading to overweightness and obesity, it can also refer to micronutrient toxicity*

Overweightness: *for a child* - w*eight-for-height >+ 2 S.D. above the median of the reference population, indicating a positive nutrition balance (overnutrition) deemed detrimental to health, for and adult a BMI in the range 25-30*

Stunting: *Height-for-age <- 2 S.D. below the median of the reference population indicating chronic undernutrition and long term growth faltering*

Stuntingoverweightness: *where stunting and overweightness is present within one individual – thus height-for-age <- 2 S.D and weight-for-height >+ 2 S.D*

Undernutrition: *negative nutrient/energy balance leading acute or chronic forms of growth faltering or micronutrient deficient forms of malnutrition*

Wasting: *weight-for-height <- 2 S.D. below the median of the reference population indicating acute undernutrition*

Acronyms

ADHS – Albanian Demographic and Health Survey

AT – Altered Trajectory

BMI – Body Mass Index

DBCM – Double Burden of Child Malnutrition

DBM – Double Burden of Malnutrition

DHS – Demographic and Health Survey

ET – Epidemiological Transition

FAO – Food and Agriculture Organization of the UN

HAZ- Height-for-Age Z-score

HTs – Health Transitions

ICT – Information and Communications Technology

IDD (and ID) – Iron Deficiency Disorders

LMIC – Low and Middle Income Country

MDC – More Developed Country

MICS – Multiple Indicator Cluster Survey

MNIs – Multiple Nutritional Insults

NTT - Nutrition Transition

P in L – Palestinians in Lebanon

PPM – Protracted Polarised Model

Sao T e P – Sao Tome e Principe

UNICEF – United Nations Children's Fund

WAZ – Weight-for-Age Z-score

WHO – World Health Organization

WHZ – Weight-for-Height Z-score

Chapter 1: Introduction

"We need a new definition of malnutrition. Malnutrition means under- and over-nutrition. Malnutrition means emaciated and obese."

(Caroline Bertini, 2003 World Food Prize Laureate)

1.1 Conceptualising and contextualising malnutrition

Globally, malnutrition is one of the leading causes of death, disability and ill-health (WHO 2013). The persistence of and focus on undernutrition in low and middle-income countries (LMICs) has rendered the term 'malnutrition' synonymous with undernutrition. This is a misnomer that, too often, remains despite a change in context – with rising levels of overweightness in the developing world. In her call for a 'new' definition of malnutrition, Bertini is appealing for researchers and developers to stop restricting themselves by relying on an increasingly redundant synonym and instead tackle the 'real' face of malnutrition in the world today – a world where more and more populations are experiencing the burden of both under and overnutrition. To those that have heeded this call, this new nutritional crisis has become known as the 'double burden of malnutrition' (DBM).

However, there is a newly emerging nutritional profile among children under-five that has been overlooked – even among researchers addressing the DBM. Among under-fives in the developing world, there are individuals who suffer concurrently from both under- and overnutrition. These 'stuntedoverweight'[1] children are the focus of this thesis.

This research utilises anthropometric indicators to identify under- and overnutrition among children – this is a contested issue and will be commented on in Chapters 2 & 3 of this thesis. The anthropometric indicator height-for-age is used to indicate if a child is shorter than expected given their age – this is known as stunting and signifies chronic undernutrition. A second anthropometric indicator – weight-for-height − is used to denote overweightness when a child has a greater weight for their height than recommended. This thesis evidences the existence of 'stuntingoverweightness' − when a child is concurrently stunted and overweight.

The observation of this paradoxical concurrency of over- and undernutrition in individuals under-five is evidence that Bertini's call does not go far enough. It is my conjecture that we do not need a 'new' definition of malnutrition but return to the 'literal' definition of malnutrition – where malnutrition is conceptualised as 'bad nutrition'. Malnutrition is a departure from 'good' or 'healthy' nutrition that can and should inclusively signify all forms of this departure – be it overnutrition, undernutrition or even the apparently paradoxical concurrency of both.

As this thesis shows there is increasing divergence in the face of poor nutrition in the developing world today. Too often LMICs still face burdens of undernutrition, increasing burdens of overnutrition as well as the additional burden of individuals suffering concurrent dual 'nutritional insults'. By reverting to the literal definition of malnutrition, malnutrition re-emerges as the inclusive term able to describe this diverging context of poor nutrition faced by individuals and populations today.

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[1] Where stunting represents chronic undernutrition and overweightness indicates overnutrition in under-fives

Specifically relevant to the concern of this thesis, this more inclusive conceptualisation of malnutrition as 'bad nutrition' would also denote the new and emerging nutritional insult facing millions of children in low and middle income countries today. This is a nutritional insult that has, for too long, been undefined and thus disregarded – where a child is subject to concurrent under- and overnutrition. In this thesis these children are referred to as the 'stuntedoverweight'.

The thesis shows that in LMICs where stuntingoverweightness among under-fives is prevalent, the population is not experiencing a double burden of malnutrition, but a burden of malnutrition that is divergent.

1.2 The Implications of Stuntingoverweightness

This research shows that there is a noteworthy prevalence of stuntedoverweight children among many populations, which has been increasing over time in some low and middle income countries (Chapter 4). Despite this, a paucity of research on these affected children persists. The research presented here aims to address this gap – its implications are significant for both the children affected and the wider research and development arena that focuses on malnutrition; and particularly child malnutrition.

Specifically, research both past and present is affected by four significant and interrelated implications of stuntedoverweight children and the failure to recognise this phenomenon.

Firstly, a failure to acknowledge that children can be both stunted and overweight (stuntedoverweight) means that stuntedoverweight children are double counted – once as stunted and once as overweight. This results in an overestimation of both stunting and overweight.

Related to this, the existence of stuntingoverweightness shows that the anthropometric indicators for stunting and overweight, consistently adopted in research on child malnutrition, are not being utilised correctly. Researchers are failing to consider the overlap in the indicators, which has led to this double-counting. As a result, the existence of stuntingoverweightness has implications for the debate on the use of anthropometric indicators in nutritional research.

Thirdly, stuntingoverweightness in children has significant implications for the Nutrition Transition Theory (NTT). The NTT depicts **what** the nutritional profile of a population looks like and explains **how** these change by relating them to macro factors thought to determine these changes – the NTT is detailed in Chapter 2. However, failing to consider stuntingoverweightness means the nutritional profiles of populations are not accurately presented. In failing to acknowledge **what** the true face of malnutrition in LMICs today is, we are unable to rely upon our understanding of **how** such nutritional profiles emerge and change.

Finally, and perhaps most importantly, overlooking the stuntedoverweight has led to a group of children hidden from view; omitted from research and therefore from possible interventions. The effects of this could be far-reaching, depleting the health and socioeconomic development of an individual across their life course. Additionally, stuntingoverweightness could lead to intergenerational effects – impeding the health and quality of life of future generations.

These implications are considered in more detail below.

1.2.1 Double counting and the use of anthropometric indicators

This research shows that a failure to account for stuntingoverweightness in children found in many LMICs has skewed the depiction of their nutritional burdens (Chapter 4). These distorted burdens are currently used to address malnutrition and influence policy – but they are not representing the reality of malnutrition burdens in affected countries.

As reported in February 2014, the 'United Nations Children's Fund (UNICEF), the World Health Organisation(WHO) and The World Bank (WB) 2012 Joint child malnutrition estimates' the prevalence of stunting was stated as ~20% and overnutrition ~20% among under-fives in Albania in 2008-09 (WHO 2013). The country would therefore be described as experiencing a 'DBM' among children – a 'double burden of child malnutrition' (DBCM).

But, as this research shows, this result is based upon 'double counting' – by recording stuntedoverweight children as both stunted and overweight. As a result the burdens of under- and overnutrition in Albania, for example, are overestimated and the burden of stuntingoverweightness has been completely excluded. In actuality, as is explored further in Chapter 4, in Albania ~10% of children are stuntedoverweight, only ~10% are solely stunted and only ~10% exclusively overweight. This is a lesser but more divergent burden of child malnutrition than the one presented by three leading organisations on child health – the WHO, UNICEF & the WB.

The effects of such misrepresentation of malnutrition on the results of research aiming to address the issue of child malnutrition cannot be overstated. Population level estimates of malnutrition prevalence rates published by organisations such as the WHO, UNICEF and the WB are used in ecological analyses – exploring the determinants of child malnutrition at the population level. In 'double counting' stuntedoverweight children and failing to recognise them as a distinct group, the reported prevalence of under and overnutrition burdens becomes invalid – the research is not measuring what it purports to. Conducting research on such invalid data undermines the conclusions and policy implications that result by failing to model the true heterogeneity of child malnutrition. Moreover, these population-level estimates are often used to identify the severity of a burden of malnutrition a country is facing. The WHO declares a population with a burden of stunting>20% has a burden of 'public health significance' – yet there is no discussion on whether stuntingoverweightness should be considered separately and the impact of either approach.

1.2.2 The Effect on Our Understanding of the NTT

The need to address stuntingoverweightness is not just a methodological one. The emergence of stuntedoverweight children represents a divergence in the nutritional burdens of children in LMICs today. This divergence calls into question the 'Nutrition Transition Theory' (NTT) – a model mapping changes in the burdens of malnutrition by relating development to changing dietary and physical activity patterns. Even with modifications to include the rising prevalence of overnutrition whilst undernutrition remains in LMICs (the DBM), the NTT fails to consider this paradoxical concurrence of nutritional insults among individuals. In doing so the NTT and even the theory of the 'Altered Trajectory' (an amended version of the NTT addressing the existence of the DBM) has precluded the identification of this divergent burden of malnutrition among children – of stuntingoverweightness, stunting and overweightness[2].

[2] In countries where acute malnutrition is prevalent, this will also include burdens of wasting.

1.2.3 The Health and Development of 'Hidden' Stuntedoverweight Children

In its current state as a hidden phenomenon, the emerging divergence in the nutritional burdens of under-fives in LMICs is not being targeted or even observed by the very policies and programmes aimed to reduce malnutrition. Not only is this reducing the efficacy of nutrition interventions, it is failing affected children. For stuntedoverweight children there is an uncertain future − as the impact of the dual nutritional burdens on their current and future health and socioeconomic attainment is unknown. Moreover, as an unidentified group, no steps are taken to understand the associated risk factors, target this group of children and address their particular form of malnutrition.

1.3 Objectives of the study

This research aims to address the implications that stuntingoverweightness has for today's research, policy and development arena. The objective of the research is to provide an evidence base of stuntingoverweightness, its determinants and thus its implications so as to begin addressing this unique form of malnutrition – stuntingoverweightness – affecting millions of under-fives in the world today.

Specific to the creation of a solid evidence base on stuntingoverweightness the objectives of this research are:

1. To describe the levels and trends of stuntingoverweightness among under-fives in LMICs.

2. To demonstrate that the 'double-counting' of stuntedoverweight children has given rise to inaccuracies in the reported prevalence rates of stunting and overweightness among under-fives in LMICs.

3. To explore the true nature of nutritional profiles in LMICs today – given the existence of stuntingoverweightness.

4. To elucidate the determinants of stuntingoverweightness among under-fives.

This evidence base has implications for research past, present and future. From this evidence base, this thesis aims to comment on these implications and inform future research. Specifically these objectives are:

5. Address the effect stuntingoverweightness has on the NTT and propose amendments.

6. Contribute to the debate on the use of anthropometric indicators in research on child malnutrition.

7. Identify stuntedoverweight children and what distinguishes them from their stunted or overweight peers – to provide a platform from which health policies and interventions can be constructed.

8. Identify paths for future research on the hitherto 'hidden' stuntedoverweight children.

In order to fulfil these objectives a comparative analysis across LMICs is conducted, followed by a within-population analysis of a selected population – Albania. The structure of the thesis is presented in section 1.4.

1.4 Structure of thesis

This introduction has presented the aims and objectives of this research. Chapters 2-9 realise these objectives. The structure of the thesis and the contents of the chapters enabling the realisation of these objectives are presented below.

Chapters 2 to 5 are concerned with understanding the levels and trends in stuntingoverweightness, its implications and determinants at the population level.

Chapter 2: Malnutrition in Transition

The objectives of this study include detailing the current nutritional profiles of LMICs and their determinants. In order to do this, the theoretical background concerning nutritional profiles of populations, how they change and why is described. The original theory that describes this process is known as the NTT – its original conceptualisation is defined in Chapter 2. However, the original NTT rests upon nutritional profiles that do not represent the current profiles of LMICs. Currently, the consensus in research is that LMICs are increasingly experiencing a DBM – thus researchers have described this new nutrition transition and why it occurs. The amendments for the NT proposed by researchers are focused on the DBM are described. This new nutritional profile of DBM is described as 'polarised', and is thought to represent a 'protracted' nutrition transition (NT) caused by rapid globalisation and urbanisation – this has become known as the 'Altered Trajectory'. However, this research proposes that the burden of malnutrition in LMICs is better considered as divergent. The chapter concludes by proposing a reconceptualization of the NT allowing for this divergence.

Chapter 3: Data and Methodology for Population Level Analysis on Stuntingoverweightness

A multidimensional dataset is required to show the divergent nature of LMICs' nutritional profiles, as well as the implications and determinants of this divergence. No dataset currently exists that relates indicators of socioeconomic development to levels of malnutrition in LMICs, while also accounting for stuntingoverweightness. I had to construct a dataset that links such data for LMICs, in order that it could be utilised for the analyses required to meet the objectives of the study. The data and the construction of the dataset are described in Chapter 3, followed by the detailing of the planned analyses. The chapter describes the recalculation of stunting and overweightness prevalence rates among under-fives – taking in to account stuntingoverweightness. Additionally, it defines the process to identify a stuntedoverweight child. Moreover, the methodology used to highlight the 'true' nutritional profiles of LMICs, given stuntingoverweightness, is explained. This involves the use of descriptive statistics and multiple linear regression models. Finally, the methodology employed in order to meet the objective of describing the factors associated with increased prevalence of stuntingoverweightness and a divergent burden of malnutrition in LMICs is described. The methods utilised and thus described are those of multiple linear regressions with a theoretical block modelling technique.

Chapter 4: Macro Results 1: Stuntingoverweightness – levels, trends and implications

Chapter 4 illustrates the current levels and trends in stuntingoverweightness, as well as the impact it has on the prevalence of stunting and overweightness among under-fives. In addition, the chapter identifies what the recognition of stuntingoverweightness means for the considered 'DBM'. The results of this chapter identify the magnitude of the overestimation of stunting and overweightness among under-fives that has been caused by the 'double counting' of stuntedoverweight children. The chapter shows the relationship between levels and trends in child stuntingoverweightness with child stunting, child overweightness and adult obesity[3] to show true nutritional profiles observable in LMICs today. By highlighting the effect of stuntingoverweightness on conceptualisations of the DBM, the divergent burden of malnutrition is evidenced. The chapter discusses the implications of this for the NTT.

[3] For both males and females

Chapter 5: Macro Results 2: Macro-Level Determinants of Stuntingoverweightness – The rapidity of globalisation and urbanisation

The analysis of Chapter 4 evidences a new nutritional profile and shows that the notion of the DBM tied to the concept of the 'Altered Trajectory' is not adequately describe the burdens of malnutrition in LMICs currently undergoing a NT. The results of Chapter 5 evidence the factors determining this change. It goes on to examine whether the factors causing changes in the nutritional profiles of LMICs today also need to be reconsidered. In order to do this, the chapter details a theoretical block modelling strategy that aimed to show whether the rapidity of globalisation and urbanisation (macro-level determinants) should still be considered the determining factors of changes in the nutritional profiles of LMICs today – even if the resultant profiles are not 'double' but 'divergent'. The chapter shows there is evidence that the pace of globalisation is important for determining increased prevalence of stuntingoverweightness in LMICs, but that there is no such evidence for urbanisation.

At the end of Chapter 5 – taking into account the results of Chapters 4 and 5 – a population is selected for the within-population analysis. The population selected is that of under-fives in Albania – the rationale for its selection is detailed here.

Chapters 6 to 8 are concerned with understanding the determinants of stuntingoverweightness within the population of Albania

Chapter 6: Determinants of Child Malnutrition - the Context of Albania

In addition to the population or macro level factors, a child's nutritional status is also determined at the community, household, maternal and individual level. This chapter presents the theoretical framework utilised to understand the multilevel determinants of child nutritional status – which will be applied in the analysis to determine the factors distinguishing stuntedoverweight children from their stunted or overweight peers. This chapter relates the theoretical framework to Albania by exploring the country's political, social, economic and demographic background. The chapter thus contextualises child malnutrition in the population of Albania.

Chapter 7: Data and Methodology

Chapter 7 presents the methodology used in this research for the within-country analysis of the determinants of stuntingoverweightness. The data for this analysis is the Albanian Demographic and Health Survey 2008-09 – the data is described and its strengths and weaknesses discussed. A multilevel modelling strategy had been planned for this analysis but could not be conducted – the reasons for this are explored in this chapter and the alternative modelling strategy used in the research is described.

Chapter 8: Results for the Determinants of Stuntingoverweightness within Albania

Chapter 8 presents the second evidence base from which stuntedoverweight children can be targeted – by focusing on the determinants of stuntingoverweightness at the household, maternal and individual level. In particular, the results show how stuntedoverweight children differ socioeconomically from their stunted or overweight peers – showing that as a whole this group behaves differently to the stunted and the overweight and thus requires separate and distinct consideration both in research and in policy formation.

Chapter 9: Summary, Implications and Future Research

A summary of the main findings is presented in this final chapter – alongside the implications for both research and policy. I conclude that our understanding of child malnutrition in LMICs is currently skewed and the notion of the DBM unfitting. We must consider under-fives who are stuntedoverweight a unique and distinct group of children – both in research and for health interventions. A failure to identify this group has emanated through the incorrect usage of anthropometric indicators and has meant that stunting and overweightness as discrete phenomena among under-fives has been overestimated. Additionally, our understanding of the NTT has become void. A protocol is put forward to ensure future research does not erroneously overlook the stuntedoverweight. Finally, an agenda is proposed for further research into stuntedoverweight children – who make up to 10% of under-fives in LMICs today – to ensure they become visible, targetable and thus tended to by health programmes.

Chapter 2: Malnutrition in Transition

"What's past is prologue."

(Antonio - The Tempest, Act II, Scene I. Shakespeare 1610-1611)

This chapter is concerned with population levels of malnutrition and the supra-population and population level factors that determine and drive changes in these burdens of malnutrition. The chapter presents the theoretical background necessary to understand the nutritional burdens of population today and how they have changed. The chapter draws upon the prevalent model from which to understand these dynamics – the Nutrition Transition Theory (NTT). The chapter argues the NTT, derived from experiences of populations who have undergone their nutrition transition (NT), is no longer wholly appropriate to model the changes in the nutritional profiles of LMICs today and the factors that drive them. Thus the original NTT serves as a prologue from which to understand the divergence in the malnutrition burdens of LMICs today. The chapter concludes with proposed modifications to the NTT to model such divergence – particularly given the observation of stuntingoverweightness among under-fives in LMICs. The proposed modifications compose what is here termed the 'Convergence-Divergence Framework' and call for an understanding not of the nutrition transition but of variable nutrition transition**s**.

In order to address the utility of the NTT for LMICs today and propose relevant adaptations, the original theory of the NTT and the current understanding of the NT, known as the 'Altered Trajectory', need to be outlined.

There are two key components to the NTT: 1) the nutritional profile of populations; and 2) the factors that determine this profile. This chapter addresses both of these components.

It is the conjecture of this research that in order to better understand the nutritional profiles of populations today, our understanding of child malnutrition needs to be addressed. Thus the first section of this chapter, 2.1, explains what child malnutrition is, why it is important and why stuntingoverweightness matters.

Following on from this, section 2.2 focuses upon the NT, its amendments and the factors theorised to determine the changing nutritional profiles of populations. Section 2.1.1 describes the original NTT as proposed by Popkin (1993) – including how nutritional profiles of populations were theorised to change over time and the factors driving this change. This section will emphasise how the original NTT was designed according to the past experiences of More Developed Countries (MDCs) and that research has emphasised that this is not the experience of LMICs undergoing their NT today.

Because the NTT is based upon the past experience of MDCs, the amendments made to it for today's LMICs are then presented in section 2.2.2. Currently, research on LMICs undergoing their NTT today is focused upon the so-called DBM. A DBM is a nutritional profile that the conventional NTT does not recognise and thus does not explain. Researchers have thus proposed changes to the NTT in the light of the DBM, and this is known as the Altered Trajectory (AT). The main theories of the AT, what it means for our understanding of the nutritional profiles of populations and how they come about, are explored. This section will emphasise that research in this area is focused on an age-polarised burden of undernutrition (among children) and overnutrition (among adults) that is theorised to be resultant of the accelerated pace of urbanisation and globalisation facing LMICs today, and which distinguishes their development experience from MDCs. The most recent modifications to the NTT include the increased recognition that a DBM is not necessarily age-polarised – for example a population can have a burden of both child undernutrition and child overnutrition. This is known as the double burden of child malnutrition (DBCM).

Following on from this, section 2.3 will outline the approach to and conceptualisation of malnutrition in this thesis – noting diversity among the nutritional profiles of LMICs. Section 2.3 will note that the current understanding of a DBCM relies upon levels and trends in child malnutrition that do not consider the paradoxical concurrence of stuntingoverweightness. This section will outline how stuntingoverweightness necessitates a re-conceptualisation of both the NTT and the AT. In doing so, section 2.3 will propose a new understanding of nutrition transitions occurring in LMICs today – a 'Convergence-Divergence Framework'. These proposed changes inform the macro analysis – the results of which are presented in Chapter 4 and 5. Chapter 4 details the results concerning the first component of the NTT – our understanding of the nutritional profiles of populations today – and shows that in failing to consider stuntingoverweightness, these profiles have been misrepresented. Chapter 5 presents the results concerning the second equally important component of the NTT - the macro factors that drive changes in the nutritional profiles of populations – by focussing on the role of macro factors in determining stuntingoverweightness.

2.1 Child malnutrition – what is it and why does it matter?

Currently, it is estimated that undernutrition is responsible for 45% of child deaths globally – 3.1 million per annum (Black et al. 2013). Recent estimates show that, in 2011, 165 million children under five were short for their age (stunted) due to chronic, long-term, undernutrition – this equates to 26% of the world's children. In addition, in 2011 an estimated 7% of the world's children – 43 million – were overweight given their height (UNICEF-WHO-The World Bank 2013)[4]. Malnutrition can have severe and far reaching consequences for a child.

Malnutrition reflects a state of poor nutrition due to either a lack of appropriate food or disease. The effects of malnutrition are diverse and can be both severe and far-reaching, particularly for children. For a child, malnutrition increases the risk of mortality, morbidity and poor cognitive development. Poor health and development in early life can limit the educational, social and economic achievements of an individual across their life course and increase the risk of poor adult health (Strauss & Thomas 1998; de Onis et al 2004; Haas 2008; Black et al. 2013). These consequences are not only severe for the affected individual, they affect the 'human capital' of populations with high levels of malnutrition, limiting their socioeconomic development through loss of productivity due to malnutrition as well as the increasing economic burdens on the health care system from caring for and attempting to alleviate malnutrition.

In this thesis, child malnutrition specifically refers to 'bad' or unhealthy nutrition among children less than five years of age[5]. It has been noted that malnutrition can refer to both under- and overnutrition as well as emerging forms of concurrent under- and overnutrition experienced by an individual.

Before describing the consequences of malnutrition further, the terms 'undernutrition' and 'overnutrition' relevant for children will be considered in greater depth.

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[4] Although the definitions used and estimates presented here do not take into account another form of malnutrition – where a child is concurrently stunted and overweight (stuntedoverweight).

[5] In research a further distinction of infant malnutrition – referring to children under 12 months of age – is sometimes used.

2.1.1 Child Malnutrition - What is it?

Malnutrition, if considered in terms of under- and overnutrition, refers to suboptimal nutritional intake (or utilization) that can then lead to clinical or 'functional' forms of malnutrition in an individual.

Undernutrition thus describes the process of consuming a deficient diet – in terms of nutrient quantity and quality – and/or the inability for the body to utilise an (in) adequate diet effectively.

There are two types of nutrients: macro- and micronutrients. Macronutrients are tasked with providing the main energy and protein sources for an individual. There are three major macronutrients – carbohydrate, protein and fat (Campbell 2011). For children, an adequate supply of carbohydrates and fats will provide the energy required to match the level of energy expenditure – particularly accounting for growth. Additionally, protein intake must be enough for the sufficient provision of essential amino acids that the body does not metabolise itself and thus requires from external sources (FAO 1987; Prentice 2005).

Micronutrients include minerals and vitamins that are required by humans for healthy nutrition, although in much smaller quantities than macronutrients. Despite these smaller quantities, micronutrients are equally necessary to the provision of energy and for the maintenance and health of a child.

Undernutrition can present as 'hidden hunger', 'growth faltering' or both. Both 'hidden hunger' and 'growth faltering' can develop intrauterine (during gestation) and at all ages after birth.

'Hidden hunger' is a term used to describe micronutrient deficiencies (MNDs), resultant of diets low in key vitamins and minerals or disorders affecting the absorption and utilisation of such essential nutrients in the body. The most pervasive deficiencies, detrimental for child health, include iodine, iron, vitamin A and zinc deficiencies (Bhan et al. 2001; Rivera et al. 2003; Tulchinsky 2010). These MNDs can severely impede child development in terms of growth and cognitive development and deplete the efficacy of the immune system – fuelling part of a dialectical relationship between malnutrition and ill-health in children[6] (Saunders et al. 2011; Allen et al. 2006; Tulchinsky 2010; FAO 2006; Gibson 2006). Globally it is estimated that 2 billion people suffer micronutrient deficiency in some form – in both developed and developing countries – although women and children in developing countries are most at risk (Adelekan 2003; Ramakrishnan 2002; Rivera et al. 2003). Increasingly, research is finding multiple MNDs, particularly among pregnant women and children (Pathak et al. 2004; Siekmann 2003; Rivera et al. 2001; Bhutta et al 2011). In such cases the effects of each deficiency can both compound and interact with each other, further impeding health (Adelekan 2003; Pathak et al. 2004). For children, the double nutritional insult of vitamin A and iron deficiency has been found to have particularly severe effects on healthy development (Allen et al. 2006; Bhutta et al. 2013). In severe cases, deficiencies of iron, niacin, vitamin C, vitamin D and vitamin A will present as anaemia, pellagra, scurvy, rickets and night blindness respectively.

Hidden hunger is not necessarily easily observable and often relies upon the collection of blood samples or in some circumstances urine to diagnose (Delisle 2008). In addition, subclinical or marginal cases of micronutrient deficiencies are often not diagnosable, even though the effects may be detrimental to the health and development of an individual (Allen et al. 2006). As a result – indicators of 'growth faltering' are the international standard outcome measures for research into child undernutrition (De Onis, Monteiro et al. 1993).

'Growth faltering' is used to describe the physical development of a foetus or child that is below what would be expected in terms of weight and height by age – and reflects a 'failure to thrive' (Wright et al. 2005). Growth faltering is directly caused by a lack of, or failure to utilize, both macro- and micronutrients (Shields et al. 2012). Undernutrition in children, as manifested by 'growth faltering', is measured through the use of anthropometric indicators. These indicators are calculated using measures of a child's height, weight and age.

[6] MNDs and their impacts upon child health and development are further detailed in Appendix I.

There are four main anthropometric indicators describing the growth of a child under five: birth weight; height-for-age (or length-for-age); weight-for-height; and weight-for-age (de Onis 2006; WHO 1995; Garza & de Onis 1999). Each indicator can denote specific types of malnutrition. Low birth-weight can indicate both intrauterine growth retardation (IUGR) and prematurity, when an infant is born before 37 weeks gestation (WHO[c]:2010; Gillespie & Haddad 2001). Weight-for-height indicates (acute) undernutrition known as wasting in children. It also indicates overweightness or obesity among under-fives. Weight-for-age is used to define growth faltering termed 'undernutrition' (not to be confused with the overarching concept of undernutrition) and is considered indicative of the effects of both acute and chronic undernutrition. Height-for-age is indicative of chronic undernutrition in children under-five years of age and is used to define 'stunting' (Marcoux 2002; de Onis 2006).

There are advantages and disadvantages to the use of each of these anthropometric indicators when focussing on undernutrition. The chosen indicator for undernutrition in this research is stunting (where height-for-age is lower than expected). Its rationale for selection rests upon the advantages of such an indicator for comparative nutrition research that set it apart as the most appropriate indicator for this research. Before detailing the appropriateness of the indicator of stunting for this research, the disadvantages of weight-for-age and weight-for-height are presented. Their suitability for use in this research is grounded in their ability to be used to distinguish between chronic and acute malnutrition, as these two types of malnutrition can have separate determinants, short term and long term consequences.

Weight-for-age is a composite measure of both acute and chronic malnutrition. Due to its composite nature, the indicator requires complex interpretation that renders it an unsuitable indicator for studies involving the assessment of the nutritional experiences of both individuals and populations (Joseph et al. 2002). Whilst at the individual level it is possible to ascertain whether the undernutrition indicated by weight-for-age is chronic or acute, at the population level such determination is restricted. As a result, weight-for-age is not considered an appropriate indicator for undernutrition in this research. As described above, weight-for-height can indicate acute malnutrition in the form of wasting. Although the consequences of wasting can be particularly severe – with higher risks of mortality – its role in comparative research on child malnutrition is limited. Wasting, as an acute form of malnutrition, can be indicative of an atypical period in a child's development. Notably, wasting can be the result of sudden, acute illness or food shortages – which is particularly complicated for research at the population level where it is impossible to indicate the extent to which the burden of wasting is caused by morbidity or rapid changes in nutritional intake and so fails to enable an understanding of the longevity of such malnutrition. Longevity in undernutrition is important, particularly for research that aims to assess the relevance of the NTT for today's LMICs – which is focused upon long term changes in a population's nutritional profiles. Reliance upon an indicator so susceptible to environmental fluctuations could have severe implications for the comparability of results.

For this research, stunting is the most appropriate indicator of undernutrition and overcomes some of the issues of both weight-for-age and low weight-for-height.

Stunting indicates chronic malnutrition and thus conditions of chronic poverty. Whilst acute malnutrition, as indicated by weight-for-age and weight-for-height, can be devastating – increasing the risk of morbidity and mortality – it is not necessarily indicative of the prevalent conditions in which a child lives and their health is. Specifically, wasting and undernutrition (low weight-for-age) can be the result of atypical experiences and thus nutritional status due to short term but drastic changes in context. Conversely, children who are stunted have experienced growth faltering due to long-term undernutrition that has resulted in them being shorter than expected given their gender and age (Victora 1992; Sahn and Stifel 2002). The chronic nature of the development of stunting means that, of the anthropometric indicators, it is the best placed to gain an overriding picture of a child's early life, which is so crucial to their development and future life chances. Additionally, the utilisation of stunting as an indicator does mean that it is possible to control for wasting and thus such sudden shocks to a child's development when analysing the determinants of stunting.

For this study, a child will be classified as 'normal', 'moderately' or 'severely' stunted through the use of anthropometric indicators and data on reference populations. Children are compared to a reference population that reflects how a child *'should'* grow and categorised as stunted based on their deviation from the *'correct'* growth patterns of the reference population (Marcoux 2002; Sahn and Stifel 2002; WHO 2006). Anthropometric indices are expressed in terms of z-scores. Z-scores[7] (or standard deviation scores) provide an indication of how an individual deviates from the reference population. A z-score of <-2 indicates moderate stunting, <-3 indicates severe stunting (WHO 2006).

There are two elements concerning the use of anthropometric indices that that have been questioned in the literature – 1) the use of a reference population and 2) the nature of categorisation of z-scores.

Currently, the WHO recommends that children, regardless of population, country or ethnic group membership, are compared to an international reference population that has been constructed, as noted above, to reflect the way a child 'should' grow (2006). A child's deviation from this reference population, be it, for example, height-for-age that deviates to a great extent from the median of the reference population, is used to designate whether a child is malnourished or not. However, there is a long standing debate on whether children from a local population should be compared to an international standard. The debate rests upon concerns that there are fundamental differences in body composition how children grow across different ethnic groups and populations (WB 2001; Wang 2004). These differences in body composition and growth would thus affect the z-scores calculated for each respective anthropometric indicator and render the classification of malnutrition in a children, and prevalence rates at the population level, invalid. This is an ongoing debate that has not been fully resolved. However, even among those who question whether these fundamental differences exist between populations the utility of anthropometric indicators to monitor malnutrition, make comparisons between populations and over time, is still accepted (Wang & Wang 2002; Wright et al 2008). Moreover, the release of the WHO 2006 growth standards are

[7] Z-score = (observed value) – (median value of reference population)/Standard deviation of reference population) (WHO 1995)

based upon an intensive studies of the growth of breastfed children from six different populations – Brazil, Ghana, India, Norway, Oman and the USA. Children from these populations have been shown to display comparable patterns of growth and as a result the use of an international reference standard is, for the majority, considered appropriate (de Onis et al. 2011). A further discussion on the use of an international reference population is beyond the scope of this thesis but the key element to take away is that there is a reliance on an international reference population and there are some concerns surrounding its use. However, despite this, anthropometric indicators are the key tools used by health researchers to monitor child malnutrition worldwide and this thesis is concerned with their use given the existence of stuntingoverweightness.

Furthermore, there is a growing debate on the use of such z-scores and their thresholds in research on child malnutrition – with researchers proposing the use of z-scores as a continuous measure or in deciles, or even using relative leg length to indicate short stature resultant of a child's wider environment (Wilson et al. 2012; Padez et al.2008). However, this research will focus on the use of the standard threshold cut-offs for z-scores to indicate growth faltering. For stunting, as previously noted, this threshold of <-2SD is used. To clarify – this is done because it is the most prevalent use of anthropometric indicators in the literature on child malnutrition and health, and this research has an important contribution to make to the research on how these anthropometric indicators are used as it shows that, if research is to continue using these thresholds for indicating stunting and overweightness, stuntingoverweightness must be taken into consideration. This is a key contribution of this research; the evidence base for which emerges from the results presented in Chapter 4 and recourse to the importance of this contribution is made throughout this thesis.

As a final note, this research is not suggesting that anthropometric indicators and thresholds should be eliminated from research. Anthropometric indicators have been very effective in indicating malnutrition and in understanding the determinants of child malnutrition. Furthermore, unlike biochemical indicators of micronutrient deficiencies, anthropometric indicators of undernutrition distinguish between mild, moderate and severe undernutrition as they provide a corresponding deviation from normal nutritional status at all levels of severity. Consequently, the use of anthropometric indicators is promoted for research on undernutrition as they are '*sensitive over the full range of malnutrition*', comparable across populations and individuals (Martorell & Ho 1984:51). But, failing to consider stuntingoverweightness means that, as anthropometric data is currently used, stuntedoverweight children are being double counted – once as stunted and once as overweight. The next section focuses on our understanding of overnutrition, its importance for child health and development – and the selection of an indicator to identify overnourished children.

Overnutrition describes the process of consuming a nutritional intake that is in excess of the macro and micronutrient requirements of an individual (Nestle & Jacobson 2000). As with undernutrition, overnutrition can occur during gestation and after.

Excessive intake of certain micronutrients, and subsequent toxicity, can lead to adverse health effects[8] (McArdle & Ashworth 1999; Renwick 2006). The relationship of the increasing benefits of micronutrient intake when in contexts of micronutrient deficiencies that rise and then decline at excessively high intakes is known as 'Bertrand's rule', and reflects non-monotonic dose response curves (NMDRCs) (Raubenheimer et al. 2005). The health effects of micronutrient toxicity can be severe – for example, excessive maternal vitamin A consumption in the first 7 weeks of pregnancy has been associated with birth defects (Rothman et al. 1995). Research on overnutrition in terms of micronutrient intake is limited – with no indicators of international or regional prevalence by micronutrient available. However, the increase in food fortification worldwide has led to an increased interest in such research (Andersen & Tetens 2008; Renwick & Walker 2008; FAO/WHO 2006). A technical workshop aimed at generating an appropriate methodology for categorising and understanding the risk of excessive micronutrient intake was conducted in 2005 and it is likely this field of research will widen in the near future (FAO/WHO 2006).

The focus of research into overnutrition in both MDCs and LMICs is centred on the excessive consumption of macronutrients. In particular, for overnutrition, the focus is

[8] There is some suggestion that excessive consumption of carbohydrates can cause toxicity (Raudenheimer et al. 2005)

on the total energy intake (and resultant net energy when combined with physical activity and energy expenditure) – and the proportion of energy intake from fat (Shankar 2010). Such overnutrition can lead to metabolic abnormalities including hypertension, low HDL cholesterol[9], dyslipidaemia and hyperinsulinaemia, as well as changes to body composition including overweightness and obesity (Gu et al. 2005; Weiss et al. 2004; Ebbeling et al. 2002; Moore et al. 2008). All of these are risk factors for diabetes and cardiovascular diseases (CVDs) (Moore et al. 2008).

For the study of overnutrition in children, and for use in this thesis, the definition of overnutrition is made using measurements of body composition – in terms of the height and weight of a child. The anthropometric indicator weight-for-height, adjusted for the age and sex of the child, is used to indicate an overweight or obese child based on their deviation from reference populations advanced by the World Health Organisation in 2006. Again the anthropometric indicator is expressed as a z-score – where scores >2 indicate overweightness, >3 indicate obesity. It is important to focus on the use of weight-for-height in indicating overweightness, as stuntingoverweightness and resultant double counting shows that the use of weight-for-height at the moment, which is currently the prevalent measure used to indicate overnutrition among children and populations today, is flawed. This research evidences how stuntingoverweightness has led to the inappropriate use of anthropometric indicators, the effect it has on our understanding of under- and overnutrition in LMICs today and the extent to which it skews our current understandings. Furthermore the research feeds back these results directly into the NTT – a theoretical model that drives research on changing burdens of malnutrition today.

Having defined under- and overnutrition, and highlighted the indicators that will be used in this research – height-for-age (stunting) and weight-for-height (overweightness) – the adverse impacts of both forms of malnutrition are explored further.

[9] high-density lipoprotein (HDL) *cholesterol*

2.1.2 Why does it matter?

Child malnutrition remains one of the leading causes of mortality, morbidity and disability worldwide (WHO 2013). The importance of addressing child malnutrition is emphasised from two perspectives – that of the child and that of the population as a whole. For a child, the chances of a full and healthy life are diminished by malnutrition. For a population, gains in overall development are increasingly constricted as burdens of malnutrition and resultant ill-health, disabilities and deaths increase.

Both under- and overnutrition hinder the chances of a healthy life and full realisation of a child's potential, and both can strain the socioeconomic development of a population.

Undernutrition during childhood, has been linked to increased risk of mortality, morbidity, delayed motor development, impaired growth, diminished learning capacity and delayed maturation. These health and developmental problems then impede the social and economic development of the individuals affected (Barrett, Radke-Yarrow et al. 1982; UNICEF 1998; Martorell 2000; Smith and Haddad 2000; Swanson 2002)

In the short term, intrauterine and early childhood undernutrition has been linked to increased risk of morbidity and mortality. Intrauterine growth restriction is linked to increased risk of neonatal mortality (deaths of individuals within 28 completed days of life) as well as increased morbidity risks such as respiratory distress syndrome (Bernstein, Horbar et al. 2000). For infants and children, undernutrition has been shown to be associated with increased duration of and susceptibility to infectious diseases, including diarrhoea and pneumonia (Chandra 1979). As a result of the synergistic relationship between malnutrition, morbidity and mortality among children, research has shown that malnutrition is an underlying cause of 50% of deaths under five years of age (Pelletier, Frongillo E. A. et al. 1995). Thus undernutrition, a preventable condition, is an underlying cause of child mortality and is currently estimated to claim over 3 million deaths of under-fives each year in developing countries (Wagstaff and Watanabe 1999; UNICEF 2007; Black et al. 2013).

For individuals who survive intrauterine and early childhood malnutrition, there can be long-term consequences affecting their life course. Undernutrition is responsible for over 21% of childhood DALYs (Black, Allen et al. 2008). DALYs or 'disability-adjusted life years' are '*the sum of years of potential life lost due to premature mortality and the years of productive life lost due to disability*' (WHO 2011). The Barker Hypothesis has linked intrauterine growth disturbance with the occurrence of coronary heart disease (CHD), hypertension, obesity and insulin resistance in adulthood, due to the impact of intrauterine undernutrition on the production of foetal hormones and physiological development (Barker, 1992; Barker, 1994, Popkin et al., 1996). Adults who did not experience undernutrition during infancy or childhood have been shown to be taller, with greater lean body mass and work capacity; females were also shown to give birth to infants who have higher birthweight, avoiding an intergenerational cycle of undernutrition (Kadiyala, Quisumbing et al. 2009). Thus childhood undernutrition has implications for the capability of an individual to have a healthy and productive life but can also increase the burden on a population's health system and decrease the available human capital of that population, affecting its social and economic development. The WHO provides guidelines for determining the public health significance of child stunting within a population and utilises a prevalence threshold of >20% to indicate such a burden. This underscores and defines the severe socioeconomic consequences of such a burden and provides a means with which to identify it.

At the other end of the spectrum of malnutrition, child overnutrition at all ages is increasingly being recognised as a major global health problem. In the short term, the health risks facing overweight children are similar to those among overweight adults, including elevated blood pressure, insulin resistance and Type II diabetes (Deckelbaum and Williams 2001; Lobstein, Baur et al. 2004; Wang and Lobsten 2006). Overnutrition in childhood has been related to long-term health consequences, as overweight children are more likely to become overweight adults. Overnutrition among adults has been linked to increased morbidity and decreased life expectancy (the number of years a person is expected to live at birth) (Olshansky, Passaro et al. 2005). Adult overnutrition increases the risk of an individual suffering a Non-Communicable Disease (NCD) including hypertension, CHD, diabetes, strokes and certain cancers, diseases which are estimated to surpass causes of death due to undernutrition in low-income populations by 2015 (Wang and Lobsten 2006; Shafique 2007; Tanumihardjo, Anderson et al. 2007). Increased childhood overweightness is a major contributor to the adult obesity epidemic and the associated NCDs (J., C. et al. 1999; Cole, Bellizzi et al. 2000; Deckelbaum and Williams 2001; Wang and Lobsten 2006).

Overnutrition in children can lead to negative psychosocial stresses including social marginalisation that can impede social development (Wadden and Stunkard 1985; Strauss and Pollock 2003), again hampering the cognitive development and educational performance of the individual, affecting their later social and economic productivity (WHO 2003; Veugelers and Fitzgerald 2005). These psychosocial effects can be far-reaching across the life course. Overnourished children are more likely to become overweight adolescents and adults, who have in turn been shown to have higher rates of depression and continued social marginalization (Strauss and Pollock 2003).

The rising prevalence of child overnutrition, in particular, is a concern for both the short- and long-term consequences it has for an individual and the populations in which they are found. The increasing prevalence of child and adult obesity worldwide impacts upon a population's healthcare and economic resources, both due to the costs of treatment and the effect on the future social and economic productivity of the affected individual child whose capabilities are impeded due to overnutrition (WHO 2003). Unlike for stunting, there is no threshold in place from the WHO that defines a burden of overweightness among children that is of public health significance. This research wants to understand the effect of stuntingoverweightness on considered burdens of overweightness through a cross-national comparison – as such the definition of a 'burden' of child overweightness will be discussed in Chapter 3 on the methodology for the comparative analysis across LMICs as well as in the results of the analysis.

So far the concepts of undernutrition and overnutrition and its importance have been introduced. Additionally, the indicators of under- and overnutrition for this research – stunting and overweightness – have been emphasised. The status quo concerning our understanding of under- and overnutrition is important for this research, which considers the paradoxical concurrence of both stunting and overweightness in one individual under-five years of age. Prior to further discussion detailing the existence of this paradoxical concurrence, the level and trends of stunting and overweightness – as currently understood in research – are now presented in more detail.

2.1.3 Levels and trends in stunting and overweightness

Undernutrition among children has been a long-standing global health problem, concentrated today among Low and Middle Income Countries (LMICs). Although globally the number of children who are stunted has decreased by 35% from 253 million in 1990, to 165 million in 2011, the prevalence of chronic undernutrition and risk for a child's current and future health remain pervasive (UNICEF-WHO-The World Bank 2013). Concurrently, levels of childhood overweightness have been rising. Globally, the level of childhood overweightness has risen from an estimated 4.2% in 1990 to 7% in 2011 (de Onis et al. 2010; UNICEF-WHO-The World Bank 2013). Although developed countries have the highest occurrence rates for overweightness in children (~12% of under-fives in 2010), the highest absolute numbers of overweight children exist in developing countries. In 2010, 38 million of the 43 million overweight children worldwide were located in developing countries (de Onis et al. 2010). In addition, the greatest increase in prevalence has occurred in developing countries – from 3.7% in 1990 to 6.1% in 2010 – a rise of 64.9%[10]. In developed countries the proportion of children overweight has risen by 48.1%[11] since 1990 from 7.9% to 11.7% in 2010 (de Onis et al. 2010).

With high burdens of undernutrition persisting and increasing levels of overnutrition in LMICs, child malnutrition remains a key public health concern. This emerging nutritional crisis has become known as the 'Double Burden of Malnutrition' (DBM). For this thesis, concentrating on child malnutrition, coincident under- and overnutrition among under-fives (in the aggregate – community or population level) is referred to as the 'Double Burden of Child Malnutrition' (DBCM). These concepts will be important

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[10] Calculated from data presented by de Onis et al. 2010 from the WHO Global Database on Child Growth and Malnutrition

[11] Calculated from data presented by de Onis et al. 2010 from the WHO Global Database on Child Growth and Malnutrition

for the discussion concerning the Altered Trajectory of the NT reported in current research on NTs in LMICs.

But, as noted at the beginning of this chapter, increasingly individuals can be subject to multiple nutritional insults (MNIs). In addition, these multiple nutritional insults can be paradoxical and can include both forms of under and overnutrition in one individual. A failure to consider this, particularly the existence of stuntingoverweightness when looking at levels and trends in child stunting and child overnutrition, leads to the double counting of individuals. The next section describes further MNIs with a particular focus on MNIs that are paradoxical in nature – i.e. where under and overnutrition are concurrent.

2.1.4 Divergence in Malnutrition: 'Multiple Nutritional Insults' and 'Paradoxical Concurrence'

The trends in malnutrition in developing countries detail a paradoxical situation – of populations increasingly experiencing a burden of under- and overweight. Consistently, however, research in this area fails to note that such dual burdens do not just co-occur at aggregate levels, but that a dual burden can coexist within an individual. Whilst research has explored individuals suffering multiple forms of malnutrition or 'nutritional insults' when they fall on the same side – that of either under- or overnutrition – research on a paradoxical duality of an individual concurrently experiencing some form of under- and some form of over- nutrition is very limited.

Macro- and micronutrient deficiencies along with under- and overnutrition can co-occur in multiple combinations. As a result an individual can be subject to multiple forms of malnutrition or 'nutritional insults'.

Multiple Nutritional Insults (MNIs) involving two or more forms of undernutrition can be severe. The relationship between micronutrient deficiency and growth faltering is well documented, with supplementation of particular micronutrients shown to improve the linear growth of under-fives – including zinc, iron, iodine and vitamin A (Bhandari et al. 2001; Sazawal et al. 2013; Sazawl et al. 2010; Salgueiro et al. 2002). Additionally, multiple micronutrient deficiencies (MNDs) have been found in children, and chronic and acute malnutrition can lead to a child that is both stunted and wasted (Bhan et al. 2001; Ferreira et al. 2008). Thus, in terms of undernutrition, a child can be subject to multiple nutritional insults. These include suffering with different types of micronutrient deficiencies, a co-existence of micronutrient deficiencies and growth faltering as well as dual forms of growth faltering.

There is no evidence of a systematic relationship between overweightness and micronutrient toxicity. However, co-existence of multiple biological insults resultant of overweightness in children have been shown to occur – such as insulin resistance and high blood pressure (Deckelbaum and Williams 2001; Lobstein, Baur et al. 2004; Wang and Lobsten 2006).

In fact, with respect to overnutrition and micronutrient intake, the most common relationship is one of overweightness (or obesity) with concurrent micronutrient **deficiencies**. This paradoxical concurrence has been observed in overweight and obese women and children who also present with iron deficiency (Cheng et al. 2011; Bagni et al. 2013). A study by Aboussaled et al. 2012 showed that 50% of obese women of reproductive age in Morocco were also anaemic – indicating a long period of iron deficiency. It has not yet been established if this is a result of energy dense, nutrient poor diet or a symptom of overweightness. However, a recent study by Cepeda-Lopez et al. cautiously proposes that the relationship between iron deficiency and overweightness may be due to the effect of inflammation resultant of obesity as opposed to nutritional intake or lifestyle behavious such as poor exercise (2012). If proven, the proposition that undernutrition in such cases, in terms of micronutrient deficiency, is a function of overweightness or obesity suggests that although the outcome is paradoxical, the causes are only those assoicated with overweightness – the factors that lead to an obesogenic environment.

But there is another observed form of 'paradoixcal malnutrition' that has also been observed in children. This is the coexistence of under- and overnutrition observed when solely measuring the body composition of children, where a child is both stunted and overweight – 'stuntedoverweight'. A call from Mamabolo et al. in 2005 for the focus of research on child malnutrition to include an assessment of stuntedoverweight children has remained largely unanswered and there is no research comprehensively exploring the international prevalence of this nutritional profile; a gap this research addresses.

From the limited research on the topic, stuntedoverweight children under-five have been observed in China, Mexico, Cameroon and South Africa (Wang et al. 2009; Fernald & Neufeld 2007; Said-Mohamed et al. 2012; Mamabolo et al. 2005).

Research that has addressed stuntedoverweight children has not provided any national estimates of stuntedoverweight children – each study has been concentrated in rural areas with low levels of socioeconomic development, with the exception of a study in Cameroon which focused on children in the capital city of Yaounde (Said-Mohammed et al. 2012).

In China, Wang et al. showed that of the 453 overweight children from Mid-western provinces in China, from a total sample of 8041, 57.6% were concurrently stunted (2009). In South Africa, 19% of black children under-three from rural villages in Limpopo were stuntedoverweight. This prospective cohort study showed that being stuntedoverweight at age 1 was significantly assoicated with (still) being stuntedoverweight by age 3 (Mamabolo et al. 2005). In Mexico, prevalence of stuntingoverweightness was 5% in non-indigenous and 10% in indigenous children – both groups of children studied were aged 24-60 months and hailed from poor, rural areas (Fernald & Neufeld 2007) Moreover, stuntedoverweight children were more likely to have overweight mothers (Fernald & Neufeld 2007). Finally, in Yaounde, Cameroon, in a selected sample of 162 children, 13.6% were found to be stuntedoverweight (Said-Mohammed et al. 2012).

It is clear that stuntingoverweightness is now observable in more than one country in the developing world, and that prevalence among certain groups of children is high – as high as 19% among black children in rural Limpopo (Mamabolo et al. 2005).

As a nutritional outcome that has been rarely reported in research, there are very little studies focused on the understanding the development of stuntingoverweightness among children and the trajectory of this development. There are three possible trajectories to development – 1) a child is stunted and then also becomes overweight 2) a child is overweight and then becomes stunted or 3) a child develops stunting and overweightness at the same time. There is very limited research that can provide an indication to the underlying biological mechanisms involvd in the development of stuntingoverweightness and thus enable the identification of its developmental pathway. To date, there has been no research on human cohort studies to specifically address the trajectory of the development of stuntingoverweightness among children.

There have been multiple studies concerning the effects of undernutrition and overnutrition on rats as a means to uncover the physiological impacts of either nutritional insult (Alfaradi & Ozanne 2011; Dyer & Rosenfeld 2011; Fowden et al. 2006; Harris et al. 1984; Howie et al. 2012; Khorram et al. 2007; King et al. 2014; Sardinha et al. 2006; Woodall et al. 1996). It should be noted that most of these laboratory studies were conducted as a means to assess the long term effects of both over- and undernutrition in early life and not the short or medium term effects. If there are any underlying or predisposing biological mechanisms that relate concurrent stunting and overweightness these will have resulted from short or medium term effects given that the stuntingoverweightness focussed upon in this research is among under-five year olds. Nonetheless, one study in particular provides evidence for the first proposed development trajectory of stuntingoverweightness – of stunting followed by overweightness.

A study by Desai et al. involved three groups of subjects (rats) – 1) a control group (healthy feeding pre birth and post); 2) a group where food was restricted during gestation but not postnatally; 3) a group where food was restricted during lactation. After 3 weeks members of each group were moved onto either a a high-fat calorie diet or standard laboratory feed. At 9 months old, for both groups 2) and 3) (those had experienced some form of undernutrition) a high fat diet had led to significantly increased body weight compared to the laboratory feed, it had not in the control group (group 1).

For all three groups a high-fat increased body fat, reduced lean body mass and increased leptin in blood plasma – a hormone involved in appetite regulation. Furthermore, for rats in group 3, increased levels of significantly increased plasma ghrelin – which increases appetite – were found (Desai et al. 2007). There were also some sex-specific differences. For females in all three groups, a high fat diet as opposed to standard feed was associated with increased basal insulin, but not glucose levels in addition to hypertriglyceridemia. However, it was only female rats who had been food restricted after birth the given a high fat diet (group 3) that presented with hypercholesterolemia (Desai et al. 2007).

These results led the authors to conclude that there were different pathophysicologic mechanisms resultant from either pre or postnatal undernutrition that become apparent in the face of a high fat diet. Notably the authors believe there is evidence that increased body fat is created (compared to lean mass) due to alterations in the regulation of adipocyte growth and function among undernourished subjects. Additionally, there appear to be apparent affects in both hormone regulation (notably those involved in appetite control) and energy (glucose) homeostatis (Desai et al. 2007).

Conversely, a study by Chakraborty et al. followed children from birth to age 9 years provided no evidence (2007). They found that children who faced intrauterine growth retardation, although they grew at a much faster rate than others in the cohort, were unable to catch up in either height or weight come the age of 9. This suggests that, even if physiological changes occurred to such early undernourished children, this had not increased the likelihood of being overweight in addition to shorter in stature. It is clear that the evidence for a subsequent development of overweightness after stunting in early childhood and why this might occur is not conclusive and far more studies are required.

As noted above, much of the studies on the effects of early life undernutrition focus on its long term effects and there is a far wider base of evidence showing that stunting in childhood is associated with overweightness and obesity in later life – most likely due to the effects of undernutrition in childhood affecting the metabolism (Popkin et al. 1996; Martins et al. 2004).

2.1.5 Divergence in Malnutrition – why does it matter?

Of the handful of studies focused on the paradoxical concurrence of under- and overnutrition in terms of growth faltering and overweightness (the stuntedoverweight), all express concern that this is potentially a rising trend that will become increasingly common in today's LMICs as development progresses.

There are three main concerns resulting from this failure to consider this increasingly prevalent stuntingoverweightness among children – they are methodological, pragmatic (in terms of interventions to address such malnutrition) and theoretical in nature.

Firstly, if stuntingoverweightness is not considered in populations where it is present, then the convention of just reporting stunting and overweightness in under-fives will continue. This is an issue of methodology – with incorrect applications of anthropometric indicators leading to a false impression of the nutritional burdens facing populations – and particularly their children – today (Wang et al. 2009). This presents a specific problem when using data sources that publish prevalence rates of stunting and overweightness in countries worldwide, yet do not consider the prevalence of stuntingoverweightness in either the construction of these rates or their conclusions. The 'WHO Global Database on Child Growth and Malnutrition' (WHO 2013) is just one example of a data source affected by the issue. Two studies have specifically noted that the WHO does not consider the potential for and observation of the co-occurrence of stunting and overweightness in one individual. However, neither study focuses on the methodological implications of this and the impact upon our understanding of the prevalence of stunting and overweightness (Valera-Silva et al. 2012; Wang et al. 2009). Children with such a nutritional profile are counted twice – once as stunted and once as overweight. This double counting will not only overestimate levels of stunting and overweightness, but also fails to provide information on a group of children suffering this emerging dual nutritional insult of stuntingoverweightness. In populations with a high prevalence of stuntingoverweightness, a vulnerable group of children is going uncounted and rendered invisible to health care programmes, policy makers and international goals on child malnutrition. Chapter 4 provides an evidence base from which to understand this double counting through a cross-national analysis of the impact of stuntingoverweightness on stunting and overweightness prevalence.

Secondly, the failure to provide insight into stuntedoverweight children means the risk factors and thus potential practical strategies to alleviate this paradoxical nutritional status cannot be formulated. Additionally, there is no systematic analysis on what being stuntedoverweight means for a child both now and into the future. The effects of under- and overnutrition, separately, are wide and they can affect an individual's life irreparably both in terms of health and socioeconomic life chances. It is not known whether being stuntedoverweight also means a 'dual burden' of consequences for a child or otherwise. With the rising understanding of long-term effects of child malnutrition on an individual's future and the subsequent intergenerationality between parents and children, the effects of stuntingoverweightness could be pervasive across generations. As stuntedoverweight children have not been recognised, they have been hidden from the view of research, health policy, programmes and interventions, thus no research has been conducted evidencing the long term health and socioeconomic impact across the life-course of the co-occurrence of this paradoxical nutritional insult. The analysis in this research identifies these children and their determinants – in doing so stuntedoverweight children can be targeted and further work can begin to address their unique nutritional status and its implications.

Finally, this research argues that stuntingoverweightness changes our understanding of the nutritional profiles of populations today. In doing so, it calls into question the validity of the theory of the NT. The NTT currently informs the majority of research on all forms of malnutrition. As noted in the introduction, proposals have been put forward to address the limitations in the understanding of the DBM. However, this research argues that stuntingoverweightness changes our understanding of the DBM – and thus raises questions for the validity of the current changes proposed to the NTT that comprise the AT. These theoretical implications are addressed in the next section of this chapter.

However, prior to the discussion, a further note on the implications of stuntingoverweightness – with particular reference to our understanding of the so-called DBM – is warranted. The DBM is beginning to dominate the world agenda concerning malnutrition. In 2006 a 'Global Agenda' for tackling the DBM was published by the United Nations Standing Committee on Nutrition (UNSCN 2006). By 2012 a 13 year strategy aiming to address maternal and child health with an explicit plan to tackle the DBM was proposed (WHO 2012). Neither refer to stuntedoverweight children who not only may alter our understanding of the DBM but also cause 'double-counting' of both stunting and overweight among children, thus skewing the inferred burdens of malnutrition among children. At this stage of burgeoning research on the nutritional profiles of LMICs it is imperative to address the stuntedoverweight and the implications they have for methodology, intervention, theory and policy.

At the close of this section the importance of focussing on child malnutrition, what it means for individuals and populations, has been addressed. The conceptualisation, definitions and indicators of malnutrition to be used in this research have been clarified and the notion of stuntingoverweightness as a 'paradoxical concurrence' has been introduced. Importantly, the implications of this 'paradoxical concurrence' at the individual and population level have been outlined. The next section focuses on the theoretical background concerning population burdens of nutrition – the NTT. The theoretical background is key to establishing a sound and relevant analysis strategy for the comparison of population level burdens of malnutrition and their drivers. It has already been noted that there are three distinct areas to discuss concerning the NTT: its original conceptualisation; the changes proposed in current research given the observation of the apparent DBM; and the changes proposed in this research given the observation of stuntingoverweightness.

2.2 Trends in the Changing Burdens of Malnutrition

The NTT describes the drivers of trends and levels in malnutrition at the population level. These drivers include the complex economic and political environments that determine the development and food systems of a country and thus food availability within it (Popkin 1996; Popkin & Drewnowski 1997; Nestle & Jacobson 2000). The theory was constructed based upon the experience of countries that have already undergone their NT and related changes in the drivers determining a population's nutritional profile to its socioeconomic development.

As originally proposed by Popkin, todays MDCs are said to have gone through distinct phases in their later NT – from a burden of undernutrition, to a burden of overnutrition – with no overlap in burdens (Popkin 1996).

MDCs are thought to currently be in the final stage of their NT – with no 'burden' of undernutrition and where burdens of overnutrition are beginning to plateau or be alleviated among higher socioeconomic groups within a population; although they may still be increasing among lower socioeconomic groups (Popkin 2001; Popkin 2002). Over time, overnutrition among those with lower socioeconomic status (SES) will also be alleviated (Monteiro et al. 2004). At the proximate level the ultimate decline in overnutrition in MDCs is and will continue to be due to healthy behavioural changes. However, as previously noted, this trajectory of the NT is not observed in countries undergoing the early stages for the NT today.

The original NTT provides a platform from which to understand the drivers of changing nutritional profiles in LMICs today. But the original NTT does not allow for the perceived DBM currently 'observed' in LMICs and as such adaptations to the theory have been proposed – here termed the 'Altered Trajectory' (AT) (FAO 2006).

However, even with modifications for the DBM, the NTT is actually still not appropriate for the study of child malnutrition in LMICs as it fails to consider stuntingoverweightness. Thus, as an extension to this discussion on the NT, an examination of what the observation of stuntingoverweightness in children has on these theoretical models (of the original NTT and the AT) is presented.

It is argued that a move to a more inclusive theory of 'convergence-divergence' in nutrition transition**s**, derived from Hawkes' work of changes in worldwide diets, is both justifiable and necessary given stuntingoverweightness and other MNIs (paradoxical or otherwise) (Hawkes 2006). In order to develop a theory of nutritional change that is relevant to the experience of LMICs today, consideration must be given to MNIs and stuntingoverweightness – this will lead to proposals for suitable modification to the current NTT and AT (FAO). Specifically the call for a move to a 'convergence-divergence' framework emphasises the need to widen the NTT and the AT – to consider the existence of nutrition transition**s** and trajector**ies.** The cross-national analysis on stuntingoverweightness conducted in this research conducts provides evidence and justification for this proposal.

Thus the discussion will show that, for today's LMICs, the original NTT provides a prologue. It is argued that it is a very useful platform from which to contextualise and explore the factors driving the levels and trends in their nutritional burdens today but it is not wholly appropriate given increasing diversity in malnutrition among individuals – particularly given paradoxical MNIs.

2.2.1 Outline of the Nutrition Transition Theory

Using the past experience of today's developed populations, Popkin formulated the nutrition transition theory (1993). Overarching political, economic and social factors shape the context in which populations and thus individuals live and – importantly – where malnutrition develops (Raphael, Curry-Steves et al. 2008; Jones, Jones et al. 2009). The nutrition transition (NT) theory typifies the relationship between changes in these macro-factors and the nutritional burdens facing a population by exploring the resultant shifts in dietary and activity patterns of populations.

The nutrition transition theory proposed by Popkin (1993) has been an accepted and long-standing model that maps the structural processes determining the nutritional burdens of a population and how they change over time. The NT represents the consecutive movement of populations through five stages – termed 'hunter-gathering', 'famine', 'receding famine', 'degenerative disease' and 'behavioural change' – each with their own unique dietary and physical activity patterns (Popkin & Gordon-Larson 2004). The NT can be considered as part of the wider 'health transitions' – including the demographic transition[12] (DT) and epidemiological transition[13] (ET) theories. Each transition links the development of societies to the overarching trends in nutrition health, mortality and fertility; as depicted in figure 2.1.

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[12] The DT theory explores the shift from high fertility and high mortality to low fertility and low mortality within a population (Kirk 1996). It is in the second stage of the DT where mortality declines rapidly, which is postulated to occur due to changes in nutrition and personal illness control, such as sanitation (Kirk 1996).

[13] The epidemiological transition theory explores the long-term shifts in mortality and disease patterns within populations as infectious diseases are displaced by man-made diseases (such as cardio-vascular diseases) as the main causes of death. The most profound changes in the age distribution and patterns of causes of death during the epidemiological transition are argued to occur among children and young women (Omran 1971).

Fig 2.1 Interrelationship between the Nutrition Transition, Demographic Transition and Epidemiological Transition

Demographic Transition

Stage	High Fertility & High Mortality	High fertility Decreasing Mortality declines rapidly	Decreasing Fertility Mortality falls slower	Low Fertility Low Mortality	Very Low Fertility Low Mortality
	Stable or slow natural increase	Rapid natural increase	Slowing increase	Stable or slow increase	Slow decrease

Nutrition Transition

Stage	Hunger-Gathering	Famine	Receding famine	Degenerative Disease	Behavioural Change
Nutritional Burden	Seasonal undernutrition No obesity	Undernutrition Periods of acute food scarcity Increasing inequality in malnutrition bye SES and gender	High prevalence of undernutrition	Increasing obesity Increased Nutrition Related Non Communicable Diseases	TBD
Diet	High carbohydrate High Fibre Low Fat	Less varied in c content Across the year, greater variety in availability	Increased fruit and veg Increased animal protein Decreased carbohydrates Decreased fibre	High fat High in refined sugars Low fibre	Dietary changes to prolong life and prevent NRNCDs
Activity Patterns	High	High Changes in type	Shifting patterns as inactivity and leisure time increase	Increasingly sedentary lifestyle	TBD

Epidemiological Transition

Stage	High prevalence of Infectious diseases	Receding pestilence, poor environmental conditions	Receding pandemics	Degenerative and Man-Made Diseases	Delayed Degenerative Disease

Figure created from: Omran 1971, Popkin 1993

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For research relating to the nutrition transition in both MDCs and LMICs the focus is on the transition from the third stage – 'receding famine'. For MDCs during this stage of receding famine, the dietary patterns within a population were typically composed of a large proportion of fruits, vegetables and increasing animal proteins. This occurs in combination with decreased intake of complex carbohydrates and dietary fibre and high physical activity levels. As a result, there is still a high proportion of undernutrition in the population – particularly concentrated among lower socioeconomic groups where living standards and access to nutritional food is low. As this stage progresses, however, undernutrition declines. The case of the UK is discussed to highlight how undernutrition declined over time in today's MDCs.

The drivers of decline during this stage of high levels of undernutrition in the UK are contested. McKeown focused on increased living standards and better nutrition – afforded by increases in wages (McKeown 1976). However, Szreter notes that this was not the only factor driving declines in undernutrition – industrialisation had previously led to greater urbanisation, so people were exposed to crowded, unsanitary environments rife for the transmission of infectious diseases (1992). The 'triad' of malnutrition, morbidity and mortality is of particular importance here, as increased risk of disease transmission led to high rates of morbidity, which has been shown to have a deleterious effect on the nutritional status of an individual. To counter the effects of the proximate disease environment, Szreter notes the importance of active efforts to improve sanitation and preventative health behaviours – public health campaigns that involve economic input (1988, 1992). Thus for the transition from stage 3 to stage 4 of the nutrition transition, key factors included improved nutrition and living standards but also improved sanitation that was facilitated by economic development and political will.

Crossing over from stage 3 to 4, physical activity levels are in decline due to increasing sedentary lifestyles – both at work and in leisure time. In combination with declining physical activity levels, an increasing intake of animal fats, processed foods and sugars ensues. This leads to the realisation of the fourth stage of the nutrition transition – that of 'degenerative disease'. The dietary and physical activity patterns in this stage create an 'obesogenic' environment – an environment rife for the development of overweightness and obesity among members of the population. The changing diets in MDCs as they progressed in the NTs are a complex story – the case of sugar is used to highlight this.

In addressing the increasing intake of sugar in the diet of Europeans, Mintz famously focused on the roles of the trade, production, consumption and power (1986). Originally a delicacy for the upper classes, a history of slavery and colonisation coincident with advances in agriculture created a supply of sugar to Europeans sufficient for its mass consumption (Mintz 1986). Coincident increases in real wages meant sugar was not only readily available; it was increasingly consumed in the diet for all socioeconomic groups of society.

In addition, advances in the food processing industry meant that during the fourth stage of the NT in MDCs the consumption of processed foods, sugars and animal products increased dramatically, leading to increases in levels of overnutrition. In conjunction with increasing life expectancy, there the prevalence of nutrition related non-communicable diseases NRNCDs and related deaths also increased (McMichael 2001).

The fourth stage gives way to stage 5 – 'behavioural change' – where the burden of overnutrition moved from the higher socioeconomic groups to become concentrated among the lower socioeconomic groups.

The stage of 'behavioural change' is yet to be fully realised among MDCs, who have progressed further in terms of the nutrition transition compared to LMICs. However, in this currently emerging stage, levels of physical activity and the consumption of a nutritious diet with no excesses of fat and sugars are increasing. These lifestyle and dietary changes are expected to lead to a reduction in CVDs and other NRNCDs in the future. Positive behavioural changes leading to healthier nutritional outcomes among individuals also reflect a socioeconomic gradient. Research has shown that in MDCs more nutritious, higher quality diets are concentrated among groups of higher socioeconomic status (Darmon & Drewnowski 2008; Pampel et al 2010; Wardle &

Griffith 2001). Explanations for this observed socioeconomic gradient have been hypothesised to be: 1) greater cost of healthy, nutrient dense food; 2) differential access to healthy foods; 3) education – including the associated level of nutrition knowledge; 4) culture and the social value placed upon food and food traditions; 5) other healthy lifestyles including increased physical activity; and 6) perceptions of weight and deliberate weight control practices (Darmon & Drewnowski 2008; Pampel et al 2010; Wardle & Griffith 2001). Notably, a move to a more nutrient rich diet is affected both by the ability to access such foods – thus the economic capacity of individuals and availability of nutrition foods to purchase – as well as the cultural factors determining food and nutrition preferences. For MDCs, alleviating the burden of overnutrition in groups of lower SES has become the priority.

The model of the NT depicted above can be referred to as a discrete, consecutive model of the NT – where stage 1 (receding famine) of the NT is completely superseded by the next stage (of degenerative diseases) and so on. It is this traditional trajectory that studies have shown occurred previously in higher-income populations including the United States, Western Europe and Japan; parts of the world that are now considered to have moved on to the fifth stage of the NT, behavioural change (Popkin 2002).

Popkin's NT theory goes beyond just a description of consecutive stages that occur as time passes; it also describes the factors driving the changes over time. For MDCs the drivers said to facilitate the changing nutritional profile of populations have included economic development, changing food availability, good sanitation, increased preventative health care behaviours and cultural values. There is also an evident socioeconomic gradient in nutrition – with groups of lower SES ultimately bearing the burden of undernutrition and then overnutrition as MDCs reached the stage of behavioural change.

The traditional conceptualisation of the nutrition transition discussed above highlighted a process through which the socioeconomic development of a population parallels a shift in the same population, from distinct burdens of 1) undernutrition to 2) overnutrition to 3) an absence of malnutrition.

Populations currently undergoing a NT are, however, experiencing an altered version of the traditional NT model where overnutrition and obesity is present in the population prior to the eradication of undernutrition (Gillespie & Haddad 2001). This has been referred to as a 'protracted-polarised model' (PPM) or 'altered trajectory' (AT), with contemporary populations undergoing a NT experiencing a transition that has a prolonged period of receding famine that remains whilst the stage of degenerative diseases begins (FAO 2006). This has resulted in the observation of what is currently considered a 'double burden of malnutrition' (DBM), with undernutrition resultant of a protracted stage one occurring in conjunction with a rapid rise in overnutrition induced by an early onset, concurrent stage two. It is argued that this altered trajectory is due to the context of the world today – namely a world of rapid urbanisation and globalisation that has led to seismic shifts in diet and activity patterns in LMICs undergoing their NT (Gillespie & Haddad 2001). The altered trajectory and its distinctive drivers are discussed in the next section, section 2.2.2.

2.2.2 The Double Burden of Malnutrition and the 'Altered Trajectory'

The original NT has provided key insights into how nutritional burdens of populations have changed in the past, however it can only be considered prologue to the experience of populations today, whose transitions are occurring on a new world stage.

It was previously noted that there are two key features to the NTT: 1) the nutritional profiles of populations and the changes over time in these profiles; and 2) the drivers of these changes.

This section will detail modifications to the NTT that describe the new patterns in the dietary changes and physical activity in LMICs. These modifications were developed in the face of a new nutritional profile – the apparent observation of the DBM in LMICs. In reference to the stages of the original NT, the DBM is where undernutrition has not been superseded by overnutrition but joined by it for a protracted stage three of the NT that becomes amalgamated with stage 4.

Prior to an explanation of the factors that have led to this change in pace and composition of the stages of the NTT, the current nutritional profiles of LMICs as observed in the literature that these modifications aim to account for is presented. Specifically, the prevalent understanding of nutritional profiles of LMICs today is that of a DBM. There are two types of DBM at the population level predominant in the literature: 1) the 'original' DBM where there are increasing burdens of overnutrition among adults and sustained high levels of undernutrition among children of low SES; and 2) the DBCM where there are increasing burdens of overnutrition among children as well as sustained levels of children that remain undernourished. It is only recently that the population level DBCM has become a focus of research on NTs.

The existence of a DBCM highlights a more diverse face of nutritional burdens than the DBM alone. However, the diverse faces of nutritional burdens are rarely taken into account in research on the nutrition transition today. The 'DBM' is the most widely used concept to describe alternations in nutrition transitions in LMICs – even if it doesn't actually represent what is happening in these populations.

To date, the most inclusive representation of the changing face of malnutrition burdens experienced today was presented by the Food and Agriculture Organisation of the United Nations (2006). This research focused on 6 countries – India, the Philippines, South Africa, China, Mexico and Egypt. In this series of research, Kennedy et al. showed that these 6 countries, all undergoing a nutrition transition, each experienced a DBM – although its profile varied (2006). In order to highlight the variety in the alterations to the traditional nutrition transition theory, Kennedy et al. provide a nuanced assessment of the DBM within populations, classified into three typologies (2006):

Typology One is typified by India and the Philippines, with a high prevalence of undernutrition in both children and adults. Overnutrition is emerging in urban areas, as well as NR-NCDs associated with this, including diabetes. A high prevalence of MNDs is also characteristic of typology one (Kennedy et al. 2006).

Typology Two is typified by South Africa, where levels of stunting are high within the population, with underweight and wasting declining. Adult malnutrition differs to child, with obesity being of higher prevalence in adulthood than forms of undernutrition. There are rising NR-NCDs, as well as rising infectious diseases such as TB. A high prevalence of MNDs persists (ibid.).

Typology Three is typified by the case studies of China, Egypt and Mexico, where the child population suffers both stunting and overweight, yet wasting and underweight are declining. Adults suffer from rapidly increasing high levels of obesity, but not underweight, with associated NR-NCDs such as diabetes and coronary heart disease increasing. Particular MNDs affect the population, including iron and vitamin A deficiencies (FAO 2006).

Despite these more nuanced typologies proposed by Kennedy et al., much of the research on the NT today and the DBM fails to recognise this. As noted previously, the focus has been on age-polarised burdens of malnutrition – represented by typology two. In this typology, there is a diametric opposition or polarisation in the nutritional burdens faced by two separate age groups of the population – the children (who face a burden of undernutrition) and the adults (who face a burden of overnutrition).

Despite the different nutritional burdens of populations undergoing the earlier stages of the NT today, the lack of acknowledgement of these nuances has meant that no distinction has been made when assessing the factors determining these different profiles.

Despite the non-specific nature of the presentation of nutritional burdens in LMICs today, the drivers causing this apparent and, as I argue, loosely defined 'DBM', have been theorised and exalted in the literature.

Research on populations experiencing a 'DBM' shows some parallels when discussing the drivers in LMICs with the literature on the NT in MDCs. Research has highlighted the importance of globalisation, rapid economic transitions, market liberalisation, urbanisation, demographic shifts, industrialisation, mass media and changes in leisure activities on both the composition of diet and the type and frequency of physical activity within LMICs (Shetty & Gopalan 1998; Shetty & McPherson 1997; Gillespie & Haddad 2001; Kennedy et al. 2006). These changing conditions affect the nature of a population's food system, thus food availability and physical activity levels, and are thought to explain the rise in overnutrition within a population. Importantly however – unlike with MDCs – in LMICs there is no preceding decline in undernutrition leading to populations facing a dual burden of malnutrition. To explain this, research specifically emphasises that it is not just the socioeconomic development of a population that is integral to changing nutritional burdens; it is the pace of this development. Specifically it is the rapid nature of the socioeconomic development in LMICs that is considered integral to the development of a double burden of malnutrition – a rapidity that is in contrast to the development and subsequent NT witnessed by the likes of the U.S. and Japan.

Even Popkin, who stylized changing nutrition burdens with the original NTT, has accepted that there have been 'shifts' in the stages of the nutrition transition that need explanation. To explain these shifts Popkin focuses on two major features of socioeconomic development distinguishing the development trajectories of LMICs today – the rapidity of globalisation and urbanisation. These key factors are considered to parallel and fuel a convergence in the world's diet to a 'Western diet' that's high in saturated fats and sugar and low in fibre in LMICs, leading to overnutrition – whilst undernutrition remains prevalent (2006; Popkin 2002; Popkin & Nielson 2003). The effects of globalisation and urbanisation on diet and activity patterns are explored below.

Globalisation is a heavily contested concept[14] yet despite this most definitions have comparable foundations. Globalisation is a process, it can be both a cause and effect, and it is change.

For Popkin shifts in the stages of the NT are resultant of the diverse effects of the process of globalisation on diet and lifestyle. Popkin focuses on four key areas: 1) globalisation of food systems; 2) the globalization of modern food processing; 3) media globalisation; and 4) the globalisation of technology (2002). These four areas are very much interlinked in their effect on food availability and thus on people's consumption patterns as well their physical activity levels.

From a broad perspective, a 'food system' is an umbrella term for all the processes involved in the provision of food – from its production to its consumption (FAO 2013). A food system is subject to the sway of both supply and demand.

The globalisation of food systems refers to the integration of the world's foods systems facilitated by economic and trade liberalisation policies, developments in agricultural production, deregulation, the strong arm of multinational corporations ('Big Food') and increased worldwide transportation capacity[15] (Pingali 2004; FAO 2013; Stuckler & Nestle 2012; Shetty & Schmidhuber 2011). Deregulation, privatisation and liberalisation of the agricultural sector and food markets began in the 1970s and 1980s. One aim of this was to form a world food system facilitating trade and production of food enabling the consumption of a nutritious diet, therefore minimising burdens of undernutrition in LMICs (GHW 2011). By 2004, a developing country was spending double what it had

[14] Scholte (2005) categorises conceptualisations of globalisation into five types:

1. Internationalization – where the focus is on increasing 'cross-border' relations
2. Liberalization – integration due to the removal of government regulations and restrictions
3. Universalisation – a conceptualisation very much grounded in geography and the ability to spread products, thoughts etc. to all corners of the globe
4. Westernisation or modernisation – with an emphasis on the 'Americanised' face of this globalisation
5. Respatialization – as supported by Scholte – this conceptualisation emphasises the reconfiguration of social geography, with pan global connections between people

[15] Both technological and economic (reduced costs associated with transportation/freight)

in the 1970s on food imports. Importations of processed food stuffs had increased whilst, concurrently, exports of domestic agricultural produce more than doubled (GHW 2011). The concerning aspect of this trend is the exportation of foods such as fruits, vegetables and fish high in economic value that are also highly nutritious, therefore decreasing the availability of such foods whilst the availability of processed food stuffs of relatively lower cost increased (Prentice 2006). Such changes are argued to have resulted in a world food system *'not driven to deliver optimal human diets but to maximise profits'* disseminating a 'Westernised diet' lacking fibre, vitamins and minerals yet abundant in sugars, fats and salt (Stuckler & Nestle 2012:1; Popkin 2006; Pingali 2004).

Additionally, transformations in the food processing industries in developing countries compounded the generation of an obesogenic environment (Wilkinson 2004). With food exportation becoming increasingly valuable, Foreign Direct Investment (FDI) has fuelled a shift from investment in raw food materials (such as cereals) to the processed food industry. This has facilitated conglomerates, thus a limited number transnational food processing corporations are spearheading the manufacture of the world's diet.

According to Stuckler & Nestle, the 10 largest US food companies control 15% of the world's food sales, and these companies are known as 'Big Food'. The proportion of world food sales controlled by Big Food is increasing as they actively focus on the relatively unsaturated food markets of LMICs (2012). Increasingly, the real epicentre of power is coming to 'Big Food' through the supermarket – dependent on improving transport systems in LMICs (Kearney 2010).

To facilitate a shift to the supermarket and processed foods, change in consumer behaviour is necessary. The key here has been the use of aggressive mass-marketing campaigns and their role in influencing dietary changes.

In summary, globalisation has meant that energy dense, nutrient poor food is available; moreover it is profitable for transnational corporations to sell it in developing countries. Mass-marketing has made it desirable, whilst changing technology and working patterns have compounded the desirability of processed foods as well as its perceived necessity. Moreover, in controlling the market share in food, 'Big Food' has made diets composed of animal protein, sugars and salt affordable, compounded by increasing income levels (Popkin 2002). Thus the consumer's behaviour has changed – and so has the diet. The change in availability of food in LMICs is occurring in a different pattern and at a substantially increased pace compared to the process in MDCs.

As well as 'globalisation' there is a related force at work that is argued to distinguish the experience of LMICs from MDCs in the NT – the increased pace of urbanisation. Research has shown urbanisation to be highly correlated with the consumption of foods that are both processed and high in sugar (Popkin & Nielson 2003). Urbanisation is argued to lead to greater exposure to factors that can determine an obesogenic environment.

As with MDCs, urbanisation in LMICs is indicative of economic development and people in urban areas are likely exposed to improved living standards and real wages. Both their locality and increased income means that there is greater access to foods and a greater diversity of foods to access. In particular, greater transport links, and the large modern supermarkets that such transport links enable, are more concentrated in urban areas in LMICs. This enables access to the 'Westernized diet' – which, if consumed in moderation, could actually alleviate undernutrition without resulting in overnutrition. In addition, urban living is associated with increased accessibility to and thus utilization of health care services – and there are those who posit the beneficial effects of urbanisation on health (Vlahov et al. 2005).

However, as shown by the previous experience of the UK, there are penalties to urban living. In fact, a systematic review of the relationship between urbanisation and health in LMICs has suggested an overall negative relationship; a deleterious effect on health and nutritional outcomes (Cyril et al. 2013). As with the case of the UK, urbanisation leads to overcrowding in areas of poor sanitation, fuelling an environment rife for infectious disease transmission. Additionally, there are further implications for the health of individuals in urban areas who are more exposed to air pollution, for example. Urbanisation is also associated with a change in physical activity patterns due to a move to sedentary working patterns and lifestyles (Van de Poel et al. 2012).

The rapidity of urbanisation is thought to magnify both the positive and negative effects of urbanisation – expounding inequalities in health in a population. What is interesting here is that in LMICs the pattern of inequality in nutrition is different. With the overlap of stage 3 and stage 4 of the NT in LMICs, undernutrition is concentrated among those of lower SES – overnutrition among those of higher SES[16].

The rapid nature of urbanisation in LMICs today is resulting in greater inequality in health outcomes; the concentration of many segments of urban society to live in areas of increasing density far outpacing the ability of a sanitation system to meet the needs of the population. Whilst urbanisation for some will lead to a more energy dense diet resulting in declining undernutrition, there is likely an 'overshoot' in the benefits of dietary changes leading to the consumption of an energy dense, nutrient poor diet leading to overnutrition. At the same time in populations with rapid levels of urbanisation, undernutrition remains. Thus the rapid pace of urbanisation is argued to lead to the development of a DBM.

There is a further factor that is thought to both facilitate the development of a DBM and magnify the effect of the rapid pace of both globalisation and urbanisation – biology.

The thrifty phenotype hypothesis is of particular importance in understanding the role of biology in separating the experience of MDCs and LMICs (Barker & Hale 1992). Also known as the Barker Hypothesis or foetal origins of adult disease (FOAD), the theory is that when a foetus is developing in an environment of poor nutrition (due to poor maternal nutrition) an adaptive process occurs preparing the foetus to survive in

[16] There is some contestation of this in the literature and it is possible that this will change over time as certain segments of population in LMICs enter stage 5 of the NT.

environments with poor nutrition. The adaptations are thought to change the development and thus structure and function of particular organs to ensure the foetus is adapted to an environment of undernutrition. The theory is based upon the observed association between low birth weight and increased risk of overweightness and CVDs in adult life – stunted children have been shown to be at greater risk of overweightness in adult life (Eriksson 2005). Thus, in an environment where nutrition then becomes abundant, the adaptations of the foetus to undernutrition are actually now maladaptive and increase the risk of NR-NCDs.

It is arguable that the FOAD are more apparent in LMICs currently undergoing the nutrition transition due to the rapidity in the changes of nutrient availability. To be specific, for LMICs the pace of socioeconomic development has meant a very real and much more amplified disparity in the nutrient availability between mothers and their children than experienced in MDCs before them in the NT – whilst mothers may have been undernourished, their children are being brought up in an environment of abundance (Galal 2002; Popkin et al. 2012).

This section has discussed the NT and the proposed factors that are distinguishing the NT in LMICs from that experienced by MDCs. The overriding arguments in the literature concerning the NT occurring in today's LMICs are thus focused on:

- The existence of a DBM
- A DBM that is polarised by age – where children still suffer with undernutrition, but adults have an increasing burden of overnutrition
- The development of this DBM is facilitated by the rapidity of both globalisation and urbanisation
- The development of an age-polarised DBM is compounded by undernutrition of previous generations and the (mal)adaptive nature of foetal development

Despite this apparent observation of the DBM and the theorisation of its drivers, there is no actual evidence base for this. Corsi et al. conducted an analysis to evidence this 'DBM' (2011). Using age-adjusted models to explore the relationship between under- and overnutrition in 36 countries they showed that a consistent negative relationship between undernutrition and overnutrition remained – thus no evidence of a DBM was found. This work seriously calls into question the reliability of the concept of the DBM and thus our understanding of the NT that is actually occurring in LMICs today.

Moreover, the literature on the NT in LMICs today fails to discuss the existence of concurrent paradoxical nutritional insults in one individual and thus what this observation means for both our understanding of 1)the nutritional profiles of LMICs and 2) our understanding of the drivers determining these nutritional profiles. The next section addresses this key issue further.

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2.3 Multiple Nutritional Insults and the Paradoxical Concurrence of Malnutrition in Children – A Proposed Move to a Convergence-Divergence Framework on Nutrition Transitions

There has been increasing diversity recognised in the nutritional burdens of populations – as evidenced by research on the DBM, the DBCM and the three typologies of nutritional burdens proposed by the FAO in 2006. However, the diversity of nutritional outcomes in individuals has been overlooked – particularly in reference to what this means for population level burdens of malnutrition. This research aims to address this gap and, in order to do so, focuses on the paradoxical concurrence of stunting and overweightness among children.

This is a particularly striking omission given failure to account for stuntingoverweightness can lead to double counting and an overestimation of both stunting and overweightness in the under-five population[17], especially as trends in child malnutrition are integral to the understanding of both the DBM and the more recently proposed DBCM. This overestimation can be very large – if stuntedoverweight black children in Limpopo were double counted, the burden of malnutrition in the sample would have been inflated by 19%[18] (Mamabolo et al. 2005). Not only will such an overestimation affect whether a DBCM – or indeed a DBM[19] – is announced in such a population, but it also renders 19% of children and their actual nutritional status invisible. In addition, in failing to adequately reflect the nutritional profile of a population, the understanding of its drivers is inhibited. Neither the original NT nor its altered trajectory provide a means to understand the development of stuntingoverweightness among und-fives – a reconceptualization of the NT in the light of this failing is required.

[17] This can also be the case for older children – but this research is focused on the under-fives
[18] As stuntedoverweight would be counted as both stunted (19%) and overweight (19%)
[19] As inflation of undernourished children but not considering paradoxical concurrence

As noted previously, the NTT relies on two aspects – 1) what the nutritional profiles of a population are and how they change over time and 2) the factors driving these changes.

This thesis calls for the acknowledgement of a more diverse nutritional profile among individuals and thus populations. In accurately reflecting the nutritional profile of populations given paradoxical MNIs, the factors that were considered to drive the original NT and the AT need to be reassessed. The question is, do they help explain the existence of paradoxical MNIs such as stuntingoverweightness?

In realising the existence of MNIs and paradoxical MNIs, it is the conjecture of this thesis that the NT occurring in LMICs today is not a uniform process. In addition, not only do the drivers of these NTs have varying effects across populations, but these drivers can also result in divergent nutritional burdens within a population.

As a means to understanding this trend in increasing diversity, this research draws upon Hawkes' work on convergence-divergence and uneven dietary development (2006).

Today, the diet of LMICs is converging – to a diet that is high in sugar, processed foods and saturated fats but low in fibre. Integral to this convergence is globalisation and its effects on the world food systems, which determine the food available to a population. However, as Hawkes notes, this convergence does not mean that the foods available are either accessible or appropriated in the same way across and within populations. Moreover, as Wilkinson suggests, changes to food processing procedures across the world are also heterogeneous (2004). Globalisation is not homogenisation, and convergence in food availability does not mean it is consumed homogenously or that other lifestyle behaviours are equally homogenised. As Appardurai states, globalisation is a '*deeply historical, uneven and even localising process'* (1996:17). Moreover, research focussed within single populations are beginning to show that not only is the pace of urbanisation divergent – the direction for particular cities can differ as well (Wu 2011). Thus the effect of both globalisation and urbanisation on nutritional burdens of populations should also potentially be considered in such heterogeneous terms. Additionally, the question arises of whether these two factors – urbanisation and globalisation – and their pace are the drivers that are distinguishing the NT of LMICs today from those that previously occurred in MDCs.

This section has shown a move from understanding the NTs of populations from: 1) the initial conceptualisation of a discrete model where burdens of undernutrition are alleviated and then replaced by overnutrition; through 2) polarisation where burdens of under and over-nutrition are present within a population at one time; and to 3) the understanding of the NT as one of convergence in some global trends, including globalisation and urbanisation, whilst a divergence in the resultant nutritional burdens is occurring.

It is the conjecture of this thesis that in order to understand trends in child malnutrition today we must accept that within populations can be found not just one burden, nor a dual or 'polarised' burden of malnutrition but a divergent burden.

2.4 Summary

It has been highlighted in this chapter that the world is facing an increasingly divergent profile of malnutrition – where several forms of malnutrition, MNIs and paradoxical MNIs can coexist within one population. By exalting a 'DBM' research has created a false sense of conformity in the experience of LMICs undergoing their NT today. In fact we must acknowledge the divergence in malnutrition and note that there are several types of population-level nutritional profiles in LMICs. These are resultant of different nutrition transitions and trajectories that emerge despite the general convergence apparent in food systems, indicators of socioeconomic development and levels of urbanisation – to name but a few. One of the areas key to this diversification is child malnutrition and notably stuntingoverweightness – and it is this that is the focus of this research.

Focussing on paradoxical MNIs and children enables the understanding of the complexities of NTs occurring in LMICs today. Children are a vulnerable group of society and the continued existence of child malnutrition (both under- and overnutrition) hinders their right to a healthy life and impedes their future socioeconomic development. In addition, this will impact upon the development of populations today and the health and success of future generations.

Paradoxical MNIs among children are underrepresented in research despite (limited) evidence of their burgeoning prevalence levels. The focus of this research is to assess stuntingoverweightness in LMICs today – giving both a name and a face to this paradoxical MNI. Stuntingoverweightness will affect our understanding of the prevalence of both stunting and overweightness among children. The international health and development agenda is consistently re-stating its commitment to the alleviation of child malnutrition. Most recently, a strategy to address the DBCM has been formulated (UNSCN 2006) – but as this literature review has shown, the current understanding of the DBCM is flawed.

This research readjusts child malnutrition prevalence levels given stuntingoverweightness. In addition it considers its relation to child stunting, child overweightness and adult obesity as a means to readdress the DBM and the DBCM, which currently do not account for stuntingoverweightness. In reassessing the DBM and DBCM in the light of stuntingoverweightness and thus the true nutritional profiles of LMICs, a move is made to establish what macro factors are associated with these more diverse profiles. As our understanding of nutritional profiles of populations must change, it is possible that our understanding of the drivers – key to the nutritional profiles of LMICs today – must also change.

Chapter 3 will present the data and methodology used to address these two key elements – the actual nutritional profiles of LMICs today and the macro factors associated with the development of this diversity – assessed through the use of stuntingoverweightness in children. Chapter 4 presents the results showing the nutritional profiles of LMICs today given stuntingoverweightness, while Chapter 5 presents the macro factors associated with its prevalence.

It has been noted that the discussion here has focused on the supra and population-level drivers of NTs, but there is an increasing need to realise the diversity occurring both at the population level and within populations. Thus Chapter 5 will conclude by discussing the selection of Albania – the case of which will be used to explore the determinants of this paradoxical MNI of stuntingoverweightness at the community, household, maternal and individual levels.

Chapter 3: Methodology for the Population-Level Analysis on Stuntingoverweightness in LMICs

"To measure the height and weight of a child is to measure their health."

(Anon.)

This chapter presents a description of the data and methodology used to understand the levels and trends in stuntingoverweightness in LMICs today and potentially its implications. Paralleling the two key components of the NTT there are two major parts to the analysis - 1) understanding the nutritional profiles of populations and 2) the factors that determine them.

The key distinguishing feature of the analysis is that it takes into consideration stuntingoverweightness. To my knowledge this is the first analysis that aims to present the levels and trends in stuntingoverweightness for all LMICs where contemporaneous data is available. In addition, to my knowledge, it is the first study aiming to understand the nutritional profiles of LMICs – namely the DBM, and the DBCM – given the observation of stuntingoverweightness. Additionally, the analysis is one of the first to focus on the nutrition transition from the perspective of child nutrition.

The data and analyses to re-examine the two key components of the NTT given stuntingoverweightness are described in the rest of this chapter. The data and methodology used to understand the nutritional profiles of populations given stuntingoverweightness is described in part 3.1 of this chapter. The data and methodology used to describe the factors associated with stuntingoverweightness in LMICs is presented in part 3.2.

3.1 Data and Methodology employed to explore the Nutritional Profiles of LMICs given Stuntingoverweightness

The aim of the analysis is to provide a comprehensive assessment of the levels and trends in stuntingoverweightness and how this affects our understanding of the nutritional profiles of populations – particularly with respect to the DBM and DBCM. In addressing the nutritional profiles of LMICs today, given stuntingoverweightness, the NTs occurring in LMICs will be better understood. The aims of this part of the macro analysis were:

1. Depict levels and trends in stuntingoverweightness in LMICs

2. Explore the effect that accounting for stuntingoverweightness has on the levels of child stunting and child overweightness – evidence hypothesised double-counting

3. Re-examine the relationship between child stunting, child overweightness and adult obesity given stuntingoverweightness and thus the existence of the DBM and DBCM

4. Detail the relationship between the paradoxical concurrence of stuntingoverweightness in children under-five with child stunting, child overweightness and adult obesity

To achieve these aims, the data requirements and description of the chosen data are described in section 3.1.1. Having described the data sources, the sample derived is described in section 3.1.2. The methodology used to explore the nutritional profiles of LMICs today and the effect stuntingoverweightness has – in line with the aims of the analysis – are described in section 3.1.3.

3.1.1 Data Requirements and Description

In this section, the data requirements to meet the aims of the analysis are outlined in section 3.1.1.1. Based upon these requirements the data sources selected are presented. These data sources are then described in section 3.1.1.2.

3.1.1.1 Data Requirements

As chapters 2 showed, stuntingoverweightness among children is consistently overlooked in research. The first aim of this research is to provide a face to stuntedoverweight children. To fulfil this aim individual level nationally representative data on the weight, height, age and sex of children across LMICs is required. In order to show trends in the levels of stuntingoverweightness such data is required for more than one time point for each LMIC.

Failing to consider stuntingoverweightness has, as I hypothesise, led to researchers utilising anthropometric indices to create child stunting and/or child overweightness prevalence rates at the population level[20] that also include stuntedoverweight children. As chapter 2 highlighted, there is no technical discussion for accounting for stuntingoverweightness in both household survey manuals and manuals for key data repositories such as the WHOCG&M – adding weight to this hypothesis. As a result I postulate that stuntedoverweight children are being double counted – once as stunted and once as overweight. This double-counting is affecting the presentation of prevalence rates of stunting and overweight as they are currently understood and assumed to be mutually exclusive. The second aim of the analysis is to evidence whether this double-counting is occurring and then examine how our understanding of the

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[20] Chapter 6-9 deal with the use of anthropometric indicators and stuntingoverweightness at the individual level

prevalence of stunting and overweightness changes if we take account of this double-counting. In order to describe the 'real' levels of child stunting and child overweightness that exist beyond this double-counting, stuntedoverweight children are considered as a separate group. Prevalence rates of stunting and overweightness need to be reconstructed from individual level data **exclusive of** stuntedoverweight children. These reconstructed prevalence rates are then compared to the prevalence rates I hypothesise **are** double-counting the stuntedoverweight, such as those presented in the WHOCG&M.

To evidence this double-counting two separate data sources are required -

1) A data source presenting the prevalence of child stunting and child overweightness among LMICs that have been created using the current standard methodology

2) Individual level data for LMICs with the weight, height and age of children under-five by sex so that new anthropometric indices and thus prevalence levels of stunting and overweightness can be created exclusive of the stuntingoverweightness.

These data sources must provide or be able to provide data that is nationally representative, available for numerous LMICs and recent. These further requirements enable provision of levels and trends in stuntingoverweightness across LMICs. Additionally, they ensure that double-counting can be evidenced through the use of contemporaneous comparisons of stunting and overweightness prevalence, inclusive and exclusive of stuntingoverweightness in LMICs.

The third aim of this analysis is to address how the observation of stuntingoverweightness affects our understanding of the DBM and the DBCM. In order to do this, additional data is required to assess the DBM. The DBM is the considered coexistence of child stunting and adult obesity – thus additional data on adult obesity rates in LMICs is required. The DBCM refers to the coexistence of child stunting and child overweightness and the data requirements for child stunting and child overweightness prevalence, both inclusive and exclusive of stuntedoverweight children, as has been described above.

The fourth aim of the analysis on the nutritional profiles of LMICs in light of stuntingoverweightness is to detail the relationship between stuntingoverweightness in children with child stunting, child overweightness and adult obesity rates – providing an indication of what the nutritional profiles of LMICs in which stuntingoverweightness is found to be highest are. This aim requires stuntingoverweightness, overweightness and stunting prevalence estimates based on individual level data for LMICs and adult obesity data.

As a final note, there are other key characteristics required of the data. Namely the sample is ultimately constricted by the availability of individual level data from household surveys. Individual level anthropometric data is integral to the analysis as it enables the construction of the prevalence of stuntingoverweightness. Additionally, this data is required to create prevalence estimates of stunting and overweightness that are exclusive of the stuntedoverweight.

Furthermore it should be noted that the research aims to be relevant for LMICs and child malnutrition today. As a result of this, at the onset of this thesis research (2009), countries were selected where such data was available from the preceding five years. This five year period (2004-2009) was chosen as the analysis aims to be both relevant and comparable in order to be best placed to provide results able to inform current research and policies addressing child malnutrition. However, between 2009 and 2013, new data were released. Given the contemporaneous nature of this research, the data in the sample was updated with the most recent data when available. Prior to a description of the sample (section 3.1.2) the chosen data sources are listed and described. The resultant sample is then described in section 3.1.2.

Based upon the data requirements for this analysis on the nutritional profiles of LMICs today, accounting for stuntingoverweightness, the following data sources were selected:

1. Demographic and Health Surveys (DHS)

2. UNICEF Multiple Indicator Cluster Surveys (MICS)

3. WHO Global Database of Child Growth and Malnutrition (WHOCG&M)

4. WHO Global Heath Observatory (GHO)

The DHS and MICS are both household surveys with anthropometric modules collecting an individual's height, weight, age and sex that can be utilised to calculate prevalence estimates of stuntingoverweightness and also prevalence estimates of stunting and overweightness that are exclusive of stuntedoverweight children. This data is used to fulfil aims 1-4 of this analysis.

The World Health Organisation's Global Database of Child Growth and Malnutrition (WHOCG&M) provides levels of stunting and overweightness in LMICs that are created utilising the conventional methodology in research today- the methodology that I hypothesise has led to double-counting. The prevalence estimates from the WHOCG&M can be compared to those I created from the DHS and MICS that exclude stuntedoverweight children to show whether or not double-counting has occurred and evidence the effect this double-counting has on prevalence estimates of stunting and overweightness if it has occurred. This data is used to fulfil aims 2 and 3 of this analysis.

The GHO provides data on adult obesity rates for males and females which are used to investigate the effect stuntingoverweightness has on our understanding of the DBM. Additionally, this data helps address the fourth aim of the research on the nutritional profiles of LMICs – by enabling stuntingoverweightness prevalence levels to be related to adult obesity levels. Thus this data allows for aims 2 and 4 to be fulfilled.

These data sources are described in the next section, section 3.1.1.2.

3.1.1.2 Data Description

This section describes the data sources for the analysis concerning the nutritional profiles of LMICs today – the household surveys - the DHS and UNICEF MICS (section 3.1.1.2.1), WHOCG&M database (section 3.1.1.2.1), and the Global Health Observatory used to gather data on adult obesity (section 3.1.1.2.3).

3.1.1.2.1 Household Surveys with Individual Level Anthropometric Data

Two nationally representative household sample surveys were used to create prevalence estimates of stuntingoverweight, stunting and overweight in LMICs – these were Demographic and Health Surveys (USAID) and Multiple Indicator Cluster Surveys (UNICEF). The individual level data is the constraining factor for the sample size as it is essential for the creating of stuntingoverweightness prevalence rates. Of the DHS and MICS available a total of 77 met the data and timeliness requirements of the research; 52 DHS and 25 MICS were utilised (the full list of countries in the sample by year is provided in section 3.1.2 when the sample is described). Prior to further description of the sample and other data sources, the DHS and UNICEF MICS are described – with a focus on their appropriateness for this research.

3.1.1.2.1.1 The Demographic and Health Surveys

The DHS are nationally representative household surveys that provide key health indicators in addition to nutritional, demographic and socioeconomic characteristics of a population. Importantly the DHS can be used for cross country comparisons and provide a wealth of data on the nutritional status of the population and associated factors even in countries where other data resources are limited (Machiyama 2010).

The DHS were designed with the intention of providing a baseline to inform health policy within countries through the analysis of the surveys. Within the DHS are standardised core questionnaires. It is the use of a standardised core questionnaire within the DHS that enables in-depth cross-country comparative analysis. Consequently, the DHS results are utilised to provide information on global trends, international cross-country comparisons as well as within-country comparisons (Manesh, Sheldon et al. 2008).

The DHS employs the use of multi-stage sampling to ensure a nationally representative sample of respondents. Although the methodology for the sample construction varies by country, inherent within the general methodology for sample instruction, it includes 9 principles from which a comparable, consistent and high quality representative survey can be achieved. These principles are listed in Figure 3.1.

Figure 3.1 General Principles of DHS Sampling Policy

1. *Use of an existing sampling frame*
2. *Full coverage of the target population*
3. *Probability sampling*
4. *Using a suitable sample size*
5. *Using the most simple design possible*
6. *Conducting a household listing and pre-selection of households*
7. *Providing good sample documentation*
8. *Maintaining confidentiality of individual's information*
9. *Implementing the sample exactly as designed*

These principles are created within a context of time, financial and capacity constraints that need to be married with the need to achieve high quality survey data. Although all are important, principles 1-4 and 9 receive further comment.

Existing sampling frames are used to ensure that the DHS can be collected within the context of these constraints, but utilising an officially recognised sampling frame is preferred to ensure its quality. Preference extends to a census frame, although when this is not available alternative sampling frames are utilised. (ICF International[a] 2012). As with all household surveys, 100 % coverage of the sample is prioritised –as this means that everyone is surveyed and limits non-response bias – although in reality 100% coverage is often not achievable. The multistage sampling employed by the DHS is a complex form of probability sampling of the DHS where each individual in the sample has a known non-zero probability of selection and this enables the calculation and thus assessment of sampling error. Sampling error is also a function of sample size and decreases as the sample size increases – as such built into the frame guiding sample construction involves the use of an appropriate sample size. An important feature of the DHS sampling principles is the need to implement the survey as specified. For child health indicators, including anthropometry, this is particularly important as correct sampling procedures lead to correct household listing from which children under-five eligible for anthropometric measurement are identified – the children upon which prevalence rates of stuntingoverweight, stunting and overweight are based.

During surveying – the core DHS questionnaires – the household and the woman's questionnaire are those that enable firstly the identification of these children and secondly acquire the permissions (informed consent) to collect anthropometric data.

For the purposes of the macro analysis it is the collection of nationally representative biomarkers from children under-five that renders the DHS highly appropriate for this analysis, notably the collection of anthropometry data. Specific for the construction of anthropometric indicators the key data collected are the age, height (or length of child lying down if the child is less than 2 years old) and weight of the child. The collection of anthropometric data is standardised to ensure comparability across DHS from different countries – this relates to both the procedures of measurement and the equipment used to collect it[21] and includes consistency checks to ensure reliability and validity of the data (ICF International[b] 2012). Due to the sampling used in the DHS described in the previous paragraph, these measurements are able to be used to create population-level prevalence rates of stuntingoverweight, stunting and overweightness among under-fives. Because of the consistency in the collection of anthropometric data and the nationally representative nature of the DHS, these prevalence rates are able to provide cross-country comparisons on the level of stuntingoverweightness among children experienced by LMICs.

The DHS is considered a reliable source of high quality data. Given the emphasis placed upon intensive training of interviewers and data-processing to ensure high response rates and consistency in data collection and control of other areas of non-sampling error, the DHS surveys are considered a source of high quality data. Furthermore, once data is collected the tool CS Pro is utilised to perform hierarchical data entry, enabling consistency checks of the data, and to compute sampling errors (MEASURE DHS 2011). It is these characteristics that make these surveys a viable data source for this research.

3.1.1.2.1.2 The UNICEF Multiple Indicator Cluster Surveys

In addition to the DHS, UNICEF MICS surveys were selected for the analysis. Underlying the rationale for the UNICEF MICS is the need to create internationally comparable indicators for the monitoring of the health of children and women. As with the DHS, the MICS surveys provide anthropometric data from which nationally representative prevalence of child malnutrition indicators can be constructed. There are

[21] The current equipment utilised in DHS surveys includes the SECA 874 digital scale and the Shorr height board.

currently 4 rounds of MICS (MICS1-MICS4) and all have been developed using technical expertise from a variety of organisations including ORC Macro International – responsible for the DHS. An important feature of the MICS project is to identify and fill data gaps – identifying countries where household surveys yielding high quality data are not currently conducted (UNICEF 2006). Thus the MICS serves to bolster the sample size of this analysis – providing nationally representative anthropometric data for countries and time periods not covered by the DHS.

The MICS is a household survey constructed to be utilisable as a monitoring tool centred on the health of women and children. Two inherent aims of the MICS are 1) to provide indicators for the monitoring of child health as well as 2) ensuring international comparability of the data. To meet these aims, the MICS has several strategies employed to ensure the data from the surveys is of high quality – focussing on a well-appointed survey questionnaire, a well-designed sampling strategy and standardisation of data collection though training and supervision of survey interviewers (UNICEF 2006).

As with the DHS, the MICS outlines optimal sample selection which includes recommendations for sample size, sampling frames, multi-stage sampling and weighting procedures. Although there will be differences in sample construction dependent upon the country, the main guidelines promote strategies to ensure the collection of data from a sample that is nationally representative.

UNICEF highlights the need for a suitable up-to-date sampling frame that may be available due to recent data collection or may need to be modified or created. Specifically, the MICS manual states that where a DHS sampling frame is available it is an '*excellent candidate'* for use as an existing sampling frame but must be evaluated for its *'availability, timeliness and suitability'* (UNICEF 2006: 417). The aim of the sampling frame is to provide valid results free from sampling bias through the use of probability sampling. As a result, and as with the DHS, correct weighting procedures and calculation of sampling errors are required. Coverage takes high priority in the MICS sampling strategy, again to ensure the completeness and thus accuracy of results.

As with the DHS, the household roster is utilised to identify children under-five who are eligible for the collection of anthropometric data – key data for this research. The collection of anthropometric data is the specific responsibility of an editor who acts in a supervisory nature to an interviewer in the MICS. It is their responsibility to ensure the correct process is conducted in the measurement and recording of a child's height and weight. The MICS follows standardised anthropometric data collection techniques and utilises the same type of equipment[22] in its measurement to minimise error and thus enhance the reliability and validity of results (UNICEF 2006). As with the DHS, consistency checks are made to ensure data quality both during and after collection of data for the MICS.

3.1.1.2.1.3 Overview of Indicators of Data Quality for DHS and UNICEF MICS Household Surveys

The above sections have discussed how DHS and MICS surveys are conducted to try to ensure the productive of a high quality, nationally representative survey with data that is both relevant and valid for assessing the health of populations. It should be noted however, that despite of the adoption of pre data collection fail safes the collected data may not be reliable or valid – in many cases this can be due to poor coverage, interviewer error during collection and missing data (either due to non-coverage, interviewer error or refusal of subjects to provide information).

[22] In MICS surveys the UNICEF Electronic Scale 890 (SECA) is used and Schorr height boards (UNICEF 2006)

For transparency in this research project, three elements of the MICS and DHS surveys will be discussed as a means to highlight any potentially poor quality data. Firstly the overall coverage rate for each survey – the proportion of subjects selected for interview that were interviewed. The last two indicators to be discussed related directly to the children – the percentage of children with missing anthropometric data (indicative of non-response) and the percentage of children whose measurements were flagged as biologically implausible (indicative of measurement error) (Fricker & Tourangeau 2010). Higher survey coverage and lower non-response and missing data are indicative of higher quality data, minimising any bias that could result from analysis of the data due to measurement error and non-response bias.

Across all surveys, the household response rates range from 93.2% in Guyana to 99.8% in Rwanda, indicating a high level of coverage across all surveys. A table of the % of missing data for children under-five as well as the percentage of children with flagged height, weight or age measurements is available in Appendix I.

With respect to data for under-fives, missing data rates ranged from 0% in 6 countries (Cameroon, Belarus, Nepal, Kyrgyzstan, Belize and Palestinians in Lebanon) to 34.2% in the Maldives. For the Maldives, this value of 34.2% is particularly high and indicates data quality issues which should be considered in interpreting results. Five further countries had a missing data value of 10% - Senegal (13.7%), Swaziland (20.7%), Guyana (16.5%), Guinea-Bissau (11.0%), Djibouti (12.5%) – again results for these countries should be interpreted cautiously keeping in mind the potential of poor data quality leading to bias in results.

3.1.1.2.2 World Health Organisation Global Database on Child Growth and Malnutrition (WHOCG&M)

The WHO Global Database on Child Growth and Malnutrition is a repository for data on child malnutrition that is fed by data emanating from *'national authorities'* (UNICEF & WHO 2011:3). The database is constructed using standardised anthropometric data from available survey data for all countries since 1985. Data is only included if survey estimates are considered valid and reliable and are selected on a case by case basis by the UNICEF and WHO evaluation team. The data base provides prevalence estimates for stunting, underweight, wasting and overweight. Crucially, there is no evidence of methodological notes to suggest that these estimates consider stuntingoverweightness and as a result I expect they have double counted the stuntedoverweight.

Importantly, the DHS and UNICEF MICS are two key data sources for the repository. The source of the data by year is available and thus it is possible to link estimates from the WHOCG&M database to the same surveys used by myself to create estimates of stunting and overweight that account for stuntingoverweightness. As of July 2012, 639 nationally representative surveys were included in the dataset, where 101 countries had data on child malnutrition from three or more surveys. All 77 countries of the sample were able to be linked to the WHOCG&M estimates by specific survey and year.

3.1.1.2.3 Global Health Observatory

The GHO provides data on a wider range of health issues. It aims to provide access to national, regional and global data that have been compiled and, importantly, verified by the GHO. Thus it provides access to a wider range of health indicators that are both accurate and available for numerous years, making it a valuable resource for this study (WHO 2011). From the GHO it was possible to obtain age standardized estimates of the prevalence of adult obesity by sex that were then linked to the correct country in the sample. The obesity measure presented in the GHO data repository is the *'percentage of* *defined population with a body mass index (BMI) of 30 kg/m2 or higher*' (for individuals > 20 years of age) (WHO 2011). Adult obesity, measured by the BMI, is the most frequently used measure of adult overnutrition in literature on the DBM (Prentice 2006; Popkin 2001; Gillespie & Haddad 2003; Tanumihadjo et al. 2007). Adult obesity is indicative of chronic overnutrition in adults, it is therefore considered indicative of 'typical' burdens of overnutrition in adults. It should be noted that the use of indicators of NR-NCDs and mortality from NR-NCDs were also considered to indicate adult overnutrition but even when age standardised (as there prevalence is higher among older ages) there are still issues concerning the collection and classification of NR-NCDs and associated deaths. As a result adult obesity rates were considered the most appropriate indicator to analyse the nutritional profiles of LMICs today.

Additionally, as the data is available for both males and females, the differential relationships between male and female adult obesity with child malnutrition can be explored. Chapter 2 highlighted the role of intergenerationality in child malnutrition outcomes given maternal nutritional status. Additionally, females have been found to have consistently higher rates of overweightness and obesity in adulthood compared to males – thought to be due to a greater propensity for fat retention and greater exposure to periods 'at risk' of overweightness (FAO 2006; Zeba et al. 2012; Bouchard et al. 1990). The ability to show adult obesity levels by sex will thus be particularly important for the analysis of the DBM given stuntingoverweightness and the nutritional profiles of populations with higher burdens of stuntedoverweight children.

The GHO yielded adult obesity rates (by sex) for 76 countries of the sample (no data existed for the MICS survey on the population of Palestinians in Lebanon).

3.1.2 Description of the Sample

Overall a sample was constructed for 77 LMICs, these countries and the year from which the data emanates is presented in Table 3.1.

Table 3.1 LMICs of the Sample and Respective Year of Household Survey Data

Country	Year	Country	Year	Country	Year
Albania	2008	**Guinea**	2005	**Namibia**	2006
Armenia	2010	**Guinea-Bissau**	2006	**Nepal**	2011
Azerbaijan	2006	**Guyana**	2009	**Niger**	2006
Bangladesh	2011	**Haiti**	2012	**Nigeria**	2008
Belarus	2005	**Honduras**	2011	**Palestinians in Lebanon**	2006
Belize	2006	**India**	2005	**Peru**	2012
Benin	2006	**Iraq**	2006	**Rwanda**	2010
Bolivia	2008	**Ivory Coast**	2011	**Sao Tome e Principe**	2008
Bosnia	2006	**Jordan**	2007	**Senegal**	2010
Burkina Faso	2010	**Kazakhstan**	2006	**Serbia**	2005
Burundi	2010	**Kenya**	2008	**Sierra Leone**	2008
Cambodia	2010	**Kyrgyzstan**	2005	**Somalia**	2006
Cameroon	2011	**Lao PDR**	2006	**Suriname**	2006
CAR	2006	**Lesotho**	2009	**Swaziland**	2006
Chad	2004	**Liberia**	2007	**Syria**	2006
Colombia	2010	**Macedonia**	2005	**Tajikistan**	2005
Congo Brazzaville	2011-12	**Madagascar**	2003-04	**Tanzania**	2010
Congo DR	2007	**Malawi**	2010	**Thailand**	2005
Djibouti	2006	**Maldives**	2009	**Timor-Leste**	2009
Dominican Republic	2007	**Mali**	2006	**Togo**	2006
Egypt	2008	**Mauritania**	2007	**Uganda**	2011
Ethiopia	2011	**Moldova**	2005	**Uzbekistan**	2006
Gabon	2012	**Mongolia**	2005	**Vanuatu**	2007
Gambia	2005	**Montenegro**	2005	**Zambia**	2007
Georgia	2005	**Morocco**	2004	**Zimbabwe**	2010
Ghana	2008	**Mozambique**	2011		

In certain instances the sample was necessarily constricted to meet the aims of the analysis – described further in the methodology (section 3.1.3).

To fulfil the first aim of the analysis – levels and trends in stuntingoverweightness in LMICs – the full sample of 77 countries yielded prevalence estimates of stuntingoverweightness. However, only 33 cases (LMICs) had data from either the DHS or MICS available for more than one time period – thus trends can only be created for 33 countries.

The second aim of the analysis was to evidence hypothesised double-counting of stuntedoverweight children and the effect this has on stunting and overweightness prevalence in LMICs. This analysis requires the use of DHS or MICS data in combination with data from the WHOCG&M. All 77 cases were available for this analysis.

The third aim of the analysis was to address the impact the observation of stuntingoverweightness has on the considered DBM and DBCM. For the DBCM the required data was available for all 77 cases; however for the DBM only 76 cases were available. One of the cases of the sample is the population of Palestinians in Lebanon for which there is no corresponding GHO data on adult obesity levels, thus the case could not be used to explore the DBM.

The fourth aim of the analysis was to document the relationship between stuntingoverweightness, stunting, overweightness and adult obesity. In order to do this data is required for all forms of malnutrition – thus again only 76 cases were utilised as Palestinians in Lebanon were excluded due to lack of data from the GHO.

3.1.3 Methodology

Having described the data sources for the analysis addressing the current nutritional profiles of LMICs given stuntingoverweightness, the methodology to meet the aims of the analysis as noted at the beginning of part 3.1 is described.

The methodology required to create estimates of the levels and trends in stuntingoverweightness is described in section 3.1.3.1. The methodology to create stunting and overweightness prevalence levels is also described in part 3.1.3.1. Following this, the methodology to explore whether stuntedoverweight children are currently included in stunting and overweightness prevalence, evidencing double-counting, is described in section 3.1.3.2. In the next section the methodology employed to reconsider the currently understood DBM and DBCM given stuntingoverweightness is described (section 3.1.3.3). The final stage of the analysis, used to describe the nutritional profiles of LMICs today, is to detail the relationship between stuntingoverweightness among children with stunting, overweightness and adult obesity. This serves as a means to document the nutritional contexts within which stuntingoverweightness occurs. The methodology for this is described in section 3.1.3.4.

3.1.3.1 Construction of Prevalence Estimates for Stuntingoverweightness

In order to establish the current levels and trends in stuntingoverweightness in LMICs the anthropometric indices height-for-age (that indicates stunting) and weight-for-height (that indicates overweightness) need to be constructed from the individual level data in the DHS and UNICEF MICS. In creating anthropometric indices for stunting and overweightness it is then possible to identify children under-five who are concurrently both stunted and overweight.

Anthropometric indices are created by comparing the growth pattern of an individual child (based on their height, weight and age) to a standard that describes how a child should grow. The growth standards to which a child is compared in this research were released by the WHO in 2006. The growth standards are age and sex specific. These growth standards were determined from an extensive 6 year study by the WHO Multicentre Growth Reference Study aiming to develop international growth standards. The study utilised data from children under-five whose growth occurred in a non-limiting environment and thus provides evidence of how a child should grow given the optimal environment[23] (where a limit is defined as anything that could restrict a child's

[23] Specifically for these growth standards a child was considered in the optimal environment if the mother breastfed the child appropriately and did not smoke.

growth) (WHO 2011). Children for the study were not limited by geography or ethnic group, and thus these new growth standards are now utilised in nearly all research on child malnutrition – as they provide a standard utilisable for the comparison of the growth of all children internationally. Specifically the population of children from which the standards are created is described as one of *'breastfed infants and appropriately fed children of different ethnic origins raised in optimal conditions and measured in a standardized way'* (WHO 2006). These reference standards have become the accepted standards to utilise in nutrition research, both at an individual, national and international level, with field tests concluding they are clinically accurate (WHO and UNICEF 2009).

To compare a child to the growth standards, the use of Z-scores is employed. A Z-score is defined as:

$$\frac{\text{(Observed value – median value of the reference population)}}{\text{Standard deviation value of the reference population}}$$

Relevant for stunting and overweightness, a child thus has a Z-score calculated for both height-for-age (giving the height-for-age Z-score (HAZ)) and weight-for-height (where the z-score is known as WHZ), and this z-score describes an individual's deviation (or lack of) in growth from children who experienced optimal growth (WHO 2006). For this research, the creation of z-scores for stunting and overweight are achieved using a WHO created and ratified statistical package which utilises an algorithm to provide age and sex adjusted HAZ and WHZ[24].

In line with the majority of research on child malnutrition the HAZs and WHZs were then subject to a Z-score classification system. This classification system serves as a means to provide an indication of whether a child is stunted or overweight. If a child has a HAZ of <-2, they are considered stunted; if a child has a WHZ of >2, they are

[24] in the statistical software package – STATA i_grow_up_standard.ado

considered overweight. It should be noted that, in line with WHO recommendations, any cases where the HAZ or WHZ is found to be >-6 or >+6 are dropped. This is because such cases are considered biologically implausible and likely reflect measurement or recording error (WHO 2006).

Once individuals are classified as stunted or overweight the standard methodology is to then create estimates of the percentage of children who are stunted and those who are overweight. But it is at this point that this research departs from the conventional methodology for the construction of stunting and overweightness prevalence. In this research children that are both stunted and overweight are reclassified as stuntedoverweight. As a result it is possible to create prevalence rates of stuntingoverweightness (as well as for stunting and overweightness - where stunting and overweightness prevalence estimates are exclusive of stuntedoverweight children).

These prevalence estimates are created from the DHS and MICS household surveys and therefore require weighting. Weighting of the data is required in order to prevent biased population parameters (in this case it would be biased estimates of stuntingoverweightness, stunting or overweightness among under-fives in their respective country). As noted in part 3.1.1.1, both the DHS and MICS use complex multi-stage sampling procedures to gather data that can be nationally representative. The sampling methodology varies across countries and thus recourse was made to the survey manuals for each case of the sample to ensure correct weighting procedures were conducted and thus unbiased prevalence rates produced.

In order to evidence trends in stuntingoverweightness prevalence, prevalence estimates for more than one time point were required. For the 33 countries where more than one household survey (DHS or MICS) with an anthropometric module was available, prevalence estimates of stuntingoverweightness were made for each respective survey year. The methodology to create prevalence estimates for each survey is as described above.

3.1.3.2 Stuntingoverweightness effect on prevalence of stunting and overweightness, evidence of double-counting

The previous section showed how estimates of stuntingoverweightness prevalence were constructed for each LMIC of the sample. In addition it also noted the methodology used to create the prevalence of stunting and overweightness **exclusive** of stuntedoverweight children. It is these prevalence estimates – stunting and overweightness exclusive of stuntedoverweight children – that are integral to the second stage of the analysis on the nutritional profiles of LMICs today. This stage aims to show the effect that not accounting for stuntingoverweightness has on estimates of stunting and overweightness as they are currently produced and disseminated in research. The analysis also aims to evidence that stuntedoverweight children are double counted – once as stunted and once as overweight further skewing the representation of malnutrition in LMICs today. In order to do this, estimates of stunting and overweightness inclusive (as listed by the WHOCG&M) and exclusive (as I created) of stuntingoverweightness are compared.

For each of the 77 cases in the sample, the levels of stunting and overweight as presented by the WHOCG&M were obtained and linked (by survey and year) to their respective LMIC in the dataset.

As previously noted, the estimates of stunting and overweightness prevalence (both inclusive and exclusive of stuntingoverweightness) emanate from exactly the same household surveys (by country, year and type – MICS/DHS). As a result of this – if the WHOCG&M excludes stuntedoverweight children - the prevalence estimates should be exactly the same.

If the estimates are not the same – either for stunting or overweightness - the indication is that stuntedoverweight children are included in the WHOCG&M estimates. If both stunting and overweightness prevalence estimates vary across the WHOCG&M estimates and those I created, there is evidence that stuntedoverweight children have been included in both stunting and overweightness estimates and thus have been double counted. If the WHOCG&M estimates of stunting and/or overweightness are inclusive of stuntedoverweight children, consistency should be observed between the WHOCG&M estimates and the estimates I created with the addition of the prevalence of stuntedoverweight children. Table 3.2 depicts this.

Table 3.2 Expected similarity/difference between WHOCG&M estimates of Stunting and Overweightness if Stuntedoverweight Children are Included or Excluded from prevalence estimates with Estimates Created from the DHS/MICS Inclusive/Exclusive of Stuntingoverweightness

		DHS/MICS Estimates **Exclusive** of Stuntingoverweightness		DHS/MICS Estimates **Inclusive** of Stuntingoverweightness	
		Stunting	**Overweightness**	**Stunting**	**Overweightness**
WHO Estimates	**Stunting Inclusive** of Stuntedoverweight	**Different**	**-**	**Same**	**-**
	Stunting Exclusive of Stuntedoverweight	**Same**	**-**	**Different**	**-**
	Overweightness Inclusive of Stuntedoverweight	**-**	**Different**		**Same**
	Overweightness Inclusive of Stuntedoverweight	**-**	**Same**		**Different**

The expected differences or similarities are based solely on differences due to the inclusion/exclusion of stuntedoverweight children. Based upon a review of the methodological literature associated with the WHOCG&M, it is expected that their estimates will be different from the new estimates I created. To assert that this difference is solely due to a failure to exclude stuntedoverweight children, the difference is quantified. If the prevalence of stunting as presented by the WHOCG&M is, as expected, different from the prevalence of stunting I created, the difference should be the % of stuntedoverweight children (Figure 3.1).

Figure 3.1 Relationship between WHOCG&M Estimates and New Estimates of Stunting

WHOCG&M ESTIMATES	NEW ESTIMATES (where % Stunting is Exclusive of Stuntedoverweight)
% Stunting =	% Stuntingoverweightness + % Stunting

Similarly, the relationship between the WHOCG&M prevalence of overweightness and new estimates of overweightness would be the same if stuntedoverweight children were included in the WHOCG&M estimates.

However, it is possible that the difference between the WHOCG&M estimates and the new estimates is not the exact percentage of stuntedoverweight children, as any discrepancy in the calculation of anthropometric indices, flagging and categorisation of 'stunted' or 'overweight' children, as well as any discrepancies in weighting procedures, can lead to differential prevalence estimates overall. As noted, I have ensured to follow the methodology for the creation of z-scores as stated by the WHO and the weighting procedures as listed in each countries survey manual. If there is some inconsistency in results, these will be discussed in Chapter 4.

Quantifying the difference between the WHOCG&M estimates and new estimates of stunting and overweightness should thus (in the absence of any other bias) be equivalent to the prevalence of stuntingoverweightness for each country. If this is found to be the case, it can be concluded that the WHOCG&M include stuntedoverweight individuals in both estimates of stunting and of overweightness. In this instance, having established that the WHO does not account for stuntingoverweightness in its estimates of stunting and overweight, and conducting consistency checks on the new estimates I made from the household surveys, the effect of stuntingoverweightness on the estimates of stunting and overweight is quantified in terms of the overestimation it causes.

The effect stuntingoverweightness has on the prevalence of stunting is calculated using the following equation:

$$\frac{\text{Prevalence of stuntingoverweightness}}{\text{Prevalence of stunting}^{25}} * 100$$

In doing so, the overestimation of the burden of stunting by not excluding stuntingoverweightness is calculated – and expressed as the % of the true burden of stunting (where % stunting in the equation is the new estimate – thus exclusive of stuntedoverweight children).

Similarly, the effect of stuntingoverweightness on overweightness prevalence among under-fives is quantified by:

$$\frac{\text{Prevalence of stuntingoverweightness}}{\text{Prevalence of overweightness}^{26}} * 100$$

This represents the overestimation of the prevalence of overweightness made when not excluding stuntedoverweight children from the prevalence estimate of overweightness.

This section has thus outlined the methodology used to show that stuntedoverweight children are double counted and the resultant inflation of stunting and overweightness prevalence among under-fives in LMICs.

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[25] New estimate (ie exclusive of stuntingoverweightness)
[26] New estimate (ie exclusive of stuntingoverweightness)

3.1.3.3 Effect of Stuntingoverweightness on our understanding of the DBM and DBCM

The previous two sections of the analysis have shown the levels and trends in stuntingoverweightness and evidenced how overlooking stuntedoverweight children has led to the misrepresentation of stunting and overweightness prevalence among under-fives in LMICS. The next stage of the analysis evidences how this misrepresentation has affected the understanding of the AT – and notably the DBM and DBCM that is now frequently referenced in research on nutrition in LMICs.

An integral argument for research describing how the NT is occurring and being manifest in populations today is that a double *burden* of overnutrition and undernutrition is observed, not just dual incidence. However, there are very limited sources that discuss what a population level burden of any type of nutritional insult is, or would look like. Thus, prior to the description of the methodology for this analysis, a note is made on the definition of a population level burden of malnutrition, specifically of stunting, overweightness and adult obesity - the 'burdens' inherent to definitions of the DBM and DBCM.

The WHO has already in place a system for the classification of the burden of child stunting a population is experiencing (1997). Any prevalence of stunting >20% among the under-five population is considered a burden of public health significance and therefore it is this cut-off that the research will use (WHO 1997). Thus any of the LMICs in the sample with a prevalence of stunting >20% are considered to have a burden of stunting at the population level. It should be noted the WHO defines these burdens based upon its current representation of stunting (i.e. inclusive of stuntingoverweightness).

In order to identify a population experiencing a DBCM, it is also necessary to define when a population is facing a burden of overweightness amongst its under-five years old population.

To my knowledge no threshold exists to define the prevalence of child overweightness within a population as a burden of public health significance or by severity either by the WHO or in any other research. In order to explore the international context further, and in the absence of a standard criteria, a preliminary arbitrary classification will be made of the *'burden'* of overweightness. For consistency, and in line with the classification made by the WHO for a burden of stunting, the threshold for the classification of a burden of overweightness will also include estimates of overweightness that are inclusive of stuntedoverweight children.

To define the burden, the distribution of overweightness across all 77 countries was assessed. At the 75th percentile, a level of 10.545% of overweight was found. Based on this, LMICs with a prevalence of >10% childhood overweightness will be identified as having a burden of overnutrition.

The literature on adult overnutrition is permeated with references to the 'burden of obesity' yet, as with child overweightness, there is no threshold presented at which adult obesity prevalence should be considered a *burden*. A threshold of 10% was also used for adult obesity (for females, at the 75th percentile a level of obesity of 13.80% was found, for males 13.65%).

Using these defined thresholds for a burden of stunting, overweightness and adult obesity (of 20%, 10% and 10% respectively), the analysis classifies countries as having a DBM or DBCM based upon these thresholds. Countries are then re-classified as having a DBM or DBCM using the new prevalence estimates of stunting and overweightness that are exclusive of stuntingoverweightness. In doing so, the effect of stuntingoverweightness on countries that would previously been defined as having a DBM or DBCM is noted.

The analysis moves further, however, to explore the relationships between child stunting with adult obesity and child overweightness – pertinent for our understanding of the DBM and DBCM respectively. An important part of the AT is the dynamics occurring between stunting and adult obesity (leading to a DBM) and between stunting and overweightness (leading to a DBCM) in LMICs. Notably, the protracted-polarised model of the AT states that declines in undernutrition stall as overnutrition increases. If this were the case among countries where a DBM or DBCM occurs, the relationship between child stunting and adult obesity (DBM) or child stunting and child overweight (DBCM) would either 1) see an attenuation in the strength of the negative relationship between stunting and overweight over time 2) See no significant relationship between stunting and overweight[27]. This should also be true of relationships on said indicators of malnutrition when examined cross-sectionally across countries with varying levels of malnutrition.

Thus the analysis aims to show the relationships between child stunting (WHOCG&M estimates) and adult obesity among all countries of the sample, and then among countries with a DBM to show the changing relationship among DBM countries. To do this, the correlation between stunting and adult obesity will be presented, followed by a simple linear regression for the effect of adult obesity (x) on child stunting (y).

The Pearson correlation coefficient is used as it is a statistical measure of the strength of the linear relationship between, for example, stuntingoverweightness and adult obesity prevalence rates. It is used to explore the data further – but it should be noted that it will not be appropriate if the relationship between two variables is not linear. In these circumstances an independent variable can be transformed and used in simple linear regression model to explore the relationship.

The linear regression model is used to model the relationship between a dependent variable with one (simple linear regression) or multiple independent variables. In a simple linear regression;

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[27] In this unlikely event, a positive relationship could be seen

$$y_i = \alpha + \beta x + e_i$$

In this model $e_i \sim N(0, \sigma^2)$ independently for i=1, …, n (Bartholomew et al. 2008).

A multiple linear regression model is an extension of this model enabling the introduction fo multiple independent variables where;

$$y_i = \alpha + \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_k x_{ik} + e_i$$

Again, where $e_i \sim N(0, \sigma^2)$ independently for i=1, …, n (Bartholomew et al. 2008).

In multiple regression, as with simple linear regression the expected value of the dependent variable is a function of the independent variables where $\beta_{1,}\ \beta_{2\ldots}\beta_k$ are partial regression coefficients and represent the effect of the specific independent variable on the dependent variable.

There are several key assumptions inherent to the linear regression model. Key assumptions are:

1. Independence – where the values of the dependent variable are statistically independent of each other
2. The dependent variable (Y) is a linear function of the independent variables
3. The error term is normally distributed with mean zero and constant variance ($e_i \sim N(0, \sigma^2)$)
4. Normal distribution – given the independent variables, the condition mean of the dependent variable is normally distributed.

(Bartholomew et al. 2008; Agresti & Finlay 2008; Hoffman 2010)

Results for the correlation and linear regression models will be presented for both the whole sample and then for DBM countries only. Chapter 4 will show that there was a necessary log transformation of adult obesity rates to meet the linearity assumption of the regression model (assumption 2 above).

This analysis is then repeated using the new estimates of stunting prevalence (exclusive of stuntedoverweight children). The results are compared to highlight how recognising and accounting for stuntingoverweightness changes the relationship between child stunting and adult obesity among the whole sample and DBM countries.

This analysis is then repeated for the relationship between child stunting and child overweightness in order to assess the DBCM and the effect the observation of stuntingoverweightness has on our understanding of it. As with the DBM, the relationship between child stunting and child overweightness will be explored figuratively across LMICs and then using correlation and linear regression models. The analysis will occur across the whole sample to model these relationships. Moreover the analysis will occur among a subset of the sample – the DBCM countries as a means to understand the dynamics between malnutrition in such populations and enable comparison of the relationship with the whole sample of LMICs. Additionally, the relationships are first explored using WHOCG&M estimates of stunting and overweightness prevalence and then using the new estimates of stunting and overweightness prevalence that have excluded stuntedoverweight children as a means to compare the results across the two estimates.

Thus this stage of the analysis will show the effect stuntingoverweightness has on the existence of a DBM or DBCM among LMICs as well as the changing nature of relationships between the key components of the DBM and DBCM that occurs when stuntedoverweight children are accounted for and excluded from the prevalence of stunting and overweightness.

3.1.3.4 Relationship between stuntingoverweightness with other nutritional burdens of LMICs

The final stage of the analysis – which has aimed to show the nutritional profiles of LMICs today – will explore the contexts in which higher levels of stuntingoverweightness are found.

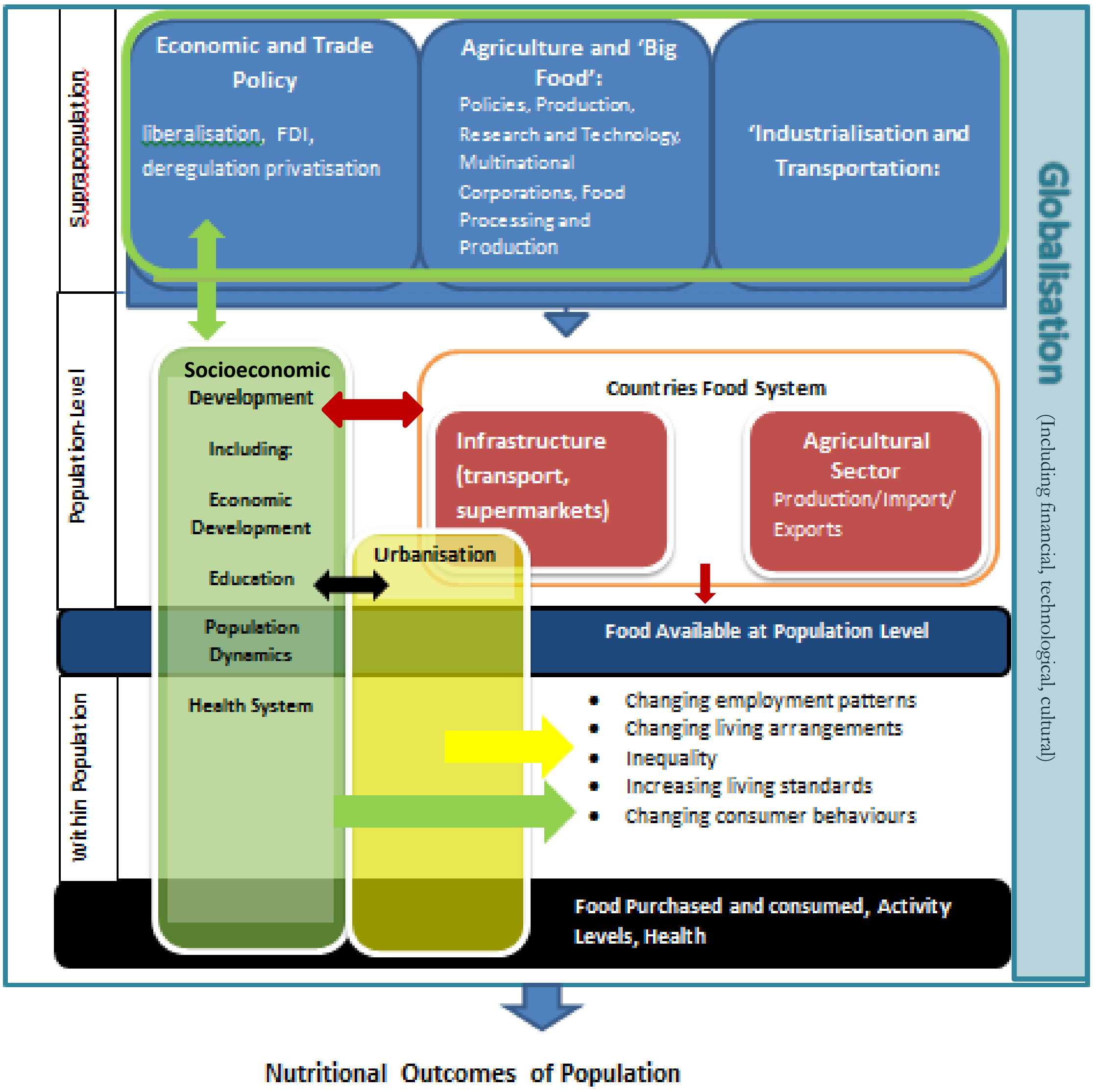
Specifically, in this final stage of the analysis, the focus is on the relationship between stuntingoverweightness with 1) child stunting 2) child overweightness and 3) adult obesity respectively. The NT rests upon our understanding of the composition of and changes to nutritional profiles of populations undergoing the NT. The aim of this analysis here is to indicate the nutritional profiles of populations with greater levels of stuntingoverweightness – vital to begin understanding the NT as it is occurring in such populations.

As before, the relationships between child stuntingoverweightness with child stunting, overweightness and adult obesity is explored using correlation, simple linear regression and then multiple linear regression. In the latter case, the continuous data for stuntingoverweightness is the dependent variable and all indicators of other forms of malnutrition are introduced into the model.

3.2 Methodology for the Factors Associated with Stuntingoverweightness in LMICS

Prior to a discussion of the data and methodology for this analysis, a conceptual framework for the analysis is introduced based upon the literature review of Chapter 2.

Conceptual Framework for Factors Associated with Population Nutrition



The conceptual framework for the population level analysis highlights the key elements found the literature review of Chapter 2 deemed integral to a populations nutrition transition and the nutrition profile of the population. It should be noted that the framework is interested in the wider population and supra-population factors that foster the contexts in which all forms of malnutrition can develop. As a population level analysis the focus is on population level indicators, but it should be noted that there will be key disparities' within the population that will lead to differential nutrition outcomes between individuals – these are the focus of the study of Albania and thus are not fully reflected in the framework.

As highlighted in Chapter 2, there is a vast array of social, economic, cultural and political factors determining the nutrition profile of a population. Fundamentally, the prevalence of different types of malnutrition in a population is related to the proximate factors affecting individuals within that population – notably diet, activity and health. Identifying the relationship of these proximate causes to the wider population requires an understanding of the factors that lead to the diet, the nature of activity levels and the health of the population.

For an individual's diet, it is the foods available and factors affecting consumption of particular foods that are integral. The factors that affect food availability are wide and multilevel in nature and were identified in Chapter 2. A countries food system determines the food available for distribution, purchase and thus consumption within a population. The food system is in part determined at the national level, and in part at the international level. At the national level, a countries food system depends on the environment of the country itself, its own agricultural sector (in terms of technology available and infrastructure to transport produce), agricultural policies (controlling the price, supply and production of foods) and a countries infrastructure (notably transportation). Concurrently, the food system is shaped by other external forces including international trade laws (notably import/export policies), financial investment (including both aid and foreign direct investment), wider agricultural factors including the diffusion of technology, so-called 'Big Food', and the implications these have for the production and processing of food stuffs and their value in the wider market. Beyond the constraints of the wider economic system, 'globalisation' (discussed in further depth in section 3.2.1.1) also includes wider cultural and ideational factors that impacts the demand for food stuffs at the international, national and individual level – where consumer behaviour within and between populations is affected. Furthermore, mass-marketing and the introduction of the supermarket as a central place for food purchases has also been highlighted as wider effects of economic, technological and cultural globalisation (Shetty & Gopalan 1998; Shetty & McPherson 1997; Gillespie & Haddad 2001; Kennedy et al. 2006; Pingali 2004; FAO 2013; Shetty & Schmidhuber 2011; GHW 2011).

Modifying these elements determining food available and desired within a population are wider developmental factors – notably economic development, urbanisation, education and population dynamics within a country. Urbanisation opens up a much larger proportion of the population to a wider variety of food stuffs, with social and economic development increasing the overall living standards of a population, increasing access to different types of food. At this same time, in many LMICs increasing inequality sees stark divisions in access to both types and quantities of food that becomes reflected in the inequality in health and nutrition within a country (FAO 2006).

Beyond the actual diet consumed, there are distal factors driving changes to physical activity levels, health and health behaviours (including food preparation) within a population. Elements of development that give rise to urbanisation and changing work patterns are considered key drivers of changing physical activity patterns within populations (Van de Poel et al. 2012).

It is clear that the status of a population's nutrition is the result of a complex interplay of social, economic, political and cultural factors that operate at the international, national and subnational levels. It is important to remember that for the DBCM, it was the rapidity of urbanisation and of globalisation that were considered to be fundamental to its development – above and beyond the factors that interplay in the conceptual framework presented. This analysis focuses on the factors associated with stuntingoverweightness, argued to be an indicator of diversity in malnutrition outcomes, a disjuncture to a strict DBCM. The lack of research on this population burden (of stuntingoverweightness) gives rise to a gap in which the analysis detailed below aims to fill – namely what elements of the conceptual framework presented above are most important to higher levels of stuntingoverweightness (and more diverse nutritional profiles of populations) and whether, despite a different typology, whether the considered drivers of the DBCM are actually relevant to stuntingoverweightness – notably the rapidity of both globalisation and urbanisation (Drewnowski & Popkin 1997). The data and methodology planned to explore this are outlined in the next section.

3.2.1 Data and Methodology for Factors associated Stuntingoverweightness in LMICs

In this section, the data and methodology employed to uncover the key macro factors associated with higher levels of stuntingoverweightness are described. Chapter 2 highlighted that I intend to argue stuntingoverweightness should be considered indicative of increasing diversity in malnutrition at the population level. An indicator of populations facing 'burdens' of under- and overnutrition among its children, overweightness among its adults in addition to increasing incidence of multiple nutritional insults (MNIs). Key emerging MNIs are those paradoxical in nature, such as stuntingoverweightness[28].

The analysis described in part 3.1 of this chapter described how nutritional profiles of populations given stuntingoverweightness would be explored in themselves. This section focuses on the second key component of the NTT and the AT – the factors that drive and result in changing nutritional profiles.

[28] Another paradoxical MNI noted was micronutrient deficiency among overweight/obese adults.

During Chapter 2 the supra and population-level factors determining the nutritional profiles of LMICs were identified. Of particular note was the disjuncture in theorised factors from the original NTT to the AT.

For the original NTT the focus was on a multidimensional range of factors associated with a population's development. Of relevance to LMICs today, the focus was on the move from stage 3 of the NT (receding famine) to stage 4 (degenerative disease). As noted in Chapter 2 and section 3.2.1, the factors associated with the move from stage 3 to stage 4 included improved living standards (including improved nutritional intake) as well as improved sanitation facilities combating the dialectical relationship between undernutrition and morbidity (McKeown 1976; Szreter 1992). These changes were fuelled by economic development occurring in a context of growing urban populations (Popkin 1993). Following this an increased sedentary lifestyle due to both changes in working environments and recreational activities (and time) in combination with an increased intake of animal fats, processed foods and sugars led to the onset of overnutrition and the realisation of 'stage 4' of the NT – degenerative disease. This again occurred in the context of socioeconomic development leading to increased levels of education, urbanisation and improved economic indicators. Additionally, changes in the production of food and access to different types of foods were increased as a result of this development process (Popkin 1993). Such factors remain integral to the context in which malnutrition occurs and thus the development of malnutrition within LMICs and thus the following key factors need to be considered for population-level nutrition research:

- Levels of socioeconomic development
- Population health systems
- Overall population health
- Agricultural production and population food availability

These will need to be operationalised for an analysis to explore how these factors are associated with stuntingoverweightness prevalence in LMICs. However, for this analysis they serve as controls.

To explain this further, recourse is made to the factors distinguishing the AT from the NT. Although (as I expect the analysis of the nutritional profiles of population today to show) the nutritional profiles of LMICs today are far more diverse than the AT allows and considers, even a diverse burden of malnutrition marks a disjuncture from the original NTT and a merging of stages 3 and 4 of the nutrition transition. It is just thus this 'merging' or protraction of stage 3 continuing as stage 4 develops has resulted in a kaleidoscope of malnutrition outcomes in the population – some of which are paradoxical MNIs. Thus it could be that the factors separating the original NTT from the AT could be the same as those that separate the original NTT from nutrition transitions that have led to divergent outcomes in malnutrition. For Drewnowski & Popkin the key factors leading to the separation from the original NTT to the AT were the pace of both urbanisation and globalisation (1997).

Thus the analysis here wants to explore, whether controlling for other factors influencing population health, the rapidity of urbanisation and globalisation are factors determining stuntingoverweightness[29]. In order to conduct this analysis, thus, indicators of rapidity of urbanisation and globalisation also need to be operationalised. To analyse whether the rapidity of globalisation and of urbanisation affects the level of stuntingoverweightness, above and beyond other factors of population health, a linear regression analysis is planned. This is described further in part 3.2.2.

The data selected to indicate the rapidity of urbanisation and globalisation as well as the levels of socioeconomic development, population health systems, overall population health, agricultural production and food availability and inequality are described in part

[29] Based on results from Chapter 4, I intend to argue stuntingoverweightness is an indicator of divergent burdens of malnutrition will reflect on the results accordingly.

3.2.1. Following this, the methodology utilised to explore whether the rapidity of both urbanisation and globalisation are key factors associated with the development of a diverse burden of malnutrition is described (part 3.2.2).

3.2.1.1 Data and Independent Variables

The data and thus variables constructed to operationalise key factors theorised to affect the nutritional profiles of populations are described in this section. It should be noted that the data utilised and consequent variables used in the analysis were subject to considerations of timeliness, accuracy, validity, reliability and availability. The sample size for this analysis is primary constricted by the number of countries from which data on stuntingoverweightness prevalence was available from the MICS and DHS – where stuntingoverweightness is the dependent variable for the analysis. As shown in part 3.1, overall, 77 countries had estimates of stuntingoverweightness available. However, this sample will be further constrained where reliable and valid data is not available. During the selection process of data for the analysis there was an ongoing dialogue in selection based upon this triad of reliability, validity and availability and this has affected the selection of certain variables. Notably, availability was an additional issue for this analysis as the sample size was only 77 to begin with and I wanted to avoid further constraints on sample size. This is because low sample size can lead to invalid results for the planned regression analysis – both type I and type II errors. Type I errors occur when, in a regression analysis, regression coefficients (β) are found to be statistically significant – when in reality there is not statically significant relationship. Type II errors are the reverse – 'false negatives' (Agresti & Finlay 2008). This issue will be discussed further in part 3.2.2 but is referred to during the description of data selected below. Prior to a discussion of the independent variables for analysis, further note on the dependent variable – stuntingoverweightness – is made.

Stuntingoverweightness is a continuous variable, and gives the prevalence rate of stuntingoverweightness (as a percentage) for 77 LMICs (see section 3.1). I have mentioned above that it is my conjecture that stuntingoverweightness can be utilised as an indicator of a divergent burden of malnutrition. This is currently a conjecture, although the results from the analysis described in part 3.1 on the nutritional profiles of LMICs today, which are presented in Chapter 4 will confirm or deny this proposition. As Chapter 4 will show, the former is the case, and as I will argue in section 4.3 of

Chapter 4 – stuntingoverweightness prevalence can be considered an indicator of a diverse or 'divergent' burden of malnutrition.

In the next sections, the independent variables found to be significant in the analysis are described. Section 3.2.1.1 details data for the rapidity of globalisation, section 3.2.1.2 details data for the rapidity of urbanisation. In sections 3.2.1.2 to 3.2.1.5 data collated and constructed into variables for the LMICs of the sample detailing socioeconomic development, population health systems, overall population health and agricultural production and population food availability are described. Variables that were also tested during the iterative model building process but were not found to improve the model are noted in Appendix VI.

3.2.1.1.1 Rapidity of Globalisation

As emphasised previously Drewnowski and Popkin believe that the sheer pace of globalisation is what has led to a different NT occurring in LMICs today than the NT that occurred in MDCs previously.

The rapidity of globalisation is a particularly difficult concept to operationalise not least because, as noted in Chapter 2, the very definition of globalisation in itself is widely debated (Apparadurai 1996; Scholte 2005; Dreher et al. 2008).

In many studies multiple indicators of different aspects of globalisation are used in research – some focus solely on particular aspects of globalisation based upon their underlying conceptualisation of globalisation. For example, the OECD publishes data designed to measure the magnitude and intensity of globalisation – focussing solely on variables to measure trade as well as foreign direct investment (FDI) and multinational corporations under the umbrella term of 'globalisation'. However, not only is this definition of globalisation constrictive and contested in the literature by those who propose a wider conceptualisation of globalisation, the data is only available for a very limited number of countries (40 countries) only one of which is in the sample of LMICs for this analysis – India (OECD Factbook 2010).

Beyond the use of multiple variables to indicate differential aspects of globalisation, there are various indexes for globalisation that have been proposed. To overcome the complexities of definitions and the multifaceted nature that is so often drawn upon in discussions of globalisation[30] many researchers promote the use of an index to capture key areas in the globalisation complex such as economic, social, environmental and political aspects. There are several indexes available; each comes with their own issues

[30] If we remember for Chapter 2 Scholte (2005) categorises conceptualisations of globalisation into five –

6. 'internationaliszation' – where the focus is on increasing 'cross-border' relations
7. Liberalization – integration due to the removal of government regulations and restrictions
8. Universalisation – a conceptualisation very much grounded in geography – and the ability to spread products, thoughts etc. to all corners of the globe
9. Westernisation or modernisation – with an emphasis on the 'Americanised' face of this globalisation
10. Respatialization – as supported by Scholte – this conceptualisation emphasises the reconfiguration of social

and arguments for and against. Two notable indicators include the KOF Index and the Globalization Index (AT Kearney/Foreign Policy 2001). The KOF Index which focuses on economic, social and political aspects of globalisation with the inclusion of trade variables (KOF2010). The KOF index has been criticised for its failure to consider geographical distance in indicators of trade which has been shown to modify results (Vujakovic 2010). The Globalization Index focuses on economic integration, interconnections, information flows and political aspects (AT Kearney/Foreign Policy 2001). It has been criticised for its focus on outcome measures of globalisation that do not consider country-specific factors such as population size and seemingly arbitrarily weights the importance of its components (Lockwood 2001). Both indexes suffer from bias that favours, and thus consistently ranks higher, smaller countries (Vujakovic 2010).

Not only are there issues with these indexes for theoretical and methodological reasons they also provide only a 'snapshot' of globalisation. Additionally and importantly it is not just the 'level' or 'depth[31]' of globalisation that is of concern to this research – it is the rapidity at which the process occurs. There is no index specifically designed to track the progress or rapidity of globalisation over time, and tracing indexes over time is hindered by data availability. Moreover, the construction of such indices is necessarily data intensive – and leads to missing data and thus restriction of the sample. For example, 13 cases of the sample for this analysis do not have data for the KOF Index. In combination (lack of indication of 'rapidity of globalisation' and lack of data), these factors render globalisation indices inappropriate for this analysis.

As a means to provide an indication of level and pace in globalisation in the LMICs of the sample, variables on ICT (information and communications technology) and increased uptake of ICT across time is by country is used. It is accepted that to focus on one just aspect of globalisation is an incomplete operationalization of globalisation, but ICT has been shown to be indicative several aspects of globalisation – including

[31] There have been measures proposed to consider the 'magnitude', 'intensity' and 'depth' of globalisation (OECD Factbook 2010; Ghemawat 2013) – however these are also contested and also suffer from the limits of data availability.

cultural, social, economic and trade dimensions (Bhandari & Heshmati; 2005 Samini et al. 2001; Moretti 2011). Additionally, the recent nature and development of ICT has meant that it is one area of both globalisation and development that marks a clear disjuncture from the experiences of MDCs who underwent their NT in the past.

Two indicators of ICT will be used as proxies for globalisation – mobile phone subscriptions per 100 people and fixed internet broadband users per 100 people.

The number of mobile cellular subscriptions (MCS) per 100 people indicates the number of people with subscriptions to a public telephone service – it includes both prepaid and post-paid contractual telephone subscriptions (WB 2013). The data is available from the World Bank DataCatalog[32] (WBDC). Also available from the WBDC is the number of fixed broadband internet (FBI) subscribers (per 100 people) – the number of subscribers with high speed internet connection (WB 2013).

MCS has been shown to be indicative of the socioeconomic development of increasingly globalised LMICs as well as a means through which to cement newly developing interconnectedness across the world. Prior to 25 years ago, there was limited or no MCS available and thus is it an excellent indicator of globalisation in the last 25 years. There are two variables constructed from the data of MCS for the analysis – they are MOBILE and MOBILE10.

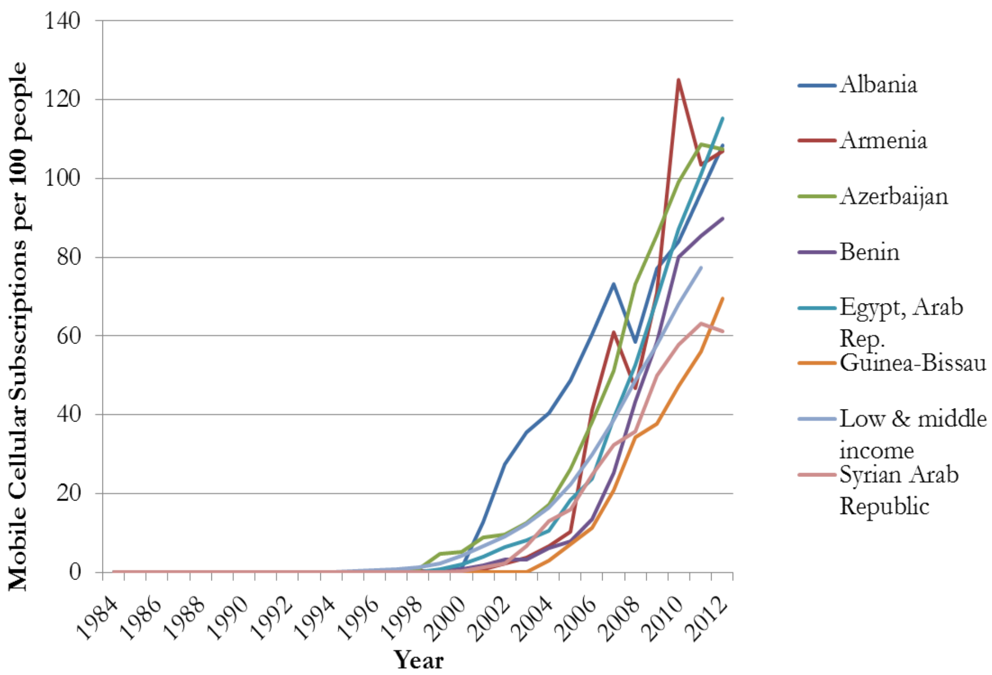
MOBILE indicates the current number of MCS per 100 people – and can be considered indicative of current levels of economic and social development as well as a proxy for the interconnectedness associated with globalisation. Due to the wide availability of MCS data from the WBDC – the number of MCS per population are linked to each case of the dataset by respective year of the survey from which the data emanates – indicating current levels in MCS.

[32] The data is sourced from the International Telecommunication Union, World Telecommunication/ICT Development Report and database, and World Bank estimates (WB 2013).

Additionally, the variable MOBILE10 is derived from the data in the WBDC. MOBILE10 is an indicator of the percentage change in MCS subscriptions per 100 people in the last 10 years. Data for 10 years preceding the survey for all countries of the sample on MCS were harvested and linked to their respective country case.

Although from a global perspective the onset of MCS began 25 years ago as can be seen from figure 3.3, the onset in LMICs and rapid increase only really began in the 1990s onwards which is why the time period to measure rapidity of increase is restricted to the 10 years prior to the MICS/DHS surveys of respective countries in the sample. MOBILE10 serve as a means to understand increasing 'globalisation' by proxy – greater values indicate a greater increase (or decrease) in MCS over the last 10 years. MOBILE10 indicates the rapidity of MCS development and increase in LMICs as acts as a proxy for the pace of globalisation – and particularly technological, cultural and economic aspects of globalisation. As the pace of globalisation is likely dependent upon the level of baseline level of globalisation - which varies across countries (see figure 3.3) - both variables MOBILE and MOBILE10 are included in the analyses.

Figure 3.3 Mobile Cellular Subscriptions per 100 people Among Countries with Highest Prevalence of Stuntingoverweightness and Average for all LMICS 1984-2012

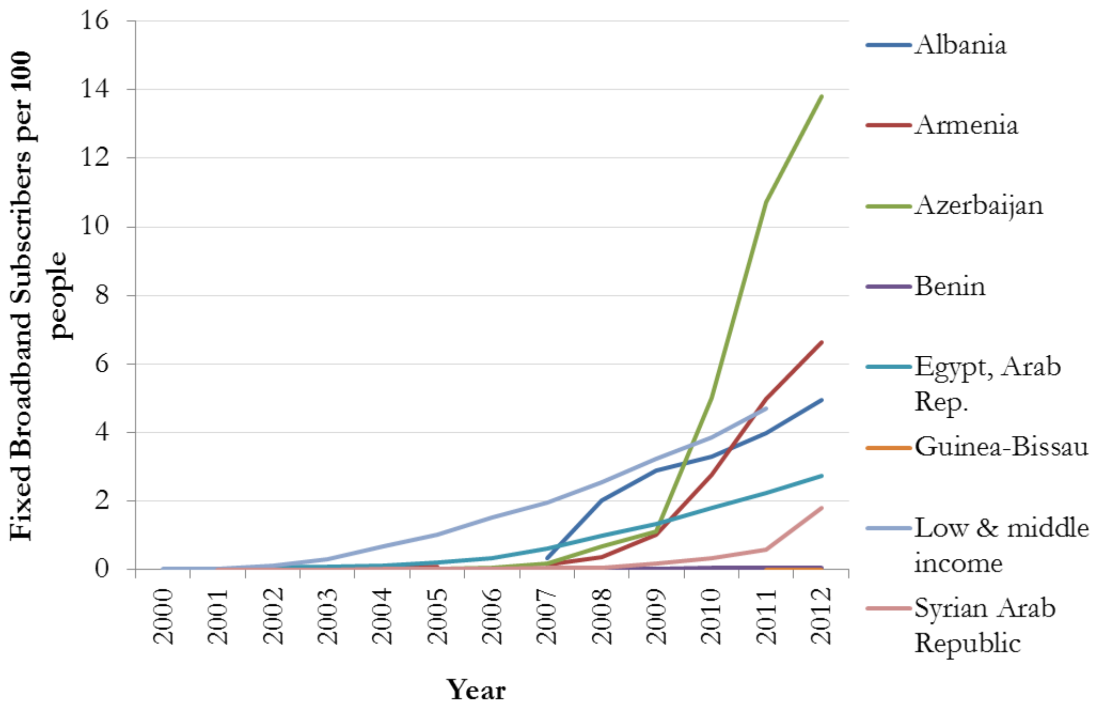


FBI is another ICT variable that is associated with increased levels of economic development. Additionally, it has been shown that increased FBI have a dialectical relationship with FDI & capital flows particularly due to their relationship with trade openness (Addison & Heshmati 2003; Fau & Motiwalla 2007). Thus again FBI can be considered of both the globalisation of communications systems in itself but also an indicator of wider aspects of globalisation such as economic factors including trade and FDI which data for other studies relies upon (OECD Factbook 2010; Vujakovic 2010). There are two variables emanating from the WBDC FBI data – they are INTERNET and INTERNET5.

The current levels of fixed broadband internet subscribers (per 100 people) (INTERNET) reflects the number of subscribers to broadband utilising a high speed technology – including cable modems or digital subscriber lines (World Bank 2011)

Additionally, the variable INTERNET5 is derived from the data in the WBDC. INTERNET5 is an indicator of the percentage change in FBI per 100 people in the last 5 years. Data for 5 years preceding the survey for all countries of the sample on FBI were harvested and linked to their respective country case. Due to the late onset of such technology, data availability is limited to a 5 year period preceding the survey. It is this percentage change variable, which in the presence of the level of FBI, is hypothesised to impact upon the overall context in which malnutrition has developed and change the way in which nutritional profiles of populations are manifest today. Figure 3.4 shows fixed broadband subscribers over time for selected countries. From the graph, it is clear that among LMICs the increase in FBI really began 2002 onwards – which is why a 5 year period was selected to show increase as opposed to 10 years given that the sample has nutritional data from 2004 onwards and the time frame for increase needs to be consistent to allow for comparability in results.

Figure 3.4 Fixed Internet Subscribers in Countries with Highest Prevalence of Stuntingoverweightness and Average for all LMICS 2000-2012



It should be noted that there are further variables incorporated into the analysis, described below that are likely capturing effects of globalisation. These include economic aspects of globalisation – such as GNI per capita (described in section 3.2.1.3) as well as indicators of changing food systems such as percentage of employed working in agricultural sector (levels of and over time), the Food Production Index, and population food composition data (described in section 3.2.1.5) that can control for other aspects of globalisation beyond the cultural and technological dimensions of globalisation the ICT variables used identify. This section has highlighted that the measurement of globalisation is notoriously complicated – and aiming to indicate the pace of globalisation over change is particularly difficult. Focussing on technological globalisation data on ICT has been incorporated into the analysis as it enables the use of high quality data across for several years, available for several countries to demonstrate and indicate the effect of globalisation – both in terms of levels and of trends.

3.2.1.1.2 Rapidity of Urbanisation

At face value, urbanisation as a concept suffers less from the multiplicity of conceptualisations facing globalisation; however this is not necessarily the case. 'Urbanization' can be considered the process of 'urban growth' specifically in terms of the growth of the proportion of the population living in urban areas (UNFPA 2007). It is important to note that there are several affecting the change in the level of percentage of population living in urban areas. These include the natural increase in the urban population (births-deaths), net migration as well as the redefinition of certain areas to 'urban' (UN ESCAP 2001; UNFPA 2007). A key issue comes from the definition of an 'urban' area and whether this definition is based upon the characteristics of the place or of the population – although the former is more often the case (Weeks 2010). Moreover, the evidence is that there is no strict 'urban' vs 'rural' distinction in reality – it is a spectrum often overlooked (Stewart 1958; Friedmann 1996; Iaquinta et al. 2000; Weeks 2010). This is particularly important for research addressing the percentage of total population living in urban areas as there are likely inconsistencies in the conceptualisation of the urban area across time and between countries. For research concerned with urbanisation the indicator used is often the urban population as a percentage of the total population which is clearly dependent on the definition of the urban area. The WBDC provides data on the number of people living in urban areas using administrative, national definitions of urban areas based upon WB and UN data. A study by Brockerhoff revealed the nature of cross-country differences in the definition in urban population[33] with definitions based on administrative areas, economic activity or population size/density (2000).

Despite these issues, for cross-sectional and cross-national analyses, aggregate data collated by the UN or WBDC (based in part upon the UN data) is the best indicator there is for the percentage urban population (of total) and is available for several years and it continues to be used in research today. For this research URBAN is the variable indicating the current level the percentage of the population that is urban and was sourced from the WBDC and linked to each country in the sample for the specific year in which their respective DHS/MICS survey was conducted. It is important to control for the level of urbanisation as this is related to the pace/rapidity of urbanisation.

However, as shown in Chapter 2, the concern is the rapidity of urbanisation and notably the greater pace of urbanisation relative to MDCs. As with globalisation indicators, variables indicating the percentage change in the percentage of the population living in urban areas (of total) for a particular period of time will be utilised. URBAN40 represented the percentage change in the urban population in the last 40 years preceding the survey, URBAN20 the percentage change in the last 20 years. Two time periods were chose as this is likely to affect the results.

Figure 3.5 shows the urban population in LMICS (as percentage of total) among selected countries – it can be seen that rate of increase is higher among countries with lower levels of urban population – highlighting the need for the inclusion of URBAN.

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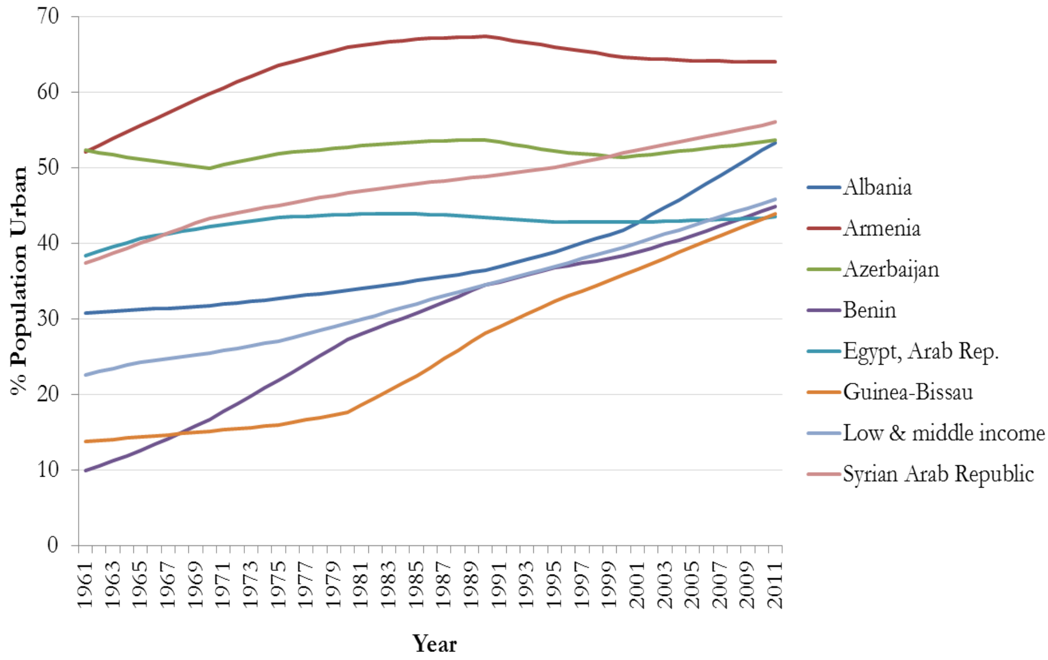
[33] Brockerhoff showed that of the 228 countries the UN provided data 50% used administrative definitions, 51 used definitions based upon population size or density, 39 used information on the economic activity patterns within the country, 22 had no definition of urban and 8 defined the whole population as urban (e.g. Singapore) or the whole population as not urban (Polynesia).

Figure 3.5 Urban population (as percentage Total) in Countries with Highest Prevalence of Stuntingoverweightness and Average for all LMICS 1960 - 2012



As with globalisation, to understand the effect of urbanisation and its rapidity, it is necessary to control for confounding factors affecting population levels of malnutrition – these are presented in the next sections.

3.2.1.1.3 Socioeconomic Development

As highlighted in chapter 2, research has shown socioeconomic development very important to population health and nutrition. Variables included to operationalise current levels of socioeconomic development of the LMICs in the analyses – in order to control for the effects – are detailed below. These variables are the gross national income per capita, female labour force participation rate, education variables – including primary completion rate, total (% of relevant age group), adult literacy rate, ratio of females in tertiary education. Additionally two variables indicating the level of infrastructure concerning sanitation and water supply facilities are utilised.

GNI per capita PPP (current international $) reflects average national income and has been shown to better reflect the people's living standards than other economic measures (UNDP 2011). GNI can be considered an extension of Gross Domestic Product (GDP) and is being increasingly utilised as an economic variable in research, as it can be said to adjust the GDP according to how much value remains within the population. In order to allow comparisons across countries, the data need to be converted to a common currency. Thus to calculate GNI per capita, PPP (current international $) the GNI of a country is converted to international dollars utilising purchasing power parity rates. An international dollar is defined as having the same purchasing power as a US$ has in the United States (World Bank 2011). GNI per capita data was linked to the countries in the sample by year of in which the survey was conducted.

Data on educational attainment is problematic both in collection and in the completeness of highlighting the effect of education across the full range of education from primary to tertiary. This is particularly important as there are differential effects found based on the level of schooling complete – particularly by gender – which has implications not only for education and health but for the relationship between cultural shifts and changing values with respect to gender that have been show to affect population health outcomes as well as future development. For example Cohen noted that secondary education is going to be vital for the creation of and innovation in current and new technologies (2008). Additionally, primary education is not only relevant for health care behaviours but also is a place where nutritional programmes focussing on children often occur – thus higher enrolment rates can represent greater nutritional intervention in some contexts (Sherman & Muehlhoff 2007). Furthermore, increasing enrolment of women in secondary and tertiary education is consistently found to be necessary for improvements in health and future socioeconomic prospects (Heward 1999). As a result mean years of schooling or expected years of schooling by sex would be the ideal indicator for education, however data is limited for all countries of the sample so other indictors of education where data was more available were utilised, detailed below.

The adult literacy rate is the percentage of people age 15 and above that can understand, read and write a short simple statement. The adult literacy rates utilised are sourced by the WBDC from UNESCO – the United National Education, Scientific and Cultural Organisation – and are considered a benchmark, the standard indicator for literacy progress worldwide and a basic indicator of national education (Psacharopoulos 1984; UNESCO 2009).Primary completion rate has been increasingly used as an indicator of a populations education in cross-country analyses (Thuilliez 2010; Cameron 2005; Bruns et al. 2003). The primary completion rate indicates the percentage of the population starting the last grade of primary education (WBDC 2013) This is because the indicator not only serves level of primary education, the completion rate indicates the overall quality of the education system – where low completion rates are indicative of poor performance and low quality in education systems (Lohani et al. 2010). Primary completion rate data was harvested from the WBDC and UN database of Millennium Development Goal Indicators and the Population Reference Bureau (PRB) (WB 2013; UNSD 2010; PRB 2011). Ratio of female to male in both secondary and tertiary education are indicators used to show the gender disparity in educational attainment across the sample. It is the ratio of females to males in respective level of education who are enrolled in education and is harvested from the WBDC (WB 2013). Finally data on public spending on education as percentage of total government expenditure was also used to construct a variable on education, used to indicate both political commitments to education as well as quality of education across the LMICs in the sample. It should be noted that not all education indicators were used in the final analyses but that all were considered for use – selection is explained further in the methodology section (section 3.2.1)

Female participation rate in labour is the proportion of the female population aged 15 years and older who are economically active; it is considered a key indicator of the labour market (World Bank 2011). Higher female participation is argued to increase labour supply, production and living standards as well as lead to greater gender equality within a population, and as a result is utilised as a variable analysing the nutritional outcomes in children. The variable is utilised in studies on child malnutrition due to the hypothesised role of increases in living standards (due to increased labour participation) on improvements in material conditions decreasing the risk of child malnutrition. In addition higher female participation in labour supply is associated with increased maternal education levels. Increased maternal education levels are hypothesised to improve child nutritional status due to the role of the associated increased empowerment and autonomy of women on the, for example, quality of diet provided to under-fives and the use of health care services for children suffering from illness that can reduce malnutrition due to the elimination of the morbidity-malnutrition synergistic relationship (Desai and Alva 1998).

Two further indicators of socioeconomic development are utilised these are the percentage of the total population with access to improved sanitation facilities and the percentage of the total population with access to an improved water source. As noted in chapter 2 improved sanitation facilities and clean water sources have been found to be key to public health, they are also indicative of improved living conditions (McKeown 1976; Szreter 1992).

The variable SANITATION reflects the percentage of the population with access to improved sanitation facilities where an improved sanitation facility adequately and hygienically separates, and thus prevents, contact of human users with human excreta (WHO/UNICEF 2012). Improved sanitation facilities include those with sewer connections, septic system connections, pour-flush latrines, ventilated improved pit latrines and pit latrines with a slab or covered pit. Unimproved sanitation facilities would include pit latrines without slabs or platforms or open pit, hanging latrines, bucket latrines, open defecation in fields, forests, bushes, bodies of water or other open spaces, or disposal of human faeces with other forms of solid waste and any sanitation facility that is either public or shared with another household (WHO/UNICEF 2012).

The variable WATER reflects the percentage of the population with access to an improved water source where an improved water source is described as one adequately protected from external contamination. These include piped water into dwelling, yard or plot, public tap or standpipe, tubewell or borehole, protected spring, protected dug well, rainwater collection and bottled water (only when the household was using an improved water source for cooking and personal hygiene) (WHO 2012; ICF Macro 2010). 'Unimproved' water sources would include unprotected dug well, unprotected spring, cart with small tank or drum, tanker truck, surface water (river, dam, lake, pond, stream, canal, and irrigation channel) and bottled water (WHO 2012; ICF Macro 2010).

3.2.1.1.4 Population health systems

Three variables were included to capture the variation in stuntingoverweightness associated with the public health systems of LMICs aiming to capture the availability and accessibility of health care services. These three variables were – government expenditure on health as percentage of GDP (HEALTHEXP), Out-of-pocket health expenditure as percentage of total private expenditure on health (OOP) and unmet need for contraception as percentage of married women ages 15-49 (UNMET).

Governmental health financing is an important component of the health systems available to people within populations. The variable HEALTHEXP indicates health care financing and the prominence placed on its funding from the government. Specifically the variable indicates public health expenditure as percentage of GDP (WHO 2011). This data emanated from WHOSIS[34] (World Health Organisation Statistical Information System) and was linked to respective cases by country and year.

In addition a variable for out-of-pocket health expenditure (as percentage of private expenditure on health) is utilised. This is because private health care payments, in particular out-of-pocket payments, have been shown to act as a barrier to accessing

[34] Since this research began has now been incorporated into the GHO

health care (Gotsadze, Bennett et al. 2005). OOPs are consistently found to affect poorer members of society more due to a more limited 'disposable' income. Data for OOP came from the WBDC.

Finally the variable UNMET was created from the collation of data from the WBDC. The '**met** need' for contraception is one of 11 core indicators used by the Commission on Information and Accountability for Women's and Children's Health .It is considered an important indicator of the coverage of health care – and particularly relevant to child health outcomes due the contribution to alleviation of unintended pregnancies and increasing birth intervals – minimising poor health outcomes both in women and their children (World Health Organisation 2011). Conversely, unmet need specifically represents the disjoint between women exposed to the risk of childbearing (fecund and sexually active) who are currently not using any form of contraception despite indicating a desire to delay their next child or have no more children (Casterline & Sinding 2000).

3.2.1.1.5 Population health

Population demographic and health variables to be utilised include life expectancy at birth, under-five mortality rate, infant mortality rate, total fertility rate and mortality rate from non-communicable diseases (NCDs) per 100,000 people.

Life expectancy at birth indicates the number of years an individual will live if s/he experiences the current age specific mortality rates prevalent at the time of their birth throughout their life. Life expectancy at birth thus reflects the overall mortality level of a population and enables cross-national comparisons. It is a basic summary measure of a population's health and is thus recommended for use in studies where the health status of a population is of importance (WHOSIS 2011).

The infant mortality rate (IMR) gives the number of infants that die before the age of one per 1,000 live births. It is a leading indicator of child health within a population, as well as for the whole population and its development. The use of the IMR as an indicator of overall population health has been criticised – suggesting it does not reflect the health experiences of the older population thus cannot provide an indication of population health. However research has shown a strong linear association between disability adjusted life expectancy and IMR suggesting that the use of the IMR does not disregard the health of the wider population beyond infants (Reidpath & Allotey 2003). Thus IMR remains an important indicator of health both for the child and whole population, which is due to the relationship between the structural factors that affect the health of the entire population and also impact upon child health (Reidpath and Allotey 2003). This is important for the analyses here as the overall population health is indicative of the socioeconomic development of the population. Furthermore, the health of the adult population is important due to the intergenerational nature of health and malnutrition, particularly maternal health and malnutrition as noted in chapter 2. Data on IMR was collated from the WBDC and linked to each case in the sample by respective country and year.

The total fertility rate (TFR) represents the number of births per woman that would occur if women of childbearing age were to experience the current age-specific fertility rates throughout their life. The methodology for the collection of fertility data is well developed and widely employed, thus reliable up-to-date data on fertility are available for nearly all populations worldwide. Changes to fertility rates can directly affect the population growth of a population and the dependency ratios, with reductions in fertility rates being linked to socioeconomic developments including increased female participation in the labour force and greater access to education (UN 2006). TFR is thus indicative of the wider socioeconomic development of the population which has been shown to be important in determining the malnutrition burden faced by populations.

A further dimension of population health that will be incorporated into this analysis will be mortality due to NCDs because of the parallel between the NT and the epidemiological transition (ET) that sees a rise in the burden of NCDs within a population and can lead to a double burden of disease paralleling a DBM. Age-standardized mortality rate by NCDs (per 100,000 people) is the variable chosen to give an indication of the stage of the ET that the population is experiencing.

3.2.1.1.6 Agricultural production and population food availability

Chapter 2 highlighted the importance of changes to world food systems to the NTs occurring in LMICs. These changes are reflected in the changes to both the quantity and composition of food available in LMICs and consequently the diet consumed. These changing food systems are reflected in the agricultural sector – in terms the percentage of GDP generated by the sector. Additionally, these changes are reflected by the food a country produces. Another key factor regarding changing world food systems is the food available given the importation and exportation of food stuffs. Several variables are included to indicate these aspects. Both areas are key to food security – where a consistent and accessible supply of nutritious foods sufficient to enable growth, development and well-being is available (FAO et al. 2013). There are four dimensions to food security – availability, access, utilization[35] and stability – the indicators here refer to accessibility. Additionally, indicators utilised in this analysis will concern the changes in the composition of the diet – integral to the NT – indicated by changes in the availability of animal fats and sugars.

To highlight shifts in the agricultural sector two variables are utilised - agriculture, value added as percentage of GDP (AGRI_GDP) and the food production index (FPI) both variables are based upon data collated from the WBDC. AGRI_GDP is not only an indicator of the extent of the agricultural sector, it is closely related to increased GDP per capita in LMICs (Tiffin & Irz 2006). However, the FPI and population level indicators of per caput nutrition move beyond this to indicate the net gain in terms of food availability for a population. The food production index (FPI) represents the net production of nutritious food across and is used as an indicator of food security – in terms of availability (FAO et al. 2013).

[35] The FAO utilise access to improved sanaitaiton and water sources as indicators of utilization in terms of food secutiry (FAO 2013)

The importance of these variables relates to the role of nutrient availability and changing dietary composition at the population-level on the burden of malnutrition a country faces. The data emanated from the food balance sheets (FBS) disseminated by the FAO. FBS contain basic information of the food supply of a country which enables the analysis of the patterns in per caput food supply by food groups in terms of calories, proteins and fats (FAO 2001). Per capita food supply is calculated by dividing the food supply of each food item available for human consumption by the population to which it is provided. Food composition factors are applied to the food items available to the population to enable food supply to be expressed in terms of dietary energy value (calories), protein and fat content (FAO 2011). Five variables were introduced into the analysis. These variables were calories per capita (total) (KCAL), percentage of total calories from animal fats (FATS), percentage total calories from sugars and sweeteners (SUGAR). These three variables are used as indicators of food security (FAO et al. 2013). Additionally it is also the changing composition of diet – particularly increasing intake of animal fats and sugars that are considered important for accelerated NTs occurring today (Popkin 2002). Given this, variables modelling changes in these key components in the composition of diet over last 10 years were generated. These variables are - percentage change in the percentage of total calories from fat (FAT10) and the percentage change in the total percentage of calories from sugars and sweeteners (SUGAR10) were created. These two variables indicate the changing composition of the diet.

3.2.1.1.7 Inequality

As a final note, variables indicating the level of inequality within a country were sought for inclusion. The ideal indicator was considered to be the Gini Coefficient however the data availability was too sparse for this study. As a result alternative indicators of inequality were utilised - the income share held by the lowest 20% (INCOME_LOW) and the poverty gap at the national poverty line (POVERTY GAP). These variables significantly reduced the sample size – as a result they were tested by modelled separately to the main modelling procedures – these outlined in the next section - 3.2.2 – as well as the considerations made for the analysis of inequality.

3.2.2 Methodology

This section explores the population-level analyses of this research in order to ascertain the macro determinants of the stuntingoverweightness in low and middle income countries.

The dependent variable for the analysis is the prevalence of stuntingoverweightness – a continuous variable. The selected model for the analysis is the linear regression model – which was previously defined in part 3.1.3.3. It is particularly well specified to this analysis as it enables the effect of globalisation and urbanisation to be assessed before and after controlling for other key factors affecting malnutrition. The model building strategy is outlined in part 3.2.2.1 and model diagnostic procedures are presented in part 3.2.2.2.

Although this research is necessarily exploratory in nature – given the lack of research on stuntingoverweightness among children in LMICs - the selection of variables has been made based upon prior knowledge of key factors affecting population nutrition and Popkin's theory regarding the role of the rapidity of urbanisation and globalisation (1993). In order to understand which factors play an integral role in the prevalence of stuntingoverweightness a necessarily exploratory model building strategy is required.

3.2.2.1 Model Building Strategy – An exploratory approach

The most important aim of any model building strategy is widely agreed to be the establishment of a parsimonious model informed by theory (Royston & Sauerbrei 2008). The selection of a model is a contested issue in statistical analysis – particularly when attempting to model a new phenomenon with no theoretical framework addressing the phenomenon directly. The issue for this analysis is that there is no established theory concerning determinants of stuntingoverweightness at the population level[36] – where stuntedoverweight individuals mark a paradox and concurrence of both under- and overnutrition.

However, stuntingoverweightness does mark a disjuncture from the original NT and although, as I will argue, the reconceptualization of NTs today (the AT) does not adequately represent the 'true' nutritional profiles of LMICs and their diversity it is possible that its hypothesised reasons for the disjuncture from the original NT are correct. These hypothesised determinants are the rapidity of globalisation and urbanisation and this analysis aims to test whether there is any evidence that the rapidity of globalisation and urbanisation determine the prevalence of stuntingoverweightness and diverse malnutrition burdens. In order to do so the effect of the rapidity of globalisation and urbanisation need to be tested in a '*multivariate context*' to control for potential confounding factors that have been shown to influence other aspects of population health although, due to lack of research in the area, not specifically stuntingoverweightness (Royston & Sauerbrei 2008: xv). As the effect the rapidity of globalisation and urbanisation have on stuntingoverweightness may vary in the context of other key factors concerning population health – notably socioeconomic development, population health systems, population health, food availability and inequality – each 'group' of variables will be introduced separately into a baseline model that controls for the level and rapidity of urbanisation and globalisation. Informed by the results of Chapter 4, the model will also control for other types of malnutrition (child stunting, child overweightness, adult obesity) this will be discussed at the end of Chapter 4. The model building will be an iterative process and will build based upon the results of the introduction of variables from the 5 groups of variables described in part 3.2.1.

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[36] This is also true of the individual level and will be discussed in Chapter 7

To determine if a variable should remain in the model once included, recourse to the significance of the regression coefficient, the F-test and R^2 will be used. A significance level of 5% is utilised. The F-test tests whether all of the regression coefficients equal 0 (thus have no effect on or association with stuntingoverweightness). The R^2 is an indication of variance in stuntingoverweightness the model is explaining – higher values indicate a better fitting model (Agresti & Finlay 2008). In addition to the utilisation of selection procedures, diagnostic procedures are conducted to ensure the assumptions of the linear model – as presented in 3.1.3.3 – are met.

3.2.2.2 Model Diagnostics

Four key assumptions of the linear regression model were presented in section 3.1.3.3. There are pre-modelling procedures that can be undertaken to ensure the model is correctly specified and not violating the assumptions of the model. Additionally, there are post-modelling diagnostic tests that can be used to assess whether these assumptions were upheld.

Not only should the model meet the necessary assumptions it must be correctly specified to provide valid and reliable results. An important part of this is eliminating any bias resulting from irrelevant or omitted variables. The former will be tested using significant tests for the regression coefficient as well as the F-test and R^2, the latter is alleviated by a wide literature review but can also be tested using the Ramsey regression specification-error test.

Multicollinearity is a prevalent issue in statistical analysis – and occurs when independent variables are highly correlated and can lead inflated standard errors. In order to overcome this issue – variables are checked for correlation prior to use in the model. Furthermore the condition number can be assess – where condition numbers are the square root of a combination of Eigen values calculated from the correlation matrix in principal components analysis – where Eigen values are high or show large variability there is evidence of multicollinearity and the subsequent condition number will be larger. Finally, the variance inflation factor (VIF) can be used to assess multicollinearity in a model where values >10 indicate multicollinearity (Jeeshim 2002).

Finally residual diagnostics are conducted – to assess whether the assumption of error terms that are normally distributed with constant variance (and mean zero) (e_i ~N(0, σ2))is upheld. Residual plots enable a visual assessment of this and will be assessed.

3.3 Summary

This chapter has described the methodology utilised to understand child malnutrition given stuntingoverweightness and its drivers in LMICs. The results emanating from the methodology described here are presented in Chapters Four and Five. Chapter Four details the first three considerations outlined here regarding the nutritional profiles of populations. They are 1) levels and trends in child malnutrition – accounting for stuntingoverweightness, 2) SO and overall nutritional profiles of populations and 3) the nutritional profile of populations with higher levels of SO. Chapter 5 reports the results of the analysis of macro factors associated with stuntingoverweightness in LMICs.

Chapter 4: Population-Level Results - Stuntingoverweightness Prevalence in LMICs – Levels, Trends and Implications

In this chapter the nutritional profiles of LMICs – given stuntingoverweightness – are presented. The first results of this chapter outline the levels and trends in stuntingoverweightness (part 4.1). These are utilised to evidence the current existence of 'double-counting' of stuntedoverweight children that's endemic in research on child malnutrition today. The extent to which this double-counting has overestimated the burdens of child stunting and child overweightness is then demonstrated. In outlining these results a contribution is made to the current controversy concerning the use of anthropometric indices and their thresholds in child malnutrition studies. In part 4.2, results will be presented that cast light on the implications of stuntingoverweightness and how the double counting of the stuntedoverweight affects our current understanding of the nutritional transition in LMICs today – with particular reference to the AT, DBM and DBCM.

At this juncture, the relationship between stuntingoverweightness and child stunting, child overweightness and adult obesity is presented and examined (part 4.3). It is through this analysis that the truly divergent picture of malnutrition in LMICs today emerges. The results are then summarised in part 4.4 and the contribution these analyses have made to our understanding of the NTs occurring in LMICs today is asserted.

4.1 Stuntedoverweight prevalence - Levels, Trends and Implications for Stunting and Overweightness

A key aim of this research was to evidence and render visible stuntedoverweight children. In order to do this, prevalence rates of stuntingoverweightness for the 77 countries in the sample have been established. Where available, trends in stuntingoverweightness prevalence over time are also presented. These results are presented in section 4.1.1.

Section 4.1.2 is focussed on the effect stuntingoverweightness has on our understanding of stunting, overweightness and growth faltering malnutrition as a whole in LMICs. As noted in Chapter 3, based upon the methodology for the construction of stunting prevalence evidenced in the manual for the WHOCG&M, it is hypothesised that stuntedoverweight children are currently included in both the prevalence rates of stunting and of overweightness. Section 4.1.2.1 evidences this – firstly by showing that stuntedoverweight children are included in the prevalence of stunting. The effect of this is discussed, with the discussion focusing on the inflation of stunting prevalence rates in both real terms (percentage points) and in terms of the % overestimation stunting prevalence.

In section 4.1.2.2, results are presented that evidence that stuntingoverweightness prevalence is also included in the prevalence estimates of overweightness presented in the WHOCG&M. Again the discussion will focus on how including stuntedoverweight children in the prevalence of overweightness has inflated statistics for overweightness prevalence; and this inflation is presented both in 'real terms' (percentage point increase) and in the level of overestimation of the prevalence of overweightness.

The results presented in 4.1.2 show that the double-counting of stuntedoverweight children is having a tangible impact on prevalence estimates of both stunting and overweightness. This double-counting of stuntingoverweightness is argued to be endemic in research on child malnutrition that relies on anthropometric indices and the associated thresholds recommended to define a child as stunted (<-2SD height-for-age) or overweight (+2SD weight-for-height).

Section 4.1.2.3 shows the impact double-counting has on the overall depiction of burdens of growth faltering malnutrition in LMICs today.

Thus, the levels of stuntingoverweightness presented in section 4.1.1 are then compared to levels of stunting and overweightness depicted by the WHOCG&M to evidence double-counting (section 4.1.2) and the results summarised in section 4.1.3.

4.1.1 Levels and Trends in Stuntingoverweightness

As described in the methodology, the prevalence levels of stuntingoverweightness by country were constructed using individual level data from the nationally representative DHS and MICS. Children who are defined as stunted by their z-score for height-for-age (<-2SD) and also defined at the same time as overweight by their z-score for weight-for-height (>2SD) were identified as stuntedoverweight. For each country, the prevalence of stuntingoverweightness was constructed using the recommended weighting procedures from the respective household survey methodological materials. The prevalence of stuntingoverweightness by country and year is presented in Table 4.1.

The most alarming result that emanated from the analysis presented here is that there are stuntedoverweight children under-five in **every single population** in the sample – yet these children remain largely invisible to the wider research community concerned with child health and nutrition. Across the 77 populations in the sample, the prevalence of stuntingoverweightness ranges from 0.33% in Suriname in 2006 to 10.42% in Egypt in 2008.

Table 4.1 Prevalence of Stuntingoverweightness among under-fives for all 77 Countries in the Sample.

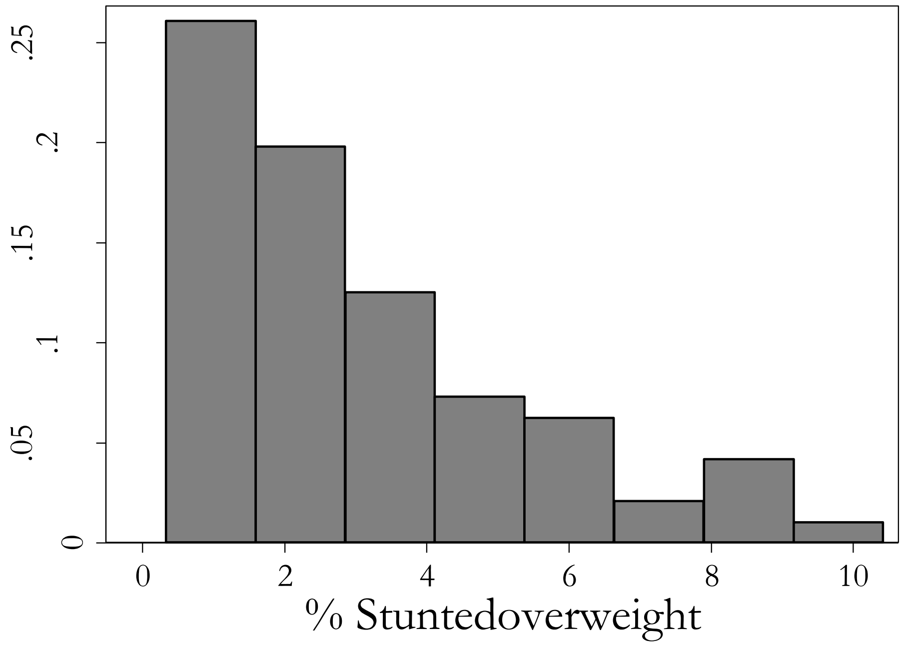
Country	Year	% Stunted-overweight	Country	Year	% Stunted-overweight
Albania	2008	9.04	**Lesotho**	2009	3.07
Armenia	2010	7.05	**Liberia**	2007	2.2
Azerbaijan	2006	8.55	**Macedonia**	2005	2.67
Bangladesh	2011	0.68	**Madagascar**	2003-04	3.69
Belarus	2005	0.62	**Malawi**	2010	5.07
Belize	2006	1.90	**Maldives**	2009	1.19
Benin	2006	6.85	**Mali**	2006	2.13
Bolivia	2008	2.51	**Mauritania**	2007	0.67
Bosnia	2006	5.99	**Moldova***	2005	1.97
Burkina Faso	2010	1.43	**Mongolia**	2005	3.93
Burundi	2010	1.92	**Montenegro**	2005	2.54
Cambodia	2010	0.96	**Morocco***	2004	5.50
Cameroon	2011	2.42	**Mozambique**	2011	4.61
Central African Rep.	2006	3.45	**Namibia**	2006	1.56
Chad	2004	0.98	**Nepal**	2011	0.67
Colombia	2010	0.51	**Niger***	2006	1.97
Congo (BV)	2011-12	1.40	**Nigeria**	2008	5.47
Congo DR	2007	4.07	**Palestinians (Lebanon)**	2006	8.61
Djibouti	2006	6.07	**Peru**	2012	0.46
Dom.Republic	2007	0.95	**Rwanda**	2010	3.56
Egypt	2008	10.42	**Sao Tome e Principe**	2008	5.74
Ethiopia	2011	0.88	**Senegal**	2010	1.41
Gabon	2012	2.34	**Serbia**	2005	3.02
Gambia	2005	0.88	**Sierra Leone**	2008	5.09
Georgia	2005	4.85	**Somalia**	2006	1.43
Ghana	2008	2.43	**Suriname**	2006	0.33
Guinea	2005	1.06	**Swaziland**	2006	3.65
Guinea-Bissau	2006	8.36	**Syria**	2006	8.75
Guyana	2009	2.06	**Tajikistan**	2005	3.10
Haiti	2012	1.14	**Tanzania**	2010	2.62
Honduras	2011	0.59	**Thailand**	2005	1.45
India	2005	0.97	**Timor-Leste**	2009	3.56
Iraq	2006	5.73	**Togo**	2006	1.73
Ivory Coast	2011	1.28	**Uganda**	2011	1.75
Jordan	2012	5.30	**Uzbekistan**	2006	2.98
Kazakhstan	2006	4.54	**Vanuatu**	2007	1.61
Kenya	2008	2.40	**Zambia**	2007	5.33
Kyrgyzstan	2005	2.96	**Zimbabwe**	2010	2.04
Lao PDR	2006	0.72			

*Not weighted

Source: MICs and DHS with Anthropometric Modules 2004-2012

Assessing the distribution of stuntingoverweightness prevalence across the sample, it is clear the distribution is positively skewed (figure 4.1). Thus the majority of LMICs currently have a relatively low prevalence of stuntingoverweightness (figure 4.1). The median prevalence of stuntingoverweightness in the sample is 2.41% and the mean is 3.09%. At the 25th percentile the prevalence is 1.34% and at the 75th it is 4.58%. All of these statistics reflect this positive skew.

Figure 4.1 Distribution of Stuntingoverweightness Prevalence in Sample



Source: MICs and DHS with Anthropometric Modules 2004-2012

Whilst the majority of countries may have a low prevalence of stuntingoverweightness at the moment, the evidence suggests that the majority of countries are also seeing an increasing prevalence of stuntingoverweightness over time.

Of the 77 populations in the sample, 33 countries had nationally representative MICS or DHS data with anthropometric modules for at least two time points. For these countries, the prevalence of stuntingoverweightness was constructed for each respective available year – the trends in stuntingoverweightness that these results reveal are presented in figures 4.2 and 4.3.

Of the 33 countries for which trends were constructed, 12 countries show the prevalence of stuntingoverweightness decreasing over time. Of these 12 countries, 6 countries had data for 3 or more time points available and were therefore considered best placed to reflect trends in stuntingoverweightness over time. These 6 countries were Malawi, Cameroon, Rwanda, Peru, Ethiopia and Cambodia. Only half of these 6 countries saw a consistent decline over time – Rwanda, Cameroon and Peru.

Peru has seen a very consistent decline in stuntingoverweightness prevalence over time – from 3.5% in 2000 to 0.5% in 2012, with Cameroon seeing a sharper decline in stuntingoverweightness prevalence between 2004 and 2006 (from 3.9% to 2.8%) than between 2006 and 2011 (where stuntingoverweightness prevalence declined from 2.8% to 2.4% in 2011). The decline for Rwanda was minimal (from 4% in 2000 to 3.6 in 2010).

There are three other countries with 3 or more time points – Malawi, Ethiopia and Cambodia – that also show an overall decline across the time period, but this decline was inconsistent.

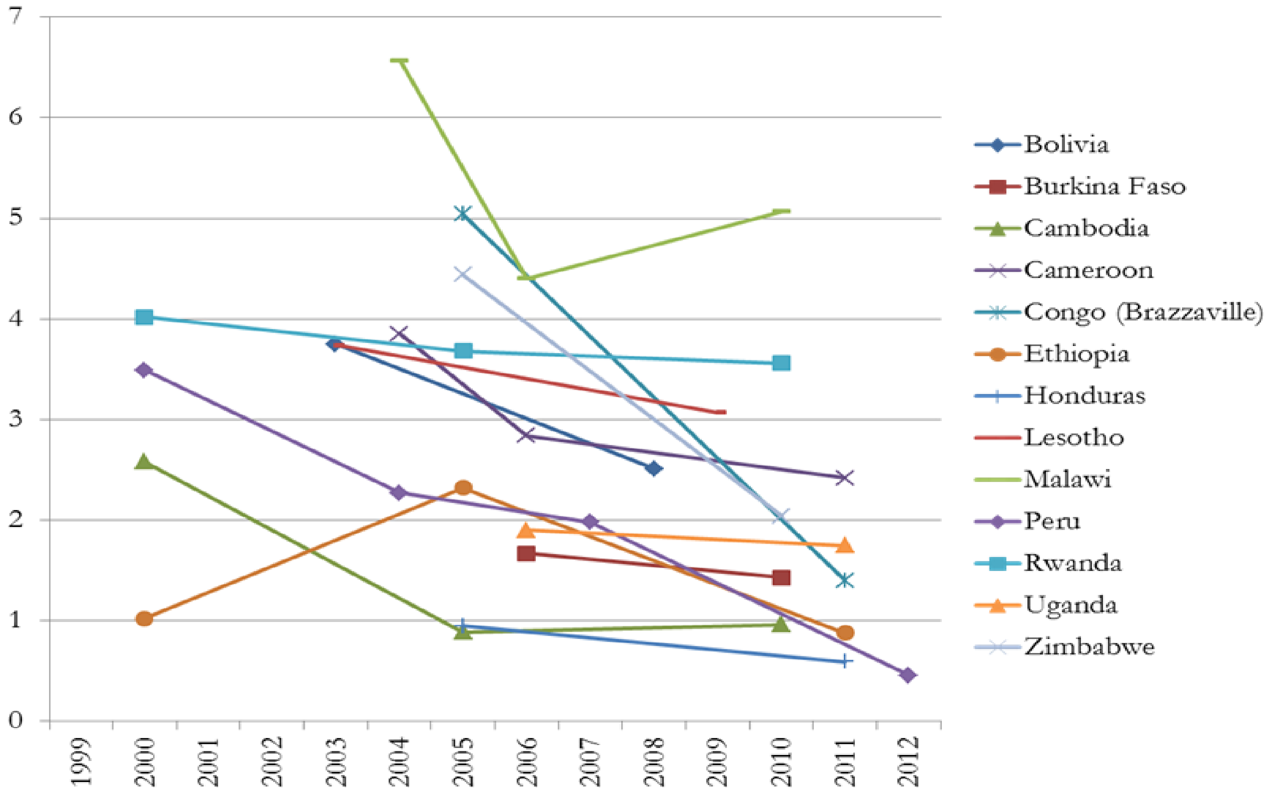
Between 2005 and 2006 Malawi saw a decline in stuntingoverweightness prevalence from 6.5% to 4.5%, although the prevalence rose again to 5.1% by 2010. Overall, Ethiopia saw a decline in stuntingoverweightness prevalence from 1.1% (in 2000) to 0.88% (in 2011). However, during this time period Ethiopia saw the prevalence of stuntingoverweightness more than double between 2000 and 2005 from 1.1% to 2.3%, prior to the decline to 0.88% in 2011. Finally, Cambodia's decline was also inconsistent

– the prevalence declined from 2.6% in 2000 to 0.9% in 2005 and then saw a minimal rise to 0.96% in 2010.

While 12 countries show a decline in stuntingoverweightness prevalence over time there is really only evidence of a consistent and significant decline in prevalence in two countries – Peru and Cameroon. Both Peru and Cameroon had a 'medium to high' prevalence level of stuntingoverweightness at the beginning of the declines in stuntingoverweightness, with prevalence levels between the 50th and 75th percentile of the sample (Table 4.1).

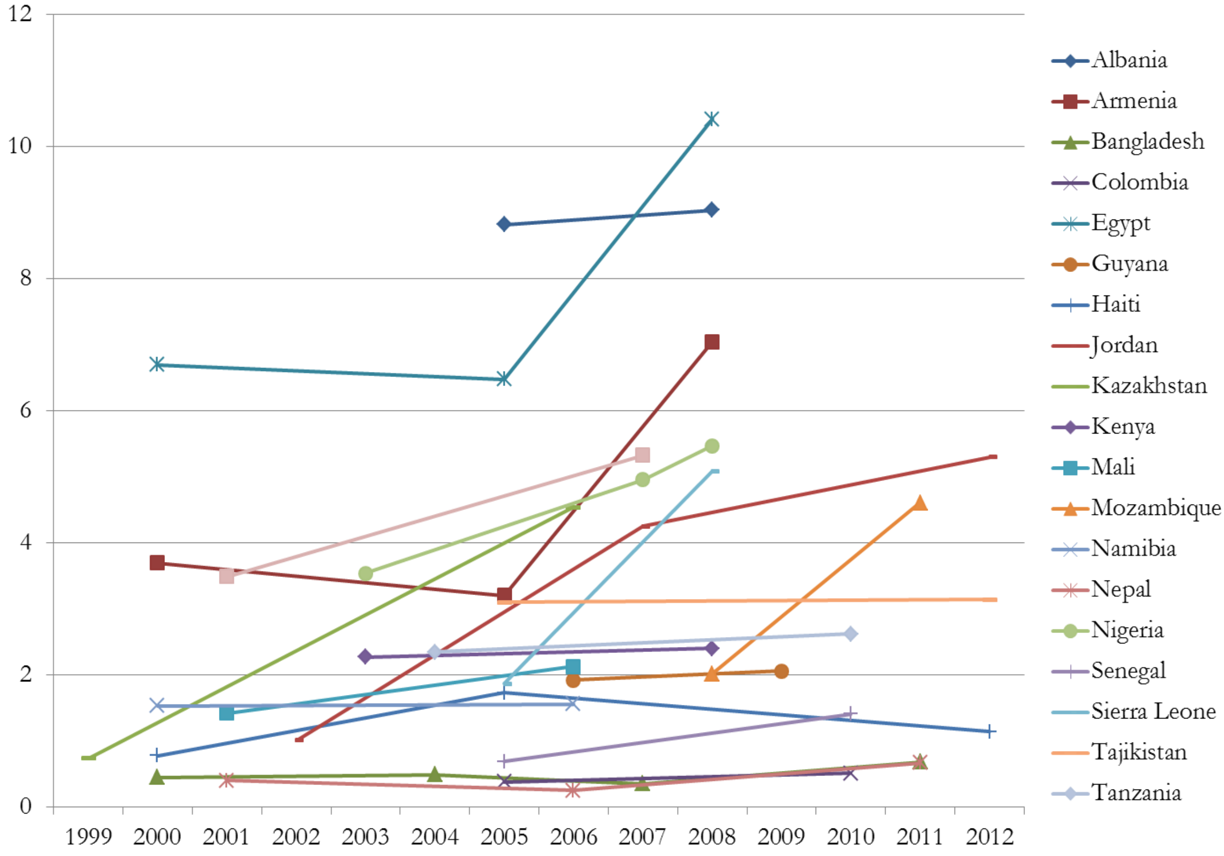
The concern emanating from these results is that the weight of the evidence is not strong enough to suggest that, among countries seeing a decline in stuntingoverweightness, this decline will be both consistent and sustained. Additionally, there is no evidence of a sustained decline in stuntingoverweightness from any of the countries with the highest prevalence of this paradoxical nutritional insult – suggesting that in countries with a propensity for higher levels stuntingoverweightness, these levels are likely to either remain at the same level or increase.

Figure 4.2 Graph Showing Stuntingoverweightness prevalence for Countries with more than one time point and decreasing prevalence of stuntedoverweight



Although 12 of the 33 countries with data for more than one time point showed a decline in stuntingoverweightness prevalence over time, the majority of these countries (21) showed increasing prevalence (figure 4.3). Apparent from figure 4.3 is that the greatest increases in prevalence are occurring among populations where the prevalence of stuntingoverweightness is already relatively high – notably Albania and Armenia. This again suggests that, among populations with higher levels of stuntingoverweightness, the trend is for the levels of stuntingoverweightness to increase.

Figure 4.3 Graph Showing Stuntingoverweight prevalence for Countries with more than one time point and increasing prevalence of stuntedoverweight



Among the 21 countries showing increasing prevalence of stuntingoverweightness over time there are four countries with three or more time points – Armenia, Egypt, Jordan and Nigeria.

Of these countries, Armenia and Egypt saw their levels of stuntingoverweightness stagnate between 2000 and 2005: in 2000 the levels were 3.6% and 6.7% for Armenia and Egypt respectively; while these levels were 3.4% and 6.4% come 2005. Between 2005 and 2008, however, the prevalence of stuntingoverweightness increased in both Armenia and Egypt – to 7.1% and 10.4% respectively.

While Armenia and Egypt showed a period of stagnation followed by an increase in stuntingoverweightness prevalence, Jordan and Nigeria both showed an increase across all time points, although later rises were incremental. For Jordan, the prevalence of stuntingoverweightness rose from 1.1% in 2002, to 4.2% in 2007, followed by a small increase to 2012. Additionally, Nigeria saw a rise in stuntingoverweightness prevalence among under-fives from 3.6% in 2003, to 5% in 2007, yet then only a small increase to 5.5% in 2008.

Although, of the 33 countries with more than one time-point, the majority have seen some increase in stuntingoverweightness prevalence, there appears to be very diverging trajectories in prevalence rates across populations. Importantly some countries are seeing increases in the prevalence of stuntingoverweightness but many are seeing either stagnation or decreases in the proportion of under-fives who are stuntedoverweight. This is a clear area for further research – to address more fully what distinguishes populations who have declining, increasing or stagnating rates of stuntingoverweightness. Given the close links between stuntingoverweightness and both stunting and overweightness separately, it would also be beneficial to address the trends in stuntingoverweightness with respect to trends in these other two forms of growth faltering.

From these prevalence rates of stuntingoverweightness, we have seen that all LMICs in the sample have some level of stuntingoverweightness among children under-five. At its highest level, over 10% of children were found to be stuntedoverweight (10.42% in Egypt in 2008).

This is a concern for many reasons. Firstly, stuntingoverweightness affects children in **all** LMICs, indicating there are millions of children worldwide who are suffering from these paradoxical, concurrent nutritional insults. These children are suffering a nutritional status that is largely invisible to research and policy makers alike – meaning that no official policies are in place to address their specific form of malnutrition. Secondly, due to the hidden nature of stuntingoverweightness, the long term consequences are unknown – although likely wholly negative both in terms of health and socioeconomic development. The future development trajectories of stuntedoverweight children are thus particularly uncertain. Additionally, the presence of stuntingoverweightness in all countries of the sample and the subsequent double-counting that ensues (evidenced in section 4.1.2) is distorting the burdens of stunting and overweightness in all LMICs. This means that in all contexts, the current implementation of anthropometric indices and threshold indication of stunting and overweightness is leading to erroneous depictions of the malnutrition suffered by children today.

The next section of the results will evidence the double-counting of stuntedoverweight children in the WHO Child Growth and Malnutrition database (WHOCG&M) and highlight the impact it has on the understanding of the levels of stunting and overweightness in LMICs today.

4.1.2 The Double-Counting of Stuntedoverweight Children and its Impact upon Levels of Stunting and Overweight

As described in Chapter 3, for this research all DHS and MICS datasets with anthropometric modules from 2005 onwards were used to construct national estimates of malnutrition. This process allowed me to establish prevalence estimates for the overlooked stuntedoverweight children, as well as for stunting and overweightness separately[37]. These prevalence rates were then compared with the WHO Global Database on Child Growth and Malnutrition as a means to evidence whether, as hypothesised, double-counting of stuntedoverweight children is occurring and quantify the extent to which it distorts statistics regarding the burdens of stunting and overweightness in LMCIs (2012). The full table of these estimates – both those constructed by myself from the MICS and DHS, and the corresponding data from the WHO Global Database – is available in Appendix II.

[37] Wasting prevalence were also constructed

The analysis showed that the WHOCG&M does not consider stuntingoverweightness in the presentation and estimation of prevalence rates for the assumed existence discrete stunting and overweightness among under-fives. To detail this, comparative results between the WHOCG&M and the anthropometric indices I created that account for stuntingoverweightness are presented below.

These results are presented for countries defined as having a burden of stunting in section 4.1.1.1 (prevalence of stunting >20%) and then for those countries defined as having a burden of overweightness in section 4.1.1.2 (prevalence of overweight children >10%). These results were chosen for presentation as the most relevant to our understanding of 'burdens' of child malnutrition today – and directly relevant for the AT. In addition it enables an examination of the effect double-counting of stuntedoverweight children has on the level of the considered 'burden'.

Finally, having evidenced that double-counting of stuntedoverweight children occurs, the effect of double counting on the overall prevalence of growth faltering malnutrition on LMICs is detailed in section 4.1.1.3.

4.1.1.1 Stuntingoverweightness and the Prevalence of Stunting

According to the WHO, of the 77 countries in the sample for this analysis, 59[38] have a stunting burden among children under-five of >20%. As noted in chapter 1, this is defined as a stunting burden of public health significance (WHO 2011). The WHOCG&M estimates of stunting (and overweight) are presented in Table 4.2. Among these 59 countries, the WHO lists the stunting prevalence in the countries of the sample as ranging from 20.3% in the Maldives (2009) to 57.7% in Timor-Leste (2009).

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[38] The WHO doesn't present the results of a survey of Palestinians in Lebanon, thus the estimates of stunting and overweightness – without taking into account stuntingoverweightness as calculated from the UNICEF MICS 2006 Survey – are presented here.

Table 4.2 WHO Prevalence Estimates of Stunting and Overweightness for Countries with a Burden of Stunting >20% (Source: WHOCG&M)

Country	Year	Stunting	Over-weight	Country	Year	Stunting	Over-weight
Albania	2008	23.1	23.4	**Liberia**	2007	39.4	4.2
Armenia	2010	20.8	16.8	**Madagascar**	2003-04	52.8	6.2
Azerbaijan	2006	26.8	13.9	**Malawi**	2010	47.8	9.2
Bangladesh	2011	41.4	1.9	**Maldives**	2009	20.3	6.5
Belize	2006	22.2	13.7	**Mali**	2006	38.5	4.7
Benin	2006	44.7	11.4	**Mauritania**	2007	28.9	2.3
Bolivia	2008	27.2	8.7	**Mongolia**	2005	27.5	14.2
Burkina Faso	2010	35.1	2.8	**Morocco**	2004	23.1	13.3
Burundi	2010	57.5	2.9	**Mozambique**	2011	43.1	7.9
Cambodia	2010	40.9	1.9	**Namibia**	2006	29.6	4.6
Cameroon	2011	32.6	6.5	**Nepal**	2011	40.5	1.5
CAR	2006	45.1	8.5	**Niger**	2006	54.8	3.5
Chad	2004	44.8	4.4	**Nigeria**	2008	41	10.5
Congo BV	2011-12	24.4	3.3	**P in L***[39]	2006	22.2	9.36
Congo DR	2007	45.8	6.8	**Rwanda**	2010	44.3	7.1
Djibouti	2006	32.6	13.4	**Sao Tome e Principe**	2008	31.6	11.6
Egypt	2008	30.7	20.5	**Senegal**	2010	28.7	2.8
Ethiopia	2011	44.2	1.8	**Sierra Leone**	2008	37.4	10.1
Gambia	2005	27.6	2.7	**Somalia**	2006	42.1	4.7
Ghana	2008	28.6	5.9	**Swaziland**	2006	29.5	11.4
guinea	2005	39.3	5.1	**Syria**	2006	28.6	18.7
Guinea-Bissau	2006	47.7	17	**Tajikistan**	2005	33.1	6.7
Haiti	2012	21.9	3.6	**Tanzania**	2010	42.5	5.5
Honduras	2005	29.9	5.8	**Timor-Leste**	2009	57.7	5.8
India	2005	47.9	1.9	**Togo**	2006	27.8	4.7
Iraq	2006	27.5	15	**Uganda**	2011	33.7	3.8

[39] *P in L (Palestinians in Lebanon) not in WHO database so estimates calculated from MICS (not accounting for stuntingoverweightness) are presented

Ivory Coast	2011	28	2.8	**Vanuatu**	2007	25.9	4.7
Kenya	2008	35.2	5	**Zambia**	2007	45.8	8.4
Lao PDR	2006	47.6	1.3	**Zimbabwe**	2010	32.3	5.8
Lesotho	2009	39	7.3				

For these same 59 countries, the estimates of stunting constructed from the DHS and MICs accounting for stuntingoverweightness are presented in Table 4.3. Between the WHOCG&M estimates of stunting (in Table 4.2) and those from the DHS and MICS that account for stuntingoverweightness (in Table 4.3) there is a very 'real' difference in value. For example, in Timor-Leste in 2009 the WHOCG&M states that there is a stunting prevalence of 57.7% (Table 4.2) but in the calculations I made, removing stuntedoverweight children, the prevalence is shown to be 54.1% (Table 4.3). The difference between these two values – (3.6%) – reflects the number of stuntedoverweight children there are in Timor-Leste (Table 4.3). This highlights that stuntedoverweight children are included in prevalence estimates of stunting by the WHOCG&M.

Before further assessing the effect of including stuntedoverweight children in the estimates of stunting prevalence, an important comment is made on the difference between the WHOCG&M estimates and those I created from the MICS and DHS.

Table 4.3 Stunting and Stuntingoverweightness prevalence for countries with stunting listed as >20% by WHO including % overestimation of stunting burden[40]

Country	Stunting %	Stunted-over-weight %	Over-estimate Stunting Burden	Country	Stunting %	Stunted-over-weight%	Over-estimate Stunting Burden
Albania	10.21	9.04	88.54	**Liberia**	35.58	2.2	6.18
Armenia	12.19	7.05	57.83	**Madagascar**	47.71	3.69	7.73
Azerbaijan	16.58	8.55	51.57	**Malawi**	41.99	5.07	12.07
Bangladesh	40.49	0.68	1.68	**Maldives**	16.77	1.19	7.10
Belize	15.55	1.9	12.22	**Mali**	35.72	2.13	5.96
Benin	36.05	6.85	19.00	**Mauritania**	25.95	0.67	2.58
Bolivia	24.58	2.51	10.21	**Mongolia**	17.82	3.93	22.05
Burkina Faso	33.05	1.43	4.33	**Morocco**	17.42	5.5	31.57
Burundi	55.94	1.92	3.43	**Mozambique**	38.21	4.61	12.07
Cambodia	38.13	0.96	2.52	**Namibia**	27.13	1.56	5.75
Cameroon	29.54	2.42	8.19	**Nepal**	39.59	0.67	1.69
CAR	34.57	3.45	9.98	**Niger**	47.78	1.97	4.12
Chad	39.97	0.98	2.45	**Nigeria**	35.1	5.47	15.58
Congo BV	21.71	1.4	6.45	**Palestinians in Lebanon**	13.59	8.61	63.36
Congo DR	40.41	4.07	10.07	**Rwanda**	40.44	3.56	8.80
Djibouti	24.2	6.07	25.08	**Sao Tome e Principe**	23.67	5.74	24.25
Egypt	18.46	10.42	56.45	**Senegal**	25.21	1.41	5.59
Ethiopia	43.46	0.88	2.02	**Sierra Leone**	30.38	5.09	16.75
Gambia	21.53	0.88	4.09	**Somalia**	36.34	1.43	3.94
Ghana	25.04	2.43	9.70	**Swaziland**	23.89	3.65	15.28
guinea	33.67	1.06	3.15	**Syria**	15.7	8.75	55.73
Guinea-Bissau	33.5	8.36	24.96	**Tajikistan**	24.66	3.1	12.57
Haiti	19.73	1.14	5.78	**Tanzania**	38.97	2.62	6.72
Honduras	21.76	0.59	2.71	**Timor-Leste**	54.06	3.56	6.59
India	47.06	0.97	2.06	**Togo**	22.2	1.73	7.79
Iraq	17.1	5.73	33.51	**Uganda**	31.41	1.75	5.57
Ivory Coast	28.49	1.28	4.49	**Vanuatu**	18.89	1.61	8.52
Kenya	32.85	2.4	7.31	**Zambia**	40.01	5.33	13.32
Lao PDR	46.92	0.72	1.53	**Zimbabwe**	29.07	2.04	7.02
Lesotho	34.49	3.07	8.90				

From Table 4.3, adding stunting prevalence to stuntingoverweightness prevalence levels should reflect the stunting prevalence as presented by the WHO in the WHOCG&M

[40] When totalling stunted and stuntedoverweight, the value should reflect the stunting burden as listed by the WHO. However, these do not marry often with the estimates I created – a note is made on this in the text.

(2012). This is because the estimates presented by the WHO are based upon the same household surveys and a review of their methodology shows that they do not account for stuntingoverweightness – leaving any child with a weight-for-height z-score >2SD to be counted as stunted, regardless of the overweight status.

However, as can be seen from Tables 4.2 and 4.3, in many cases the estimates do not marry. Of particular interest are the cases of Albania, Armenia, Belize and the Maldives where calculations from the household surveys for any stunted child (i.e. including stuntingoverweightness) actually give burdens of stunting <20% – despite the WHO listing them as >20%. The estimates I created of stunting prevalence inclusive of stuntedoverweight children were 19.25% for Albania, 19.24% for Armenia, 17.45% for Belize and 17.96% for the Maldives. These calculated prevalence rates actually take the prevalence of stunting for these countries below WHO defined cut-off for a burden of public health significance. Specifically, the WHOCG&M instead lists stunting prevalence as 23.1%, 20.8%, 22.2% and 20.3% for Albania, Armenia, Belize and the Maldives respectively. These indicate not only levels of stunting of public health significance, but levels of stunting higher than those I created directly from the household surveys.

To further understand this issue, consistency checks were conducted. It was found that the calculations I conducted for stunting prevalence (including stuntedoverweight children) marry with the results presented in the household survey reports for their respective countries. For example, in the DHS report for Albania, the stunting prevalence is listed as 19.3, for Armenia it is listed as 19.3, for Belize 17.6% and for the Maldives 18.9% (ICF MACRO 2010; NSS, MoH & ICF International 2012; SIB & UNICEF 2006; MOHF & ICF Macro 2010). The consistency between my calculations and the household survey report estimates indicates an issue with the prevalence estimates presented in the WHOCG&M. In examining the WHO data I found that their estimates for each of the four countries are based on different (larger) sample sizes than those used by both myself and in the survey reports. It is not possible to be conclusive on why a greater sample size has been used but it is possible that the WHO did not remove flagged cases[41] when calculating stunting prevalence, and I believe this can explain the discrepancy.

As these countries are listed by the WHOCG&M as having a 'burden of stunting' – even though my calculations suggest otherwise – there is merit in including them in the discussion of stuntingoverweightness and its effect on our understanding of the burdens of stunting and overweightness. This is because the thesis is ultimately concerned with the way burdens of malnutrition in LMICs are presented to stakeholders. For these countries, not only are the prevalence levels of stunting being misrepresented due to the inclusion of flagged cases, but they are also further misrepresented due to the inclusion of stuntingoverweightness.

Having discussed the discrepancy between the WHO, my estimates and the estimates presented in the survey reports (which like the WHOCG&M still do not consider stuntingoverweightness), the focus will now move back to the understanding of stunting burdens in the light of stuntingoverweightness.

Returning to Table 4.3 it can be seen that, among the estimates constructed here and accounting for stuntingoverweightness in these countries, the actual burden of stunting is found to range from 10.21% in Albania to 54.06% in Timor-Leste, not 20.3% (Albania) to 57.7% (Timor-Leste) as presented in the WHO global database. This reduction in the prevalence of discrete stunting is due to the levels of stuntingoverweightness. In fact, as every single one of the 77 populations in the sample has children who are stuntedoverweight, thus every single country's prevalence of stunting is reduced by the % of children who are stuntedoverweight (Table 4.3; Appendix II). In the 59 countries with a stunting 'burden' presented in Table 4.3, the prevalence of stuntingoverweightness ranges from 0.59% in Honduras to 10.42% in

[41] (where –as described in Chapter 3- the results for anthropometric data or indices are considered biologically implausible)

Egypt. Thus, in 'real' terms, the prevalence rates of stunting are listed 0.59 to 10.42 percentage points higher than they should be in these 59 countries.

Focussing on these 59 countries and accounting for stuntingoverweightness, it can be seen that not only has the prevalence changed – the definition of some of these countries' apparent burden of stunting has altered, too. It can be seen that 13 of the 59 countries in the sample presented by the WHO as having a burden of stunting >20% actually **do not**. Thus 22.2% of these countries, more than one fifth, have had their prevalence of stunting distorted to such an extent[42] by the inclusion of stuntedoverweight children, that they have been misrepresented as having a WHO defined burden of public health significance. These countries are Albania, Armenia, Azerbaijan, Belize, Egypt, Haiti, Iraq, Maldives, Mongolia, Morocco, Palestinians in Lebanon, Syria and Vanuatu. For these countries, the new burdens of stunting (as a discrete phenomenon that does not include children who are concurrently both stunted and overweight) range from 10.21% in Albania to 19.73% in Haiti.

As noted in the methodology, however, the aim is to move beyond just the difference in prevalence levels and this may lead to some countries not being defined as having a burden of stunting. The aim is also to evidence the extent to which the burden of stunting is overestimated by overlooking stuntingoverweightness.

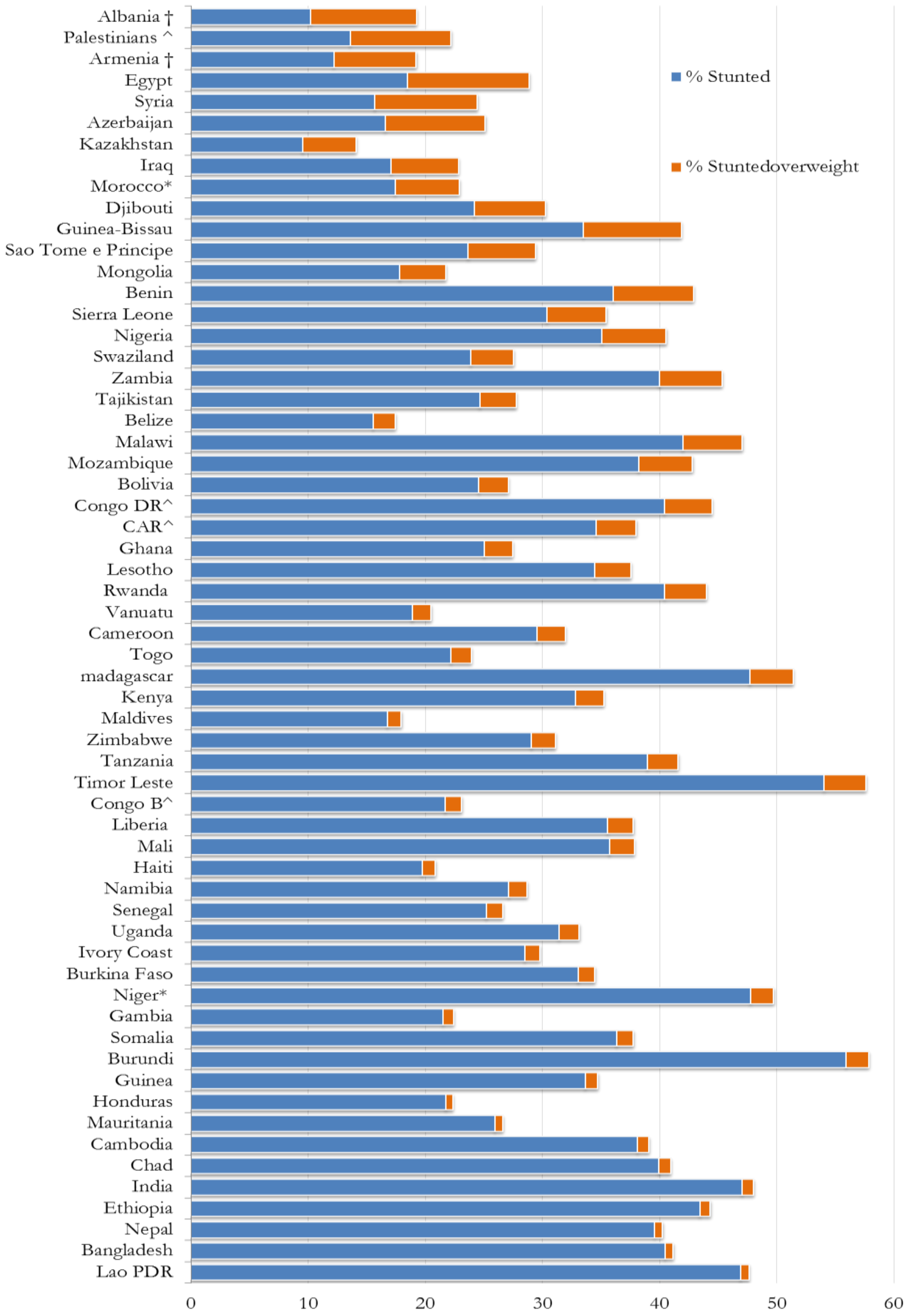
It should again be noted that as every single one of the 77 countries in the sample has stuntedoverweight children – who are overlooked when creating the prevalence of stunting – stunting prevalence in all of these countries has been overestimated. As described in Chapter 3, this overestimation is determined by calculating the % increase in the prevalence of children who are solely stunted that result from the inclusion of stuntedoverweight children.

[42] This includes misrepresentation due to, what I believe, is the inclusion of flagged cases upon which prevalence estimates in the WHOCG&M have been made.

The discussion here aims to show the effect eliminating children who are stuntedoverweight from stunting prevalence has the current status quo in defining a burden of stunting of 'public health significance' by the WHO. This threshold currently stands, as noted above, at >20% prevalence. It should be noted, however, that there is a very important discussion to have on whether or not the WHO threshold should change given the fact that in many populations stunting prevalence appears higher due to the inclusion of the stunted overweight. This is addressed again in Chapter 9 concerning the policy implications of this research. The fact that many countries are re-classified below this threshold, as will be shown below, when acknowledging and then excluding stuntedoverweight children from the prevalence of stunting gives weight to this need to revisit the WHO thresholds.

Among the 59 countries with a 'burden' of stunting (>20% according to the WHO), the overestimation of stunting prevalence ranges from 1.5345% in Lao PDR to 88.541% in Albania. The proportions of children stunted and stuntedoverweight for each country, ranked by the overestimation of stunting burden are displayed graphically in Figure 4.4.

Figure 4.4 Graph Showing Stuntingoverweightness Prevalence for Countries Listed as having a Stunting Prevalence of >20% by the WHO, Ranked by Descending % Overestimation of Stunting Burden



These results show that not only has every 'burden' of stunting been overestimated due to the inclusion of stuntedoverweight children in the prevalence estimates, many countries have been found to not actually have this burden of stunting once stuntingoverweightness is accounted for. Specifically, this section has shown that not considering stuntingoverweightness overestimates the burden of stunting in all countries in the whole sample of 77 countries; and this ranges from 1.53% in Lao PDR to 189.6% in Bosnia (the % overestimation for all countries of the sample is set out in Appendix II). In addition to this overestimation, 22.2% of countries in the sample listed as having a stunting burden of public health significance (>20%) actually have a burden <20% after accounting for stuntingoverweightness. Importantly however, this does not mean that overall there is a lower burden of growth faltering malnutrition in the population. This would only be the case if stuntedoverweight children are also included in overweightness prevalence estimates and thus 'double counted'. Finally, these results highlight how a large proportion of children's real nutritional status – stuntingoverweightness – is being overlooked.

The next section focuses on the effect of stuntingoverweightness on the understanding of overweightness burdens in LMICs. Importantly, as noted above, if it is shown that stuntedoverweight children have also been counted as overweight, then it is clear that these children have been double counted – once as stunted and once as overweight.

4.1.1.3 Stuntingoverweightness and the Prevalence of Overweight

The WHO estimates for overweightness in the 77 countries in the sample are presented in full in Appendix II. These estimates range from 1.3% in Lao PDR to 23.4% in Albania. As noted in Chapter 1 and Chapter 3, there is no definition of what constitutes a 'burden of overweight' among children and as a result a cut-off of 10% is used to indicate a 'burden' of overweightness. The rationale for this cut-off was described in Chapter 3. Using this cut-off point, there are 19 countries reported by the WHO as having a burden of overweightness among children under-five. These countries and their prevalence of overweightness are presented in Table 4.4. It is these 19 countries, distinguished by having a prevalence of overweightness >10%, that are used to explore the effect that stuntingoverweightness has on our understanding of the prevalence of overweightness in LMICs.

According to the WHOCG&M the prevalence of overweightness among under-fives ranges from 10.1% (Sierra Leone, 2005) to 23.4% (Albania, 2008) in the 19 countries with a 'burden' of overweightness.

Table 4.4 Prevalence of Overweightness Listed in WHOCG&M in the 19 Countries of the Sample that have % Overweight Children >10% according to the WHOCG&M

Country	Year	Overweight %	Country	Year	Overweight %
Albania	2008	23.4	**Mongolia**	2005	14.2
Armenia	2010	16.8	**Montenegro**	2005	15.6
Azerbaijan	2006	13.9	**Morocco**	2004	13.3
Belize	2006	13.7	**Nigeria**	2008	10.5
Benin	2006	11.4	**P in L**	2006	9.36
Djibouti	2006	13.4	**Sao T e P**	2008	11.6
Egypt	2008	20.5	**Sierra Leone**	2008	10.1
Guinea-Bissau	2006	17	**Swaziland**	2006	11.4
Iraq	2006	15	**Syria**	2006	18.7
Kazakhstan	2006	16.9			

Again, stuntingoverweightness prevalence was constructed from individual level data for each of the countries in the sample. The household surveys used were the same as those utilised by the WHO in the construction of prevalence of overweightness for the WHOCG&M. The estimates of prevalence of stuntingoverweightness and overweightness for these same 19 countries (with >10% overweight among under-fives according to the WHO) are presented in Table in 4.5. The estimates for the full sample are available in Appendix II.

Among these 19 countries, the percentage of children who are stuntedoverweight ranges from 1.9% in Belize to 10.42% in Egypt. Thus, in accounting for stuntedoverweight children, the prevalence of overweightness in these 19 countries decreases between 1.9 to 10.42 percentage points.

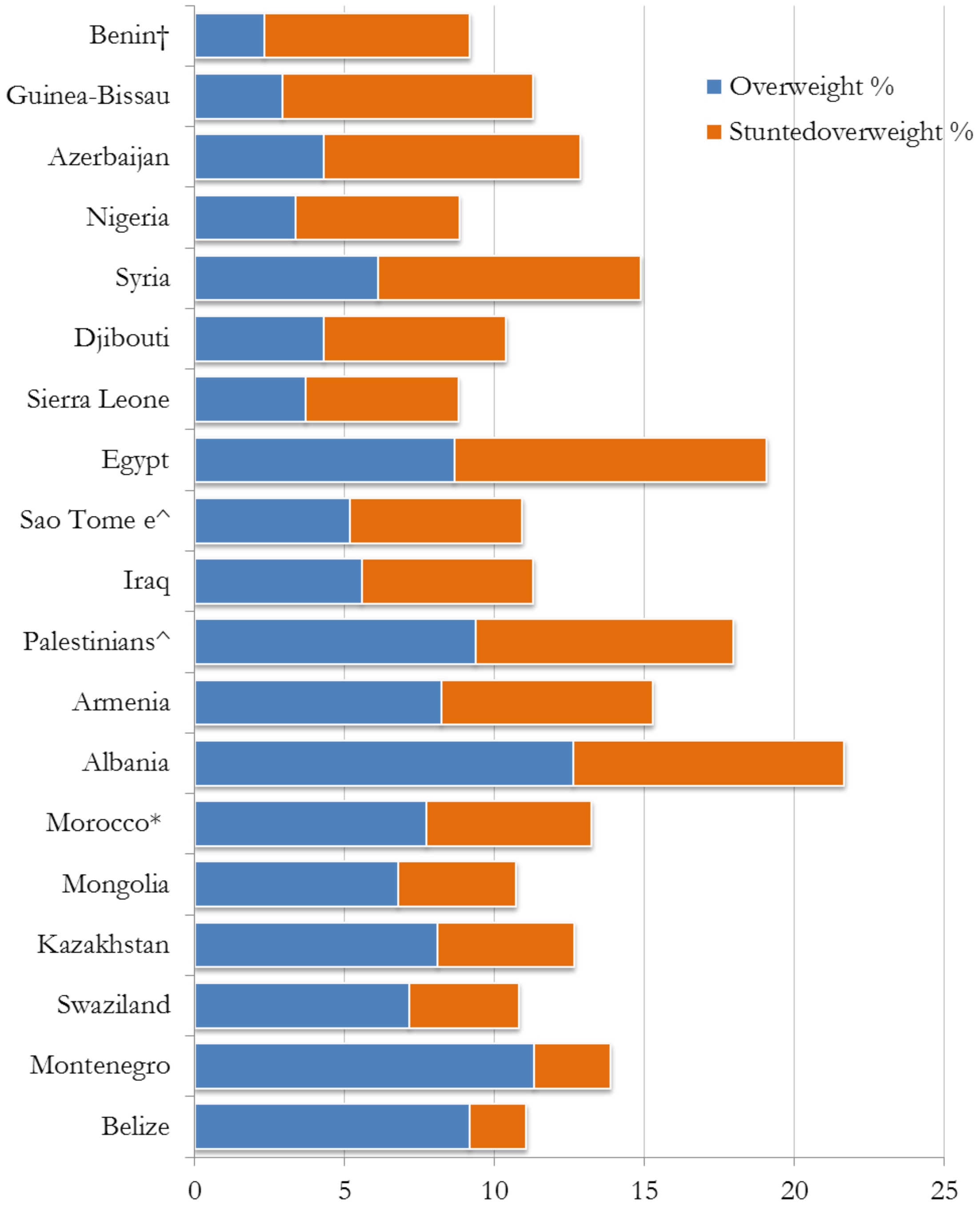
As before, when looking at burdens of stunting in section 4.1.1, there is some inconsistency between the % of overweight children presented in the WHOCG&M and the total % of overweight children (including stuntedoverweight children) calculated directly from the household surveys. Again, this is considered to be due to inconsistent methodological practices between the recommended standard survey construction of anthropometric prevalence indicators and the construction procedures used for the WHOCG&M. Taking the case of Albania, we can see that the WHOCG&M entry for 2008 is 23.4% but the Albanian DHS survey report lists prevalence as 21.7% (both rates were constructed based on the same household survey data – the Albanian DHS 2008-09). Following the recommended methodology set out by the DHS manual for the Albanian DHS, I constructed an overall prevalence of overweightness (inclusive of the stuntedoverweight) of 21.62%, which marries with the Albanian DHS. Despite the inconsistency between the WHOCG&M values and the values presented by the survey manuals on which they are based, the WHOCG&M prevalence levels are presented to stakeholders for use in research on child malnutrition. Moreover, in addition to these differences it is still very clear that the prevalence of overweightness listed in both the WHOCG&M and in the Albanian DHS survey manual is counting stuntedoverweight children as overweight.

Strikingly, if stuntedoverweight children are removed from the prevalence estimates of overweightness, only 2 of these 19 countries now have a specific burden of overweightness that is >10%. Moreover, when assessing the % overestimation of the burden that failing to account for stuntingoverweightness has caused, we see % overestimates that range from between 20.765% in Belize to 292.5% in Benin (Table 4.5). The proportion of overweight and stuntedoverweight children in each of these 19 countries ranked by overestimation is also displayed in figure 4.5.

Table 4.5 Prevalence of Stuntedoverweight and Overweight Children Under-5 for 19 Countries Listed as >10% by WHO – Ranked by Overestimation resultant of not considering Stuntingoverweightness

Country	**Year**	**Overweight %**	**Stunted-overweight %**	**Over-estimation (%)**
Belize	2006	9.15	1.9	20.76503
Montenegro	2005	11.32	2.5	22.43816
Swaziland	2006	7.15	3.7	51.04895
Kazakhstan	2006	8.1	4.5	56.04938
Mongolia	2005	6.78	3.9	57.9646
Morocco	2004	7.73	5.5	71.15136
Albania	2008	12.62	9.0	71.63233
Armenia	2010	8.22	7.1	85.76642
P in L	2006	9.36	8.6	91.98718
Iraq	2006	5.56	5.7	103.0576
Sao T e P	2008	5.18	5.7	110.8108
Egypt	2008	8.65	10.42	120.4624
Sierra Leone	2008	3.69	5.1	137.9404
Djibouti	2006	4.31	6.1	140.8353
Syria	2006	6.12	8.8	142.9739
Nigeria	2008	3.34	5.5	163.7725
Azerbaijan	2006	4.3	8.6	198.8372
Guinea-Bissau	2006	2.92	8.4	286.3014
Benin	2006	2.32	6.9	295.2586

Figure 4.5 Graph Showing Stuntingoverweightness Prevalence for Countries Listed as having an Overweight Prevalence of >10% among under-fives by the WHO Ranked by Descending % Overestimation of Overweightness Burden



In failing to take into account stuntingoverweightness when determining overweight prevalence, 'burdens' of specific overweightness among children have been overestimated by up to nearly 300% in LMICs. This is an alarmingly large overestimation – particularly in a research and policy context increasingly focussed on the 'burden of overnutrition' among children in LMICs. It has also meant that of the 19 countries listed by the WHO as having a burden of overweight >10% only two actually do – Albania and Montenegro with prevalence of overweightness at 12.62% and 11.32% respectively. For the other 17 countries, taking in to account stuntingoverweightness has meant that their overweight burdens now range from as low as 2.32% in Benin and 9.36% among Palestinians in Lebanon.

It should be emphasised that the overestimations are much larger for overweightness burdens than for those of stunting. This is a function of smaller burdens of overweightness than stunting in LMICs. As the prevalence of stuntingoverweightness is the same regardless of what the level of discrete stunting or overweightness is in these countries, the greatest overestimation is apparent in overweightness.

As with stunting, if we were only to look at the effect of stuntingoverweightness on overweightness burdens, we can see that these burdens have been overestimated and thus distorted.

This section has shown that failing to consider stuntingoverweightness overestimates the stunting, the overweight and the exact nature of the burden of growth faltering malnutrition as a whole in LMICs. The extent to which overestimation occurs is very much related to the prevalence of stuntingoverweightness relative to overweight within the population. As overweightness tends to be lower among LMICs at the moment, stuntingoverweightness has led to higher levels of overestimation in overweight burden than those seen in stunting. In addition, the evidence that stuntingoverweightness is increasing (section 4.1.1) is compounding the need to take immediate steps to rectify how data on child overweightness is presented – by making the important correction for stuntingoverweightness.

The distortion of the prevalence of overweightness among children has considerable implications on its own – but the very fact that we have seen that stunting burdens are also distorted by stuntingoverweightness shows that stuntedoverweight children have been double counted.

It has been shown how stuntingoverweightness leads to overestimation in stunting and overweightness. The results presented in section 4.1.1.3 will now show how the double-counting of stuntedoverweight children overestimates the overall burden of all forms of growth faltering malnutrition in LMICs – the overall burden of stuntingoverweightness, stunting, overweightness and wasting.

4.1.1.3 Double-counting and the Burden of Growth Faltering Malnutrition in LMICs

Having evidenced that double-counting of stuntedoverweight children occurs, the results presented in this section evidence the effect of failing to consider stuntingoverweightness on the total burden of stunting, wasting[43] and overweightness in the 78 countries of the sample. As noted in the methodology, in % points, the inflation of growth faltering in children in the sample populations is equivalent to the prevalence of stuntingoverweightness. The prevalence of stuntingoverweightness for each country, regardless of the burden of stunting or overweightness, was presented earlier – in Table 4.6. These prevalence rates show that not accounting for stuntingoverweightness has meant that all burdens of malnutrition in each country of the sample have been overestimated – from 0.33% in Suriname to 10.42% in Egypt.

Addressing the overestimation of the total proportion of children who suffer some form of growth faltering, we can calculate the % overestimation of the burden as:

[43] The prevalence of wasting is constant regardless of stuntingoverweightness but was included for completeness.

$$\frac{\%\ \text{Stuntedoverweight}}{(\%\ \text{Stunted} + \%\ \text{Overweight} + \%\ \text{Wasted} + \%\text{Stuntedoverweight})} \times 100$$

By relating the % of children who are double counted (the stuntedoverweight) to the ‘real’ prevalence of all forms of growth faltering malnutrition, it is possible to calculate the overestimation that double counting causes. The ‘real’ prevalence of total growth faltering malnutrition outcomes is equivalent to the denominator of the above equation – the % stunted added to the % overweight, % wasted and the % stuntedoverweight – where the prevalence of stunting and of overweightness do not include the stuntedoverweight and thus the stuntedoverweight are not double counted.

The ‘real’ burden of growth faltering malnutrition is presented in Table 4.6, alongside the overestimation of this total burden that double-counting creates.

Table 4.6 Total % of Children with Any Growth Faltering Malnutrition and % Overestimation Due to 'Double-Counting' of Stuntedoverweight Children

Country	% of Children w/ Any Form of Growth Faltering	% Overestimate	Country	% of Children w/ Any Form of Growth Faltering	% Overestimate
Jordan	23.79	22.28	**Ghana**	40.00	6.08
Azerbaijan	43.97	19.45	**Cameroon**	41.74	5.80
Egypt	54.54	19.11	**Belarus**	11.07	5.60
Palestinians	45.45	18.94	**Madagascar**	65.93	5.60
Armenia	38.26	18.43	**Vanuatu**	29.32	5.49
Albania	49.51	18.26	**Kenya**	44.70	5.37
Syria	48.98	17.86	**Zimbabwe**	38.72	5.27
Bosnia	34.55	17.34	**Tanzania**	49.73	5.27
Georgia	30.54	15.88	**Timor-Leste**	73.68	4.83
Iraq	39.33	14.57	**Dom. Rep**	20.12	4.72
Kazakhstan	31.20	14.55	**Liberia**	47.20	4.66
Guinea-Bissau	60.88	13.73	**Congo BR**	31.08	4.50
Morocco	45.48	12.09	**Togo**	39.78	4.35
Kyrgyzstan	24.50	12.08	**Uganda**	40.49	4.32
Benin	58.21	11.77	**Mali**	52.58	4.05
Sao T e P	49.00	11.71	**Haiti**	28.20	4.04
Macedonia	23.27	11.47	**Namibia**	38.80	4.02
Mongolia	34.34	11.44	**Senegal**	36.59	3.85
Serbia	26.93	11.21	**Maldives**	32.22	3.69
Uzbekistan	27.90	10.68	**Niger**	59.04	3.34
Montenegro	23.90	10.63	**Ivory Coast**	38.57	3.32
Sierra Leone	52.31	9.73	**Burundi**	62.91	3.05
Djibouti	65.68	9.24	**Gambia**	29.37	3.00
Zambia	57.76	9.23	**Burk. Faso**	48.09	2.97
Nigeria	59.44	9.20	**Somalia**	49.30	2.90
Swaziland	40.40	9.03	**Colombia**	18.61	2.74
Gabon	26.30	8.90	**guinea**	44.21	2.40
Malawi	58.03	8.74	**Suriname**	15.38	2.15
Mozambique	54.47	8.46	**Honduras**	28.56	2.07
Moldova	23.55	8.37	**Cambodia**	47.67	2.01
Tajikistan	40.12	7.83	**Chad**	51.72	1.89
Congo DR	57.62	7.06	**Peru**	25.57	1.80
Guyana	29.66	6.95	**Mauritania**	37.80	1.77
Bolivia	36.57	6.86	**Ethiopia**	51.99	1.69
Rwanda	52.78	6.74	**India**	60.64	1.60

CAR	52.76	6.54	**Lao PDR**	52.19	1.38
Lesotho	48.46	6.34	**Nepal**	48.68	1.38
Thailand	23.01	6.30	**Bangladesh**	51.21	1.33
Belize	30.58	6.21			

The results of Table 4.6 show that the double-counting of stuntedoverweight children inflates the overall prevalence of all forms of growth faltering malnutrition. This overestimation varies between a 1.33% overestimation (in Bangladesh) to 22.28% (in Jordan).

It should be noted that recognising this double-counting is not just important for the overall prevalence of growth faltering malnutrition – it is important to our understanding of child malnutrition in LMICs today. Notably, overlooking stuntedoverweight children has led to this double-counting and thus double-counting is the result of a failure to recognise the true diversity in growth faltering malnutrition in LMICs today. Failing to recognise the stuntedoverweight has rendered the condition of stuntingoverweightness invisible to policy makers and researchers alike, as well as increasing the assumed prevalence of overall growth faltering malnutrition.

The results of part 4.1 as a whole are now summarised in section 4.1.3.

4.1.3 Summary of Results Concerning the Levels and Trends in Stuntingoverweightness and their Implications for the Measurement of Child Malnutrition

The results in part 4.1 have documented the levels and trends in stuntingoverweightness prevalence in LMICs. These results have shown that overall, the prevalence of stuntingoverweightness in LMICs appears to be increasing. Currently, levels of stuntingoverweightness range from 0.33% in Suriname in 2006 to 10.42% in Egypt in 2008. Importantly, every single country has some level of stuntingoverweightness among its children – thus millions of children are suffering a paradoxical form of growth faltering that is consistently overlooked in research today.

The results of 4.1.2 showed that stuntedoverweight children are included in prevalence estimates of both stunting and overweightness. The levels of stunting and of overweightness in LMICs have been decomposed to show the overestimation of the prevalence of stunting and of overweightness caused by not considering stuntedoverweight children. This overestimation ranges from 1.5345% in Lao PDR to 88.541% in Albania (for stunting overestimation) and from 20.765% in Belize to 292.5% in Benin (for overweightness overestimation). In rectifying this overestimation, many populations retreat below the threshold of the 'burden' of either stunting or overweightness that they were previously thought to have crossed. A fifth of the countries presented by the WHO as suffering 'burdens' of stunting do not in fact have a prevalence of discrete stunting >20% when accounting for stuntingoverweightness. For overweightness, of the 19 countries with >10% prevalence of discrete overweightness, only 2 still had a prevalence >10% when accounting for stuntingoverweightness. Although this is evidence of continued misuse of anthropometric indices – there is some optimism to be taken from the fact that burdens of overweightness in LMICs are lower than previously thought.

As a final note on the effect of stuntingoverweightness on child malnutrition representations, section 4.1.1.3 showed that, when looking at the whole picture of malnutrition in a population, not accounting for stuntingoverweightness overestimates the total level of growth faltering malnutrition in a population and hides the diversity in growth faltering malnutrition this research is now evidencing.

In part 4.1 much has been made of the double-counting of stuntedoverweight children and why it is important in research focusing on the DBCM. Before further comment is made on this issue, it is important to note that stuntingoverweightness still has considerable implications for research focusing on just one of these burdens. As the results of the within-population analysis of Albania will show, stuntedoverweight children as a group behave differently to their stunted and their overweight peers. They are a separate socioeconomic group with different demographic characteristics. Thus I argue that any research focussing on either stunted or overweight, should consider the stuntedoverweight separately. This is particularly necessary given – as will be evidenced in Chapters 7 and 8 – their differential patterns of determinants could actually skew any results on factors thought to be increasing the risk of stunting or overweightness in young children in contexts where stuntingoverweightness is prevalent.

Additionally, in research focussing on both stunting and overweightness, data is being utilised that is 'double-counting' stuntedoverweight children. This is particularly relevant to the principal concern of this thesis – the impact of stuntingoverweightness on the conceptualisation of the NT today. Of particular interest, for example, is the developing concern of the DBCM in both research and policy recommendations. This is because the current understanding of the DBCM is based upon double-counting of stuntedoverweight individuals, thus overestimating both the burdens of stunting and of overweightness. This effect of stuntingoverweightness on the conceptualisation of the NT presently occurring in LMICs is the focus of the next section (section 4.2) of this chapter.

As a final point, the results here have raised some methodological issues to be addressed in research on child malnutrition. Namely that prevalence estimates of stunting and overweightness should routinely account for stuntingoverweightness. This is both important for data repositories, such as the WHOCG&M, but also in survey reports and any research addressing stunting and overweightness. Individual level data is required to do this and there are prevalence measures that are currently inaccurate that should be corrected retrospectively. An additional and unexpected outcome of this analysis was the observation of a clear disjoint between the prevalence rates presented in the WHOCG&M and the reports of the household surveys that feed them. Data repositories are a key tool in research focussing on population health and development and it is concerning that such a disjoint is occurring. This is an evident avenue for further research in the field of child malnutrition, acutely relevant to its accuracy and thus efficacy for tackling the issue of child malnutrition today.

As noted previously, the discussion now moves onto the results highlighting the effect stuntingoverweightness has on our understanding of the NTT and its revision – the AT – in LMICs today. The next section relates the occurrence of stuntingoverweightness to other malnutrition indicators in LMICs as a means to gauge the true overall nutritional profiles of countries with higher levels of stuntingoverweightness.

4.2 Stuntingoverweightness and the Overall Nutritional Profiles of Populations – the effect on our understanding of the DBM and DBCM

Chapter 2 highlighted how the original NTT had been adapted to account for the dual incidence of both under- and overnutrition observed in LMICs. This dual incidence marks a disjuncture from the discrete and consecutive stages of the NT the original theory proposes and is conceived as an altered trajectory (AT) of a NT occurring in LMICs today.

The focus of adaptations to the NTT and subsequently proposed AT were shown to be focussed on a polarisation in burdens of malnutrition (leading to a burden of undernutrition as well as a burden of overnutrition) by both age and socioeconomic group. With the latter, the socioeconomic gradient in malnutrition is thought to vary as populations continue to develop. This specific change is known as the double burden of malnutrition (DBM) and has been assumed to be occurring in rapidly developing LMICs. More recently, the understanding of a DBM has widened due to the observation of increasing levels of overweight children in LMICs whilst high levels of stunted children remain – this latter observation is a more specific form of a DBM and is known as the double burden of child malnutrition (DBCM).

However, as Corsi et al. noted there is very little evidence of dual *burdens* of malnutrition*,* although incidences of both forms of under- and overnutrition have been observed (2011). Yet it is apparent in the literature that it is the *'burden'* that is the defining feature for LMICs, not just the incidence. The case of MDCs is particularly useful in highlighting this. MDCs are thought to be in a stage of behavioural change – where the burden of malnutrition is firmly a burden of overnutrition, which will eventually decline as health and lifestyle behaviours improve. But there is still some incidence of undernutrition in MDCs today. For example, studies have shown high levels of undernutrition among hospital admissions in the UK (Edington et al. 2000). What is apparent, however, is that in MDCs the *burden* of malnutrition is very much skewed towards overnutrition, whilst the *incidence* of undernutrition is very low. In other words, undernutrition, whilst present, is not a *burden*. In research concerning LMICs, however, the suggestion is that the burden of undernutrition remains medium to high – with declines slow or stagnating. In addition overnutrition is of a high enough level to be of significant concern to public health and is increasing, thus it is a *burden*.

With respect to the NTT and the AT, Corsi et al. have already raised concerns about the lack of evidence concerning a double *burden* of malnutrition at the population level. However, neither their concerns nor those of any other researcher on the DBM have addressed the issue of what the existence of stuntedoverweight children means for both the considered 'age-polarised' DBM nor the child-specific DBCM. Chapters 1 and 2 highlighted the lack of research on stuntedoverweight children. Given this omission in the literature it follows that the impact stuntedoverweight children would have on the considered DBM or DBCM has also been overlooked and under investigated.

Part 4.1 of this chapter has shown that stuntedoverweight children are found in all LMICs and currently represent up to ~10% of children under-five. Moreover, stuntedoverweight children have been double counted in research – once as stunted and once as overweight. This double-counting has overestimated the prevalence of both stunting and overweightness. Stunting and overweightness prevalence are the two key indicators for research on the DBM and the DBCM. As research on the DBM is focused on the age polarisation of nutritional burdens (alongside socioeconomic polarisation) the burden of stunting is necessary to its definition. Yet as part 4.1 has shown, the prevalence of stunting has been overestimated. In accounting for this overestimation of the prevalence of stunting among children, a fifth of countries currently defined as having a burden of stunting of public health significance (>20%) in the WHOCG&M were in fact found to not be suffering from this burden. This calls into question the nature and even existence of the DBM.

The prevalence of both of the key indicators determining a DBCM – child stunting and child overweightness – have been found to be overestimated in research on the DBCM. Specific to the DBCM, part 4.1 showed that both child stunting and child overweightness are overestimated and, crucially, if research is addressing both forms of malnutrition together the analysis rests upon prevalence rates that include double counted stuntedoverweight children. In effect, this means that the burdens of stunting and overweightness were overestimated through this double-counting, skewing the results and leading to prevalence estimates created on a sample of children that does not actually exist. In fact, overweightness estimates were so large that only 2 of 19 countries depicted by the WHOCG&M as having prevalence of overweightness >10% actually did. Again, however, given the overlooked nature of stuntingoverweightness no research has addressed what stuntingoverweightness means for this 'DBCM'.

The results presented here address this key gap in the literature – assessing the effect stuntingoverweightness has on the considered DBM and DBCM. Part 4.2.1 presents the effect stuntingoverweightness has on the DBM. To do this, the relationship between child stunting levels and adult obesity is explored before and after accounting for stuntingoverweightness. Part 4.2.2 presented the effect stuntingoverweightness has on the understanding of the DBCM. To do this, the relationship between child stunting and child overweightness is explored both before and after accounting for stuntedoverweight children. The results of this section are summarised in part 4.2.3, where are move to a perspective of divergence in malnutrition is called for.

4.2.1 The effect of stuntingoverweightness on our understanding of the DBM

This section describes the relationship between child stunting and adult obesity levels in LMICs. The relationship is presented before and after controlling for stuntedoverweight children. As Corsi et al. noted, a consistent negative relationship between child stunting and adult obesity across LMICs indicates that a DBM is not currently apparent in LMICs (2011). However, even this research – unique in its attempts to try to evidence the DBM – does not account for stuntingoverweightness and the consequent overestimation of stunting prevalence endemic in research on child malnutrition today.

Thus, as described in Chapter 3, the results of this analysis are concerned with the relationship between child stunting and adult obesity. Notably, the focus is on the relationship between child stunting and adult obesity before and after recognising stuntedoverweight children as a separate group and if or how the relationships inherent to the considered DBM change. The relationship between child stunting and adult obesity is explored descriptively using graphical representations and the Pearson correlation coefficient. The relationship is then described through the use of simple linear regression models.

As described in Chapter 3, there were two stages to the analysis. The first stage was to explore the relationship between child stunting and adult obesity levels when stuntedoverweight children were not removed from the levels of child stunting. These results are presented in section 4.2.1.1. In this section, prior to accounting for stuntedoverweight children, the relationship between child stunting levels (inclusive of child stuntingoverweightness) and adult obesity is described. This description considers first the whole sample and then focuses on a restricted sample – for populations with a considered DBM (>20% stunting and >10% adult obesity). In the latter, restricted sample, based upon the current understanding of the DBM in the literature there should be no negative relationship between child stunting and adult obesity. In line with the literature on the DBM the most appropriate relationship supportive of the DBM would be no relationship between child stunting and adult obesity – although the existence of a positive relationship could also be indicative of a stagnation of child stunting whilst adult obesity levels rise. The lack of a negative correlation between child stunting and adult obesity is inherent to the definition of an age-polarised DBM.

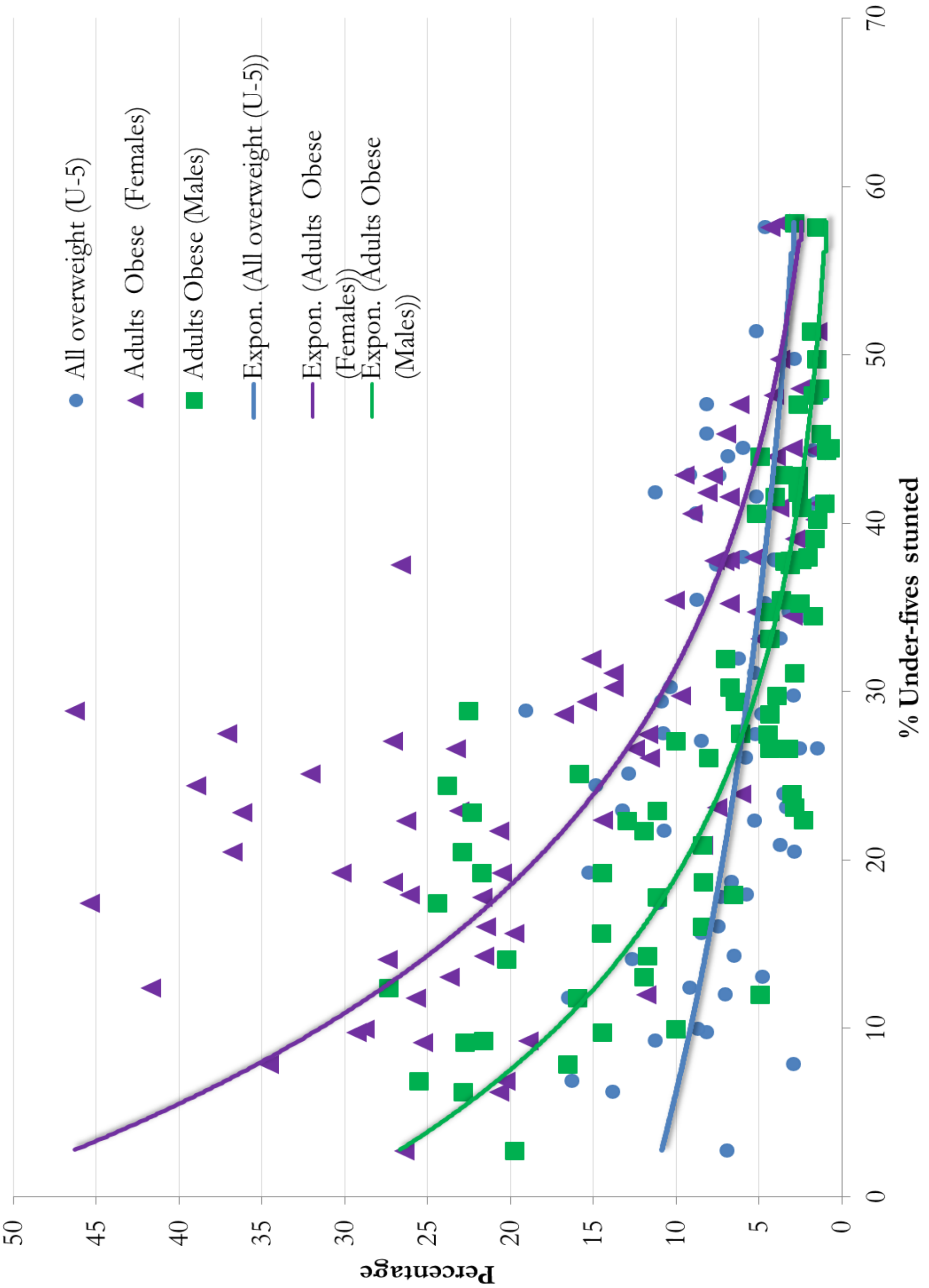
The analysis is then repeated removing stuntedoverweight children from the prevalence estimates of child stunting. The relationship between child stunting (exclusive of stuntedoverweight children) and adult obesity in LMICs is then described. The changing nature of this relationship given the accounting of stuntingoverweightness is emphasised. This is key to illustrating how overlooking stuntedoverweight children is affecting our understanding of the DBM and thus the NTT (as the AT), which are integral to research on the nutrition transition in LMICs today.

4.2.1.1 Relationship between Child Stunting and Adult Obesity (Inclusive of Stuntingoverweightness)

Figure 4.5 shows the relationship between child stunting and adult obesity levels among males and females. The estimates of child stunting presented in this graph are inclusive of stuntedoverweight children. Child overweightness (also inclusive of stuntedoverweight children here) is included in the graph for completeness and will be referred to later on in this section. For the DBM, the focus is on the relationship between child stunting and adult obesity in line with the current literature on the DBM. However, the consideration of child overweightness is discussed in this section as well, as it provides key insights into our understanding of the current nutritional profiles of LMICs.

The graph shows that there is a negative exponential relationship between adult obesity and child stunting (for both male and female adults). At higher levels of child stunting, there are lower levels of adult obesity. Additionally, levels of adult obesity increase at a greater rate as child stunting prevalence declines.

Figure 4.5 Child Stunting with Child Overweightness[44], Female Adult Obesity and Male Adult Obesity (inclusive of stuntedoverweight children)



[44] Both stunting and overweight prevalence for children is inclusive of stuntedoverweight children

What is evident is that adult obesity (for both men and women) occurs concurrently with child stunting in all of the countries in the sample. This suggests that undernutrition in the population (indicated by child stunting) is not fully eradicated prior to the onset of adult overweightness and obesity in LMICs today. This illustrates that the original discrete and consecutive conceptualisation of the NTT does not apply to these LMICs.

As a further note – as discussed in Chapter 2 and Chapter 3 – the graph shows the prevalence of adult obesity is consistently higher for females than males in all LMICs. This reflects the literature and is thought to be mainly due to biological factors. Firstly, levels of fat and its distribution are key elements of sexual dimorphism and are thought to be an adaptive – with women having greater levels of subcutaneous fat as an adaptive response to the excess energy requirements of women, particularly with regards to reproductive functioning (Zafon 2007). Of further note concerning the relationship between adult obesity levels and stunting is that the gap between male and female obesity rates widens as child stunting declines. Thus the sex differences in obesity rates increase in countries further along in the NT. This again parallels with the literature, which notes that male obesity rates plateau before female rates (Case & Menendez 2009). Although complex, two main reasons for this are the greater propensity of females to become obese and also the greater amount of periods in the life course at which females are at greater risk of obesity – namely pregnancy and menopause (Zafon 2007).

The literature notes how, for LMICs today, obesity rates are likely increasing at a greater rate than MDCs due to the rapid development of obesogenic environments in these countries. As shown in Chapter 2, the Foetal Origins of Adult Disease (FOAD) hypothesis is particularly important for rapidly developing LMICs today. As a result of this rapid pace of development, individuals born into living conditions of chronic poverty and poor nutrition are now facing increasingly 'obesogenic' environments in adulthood. Physiological adaptations protective in environments of poor nutrition developed intrauterine have become maladaptive in the face of obesogenic environments. The 'thrifty phenotype' moves from adaptive to maladaptive over the life course due to the improving socioeconomic conditions which increases risk of obesity among affected individuals. As a result, adult obesity levels in LMICs are likely currently compounded by this 'echo' effect of the FOAD.

Although we know that the levels of obesity increase at a greater rate due to this now maladaptive developmental process, for females, it is possible that there is also an element of further sex inequalities, with malnutrition in early childhood potentially compounding females' propensity to become overweight or even obese. These include differing health behaviours towards females over males, for example, creating an early childhood environment that is also contributing to the higher propensity of females to become obese – further compounding the long arm of child malnutrition. But there is evidence that as countries move further along the NT, sociocultural factors – including gender differences in diet quantity and composition, physical activity levels and cultural ideals of body shape – are fuelling overnutrition among women leading to higher rates of obesity among adult females (Kanter & Caballero 2012).

In summary we can see that there is definitely a dual incidence of child stunting (including the stuntedoverweight) and adult obesity in all LMICs – this highlights the inadequacy of the original NTT to describe the nutritional profiles of LMICs today. The relationship is a negative one: as stunting declines, adult obesity rates are found to increase. Additionally the levels of adult obesity appear to increase at a greater rate as child stunting levels decline. Adult obesity levels were separated by sex (as described in Chapter 3) and it can be seen that adult female obesity levels are consistently higher than male obesity levels across all levels of stunting (inclusive of stuntingoverweightness). An interesting feature of the relationship between adult obesity and child stunting is that the gap between male and female adult obesity rates widens as child stunting declines and a population continues further into their NT. This can be explained by the observation that male obesity rates tend to plateau earlier than females.

With respect to the AT it is not just a dual incidence that is its defining feature – it is a dual *burden* of undernutrition and overnutrition. Taking the cut-offs as described in Chapter 3 for defining 'burdens' of child stunting and adult obesity, a population is considered as having an age polarised DBM if child stunting prevalence is >20% and adult obesity rates (for females) is >10%[45] (Table 4.6). Figure 4.6 displays the child malnutrition and adult obesity rates among countries that satisfy these criteria[46].

Table 4.6 – Child Stunting and Adult Obesity Rates among LMICs with a DBM (inclusive of stuntedoverweight children)

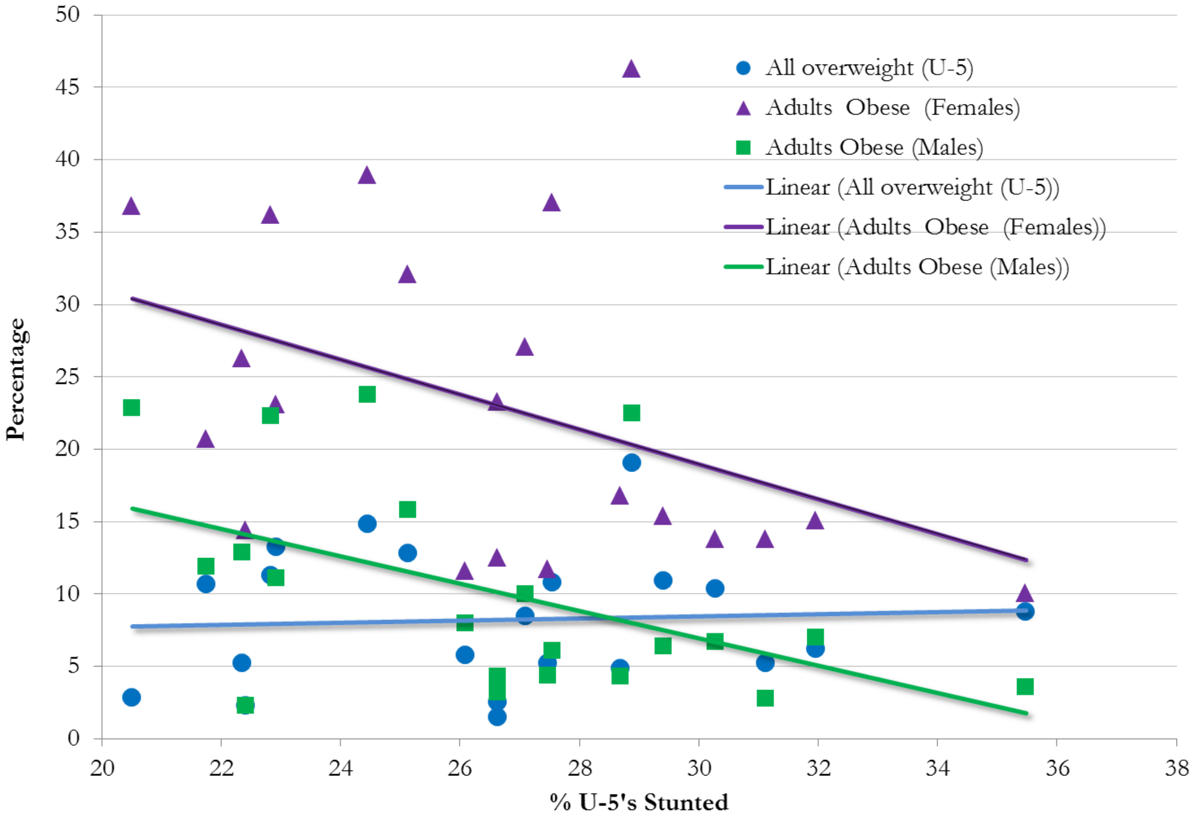
	% U-5 Stunted	**% U-5 overweight**	**Adults Obese (Females)***	**Adults Obese (Males)***
Azerbaijan	25.13	12.85	32.1	15.8
Bolivia	27.09	8.49	27.1	10
Cameroon	31.96	6.22	15.1	7
Djibouti	30.27	10.38	13.8	6.7
Egypt	28.88	19.07	46.3	22.5
Gambia	22.41	2.29	14.4	2.3
Ghana	27.47	5.23	11.7	4.4
Honduras	22.35	5.27	26.3	12.9
Iraq	22.83	11.29	36.2	22.3
Mauritania	26.62	1.5	23.3	4.3
Mongolia	21.75	10.71	20.7	11.9
Morocco	22.92	13.23	23.1	11.1
Namibia	28.69	4.85	16.8	4.3
Sao Tome e Principe	29.41	10.92	15.4	6.4
Senegal	26.62	2.57	12.5	3.2
Sierra Leone	35.47	8.78	10.1	3.6
Swaziland	27.54	10.8	37.1	6.1
Syria	24.45	14.87	39	23.8
Tajikistan	26.09	5.79	11.6	8
Vanuatu	20.5	2.86	36.8	22.9
Zimbabwe	31.11	5.26	13.8	2.8

*data only provided up to 1 d.p.

[45] The justification for the use of female obesity rates as opposed to male rates to define a DBM was set out in Chapter 3

[46] Again child overweightness was been included for completeness and will be addressed in part 4.2.2

Figure 4.6 – Prevalence of Child Stunting by Adult Obesity (for male and female adults) in LMICs defined as having a DBM



Among populations with a DBM the relationship between child stunting and adult obesity remains negative. This indicates that even among countries with a DBM (indicated here using stunting prevalence inclusive of stuntedoverweight children) the prevalence of adult obesity is expected to increase as stunting declines. This is a promising result as it suggests that in LMICs where burdens of both adult obesity and child stunting exist, child stunting should be expected to continue to decline even if it was not eradicated prior to the onset of adult obesity. Additionally there is a much more linear relationship between child stunting and adult obesity – which suggest adult obesity rates are not currently increasing at a pace that is far in excess of the decline in stunting in DBM countries.

Another key point to emphasis is that levels of adult obesity among females are higher than males in all DBM countries. This is consistent among nearly all LMICs in the sample[47] (figure 4.5).

Focussing further on sex differences in the relationship of adult obesity and child stunting, it appears that the rate of increase in adult obesity with declining stunting is much higher among females than males in all countries of the sample (figure 4.5). However, among LMICs with a DBM (as defined by >20% stunted children, >10% obese females or males) there is no difference in the nature of the relationship between obesity and stunting across the sexes, just in the levels – where females still have higher levels of obesity in all these countries. As a final point, the gap between female and male obesity levels respective to child stunting is more consistent among DBM countries than the whole sample. Although there appears to be a slight widening of the gap among DBM countries with lower stunting levels, overall the gap is very consistent – as indicated by the more or less parallel nature of the female and male adult obesity trend lines. It is possible that in these DBM countries male obesity is yet to plateau – indicating they are not as far along in the NT as other countries. The increasing rate of sex divergence in adult obesity levels is clearly an area for more research in NTs in LMICs. Although the causes can't be elucidated from the analysis presented here, it could be that among DBM countries the NT is in a stage where the male advantage with respect to obesity is not yet being realised, hindering the plateauing of male obesity rates.

So far, the relationship between child stunting and adult obesity has only been assessed through the visual representation of prevalence rates. These relationships – between child stunting and adult obesity – were also explored using Pearson's correlation and linear regression to assess whether any statistically significant relationships exist between child stunting and adult obesity rates (for males and for females separately). Among the

[47] There are 3 exceptions – Haiti (where 8.4% of female adults and 8.4% of male adults are obese), Montenegro (where 20.7% of females are obese and 22.8% of males) and in Rwanda (where 4% of females are obese and 4.8% of males)

full sample, there was a significant negative correlation found between child stunting with female obesity levels (*r* = -0.693, 95% C.I. -0.795:-0.555) and with male obesity levels (*r* = -0.741, 95% C.I. -0.828:-0.619). Both female and male obesity rates are highly negatively correlated with stunting prevalence – with males having a slightly stronger correlation with child stunting levels.

Among countries with a DBM, however, the results differ. There is no significant correlation between either adult male obesity levels and child stunting (*r* =-0.570, 95% C.I. -0.883; 0.092) or adult female obesity levels and child stunting (*r* =-0.508. 95% C.I. -0.862: 0.179). This is in line with the expectations of this research. For an age-polarised DBM – currently the prevalent mode of a DBM referred to in the literature (not accounting for stuntingoverweightness) – it is considered that child stunting levels have plateaued; the decline in stunting is stagnating. Concurrently adult obesity levels are thought to be rising. In such a situation it is expected there would be no correlation (negative or positive) between child stunting and adult obesity. When looking at the results for a population with a DBM as defined in this research (>20% stunting >10% adult obesity (male or female)) there is no significant correlation between child stunting and adult obesity levels and this supports the conventional understanding of this age-polarised DBM.

The next results presented are those of linear regression models (Table 4.7). The linear regression models, as outlined in Chapter 3, assess the relationship between adult obesity levels and child stunting (the dependent variable). Table 4.7 presents regression results for the full sample of LMICs, table 4.8 for DBM countries.

Table 4.7 Linear Regression Results for the Relationship of Child Stunting with Adult Obesity among all LMICs of Sample

	Dependent Variable Y=Child Stunting %			
	Model 1	**Model 2**	**Model 3** (controlling for U-5 overweight)	**Model 4** (controlling for U-5 overweight)
Independent Variables:				
log(Adult Obesity Female)	-11.065***		-11.180***	
log (Adult Obesity Males)		-11.014***		-12.681***
Child Overweight %			0.0380	0.515*
Constant	55.798***	47.559***	55.805***	46.672***
N	77			

As explained in Chapter 3, the variables for both female obesity and male obesity levels underwent log transformations to meet the necessary assumptions of the linear regression model.

In the full sample, the results of the simple linear regression for child stunting highlight a negative relationship between child stunting and both adult male and female obesity (Table 4.7, Model 1 & Model 2). For a 1 unit increase in the log of female adult obesity there is an 11.07% decrease in the percentage of children under-five who are stunted. For a 1 unit change in the log of male obesity levels, there is an 11.01% decrease in child stunting prevalence. These results show a uniform negative relationship between child stunting (inclusive of stuntedoverweight children) with both female and male obesity rates.

As an additional caveat to the analysis, child overweight (as specified by the WHO – thus inclusive of stuntedoverweight children) was controlled for in the linear regression models (Table 4.7, Model 3 & Model 4). The level of child overweightness was included in the regression model as a means to establish whether the relationship between child stunting and adult obesity varies given on the level of child overweightness. This is because child overweightness is also an important aspect of a population's nutritional profile and changes in burdens of malnutrition.

When controlling for child overweight, the relationship between child stunting and female obesity levels remains very similar. The associated reduction in stunting prevalence with adult obesity is 11.18% – compared to a reduction of 11.07% when not controlling for child overweightness levels. Additionally, there is no significant association between child overweightness and child stunting levels, controlling for female adult obesity (Table 4.7, Model 3).

Interestingly, however, controlling for child overweight increases the magnitude of the relationship between child stunting and male adult obesity to a much larger extent (Table 4.7, Model 2 & Model 4). When controlling for child overweightness, a one unit increase in the log of adult male obesity results in a reduction in child stunting prevalence of 12.68% (Table 4.7, Model 4). Prior to the introduction of child overweightness prevalence into the model, the regression coefficient for adult male obesity was -11.01 (Table 4.7, Model 2). Moreover, in this model child overweightness is found to be significantly and positively associated with child stunting levels (β=0.515). Thus, when assessing the whole sample of LMICs and not accounting for stuntingoverweightness, there appears to be a disjuncture between the relationships of child stunting and child overweightness dependent upon controlling for adult female or male obesity level.

The results for the same regression analyses conducted for only DBM countries are presented in Table 4.8. Log transformations for female and male adult obesity rates were utilised among the DBM sample in the regression models[48]. Among these countries no significant relationship between female obesity rates and child stunting

[48] The ladder command in Stata showed the log transformation best to provide a normal distribution

levels (inclusive of stuntedoverweight children) was found – before or after controlling for child overweightness (Table 4.8, Model 1 & Model 3).

Table 4.8 Linear Regression Results for the Relationship of Child Stunting with Adult Obesity among DBM Countries

	Dependent Variable Y=Child Stunting %			
	Model 1	**Model 2**	**Model 3** (controlling for U-5 overweight)	**Model 4** (controlling for U-5 overweight)
Independent Variables:				
log(Adult Obesity Female)	-3.336		-4.737	
log (Adult Obesity Males)		-3.143*		-5.143***
Child Overweight %			.282	.545*
Constant	37.285***	33.492***	39.233***	33.058***
N	21			

This is an interesting finding and suggests that in countries with a DBM, increasing levels of female obesity are not associated with declines in child stunting. Such a finding reinforces the notion of the protracted polarised model for these countries – where stunting levels have plateaued, their decline stagnated and female obesity levels are increasing.

Yet among DBM countries the relationship between male obesity rates and child stunting is consistent with that found in the full sample of LMICs – where higher levels of adult male obesity are associated with reduced levels of child stunting. A one unit increase in the log of adult male obesity levels was found to be significantly associated with a 3.14% reduction in child stunting prevalence (Table 4.8, Model 2). This significant negative association was magnified when controlling for child overweightness – the coefficient for adult male obesity rose from -3.14 to -5.14 (Table 4.8, Model 4). Across the whole sample and among DBM countries the results suggest a gendered perspective to adult obesity rates are important for considering age-polarised burdens of malnutrition in LMICs.

So far, the results presented have shown that among the whole sample and in DBM countries there are some commonalities. Namely:

- There is a dual incidence of child stunting with both female and male adult obesity

- Across all levels of stunting, female adult obesity rates are higher than male adult obesity rates

- Where significant relationships between stunting and adult obesity rates are found they are negative – indicating that a move towards increase obesity levels is associated with reduced undernutrition among children and thus further progression in the countries' NTs

- When controlling for male adult obesity, there is a positive relationship between child stunting and child overweightness – this is indicative of a DBCM and will be discussed further in part 4.2.2

When including stuntingoverweightness in the prevalence of stunting and thus our understanding of the DBM, there are some distinctive features of the relationship between child stunting and obesity in DBM countries when compared to the whole sample. Namely:

- There is no significant relationship between child stunting levels and adult female obesity rates. This is indicative of a protraction in stage 3 of the NTT occurring as stage 4 begins – thus sustained child undernutrition in the face of increasing adult overnutrition

- The gender gap in adult obesity rates is much more consistent in DBM countries – indicating male obesity rates have not plateaued

Before it is possible to comment on the DBM and contribute to our understanding of the NTT today, however, this analysis must be re-run using prevalence rates that do not include stuntedoverweight children and the results compared.

As part 4.1 showed, the child stunting rates utilised above are inclusive of stuntedoverweight children. In the models that also control for child overweightness (Table 4.7 and Table 4.8) the relationships the results exposed actually include children who are double counted – the stuntedoverweight. This double-counting is likely to affect the nature of the results achieved. It is the premise of this research that not accounting for stuntingoverweightness provides inaccurate and misleading results as it does not consider the true diversity of nutritional profiles in LMICs today.

To document and thus compare the effect stuntingoverweightness has on our understanding of the DBM, section 4.2.1.2 presents the relationship between child stunting and adult obesity when excluding stuntingoverweightness from child stunting prevalence. This is compared to the results of 4.1.2.1 to show if and how our understanding of the DBM changes in the light of stuntingoverweightness. The DBM in this instance is still defined as a stunting prevalence of >20% and adult obesity levels >10% but the stunting prevalence does not include stuntedoverweight children.

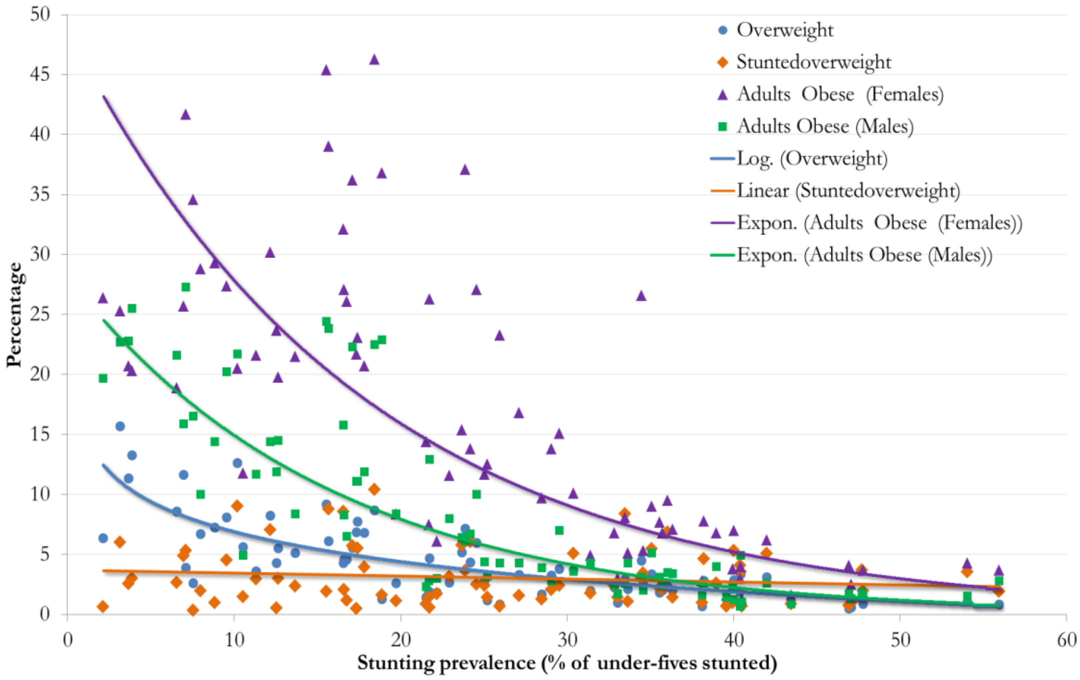
4.2.1.2 Relationship between Child Stunting and Adult Obesity (Exclusive of Stuntingoverweightness)

As with the analysis of 4.2.1.1, the relationship between child stunting (exclusive of stuntingoverweightness) and adult obesity levels is explored descriptively using graphical representations (Figure 4.7 and Figure 4.8) and correlation coefficients. The relationship is then described through the use of linear regression models.

Figure 4.7 shows the relationship between stunting prevalence and adult obesity levels for the whole sample of LMICs – where the prevalence of stunting among children is exclusive of stuntedoverweight children. The relationship between child stunting and both female and male adult obesity remains exponential – at lower levels of stunting, the levels of adult obesity increase. The rate of increase in obesity levels increases as child stunting levels decline. The nature of this relationship is consistent with the relationship displayed in Figure 4.5 – where stunting rates were inclusive of stuntingoverweightness. Additionally, the widening gap between male and female obesity rates apparent as stunting prevalence declines is also consistent, whether including or excluding stuntedoverweight children (Figure 4.5 & Figure 4.7) – indicative of the earlier male plateau that has been consistently observed in obesity rates (Case & Menendez 2009).

Even when excluding stuntedoverweight children from the prevalence of stunting, a dual incidence of child stunting and adult obesity is still apparent in LMICs. This again clarifies the need to reconceptualise the original NTT, as populations are not undergoing consecutive and discrete stages of the NT. However, the overriding negative relationship between stunting and adult obesity in all LMICs highlights that the trend is for undernutrition to continue to decline whilst overnutrition is increasing.

Figure 4.7 Child Stunting with Child Stuntingoverweightness, Child Overweightness, Female Adult Obesity and Male Adult Obesity (Where % Child Overweightness and % Child Stunting are Exclusive of Stuntedoverweight Children)



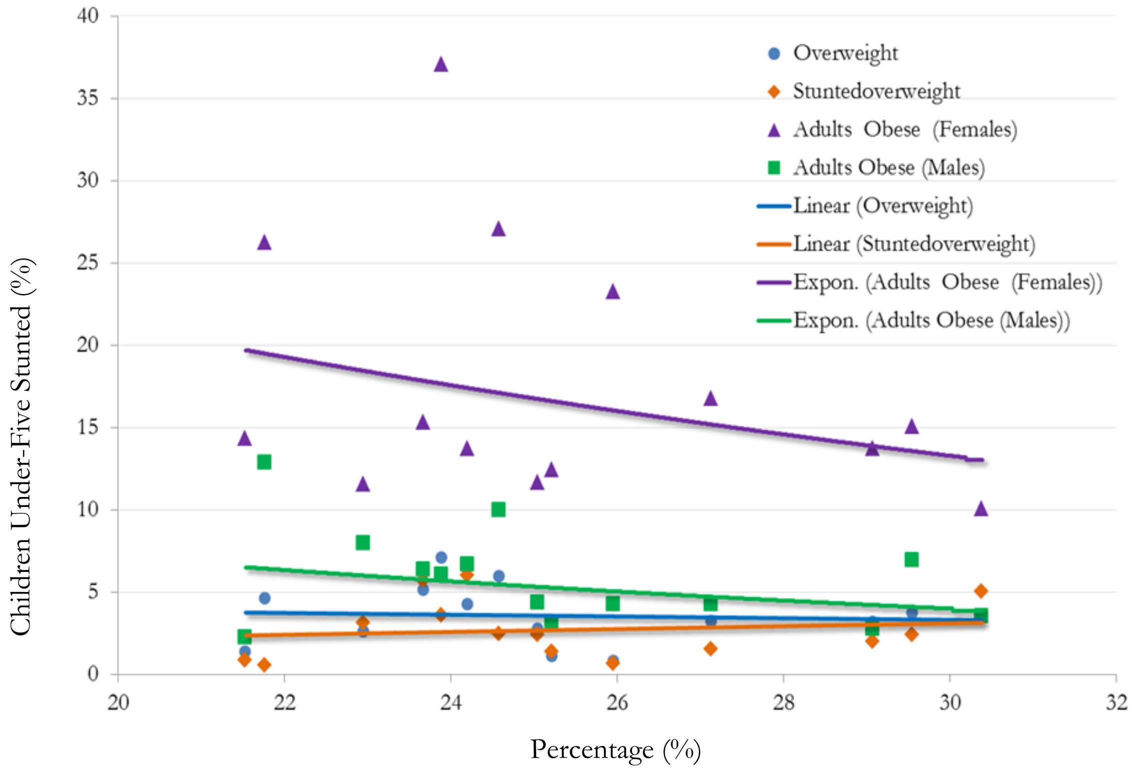
However, as noted previously for the modified NTT – the theory of the AT – it is not the dual incidence that is of interest – but the dual *burden*. Thus the relationship between child stunting and adult obesity was examined among countries with a DBM (>20% stunting and >10% female adult obesity) (Figure 4.8). Importantly the criteria of >20% stunting among under-fives is now exclusive of stuntedoverweight children. Using the cut off of 20% for stunting (not including stuntingoverweight) and 10% for female obesity, 15 countries were defined as having a DBM (Table 4.9). Excluding the stuntedoverweight from stunting prevalence meant that 7 countries were no longer defined as having a DBM – they were Azerbaijan, Egypt, Iraq, Mongolia, Morocco, Syria and Vanuatu.

Table 4.9 Child Stunting and Adult Obesity Rates among LMICs with a DBM (Exclusive of Stuntingoverweightness)

	% Stunting (U-5s)	% Overweight (U-5)	% Adult Females Obese	% Adult Males Obese
Bolivia	24.58	5.98	27.1	10.0
Cameroon	29.54	3.8	15.1	7.0
Djibouti	24.2	4.31	13.8	6.7
Gambia	21.53	1.41	14.4	2.3
Ghana 08	25.04	2.8	11.7	4.4
Honduras	21.76	4.68	26.3	12.9
Lesotho	34.49	4.49	26.6	3.1
Mauritania	25.95	0.83	23.3	4.3
Namibia	27.13	3.29	16.8	4.3
Sao T e P	23.67	5.18	15.4	6.4
Senegal	25.21	1.16	12.5	3.2
Sierra Leone	30.38	3.69	10.1	3.6
Swaziland	23.89	7.15	37.1	6.1
Tajikistan	22.95	2.65	11.6	8.0
Zimbabwe	29.07	3.22	13.8	2.8

Among these DBM countries the relationship between child stunting and adult obesity remains negative (Figure 4.8). However, the strength of the relationship appears attenuated when compared to the whole sample (Figure 4.8, Figure 4.7).

Figure 4.8 Child Stunting by Adult Obesity (for male and female adults) in LMICs defined as having a DBM (Exclusive of Stuntedoverweight Children)



The positive implication of the negative relationship remains – that even among LMICs where *burdens* of both adult obesity and child stunting exist, child stunting appears to continue to decline even though it was not eradicated prior to the onset of adult obesity. Additionally, among DBM countries the gender gap in adult obesity levels remains. In comparison to countries defined as having a DBM that included stuntedoverweight children (Table 4.6, Figure 4.6) countries with a DBM (exclusive of stuntedoverweight children) see a greater propensity for the disparity in female and male obesity rates to increase as stunting prevalence declines. This suggests that, recognising and thus excluding stuntedoverweight children from the prevalence of stunting, there is evidence that male obesity rates are beginning to decline. This was previously obscured as stuntingoverweightness was included in stunting rates.

The next results discussed concern the correlation between child stunting and adult obesity for the full sample of LMICs and for DBM countries (where stunting is exclusive of stuntedoverweight children).

Among the full sample, the correlation between child stunting and female obesity levels was found to be -0.74 (95% C.I. -0.83; -0.62). For child stunting with male obesity levels the correlation coefficient was -0.79 (95% C.I. -0.89; -0.69). In removing stuntedoverweight children from stunting prevalence, the correlation between child stunting and adult obesity is actually found to be stronger than when stuntingoverweightness was included. In correctly presenting the 'real' prevalence of child stunting there appears to be greater evidence that as adult obesity rises, stunting continues to decline for all LMICs – which would suggest that there is a dual incidence of under- and overnutrition at this moment; but if trends continue the dual incidence will shift to a burden of overnutrition and low incidence of undernutrition (among children).

Among DBM countries, the correlation between child stunting with female obesity levels and with male obesity levels is not found to be significant. For the relationship between child stunting and female obesity the correlation coefficient was -0.04 (95% C.I. -0.54; 0.48) – highlighting that among DBM countries the protracted-polarised stage where child stunting decline has stagnated whilst female obesity has increased. This result was paralleled with male obesity rates, as the correlation coefficient for male obesity with child stunting was also not significant (r = -0.45, 95% C.I. -0.78; 0.08). The results marry with those found among the sample of DBM countries that were defined using stunting prevalence inclusive of stuntingoverweightness.

The next results presented are those of linear regression models – initially presented for the full sample (Table 4.10) and then for DBM countries (Table 4.11).

Table 4.10 Linear Regression Results for the Relationship of Child Stunting with Adult Obesity among all LMICs of Sample (Where Child Stunting is Exclusive of Stuntingoverweightness)

Dependent Variable Y=Child Stunting %				
	Model 1	**Model 2**	**Model 3** (controlling for U-5 overweight)	**Model 4** (controlling for U-5 overweight)
Independent Variables:				
log(Adult Obesity Female)	-11.820***		-8.416***	
log (Adult Obesity Males)		-11.739***		-9.671***
Child Overweight %			-1.489***	-0.824*
Constant	54.565***	45.715***	52.452***	45.613***
N	77			

The results of the simple linear regression for child stunting (dependent variable) with the log of female and log of male adult obesity separately again highlight a negative relationship between child stunting and adult obesity. Compared to the results for the full sample when stuntingoverweightness was included in stunting prevalence (Table 4.7), these results (exclusive of stuntingoverweightness) show a stronger relationship between child stunting and both male and female adult obesity levels. Not including stuntingoverweightness in stunting prevalence, the regression coefficient for female obesity was -11.07, magnified to -11.82 when excluding the stuntedoverweight. The same was found for the relationship between male obesity and child stunting. Including stuntedoverweight children the coefficient was -11.01 (Table 4.7). The negative association between child stunting and male obesity was magnified when excluding stuntedoverweight children to -11.74.

Controlling for the level of child overweightness (exclusive of stuntingoverweightness) in the regression analysis both regression coefficients for female and male adult obesity decrease – yet remain significant. For female obesity, controlling for child overweight, the regression coefficient increased from -11.820 to -8.416, for male obesity the coefficient decreased from -11.739 to -9.761. This is a departure from the relationship seen when controlling for child overweightness in the full sample of Table 4.7 - where stuntingoverweightness was included in stunting and in overweightness prevalence levels. In the earlier results that were inclusive of stuntingoverweightness, the effect of male obesity levels of child stunting prevalence magnified with the introduction of child overweightness – the regression coefficient changed from -11.01 to -12.68 when including child overweightness. The magnitude of the negative relationship between female obesity and child stunting was also shown to amplify with the inclusion of child overweightness – from -11.07 to -11.18.

Additionally, in the models presented in Table 4.10 (where child malnutrition rates are exclusive of stuntingoverweightness) there is another key departure from the results of Table 4.7. Namely, in the analysis presented in Table 4.10 child overweightness is found to be significantly negatively associated with child stunting levels in LMICs both when controlling for adult female and for adult male obesity rates. This indicates that in LMICs – regardless of adult obesity – child overweightness is tending to increase as child stunting declines. This finding is discussed further in part 4.2.2, which is specifically focussed on the DBCM.

The main distinction relevant to the DBM from the results of Table 4.10 is that we can see adult obesity rates are capturing some of the variability in child stunting prevalence above and beyond the variance explained by child overweightness. This indicates that adult obesity rates are important in understanding trends in child stunting in LMICs today, even among research beginning to focus on the DBCM (as discussed in part 4.2.2). Before discussing the results of this section in greater depth, the regression results for the same analysis conducted on DBM populations (defined in the absence of stuntingoverweightness) are presented (Table 4.11).

Table 4.11 Linear Regression Results for the Relationship of Child Stunting with Adult Obesity among DBM Countries (Exclusive of Stuntedoverweight Children)

	Dependent Variable Y=Child Stunting %			
Independent Variables:	**Model 1**	**Model 2**	**Model 3** (controlling for U-5 overweight)	**Model 4** (controlling for U-5 overweight)
log(Adult Obesity Female)	-0.2898		-0.617	
log (Adult Obesity Males)		-2.986		-4.425
Child Overweight %			0.129	0.736
Constant	26.781*	30.784***	27.408**	30.443***
N			21	

The regression results presented in Table 4.11 show that there are no significant relationships found between child stunting with adult obesity (either male or female) or with child overweightness when stuntedoverweight children are excluded from the prevalence estimates of both stunting and overweightness. This is a disjuncture from the results of Table 4.8 which showed a negative correlation among DBM countries between stunting and adult obesity and a positive association among DBM countries between stunting and overweightness.

The striking implication of these results is that, in acknowledging and identifying stuntedoverweight children as a distinct group of malnourished children (in contrast to both their exclusively stunted and their exclusively overweight peers), there is actually greater evidence of a protracted-polarised trajectory of child undernutrition stagnating whilst adult overnutrition increases. Accounting for stuntingoverweightness means there is no significant negative association among DBM countries between forms of growth faltering malnutrition found at the opposite ends of the under-over spectrum. This emphasises a dual burden is present among these countries according to the definition provided by the thresholds imposed in this research. This is further evidenced by the relationship between the stunting and obesity levels that exceeded these thresholds - giving more evidence of an AT. But finding this evidence actually rests on accepting a more diverse profile of growth faltering malnutrition and considering stuntedoverweight children as a separate group compared to their exclusively stunted and overweight peers.

The results of this section will now be summarised before moving on to specifically focus on the DBCM.

4.2.1.3 Summary of the effect of stuntingoverweightness on the understanding of the DBM and the NT

Part 4.1 of this chapter outlined that stuntedoverweight children had led to an overestimation of stunting burdens and overweightness burdens among under-fives. Moreover, when both child stunting and child overweightness were considered, the inclusion of stuntedoverweight children in both estimates led to 'double-counting' of these children. Section 4.2.1 aimed to evidence the impact the overestimation of stunting prevalence (as caused by the inclusion of stuntedoverweight children) had on our understanding of the age-polarised DBM – where a population is thought to face a high proportion of undernutrition among their children and a high proportion of overnutrition among the adults.

The results of this section have shown that overestimating stunting prevalence by including stuntedoverweight children does change our understanding of the DBM. Failing to separate stuntedoverweight children from stunted child actually attenuates the negative association that really exists between stunting and adult obesity across all LMICs. The results suggest that actually, while in all countries there is a dual incidence of child undernutrition and adult overnutrition, the overwhelming trend is still one of a continued decline in child undernutrition as adult overnutrition increases. Although this dual incidence means that LMICs do have additional burdens place upon them in terms of the nature of malnutrition, the results are optimistic in that they do not suggest that undernutrition has stagnated in all LMICs, which would put greater pressure upon health care systems of these LMICs.

In addition, failing to account separately for stuntingoverweightness meant 7 countries originally identified as having a DBM in fact do not (based upon the thresholds defined in Chapter 3). Again, this is a positive result for LMICs as it again suggests that, while there is a double incidence of malnutrition, currently fewer countries are experiencing this age-polarised DBM than would be thought if we weren't to consider the stuntedoverweight as a separate group.

But, according to this analysis, of the 77 LMICs in the sample – even recognising stuntingoverweightness – 15 do have a DBM and in these countries undernutrition is stagnating whilst overnutrition among adults increases. Moreover, among these countries, in excluding stuntingoverweightness from the prevalence of stunting (and of child overweightness) we see even more evidence of this stagnation and a relationship between child undernutrition and overnutrition consistent with the understanding of a DBM in the AT.

It should not go unnoticed that 'stuntingoverweightness' in itself can be considered an individual-level double burden of malnutrition. It is perhaps noteworthy that these results have shown that only in accounting for an individual-level double burden of malnutrition in children does solid and consistent evidence of an age polarised double burden of malnutrition at the population level arise.

This section has highlighted several important aspects that should be considered in research concerning the DBM in the future.

- Stuntingoverweightness changes our understanding of the DBM and stuntedoverweight children should be identified as a separate group in future research

- There is evidence of an age polarised DBM, thus age stratification of malnutrition burdens should continue to feature in research on the NTs

- It is important to consider the DBM and thus the AT from a gendered perspective – as the relationship of adult obesity and child stunting differs when considering female or male adult obesity rates

A final point to make regarding stuntingoverweightness on our understanding of the DBM regards child overweightness. Child overweightness was included in the regression models to see if the relationship between child stunting and adult obesity varied across child overweightness. The evidence showed that this was not the case, but what was revealed is that the relationship between child stunting with child overweightness changes when stuntedoverweight children are identified as a separate group. This is particularly important given analyses using both child stunting and child overweightness not excluding the stuntedoverweight will rest upon samples that have double counted cases – specifically the stuntedoverweight. Additionally, this is particularly important as it suggests that stuntingoverweightness changes the understanding of the DBCM that is becoming increasingly referred to in both the scientific literature and the policy arena. The next section presents results designed to evidence if and how stuntingoverweightness affects our understanding of the DBCM (section 4.2.2.).

4.2.2 The effect of stuntingoverweightness on our understanding of the DBCM

The other most prominent 'double burden' of malnutrition that is cited in the literature is the double burden of child malnutrition (DBCM). The results of this section aims to evidence if and how the observation of stuntingoverweightness changes our understanding of the DBCM.

The DBCM is observed when there are *burdens* of both stunting and overweightness among children. Notably, given the oversight of stuntedoverweight children endemic to research in this area, there is no mention of stuntingoverweightness in the discussions of the DBCM. Thus these 'double burdens' of the DBCM are presented in the literature in line with the current understanding of stunting and overweightness – an understanding that assumes the exclusive nature of stunting and of overweightness prevalence.

Yet, as part 4.1 of this chapter has evidenced, children who are concurrently stunted and overweight are found in all LMICS. Moreover, the way prevalence estimates of both stunting and overweightness are currently constructed includes stuntedoverweight children. The incorporation of stuntedoverweight children to both stunting and overweightness prevalence is leading to an overestimation of these prevalence rates. Additionally, and particularly important for studies on the DBCM, when focusing on rates of stunting and of overweightness, researchers are relying on prevalence rates that double-count stuntedoverweight children – once as stunted and once as overweight.

This double-counting could skew the nature of any considered relationship between stunting and overweight among children and thus our understanding of the DBCM. The results presented in this section analyse the effect accounting for stuntingoverweightness has on the concept of the DBCM. Firstly, the relationship between stunting and overweight without considering stuntingoverweightness among children is presented (section 4.2.2.1). Following this, the relationship between children stunting and overweightness accounting for stuntingoverweight children is presented (section 4.2.2.2). The results are compared as a means to evidence the impact stuntingoverweightness has on our understanding of the DBCM.

4.2.1.1 Relationship between Child Stunting and Child Overweightness (Inclusive of Stuntingoverweightness)

In this section, as described in the methodology, the relationship between stunting and overweightness among children (not accounting for stuntingoverweightness) is explored graphically, through the use of the Pearson correlation coefficient and then through the use of linear regression models. These analyses are conducted on the full sample of LMICs and then on LMICs that have this considered 'DBCM'.

Figures 4.7 and 4.8 displayed the relationship between stunting and overweight among children in the whole sample and among countries with a DBM. Here, the relationship between stunting and overweight is presented firstly for the whole sample (Figure 4.10) and then only for countries with a DBCM (Figure 4.11). To reiterate, a DBCM is defined when a population has a stunting prevalence among under-fives >20% and an overweight prevalence among under-fives >10% (here inclusive of stuntingoverweightness).

Figure 4.10 % Stunted and % Overweight Under-fives in all LMICs of sample (Inclusive of Stuntedoverweight Children)

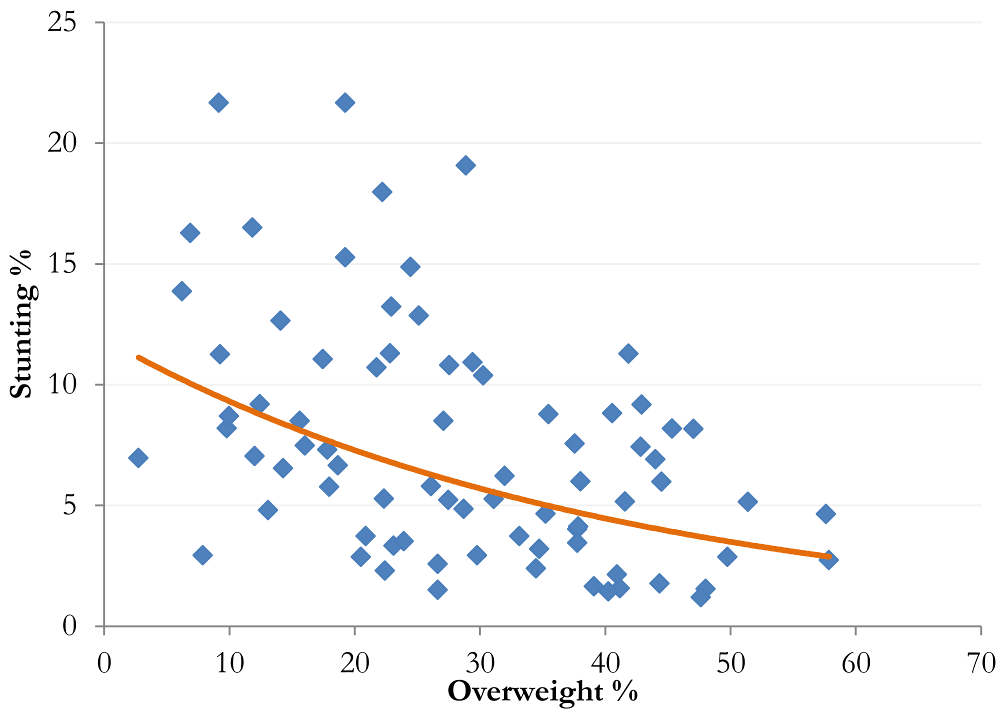


Figure 4.10 shows a curvilinear negative relationship between % stunted and % overweight children in the full sample of LMICs. The graph shows a clear dual *incidence*

of overweightness and stunting among all LMICs. The negative relationship suggests that as undernutrition in children declines, overnutrition increases. As the relationship is curvilinear, however, higher levels of overweightness are associated with smaller absolute declines in stunting prevalence. As noted in Chapter 2, the defining feature of the AT, and specifically the DBCM, is that there are dual burdens of stunting and overweightness.

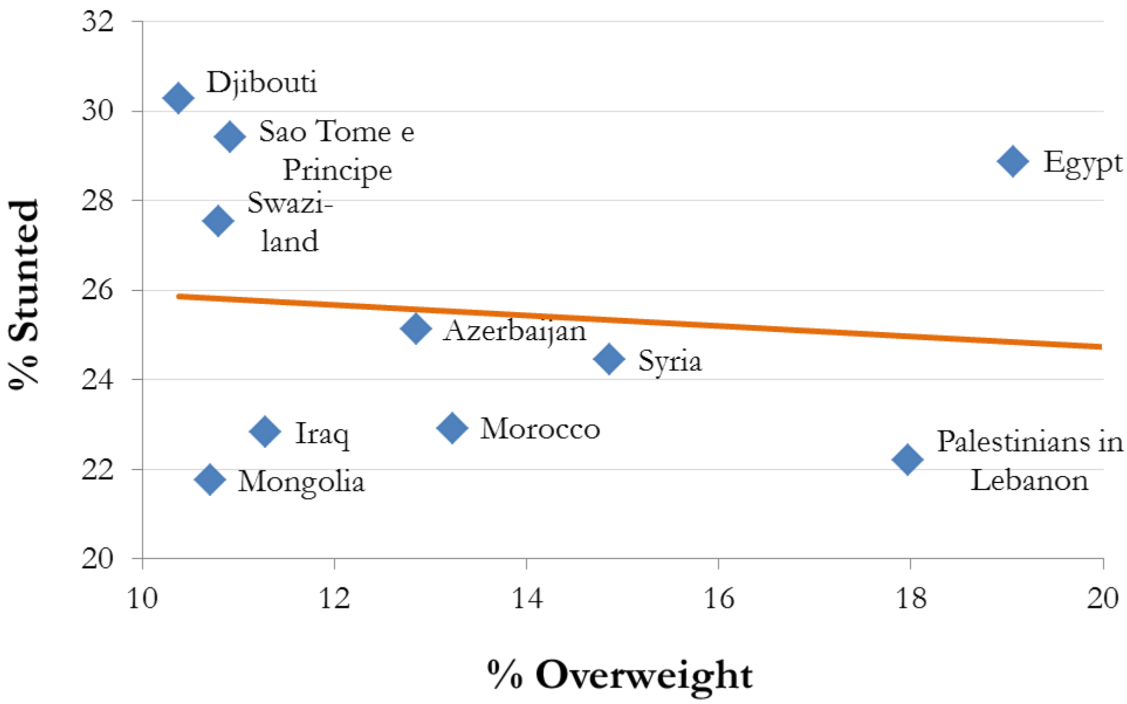
From the full sample, not correcting for stuntedoverweight children, 10 countries are found to have a DBCM (Table 4.12).

Table 4.12 Stunting and Overweight Prevalence in LMICs with a DBCM (inclusive of stuntedoverweight children)

Country	% U-5 Stunted	% U-5 Overweight
Azerbaijan	25.13	12.85
Djibouti	30.27	10.38
Iraq	22.83	11.29
Mongolia	21.75	10.71
Morocco	22.92	13.23
Palestinians in Lebanon	22.2	17.97
Sao Tome e Principe	29.41	10.92
Swaziland	27.54	10.8
Syria	24.45	14.87

Among these countries with a DBCM a negative relationship between stunting and overweight is apparent but minimal. This coincides with the existence of a protracted-polarised stage of a NT occurring in these countries – where child stunting is still in decline but this decline has stagnated whilst child overweightness is increasing – which gives weight to the AT.

Figure 4.11 % Stunted and % Overweight Under-fives in DBCM Countries (Inclusive of Stuntedoverweight Children)



When addressing stunting and overweightness only in DBCM countries, the there is no significant correlation found between child stunting and overweightness in LMICs with a DBCM (*r* = -0.22, 95% C.I. -0.73, 0.44). Given the nature of the curvilinear relationship presented in figure 4.10%, this is expected. This suggests a possible AT with a protracted stage 3 of the NT occurring as stage 4 begins, leading to an apparent polarisation in malnutrition among children.

Table 4.13 Linear Regression Results for the Relationship of Child Stunting with Child Overweightness among all LMICs of Sample (Where Child Stunting is Inclusive of Stuntingoverweightness)

	Dependent Variable Y=Child Stunting %			
Independent Variables:	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Child Overweight %	-2.99***	-5.9***	-1.37	-1.59
(Child Overweight %)^2		0.23**	-0.01	0.05
log(Adult Obesity Female)			-8.51***	
log (Adult Obesity Males)				-9.17***
Constant	38.10***	43.88***	52.41***	46.54***
F-test	-	11.21***	-	-
N	77			

As the relationship between stunting and overweightness in the full sample was found to be curvilinear, a quadratic term for child overweightness was introduced into the model. Whether this variable improved the model was tested using an F-test with a nested model containing just overweightness (1) and then overweightness^2 (Models 1 and 2, Table 4.13). The results of the F-test showed that a quadratic term for child overweightness improves the model (F 11.21, p=0.013). For the full sample, the negative relationship between child stunting and child overweightness is consistent in the simple linear regression model (Table 4.13, Model 1) – but at higher levels of overweightness the decline in stunting is lower (as indicated by the coefficient of the quadratic term Table 4.13, Model 2).

These relationships are no longer significant when controlling for either adult female obesity rates, or adult male obesity rates. This indicates multicollinearity and suggests that child and adult obesity (male or female)explain much of the same variability in stunting prevalence among children across LMICs (when stuntingoverweightness is including in stunting prevalence).

These results are interesting, as they show that when assessing the relationship between stunting among children (that includes stuntedoverweight children) the relationship can be wholly explained by adult obesity rates – despite a possible interpretation of the NT where obesity among adults increases before child overweightness. To expand - the theories of the epidemiological transition (ET) and the NT highlight a disparity in onset of the transitions - where Omran argued that adults were first to undergo the ET (1971). Given the interrelationship between the ET and the NT, the onset of overnutrition would also be expected to occur first among adults and then children. As noted in the discussion of the DBM, there is evidence that could support the argument that of the variance in child stunting. This is at odds with what has been observed with respect to a disjuncture in onset across age groups in in populations undergoing NTs. However, at this stage the results where stuntingoverweightness are excluded need to be considered prior to confirming/denying this. Particularly, as is the concern of this thesis, there is a high likelihood that the understanding of the DBCM alters when considering stuntingoverweightness, as occurred with the DBM.

Among the 10 countries identified as having a DBCM (inclusive of stuntingoverweightness) there is no significant relationship found between child stunting and child overweightness (overweightness and overweightness^2). This is indicative of a protraction of levels of undernutrition caused by a stagnating decline as overweightness increases.

Table 4.14 Linear Regression Results for the Relationship of Child Stunting with Child Overweightness among DBCM Countries of Sample (Where Child Stunting is Inclusive of Stuntingoverweightness)

	Dependent Variable Y=Child Stunting %		
Independent Variables:	**Model 1**	**Model 2**	**Model 3**
Child Overweight %	-0.423	0.988	1.153
log(Adult Obesity Female)		-0.376	
log (Adult Obesity Males)			-0.698*
Constant	32.539**	25.321*	22.065*
N		21	

However, it must be reiterated that these results cannot be relied upon as they have been achieved by relying on conventional understandings of the chid malnutrition in LMICs and, notably, by failing to consider stuntingoverweightness. As shown in part 4.1 of this chapter, this has led to overestimation of both stunting and overweightness in all countries in the sample. This is likely to affect the relationships found between these two forms of malnutrition (stunting and overweightness) Thus, the next results emanate from an analysis exploring the relationship between child stunting and overweightness that is exclusive of stuntedoverweight children – so the prevalence rates of stunting and overweightness do not include stuntedoverweight children.

4.2.2.2 Relationship between Child Stunting and Child Overweightness (Excluding Stuntedoverweight Children)

When excluding stuntedoverweight children from the prevalence of child stunting and overweightness, there remains a negative relationship between child stunting and overweightness (Figure 4.12). However, this relationship appears more exponential than when including stuntedoverweight children (as seen in Figure 4.10).

Figure 4.12 Graph Showing Stunted and Overweight Prevalence for all LMICs with Stuntingoverweightness (as indicated by area of data points)

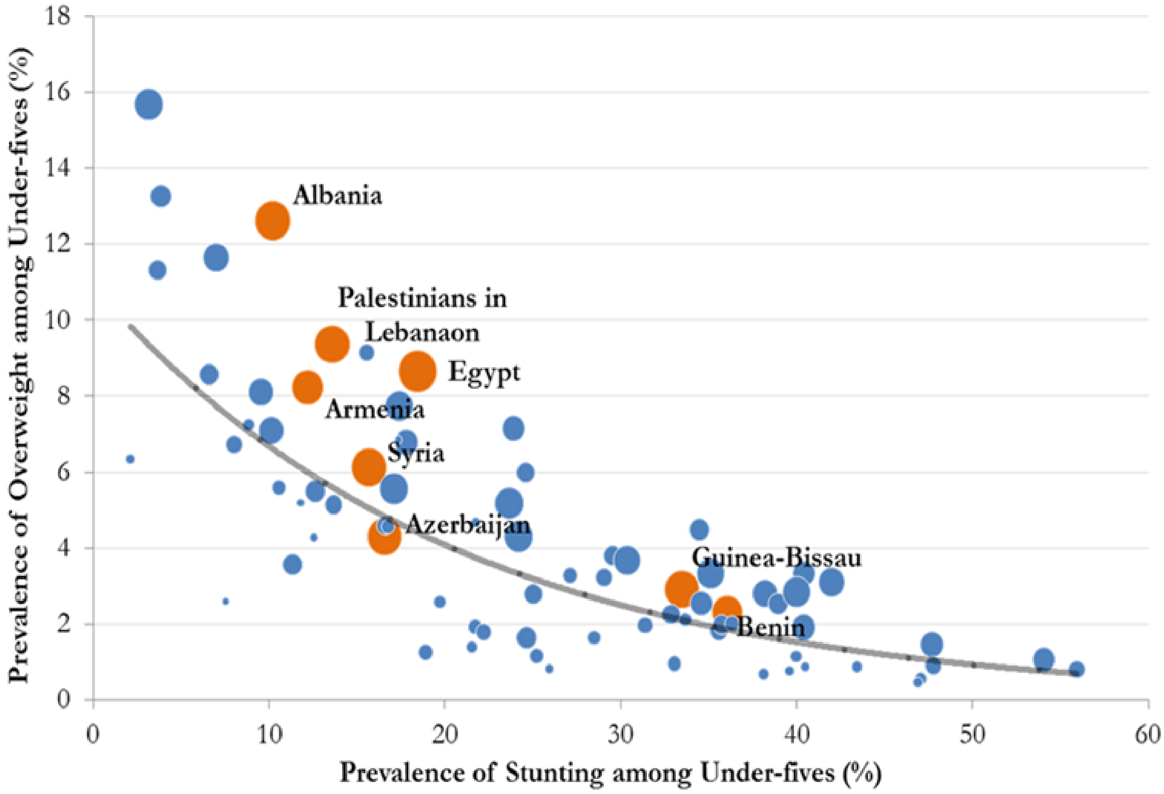


Figure 4.12 suggests that child overweightness grows at an increasing rate as child stunting declines among the full sample of LMICs (when stuntedoverweight children are not included in the prevalence rates).

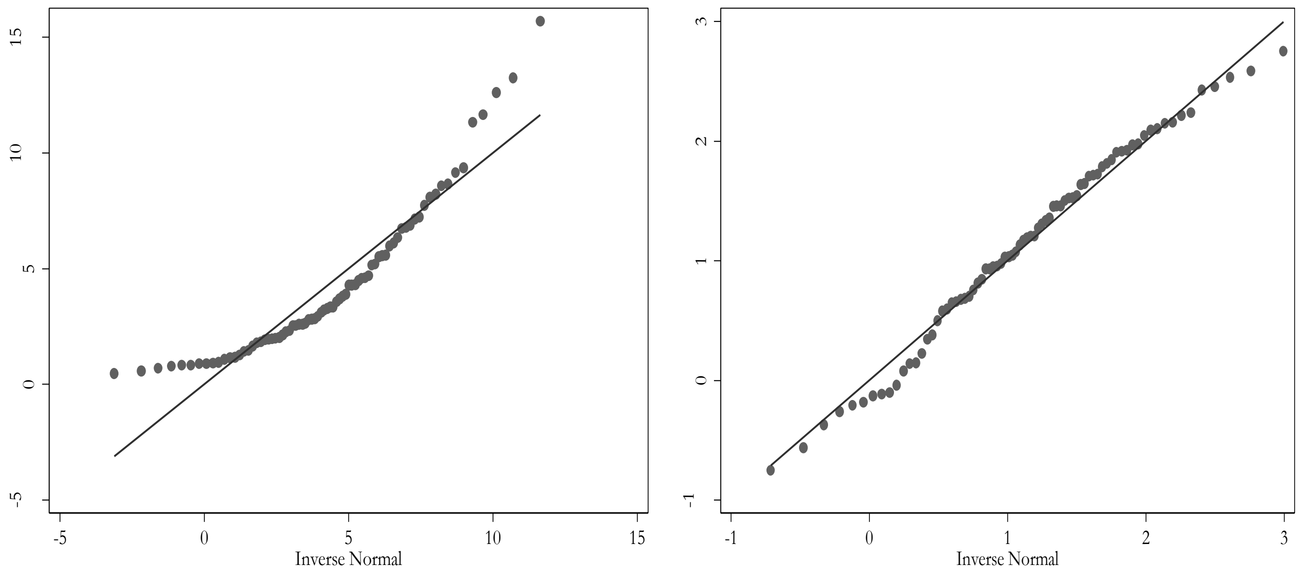
At this stage, the intention was to explore the relationship between child stunting and overweightness among DBCM countries. However, when excluding stuntedoverweight children from the prevalence of stunting and overweightness no LMIC in the sample is found to have DBCM according to the predefined criteria used in this research. This is a key finding as it shows that, specific to child malnutrition, there is currently no *double burden* as currently presented and understood in the literature.

Although there are no countries with a DBCM, Figure 4.12 shows further information concerning the relationship between child stunting and overweightness as it also contains information on the levels of stuntingoverweightness (represented by the area of the data points). The orange data points represent countries in the top 10% prevalence of stuntingoverweightness in the sample of LMICs. These countries with the highest prevalence appear to cluster at higher levels of overweightness and relatively low levels of stunting compared to the whole sample of LMICs. This suggests that, specific to children, the concern is not a double burden of malnutrition but a **diverse** burden. Before discussing this further, the regression results for the relationship between stunting and overweightness for the whole sample are presented.

The correlation between child stunting and overweightness is found to be a significant negative correlation (*r* = -0.74, 95% C.I. -0.83; -0.61). However, as noted, removing stuntedoverweight children from the prevalence of stunting and overweightness reveals a more exponential relationship between these latter forms of growth faltering malnutrition. Overweight prevalence was thus transformed (using a log transformation). The quantile distribution plots (against the quantiles of the normal distribution) pre and post transformation of the variable for child overweightness are shown in Figure 4.13 – highlighting the need for this log transformation.

Figure 4.13 Q-Q Plots for Overweightness Pre and Post Log transformation

With the transformed variable for child overweightness, the results of a simple linear



regression model for the relationship between child stunting and overweightness are presented in Table 4.15. The results show a significant negative association between child overweightness and child stunting – a one unit increase in the log of child overweightness is associated with a 12.99% reduction in stunting prevalence.

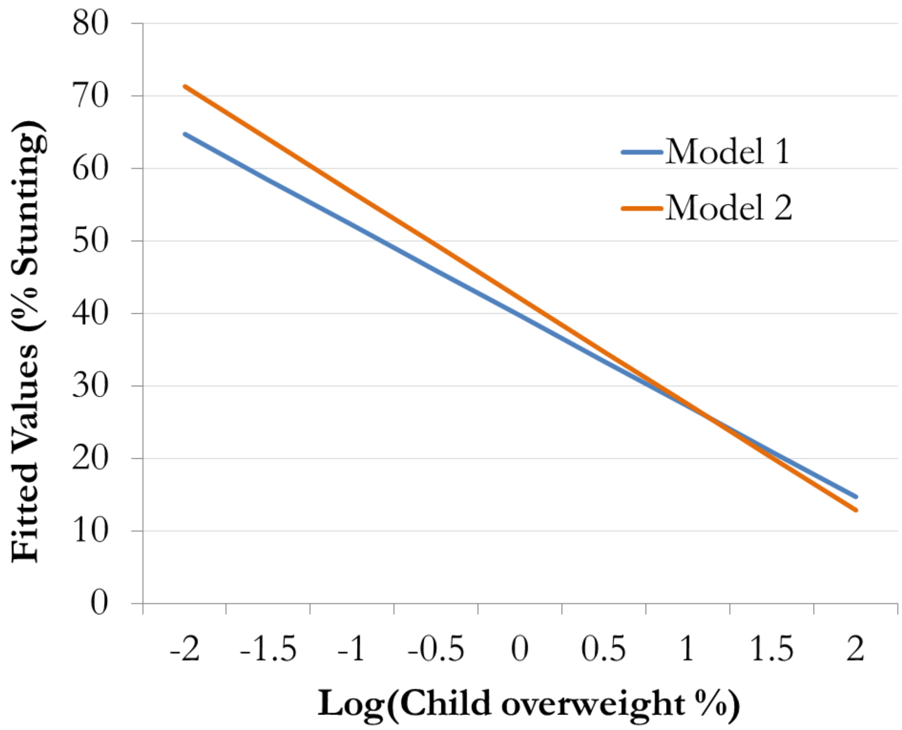
Table 4.15 Linear Regression Results for the Relationship of Child Stunting with Child Overweightness among all LMICs of Sample (Where Child Stunting is Exclusive of Stuntingoverweightness)

	Dependent Variable (Y) = % Stunted U-5s	
Independent Variables	**Model 1**	**Model 2**
Log(Child overweight %)	-12.523***	-14.637***
Stuntingoverweightness %	-	1.520**
Constant	39.665***	37.272***
N	77	

Controlling for the percentage of children who are stuntedoverweight, the association between child overweightness and child stunting – where β for log(child overweightness) remains negative and of a similar magnitude at -14.64 (Table 4.15, Model 2). A significant and positive association between child stunting and stuntingoverweightness is found (β 1.520).

The fitted values for Model 1 and Model 2 (Table 4.15) are shown in Figure 4.14. These emphasise that, when controlling for stuntingoverweightness, there is only a very small change in the magnitude of the relationship between overweightness and stunting.

Figure 4.14 Fitted Values for Child Stunting and Overweightness with (Model 2) and without (Model 1) Controlling for Stuntingoverweightness



As before (when stuntingoverweightness was still included in prevalence estimates), the relationship between child overweightness and adult obesity was assessed when controlling for adult obesity rates (both male and female). The results are presented in Table 4.16.

In these models, it can be seen that the introduction of adult female obesity (Table 4.16, Model 2) and the introduction of adult male obesity (Table 4.16, Model 3) both reduce the magnitude of the effect of overweightness. This is a disjuncture from previous results inclusive of stuntingoverweightness. Previously it was found that introduction of female obesity increased the magnitude of the effect of child overweightness (Table 4.13, Model 2).

Table 4.16 Linear Regression Results Child Stunting with Child Overweightness (Controlling for Adult Obesity Rates) Exclusive of Stuntedoverweight Children

	Dependent Variable Y=Child Stunting %		
Independent Variables:	**Model 1**	**Model 2**	**Model 3**
Log(Child Overweight %)	-12.523***	-6.042*	-4.007*
Log(Adult Obesity Female)		-7.703***	
Log (Adult Obesity Males)			-9.066***
Constant	39.665***	51.260***	45.626***
N		77	

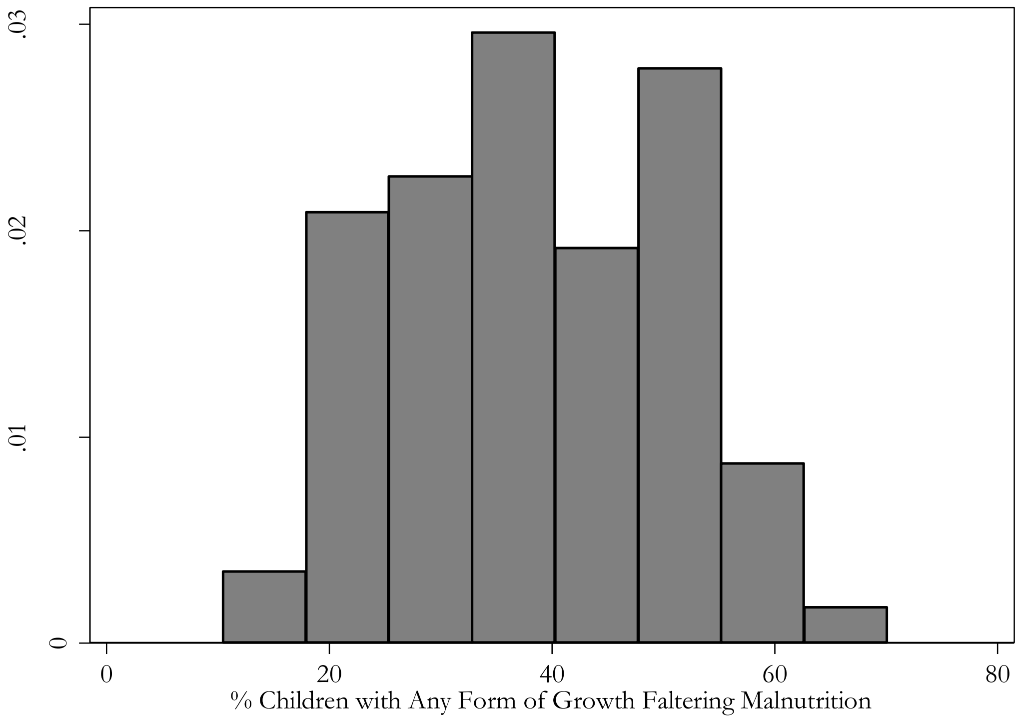
In removing the double counted stuntedoverweight children from the analysis the effect of adult obesity becomes much more consistent – both male and female adult obesity levels attenuate the effect of child overweightness. This suggests that both forms of adult obesity are explaining some of the variation in stuntingoverweightness prevalence among LMICs that the variable for child overweightness explained. Additionally, the magnitude of the effect remains stronger for adult obesity rates than for child overweightness. The relationship remains negative, which highlights that greater rates of child overweightness, and of either male of female adult obesity rates, are associated with lower rates of child stunting. Thus also a dual incidence of undernutrition and overnutrition is occurring, yet declines in child stunting are expected to continue despite rises in child overweightness in all LMICs. This highlights that in accounting for stuntedoverweight children – another, unique form of growth faltering malnutrition – there is no DBCM in LMICs (according to currently accepted definitions). Moreover, in LMICs again we see that adult obesity levels have risen and are associated with increasing declines in child undernutrition. The consistency in the results for male and female obesity rates bolsters the evidence that NTs begin first among adults – in line with Omran's theories (1971). As a final point, from the results presented in Table 4.16, it is again apparent that male obesity is associated with a larger reduction in stunting prevalence (compared to female adult obesity). This has been a consistent theme throughout parts 4.2.1 and 4.2.2 and highlights the need for a gendered perspective when considering adult nutrition in the context of NTs. An explanation for this lies in the disparity in onset of NTs for both male and adult females. Additionally, the closer intergenerationality between female and child nutritional status (particularly due to intrauterine development) is a likely route for research to explain this disparity further.

4.2.2.3 Summary

To summarise the key findings of this section, it has been shown that accounting for stuntedoverweight children has severe implications for the DBCM – as it shows that (in terms of current definitions) no DBCM is currently present in any LMICs.

Furthermore, in recognising stuntedoverweight children, this new form of growth faltering malnutrition has been bought to the forefront. It has been shown that in LMICs the under-five population is experiencing a triple incidence of stuntingoverweightness, stunting and overweightness. Appendix II also presents prevalence rates for wasting in the LMICs of the sample and every single country had some proportion of their children who were experiencing this form of acute malnutrition. Thus a quadruple incidence of growth faltering malnutrition is seen in all LMICs today. It is not possible to say specifically that there is a DBCM, as levels of stunting and overweightness (not including stuntingoverweightness) do not meet the thresholds defined in this research for a DBCM. But equally even if some countries had met this criteria it would not be desirable to state they have a DBCM – when there would also be incidences of stuntingoverweightness and wasting in these same 'DBCM' countries. It is for this reason that this research argues that we need to begin to understand malnutrition burdens – particularly among children – as diverse burdens. Whilst stunting or overweightness (as shown in the analysis of 4.2.2) might not constitute a burden in themselves or even together, if we were to look at the prevalence of all forms of growth faltering malnutrition in LMICs today it is clear that in the majority of LMICs there is 20-60% prevalence (Figure 4.15). Such prevalence rates are unacceptably high given the implications for a child's health and development of all forms of growth faltering. Moreover, within these rates of total growth faltering malnutrition, there is a hugely diverse profile with differing levels of stunting, overweightness, stuntingoverweightness and wasting across LMICs.

Figure 4.15 Histogram of % Children with Any Form of Growth Faltering Malnutrition in LMICs



It is for this reason that I propose we need to recognise that there is a diverse burden of malnutrition occurring in LMICs today. This section highlights this diverse burden in childhood, whilst section 4.2.1 highlighted the diversification in considered malnutrition burdens that occurs when stuntingoverweightness is considered. Section 4.2.3 summarises the results of part 4.2 – drawing upon the need to approach malnutrition from a perspective of divergence; a need that has been made apparent by the effect considering stuntingoverweightness has on our understanding of the DBM and DBCM.

4.2.3 Summary

Part 4.2 has shown that research needs to begin accounting for stuntedoverweight children in research on malnutrition as a matter of course. This is because it changes our understanding of the burdens of malnutrition and the nutritional profiles of LMICs today.

A central area of research in malnutrition today is the discussions of the AT, and thus the DBM and (more recently) the DBCM that are theorised to result from it.

Part 4.2 has shown that recognising stuntingoverweightness changes our understanding of the DBM and the DBCM. In doing so there is a need to readdress the AT.

With respect to the DBM – the recognition of stuntingoverweightness actually gives more weight to the existence of a 'DBM' purely in terms of the relationship between child stunting and adult obesity.

Crucially, however, this really means that only in widening our understanding of malnutrition do we see such relationships and thus we actually need to view malnutrition at the population level from a perspective of divergence. A perspective of divergence recognises the true face of malnutrition among individuals and thus populations – where MNIs can exist in individuals who are present in populations alongside individuals experiencing exclusive nutritional insults. Moreover, specific to the analysis of the DBM it was shown that understanding malnutrition across age groups and genders renders visible nuances in the nutritional profiles of LMICs today – further highlight a need for an understanding of malnutrition that is more divergent and an approach to its study that recognises this.

Finally, with respect to the DBCM the analysis has shown that if we account for stuntingoverweightness there is no evidence of a double burden of child malnutrition in LMICs today – at the very least there is a triple burden of growth faltering malnutrition among children. This re-emphasises the need to move from discussions of malnutrition in terms of binary oppositions – of mutually exclusive yet co-occurring burdens of stunting and overweightness – to terms of divergence recognising the complexity of malnutrition today.

The recognition of stuntingoverweightness has been pivotal in this research for realising the true divergent nature of malnutrition. As a result, part 4.3 analyses the nutritional profiles of LMICs from the perspective of stuntingoverweightness – highlighting what other forms of malnutrition are present when higher burdens of stuntingoverweightness occur.

4.3 Stuntingoverweightness and the Diverse Nutritional Profiles of Populations

Part 4.1 of this chapter showed that stuntedoverweight children are found in all LMICs. Part 4.1 also showed that – particularly relevant for research addressing all forms of growth faltering malnutrition in a population – stuntedoverweight children are currently double counted. This double-counting means that stuntedoverweight children are counted once as stunted and once as overweight. This overestimates the prevalence of both stunting and overweightness among children. Part 4.2 evidences that a failure to recognise stuntingoverweightness skews our understanding of the nutritional profiles of LMICs and hides the true diverse nature of malnutrition that is currently present. Stuntingoverweightness is a form of growth faltering malnutrition that is endemically masked in research on malnutrition today.

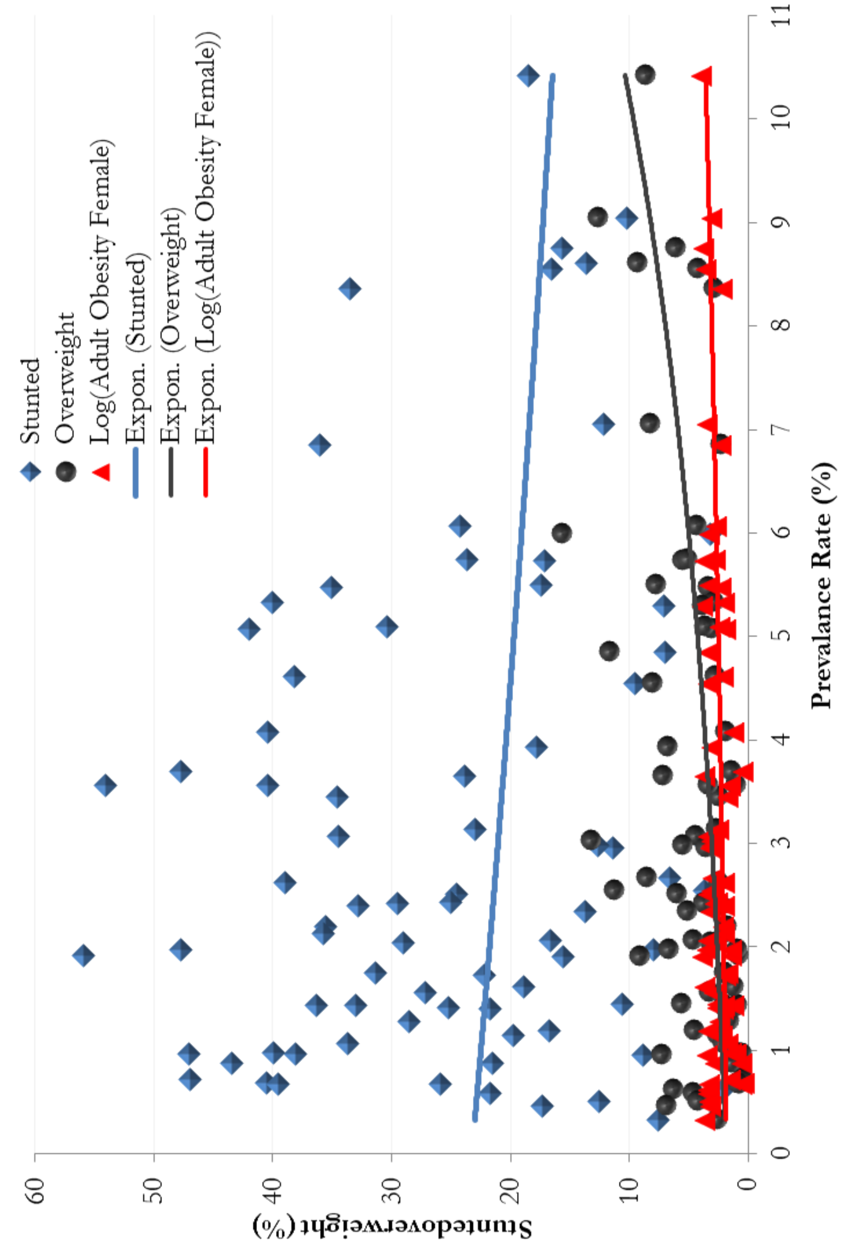
This section aims not only to re-emphasise the existence of stuntingoverweightness in all LMICs but also to show what the overall nutritional profiles of populations in which stuntedoverweight children are concentrated are. This serves to highlight the need for a diverse perspective of malnutrition and thus a need for a convergence-divergence framework of the NTT. Moreover, this section moves the research closer to understanding the context in which this currently hidden form of malnutrition (stuntingoverweightness) develops, thus enabling the emergence of specific strategies to address stuntingoverweightness.

Thus this section specifically aims to elucidate the relationships between stuntingoverweightness prevalence and levels of child stunting, child overweight and adult obesity. These relationships are explored graphically, and through the use of correlation and linear regression.

Figure 4.16 depicts the relationship between stuntingoverweightness and stunting, overweightness and adult obesity (female[49]). Interestingly, among all LMICs there is a positive relationship between stuntingoverweightness and child overweightness, as well as male and female adult obesity levels. These increases occur in contexts where child overweightness and adult obesity – indicative of entry in to the degenerative stage of the NT – are higher. This suggests that stuntingoverweightness is more prevalent in LMICs further along in their respective NTs. Emphasising this point is the relationship stuntingoverweightness and stunting among children – shown in Figure 4.16.

[49] Due to similarity in adult female and adult male obesity rates, adult male obesity rates are not presented on graph for ease of interpretation – a graph including adult males is available in Appendix III

Figure 4.16 Child Stuntingoverweightness with Child Stunting, Child Overweightness[50], Female Adult Obesity



50 Both stunting and overweight prevalence for children are exclusive of stuntedoverweight children.

In addition, as shown when looking at the DBM and the DBCM, stunting and overweightness (of adults and children) now occur concurrently in all LMICs in the sample, in addition to stuntingoverweightness. This adds further evidence that LMICs today are not experiencing the trajectory in nutritional changes as described in the original NTT – where stunting is thought to be eradicated prior to the onset of overweightness. This is true both within the under-five age group and across age groups – where child stunting and adult overweightness and obesity coexist in the same population. Furthermore, there are issues for AT in explaining the changes occurring in the nutritional profiles of LMICs today as currently understood.

Thus from the graph, the main conclusion to be drawn at this stage is that there is a diverse burden of malnutrition occurring in LMICs today. This diversity occurs both among under-fives and within populations as a whole – when looking across age groups. There is a co-occurrence of all forms of growth faltering among children – including stunting, overweightness, stuntingoverweightness and wasting (see Appendix II) as well as increasing burdens of both male and female obesity. But before affirming these conclusions, the relationships between child stuntingoverweightness with child stunting, child overweightness and adult obesity are explored through the use of correlation and regression analyses.

There are significant positive correlations between child stuntingoverweightness and child overweightness (0.442), adult female obesity (0.305) and adult male obesity (0.344). There is no significant correlation between stuntingoverweightness and stunting among children.

These relationships are consistent in the simple linear regression (Table 4.17). There remains a negative relationship between child stunting and stuntingoverweightness – as child stunting increases by 1% stuntingoverweightness decreases by -0.029% – indicating that stuntingoverweightness is associated with progression through or away from the stage of receding famine. Between all indicators of overnutrition and thus the stage of degenerative disease in the population – there is a statistically significant (at the

5% level) positive relationship with stuntingoverweightness. The strongest relationship exists between child stuntingoverweightness and child overweightness in LMICs. A 1% increase in child overweightness is associated with a 0.322% increase in child stuntingoverweightness. A 1 unit increase in the log of adult female obesity is associated with a 0.755% increase in stuntingoverweightness, whilst a 1% unit increase in log(adult male obesity) is associated with a 0.724% increase in stuntingoverweightness among children.

These results confirm that stuntingoverweight is more prevalent among populations with high rates of overnutrition and suggests it is more common among countries further along in their NT.

Table 4.17 Linear Regression Results for the Relationship between Child Stuntingoverweightness and Child Overweightness and Adult Obesity

	Dependent Variable Y=Child Stuntingoverweightness%			
Independent Variables:	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Child Stunting	-0.029			
Child Overweight		0.322**		
Adult Obesity (females)			0.755**	
Adult Obesity (Males)				0.724**
Constant	3.896***	1.787***	1.233	1.843**
N	77			

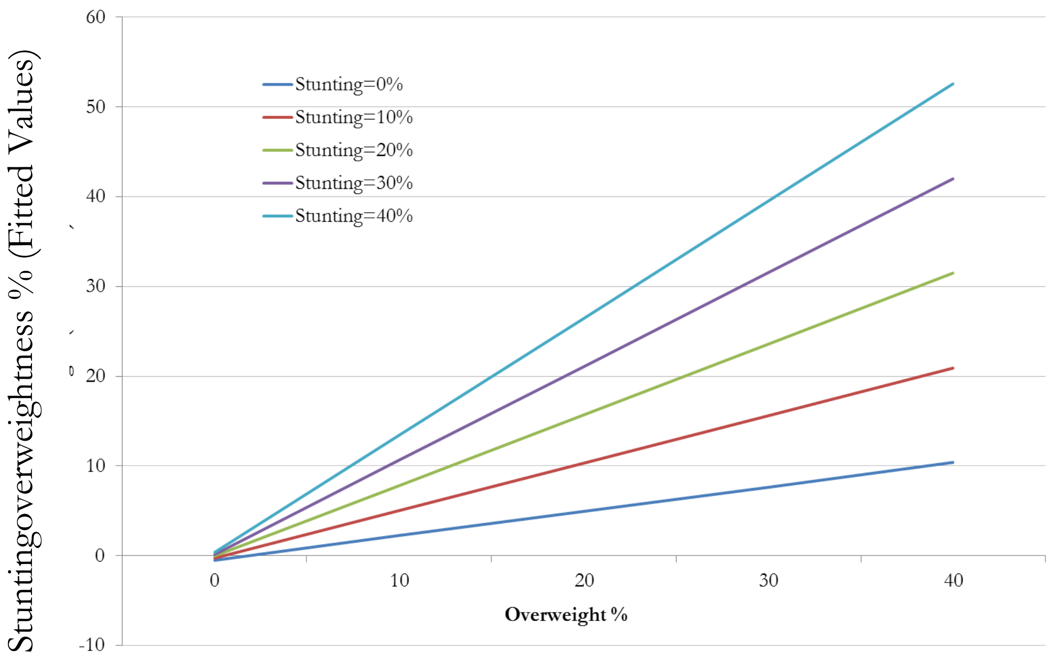
However, when controlling for child overweightness, the relationship between stuntingoverweightness and stunting becomes a positive relationship, significant at the 5% level (Table 4.19). This suggests that there is an interaction between the level of overweightness and stunting among children in a population that is affecting the relationship between stuntingoverweightness and stunting. As a result of this finding, an interaction term between stunting prevalence and overweight prevalence among children was introduced into the model – which was found to be significant at the 5% level (Table 4.18).

Table 4.18 Regression Results for Child Stuntingoverweightness with Child Stunting, Child Overweightness and the Interaction between Child Stunting and Child Overweightness

Y=Child Stuntingoverweightness U-5	**β**
Child Stunting	0.021
Child Overweight	0.271*
Interaction Term: Child Stunting*Child Overweight	0.026***
Constant	0.029***
N	77

This is interesting as it suggests that the greater the level of stunting, the greater the relationship between overweightness and stuntingoverweightness in children (Figure 4.19). This provides further evidence that the observation of stuntingoverweightness is indicative of a diverse burden of child malnutrition in LMICs – where higher levels of stunting and higher levels of overweight are associated with higher levels of stuntingoverweightness.

Figure 4.19 Fitted Values for Stuntingoverweightness by Child Overweightness and Stunting Prevalence



However, there is more evidence of the diversity of malnutrition facing LMICS – discovered when including adult obesity rates into the model as well. The models highlighted in Table 4.19 (Models 6 and 7) show the diverse nature of growth faltering malnutrition occurring in LMICs. Stuntingoverweightness prevalence is significantly positively associated with increased levels of child stunting, child overweightness **and** adult obesity (either male or female). The greater the prevalence of all of these forms of growth faltering malnutrition, so the prevalence of stuntingoverweightness increases.

Table 4.19 Linear Regression Results for Stuntingoverweightness with Child Overweightness, Child Stunting and Adult Obesity

	Y=Child Stuntingoverweight U-5							
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**
Independent Variables:								
Child Stunting	0.066*	0.053	0.083*	-	-	0.124***	0.117**	0.136***
Child Overweight	0.52***	-	-	0.275**	0.311**	0.459***	0.407*	0.427***
Log(Adult Obesity (F))	-	1.377**	-	0.126	-	1.166**	-	0.928
Log(Adult Obesity (M))	-	-	1.700**	-	-0.056	-	1.074*	0.490
Constant	-0.729	-1.636	-1.957	-1.624*	-1.882***	-4.855*	-3.448*	-5.288*
N	77							

4.3.1 Summary

These results have highlighted that among countries with greater levels of stuntedoverweight children, there is not only a more diverse face of malnutrition (in terms of type of growth faltering malnutrition) but there are greater levels of all forms of growth faltering malnutrition that this research has focussed on – stunting, overweightness and adult obesity. This indicates that in LMICs with higher levels of stuntingoverweightness there is a diverse burden of growth faltering malnutrition.

Stuntingoverweightness is a form of growth faltering malnutrition that is routinely overlooked in research. These results have shown that when stuntingoverweightness is brought to the forefront of research aiming to understand the changing nutritional profiles of LMICs today, key implications emanate. Notably stuntingoverweightness is a form of growth faltering malnutrition that occurs alongside stunting, overweightness, wasting and adult obesity in countries today. In itself it is a double burden of malnutrition for the individual it afflicts, but for a population stuntingoverweightness is yet another form of growth faltering malnutrition that needs to be addressed. Stuntingoverweightness is more likely to occur in populations with a divergent burden of malnutrition – where child stunting, child overweightness and adult obesity levels occur. For these countries, resources need to meet the diverse face of malnutrition experienced by its population – but to do this, stuntingoverweightness must be routinely recognised and accounted for in malnutrition research.

4.4 Summary

This chapter has outlined the levels and trends in stuntingoverweightness and the implications stuntingoverweightness has for our understanding of the NTs occurring in LMICs today.

Part 4.1 showed that stuntedoverweight children exist in all LMICs. This means that millions of under-fives are currently facing a paradoxical concurrence of nutritional insults systematically overlooked in research and thus health interventions. This is the most pressing concern of this thesis on stuntingoverweightness and its implications – there are currently millions of children whose nutritional status is not recognised. Moreover, because of this endemic oversight, the implications in terms of health and development for a stuntedoverweight child are unknown – leading to great uncertainty for these children's future. Whatever the future holds for these children, currently nothing is specifically being done to address their nutritional status today; compounding a vicious cycle of ignorance. Of great concern is that all indications are that stuntingoverweightness is increasing in prevalence in the majority of LMICs. If stuntingoverweightness remains so hidden in research on child nutrition today, it is likely that more and more children suffering this form of malnutrition will be marginalised and left to face an uncertain future.

One way to reincorporate these children into nutrition research today is to aim to see malnutrition not in terms of binary oppositions but in terms of divergence. Chapter 2 has highlighted that malnutrition can occur in multiple forms, concurrently and in complex combinations. An individual could be both overweight and underweight (suffering dual forms of growth faltering) and additionally could experience micronutrient toxicity and deficiency – a quadruple burden.

The issue of diversity is problematic for health research, which often relies upon models – simplified reflections of populations and their health that enable an easy access guide to their needs and trends in those needs. In its original conceptualisation, the NTT provided a 'cheat-sheet' – a guide to what malnutrition a population will suffer and when, according to their level of development. Yet all too quickly it was realised that LMICs today aren't facing a discrete, consecutive and all-together 'tidy' NT. In our haste to rectify a theory that was not able to support the observation of under- and overnutrition in one population, the AT was proposed. The use of binary oppositions – covering both under and overnutrition in populations – gave the NTT a new lease of life in the form of the AT – applicable to LMICs today and highlighting that resource poor settings are likely to face an increasing strain as they respond to the double threat of under- and overnutrition. The close relationship between the ET and NT bolstered the AT, with the double burden of disease serving to justify the proposition of a double burden of malnutrition in and of itself. It is known that there is a synergy between undernutrition and infectious diseases – burden 1 for the ET and NT ticked. It is also known that overnutrition leads to increasing rates of NR-NCDs – burden 2 for both the ET and NT ticked. But the terms have been too narrowly defined; these 'burdens' too are constricting to capture the true diversity of malnutrition today. Through these narrow definitions a disservice to all those who are facing multiple and paradoxical nutritional insults is apparent for they are neither wholly one nor wholly another – they are both. They do not meet these currently restrictive definitions and as a result are overlooked.

Ironically, in going unseen by researchers, stuntedoverweight children have actually been observed more than once – once as stunted and once as overweight. They have been 'double counted'. But as was the concern of this chapter, if we shed light on these individuals (those who have a claim to both burdens) what does this mean for the model?

Part 4.1 showed that by separating those who have a stake in each 'burden', the prevalence of child stunting and child overweightness is reduced. Levels of stunting and overweightness have been overestimated for as long as stuntedoverweight children have existed.

Part 4.2 showed that, in overestimating the prevalence of child stunting, the concept of the DBM is void. The DBM can only be evidenced when stuntedoverweight children are illuminated – but in illuminating stuntedoverweight children you are moving beyond a theory of malnutrition that concerns only states of binary oppositions at the population level (which ultimately is what the DBM is). Furthermore part 4.2 explained that accounting for stuntingoverweightness shows a divergent and not a double burden of malnutrition among children in LMICs. It also showed that not a single LMIC has this elusive 'DBCM' as it is conventionally understood.

Part 4.3 cemented these issues, showing that stuntingoverweightness can be used as a true indicator of the diverse malnutrition profiles facing LMICs today. The results show that stuntingoverweightness occurs in greater numbers in populations truly facing a divergent burden of malnutrition – with higher rates of child stunting, child overweightness and adult obesity.

Each part of this chapter combines to show that ultimately changes to our understanding of the nutrition of populations today must occur – and our current understanding is very much based on the NTT and AT. So what do these results mean for these theories?

It was shown in Chapter 2 that there are two key components to both the NTT and the AT – the nutritional profiles of populations and the factors that determine them. This chapter can only speak to the first pillar of these theories – the nutritional profiles of populations. Stuntingoverweightness and its recognition destabilises this pillar: the nutritional profiles of LMICs today are not polarised, they are not binary; they are diverse.

Thus are the AT and NTT defunct? I would argue no – although these theories have rendered themselves too constrictive for the reality of malnutrition occurring in the world today, they undeniably both have general elements that are practically beneficial. There are profiles on nutrition that can vary across populations and these profiles change over time. Although LMICs today are experiencing great diversity, the past changes in nutritional profiles that have previously occurred both in today's LMICs and in MDCs have much to say about the nutritional status of individuals and populations today – particularly given the intergenerationality of nutrition.

For the first key component of the NTT and AT – the nutritional profiles of populations - this chapter has shown that at this stage in human history, we must allow for divergence in malnutrition.

The second key component of the NTT and the AT is that there are external drivers affecting and thus changing the nutritional profiles of populations. Stuntingoverweightness does not undermine this general point – but it may affect what we understand these factors to be. Chapter 5 addresses this question.

Chapter 5: Results for the Population-Level Determinants of Stuntingoverweightness in LMICs – a focus on Globalisation and Urbanisation

The analyses presented in this chapter address one of the main goals of this research – providing greater insight into the NTs occurring in LMICs and their drivers, given the observation of stuntingoverweightness. It is theorised that the rapid pace of urbanisation and globalisation has led to the AT of the NT – this analysis assesses whether these factors are explaining that altered trajectories occurring in LMICs have led to the divergent burdens of malnutrition observed in Chapter 4.

As described in Chapter 3 (part 3.2) the analysis was necessarily exploratory in nature and an iterative approach was taken to model building. The baseline model for the following analyses emanates from the results of Chapter 4 – this is detailed in section 5.1. To this model, variables for the levels and rapidity of urbanisation and globalisation were then introduced (section 5.2). The chapter then details the introduction of independent variables from the 5 groups of variables detailed in Chapter 3 – namely: socioeconomic development; population health systems; population health; agriculture and food availability; and finally inequality (sections 5.3-5.5.7). A model is then selected that is considered to be the most parsimonious. At each stage the effects of urbanisation and globalisation are closely assessed.

5.1 Baseline Model for Analysis

This baseline model for this analysis controls for child stunting, child overweightness and adult female obesity, which Chapter 4 showed were significantly and positively associated with stuntingoverweightness. The model was originally presented in in Model 6, Table 4.19 of Chapter 4 but it is re-presented in Table 5.1 as the sample size has been reduced from 77 to 73[51].

The baseline model was selected based upon the results of Chapter 4. It includes significant relationships between stuntingoverweightness and the prevalence of other forms of malnutrition integral to understanding the nutritional profiles of LMICs and their NTs. Chapter 4 showed that stuntingoverweightness is more prevalent in countries with higher levels of child stunting, child overweightness and adult obesity[52]. The prevalence of these three indicators of malnutrition are controlled for in this analysis as a means to capture the variation in stuntingoverweightness. Additionally, the inclusion of these variables means that it is possible to assess whether any of the other independent variables included in the model have differential effects on the level of stuntingoverweightness dependent upon the levels of child stunting, child overweightness and adult obesity.

This baseline model is presented in Table 5.1, where despite changes in the sample size from the model in Chapter 4, the association of stuntingoverweightness with child stunting, child overweightness and female obesity is consistent. A 1% increase in stunting is significantly associated with a 0.124% increase in stuntingoverweightness prevalence. A 1% increase in overweightness is significantly associated with a 0.459% increase in stuntingoverweightness and a one unit increase in the log of female adult obesity is associated with a 1.16% increase in stuntingoverweightness. The interesting feature of these relationships is the stronger associations between overweightness (and adult obesity) and stuntingoverweightness. This suggests stuntingoverweightness is linked to greater progression along nutrition transition trajectories, as overweightness is

[51] This includes Palestinians in Lebanon…..due to missing data

[52] All estimates are exclusive of stuntingoverweightness

still considered indicative of a more advanced NT – even if there is a protraction in the decline in stunting.

Table 5.1 Stuntingoverweightness and Other Forms of Malnutrition – Stunting, Overweightness and Adult Obesity (Female) – Baseline Linear Regression Model for Analysis

	β ***(SE)***
Child Stunting	0.124*** *(0.033)*
Child overweight	0.459*** *(0.105)*
Log(Adult obesity (females))	1.166** *(0.432)*
	-4.855* *(1.891)*
R-Square	29.36
N	73

5.2 Stuntingoverweightness and its Relationship with the Levels and Pace of Globalisation and Urbanisation

As noted in the Chapter 3, levels in urbanisation and globalisation are indicated by INTERNET and MOBILE. The pace of urbanisation and globalisation were indicated using INTERNET5, MOBILE10, URBAN40 and URBAN20. Descriptive statistics for these variables are provided in Table 5.2. Initially, the relationship between the levels of globalisation and urbanisation are explored, followed by the analysis of variables indicating the pace of change.

Table 5.2 Descriptive Statistics for Level and Pace of Urbanisation

Variable	Variable Description	Mean	Std. Dev.	Min	Max
URBAN	% of Population Living in Urban Areas (of total population)	42.84	17.97	10.64	86.46
INTERNET	Number of Fixed Broadband Internet Users per 100 population	0.53	1.13	0.00	5.56
MOBILE	Number of Mobile Cellular Subscriptions per 100 population	44.46	35.29	1.29	187.36
URBAN20	% Increase in Urban Population in Last 20 years	28.66	35.88	-12.89	247.30
URBAN40	% Increase in Urban Population in last 40 years	109.12	101.12	-37.37	489.29
INTERNET5	% Difference in Fixed Broadband Internet Users in last 5 years	0.41	1.00	-1.62	4.82
MOBILE10	% Difference in Mobile Cellular Subscribers in Last 10 years	42.36	33.14	1.29	165.71
N		73			

5.2.1 Levels in Globalisation and Urbanisation

In this section, the analysis assesses the relationship between stuntingoverweightness and the level of globalisation and urbanisation. These are explored separately in section

5.2.1.1 and 5.2.1.2 respectively, then together in section 5.2.1.3. As can be seen in Table 5.2, within the sample, LMICs vary in the level of urbanisation from just 10.64% of the population living in urban areas in Burundi to 86.46% in Gabon. INTERNET (fixed broadband internet subscribers per 100 people) ranges from 0 in eight LMICs[53] (including Guinea-Bissau[54]) to 5.56 in Colombia. MOBILE (the number of mobile cellular subscriptions per 100 people) ranges from 35.92 in Chad to 187.36 in Gabon.

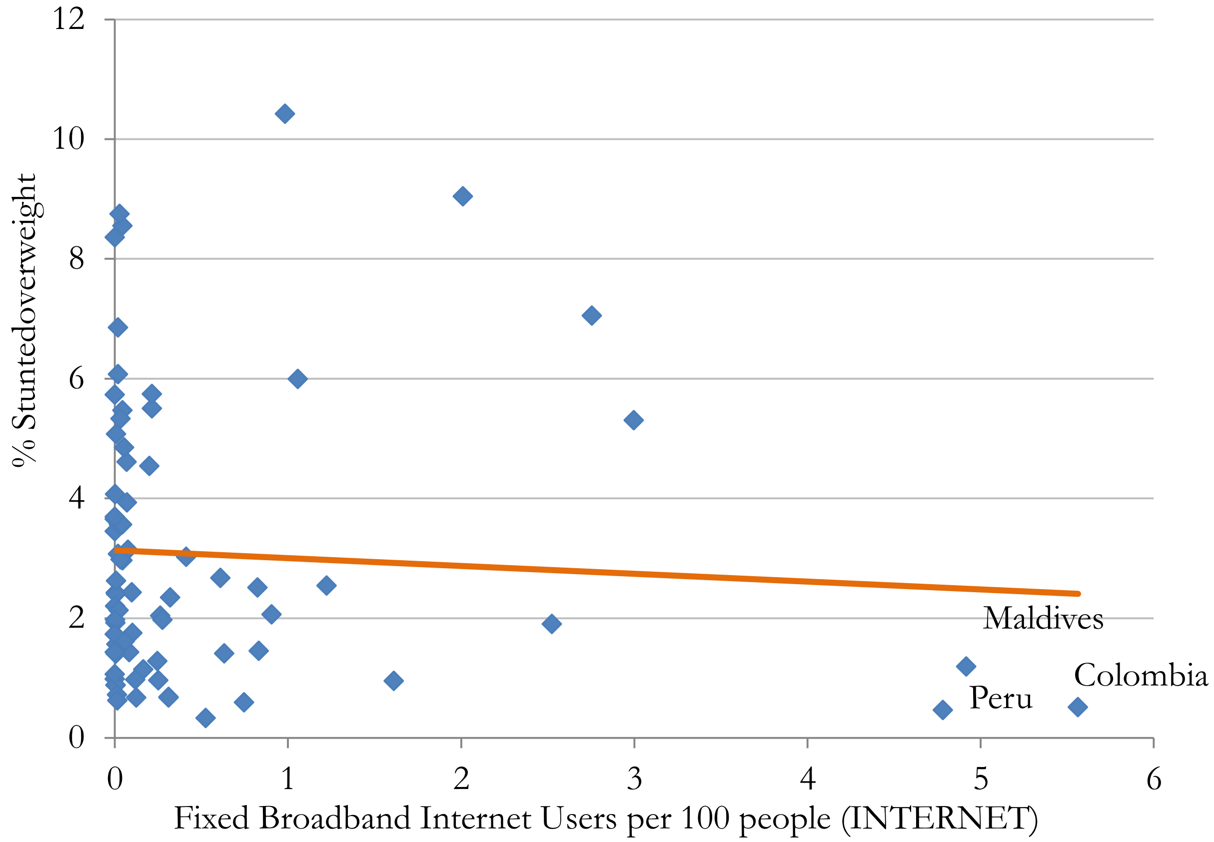
5.2.1.1 Stuntingoverweightness and the Level of Globalisation

Focussing initially on globalisation – the relationships are explored between stuntingoverweightness and INTERNET, then stuntingoverweightness and MOBILE. The bivariate relationship between INTERNET and MOBILE with % stuntingoverweight is explored graphically (Figure 5.1 and Figure 5.3 respectively), using the Pearson correlation coefficient and then using simple linear regression.

Figure 5.1 shows the relationship between stuntingoverweightness and INTERNET across the sample. Although there appears to be a negative relationship there are three observed outliers – the Maldives, Peru and Colombia. In their absence a positive relationship is observed (Figure 5.2).

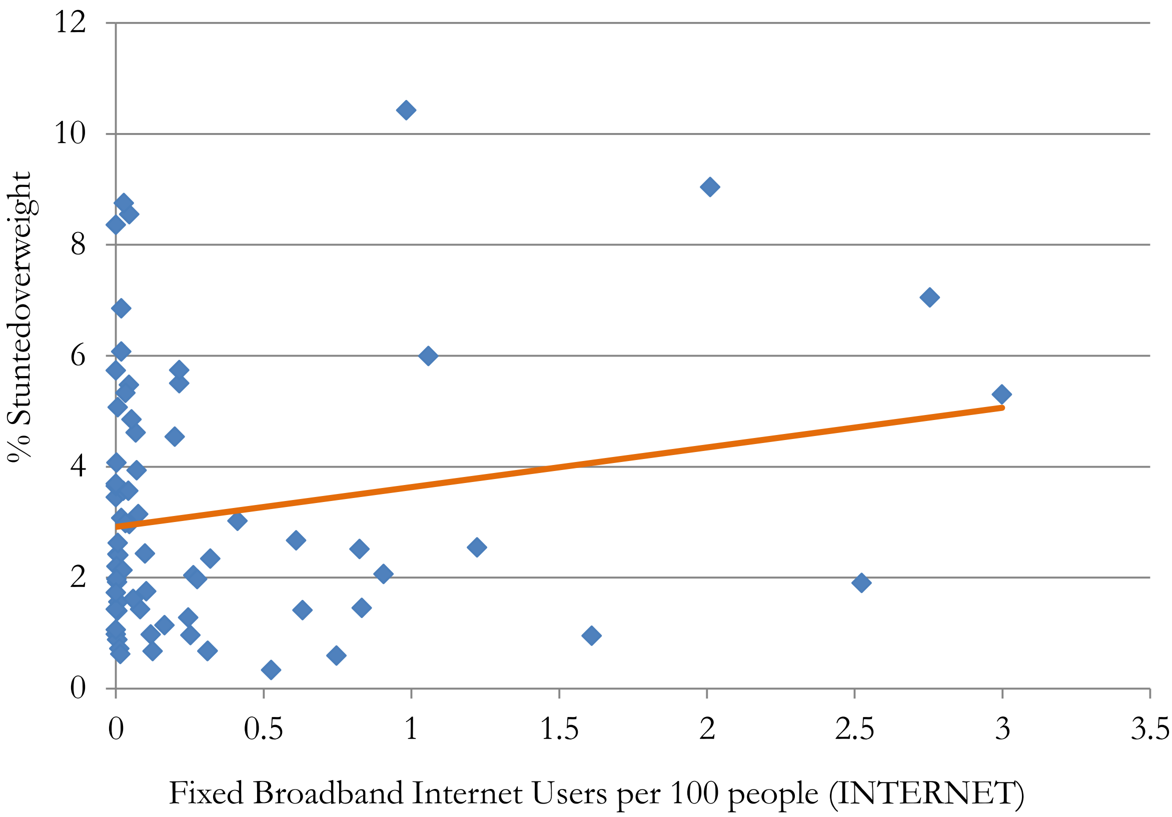
[53] Madagascar, Somalia, Guinea-Bissau, Swaziland, Guinea, Togo, Chad and Central African Republic (CAR)
[54] Guinea-Bissau has one of the highest levels of stuntingoverweightness in the sample (8.36%)

Figure 5.1 % Under-Fives Stuntedoverweight and Fixed Broadband Internet Users per 100 people in LMICs



There is no impact upon the significance of either the correlation coefficient or regression coefficient if the cases of Maldives, Peru and Colombia are removed. Removing these three cases yields a correlation coefficient of 0.1963 (CI -0.037; 0.409) and a regression coefficient of 0.72 (CI -0.14; 1.57).

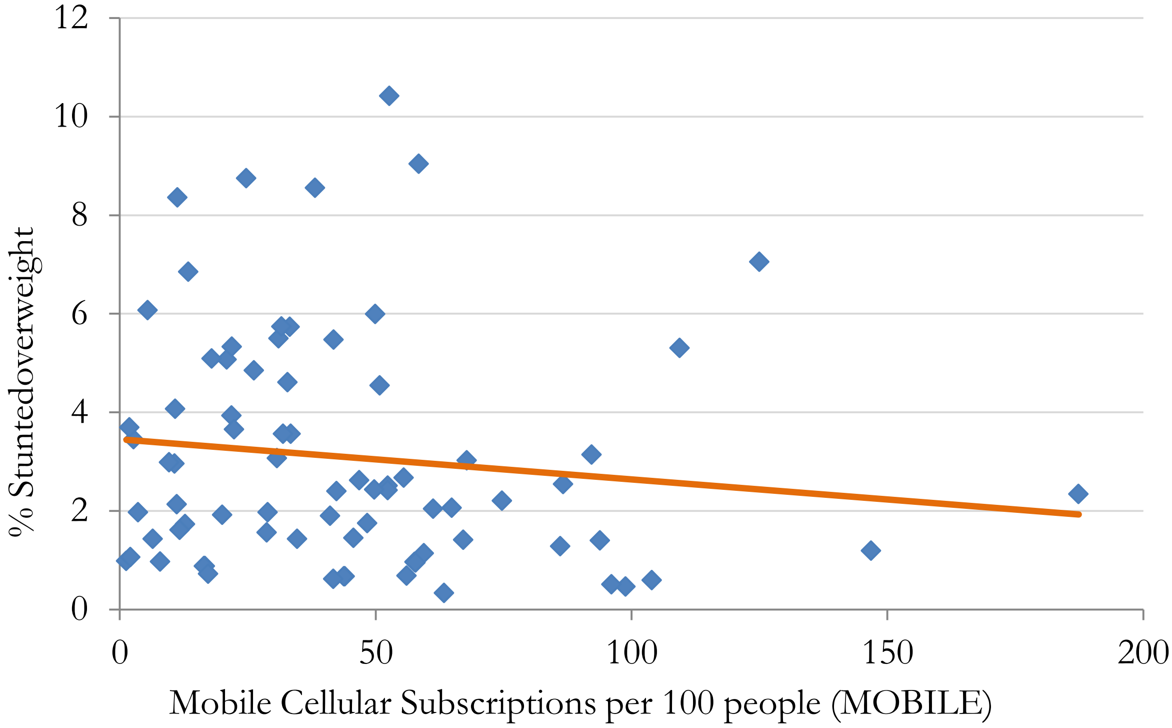
Figure 5.2 % Under-Fives Stuntedoverweight and Fixed Broadband Internet Users per 100 people in LMICs Excluding the Maldives, Peru and Colombia



Including these cases, the correlation coefficient is -0.06 (CI-0.29; 0.166), the regression coefficient is -0.13 (CI -0.61; 0.35). Thus, from a bivariate perspective no statistically significant relationship between stuntingoverweightness prevalence and level of globalisation (as indicated by INTERNET) is observed.

Figure 5.3 shows the relationship between stuntingoverweightness and MOBILE in the LMICs of the sample. There is much more variability in MOBILE in the sample when compared to INTERNET – expected given the late onset of fixed broadband relative to mobile cellular subscriptions worldwide. Figure 5.3 shows a negative relationship between stuntingoverweightness and MOBILE – as the level of globalisation increases (as indicated by MOBILE) so levels of stuntingoverweightness decrease. The direction of this relationship is found to be consistent assessing the correlation coefficient (r= -0.122 CI -0.339: -0.106) and the regression coefficient (β= -0.008 CI -0.023: -0.007) but neither are statistically significant.

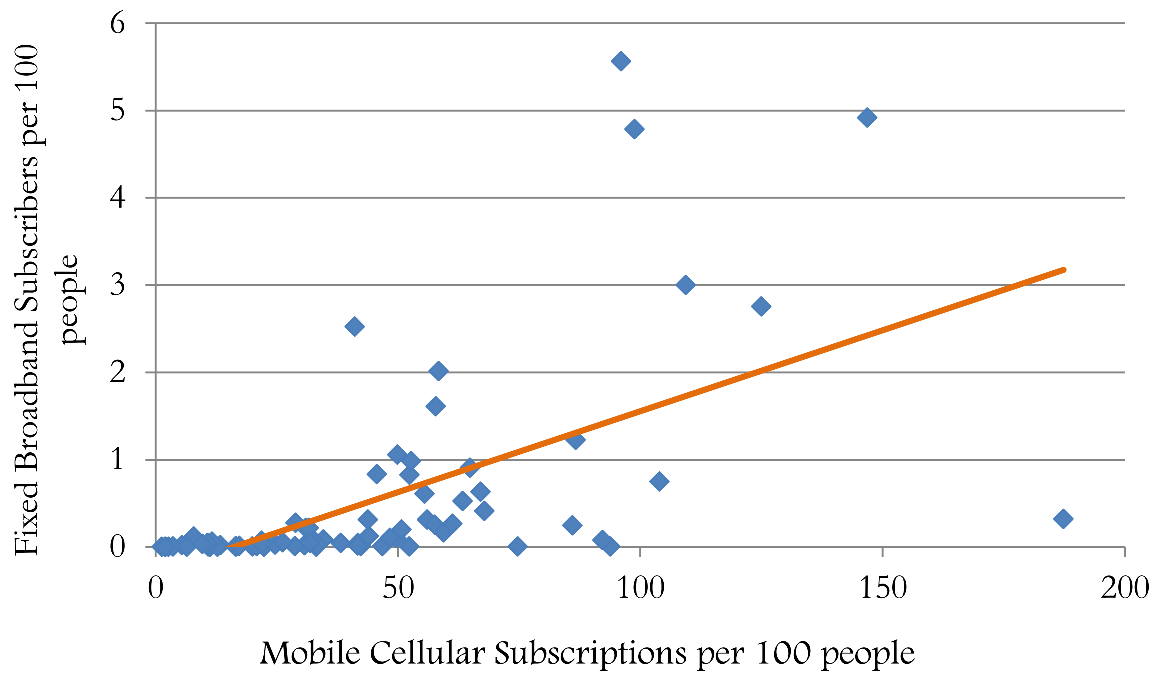
Figure 5.3 % Under-Fives Stuntedoverweight and Mobile Cellular Subscriptions



These results suggest that for both INTERNET and MOBILE there is no significant relationship with stuntingoverweightness prevalence. Thus at this stage in the analysis there is no evidence that the level of globalisation (as indicated by INTERNET and MOBILE) is significantly associated with stuntingoverweightness prevalence in LMICs.

These variables will now be added to the baseline model. However, before inclusion the relationship between MOBILE and INTERNET needs to be assessed due to the risk of multicollinearity. Figure 5.4 shows there is a positive relationship between MOBILE and INTERNET.

Figure 5.4 Fixed Broadband Internet Users per 100 people and Mobile Cellular Subscriptions per 100 people in LMICs



Additionally there is a statistically significant correlation (*r*= 0.58 CI= 0.41: 0.71), although the correlation is not 'high' when using the convention threshold of *r*= 0.7. Moreover the condition number is <10 (3.796). This pre-regression check suggests that there is no multicollinearity in reference to these two variables. As a result, both INTERNET and MOBILE are introduced into the baseline model – first separately and then together (Table 5.3).

Table 5.3 Linear Regression Results for MOBILE AND INTERNET added to the Baseline Model for Analysis (Dependent variable: % Stuntedoverweight)

	Baseline	M1[55]	M2	M3
Stunting %	0.124*** *(0.033)*	0.114** *0.033*	0.108** *0.035*	0.108** *0.035*
Overweight %	0.459*** *(0.105)*	0.467*** *0.103*	0.440*** *0.104*	0.455*** *0.105*
Log(Adult obesity (female))	1.166** *(0.432)*	1.227** *0.428*	1.183** *0.428*	1.220** *0.429*
INTERNET	-	-0.409 *0.22*	-	-0.313 *0.257*
MOBILE	-	-	-0.012 *0.007*	-0.006 *0.008*
(Constant)	-4.855* *(1.891)*	-4.612* *1.865*	-3.892 *1.96*	-4.159* *1.971*
R-squared	29.36	0.3	0.292	0.296
N		73		

When controlling for other forms of malnutrition, neither of the variables INTERNET or MOBILE are found to be significantly associated with the prevalence of stuntingoverweight among under-fives. Additionally, neither is found to be significantly associated with stuntingoverweight when both are included in the model. These results are consistent for both INTERNET and MOBILE. Thus at this stage the analysis shows no indication of a significant relationship between level of globalisation and stuntingoverweightness in LMICs (when controlling for other forms of malnutrition).

[55] Where M stands for Model, thus M1 is Mdeol 1, M2 Model 2 and so on.

5.2.1.2 Stuntingoverweightness and the Level of Urbanisation

Table 5.2 showed the level of urbanisation varied widely among LMICs of the sample, from 10.64% to 86.46% of a country's total population living in urban areas. Visually, there is an apparent positive relationship between the level of urbanisation and stuntingoverweightness (Figure 5.5). However, there is no significant correlation between URBAN and stuntingoverweightness (r = 0.1592, CI -0.069: 0.3714). Additionally, in a simple linear regression model for stuntingoverweightness with URBAN (the independent variable) there was equally no statistically significant association found (β= 0.02, CI -0.009; 0.051). When URBAN was introduced to the baseline model for the regression analysis, the relationship found between URBAN and stuntingoverweightness remained non-significant – controlling for stunting, overweight and adult obesity (female) (Table 5.4).

As with globalisation, there is no indication that the current levels of urbanisation are a factor determining stuntingoverweightness in LMICs today.

Figure 5.5 Stuntingoverweightness and % of Total Population Living in Urban Areas in LMICs

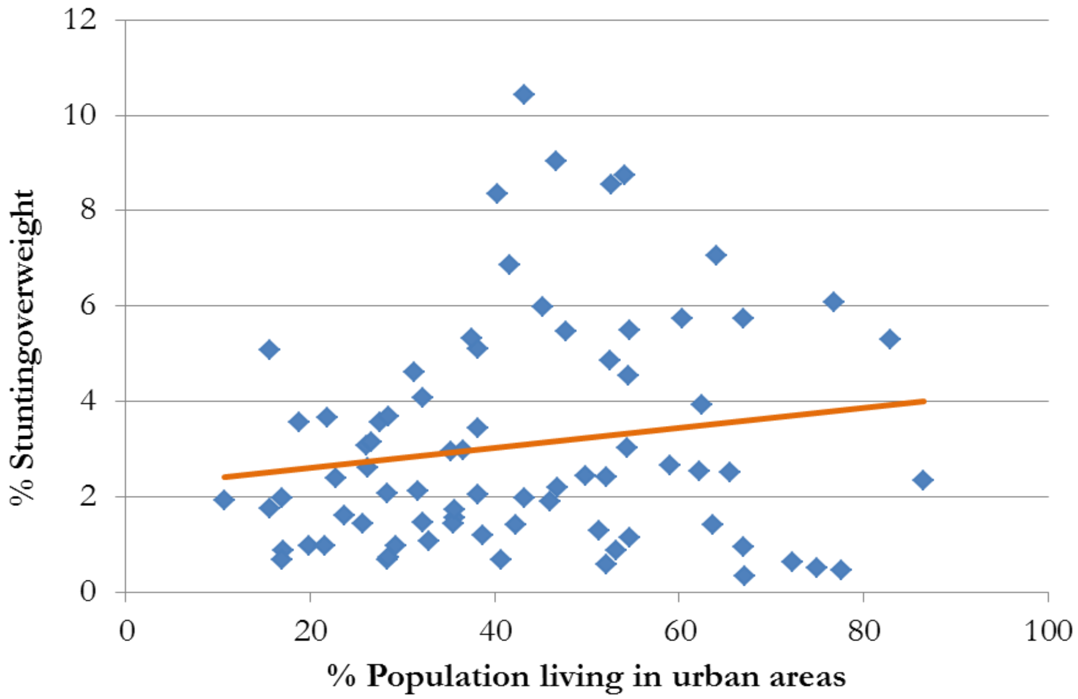


Table 5.4 Regression Results for Introduction of URBAN to Baseline Model (where Stuntingoverweightness is the dependent variable)

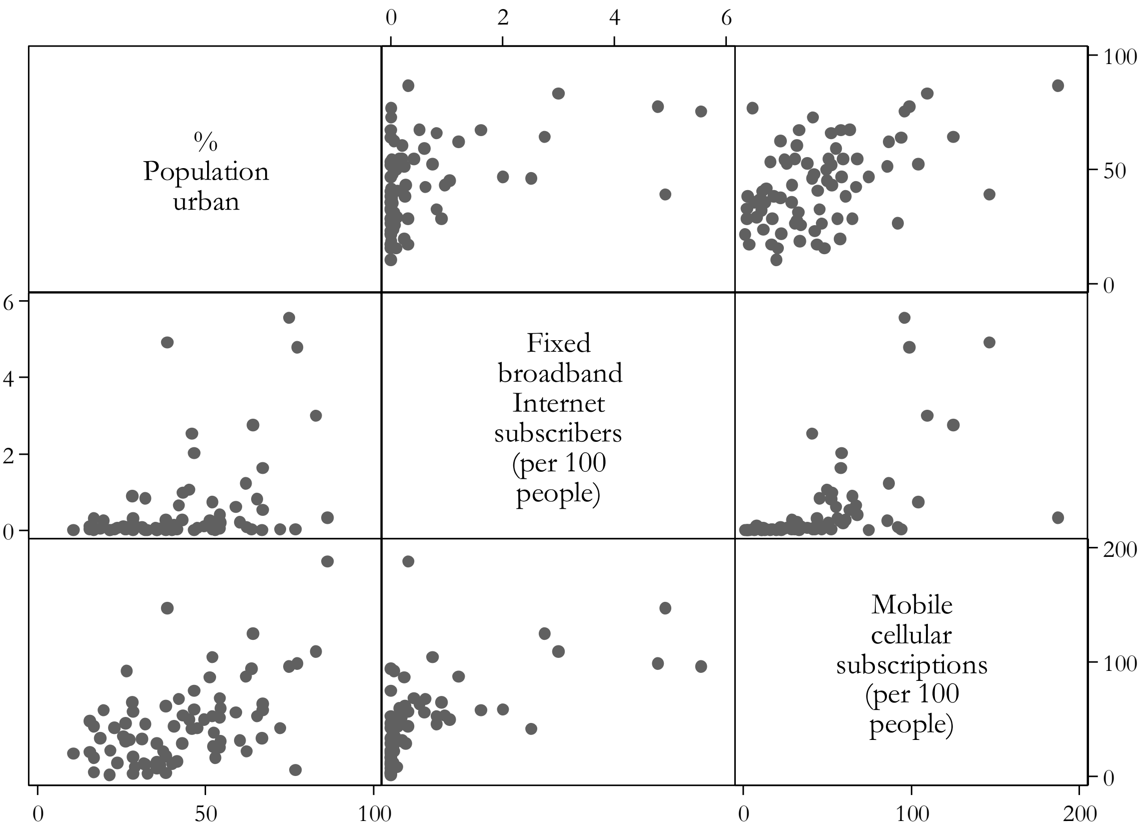
	Baseline	M4
Stunting %	0.124***	0.136***
	(0.033)	*0.037*
Overweight %	0.459***	0.469***
	(0.105)	*0.105*
Log(Adult obesity (female))	1.166**	1.102**
	(0.432)	*0.44*
URBAN		0.016
		0.018
(Constant)	-4.855*	-5.727**
	(1.891)	*2.141*
R-squared	29.36	27.3

However, Chapter 2 highlighted that globalisation and urbanisation are two processes that are occurring in parallel in LMICs. Additionally, their impacts on population health are interrelated. For example, globalisation has led to changing world food systems and thus differential levels in and types of foods available at the population level, whilst urbanisation has meant more and more people have access to this diet through the resultant accessibility of a modern supermarket (GHW 2001; Drewnowski & Popkin 1997). As a result, it is hypothesised that the effect of the level of globalisation may vary with the level of urbanisation. Analyses assessing this possible dependence are now presented in section 5.2.1.3.

5.2.1.3 Stuntingoverweightness and the Levels of Both Urbanisation and Globalisation

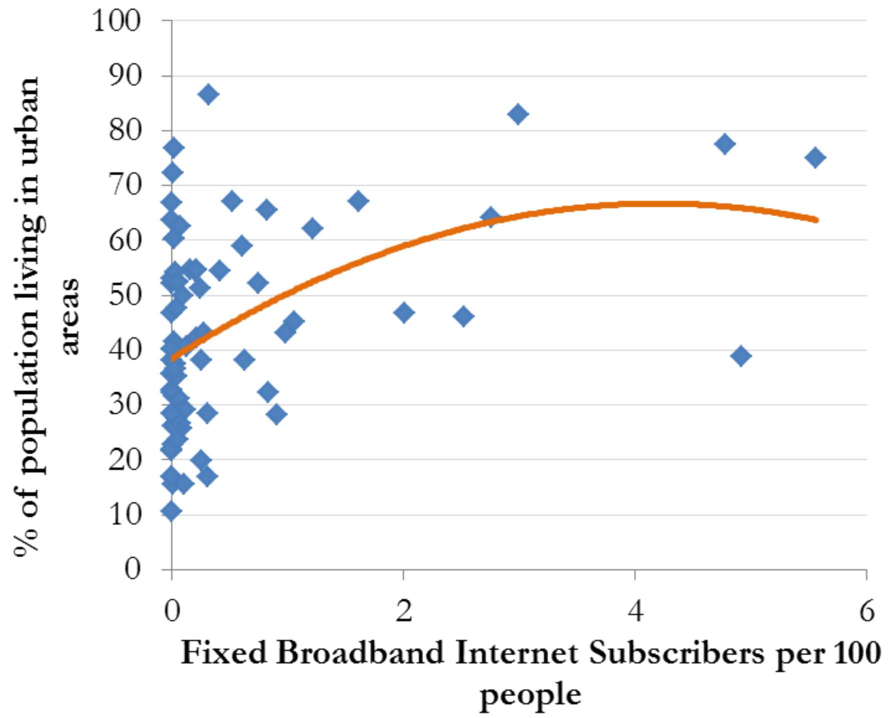
The relationships between URBAN, MOBILE and INTERNET are displayed in Figure 5.6. There appear to be positive relationships between all of the variables. The correlation between URBAN and MOBILE is 0.502 (CI 0.310: 0.654) while the correlation between URBAN and INTERNET is 0.405 (CI 0.196:0.579). Both correlation coefficients are significant.. This is consistent with the parallel relationships between urbanisation and globalisation and specifically correlates with research that has shown that ICT prevalence tends to be higher in more urbanised populations as a whole.

Figure 5.6 Relationships between URBAN, INTERNET and MOBILE



Of note is that the relationship between URBAN and MOBILE appears to be linear, but the relationship between URBAN and INTERNET is not – the positive relationship between INTERNET and URBAN plateaus at higher levels of INTERNET (Figure 5.7).

Figure 5.7 Relationship between URBAN and INTERNET in LMICs



It should be noted that urbanisation is a long running process in all populations of the world but the introduction of new ICT (Information and Communications Technology) is very much in its infancy in comparison. ICT is an indicator of a new wave of globalisation that is happening very rapidly for LMICs and MDCs alike and this can explain why population's levels of urbanisation are ahead of the introduction of fixed broadband internet. As a further caveat – looking to the future, the introduction of greater internet access and 'flattening' of the world that occurs through ICT is predicted to hasten due to greater integration of third generation wireless connectivity via mobile networks (Gunasekaran & Harmantzis 2007; Friedman 2005).

Both indicators of globalisation and urbanisation are added to the baseline model to assess whether their effects are dependent upon one another (Table 5.5). It should be noted that pre-regression checks have shown that URBAN is not highly correlated with either MOBILE or INTERNET (both r<0.07). Additionally the condition number of these variables is <10 at 6.8, suggesting multicollinearity will not be an issue when the variables are added to the baseline model. Table 5.5 show these results in Model 5 to 7 (M5, M6 and M7) where INTERNET was introduced into the model with URBAN, then MOBILE was introduced into the model in place of INTERNET, and finally both indicators of globalisation (INTERNET and MOBILE) were tested in the presence of the URBAN.

Table 5.5 Introduction of Globalisation Variables to Regression Model Controlling for Level of Urbanisation (where Stuntingoverweightness is the dependent variable) Models 4-7

	Baseline	M4	M5	M6	M7
Stunting %	0.124***	0.136***	0.132***	0.125***	0.126***
	(0.033)	*0.037*	0.036	0.036	0.036
Overweight %	0.459***	0.469***	0.483***	0.452***	0.469***
	(0.105)	*0.105*	0.103	0.104	0.104
Log(Adult obesity	1.166**	1.102**	1.140*	1.075*	1.111*
(female))	*(0.432)*	*0.44*	0.431	0.431	0.431
URBAN		0.016	0.023	0.027	0.028
		0.018	0.018	0.018	0.018
INTERNET			-0.469*		-0.336
			0.224		0.255
MOBILE				-0.015*	-0.009
				0.008	0.009
(Constant)	-4.855*	-5.727**	-5.888**	-5.127*	-5.466*
	(1.891)	*2.141*	2.096	2.116	2.129
R-squared	29.36	27.3	30.7	30.3	30.9
N			73		

Interestingly, in Models 5 and 6 (Table 5.5) we can see that INTERNET and MOBILE become significant predictors when introduced (separately) into a regression model that controls for URBAN. This suggests that the effect of INTERNET and MOBILE on stuntingoverweightness varies across levels of urbanisation in LMICs. Controlling for the level of urbanisation, the level of globalisation is associated with lower levels of stuntingoverweightness. This is an interesting result, as it suggests that globalisation minimises the risk of stuntingoverweightness. To explore this further, an interaction term was introduced into Model 5 for URBAN*INTERNET, while an interaction term for URBAN*MOBILE was introduced into Model 6. Of these two interaction terms neither showed a significant relationship with stuntingoverweightness (see Appendix IV for models). The weight of the evidence from these analyses is that there is no significant relationship between the level of globalisation or urbanisation with stuntingoverweightness.

Yet, as revealed in Chapter 2, it is the pace of both globalisation and urbanisation that is thought to be driving the changing nature of NTs occurring in LMICs today, not just the level. In accordance with this hypothesis variables, capturing the rapidity of globalisation and urbanisation and their effect on the prevalence of stuntingoverweightness are explored in the next section (5.2.2).

5.2.2 Analyses Exploring the Relationship Between the Pace of Globalisation and Urbanisation and Stuntingoverweightness in LMICS

This section addresses whether there is a relationship between stunting overweightness in LMICs and the pace of globalisation and urbanisation. In addition, it will explore whether the effect of the pace of change in these two factors varies according to the levels of stunting, overweight or adult obesity. Moreover, the results presented below will show if the effect of the pace of globalisation and urbanisation varies according to current levels in globalisation and urbanisation.

Results will first be presented for the 'rapidity of globalisation' (section 5.3.2.1). As described in Chapter 3, this is indicated by proxy using the variables INTERNET5 and MOBILE10. INTERNET5 is the percentage difference[56] in the number of fixed broadband internet users in the last five years in LMICs. MOBILE10 is the percentage difference in the number of mobile cellular subscribers in the last 10 years[57].

Following this, the results concerning the rapidity of urbanisation are presented in section 5.3.2.2. The relationship between stuntingoverweightness and the pace of urbanisation is assessed using data on percentage change in the number of people living in urban areas in a 40 and 20 year period in LMICs (the variables are termed URBAN40 and URBAN20 respectively). Finally, results aiming to assess if there is a relationship

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[56] Percentage change could not be calculated as there are initial values of 0 for fixed broadband internet users 5 years ago

[57] Again, there were no mobile cellular subscriptions, so percentage difference was used - although the level of mobile cellular subscriptions was included in models as a control

between these two dynamics (globalisation and urbanisation) –and whether their levels affect stuntingoverweight prevalence – are presented in section 5.2.2.3.

5.2.2.1 Stuntingoverweightness and the Pace of Globalisation

Within the sample, the difference in the number of fixed broadband internet users per 100 population (INTERNET5) ranges from a decrease of -1.62 in the Dominican Republic (2002-2007) to an increase of 4.82 in Colombia (from 2005 to 2010). The difference in number of mobile cellular subscriptions per 100 people in the last 10 years (MOBILE10) for countries in the sample ranges from 1.29 in Chad (from 1999 to 2004) to 165.71 in Gabon (from 2007 to 2012). It is the relationship between these two variables with stuntingoverweightness that is explored in this section. Initially each relationship is explored from a bivariate perspective – using Pearson's correlation and simple linear regression. Following this they are introduced to the baseline regression model. However, an important point to make is that the current levels of these variables (INTERNET and MOBILE) will also be included in these models as it is expected the effect of INTERNET5 and MOBILE10 will depend on the levels of globalisation (as indicated by INTERNET and MOBILE).

No significant correlation was found between either stuntingoverweightness with INTERNET5 (r= -0.12, CI -0.34: 0.11) or stuntingoverweightness and MOBILE10 (r= -0.02, CI -0.25: 0.21). In a simple linear regression model, there was no significant association between INTERNET5 and stuntingoverweightness (β -0.04, CI -0.59: 0.52).Additionally there was no significant association between MOBILE10 and stuntingoverweightness (β= -0.009, CI -0.03: 0.01). This was to be expected given the importance of the level of globalisation to the pace of change.

The variables were then introduced into the baseline model for the analysis, separately, with the results displayed in Table 5.6 (Model 8 shows the results for INTERNET5, Model 9 for MOBILE10). No significant association was found between stuntingoverweightness and INTERNET5 when controlling for other forms of malnutrition. This was also true of MOBILE10.

The models were re-run with the current level of INTERNET and MOBILE. When INTERNET5 and MOBILE10 were introduced, there was no significant association found between either MOBILE10 with stuntingoverweightness or INTERNET5 with stuntingoverweightness prevalence in LMICs (Table 5.6, Models 10 and 11 respectively).

Table 5.6 Stuntingoverweightness and the Pace of Globalisation, linear regression results Models 8-10

	Baseline	M8	M9	M10	M11
Stunting %	0.124*** *(0.033)*	0.116** *0.034*	0.103** 0.036	0.108** *0.034*	0.104** *0.037*
Overweight %	0.459*** *(0.105)*	0.488*** *0.107*	0.506*** (0.113)	0.479*** *0.106*	0.52*** *0.115*
Log(Adult obesity (female))	1.166** *(0.432)*	1.136* *0.428*	1.005* (0.449)	1.156* *0.428*	0.988* *0.452*
INTERNET5		-0.329 *0.246*		-0.321 (0.245)	
MOBILE10			-0.012 (0.008)		-0.063 *0.078*
INTERNET				-0.819 (0.541)	
MOBILE					0.048 0.073
(Constant)	-4.855* *(1.891)*	-4.560* *1.898*	-3.533 2.03	-4.275 *1.890*	-4.159* *1.971*
R-squared	29.36	29.21	31.45	30.51	0.296
N	73				

These results suggest, at this stage, that there is no association between either the level or the pace of globalisation with stuntingoverweightness, either when explored using bivariate relationships or in multivariate models controlling for other forms of malnutrition in LMICs.

However, if we assess the repercussions of the introduction of INTERNET5 into the baseline model, there is a clear magnification in the effect of child overweightness on stuntingoverweightness prevalence in LMICs. The regression coefficient for child overweightness has increased from 0.459 in the Baseline Model to 0.488 in Model 8 (Table 5.6). Additionally the regression coefficient for child stunting has diminished from 0.124 in the Baseline to 0.116 in Model 8 (Table 5.6). Controlling for INTERNET, the effect of stunting on stuntingoverweightness is further attenuated – from 0.124 in the Baseline, through 0.116 in Model 8 to 0.108 in Model 10 (Table 5.6). The changing magnitude of these relationships suggests a potential interaction between INTERNET5 and child stunting, as well as with child overweightness prevalence.

Three models were run to test these interactions. To Model 8 an interaction term for INTERNET5 with child stunting was introduced (INTERNET5*Stunting) – yielding Model 12 (Table 5.7). In this model, the interaction term is found to be statistically significant; there is a negative relationship between the interaction term INTERNET*Stunting and stuntingoverweightness. Additionally, controlling for this interaction term, the effect of INTERNET5 has become significant – for the main effect of INTERNET5, a 1% increase in the difference between fixed broadband users in the last 5 years is now associated with a 2.0% decrease in stuntingoverweightness prevalence. The addition of the interaction term increased the R^2 of the model from 27.3 to 29.21 (Model 4, Table 5.5; Model 8, Table 5.6).

The results show that stunting remains indicative of greater levels of stuntingoverweightness, while a greater pace of globalisation (indicated by INTERNET5) also increases the prevalence of stuntingoverweightness. However, in situations where the levels of stunting are high and the pace of globalisation is high, their positive associations are attenuated (as shown by the negative coefficient of the interaction term INTERNET5*Stunting).

Related to theories of the NTT, it appears that in a diverse malnutrition environment, stuntingoverweightness is more prevalent. Additionally there is evidence that stuntingoverweightness and this diversity are also more prevalent in contexts of rapid globalisation. However, at particularly high levels of stunting and at high pace of change in internet users, the positive relationship is attenuated. This adds further evidence to the idea of stuntingoverweightness occurring in LMICs that have seen a protraction in the decline of stunting as overnutrition increases – for stuntingoverweightness will be highest, according to the model, where there are relatively lower levels of stunting compared to other LMICs in the sample, but stunting is still present.

Table 5.7 Stuntingoverweightness and the Pace of Globalisation, linear regression model incorporating Interaction Terms for Change in Number of Fixed Broadband Internet Users in the last 5 years with Child Stunting and Child Overweightness

	M12	**M13**	**M14**
% Stunted	0.127***	0.104**	0.121***
	(-0.033)	*-0.035*	0.033
% Overweight	0.443***	0.371**	0.442***
	(-0.104)	*-0.137*	0.104
Log (Adult Obesity) female	1.227**	1.186**	1.230**
	(-0.422)	*0.438*	0.423
INTERNET5	2.002*	-1.199	-2.305*
	(0.91)	*0.691*	*(0.966)*
INTERNET5*Stunting	-0.161**		-0.147*
	(0.061)		(0.063)
INTERNET5*Overweight		0.15	-0.147
		0.112	*(0.062)*
INTERNET			1.797
			(0.936)
(Constant)	-4.810*	-3.940*	-4.160*
	(1.823)	*(1.943)*	*(1.873)*
R-squared	34.90	30.03	34.80
N		73	

Additionally, an interaction term between INTERNET5 and child overweightness (INTERNET5*Overweight) was introduced to Model 5 (Table 5.5) to form Model 13. As can be seen in Model 13 (Table 5.7) this interaction term was not found to be significant, nor did INTERNET5 become significant when controlling for this interaction term. This suggests that there is no interaction between the pace of globalisation and child overweightness on the level of stuntingoverweightness in

LMICs. Model 14 introduced the current level of fixed broadband internet users (INTERNET) to Model 13, in addition to the interaction term INTERNET5*Stunting. The results of Model 14 again show no interaction between the pace of globalisation and the effect of overweightness on the prevalence of stuntingoverweightness. However, the results for the interaction between child stunting and the change in the number fixed broadband internet users per 100 populations in the last 5 years remains significant – as seen in Model 12 (Table 5.7). This consistency in results adds weight to the evidence that that, overall, an increased pace of globalisation (as indicated by the increased number of fixed broadband users) does increase the prevalence of stuntingoverweightness. At higher levels of stunting – that are not indicative of a protracted stage 3 of the NTT and thus not expected to be associated with a divergent burden of malnutrition – the prevalence of stuntingoverweightness will be lower. This is due to the attenuation of the main effects of INTERNET5 and child stunting when an interaction term between them is introduced.

It should be noted that there was an indication of an interaction between the rapidity of increase of mobile cellular subscribers and adult obesity, child overweightness and child stunting. Thus three interaction terms were tested (separately) – MOBILE10*child stunting, MOBILE10*child overweight and MOBILE10*adult obesity – and each was significant (the results are available in Appendix IV). The results were consistent with those seen from the use of INTERNET5 as a proxy for the rapidity of urbanisation, although the strength of the associations was particularly low. However, the effect of these derived interaction terms were interaction terms was so small (at -0.000, 0.001 and 0.001 respectively) that no further comment will be made on them.

In summary – with respect to the rapidity of globalisation – there is evidence that this is important in the determination of stuntingoverweightness. This effect, however, is also dependent on other aspects of the nutritional profiles of LMICS – notably child stunting and thus the protracted third stage of the NT. This further emphasises the need to observe and consider the 'real' and divergent nature of growth faltering malnutrition in LMICs today in order to understand the effect of globalisation and its pace.

For the analyses moving forward, only the indicators for globalisation and its rapidity derived from internet users data will be utilised to ensure the most parsimonious model is used. This is justified due to the consistency in results across the variables for mobile subscriptions and fixed broadband users, as well as the very small effect of MOBILE10 and its interaction terms on child stunting, child overweightness and adult obesity.

An additional point arising from this analysis is that is there is currently great value in using data on internet connections rather than mobile cellular subscriptions when using ICT variables as proxies for globalisation – particularly when the pace of globalisation is important. This is very much related to the fact that the internet is a comparably newer technology than mobile cellular subscriptions; and the pace of uptake appears to be far quicker than seen for mobile cellular subscriptions in the past (see Figure 3.3 and Figure 3.4, Chapter 3). Additionally, as the onset of the internet began later, previous gains in globalisation are underpinning the faster adaption of broadband connections. Moreover, the internet enables a far greater diffusion of knowledge than mobile cellular subscriptions and is better placed to facilitate new and wider global production networks (Ernst & Kim 2002). These features are particularly relevant to the changing values and world food systems thought to be integral to the changing nutritional profiles of populations (Popkin 1993; Drewnowski & Popkin 1997; Hawkes 2006).

However, the rapidly changing nature of both the levels of internet use and the vehicles through which its use is achieved will need to be considered in future research. Notably the onset of new generation technology – such as wireless connections through mobile networks (3G) will need to be considered in future research utilising ICT data as proxies for globalisation. In particular, wider use of 3G (and then 4G) will mean that mobile cellular subscription data will begin to largely reflect access to the internet in LMICs. The variables utilised for globalisation in this research are key limitations of the analysis which are explored in Chapter 9.

The next section focuses upon the pace of urbanisation and its relationship with increasingly divergent burdens of malnutrition.

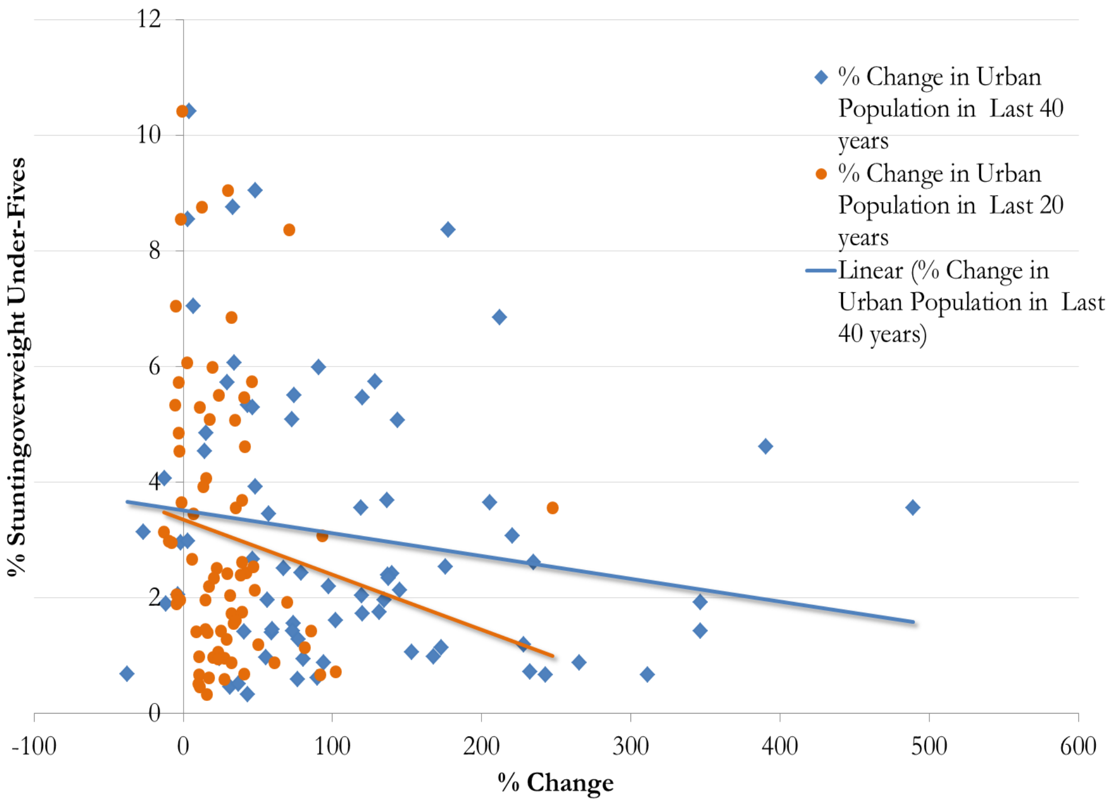
5.2.2.2 Rapidity of Urbanisation

As shown in Chapter 2 it is not just the pace of globalisation that is theorised to drive a departure from the original NT seen in MDCs; it is it also the rapid nature of urbanisation occurring in LMICs today.

Table 5.2 shows that the percentage change in urban population (percentage of total) ranges from -12.89 (Tajikistan) to 247.30 (Rwanda) in the last 20 years, and from -37.37 (Bangladesh) to 489.29 (Rwanda) in the last 40 years. The results indicate whether there is an associated between the percentage change in urban population in the last 40 years (URBAN40) and in the last 20 years (URBAN20). As noted in the methodology, the rate of increase in urbanisation for each LMIC differs depending on the length of the time period utilised. As a result both URBAN40 and URBAN20 are tested in the models but if a relationship between the pace of urbanisation and stuntingoverweightness is found, only one of the two variables will be selected for use going forward in this analysis.

Figure 5.8 shows the relationship stuntingoverweightness has with URBAN20 and with URBAN40. From this graph, a negative relationship between stuntingoverweightness and both variables for the percentage increase in the urban population is observed. The relationship is stronger between stuntingoverweightness and URBAN20 than it is with URBAN40.

Figure 5.8 Stuntingoverweightness with URBAN20 and URBAN40



Bivariate analyses show no indication of a statistically significant relationship between URBAN40 or URBAN20 and stuntingoverweightness prevalence in LMICs. Between URBAN40 and stuntingoverweightness the correlation coefficient was -0.170 but not significant (CI -0.382: 0.059). The linear regression coefficient was also not significant (β= -0.004, CI -0.009: 0.001). Equally between URBAN20 and stuntingoverweightness the correlation coefficient was not significant (*r*= -0.145, CI -0.36: 0.08); nor was the regression coefficient from the simple linear regression model (β= -0.009, CI -0.024: 0.006).

Both variables – URBAN40 and URBAN20 – were introduced to the Baseline Model separately (Model 18 and model 19 respectively, Table 5.8). Consistent with the bivariate analyses described above, there is no evidence of a statistically significant association between the pace of urbanisation and the prevalence of stuntingoverweightness in LMICs, controlling for other forms of growth faltering malnutrition in the population (Model 18 and Model 19, Table 5.8).

Table 5.8 Stuntingoverweightness and the Pace of Urbanisation, Linear Regression Results

	Baseline	**M18**	**M19**	**M20**	**M21**
Stunting %	0.124*** *(0.033)*	0.133*** 0.035	0.127*** 0.034	0.142*** 0.037	0.139*** 0.037
Overweight %	0.459*** *(0.105)*	0.499*** 0.109	0.463*** 0.105	0.507*** 0.110	0.472*** 0.106
Log(Adult obesity (female))	1.166** *(0.432)*	1.083* 0.437	1.118* 0.439	1.033* 0.444	1.058* 0.446
URBAN40		-0.003 0.003		-0.003 0.003	
URBAN20			-0.005 0.007		-0.005 0.007
URBAN				0.012 0.018	0.015 0.018
(Constant)	-4.855* *(1.891)*	-4.665* 1.880	-4.693* 1.911	-5.439* 2.138	-5.540* 2.167
R-squared	29.36	29.8	27.0	29.2	26.7
N	73				

In Model 20 and Model 21 (Table 5.8) the relationship between URBAN40 and URBAN20 was explored further by controlling not only for other forms of growth malnutrition but also for the current level of urbanisation in LMICs (URBAN). The results show, however, that neither URBAN40 nor URBAN20 have a significant association with stuntingoverweightness upon entry of URBAN (percentage of total population currently living in urban areas) (Model 20 and Model 21; Table5.13).

These results have shown that there is no indication that either the level of urbanisation or the pace at which it changes are associated with stuntingoverweightness in LMICs today – both in a bivariate analysis and controlling for other nutritional indicators of the populations.

5.2.3 Summary of Results for Stuntingoverweightness and the Level and Pace of Globalisation and Urbanisation

This section has shown no significant association has been found between either the level or pace of urbanisation with stuntingoverweightness in LMICs today. This is at odds with the literature on factors that drive LMICs away from the original, discrete trajectory of the NT. However, there is an indication that the rapidity of globalisation is associated with stuntingoverweightness prevalence.

As Chapter 2 showed, the rapidity of urbanisation and globalisation were thought to determine the altered trajectories of NT occurring in LMICs today. When we assess the prevalence of stuntingoverweightness as an indicator of an altered trajectory, however, there is only evidence of a relationship between globalisation (its level and pace) with stuntingoverweightness. This relationship is only evidenced in models that control for the broader nutritional profile of LMICs – namely by including child stunting, child overweightness and adult obesity. The dynamic relationship between stuntingoverweightness and globalisation is at its peak among LMICs, with stunting levels indicative of a protracted stage 3 of the NT – but importantly it is not the original AT that has been evidenced here. The protraction of stunting and interrelation with globalisation is indicative of a divergent burden of malnutrition – which is reliant on bringing to the forefront stuntedoverweight children currently invisible to research and policy makers today.

However, to confirm that the pace of globalisation is a key driver of the divergence in NTs and malnutrition seen in LMICs today, the relationship with stuntingoverweightness must be upheld when controlling for other macro factors know to be associated with a population's health and nutrition. Additionally, the urbanisation hypothesis cannot be rejected at this stage – as a relationship between urbanisation and stuntingoverweightness might become visible when controlling for these other macro factors. As described previously, there are five key areas that are to be tested: socioeconomic development; population health systems; population health; agriculture and food availability; and inequality.

For is the next stage of these analyses (Sections 5.3 to 5.9) a second baseline model – Baseline Model 2 – is introduced. This model includes URBAN, URBAN40, INTERNET, INTERNET5 and the interaction term between INTERNET5 and child stunting (Table 5.9). Once independent variables (for socioeconomic development; population health systems; population health; agriculture and food availability; and inequality) have been tested in the original baseline model (known hereafter as 'Baseline Model 1' (BM1) (Table 5.1), they will then be introduced into 'Baseline Model 2' (BM2).

Table 5.9 Baseline Model 2

	β **(S.E.)**
% Stunting	0.144*** *(0.036)*
% Overweight	0.500*** *(0.109)*
Log(Adult Obese) Females	1.059* *(0.433)*
URBAN	0.023 *(0.018)*
URBAN40	-0.003 *(0.002)*
INTERNET	1.600 *(0.936)*
INTERNET5	-2.258* *(0.911)*
Interaction INTERNET5*Stunting	-0.138* *(0.062)*
(Constant)	-5.617** *2.037*
R-squared	0.372
N	73

Retaining URBAN and URBAN40 is vital to reveal whether, controlling for other key factors, a relationship between urbanisation (level and/pace) is present. Additionally, the variables INTERNET, INTERNET5 and the interaction between INTERNET5 and stunting prevalence are retained to show whether the current understanding of globalisation and the pace of globalisation, and their relationship with stuntingoverweightness in LMICs, exists above and beyond other factors determining population health and nutrition.

5.3 Stuntingoverweightness, Globalisation, Urbanisation and Socioeconomic Development

In this section variables indicating the level of socioeconomic development in LMICs of the sample are introduced to 'Baseline Model 2'. The variables chosen for the analysis were GNI, LABOUR, PRIMARY, RATIOEDU[58], SANITATION and WATER. A description of these variables and their descriptive statistics is available in Table 5.10.

Table 5.10 Socioeconomic Development Variables

Variable Name	Description	Mean	Std.Dev	Min	Max
GNI	Gross National Income Per Capita US$ PPP 2000s	3569.32	2927.07	330	14290
LABOUR	Labour participation rate, female (% of total female population age 15+	56.93	18.21	13.70	88.3
PRIMARY	Primary Completion rate, total (% of relevant age group)	77.03	21.20	26.84	120.32
RATIOEDU	Ratio of girls to boys in primary and secondary education (%)	93.94	11.01	53.43	109.35
SANITATION	Improved sanitation facilities (% of Population with Access)	52.22	30.46	8.80	98.60
WATER	Improved water source, rural (% of rural population with access)	67.87	21.35	8.30	99.30
N					73

Initially, the bivariate association between each variable with stuntingoverweightness is explored. In addition, each variable is introduced into the original baseline model (BM1) to see if an association exists controlling for other forms of malnutrition in the LMICs of the sample (Table 5.11).

[58] As explained in Chapter 3, several variables were considered to explore the relationship between stuntingoverweightness and population levels of education. The final selection was for PRIMARY, RATIOEDU. This was in part due to the updates to the sample as new DHS were released and data availability. The sample size was maintained at 73 by using these variables only.

Table 5.11 Stuntingoverweightness and Socioeconomic Development, Linear Regression Results (not controlling for Globalisation and Urbanisation)

	BM1	M22	M23	M24	M25	M26	M27
% Stunted	0.124***	0.105**	0.115**	0.114**	0.122**	0.115**	0.116***
	0.034	*0.034*	*0.033*	*0.038*	*0.036*	*0.036*	*0.034*
% Overweight	0.459***	0.520***	0.518**	0.389***	0.462***	0.472***	0.421***
	0.105	*0.107*	*0.112*	*0.115*	*0.109*	*0.106*	*0.107*
Log (Adult Obesity) females	1.166*	1.289*	0.780	0.996*	1.171*	1.471**	1.566**
	0.433	*0.429*	*0.477*	*0.44*	*0.439*	*0.501*	0.476
GNI		-0.0002*					
		0.000					
LABOUR			-0.018				
			0.015				
SANITATION				-0.001			
				0.012			
WATER					-0.010		
					0.014		
PRIMARY						-0.013	
						0.015	
RATIOEDU							-0.046
							0.025
(Constant)	-4.855**	-4.051	-2.868**	-4.786*	-3.981	-3.934	-1.262
	1.891	*1.915*	*2.337*	*2.028*	*2.254*	*3.262*	2.949
R-squared	0.275	0.324	0.303	0.265	0.270	0.358	0.299
N				73			

Within the sample, GNI per capita (US$PPP) ranges from 330 in Liberia (2007) to 14,290 in Gabon (2012). Using GNI as an indicator of socioeconomic development, there is no apparent relationship with stuntingoverweightness in the bivariate analyses performed. The correlation coefficient between stuntingoverweightness and GNI was not found to be significant (*r*= 0.042, CI -0.19: 0.27). In a simple linear regression model no significant association between GNI and stuntingoverweightness was found (β= -0.02, CI -0.06: 0.02). When introduced into Baseline Model 1 (Table 5.1; Table 5.11), however, a statistically significant association is found between GNI and stuntingoverweightness. For every $1000 increase in GNI per capita (current US$, PPP) there is an associated 0.2% increase in stuntingoverweightness prevalence. This result suggests that, when controlling for other forms of malnutrition, stuntingoverweightness is associated with higher levels of economic development. This coincides with the considered drivers of the AT, suggesting that as social and economic development continues the nutritional profile of population's changes – although as I argue it is to a more diverse burden of malnutrition not a double burden of malnutrition.

Upon introduction to BM2, however, there is no remaining significant association between GNI and stuntingoverweightness, controlling for all other variables (Model 28, Table 5.12). In Model 28, the regression coefficient for GNI is no longer significant (β= 0.000, CI -0.0004: 0.00002).

These results highlight that the level of socioeconomic development is important to the development of stuntingoverweightness – where higher levels of development are associated with higher levels of stuntingoverweightness. Additionally, they highlight that stuntingoverweightness emerges further along in a population's NT. However, the variance in stuntingoverweightness explained by GNI is captured by indicators of the levels and pace of urbanisation and globalisation. Beyond GNI the relationship between globalisation and stuntingoverweightness remains – suggesting greater rapidity in globalisation indicated by fixed broadband internet users is associated with greater levels of stuntingoverweightness. Furthermore, the interaction between INTERNET5 and child stunting remains – highlighting that stuntingoverweightness is more prevalent in countries with a diverse burden of child malnutrition, where levels of stunting remain unacceptably high in the face of increased child overweightness and adult obesity, although the levels of stunting are lower than those populations at earlier stages of the NT. As before, however, there is no evidence for a relationship between stuntingoverweightness and urbanisation at the population level; the regression coefficients for both URBAN and URBAN40 are still not significant (Model 28, Table 5.12).

Table 5.12 Stuntingoverweightness and Socioeconomic Development, Controlling for the Level and Pace of Urbanisation & Globalisation

	BM2	M28	M29	M30	M31	M32	M33
% Stunted	0.144***	0.139***	0.142***	0.156***	0.150***	0.154***	0.140***
	0.036	*0.037*	*0.037*	*0.039*	*0.04*	*0.043*	*0.039*
% Overweight	0.500***	0.548***	0.499***	0.477***	0.494***	0.439***	0.464***
	0.109	*0.113*	*0.11*	*0.113*	*0.111*	*0.12*	*0.115*
Log (Adult Obesity) females	1.059*	1.118*	1.010*	0.996*	1.065*	1.257*	1.471**
	0.433	*0.434*	*0.475*	*0.44*	*0.436*	*0.536*	*0.501*
URBAN	0.023	0.031	0.022	0.028	0.025	0.03	0.019
	0.018	*0.018*	*0.018*	*0.019*	*0.018*	*0.021*	*0.019*
URBAN40	-0.003	-0.003	-0.002	-0.002	-0.003	-0.003	-0.003
	0.002	*0.003*	*0.003*	*0.003*	*0.002*	*0.003*	*0.003*
	1.6	-0.455	-0.659	-0.737	-0.659	-0.711	-0.662
INTERNET	-0.936	*0.562*	*0.557*	*0.561*	*0.556*	*0.586*	*0.554*
INTERNET5	-2.258*	2.202*	2.228*	2.311*	2.289*	2.211*	1.94
	0.911	*0.963*	*0.979*	*0.969*	*0.975*	*1.075*	*1.003*
INTERNET5*Stunting	-0.138*	-0.138*	-0.136*	-0.140*	-0.142*	-0.138	-0.11
	0.062	*0.062*	*0.063*	*0.062*	*0.063*	*0.071*	*0.067*
GNI		0.00					
		0.00					
LABOUR			-0.004				
			0.016				
SANITATION				0.011			
				0.013			
WATER					0.006		
					0.014		
PRIMARY						0.002	
						0.016	
							-0.026
RATIOEDU							*0.025*
(Constant)	-5.167**	-5.497**	-5.194	-6.513**	-6.196*	-6.529*	-3.934
	2.038	*2.037*	*2.602*	*2.282*	*2.526*	*2.802*	*3.262*
R-squared	0.376	0.401	0.366	0.373	0.367	0.302	0.358
N				73			

In addition to GNI, the relationship between LABOUR and stuntingoverweightness was explored. Within the sample the percentage of total female population age 15+ in the labour force ranges across LMICs from 13.7% in Iraq (2006) to 88.3% in Tanzania (2010). Labour participation rate, female (% of total female population age 15+) for each country in the sample is an indicator of socioeconomic development and has been shown to be positively associated with rising levels of female empowerment, autonomy and equality – which can have a positive impact on child health and nutrition (Kabeer 2005; Kerber et al. 2007). There is a statistically significant correlation between stuntingoverweightness and LABOUR (r= -0.29, CI -0.48: -0.06), highlighting the protective effect of female employment participation of child nutritional outcomes. This protective effect is also found in a simple linear regression (β= -0.04, CI -0.07: -0.01). However, when controlling for other forms of malnutrition in the population, this significant relationship is no longer witnessed (Model 23, Table 5.11). This highlights that the protective effect of LABOUR on stuntingoverweightness is also explained by other forms of malnutrition – notably child overweightness and adult obesity, which are themselves associated with higher levels of socioeconomic development. Introducing LABOUR to BM2 shows this is consistent when controlling for globalisation and urbanisation as well, highlighting that LABOUR is important in alleviating stuntingoverweightness but is part of a wider context of higher and more rapid socioeconomic development. Key to the question of globalisation and urbanisation – the pace of globalisation remains significant (indicated by INTERNET5) controlling for LABOUR, but there is still no evidence for the level and pace of urbanisation determining the nutritional profiles of LMICs today at the population level.

Within the sample the primary completion rate (PRIMARY) ranges from 26.84 in the Central African Republic (2006) to 120.32 in the Maldives (2009). Although increased educational levels are associated with higher levels of socioeconomic development, which could in turn see a reduction in stuntingoverweightness in LMICs, there is no statistical relationship found in the bivariate analyses (r= 0.037, CI -0.20: 0.27; β = 0.004, CI -0.02: 0.03). Additionally, when controlling for other forms of malnutrition in the population there is still no statistically significant relationship between PRIMARY and stuntingoverweightness (Model 26, Table 5.11). This lack of a statistically significant association remains when introducing indicators of the levels and pace in globalisation and urbanisation. Thus, there is no evidence that population-level primary completion rates are associated with stuntingoverweightness. Moreover, the positive relationship between the pace of globalisation and stuntingoverweightness remains – whilst there is still no evidence for urbanisation and the pace of urbanisation (measured at the population level) on the level of stuntingoverweightness and diverse burden of malnutrition faced by LMICs today (Model 26, Table 5.11). As explained in Chapter 3, a key feature of education and its protective effect on child health also lies in the equality of education between males and females – particularly given the importance of maternal education for child health outcomes (Bicego & Boerma 1993). To assess the association between population level educational attainment and gender inequality in attainment on stuntingoverweightness, the relationship between stuntingoverweightness and RATIOEDU was explored.

The ratio of girls to boys in primary and secondary education ranges from 53.43 in Somalia (2006) to 109.35 in Suriname (2006). This clearly indicates that a large gender divide in education exists in Somalia. A lower RATIOEDU is indicative of decreased female education levels and more traditional values and gender roles, which have been shown to affect health care behaviours such as access to health care facilities and utilisation. This is particularly important for children as it is likely the current gender inequality of educational enrolment was paralleled in their mother's generation. Low levels of maternal education have consistently been shown to limit the autonomy and empowerment of mothers, which hinders health seeking behaviours as well as lowering levels of health related knowledge overall – leading to poor nutritional outcomes in children (Bicego & Boerma 1993). However, the bivariate analysis shows no indication of a relationship between RATIOEDU and stuntingoverweightness at the population level. The correlation coefficient was -0.041 but no statistically significant correlation was found (CI -0.286: 0.209). Additionally, in a simple linear regression model no statistical association between RATIOEDU and stuntingoverweightness was found (β= -0.008, CI -0.06; 0.04). When introduced to BM1 and BM2 there is still no statistically significant relationship between RATIOEDU and stuntingoverweightness (Model 27, Table 5.11; Model 33, Table 5.12).

The percentage of the population with access to improved sanitation facilities ranges from to 8.8 in Niger (in 2006) to 98.6 in Uzbekistan (in 2006) among the LMICs of the sample. There was no significant correlation found between SANITATION and stuntingoverweightness (*r*= 0.202, CI -0.02: 0.41). In a simple linear regression model there was no significant association found between SANITATION and stuntingoverweightness (β= 0.016, CI -0.01: 0.03). Controlling for other forms of malnutrition in the population, there is still no evidence of a relationship between population level access to improved sanitation facilities and stuntingoverweightness (Model 24, Table 5.11). Additionally, controlling for the level and pace of globalisation and urbanisation there is no statistically significant relationship found (Model 30, Table 5.12). Of importance to this analysis is that the pace of globalisation is still associated with an increased prevalence of stuntingoverweightness, whilst there is still no evidence of urbanisation and its pace of onset having a relationship with stuntingoverweightness at the population level in LMICs. SANTIATION is an indicator of the wider socioeconomic development of a population. Low levels of access to improved sanitation facilities not only suggest lower levels of development, but also greater risk of infectious disease transmission – where consistent infections can lead to stunting among children. If stuntingoverweightness develops sequentially, then stunting would be a necessary predisposition for the development of stuntingoverweightness. At the same time, overweightness requires access to excess macronutrients and tends to be associated with higher levels of stuntingoverweightness. These conflicting requirements are likely to manifest in a macro environment ripe for the development of stuntingoverweightness – the dual concurrence of under- and overnutrition within one individual. This could explain why no significant relationship with stuntingoverweightness is found at the population level.

Finally, the relationship between WATER and stuntingoverweightness was explored. WATER (the percentage of the rural population with access to improved water source) ranges from 8.3 in Somalia (2006) to 99.3 in Belarus (2005) among the LMICs of the sample. The variable indicates the low levels of socioeconomic development specifically in rural areas, as well as the development level of the whole population and to an extent the inequality of development within a population. There is no significant association found between WATER and stuntingoverweightness either in the bivariate analyses (*r*= 0.07, CI -0.15: 0.3; β= 0.01, CI -0.02: 0.03) or when controlling for other variables. Controlling for other forms of malnutrition in the population, there is no significant association between WATER and stuntingoverweightness (β= -0.01, CI -0.04: 0.02; Model 25, Table 5.11). Additionally, there is no statistically significant association found when controlling for the level and pace of globalisation and urbanisation (β= 0.01, CI -0.02: 0.03; Model 30, Table 5.12). Thus beyond WATER, the pace of globalisation is still found to be a driver of higher levels of stuntingoverweightness.

5.3.1 Summary

The results of this section have shown evidence that stuntingoverweightness does occur at higher levels of socioeconomic development – as indicated by both GNI and LABOUR. However, their effect on the variation in stuntingoverweightness is captured by other forms of malnutrition and indicators for the level and pace in globalisation. For this reason neither variable will be introduced to the final model selected for the analysis. However, it is important to note that the pace of globalisation (as indicated by INTERNET5) is still significant above and beyond the variation explained by both GNI and LABOUR, adding weight to the evidence that the pace of globalisation is a key contributor to the disjuncture in the NT as seen in LMICs today (away from the original NT seen in MDCs). Moreover, the fact that stuntingoverweightness prevalence is greater at higher levels of socioeconomic development indicates that it is a result of a more advanced NT than is seen in countries with lower levels of stuntingoverweightness. This is fundamental to the argument of this thesis – that as

LMICs today move along their NT in the face of rapid globalisation, there is an increasing divergent burden of malnutrition that is not just a burden of under- and overnutrition but also a burden of paradoxical MNIs.

5.4 Stuntingoverweightness Prevalence and Population Health Systems - Availability and Accessibility

As noted in Chapter 3, Section 3.2, three variables were included to test the effect of a population's health system on the prevalence of stuntingoverweight. These three variables were: government expenditure on health as percentage of gross domestic product (GDP) (HEALTHEXP); out-of-pocket health expenditure as percentage of total private expenditure on health (OOP); and unmet need for contraception as percentage of married women ages 15-49 (UNMET). These variables are described in Table 5.13.

Table 5.13 Population Health System Variables

Variable	Description	Mean	Std. Dev	Min	Max
HEALTHEXP	Health Expenditure, total (% of GDP)	6.31	2.31	2.29	18.14
OOP	Out-of-pocket health expenditure (% of private expenditure on health)	77.19	23.09	7.28	100
UNMET	Unmet need for contraception (% of married women age 15-49)	21.82	9.57	1.1	40.6
N	73				

Within the sample, the health expenditure as percentage of GDP ranges from 2.29% in Congo (Brazzaville) (2011) to 18.14% in Sierra Leone (2008). There is no statistically significant correlation found between stuntingoverweightness and HEALTHEXP (r= 0.05, CI -0.18: 0.27), nor is a statistically significant association between stuntingoverweightness and HEALTHEXP found in a simple linear regression (β= 0.05, CI -0.19: 0.29). Upon introduction to BM1, there remains no statistically significant relationship between stuntingoverweightness and HEALTHEXP when controlling for other forms of malnutrition in the population (β= -0.06, CI -0.27: 0.14; Model 34, Table 5.14).

Table 5.14 Stuntingoverweightness and Population Health Systems, Linear Regression Results (not controlling for urbanisation and globalisation)

	BM1	M34	M35	M36
% Stunted	0.124***	0.129***	0.115**	0.114**
	0.034	*0.035*	*0.033*	*0.038*
% Overweight	0.459***	0.469***	0.518**	0.389***
	0.105	*0.108*	*0.112*	*0.115*
Log (Adult	1.166*	1.209*	0.780	0.996*
Obesity) females	*0.433*	*0.440*	*0.477*	*0.44*
HEALTHEXP		-0.065		
		0.000		
OOP			0.013	
			0.011	
UNMET				0.004
				0.03
(Constant)	-4.855**	-4.706*	-6.354**	-5.239*
	1.891	*1.958*	*2.217*	*2.264*
R-squared	0.275	0.270	0.282	0.257
N		73		

Controlling for level and pace in globalisation and urbanisation along with other forms of malnutrition, there is still no statistically significant association between stuntingoverweightness and HEALTHEXP (β= -0.14, CI -0.42: 0.14) (Model 37, Table 5.15). HEALTHEXP was introduced to reflect greater availability of health care systems to the population; however it fails to capture the quantity and quality of health care systems in populations. It is arguable that the variable captures only the prominence placed on it from government funding but not the 'real' status of a country's health system. It could be that the lack of relationship seen here is either due to the large variability in access, availability and quality of health systems within populations and/or that there is a disjuncture between governmental funding and the resultant access to and quality of health care systems.

The relationship between OOP and stuntingoverweightness was explored because OOPs have consistently been shown to be a barrier to health care access – particularly among poorer segments of society (Gotsadze et al. 2005). Within the sample the percentage of total private health expenditure spent on out-of-pocket payments ranges from 7.29% to 100%. From the bivariate analyses, no statistically significant association between stuntingoverweightness and OOP is observed (r= 0.16, CI -0.07: 0.38; β= 0.02, CI -0.01: 0.04). When controlling for other forms of malnutrition there is still no statistically significant association observed between stuntingoverweightness and OOP (β= -0.01, CI -0.01: 0.04; Model 34, Table 5.14). Furthermore, controlling for the level and pace of both globalisation and urbanisation there is still no statistical associated found between stuntingoverweightness and OOPs (β= 0.01, CI -0.01: 0.03; Model 38, Table 5.15). This does not mean there is no relationship between OOPs, barriers to health care and child nutritional outcomes – but just that this relationship is not directly observed at the population level. Regardless of the relationship between stuntingoverweightness and OOP, the positive association between the pace of globalisation remains (as indicated by the increased number of fixed broadband internet users per 100 people in the last 5 years).

The final health system variable used to assess the relationship between stuntingoverweightness and the access/availability of health care is UNMET. UNMET (the unmet need for contraception (as percentage of married women age 15-49)) was included to better capture the limited accessibility and availability of health care for mothers with child nutritional outcomes – as the indicator refers to women of reproductive age (ages 15-49)[59]. Within the sample, UNMET ranges from 1.1% in Kyrgyzstan (2005) to 40.6% in Uganda (2011). Thus among the LMICs of the sample, Uganda appears to have the largest unmet need for contraception. The bivariate analyses show no statistically significant relationship between stuntingoverweightness and UNMET (r= -0.09, CI -0.33: 0.16; β= -0.02, CI -0.09: 0.04). Controlling for other

[59] Although it does not completely capture this as not all 15-49 year olds are mothers, and UNMET refers to an unmet need for contraception and not health care

forms of malnutrition, the relationship between stuntingoverweightness and UNMET is not found to be statistically significant (β= 0.004, CI -0.06: 0.06, Model 36, Table 5.14). The relationship is also not found to be significant when controlling for the level and pace of either globalisation or urbanisation (β= 0.016, CI -0.04: 0.08; Model 39, Table 5.15). These results show no relationship between UNMET and stuntingoverweightness as the population level. However, the results do show that a greater pace of globalisation is significantly associated with increased rates of stuntingoverweightness when controlling for population health systems. Additionally, these results do not suggest that there is no relationship between access and availability to health care and child nutritional outcomes within populations.

Table 5.15 Stuntingoverweightness and Population Health Systems, Linear Regression Results (controlling for other forms of malnutrition and level and pace in globalisation and urbanisation)

	Base Model 2	**M37**	**M38**	**M39**
% Stunted	0.144***	0.149***	0.153***	0.139**
	0.036	*0.037*	*0.037*	*0.042*
% Overweight	0.500***	0.509***	0.476***	0.503***
	0.109	0.111	0.112	0.138
Log (adult Obesity)	1.059*	1.151*	1.182*	1.140*
Female	*0.433*	*0.44*	*0.447*	*0.495*
URBAN	0.023	0.019	0.021	0.024
	0.018	*0.018*	*0.018*	*0.022*
URBAN40	-0.003	-0.002	-0.003	-0.004
	0.002	*0.003*	*0.003*	*0.003*
INTERNET	1.6	1.792	1.764	1.601
	0.936	*0.957*	*0.956*	*1.014*
INTERNET5	-2.258*	-2.405*	-2.369*	-2.385*
	0.965	*0.98*	*0.978*	*1.042*
Interaction Term	-0.138*	-0.151*	-0.149*	-0.134
INTERNET5*Stunting	*0.062*	*0.064*	*0.064*	*0.068*
HEALTHEXP		-0.139		
		0.138		

OOP			0.01	
			0.011	
UNMET				0.016
				0.3
(Constant)	-5.617**	-5.033*	-6.706**	-5.858*
	2.038	*2.16*	*2.319*	*2.469*
R-squared	0.376	0.381	0.379	0.367
N		73		

5.4.1 Summary

The results of this section have shown no relationship between stuntingoverweightness and the access to and availability of health care at the population level. However, the variables included in this analysis do not reflect the quality of health services within a population, nor the nature of health care behaviours. Additionally, as stuntingoverweightness is considered an indicator of diversity in malnutrition, it is conceivable that an aggregate level analysis is masking the true nature of the relationship between health care access and nutritional outcomes occurring within the population – this is known as the ecological fallacy. What the results have shown, however, is a consistent significant and positive relationship between divergent malnutrition burdens and the pace of globalisation, reinforcing the hypothesised drivers of the AT but showing that they are actually related to diverse (not double) burdens of malnutrition.

5.5 Stuntingoverweightness and Population Health

The results of the inclusion of variables indicating population health into Baseline Model 2 are now explored. Chapter 2 highlighted the interrelation between the demographic, epidemiological and nutrition transition (DT, ET and NT respectively). The variables explored for their relationship with stuntingoverweightness in this section (life expectancy at birth e_0, total fertility rate (TFR), deaths from non-communicable diseases per 100,000 people (NCDs) and the infant mortality rate (IMR)) indicate the stage of the ET and DT a population is undergoing. These variables are described in Table 5.16.

Table 5.16 Population Health Variables

Variable	Description	Mean	Std. Dev.	Min	Max
e_0	Life expectancy at birth (years)	62.47	8.99	44.07	76.63
TFR	Total Fertility Rate (births per woman)	3.93	1.66	1.19	7.60
NCDs	Deaths from Non-Communicable diseases per 100000 population	502.4	243.3	159.60	949.5
IMR	Infant deaths per 1000 live births	48.87	28.36	7.30	127.5
N	73				

Within the sample e_0 ranges from 44.07 years in Sierra Leone (2008) to 76.63 years in Albania (2008). No significant correlation is observed between stuntingoverweightness prevalence and e_0 (*r*= 0.07, CI -0.16: 0.29). Furthermore no significant association is found between stuntingoverweightness and e_0 in a simple linear regression model (β =0.02, CI -0.04: 0.08). Controlling for other forms of malnutrition, there is still no evidence for a relationship between stuntingoverweightness and life expectancy at birth (β= -0.019, CI -0.09: 0.05; Model 40, Table 5.17). Moreover, there is no relationship found between stuntingoverweightness and life expectancy at birth when also controlling for the level and pace of both globalisation and urbanisation (β= 0.03, CI -0.5: 0.11; Model 44, Table 5.18).

The TFR ranges from 1.19 in Bosnia (2006) to 7.6 in Niger (2006). At the population level, no significant relationship is found between TFR and stuntingoverweightness in either the bivariate or multivariate analyses. In the bivariate analyses the correlation coefficient was -0.08 (CI -0.3: 0.15) and the regression coefficient was -0.11 (CI -0.42: 0.22). Controlling for other forms of malnutrition, the regression coefficient for TFR on stuntingoverweightness was 0.27 (CI -0.16: 0.7) (Model 41, Table 5.17). Further controlling for the level and pace of globalisation and urbanisation, there remains no statistically significant relationship between stuntingoverweightness and TFR (β= 0.11, CI -0.33: 0.56; Model 45, Table 5.18).

Table 5.17 Stuntingoverweightness and Population Health, Linear Regression Results (not controlling for level and pace of urbanisation and globalisation)

	BM1	M40	M41	M42	M43
% Stunted	0.124*** *0.034*	0.115*** *0.038*	0.100* *0.038*	0.133** *0.039*	0.099** 0.036
% Overweight	0.459*** *0.105*	0.469*** *0.107*	0.499*** *0.109*	0.438*** *0.114*	0.493*** 0.105
Log (Adult Obesity) females	1.166* *0.433*	1.126* *0.441*	1.060* *0.439*	1.199* *0.441*	1.102* 0.429
e_0		-0.019 *0.034*			
TFR			0.270 0.216		
NCDs				0.001 *0.001*	
IMR					0.019 0.011
(Constant)	-4.855** *1.891*	-3.412 *3.245*	-5.225** *1.907*	-5.498* *2.333*	-5.136** 1.874
R-squared	0.275	0.268	0.281	0.267	0.294
N			73		

Within the sample, the number of deaths from non-communicable diseases per 100,000 people by LMIC ranges from 150.96 in Niger (2006) to 949.54 in Serbia (2005). There is no evidence of a statistically significant relationship between stuntingoverweightness and NCDs. For the bivariate analyses the correlation coefficient was found to be 0.218 (CI -0.01: 0.42), while the regression coefficient from the simple linear regression was 0.02 (CI -0.001: 0.04). Controlling for other forms of malnutrition in the population, there is still no statistically significant relationship between stuntingoverweightness and NCDs (β= 0.001, CI -0.003: 0.004; Model 42, Table 5.17). When additionally controlling for the level and pace of globalisation and urbanisation there remains no statistically significant relationship found between stuntingoverweightness and NCDs (β= 0.003, CI -0.001: 0.006; Model 46, Table 5.18).

Table 5.18 Stuntingoverweightness and Population Health, Linear Regression Results (controlling for level and pace of urbanisation and globalisation)

	BM2	**M44**	**M45**	**M46**	**M47**
% Stunted	0.144***	0.156***	0.133**	0.169***	0.140**
	0.036	0.04	0.042	0.041	0.041
% Overweight	0.500***	0.484***	0.519***	0.448***	0.505***
	0.109	0.112	0.116	0.117	0.112
Log (Adult Obesity)	1.059*	1.135*	1.008*	1.131*	1.050*
Female	0.433	0.445	0.447	0.435	0.438
URBAN					
	0.023	0.024	0.021	0.027	0.022
	0.018	0.018	0.018	0.018	0.018
URBAN40		*-0.002*	*-0.003*	*-0.002*	*-0.003*
	-0.003	0.003	0.002	0.003	0.002
	0.002				
INTERNET	1.6	1.656	1.501	1.621	1.582
	0.936	*0.941*	*0.961*	*0.932*	*0.947*
INTERNET5	-2.258*	-2.376*	-2.170*	-2.284*	-2.227*
	0.965	*0.98*	*0.986*	*0.961*	*0.983*
Interaction term	-0.138*	-0.148*	-0.13	-0.144*	-0.136*
INTERNET*stunting	*0.062*	*0.064*	*0.065*	*0.062*	*0.064*
e0		0.03			
		0.038			
TFR			0.115		
			0.223		
NCDs				0.002	
				0.002	
IMR					0.03
					0.013
(Constant)	-5.617**	-7.966*	-5.673**	-7.571**	-5.623**
	2.038	*3.622*	*2.052*	*2.559*	*2.053*
R-squared	0.376	0.372	0.368	0.381	0.366
N			73		

Finally, the relationship between stuntingoverweightness and IMR was explored. Within the sample the IMR ranges from 7.3 in Belarus (2005) to 127.5 in Sierra Leone (2008). There is no statistically significant correlation between stuntingoverweightness and IMR (r= -0.02, CI -0.24: 0.21); there is also no statistically significant association found between stuntingoverweightness and IMR in a simple linear regression model (β= -0.001, CI -0.02, 0.02). The relationship between stuntingoverweightness and IMR does not become significant when controlling for other forms of malnutrition within a population (β= 0.02, CI-0.02, 0.04; Model 43. Table 5.17) nor when additionally controlling for the level and pace of globalisation and urbanisation (β= 0.003, CI -0.02: 0.03; Model 47, Table 5.18).

5.5.1 Summary of Results

The results of this section have shown no statistically significant relationship between stuntingoverweightness and either life expectancy at birth e_0, total fertility rate (TFR), deaths from non-communicable diseases per 100,000 people (NCDs) or the infant mortality rate (IMR). Whilst this analysis has not been able to provide an indication of the interrelation between the NT, DT and ET at the population level, it does not mean direct interrelationships don't exist within populations. What is apparent, however, is that a faster pace of globalisation (indicated by INTERNET5) remains significantly positively associated with stuntingoverweightness above and beyond the introduction of indicators of population health. This underlines the role of globalisation in the divergence of malnutrition burdens of LMICs.

5.6 Stuntingoverweightness, the Agricultural Industry and Food Availability

For this stage of the analysis, variables are introduced indicating two key features of a country's food system – the agricultural industry and food availability. The variables assessed are: value added as percentage of GDP by agriculture (AGRI_GDP) and the food production index (FPI); calories per capita (total) (KCAL); the percentage of total calories from animal fats (FATS); and the percentage of total calories from sugars and sweeteners (SUGAR). In addition, the shift in the composition of the diet for the last 10 years is of interest, thus variables for the percentage change in the proportion of total calories from fat (FAT10) and the percentage change in the total proportion of calories from sugars and sweeteners (SUGAR10) and their relationship with stuntingoverweightness is explored. These variables are detailed in Table 5.19. Data from the FAO Food Balance Sheets (FBS) (necessary for KCAL, SUGAR, FAT, SUGAR10 and FAT10) was not available for all countries in the sample, thus all analyses using the FBS data were run on a smaller sample where n=70. As a result the only two variables (AGRI_GDP and FPI) available for the full sample (n=73) are discussed first.

Table 5.19 Agriculture and Food Availability Variables

Variable	Description	Mean	Std. Dev.	Min	Max
AGRI_GDP	Agriculture, value added (% of GDP)	22.24	13.25	3.37	65.59
FPI	Food Production Index	111.35	15.96	77.69	156.77
KCAL	Calories per capita (total)	2499.493	368.33	1604	3406
SUGAR	Percentage of total calories from sugars and sweeteners	7.61	4.40	1.23	17.58
FAT	Percentage of total calories from animal fats	1.59	3.66	0.10	5.59
SUGAR10	Percentage change in the proportion of calories from sugars and sweeteners	0.38	2.00	-4.58	7.87
FAT10	Percentage change in the proportion of total calories from fat	0.08	0.99	-2.87	5.67
N					73

Within the sample the value added (as percentage of GDP) by agriculture in LMICs ranges from 3.37 in Jordan (2012) to 65.59 in Liberia (2007). There is no significant relationship found between AGRI_GDP and stuntingoverweightness. In bivariate analyses the correlation coefficient (for AGRI_GDP with stuntingoverweightness) was -0.072 (CI -0.30: 0.17), whilst the regression coefficient was -0.013 (CI -0.06: 0.03). Controlling for other forms of malnutrition in the population did not render the relationship between stuntingoverweightness significant (Model 48, Table 5.20), nor did controlling for the level and pace of globalisation and urbanisation (Model 50, Table 5.21).

Table 5.20 Stuntingoverweightness and Agricultural Industry Variables, Linear Regression Results, (not controlling for level/pace of globalisation and urbanisation)

	BM1	M48	M49
% Stunted	0.124***	0.119***	0.100*
	0.034	*0.038*	*0.038*
% Overweight	0.459***	0.469***	0.499***
	0.105	*0.107*	*0.109*
Log (Adult Obesity) females	1.166*	1.126*	1.060*
	0.433	*0.441*	*0.439*
AGRI_GDP		-0.019	
		0.034	
FPI			0.006
			0.015
(Constant)	-4.855**	-3.412	-5.29
	1.891	*3.245*	*2.709*
R-squared	0.275	0.268	0.269
N		70	

As explained in Chapter 3, the FPI represented the aggregate volume of disposable agricultural production relative to the period 2004-2006 (FPI 2004-2006 =100) (FAO 2013). A higher FPI indicates greater agricultural production relative to 2004-2006 and gives an indication of relative production across all LMICs of the sample. FPI ranges from 77.69 in the Maldives in 2009 (indicating a constriction in food production) to 156.77 in Malawi in 2010 (indicating an expansion of food production relative to the 2004-2006 period). No statistically significant relationship was found between FPI and stuntingoverweightness. The correlation coefficient was –0.06 (CI -0.28L 0.18); the regression coefficient from a simple linear regression model was -0.008 (CI -0.04: 0.03). When controlling for other forms of malnutrition in the population, the relationship was still not found to be significant (β= 0.006, CI -0.02: 0.04; Model 49, Table 5.20). When additionally controlling for the level and pace of globalisation and urbanisation the relationship again was not found to be statistically significant (β= 0.008, CI -0.02: 0.04).

Table 5.21 Stuntingoverweightness and Agricultural Industry Variables, Linear Regression Results (controlling for levels and pace of globalisation and urbanisation)

	BM2	M50	M51
% Stunted	0.144***	0.142**	0.142***
	0.036	0.043	0.037
%Overweight	0.500***	0.499***	0.500***
	0.109	0.114	0.111
Log (adult obesity) females	1.059*	1.057*	1.074*
	0.433	0.479	0.448
URBAN	0.023	0.026	0.021
	0.018	0.019	0.018
URBAN40	-0.003	-0.003	-0.003
	0.002	0.003	0.002
INTERNET	1.6	1.581	1.63
	0.936	0.991	0.948
INTERNET5	-2.258*	-2.258*	-2.312*
	0.965	1.012	0.983
Interaction	-0.138*	-0.138*	-0.139*
INTERNET5*stunting	0.062	0.066	0.063
AGRI_GDP		0.011	
		0.026	
FPI			0.008
			0.015
(Constant)	-5.617**	-5.852*	-6.438*
	2.038	2.43	2.728
R-squared	0.376	0.358	0.358
N		70	

The results thus far show no indication that the agricultural sector – neither its size (with respect to value added to GDP – AGRI_GDP) nor its recent expansion/decline (FPI) – is associated with stuntingoverweightness. These variables aimed to capture the effect of changing world food systems, but it is also important to look at the changing composition of the diet that Drewnowski and Popkin argued was integral to the shift in stages of the NT – the establishment of obesogenic environments.

As noted in the Chapter 3, the FAO FBS were used as the data source to create indicators of both the current levels of calories in the diet and the current composition of the diet. The issue with the FBS was that there were instances of missing data from the WB DataCatalog and the GHO, restricting the sample size to 70. Given the inextricable link between food availability and population nutrition, I did not want to the exclude analyses of food availability variables but needed the greatest possible number of cases for the analyses. As a result, the analysis of food availability data (only) is based upon a sample of 70 – not the 73 of before. Thus Baseline Model 2 will also only include these 70 cases. The results of these models were checked carefully to ensure consistency in results with the larger sample. The results were consistent, indicating that they are robust despite the removal of 3 cases.

Across the sample, the calories available per capita range from 1604 kcal per capita in Burundi (2009[60]) to 3406 in Egypt (2008). The composition of the diet also varies across widely across the LMICs of the sample. In Burkina Faso only 1.23% of total calories per capita come from sugars and sweeteners, whilst 17.58% of total calories per capita come from such sources in Suriname (2006). Additionally, the proportion of total calories emanating from animal fats ranges from 0.1% in Liberia[61] (2007) to 5.59% in Belize. In the last 10 years, the proportion of calories from sugar has decreased by 4.58% in Zimbabwe and increased by 7.87% in Malawi. The proportion of total calories from animal fats has decreased by 2.87% in Peru but increased by 5.67% in Albania.

The literature suggests that the world's diet is converging, that dietary intake is increasing in quantity in all populations and moreover converging in composition (Hawkes 2006). However, within the sample 9[62] of 70 countries saw a decline in overall calories per capita in the last 10 years. Additionally, although the literature insists that diets are universally 'sweetening' (Popkin 2003), only 45 countries of the 70 in the

[60] FAO data was only available up to 2009, although data on stuntingoverweightness prevalence relates to the year 2010

[61] This was re-checked for consistency with the FBS from FAOSTAT and found to be correct according to the FAO

[62] Belarus, Burundi, Guyana, India, Kenya, Suriname, Uganda, Uzbekistan, Zambia, Madagascar

sample actually saw an increase in the proportion of calories from sweeteners and sugars in the last 10 years[63]. Only 34 saw a rise in the proportion of calories coming from animal fats, the 36[64] other countries of the sample saw a decline. These results suggest that there is a much greater diversity in NTs than previously thought. Whilst the weight of the evidence would suggest that overall the quantity of foods available are increasing, there is no evidence to suggest that in the last 10 years the composition of diets in LMICs has been converging – at least at the population level.

Exploring the bivariate relationships between variables on dietary availability and changing composition (KCAL, SUGAR, FAT, SUGAR10, FAT10) and stuntingoverweightness, only one variable has a statistically significant association – KCAL. There is a positive and statistically significant correlation between KCAL and stuntingoverweightness (r= 0.325, CI 0.09L 0.519). Additionally there is a significant positive association found in a simple linear regression model of KCAL with stuntingoverweightness (β= 0.002, CI 0.0006: 0.004).

What is apparent is that there is evidence of a relationship between the level of available total calories per capita and stuntingoverweight prevalence – indicating that stuntingoverweight is prevalent in populations at later stages of the NT, where a greater quantity of calories is available. However, so far no evidence has been found to link dietary composition and changes in its composition to stuntingoverweightness prevalence.

Each variable was tested in BM1 (where other forms of malnutrition in the population are controlled for) and then in BM2 (where other forms of malnutrition and the level

[63] Armenia, Belize, Bolivia, Burkina Faso, Burundi, Djibouti, Egypt, Gambia, Haiti, Mali, Morocco, Namibia, Nepal, Swaziland, Zambia, Madagascar, Zimbabwe, Belarus, Dominican Republic, Gabon, Jordan, Macedonia, Suriname, Uzbekistan and Colombia saw a proportional decline.

[64] Azerbaijan, Belize, Burkina Faso, Burundi, Cambodia, Congo DR, Djibouti, Egypt, Ethiopia, Gambia, Guinea-Bissau, Haiti, Honduras, Ivory Coast, Lao PDR, Lesotho, Malawi, Mongolia, Morocco, Mozambique, Nigeria, Sierra Leone, Vanuatu, Zimbabwe, Madagascar, Belarus, Dominican Republic, Gabon, Guyana, Jordan, Kyrgyzstan, Moldova, Peru, Thailand, Colombia

and trends in urbanisation and globalisation are controlled for). The results are displayed in Table 5.22 and 5.23 respectively.

Controlling for child stunting, child overweightness and adult female obesity a statistically significant association was found between total calories per capita (KCAL) and stuntingoverweightness. An increase of 100 calories per capita per day is associated with a 2% increase in stuntingoverweightness prevalence. This is consistent with my hypothesis that stuntingoverweightness occurs in LMICs further along their nutrition transitions. There are no statistically significant relationships found for SUGAR, FAT, SUGAR10 or FAT10 in this model. This is surprising as changing dietary composition was considered a key driver of changing nutritional profiles, yet it has not been found significant in bivariate analyses, or when controlling for other forms of malnutrition. Whilst much focus is placed upon world food systems and the quantity and composition (or quality) of diet available at the population level, there is no evidence of a direct link with the latter and stuntingoverweightness at the population level in these models (Models 53-56, Table 5.22).

Table 5.22 Stuntingoverweightness and Food Availability, Linear Regression Results, (controlling for other forms of malnutrition only)

	BM1	M52	M53	M54	M55	M56
% Stunted	0.145***	0.149***	0.102***	0.113***	0.115***	0.117***
	0.037	0.036	0.035	0.035	0.035	0.035
% Overweight	0.493***	0.498***	0.513***	0.596***	0.487***	0.495***
	0.112	0.111	0.111	0.119	0.117	0.122
Log (Adult	1.035*	0.847	1.321**	0.967*	1.042*	1.015*
obesity) females	0.447	0.427	0.480	0.453	0.463	0.471
KCAL		0.002*				
		0.001				
SUGAR			-0.164			
			0.95			
FAT				-0.416		
				0.233		
SUGAR10					0.175	
					0.124	
FAT10						0.216
						0.261
(Constant)	-5.499*	-10.243***	-3.601*	-4.149*	-4.466**	-4.434*
	2.096	3.079	1.950	1.947	1.962	1.982
R-squared	0.366	0.339	0.330	0.313	0.301	0.287
N	70	70	70	70	70	70

When KCAL, SUGAR, FAT, SUGAR10 and FAT10 were then introduced into BM2 – where the level and pace of globalisation and urbanisation is controlled for – the results were very consistent. Only KCAL is found to have a statistically significant relationship with stuntingoverweightness. Again it is a positive relationship and the magnitude of the effect is consistent – where an increase of 100 calories per capita is associated with a 2% increase in stuntingoverweightness prevalence.

Table 5.23 Stuntingoverweightness and Food availability, Linear Regression Results (controlling for levels and pace of globalisation and urbanisation)

	BM2	M57	M58	M59	M60	M61
% Stunted	0.145***	0.183***	0.137***	0.144***	0.147***	0.145***
	0.037	0.038	0.037	0.038	0.037	0.038
% Overweight	0.493***	0.474***	0.481***	0.472***	0.454***	0.487***
	0.112	0.107	0.11	0.122	0.113	0.118
Log (Adult	1.035*	1.043*	1.323**	1.050*	1.117*	1.049*
obesity) females	0.447	0.427	0.474	0.451	0.445	0.457
URBAN	0.023	0.024	0.021	0.023	0.029	0.023
	0.019	0.018	0.018	0.019	0.019	0.019
URBAN40	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003
	0.003	0.002	0.002	0.003	0.002	0.003
INTERNET	1.664	1.756	1.679	1.584	1.614	1.624
	0.951	0.908	0.937	0.973	0.94	0.982
INTERNET5	-2.308*	-2.221*	-2.143*	-2.223*	-2.229*	-2.258*
	0.98	0.936	0.972	1.005	0.97	1.025
Interaction term	-0.143*	-0.151*	-0.138*	-0.138*	-0.139*	-0.140*
INTERNET5 *Stunting	0.063	0.06	0.062	0.064	0.063	0.066
KCAL		0.002*				
		0.001				
SUGAR			-0.124			
			0.075			
FAT				0.033		
				0.073		
SUGAR10					0.189	
					0.12	
FAT10						0.048
						0.26
(Constant)	-5.499*	-11.316***	-4.943*	-5.489*	-5.961**	-5.527*
	2.096	2.974	2.094	2.11	2.092	2.118
R-squared	0.366	0.422	0.383	0.357	0.381	0.355
N	70	70	70	70	70	70

These results underline the proposition of this research, that stuntingoverweightness prevalence is higher in LMICs who are further along in their NT, thus a greater quantity of diet, and higher level of globalisation indicators will be seen. The pace of globalisation remains important for the prevalence of stuntingoverweightness, indicating possible changing dietary, values and socioeconomic status are key mechanisms in determining stuntingoverweightness among children. Interestingly there is no association to be found between stuntingoverweightness and population level indicators of urbanisation – with or without controlling for related factors such as socioeconomic development and globalisation. This is not to say that urbanisation is not important in determining the trajectory of the NT an LMIC is taking today – it is just not observable at the population level at this stage.

This is one key caveat to this analysis – it may be that dynamics within populations leading to stuntingoverweightness prevalence are being masked due to the aggregate nature of this analysis. Chapter 2 highlighted how changing socioeconomic gradients and increasing inequality were thought integral to the development of the DBM, and it is likely such inequality is not being captured in the analyses presented above.

In the next section an additional analysis is presented, to bolster this discussion and focus further on inequality. It was not presented in the main part of this chapter as the analysis relies on a heavily restricted sample and thus its results are considered tentative.

5.7 Additional Results: Stuntingoverweightness and Inequality

Chapter 2 highlighted the importance of inequality in our understanding of trends in malnutrition and population health today. This is particularly relevant for theories of the polarisation of malnutrition between socioeconomic groups, which are implicit to the theory of the AT, DBM and DBCM.

I argue that LMICs are increasingly facing a diverse burden of malnutrition and stuntingoverweightness serves as an indicator of this diversity. The socioeconomic distribution of these diverse forms of malnutrition is explored further in Chapters 6 to 9, but the consistently observed gradient in socioeconomic status and nutritional outcomes suggests that this diversity will also be distributed across levels of socioeconomic status. As a result it is expected that there will be a relationship between stuntingoverweightness and inequality in LMICs – where higher levels of inequality reflect greater socioeconomic stratification, leading to a more diverse profile of malnutrition in the population.

As explained in the methodology, the desired indicator for an analysis on inequality and stuntingoverweightness in LMICs was the GINI Coefficient – but the data was severely restricted. Two other variables were selected –the income share held by the lowest 20% (INCOME_LOW) and the poverty gap at the national poverty line (POVERTY GAP). Although using these variables meant more cases had data for variables indicating inequality, there were still large numbers of missing cases. The sample was severely restricted when including these variables into the analysis, dropping to 57 when including INCOME_LOW and to just 48 when including POVERTYGAP. Given this constriction in the sample size and concerns regarding the resulting validity of results, the inequality variables were not included on the main analysis described above in sections 5.1 to 5.2. Yet given the hypothesised importance of inequality, they were used in an additional, separate analysis.

Both variables were added to Baseline Model 2 (separately) for their respective restricted samples. Although POVERTYGAP was not found to be significantly associated with stuntingoverweight prevalence (see Appendix V for results), INCOME_LOW was. In fact, it appears that a greater income share held by the poorest 20% of the population is associated with a higher level of stuntingoverweightness (Table 5.4) – indicating that stuntingoverweightness is more prevalent in countries that appear more egalitarian (at least economically) at the population level. This is an interesting result and its interpretation is hampered by the fact that where stuntedoverweight children fall on the socioeconomic gradient is currently unknown.

Table 5.24 Stuntingoverweightness and Inequality, Linear Regression Results

	BM2	M63
% Stunting	0.144***	0.156***
	0.036	0.038
% Overweight	0.500***	0.460***
	0.109	0.108
Log(Adult Obese)	1.059*	1.746**
Females	0.433	0.45
URBAN	0.023	0.001
	0.018	0.019
URBAN40	-0.003	-0.003
	0.002	0.002
INTERNET	1.600	1.562
	(0.936)	0.84
INTERNET5	-2.258*	-1.869*
	0.911	0.867
Interaction Term	-0.138*	-0.118*
INTERNET5*Stunting	0.062	0.056
INCOME_LOW		0.371*
		0.126
(Constant)	-5.617**	-
	2.037	8.918***
		2.421
R-squared	37.2	41.92
N	73	57

As a further caveat, it is currently unknown how stuntingoverweightness develops. This affects our understanding of the dynamics between stuntingoverweightness and stunting in a population. These dynamics could have implications for the considered 'egalitarian' context in which stuntingoverweightness is observed. There are two main hypotheses I intend to put forward for the development of stuntingoverweightness (they are briefly introduced here for discussion but are detailed in greater depth in Chapters 6-9). The two main hypotheses are:

1) Stunting is a precursor to stuntingoverweightness. From this perspective a stunted child is exposed to an obesogenic environment, leading to the development of overweightness and thus stuntingoverweightness. Within this hypothesis is the question of whether stunted children are at greater risk of becoming overweight

given their chronically malnourished history – is stuntingoverweightness an example of the rapid onset of a maladaptive phenotype developed intrauterine?

2) The second hypothesis would see stunting and overweightness develop concurrently within an individual – perhaps due to energy dense, nutrient poor diets leading to both stunting and overweightness.

The interest for the analysis of inequality here is whether stunted children become stuntedoverweight children due to improved socioeconomic conditions and obesogenic environments that result from this improvement. If this were the case, the development of stuntingoverweightness would directly reduce the prevalence of stunting in a population. It may also explain why stuntingoverweightness appears to be more prevalent in more egalitarian societies – as stunted children become stuntedoverweight they are indicative of a move of the very poor to higher socioeconomic positions and thus indicative of a distribution of malnutrition by socioeconomic status within the population.

5.8 Model Diagnostics, Conclusions and Limitations of Analysis

To conclude this chapter, a final regression model was selected. It should be noted that the models included here have been presented by variable groups, yet as mentioned in the methodology an iterative model building strategy was utilised to explore the relationships between stuntingoverweightness and its potential population level determinants. Thus once all variables had been tested, I went back and analysed each model and the effects of the variables when controlling for variables from different groups controlled for. No further significant relationships came to the fore other than those already outlined in sections 5.1 to 5.7. As a result the following model was selected. This is a model that reflects the prevalent relationships found throughout the analyses and also highlights the consistent lack of association between urbanisation and stuntingoverweightness. The model was first seen in section 5.6 (Model 57, Table 5.23) and is represented again below in Table 5.25.

The model shows again that stuntingoverweightness prevalence is higher in contexts with a divergent burden of malnutrition – with child stunting, child overweightness and adult obesity all co-occurring with stuntingoverweightness. Additionally, stuntingoverweightness is indicative of greater progression along the NT – with increased levels of globalisation and greater quantities of food stuffs available, leading to a greater availability of total calories per capita.

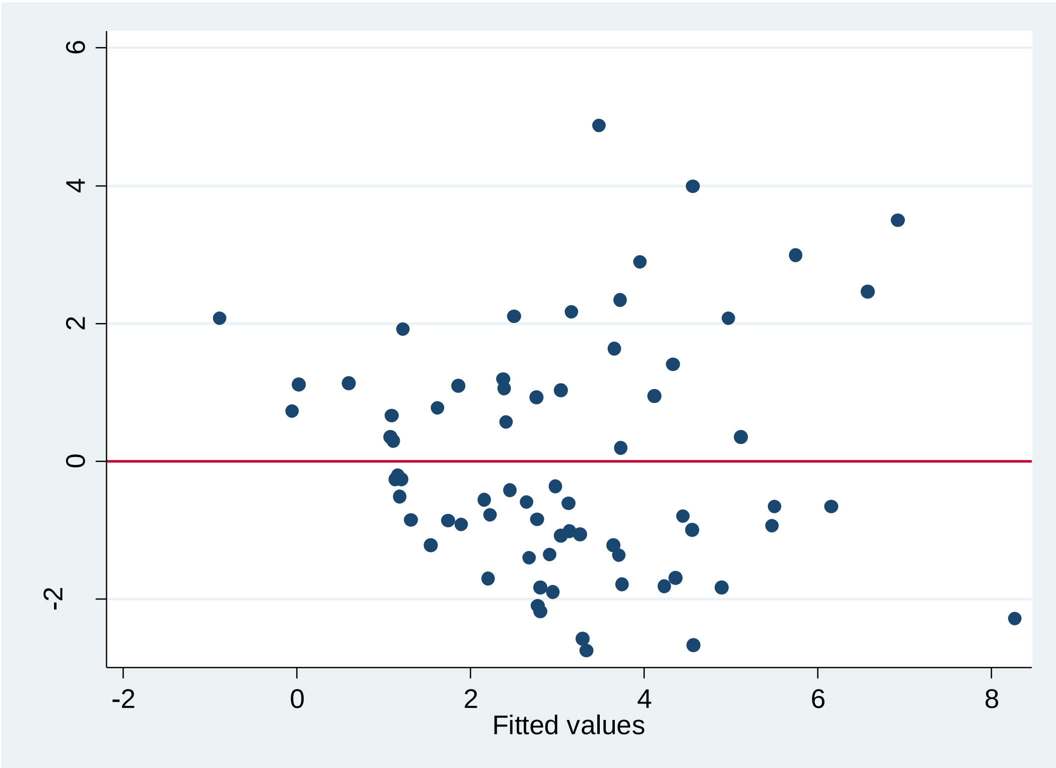
Table 5.25 Final Model – The relationships between Stuntingoverweightness, other forms of Growth Faltering Malnutrition, Globalisation, Urbanisation and Dietary Availability, Linear Regression Results

	M64
% Stunted	0.183***
	(0.038)
% Overweight	0.474***
	(0.107)
Log (Adult obesity) female	1.043*
	(0.427)
URBAN	0.024
	(0.018)
URBAN40	-0.003
	(0.002)
INTERNET	1.756
	(0.908)
INTERNET5	-2.221*
	(0.936)
Interaction INTERNET5* stunting	-0.151*
	(0.06)
KCAL	0.002*
	(0.001)
(Constant)	-11.316***
	(2.974)
R-squared	0.422
N	70

Additional pertinent results have emanated from this analysis. Namely, there is no apparent convergence in changing dietary composition across LMICs today – again highlighting the diversity in NTs that occurring. Above and beyond the observation of stuntingoverweightness, this is further evidence that the wider research community is consistently restricting itself to looking only at models of the nutrition transition that are actually occurring. Not only are many countries not seeing a 'sweetening' of the diet – many have actually seen decreased levels of sugars and sweeteners availability at the population level (25 of 70 LMICs). This is also true when considering animal fats, where there is no evidence of consistent trends in dietary composition. The greatest evidence for dietary convergence comes from general increase in the amount of calories available per capita – although even this is not seen in all LMICs.

The final model was subject to residual analyses. The model diagnostics revealed some issues with the model. Notably, the residuals highlight heteroscedasticity indicating there is some non-random variance that is not being captured by the model (figure 5.8).

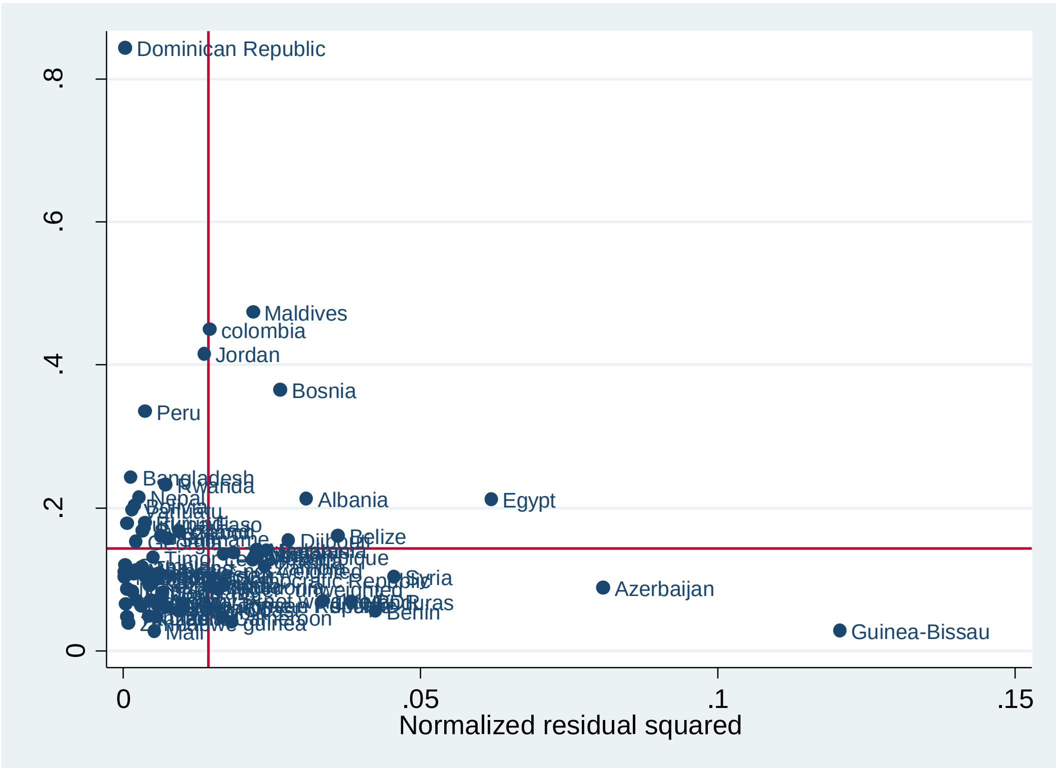
Figure 5.8 Studentized Residuals and Fitted Values Plot



It is likely that this heteroscedasticity is due to variable omission bias, with the variables in the model failing to accurately operationalise key factors associated with the nutritional profiles of population. Of particular note would be globalisation, which it has already been noted only captures a specific area of technological globalisation (ICT) – which in itself has been argued to have a plethora of effects on malnutrition – both protective and facilitating (notably spread of inaccurate health information) (Gillespie & Haddad 2003). Moreover, it is likely that the model failed to operationalise the complex relationships that determine a countries food system – notably trade policies so integral to the production, import and export of food stuffs determining the composition of the diet available to the members of a population. Above all, there are questions raised as to whether stunting, overweightness and adult obesity (female) should have been included in the model. The motivation for their use was to control for the variation in the diversity of nutritional burdens across countries – to elucidate key factors associated with the development of stuntingoverweightness, however this seems a fallacious argument given that stuntingoverweightness has been shown to be clustered within populations with diverse nutritional profiles (Chapter 4).

Another key point to make is that there are some observations with far larger residuals and greater leverage on the regression model (figure 5.9).

Figure 5.9 Normalized Residuals and Leverage for Countries in the Sample



Guinea-Bissau and the Dominican Republic are both extreme cases of this. Summary statistics for the whole sample for the variables in the model, and for Guinea-Bissau and Dominican Republic are presented in Table 5.25

Table 5.25 Summary Statistics for Whole Sample, Guinea-Bissau and Dominican Republic

			Whole Sample			
	Guinea-Bissau	Dominican Republic	Mean	Std. Dev	Min	Max
Stunting-overweightness %	8.36	0.95	3.16	2.41	0.33	10.42
Stunting %	33.50	8.84	25.36	13.38	2.13	55.94
Overweightness %	2.92	7.24	4.26	3.31	0.47	15.68
Log(Adult obesity) %	2.09	3.38	2.46	0.92	0.26	3.84
Urban	40.28	67.04	42.84	17.97	10.64	86.46
Urban 40	177.69	80.66	109.11	101.98	-37.37	489.29
Internet	0.00	1.61	0.53	1.13	0.00	5.56
Internet5	0.00	3.23	0.11	0.44	0.00	3.23
Interaction INTxStunting	0.00	-14.31	6.53	14.62	-14.31	78.34
Kcal	2411.00	2485.00	2499.49	368.33	1604.00	3406.00

It is apparent that Guinea-Bissau is an outlier when it comes to internet users –with 0.00 – this is likely an issue of data quality and an inability to thus measure the access of the population to the internet and other technological aspects inherent to globalisation. These are clear factors that need further consideration for population level analyses into nutrition.

Throughout this analysis, care has been taken to emphasise its ecological nature. From the analysis we have seen evidence of the general context in which stuntingoverweightness develops – but to be truly influential and useful to policy makers, health care workers and researchers alike, it is necessary to find out who stuntedoverweight children actually are and how they differ from their stunted and overweight counterparts. In order to achieve this, a within-population analysis is planned to uncover the determinants of stuntingoverweightness in an individual under-five. In order to conduct such an analysis one population was selected – Albania. Prior to embarking upon the next part of this thesis (the within-population analysis), the selection of Albania will be justified and the population-level context outlined.

5.8.1 The selection of Albania

Albania was selected for a within-population analysis on stuntingoverweightness. There were three reasons for its selection: 1) its diverse nutritional profile; 2) the rapid socioeconomic development Albania has faced in the last 20 years; and 3) the availability, timeliness and quality of individual-data with an anthropometric module available.

The analysis of Chapter 4 showed that Albania's nutritional profile has a very diverse burden of malnutrition. Albania has the second highest incidence of stuntingoverweightness in the sample (9.04% of under-fives). Additionally, the other burdens of growth faltering malnutrition (exclusive of stuntingoverweightness) are comparable in Albania – where 12.62% of children are stunted, and a further 10.21% are overweight. Due to this highly diverse burden, the overestimation of both stunting and overweightness rates caused by the inclusion of stuntingoverweightness were particularly high for Albania. The stunting prevalence in Albania was overestimated by 88.53% and the overweight prevalence by 71.63%. In addition, adult obesity rates are high in Albania, where 20.5% of males >20 years of age are obese and 21.7% of adult females (GHO 2011).

As a post-transition country with a history of highly restrictive self-imposed political, social and economic isolation, the magnitude of changes that have occurred in Albania in the last 30 years are arguably incomparable to any other country in the world (Gjonça 1997). The collapse of communism came at a time when the world was becoming increasingly globalised at a greater rate than any other period of time in recent history.

For Albania, in the 1990s and 2000s, this didn't transpire solely through the advent of foreign direct investments and mobile cellular networks; rather a huge array of changes associated with a transition to a market economy occurred. These included manufactured cigarettes courtesy of Philip Morris, the onset of private vehicles (cars), 'democratic' elections, Ponzi schemes and the ability to migrate both internally and internationally (migration was severely restricted under communism) (Shapo 2003; Qirjako 2008; De Soto 2002; Carletto 2004). If ever there was a natural experiment for Popkin's theories on the pace of globalisation driving a disjuncture from the 'original' nutrition trajectories of populations, Albania could have been it.

Pre-collapse, the data on malnutrition was limited and certainly not in the public domain. Since 1990, however, significant research has been undertaken on the health and mortality of the population. Gjonça showed a north-south gradient in mortality in Albania. This regional variation in mortality in Albania was shown to be consistent over time, and can be explained by differing regional dietary patterns (2001). Nutrition has long been integral to inequalities in health in Albania. With the advent of a more diverse profile of malnutrition, and notably stuntingoverweightness, it is clear there are further routes through which inequalities in health outcomes are becoming manifest – one being the development of the paradoxical concurrence of stunting and overweightness.

In 2008, the ADHS (Albanian Demographic and Health Survey) was collected (data collection finished in early 2009). The timeliness of the data made it apt for research on such a contemporaneous health issues as stuntingoverweightness. Additionally, Demographic and Health Surveys, as outlined in Chapter 3, are consistently found to be sources of high quality nationally representative data, with a standard anthropometric module enabling research into the determinants of an individual's nutritional status.

The intersection of these three factors – Albania's diverse profile of malnutrition, the huge socioeconomic upheaval that has occurred in the country in the last three decades and the availability of timely high quality data – meant that Albania was selected for the within-population analysis.

This within-population analysis will be detailed in the next four chapters. A literature review on the factors that determine malnutrition at the individual level is presented in Chapter 6, with recourse to understanding these factors in the Albanian context. Following this the methodology for the analysis is outlined, followed by the presentation of the results. In conjunction with the macro level analysis described above, the within-population analysis will cement my contention that understanding the diverse nature of malnutrition facing children today is vital to both the integrity of research and more importantly the health of future generations.

Chapter 6: Albania and the Determinants of Malnutrition

"Mish----ish---sh"

[Meat --- none to eat---but don't repeat---only whisper]

(Albanians under Communism (Jones 1993))

At the close of Chapter 5 I highlighted the need for a within-population analysis to further elucidate the determinants of stuntingoverweightness. The population selected for this within-population analysis is Albania. The model for malnutrition determinants (both under- and overnutrition) used in this analysis is a modified version of Mosley and Chen's multilevel model for the determinants of child survival. This is outlined in Part 6.1. Section 6.2 introduces the selected population and sets out the characteristics of life within Albania relevant to this framework. The determinants of child malnutrition are highlighted in order to contextualise the analysis.

6.1 A Multidimensional Approach to Stuntingoverweightness

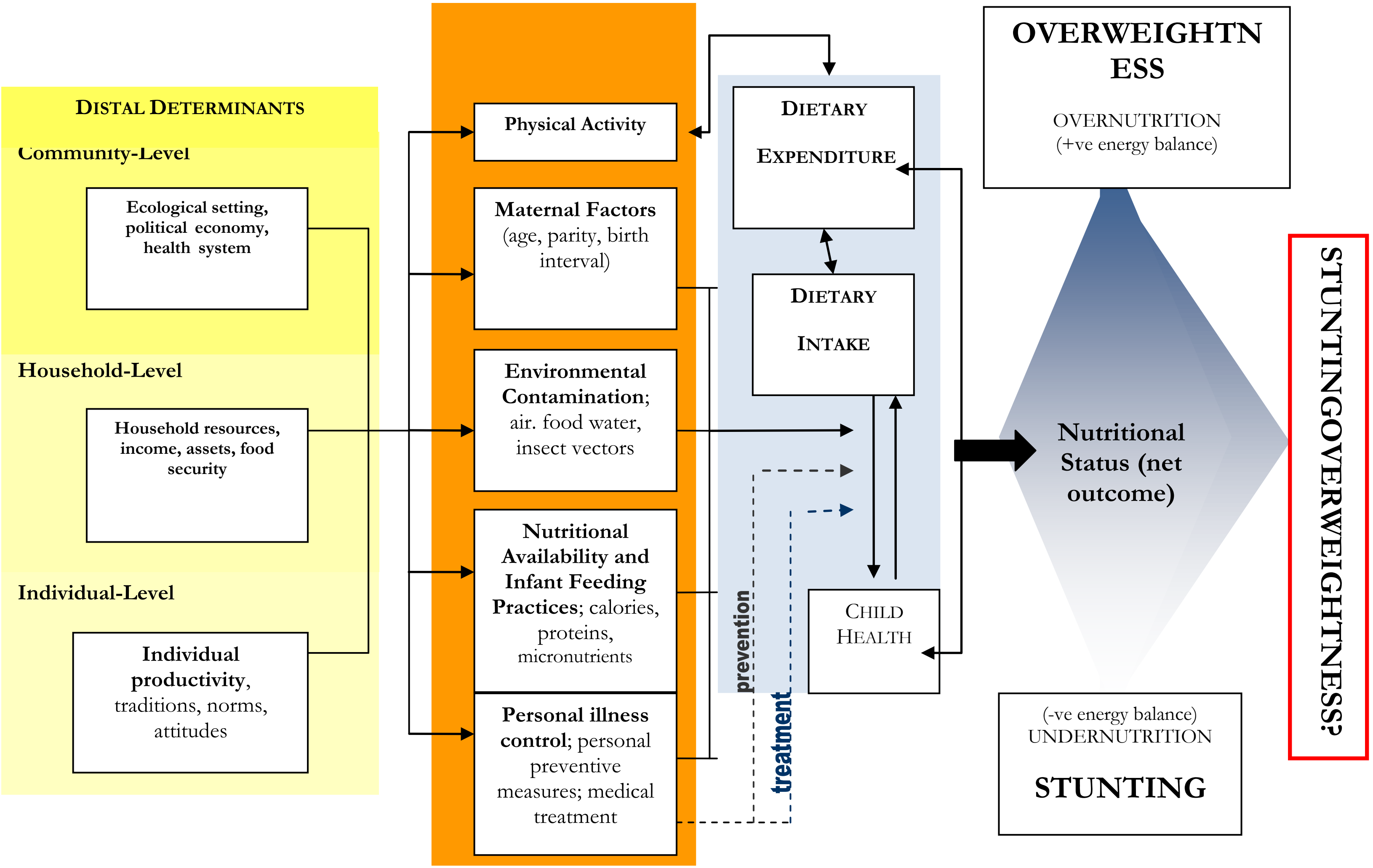
The limited research conducted on stuntedoverweight children means there is currently no understanding of how stuntingoverweightness develops. This analysis aims to address this knowledge gap and elucidate key characteristics of stuntedoverweight children as a means to identify their determinants. There is no theoretical framework for child malnutrition that defines or recognises paradoxical malnutrition outcomes – thus the framework underpinning this analysis is based upon the framework proposed by Mosely and Chen for child survival (1984).

Fundamentally, malnutrition is experienced by an individual. The trajectory that leads to and sustains their nutritional status varies according to their wider environment. The wider context determining an individual's nutritional status is not only the country in which they reside; it is their community (meso-level), household and personal (micro-level) biological and behavioural traits. For a child, their mother also has a key role in determining whether or not they become malnourished. This chapter outlines the determinants of malnutrition at these respective levels. Beyond their multilevel nature, it is important to note that these determinants can operate directly or indirectly to influence an individual's nutritional status. Proximate factors are those that impact upon the nutritional status of a child directly; these include the environment, maternal factors, nutritional availability and morbidity (Huynen, Martens et al. 2005). Distal factors are those that impact upon the nutritional status of a child indirectly through their impact upon another factor; they do not necessarily affect nutrition status directly (Krieger 2008). These distal factors include macro, meso and micro socioeconomic factors as well as cultural norms and traditions. When distal factors impact upon proximate factors or other distal factors (or both), these factors are then commonly referred to as 'intermediate variables' or 'mechanisms', and conceptualised as mediating factors (Victora, Huttly et al. 1997).

Mosely and Chens' framework is multilevel in nature. It relates direct and indirect factors that operate at multiple levels to elevate mortality risks. This framework is well-appointed for studies on malnutrition. Additionally, the risk factors Mosely and Chen propose are multifaceted, from socioeconomic factors to biological predispositions, and marry with the risk factors for malnutrition. Importantly for studies on children, the Mosely and Chen framework includes maternal factors as proximate determinants and relates them to health outcomes among children (1984). Consequently, this is one of the most comprehensive frameworks available for research on child health and important malnutrition today. Given its comprehensive and multidimensional nature, it is particularly well suited to decoding the determinants of the understudied phenomenon of stuntingoverweightness.

The theoretical framework is depicted in Figure 6.1. The key point to note about the framework is the ultimate nutritional outcomes – as stuntedoverweight children experience a net outcome of nutrition that is both excessive and deficient. It is the determinants of this nutritional status with which this analysis is concerned. As there is no theoretical framework for the determinants of this concurrent paradoxical nutrition status, the determinants of both stunting and of overweightness, separately, are considered. These are often 'two sides of the same coin', as will become apparent as the discussion moves on to discuss the determinants of nutritional status presented in the framework. It is the hypothesis of this research that stuntedoverweight children will nonetheless be distinct from those who are separately stunted or singularly overweight. Additionally, it is hypothesised they will have a unique constellation of determinants that have previously been found to be important for both stunting and overweightness as separate phenomena. Initially the proximate determinants of nutritional status are discussed, namely: the 'environment' (section 6.1.1); 'maternal factors' (6.1.2), 'genetic and biological factors' (6.1.3); 'nutrient availability/diet' (6.1.4); and 'personal illness control' (6.1.5). Following this the distal factors determining a child's nutritional status are discussed: firstly cultural values and norms (section 6.1.6); then specific socioeconomic factors operating at the household, maternal and individual levels (6.1.7) (termed micro); and then at the community level (6.1.8) (termed meso). The terminology used here of 'meso' (for community) and 'micro' (for the individual, maternal and household levels) is not strictly correct but nonetheless provides a useful separation point to make the discussion clearer.

Figure 6.1 Theoretical Framework



Adapted from Mosley and Chen Framework for Child Survival (1984)

6.1.1 Environment

The role of 'environment' on nutritional outcomes is wide-ranging and includes conditions relating to the production of food and disease ecology (Jonsson 1993). In this instance, environment is understood to be the geographic context in which people live (Oppong and Harold 2010).

For countries that rely on food produced self-sufficiently within their borders, the environmental context determines the types of crops that can be cultivated and animals reared. As intra-population food production is highly sensitive to environmental conditions in which the population is situated, it is dependent upon the physical environment and seasonality of the geographic context (Ehrlich, Ehrlich et al. 1993). If intra-country food production fails to provide a diet of sufficient nutritional quality to pregnant women and mothers, neonates and exclusively breastfed children are at a higher risk of undernutrition. The lack of appropriate diet will also directly impact upon the nutritional status of children who are not exclusively breastfed and those who are weaned, which can lead to undernutrition among children. For a population relying on intra-country food production that provides a diet of mainly animal fats and refined sugars or diets providing excessive energy intakes, there may be a greater risk of maternal overweightness. Obesity can impact negatively upon the developing foetus, leading to overnutrition (this is discussed further in part 6.1.2 on maternal factors). For weaned children, a diet determined by the environment of the population may be one that is energy-dense and rich in animal fats and refined sugars, which can lead to overnutrition in children. However, global food production, distribution and thus supply to a population are parts of an increasingly complex web of political, social, economic and biophysical factors, and can very rarely be considered as determined solely by the environment in which a population or individual is situated (Grivetti 1978; Ehrlich, Ehrlich et al. 1993). Furthermore, within a population there are likely to be differentials in food availability that can lead to intra-population variations in the diet available and thus impact upon child malnutrition.

Disease ecology refers, here, to factors that determine the spatio-temporal patterns of infectious diseases. This is important for malnutrition due to its impact upon morbidity, which can consequently impact upon the nutritional status of a child (Pimental, Tort et al. 1998). The incidence of infectious disease is a result of the interactions of populations with each other in and with the surrounding environment. Infectious diseases are transmitted directly, via a host (e.g. zoonotic diseases) or by an infectious agent (e.g. vector-borne diseases). The environmental context of disease affects the transmission of infectious diseases due to the impact upon these modes of transmission (Oppong and Harold 2010). An example includes diarrheal diseases, where an environment consisting of poor sanitation and water supply and overcrowding, typical of rapidly urbanising areas in developing countries, can result in the transmission of pathogens (Behm 1991; Levine and Levine 1995; Pongou, Ezzati et al. 2006).

Infectious diseases highlight the synergistic relationship between malnutrition and morbidity, as morbidity such as diarrhoea or acute respiratory infections can lead to malnutrition, whilst malnutrition itself increases an individual's susceptibility to infectious diseases and increases the severity of infection (Black 1984; Martorell and Ho 1984; Fotso and Kuate-Defo 2005). As with the availability of food, disease ecology affects undernutrition, although it has not been linked to overnutrition amongst children.

Environment can be a contributing factor to the determination of a child's nutritional status, although it is one of many factors and its importance varies between contexts. Thus the relevance of environmental conditions to nutrition research context needs to be considered. The 'environment' in terms of rural/urban divisions and infrastructure, such as sanitation and health care facilities, will be discussed in parts 6.1.7 and 6.1.8.

6.1.2 Maternal Factors (Biological)

Maternal factors include age, parity, birth interval and maternal nutritional status, all of which have been shown to affect the nutritional status of infants and children. Parity refers to the number of child born alive by a woman. Nulliparous women have never given birth to a viable infant; women that have given birth to one live infant are referred to as primiparous. The term birth interval refers to the period between successive births. Maternal nutritional status is measured by the Body Mass Index (BMI) with females having a BMI>25 defined as overweight and >30 as obese (WHO 2011). The effect these factors have been shown by research to have on the nutritional status of under-fives is discussed below.

Increased maternal age and nulliparity are linked to elevated risks of low birthweight (undernutrition) (Raymond et al. 1994). Low maternal age is also associated with poor health outcomes among infants, notably higher mortality rates, which are thought to be due to higher rates of low birthweight among younger mothers (Fernald et al. 2007; Friede et al. 1987). The risk of low birthweight children is also considered to be greater for individuals born following a short birth interval (<24 months) and to mothers with high parity (≥3 children) (Kramer 1987). Furthermore, malnourished (in terms of undernutrition) mothers are more likely to give birth to low birthweight individuals, increasing the risk of morbidity, growth failure and mortality (Kadiyala et al. 2009). Thus maternal age and parity have been shown to be independently positively associated with undernutrition among neonates (Thomson, Billewicz et al. 1968). This has long term consequences for the health and development of an individual.

Maternal obesity has been shown to be a significant risk factor for congenital anomalies in neonates, including neural tube defects (Ray, Wyatt et al. 2005). It is also associated with obstetric complications and with increased mortality risks in neonates (Catalano and Ehrenberg 2006). Furthermore, increased maternal BMI has also been associated with the increasing prevalence of large-for-gestational age and macrosomic births (over 4kg) (Ananth and Wen 2002; Surkan, Hsieh et al. 2004).

Maternal factors including age, parity, birth interval and nutritional status have been shown to be linked to the nutritional outcomes of infants. Due to the long-term implications of birthweight on the health of an infant and child, highlighted by the

Barker hypothesis – discussed in Chapter 2 – the importance and impact of maternal factors on the nutritional status of an individual throughout the life course is emphasised.

6.1.3 Genetic and Biological Factors

Genetic and biological factors refer to factors inherent to the individual, including age, sex and their genetic make-up.

Age is an important factor in the development of both stunting and overweightness. Research has shown that stunting (or growth faltering) can begin immediately after birth, with growth faltering occurring before three years of age being irreversible (Shrimpton, Victora et al. 2001). Two critical periods for the development of obesity under the age of five years have been observed, which come in gestation and in early infancy (Dietz 1994). Age has also been implicated in the development of stuntingoverweightness, with one hypothesis for its development arguing that it develops successively. From this hypothesis, stunting is theorised to develop first, due to early childhood growth faltering, which is followed by rapid weight gain later on in childhood (Wang and Lobsten 2006). In such a situation, stuntingoverweightness could be said to occur 'subsequently' – where stunting occurs first, followed by an onset of overweightness.

It has been argued that female children are more susceptible to malnutrition than their male counterparts, with explanations focussing on a sex-specific bias in the distribution of food within the household (Sommerfelt and Arnold 1998). However, Marcoux conducted a review of 306 child nutrition surveys and found that only 40 revealed a significant sex difference in stunting, only one of which showed females being more affected than males (2002). Furthermore, research that suggested this bias existed argued this was, as previously noted, not due to inherent biological differences between male and female children, but due to an anti-female bias in intra-household food allocation. There is thus limited evidence of a sex-specific biological bias affecting nutritional status among children (Haddad, Peña et al. 1996; Marcoux 2002). At the same time, there are known differences in the distribution of fat in the body across male and female children, as well as differential onset of health issues related to overweightness at similar levels of obesity (Sweeting 2008). However, no research exists on sex bias in stuntingoverweightness and thus the sex of the child will be considered in the analyses.

Genetic factors have been linked to children being overweight, with some research suggesting a genetic contribution to weight-for-height estimated between 40% and 70% (Barsh, Farooqi et al. 2000; Farooqi 2005). Genetic factors are thought to impact upon the regulation of body fat, with genetic variability apparent in an individual's propensity to gain weight in a particular context. However, genetic factors are just one of a number of influences that directly affect the nutritional status of an individual. Other direct determinants include morbidity and behavioural factors, such as diet and physical activity (Han, Lawlor et al. 2010). Overweightness is the result of multiple factors, both genetic and non-genetic, with the wider socioeconomic and environmental context also playing an integral role into the determination of an individual's nutritional status (Farooqi 2005). There is no information on genetic factors and stuntingoverweightness.

6.1.4 Nutrient Availability/Diet

The quantity and quality of diet, and thus the nutrients available to children, determines their dietary intake. Excessive dietary intake leads to overnutrition, with insufficient dietary intake leading to undernutrition. However, the exact nutrients and food types deemed critical for adequate nutrition among children by researchers have been subject to controversy; particularly the role of protein (McLaren 1974; Church 1979; Speth 2010).

In 2002 the World Health Organisation adopted the Global Strategy for Infant and Young Child Feeding, outlining an internationally approved (and subsequently adopted) reference detailing the recommended dietary intake for infants and children (WHO and

UNICEF 2003). According to these international guidelines, in the absence of any exceptional circumstances, all infants should be exclusively breastfed for up to six month to ensure the necessary nutrient provision for healthy development. From 6 months to 23 months of age, it is recommended that complementary feeding practices are introduced appropriately, as breastmilk can no longer provide the energy and nutrient requirements of the infant (WHO 2009).

It is important to note that even when the optimal dietary intake is provided to a child, it can still result in malnutrition. For optimal dietary intake to translate into a healthy nutritional status, a child must be able to metabolise the food correctly as well as have appropriate energy expenditure levels (Golden 2002). These two integral factors can be affected by issues such as morbidity and food preparation practices related to food hygiene.

Where poor nutrition occurs a child can become stunted (due to consistent low levels of nutrition) or overweight (due to consistent excessive intake of nutrients – particularly macronutrients). With respect to stuntingoverweightness, the second theory concerning its development is that these children are consuming an energy-dense (high macronutrient intake) diet that is micronutrient deficient – from this perspective stuntingoverweightness is considered to develop concurrently.

6.1.5 Personal Illness Control

Personal illness control, for children, relates to the illness control practices of care-givers, including the use of medical services and illness prevention practices. Personal illness control is important for nutritional outcomes among individuals, as mild and moderate malnutrition in children are likely to lead to impaired immunocompetence, with children experiencing malnutrition suffering more severe infections than their healthy counterparts, which has been linked to higher risks of undernutrition (Calloway 1982). Correct feeding practices and food preparation techniques are key components of personal illness control, as nutritious food, hygienically prepared, is vital for the maintenance of a healthy nutritional status in children. The provision of an adequate diet alone can also be considered 'illness control' behaviour, as an inappropriate diet can lead to both over- and under-nutrition as discussed in part 6.1.4.

Characteristics of the parents, the household, the community and the wider population can have an indirect impact upon personal illness control. An overview of the role of the socioeconomic characteristics of these entities and how they impact upon personal illness control explored in greater depth in sections 6.1.7 and 6.1.8. Personal illness control behaviour has also been shown to be influenced by cultural norms and the wider social landscape. The indirect role of cultural norms and social capital on both over- and under-nutrition among children will be explored in the next section.

The next section, 6.1.6, explores cultural norms and values thought to influence child nutritional outcomes. It is the first set of distal factors to be discussed.

6.1.6 Cultural Values, Norms and Social Capital

Cultural norms and social capital have been shown to indirectly impact upon child nutritional status. For example, adherence to some cultural norms that result in unsatisfactory feeding practices have a negative impact upon the nutritional status of the child (De Onis and Yip 1996). Furthermore, tradition and cultural norms that impact upon the position of women in society have been associated with poorer health outcomes in children. This is hypothesised to be due to the effect of family structure on power differentials within a household and is related to the concept of female autonomy and empowerment. Improved women's status has been shown to have a positive impact upon the nutritional status of children, which is argued to be due to a greater propensity for women to make key decisions concerning the health care behaviour applied to their children. This includes greater utilisation of health services when illness is suspected, which due to the relationship between morbidity and malnutrition would reduce the risk of undernutrition (Habicht, Martorell et al. 1974). Changes to female autonomy and empowerment have been linked to education, and this area of interest will be detailed further during a discussion of the role of maternal education in part 6.1.7.1.

The wider social landscape has been shown to be important; with research highlighting that social capital can have a positive impact upon the nutritional status of a child. Although there is no one definition of social capital, the concept encompasses aspects of 'community', 'participation' and 'empowerment' that have the potential to decrease inequalities in health (Veenstra 2005; WHO and UNICEF 2009; de Onis, Blössner et al. 2010). Social capital is hypothesised to provide knowledge and care networks for care-givers and their families, leading to improved well-being in terms of social, nutritional and healthy development. Social capital has also been shown to have a positive relationship with a household's resistance to economic shocks, which could impact upon the nutritional status of an individual through the impact of economic shocks on material conditions – in particular the availability of food that is nutritionally appropriate to avoid under- or overnutrition among children (Martorell, Mendoza et al. 1988).

6.1.7 Micro Socioeconomic Factors

Micro socioeconomic factors describe here encompass the socioeconomic status of individuals and their households, the importance of which for malnutrition is highlighted by the observation of a socioeconomic gradient in nutritional status within societies (Sobal and Stunkard 1989).

For research on children, micro socioeconomic factors are measured by proxy, utilising the individual-level socioeconomic status of the child's care-giver, head of household, or household-level socioeconomic variables as an indication of the context in which the child resides. Income (and wealth), education and occupation are key components of socioeconomic status with which health and malnutrition status vary (Adler, Boyce et al. 1994; Brenner 1995). Due to the complexity of the concept of 'socioeconomic status' (SES) at both the household and the individual level, numerous approaches to its measurement are taken with differing emphasis on each of the composing factors. Furthermore, the choice of SES measures is dependent upon the quality and type of data available (Falkingham and Namazie 2002).

As with household socioeconomic factors, individual-level socioeconomic factors of parents and care-givers include income, wealth, education and occupation which have been shown to affect child nutritional outcomes, although the exact mechanisms through which these occur are contested (Sobal and Stunkard 1989; Fotso and Kuate-Defo 2005; Poel, Hosseinpoor et al. 2008; Uthman 2009). Research has focussed on the effects of maternal socioeconomic factors, particularly maternal education, which has been described as the singularly most important determinant of child health (Caldwell 1979). All four factors – income, wealth, education and occupation – impact upon child nutritional status indirectly, and this will be explored in greater depth below.

The effect that socioeconomic factors can have on child nutrition is mediated by two separate types of mechanisms: 1) by the impact on material conditions; 2) by the impact on risk-modifying behaviour. The mechanisms involved in education, occupation, income and wealth, the key aspects of micro socioeconomic status, are explored below.

6.1.7.1 Education

Education has been the focus of much work on the determinants of child nutritional status, health and mortality. In particular there has been a focus on maternal education, which has been described as the most important determinant of differentials in child nutrition, health and survival, particularly as women are generally the primary care givers to children (Caldwell 1979). More recent literature also looks at the role that paternal education, and education levels of the household, in terms of the head of the house's education level and the differentials in education levels among key household members.

Maternal education has also been shown to have a significant positive effect on child malnutrition (Bicego and Boerma 1993; Skoufias 1999; Basu and Stephenson 2005). The mechanisms through which maternal education is hypothesised to have a beneficial impact upon child nutritional status can be divided into five categories: 1) socioeconomic status; 2) knowledge; 3) attitudes; 4) autonomy; and 5) reproductive factors (Frost, Forste et al. 2005).

Increased maternal education is both a component and determinant of socioeconomic status, both at the individual (maternal) and household levels. Higher levels of education are associated with increased levels of income, which can lead to improved material conditions including better housing conditions, greater access to nutritional diets, medicines and health care services (Black, Morris et al. 1988; Brenner 1995; Marmot, Bobak et al. 1995; Kaplan, Pamuk et al. 1996). The effect is also compounded by the observation that educated women are more likely to marry educated men, augmenting the socioeconomic status of the household (South 1991). From this perspective, maternal education can be associated with a decreased risk of undernutrition, where morbidity is reduced due to improved material conditions and sanitation conditions and the nutritional requirements of the child are met. Conversely, increased socioeconomic status may lead to increased consumption of energy-dense foods that can lead to overnutrition in children.

Research has shown that maternal education has an effect upon child health independent of other socioeconomic factors of the household (Hobcraft 1993). 'Knowledge' is argued to be one of the facets of maternal education through which impacts upon child nutrition, health and survival occur. The notion of knowledge and its role in the impact of maternal education is multifaceted, relating to enhanced cognitive skills and increased understanding of health processes as well as the effect on health behaviours itself. In relation to malnutrition, it can increase the knowledge of healthy diets, with this knowledge being translated into nutritious dietary practices and ultimately better nutritional outcomes in children, in terms of reduced levels of both undernutrition and overnutrition (Hobcraft 1993; Basu and Stephenson 2005; Frost, Forste et al. 2005). Education can directly provide greater understanding of health causation and prevention, changing health behaviours such as increasing the use of modern health care. Maternal education has also been shown to lead to more hygiene and cleanliness practices, which can reduce morbidity (for example caused by diarrheal diseases, which have been linked to undernutrition). However, this has been disputed, notably by Caldwell (1979), who did not note an inverse relationship between maternal education and diarrheal disease prevalence. Nonetheless, more recent literature has again highlighted the link between maternal education and improved hygiene behaviours (Hobcraft 1993; Basu and Stephenson 2005; Luby and Halder 2008).

Maternal education is hypothesised to lead to a shift in attitudes that translates to behaviours that result in improved nutritional status of children. In particular, maternal education is considered to lead to a shift from traditional conceptualisations of health and disease cause and prevention to an increase in the acceptance and understanding of the benefits of 'modern medicine', described in early works as a move away from 'fatalistic' notions of child illness (Caldwell 1990; Frost, Forste et al. 2005). This is hypothesised to translate into a change in health behaviours, for example greater attempts to maintain good nutrition of the child, reducing both under- and over-nutrition. Another behavioural change such as the increased use of health services is also important for reduced risk of undernutrition due to the impact upon reducing child morbidity, with which undernutrition has been shown to have a synergistic relationship (Black 1984). Research has shown that educated women are more likely to utilise medical services when their child has a cough, fever or diarrhoea (Bicego and Boerma 1993). Furthermore, research has found that maternal education can also impact upon other attitudes such as household tastes and preferences – which can lead to changes in dietary patterns within the household (Skoufias 1999). Dependent upon the resulting dietary patterns, this can lead to reduced risk of undernutrition and overnutrition, or even increased risk of overnutrition if consistently high levels of energy-dense foods are consumed. Finally, some studies have hypothesised that maternal education leads to a shift in attitudes of women focussing on 'quality' in children, seeking a healthy life encouraging the social and economic development of their children, which translates to greater investment in the child and also a lower fertility rate (Hobcraft 1993). This impacts both on the health of a child due to changes in health care behaviours towards the child, but can also be said to reduce parity, which has been linked to undernutrition in neonates.

The role of autonomy as a mechanism facilitating the impact of maternal education on child nutritional status has been emphasised in many studies. It has been argued that maternal education can shift the balance of power in household relationships, enabling women to become the primary decision makers for the care of the children (Caldwell 1979; Caldwell 1990; Hobcraft 1993). Maternal education has also been linked to an increased ability of women to question doctors and manipulate vital services integral to the wellbeing of their children (Frost, Forste et al. 2005). In this respect, maternal education can indirectly reduce the risks of undernutrition among children.

Maternal education has been linked to a greater level of reproductive control among women, delayed age at child bearing and reduced fertility levels. An indirect effect of this includes reduced parity and thus lower risk of child malnutrition as stunting has been shown to increase with birth order (Frost, Forste et al. 2005).

The role of maternal education is emphasised far more in the literature than that of paternal education. This may be rooted in past research highlighting a greater impact of maternal education on child nutritional, health and survival outcomes when compared to the impact of paternal education on child health outcomes (Caldwell 1979). More recent studies have suggested that this disparity in parental education impact remains. As a result, the paternal education is conceptualised to impact upon child nutritional outcomes via the socioeconomic mechanisms discussed previously. Higher paternal education levels are associated with increased income and wealth, which enables greater access to improved material conditions that can lead to improved nutritional outcomes in children. Higher household socioeconomic status has also been linked to different preferences, tastes and lifestyles that alter behaviours that can positively impact upon the nutritional status of a child – for instance in terms of improved nutritional intake.

As with maternal and paternal education, household-level education is considered indicative of occupation, housing facilities, neighbourhood assets and income. It can affect malnutrition through its impact upon material conditions (Brenner 1995). Household education levels can be measured either by assessing the education of the head of the household (which may or may not be the mother or father of the child) or by assessing the joint education levels of the mother and father. Household education is considered to be particularly important in determining lifestyle and behaviour within the household (Shavers 2007). Thus education levels can affect child nutrition indirectly through work and economic conditions, social-psychological resources and health lifestyle of the household (Ross and Wu 1995). The enhanced social-psychological resources argument proposed by Ross & Wu relates to greater control and problem solving capacities of the household enabling better, more effective use of health care and nutritional information leading to improved nutritional status (Ross and Wu 1995).

Overall maternal education is considered protective against stunting. However, as it is highly correlated with overweightness and overweightness is argued to current remain concentrated among higher socioeconomic groups in LMICs, it may well fuel overnutrition. The effect on stuntingoverweightness will be explored in the analysis. As a final note, the effect of socioeconomic factors (including education) is considered context-dependent, highlighting the need for a multidimensional and multilevel approach to address malnutrition.

6.1.7.2 Occupation

The occupation of the head of the household is utilised to provide an indication of household occupational group and SES. As the link between education and income, occupation (and employment) provides an indication of the income and wealth of the family. Thus the occupation of key members of the household can impact upon child nutritional status through the mechanisms of material deprivation (or lack of). There has also been evidence presented that suggests the type of employment that is undertaken can contribute to health outcomes (Marmot, Bobak et al. 1995). In relation to child nutritional outcomes, studies have shown that father's occupation does have a significant effect, with manual workers such as farm labourers being associated with poorer nutritional outcomes among children in India (De Onis and Lobstein 2010). Higher education levels are associated with decreased manual employment in individuals, as well as an increased income. Consequently fathers' occupation can be said to affect education due to the compounding effects of other socioeconomic factors such as increased education thus increased nutritional knowledge, although factors including the impact upon household decision making has also been implicated (de Onis, Garza et al. 2007).

Maternal employment and occupation has also been highlighted as having an impact upon nutritional outcome in children. Studies exploring the effects of maternal employment on nutritional status have provided contradictory results, with some suggesting a positive and some a negative impact upon child nutritional status in terms of undernutrition (Leslie 1988; Basu and Basu 1991; Glick and Sahn 1998; Glick 2002). The mechanisms through which maternal employment affects the nutritional status of children include those relating to increased socioeconomic conditions of the household, with greater income and wealth levels and thus improved household infrastructure. Furthermore, maternal employment has been linked to increased maternal autonomy and female empowerment, which has a positive effect on the household's care-giving behaviours such as food preparation practices and health care utilisation (Kalita 2006). Concurrently maternal employment has been argued to be potentially negative if it disrupts good feeding practices of infants and young children (such as breastfeeding) and care of the children. Despite these warnings, the overwhelming majority of studies highlight that higher levels of maternal employment, which is related to higher levels of maternal education, has a significant positive effect on the nutritional status of children under-five (Dibley, Goldsby et al. 1987).

6.1.7.3 Income

Household-level income was previously considered to be the most important determinant of nutritional status. Household income is most frequently measured as the labour income of the household, although it may also include remittances received by the household from economic migrants (McKenzie 1996). Household expenditure is another measure of the income levels of the household; however, it is data-intensive, which can hinder its use in research (Thomas 1993). Sufficient household-level incomes can be utilised to invest in necessary material conditions or resources that both directly (adequate food) and indirectly (including adequate housing, education and health care) affect child nutrition (Black, Morris et al. 1988; Marmot, Bobak et al. 1995; Kaplan, Pamuk et al. 1996). Increased income has been associated with positive changes in the food consumption patterns of the household, resulting in a greater consumption of nutritious diets – reducing the risks of child undernutrition (Strauss and Thomas 1995). Household income growth has also been shown to be associated with investment in better household infrastructure including sanitation facilities (Alderman, Appleton et al. 2001). Whilst increased per capita household income has been shown to have a positive relationship with the nutritional status of a child it is no longer considered a 'magic bullet' (Alderman, Appleton et al. 2001). Household income is now both a component and indicator of a wider concept of household SES, an improvement in which augments the nutritional status of children within that household (Brenner 1995). However, increasing income alone will not eliminate child malnutrition. Furthermore, research has shown that increased income can in some cases lead to increased risks of malnutrition, in the form of overnutrition, due to a negative impact on foods purchased and consumed, such as increased intake of processed foods, within a household (Popkin and Nielsen 2003; WHO 2011). The effect on stuntingoverweightness is not currently documented.

6.1.7.4 Wealth

Household wealth is closely related to income but is considered to provide a greater indication of the long term SES of a household as it is an indication of a household's accumulated assets (Sheppard, Norris et al. 2009). Consequently household wealth is also indicative of the ability of households to combat emergencies and economic shocks (Shavers 2007). Household wealth is commonly measured through the use of asset indexes. A widely used asset index is that proposed by Filmer and Pritchett based on principal component analysis (PCA) which can turn the ownership (or not) of several assets into one comparable, weighted index that relates the ownership of specific assets to the ownership or absence of others (Filmer and Pritchett 2001; Moser and Felton 2007). Furthermore, wealth measurements are more useful in contexts where there are large informal economies and remittances in-kind (remittances received as goods) (Adams 2006; Lopez Cordova and Olmedo 2006). As with income, household wealth is considered to affect child nutritional status through its impact on both material conditions and behavioural factors including access to adequate and nutritious food and health care (Hong, Banta et al. 2006).

Increased household wealth is also associated with better household infrastructure, with improved sanitation facilities being linked to reduced morbidity in children, which can lead to improved nutritional status. In particular, improved household infrastructure is associated with a reduced incidence of respiratory diseases, repeated instances of which have been shown to directly cause poor nutritional status and augment the effect of insufficient dietary supply. The effect of household wealth on stuntingoverweightness is currently unknown.

Again, the effects of household wealth are context dependent. Furthermore, the effect can be seen as representative of, as well as compounding the effects of, comparatively wealthy communities. Wealthier households tend to be in wealthier communities; however, a wealthy household in a poor area may not see the same benefits due to the contextual effects of the area. These will be explored in greater detail below.

6.1.8 Meso Socioeconomic Determinants

Socioeconomic factors can affect health at more local levels than that of the whole population. In light of this, much research focuses on community or neighbourhoods effects on the health of individuals (Diez Roux 2001; Ellen, Mijanovich et al. 2001; Pickett and Pearl 2001; Reijneveld 2002; Rajaratnam, Burke et al. 2006; Lebel, Pampalon et al. 2007; Debrand, Pierre et al. 2008; Ross and Mirowsky 2008; Kandula, Wen et al. 2009; Uthman 2009; Luke and Xu 2011). The perceived impact of community or neighbourhood on an individual's health status is referred to as 'contextual effects'. This is in contrast to the hypothesis of compositional effects, which specifies that because certain people reside in certain places, the apparent contextual effects deemed to be due to the community are actually due to the socioeconomic characteristics of the individuals who reside there (Veenstra 2005).

Nutrition research explores two areas: 1) community factors that are either derived from the characteristics of the individuals of the neighbourhood (for example, median education level); or 2) integral factors (for example, number of schools) (Pickett and Pearl 2001). The former encompasses a broad range of socioeconomic factors – including income, wealth, occupation and employment, and education – which are derived from the characteristics of the individuals, such as average per capita income (Ross and Mirowsky 2008). For these to be considered contextual effects these effects essentially based upon 'compositional' measures are conceptualised to exert a collective influence within a particular context. For example, higher maternal education levels are considered to result in a context of greater shared health knowledge (Desai and Alva 1998). The latter tends to focus on infrastructure including health care systems, transport systems and educational facilities (Rajaratnam, Burke et al. 2006; Linnemayr, Alderman et al. 2008).

Context effects are also themselves contextually dependent, thus the research context needs to be carefully considered in order to ensure that the correct context factors are explored in analyses (Pickett and Pearl 2001; Debrand, Pierre et al. 2008). Furthermore, context effects can only be confirmed or rejected appropriately by research if micro socioeconomic factors are comprehensively assessed in the research as well (Ross and Mirowsky 2008). It is particularly important to explore the association of meso socioeconomic factors with the stuntingoverweightness and diverse community nutritional profiles in this research, as the results will be able to provide an indication of what community-level policy packages may improve the nutritional outcomes among children for the overweight, the stunted and the stunted-overweight.

A recent development in the discussion of the role of socioeconomic factors and health research acknowledges that micro socioeconomic determinants are context-dependent. A key example is that the effect of maternal education has been shown to be weaker in the sub-Saharan African countries, although the reasons for this remain open to discussion (Hobcraft 1993). This has facilitated a greater focus upon the role of meso socioeconomic determinants on child health outcomes – including nutritional status, and the mechanisms through which meso socioeconomic determinants affect children's health outcomes.

Introductory studies on the role of meso factors have tended to include cluster-level fixed effects, aiming to capture the community or neighbourhood effect. This is based upon hypotheses that common neighbourhood characteristics, including community values and resources, impact upon nutritional status of children (Alderman, Appleton et al. 2001). Studies have taken the research further by assessing the differential effects of particular community and neighbourhood characteristics including education, income and infrastructure.

Neighbourhood effects are considered to impact nutrition either directly or indirectly – influencing the nutritional status of an individual through mechanisms such as the availability and accessibility of food, health services and community education. Community food security, enabling access to a sufficient and diverse diet in the community, directly impacts upon the nutritional status of a child (Tontisirin, Nantel et al. 2002).

6.1.9 Summary

This section has highlighted the multilevel and multidimensional nature of the determinants of a child's nutritional status. A consistent theme throughout the discussion is the limited research on the determinants of stuntingoverweightness. It is the hypothesis of this research that they will be found to differ from their stunted and overweight counterparts. As no known theoretical framework exists mapping the determinants of stuntingoverweightness or routes to its development, the determinants of over- and undernutrition as explored above are used to identify the distinctive characteristics of stuntedoverweight children.

Importantly, this discussion has re-emphasised the two proposed trajectories for the development of stuntingoverweightness over time. One hypothesis is that it develops concurrently – possibly due to the consumptions of energy-dense, nutrient-poor foods. Another hypothesis is that stunting develops initially, followed by overweightness when a child is exposed to a more obesogenic environment (where circumstances have changed most probably leading to a change in diet quantity and composition). The planned analysis will be conducted on cross-sectional data, so the research will not be able to indicate which (if any/both) pathway is correct but it is an important point that will be referred back to both in the results and in the final discussion concerning this research.

In order to understand the observation of stuntingoverweightness among under-fives, particularly given the limited studies in the area, a within population analysis of Albania is planned. To contextualise the study, Part 6.2 introduces Albania, its history – particularly in terms of population health – and the current context in which stuntingoverweightness exists.

Part 6.2 Health, Development and the Determinants of Malnutrition in Albania

Albania has a history of child malnutrition in her population. Under communism a network of "dystrophic hospitals" existed focussing on tackling serve malnutrition among children (Nuri & Tragakes 2002). Despite this, the communist regime did not acknowledge the existence of malnutrition in Albania and furthermore, discussions concerning food insecurity were scrutinised and thus avoided by Albanians (Nuri & Tragakes 2002; Jones 1993). The saying *"Mish----ish---sh"* in Albania reflected the restrictive nature of the communist regime and its attempts to cover up malnutrition. Colloquially it meant 'meat… there is none to eat… but don't mention it'. Its more direct translation is *[Meat --- none to eat---but don't repeat---only whisper]* (Albanians under Communism (Jones 1993: 143)).

Since the collapse of communism, discussions on malnutrition and health in the Albanian population are no longer so restricted. However, there remains limited research on child malnutrition in Albania today.

In this section a brief introduction to the historical context of Albania is presented (section 6.2.1). Following this a review of the health of the Albanian population is presented (section 6.2.2) (the focus is on health and mortality due to the absence of malnutrition research). In section 6.2.3 a move is made to explore the context of Albania directly in terms of the determinants of malnutrition described in part 6.1.

A focus on the macro-factors affecting the population of Albania is particularly important in this research due to the huge social and economic changes that have occurred within Albania since 1990. In line with the literature on the AT and what drives countries away from the original NTT, Albania has experienced both large and rapid changes in her macro socioeconomic environment and has become rapidly globalised. These are briefly explored below.

6.2.1 Historical Context of Albania

The policies of self-reliance imposed by Albania's communist regime led to a lack of export earnings, precipitating slow development and poverty (EOHCS 1999). Policy prioritised both health and education; the 1946 constitution guaranteed free education for all and, in 1950, primary school education became compulsory. Universal access to health care was also prioritised by the government. A government commitment to providing access to health care in remote areas is thought to have resulted in a health care centre in every village by 1971, making health care accessible to the vast majority of the population (Hall 1994 cited by Gjonça et al. 1997). These macro socioeconomic factors have been related to the GHLC the county experienced which have many parallels with factors in GHLC countries that were identified by Caldwell as routes to low mortality (1986). These include factors noted above, such as *'economic changes, social policy*…[emphasising universal access to]…*education, equal access to health, and equal income distribution'* (Gjonça 2001). Furthermore, during the period 1950-1989, the political agenda prioritised accessible education and medical services. The role of women was also addressed; gender discrimination was substantially reduced (Gjonça 2001). Thus socioeconomic macro factors have been particularly significant in determining the health of the Albanian population in the past.

During the 1990s, Albania underwent significant economic and social changes following the collapse of Communism. Serious economic problems emerged in the late 1980s, with a continued decline in national output averaging 1.6% per year between 1986 and 1990 (Pashko 1993). The economic crisis and political transition had severe implications for the country's infrastructure and its population's standard of living (Sardon 2001). These two issues have had an important, potentially long-lasting, impact on factors integral to shaping the health of the Albanian population. During the political and economic transition of 1991-1992 nearly 25% of health centres in Albania's cities and 60% of those in smaller villages became unusable (EOHCS 1999). With restrictions on internal migration lifted, rising unemployment and lowering standards of living provoked a large number of skilled professionals (including doctors and nurses) to migrate from rural to urban areas, in search of employment (or better pay) (James, 2000). In the northeast, the declining quality of health care due to the outflow of medical professionals was compounded by the reduced availability of drugs and reusable medical equipment such as needles (Smeets, Caushi et al. 1997). More recent literature has been encouraging concerning the macroeconomic performance of Albania (Treichel 2002). By 2000, Albania's GDP had recovered to the 1989 level (Rechel, Schwalbe et al. 2004).

There have been numerous changes in the socioeconomic context of the Albanian population since the 1990s. Although rapid changes have occurred, data for 2007 highlights that Albania, in a Central and Eastern European context (CEE), continues to be a GHLC country – suggesting a macro environment conferring good adult health has either persisted, or indicators of adult health have not yet declined. For this research on child malnutrition the important fact remains of a health gap between the health of adults and children in Albania that has been consistent over time, with GHLC for adults not being paralleled amongst children. In addition, Albania is experiencing the second highest prevalence of stuntingoverweightness and similarly high levels of overweightness and stunting. This diverse child malnutrition profile is relatively large compared to the other LMICs of the sample, and suggests there are key contextual factors that facilitated this situation – namely, as Chapter 5 suggests, rapid globalisation and development.

In addition to the rapidly changing socioeconomic context, Albania has a strong history to be told relating to the populations health. This will be described in the next section.

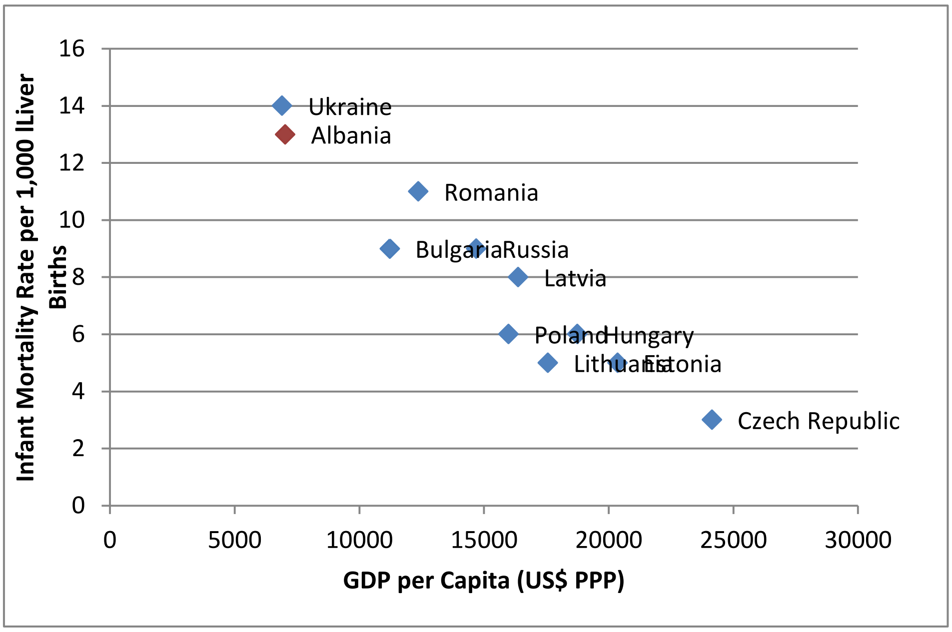
6.2.2 Introduction to Health in Albania

Despite the lack of information concerning child malnutrition in Albania, it is clearly an interesting case with great diversity in growth faltering malnutrition at the population level. To understand malnutrition in Albania further, the discussion focusses on child health – as there have been a very limited of studies on malnutrition in Albania to date.

Albania has also been experiencing a similar trajectory of divergence in her epidemiological transition (ET) as with her nutrition transition. Both endogenous and exogenous causes of death are present among Albanian infants and children. In terms of mortality and in accordance with the ET theory, where *'the most profound changes in health and disease patterns obtain among children and young women',* Albania infant and child mortality rates declined sharply before 1990 (Omran 1971: 521). However, levels of infant and child mortality in Albania remain high in comparison to other Eastern Europe post-communist countries and other European countries (Figure 6.2).

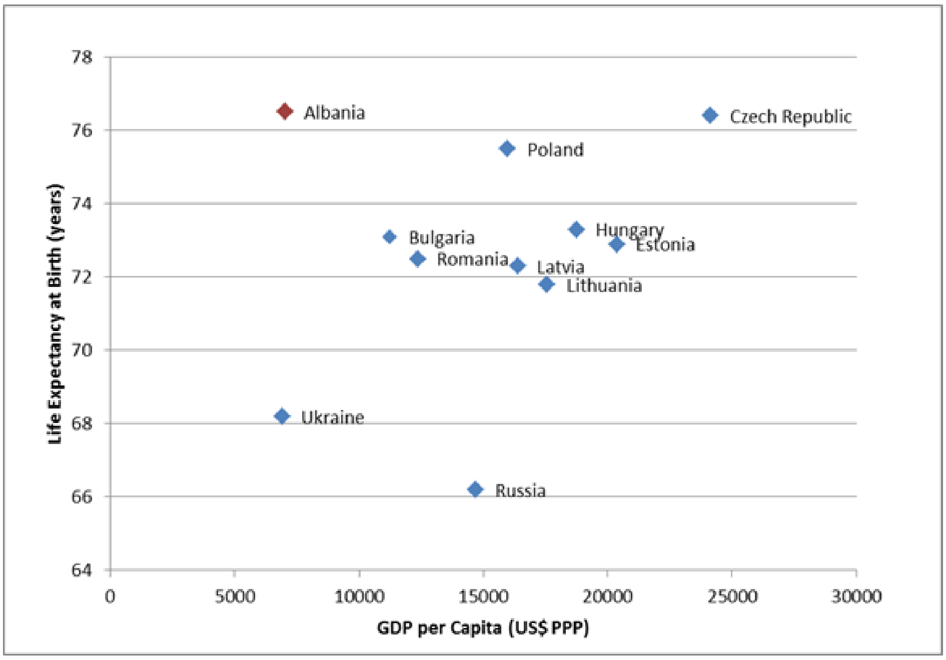
This is in sharp contrast to adult health in Albania, which has been shown to be particularly good, especially given the economic performance of the country. Gjonça demonstrated that the mortality experience of Albania, from 1950 to 1989, paralleled that of the classical GHLC countries. During this period, life expectancy at birth (e_0) rose from 51.7 in 1950 to 70.7 years in 1989, yet absolute income levels were estimated at just $390 per capita in 1990 (Gjonca 2001) (World Bank 1996 cited by Gjonça 2001). Gjonça concluded that Albania was experiencing a *'mortality paradox'* in the light of its good average population health despite poor economic performance. This mortality paradox remains in 2008 (figure 6.3).

Figure 6.2: Infant Mortality Rate and GDP per capita for Selected CEE Countries (2008)



Data Source: World Health Statistics 2010; WHO library Cataloging-in-Publication Data, WHO

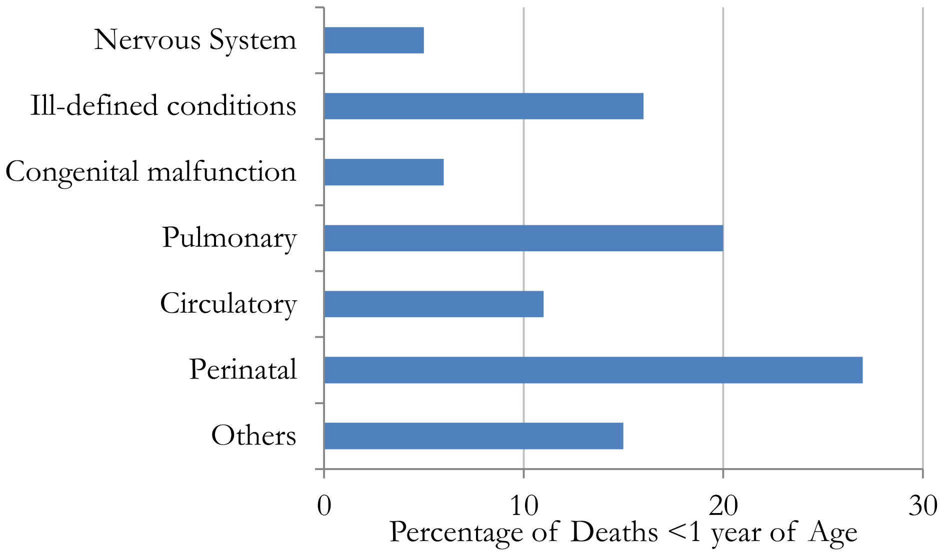
Figure 6.3: Life Expectancy at Birth and GDP per capita for Selected CEE Countries (2007)



Data Source: Human Development Report 2009 (UNDP)

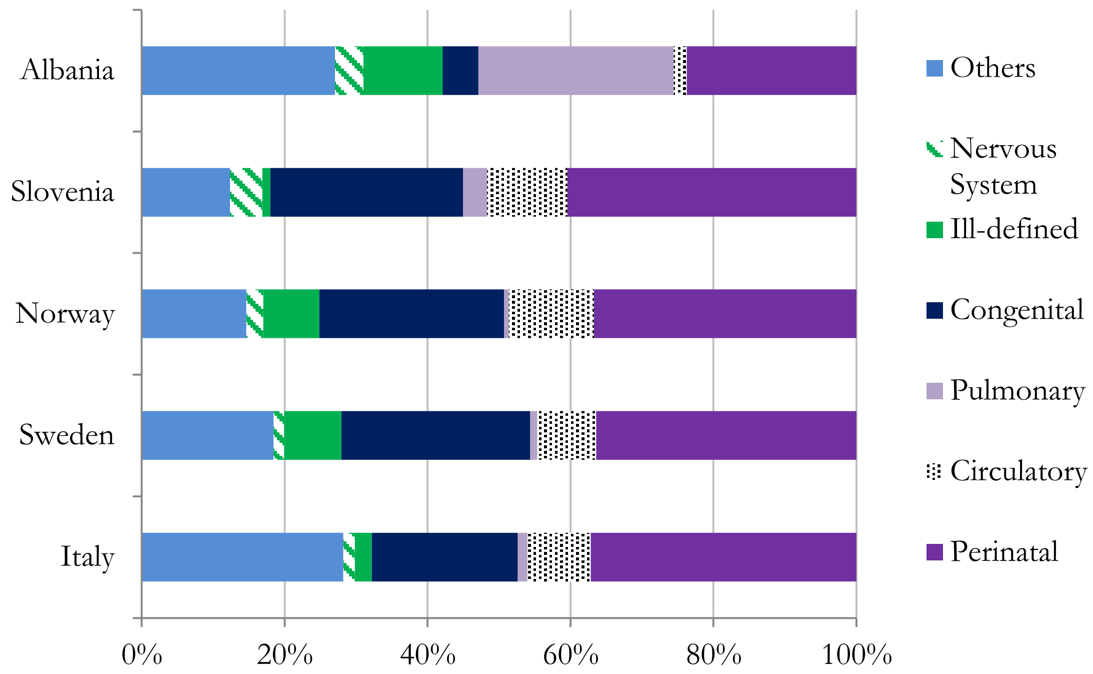
Thus the population of Albania can be said to experience a 'health gap', with worse health outcomes in children, compared to adults, for the country's GDP per capita (Figure 6.3; Figure 6.4). This health gap is also highlighted by the case of the Ukraine in the CEE context (Figure 6.3), where the high IMR is concurrent with a low e0 (Figure 6.5), unlike the high IMR and high e0 of Albania. In addition to the gap between adult and child health, the decline in infant and child mortality has not yet paralleled a displacement of deaths due to exogenous causes by those of endogenous causes (Figure 6.4). There are a greater proportion of deaths due to exogenous causes such as pulmonary diseases in Albania compared to other European countries, causes of death associated with conditions of poverty (Figure 6.4; Figure 6.5). According to the ET theory, the Albanian population can be said to be experiencing the 'contemporary' or 'delayed' model of transition that has given rise to a 'double burden' of disease within the population, with increasing rates of 'man-made' diseases in both the adult and child population, concurrent with limited decline in the proportions of the exogenous causes of death among under-fives (Murray and Lopez 1996). Given the parallels in the ET and NT it is thus unsurprising that Albania is facing a diverse burden of malnutrition given the analysis of the causes of death of the under-five population.

Figure 6.4 Causes of Death for Infants (< 1 year) Albania 2001



Data Sources: INSTAT 2002 'Causes of Deaths for the Year 2001 (According to International Classification ICD-9'

Figure 6.5 Causes of Infant Deaths as % of All-Cause Mortality for Selected Countries 2001



Data Sources: WHO Statistical Information System (WHOSIS) http://apps.who.int/whosis/database/mort/table2.cfm accessed 28/02/2010

Despite an intriguing health situation, with a double burden of disease which suggests the probability of a diverse burden of malnutrition, there has been no research on the determinants of child malnutrition in Albania using nationally representative data. This gap in the literature appears is compounded by the fact that child health has been lagging behind the health advantages of the adult population. This adult health advantage is reportedly due to favourable socioeconomic conditions and diet according (Gjonça 2001) – which are also key factors determining the malnutrition status of under-fives. This leads to question why the socioeconomic context has favoured adults but not children. In order to understand this situation further, the key factors determining child malnutrition are explored for Albania in the next section (6.3). This background information will be integral to establishing an appropriate analytical strategy with which to understand the determinants of the stuntingoverweightness in Albania.

6.2.3 Factors Associated with Malnutrition and the Albanian Context

In this section, details on the key factors determining child malnutrition in Albania as explored in Part 6.1 are presented. This will serve to contextualise the analyses and thus enabling the correct selection of variables for them. A particular note to three key 'Albanianisms' – characteristics in Albania that are unique and may be influencing child malnutrition is made – these are height, the rural/urban divide and region.

6.2.3.1 Environment of Albania

It was previously noted that two key important factors of the environment for child nutrition status are the effects of the environment on food production and disease ecology.

In relation to food production, there has been shown to be a climatic gradient within Albania that gave rise to different traditional patterns of food production and consequent consumption. These were apparent within Albania even until the early 1990s due to the closed nature of the communist government that restricted imports and exports, thus hindering the movement of the globalised food markets into Albania and requiring the Albanian population to often rely on what could be produced within the country (Gjonça 2001).

There are two distinctive areas of Albania that differ in both topography and climate. The Northern region is mountainous and experiences a continental climate. As a consequence the traditional food produce of the area was based upon foods of animal origin. The central and coastal region is lowland and experiences a Mediterranean climate. As a consequence the traditional food produce of the area was based upon olive oil, fresh fruits and vegetables (Gjonça, Wilson et al. 1997). However, since the

1990s, global food markets have penetrated the Albanian markets, introducing greater proportions of refined carbohydrates, animal fats, processed foods and confectionary to the population (De Soto, Gordon et al. 2002).

In relation to disease ecology, recent studies have suggested some environmental conditions in Albania that are beneficial to the spread of some infections. The literature has highlighted three infectious diseases associated with childhood that are linked to the environment of Albania – giardiasis, hepatitis A and visceral leishmaniasis (La Cava and Nanetti 2000; Knai, Suhrcke et al. 2007). These studies related the prevalence of the diseases to increasing urbanisation, water contamination and the presence of zoonotic reservoirs (La Cava and Nanetti 2000; Berrilli, Di Cave et al. 2006; Knai, Suhrcke et al. 2007).

6.3.2.2 Maternal factors

As highlighted previously, maternal factors including age, parity and birth interval have been shown to affect the nutritional status of infants and children. The median age of child bearing in Albania is 23.5 years, with only 2% of 15-19 year olds having given birth (Institute of Statistics., Institute of Public Health. et al. 2010). According to data from the ADHS 2008-09 the mean birth interval is 47 months, and 15% of births from 2003-2008 are subject to a birth interval <24 months in Albania. On average, the shortest birth interval occurs in the mountainous region, at 41 months (Institute of Statistics., Institute of Public Health. et al. 2010). Smoking levels among women are reportedly increasing but smoking remains rare (4%), with the highest smoking prevalence among 20-29 year old women. Smoking among women is concentrated in women in Urban Tirana (14%), women in tertiary education (15%) and women in the wealthiest 20% of the population (12%) (Institute of Statistics., Institute of Public Health. et al. 2010). In terms of malnutrition, 3% of Albanian women (all ages) have a body mass index (BMI) below 18.5, indicating undernutrition, yet 39% are overweight (Institute of Statistics., Institute of Public Health. et al. 2010).

6.2.3.3 Genetic and Biological Factors

There is one interesting genetic factor that may be important for this analysis. Albanians from the North, historically, belong to the ethnic group of the 'Ghegs', whilst Albanians of the South are 'Tosks'. An anthropological study by Coon in 1950 referred to the mountains of the NE in which the Ghegs reside as 'The Mountain of Giants' as Ghegs were found to be statistically taller than the Southern Tosks. Due to the restricted mobility prior the fall of Communism in Albania, there is unlikely to have been much change in this geographical and ethnic distribution of height prior to the 1990s, by which time most of the mothers in this 2008-09 sample were born. However, since the fall of communism huge internal migration has occurred and these mothers with their 'tall genes' may well be now found throughout Albania. As height is determined genetically (through several genes) the inheritance of height might be important to understanding the prevalence of stuntingoverweightness and stunting in Albania (as both will present a low height-for-age). This is considered an 'Albanianism'. However, it should be noted that while genes determine an individual's potential height, it is their living conditions that determine whether this potential is realised. To test for the genetic potential of a child in terms of their height, the focus will actually be on maternal height. However, as discussed further in Chapter 7, maternal height does not just reflect genetic potential of offspring it can reflect the early life experience of the mothers. There is a large body of evidence that poor nutritional outcomes in childhood (indicative of poor early life living conditions) are intergenerational, and can affect future generations. The resultant interplay between genetics and the intergenerationality of early life conditions will be important to consider when assessing maternal height and child malnutrition outcomes in Albania – particularly as the Ghegs are from the Northern areas of Albania which, as will be highlighted shortly (Section 6.2.2.8), have had consistently lower levels of socioeconomic development relative to the other areas of Albania (Gjonça 2001).

6.2.3.4 Nutritional availability/Diet

For children aged 0 to 24 months, the optimal infant and young child feeding (IYCF) programme includes the initiation of breast feeding within one hour after birth, exclusive breastfeeding for the first 6 months of life, breastfeeding to continue until 24 months, in concurrence with appropriate complementary feeding practices (WHO 2009). Only 19% of 6-23 month olds are fed according to the recommended IYCF practices in Albania (Institute of Statistics., Institute of Public Health. et al. 2010). Micronutrient intake for children 6-35 months is indicated by food consumed in 24 hours prior to the survey in the ADHS 2008-09. 88% and 84% of 6-35 month olds consume foods rich in vitamin A and iron respectively; however, children in the northeast consume the lowest levels (Institute of Statistics., Institute of Public Health. et al. 2010). Nutrient availability for 6-59 months olds is also evidenced by the adequate iodisation of salt in households, which is true for 76.2% of households in Albania.

Research has also suggested there is a regional discrepancy in nutrient availability within the population that may be affecting the nutrient availability for children (UNSCN 2006). This disparity has been argued to continue to exist, with regional disparities in the consumption of 'junk foods' emerging, particularly in the coastal region, although more research is required (Buonomo, Cenko et al. 2005) Buonomo et al. analysed a sample of 112 children who were followed for a period of six months during 2000 in the Lezhë district in the North of Albania. Iron deficiency anaemia (IDA) was found in 47% of the children and 44 out of 57 children who were fed cow's milk had IDA (Palombi, Villa et al. 2001).

6.2.3.5 Personal Illness Control

The ADHS 2008-09 provides information on personal illness control. It shows that 71% of children experiencing acute respiratory infection symptoms were taken to a medical centre, while 61% with diarrhoea were taken to a medical centre. In terms of maternal medical care, 67% of pregnant women received the recommended four antenatal appointments from a skilled professional, in line with the World Health Organisation guidelines, and 88% received a post-natal care check-up (Institute of Statistics., Institute of Public Health. et al. 2010). 95% of children aged 18-29 months are fully vaccinated (Institute of Statistics., Institute of Public Health. et al. 2010).

6.2.2.6 Cultural Norms and Social Capital

There is evidence that traditional values still penetrate the Albanian society. For example, in Albania, modern contraceptive use is low and high rates of use occur only among women with higher levels of education that reside in the capital, Tirana (Gjonça, Aassve et al. 2008). There is also a hypothesised regional variation in changing social and cultural attitudes, with research suggesting that the coastal and central regions reportedly showing the most increasing distance from traditional values in favour of more 'Western' oriented norms. Research has reported a greater level of traditional family disintegration in the coastal and central regions with females increasingly choosing their husbands (as opposed to their fathers). However, this disintegration in traditional practices is also suggested to have intensified power divisions between men and women in households, with 75% of women reporting domestic violence (Gabrieli, Sanchez et al. 2004). Moreover, there is evidence of a skewed sex ratio at birth – with excess female mortality – which could be closely related to the cultural norms and values that prevail in certain regions of Albania (Guilmoto & Guthie 2013). Further research is required to assess these changes in greater depth, but it appears possible that there are changing norms and values within Albania that could impact upon the nutritional status of children.

Social capital and child nutritional status is an understudied area of research in the Albanian context. A field test of a social capital survey was conducted in 2005 in Albania by the World Bank and the Centre for Economic and Social Studies (Albania). The survey results highlight the role of extended family groups (the 'fis') on social structure in Albania, particularly in the Northern region. The 'fis' is said to influence many decisions within the family, household and for the individual. Trust was shown to be greater in areas where the fis is strong, and vice versa in areas where there are limited extended family networks (Treichel 2002). These findings coincide with other research on the family structure in Albania, where large families are traditional. However recent work by Gjonça et al. suggests that the prevalence of large families is declining, although a small number remain in the northern part of the country (Gjonça, Aassve et al. 2008).

Concurrently however, there is an international expansion of the family network due to international migration that has led to a high amount of remittances – both financial in nature and in goods. Estimates suggest that approximately one-quarter of the economically active members of the Albanian population work abroad and send remittances in some form to their families (Rechel, Schwalbe et al. 2004).

6.2.2.7 Micro Socioeconomic factors in Albania

2004-2009 marked a period averaging 5% economic growth in Albania. In the context of the continued macroeconomic improvements, socioeconomic disparities within the country are increasing. The income distribution of the population has become increasingly skewed with poverty trends reportedly worsening, impacting upon the socioeconomic status households and individuals (Treichel 2002).

Changes in income may impact negatively on the nutritional status of children. In the case of Albania a key mechanism hypothesised for this is the widespread informal payments made to health service providers. Recent estimates suggest that 45-67% of patients make informal payments at health care facilities when seeking treatment (Vian and Burak 2006; Burak and Vian 2007). Informal payments can have a detrimental impact on the nutritional status of under-fives, notably through restricting access to health care; for example, poorer people have been shown to delay seeking treatment (Falkingham 2004 cited by Burak & Vian 2007). A delay in seeking treatment would allow the synergistic relationship between morbidity and malnutrition to thrive.

Furthermore, using data from the Albanian Living Standard Measurement Survey from 2002, Vian et al. show that the poor spend a larger proportion of the total per capita consumption on health care than their wealthier counterparts, affecting the availability of income for the purchase of other resources such as a diverse diet (Rechel, Schwalbe et al. 2004; Vian and Burak 2006).

The migration that has occurred in Albania has resulted in greater ramifications than only increasing levels of urbanisation. Data from INSTAT (the Albanian Institute of Statistics) show migration has affected all areas of Albania, with data from the ADHS 2008-09 showing that more than half of households report at least one internal or international migrant (INSTAT 2004 cited by Gjonça et al. 2008; Institute of Statistics., et al., 2010). The characteristics of migration, whether for economic reasons, internal, external, temporary or permanent, can impact upon a household's socioeconomic status. Remittances received from migrants can improve the socioeconomic status of the household, potentially having a positive effect on nutritional status (Figure 6.1) (McKenzie 1996). Furthermore, data from the ADHS 2008-09 show that a greater proportion of households with international migrants have at least one child of the emigrant remaining behind when compared to internal migrations. Parental migration has been shown to have a negative impact on child education in Albania and thus may also have a negative impact on child nutrition (Giannelli and Mangiavacchi 2010).

Migration in Albania is indicative of a changing economic environment, changes which have led to alterations in the labour market composition of Albania. As socioeconomic inequalities have increased, the number of people working in non-agricultural and private sector jobs has also increased (Mancellari, Papapanagos et al. 1996). Concurrently, there has also been a rise in unemployment in Albania (Çuka, Papapanagos et al. 2003). These labour market developments in Albania have not affected all individuals and households equally within the population and are likely to have increased disparities in nutritional status among under-fives due to these increasing disparities in socioeconomic status. .

Part 6.1 highlighted that wealth can impact upon child malnutrition due the effect upon material conditions as well as its relationship to other distal determinants such as education. The ADHS provides information on some key household assets: 92% of the households in Albania utilise improved toilet facilities, although rural areas utilise a greater proportion of toilets that are not connected to piped sewerage system (only 26.5% compared to 89.8% in urban areas). Furthermore, majority of households utilise an improved drinking water source; 97% in urban areas, 94% in rural areas (Institute of Statistics., Institute of Public Health. et al. 2010). The urban-rural differentials in wealth revealed in the presence of improved toilet facilities is important to note when analysing wealth in Albania and will inform the methodology for the analysis accordingly.

Finally, in reference to the third component of socioeconomic status at the micro level – there are thought to be increasing inequalities in educational attainment. Secondary school enrolment dropped from 80% in 1990 to about 44% in 2002 (Gjonça et al. 2008). Gjonça et al. postulate that this may well be the result of increasing inequality and poverty within Albania, necessitating a larger proportion of children of secondary age to start work early, which may then lead to a perpetuating cycle of socioeconomic inequalities through the restriction of occupation opportunities (Institute of Statistics., Institute of Public Health. et al. 2010). Given this apparent burgeoning importance of education disparities in determining the socioeconomic context of individuals, it is important this is accounted for in the analyses.

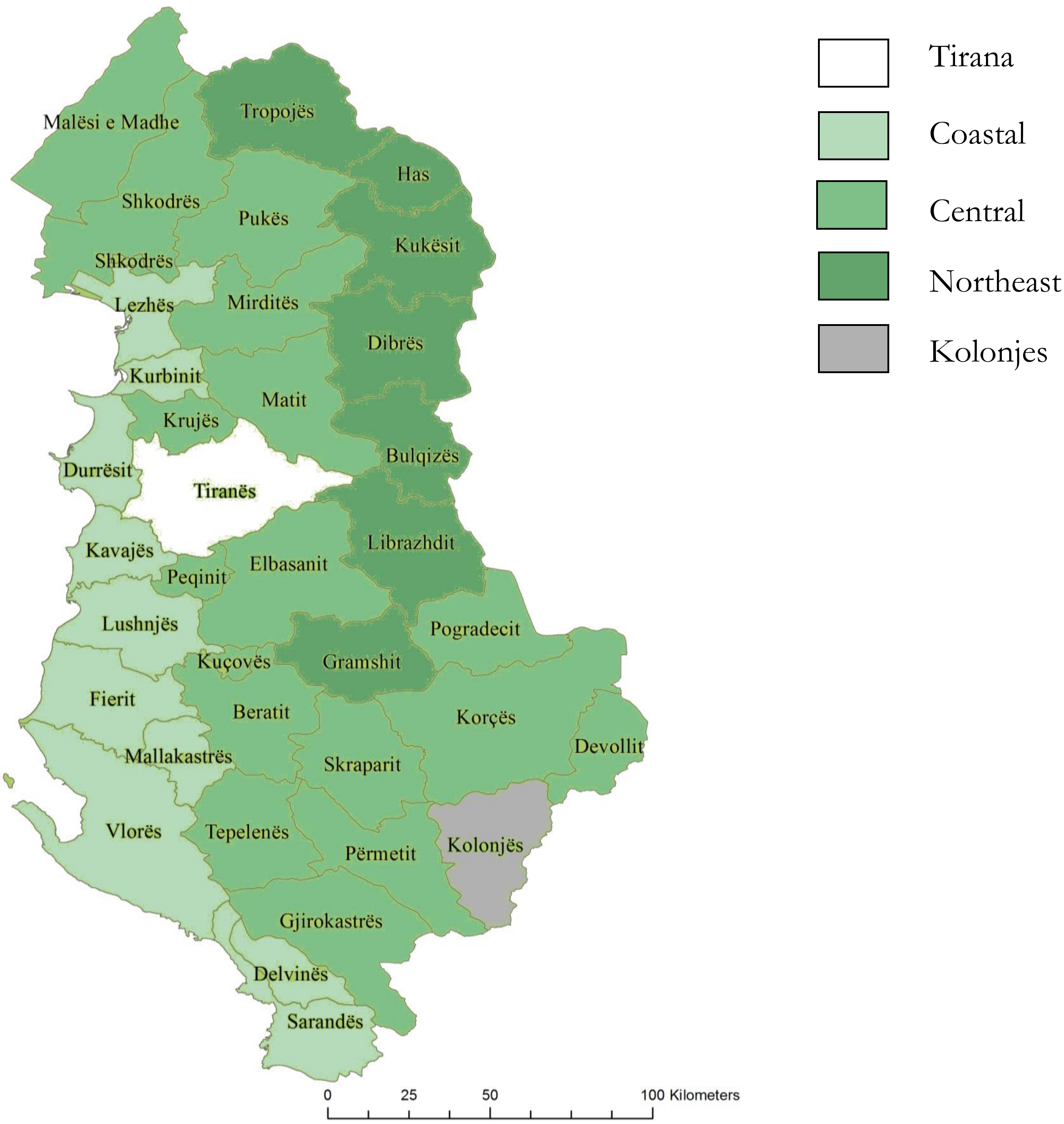
6.2.2.8 Meso Socioeconomic factors in Albania

Within Albania, contextual factors have previously been shown to be important for health outcomes among the population thus it is reasonable to consider that they will be important for malnutrition as well. Previous research has shown the importance of region of residence on adult health, with region acting as a proxy for both socioeconomic development within the country, and for tradition (Gjonça, Aassve et al. 2008). This is considered an 'Albanianism'. Within Albania there are four main regions

– urban Tirana (most developed) and the three agro-ecological/economic regions; the coastal, central and north-eastern (least developed) areas (Figure 6.6).

Additionally, under communism the government was committed to flattening the divide between the rural and urban population, with steadfast governmental commitments to providing access to health and education to the whole population – particularly in rural areas (Hall 1994 cited by Gjonça et al. 1997). This is the third 'Albanianism' this research identifies. A key cornerstone of this research will be to see if there remains a regional distribution in health (in terms of child malnutrition) and whether there is an attenuated rural/urban divide given its history. These are particular important to consider given the changes that occurred in the 1990s and onwards, with huge socioeconomic changes and high levels of migration serving to redistribute the population of Albania and potentially change the landscape of 'equality'. These changes are now described.

Figure 6.6: Districts and Regions of Albania[65][66]



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65 Note Kolonje is part of the central region – however – there is no data for under-fives in Kolonje from the ADHS – this will be explored further in Chapter 7 which describes the methodology for the analysis on Albania

66 Created in ArcGIS

As noted in Part 6.1.8, contextual effects have been related to the nutritional status of under-fives. The importance of contextual effects in Albania is further highlighted by the changing access to both education and healthcare within Albania. These further emphasise how inequalities are increasing between communities within the Albanian population in recent times.

Following the transition to a market economy in the 1990s, public expenditure on education decreased from 9% in 1990 to 8% in 1992. In absolute terms this corresponds to a fall from 1000 million lek, to just over 300 million lek (Pango 1996). Furthermore, the quality of education in Albania is said to have been declining further since the mid-1990s, accelerated by the economic crises of 1997 (De Soto et al. 2002). The decline has reportedly resulted in falling education levels, with many rural and new peri-urban areas witnessing higher illiteracy rates (*ibid*.). Community education levels will be incorporated into the analysis on the individual-level data to study stuntingoverweightness in Albania. This is particularly due to the literature that has suggested a collective effect of higher community maternal education levels, for example, on under-fives nutritional status (Desai and Alva 1998).

Alongside the changes to the economy and education within the population, restrictions on internal and international migration were lifted after communism, resulting in differential effects across communities. A combination of rising unemployment and lowering standards of living provoked a large number of skilled professionals to migrate from rural to urban areas, leading to rapid urbanisation (James 2000). In addition to rapid urbanisation, this led to an asymmetrical effect on the health care system within the country as skilled health workers moved to urban areas leading to dilapidated and ill-equipped health care services in rural and mountainous areas (EOHCS 1999; James 2000). The latest information on the health care system suggests this asymmetry remains today and as a result integral factors on the health care system in Albania should be included in the analysis on the ADHS (Tomini and Maarse 2011).

Rapid urbanisation has been linked to rapid shifts in the structure of diet, notably increases in the consumption of animal fats, sugar and decreased cereal intake (Popkin 1997). Furthermore, the migration of skilled workers may have differential implications for communities based on the community from which migrants leave and their eventual destination, potentially impacting upon health structures and education facilities within the communities. Moreover, there is a regional pattern in the number of children of emigrants remaining in the household in Albania, with the largest proportion of households reporting this experience in the north-east region (20% of households).

Evidence is also emerging of a regional disparity in nutritional changes, with the coastal and central regions of Albania becoming increasingly culturally and economically orientated towards Western European countries. In contrast, many studies have pointed to a return to traditional values in the most physically isolated areas within Albania, such as Gramsh and the northeast region of the country – areas that remain the most remote in Albania (La Cava and Nanetti 2000). There is a postulated downward turn in physical activity levels within the population, particularly in urban areas, due to the introduction of more automobiles, mechanised agricultural equipment and technologies such as the television, following transition due to liberalized imports and exports in Albania (De Soto et al. 2002). Placed in the context of the importance of traditional regional dietary patterns to the health of adults, further weight is added to the need to assess contextual factors in the Albanian population.

In a different study, Buonomo et al. found a high prevalence of low anthropometric indices in northern rural areas. The main risk factors for underweight were reported as a recent history of diarrhoea, being female and rural or mountain residency, as well as the absence of sanitation and low birthweight (Buonomo, Cenko et al. 2005). This would suggest a regional pattern to malnutrition that parallels that of adult health and mortality, and traditional dietary patterns within the country (Gjonca, Wilson et al. 1997).

6.3 Summary

This research intends to extend the knowledge and literature concerning the determinants of stuntingoverweightness through within-population analysis of Albania. In this chapter the key determinants of malnutrition have been outlined both theoretically and within the context of Albania. This chapter has shown that there is a history of malnutrition within Albania, and there are parallels between her diverse nutritional profile evidenced in Chapter 4 and the epidemiological transition occurring within the country. This chapter has paved the way to ensure analyses that are well informed are conducted to elucidate the determinants of stuntingoverweightness among under-fives in Albania. Three key 'Albanianisms' have been identified: 1) ethnic differences in height; 2) regionality; and 3) a long history of governmental commitments attenuating the rural/urban divide. These will be considered closely when assessing the results emanating from an analysis on Albania. Chapter 7, details the data and methodology employed to understand the determinants of stuntingoverweightness in Albania, given the review of the literature presented here.

Chapter 7: Data and Methodology

A failure to recognise the presence of stuntingoverweightness among children has led to a lack of in-depth analysis into the phenomenon. This is true both across and within populations. This chapter outlines the data and methods used to understand the determinants of stuntingoverweightness within a population - Albania. The data and methodology allows for a comparison of stuntingoverweightness with stunted, overweight and all other children within Albania. This thesis provides an opportunity to understand the determinants of nutritional outcomes within the context of a population experiencing a diverse burden of child malnutrition. The methods of analysis presented here, outline how the determinants of stuntingoverweightness within Albania will be uncovered.

The determinants of child nutrition within a population have been shown to be many and multilevel in nature. The Albanian Demographic and Health Survey 2008-09 (ADHS) provides a comprehensive data source with which to address such determinants of child nutrition at the individual, maternal and household level. This chapter details the data and the methodology implemented that allows for such multivariate research.

There are three parts to this chapter; the first part of this chapter, 7.1, describes the ADHS data. Part 7.2 explores the variables obtained from the data source and their construction. In the third part of the chapter, part 7.3, summarises the chapter.

It should be highlighted at this stage that the analysis aimed to use multilevel models to examine all variables across all levels together. This was not possible. Although checks and procedures were put in place, the multilevel models specified did not converge. Section 7.3.3 details the planned analysis using multilevel models and the steps that were taken to try and ensure the models converged. Despite best practice, reliable models were not obtained from these procedures. As a result, logistic and multinomial regression models are run at the individual level. These analyses address the individual-level, maternal- and household-level determinants of stuntingoverweightness but the analysis will be referred to as a whole as the 'individual' level analysis, for ease of comprehension. To begin with, the data and the reasons for its selection are outlined below.

7.1 The Albania Demographic and Health Survey 2008-09

To my knowledge, only five studies have identified stuntedoverweight children (Fernald & Neufeld 2007; Mamabolo et al. 2005; Popkin et al. 1996; Said-Mohamed et al. 2012; Wang et al. 2009). None of these studies have utilised a nationally representative data source to explore the determinants of stuntingoverweightness, nor have they explored the determinants across multiple levels – namely at the individual, maternal, household and district (meso) levels. Furthermore, none of the studies have explored stuntingoverweightness within Albania, a population identified by this research as having the second highest prevalence of stuntedoverweight children among LMICs.

The ADHS provides an opportunity to analyse in-depth the determinants of stuntingoverweightness within a population currently experiencing a diverse burden of malnutrition at the population level. Using the ADHS, it is possible to extract data of a multilevel nature in order to explore the biological, behavioural and socioeconomic factors that have been highlighted in Chapter 6 as important determinants of stuntingoverweightness. Importantly, the ADHS allows comparison of stuntedoverweight children to those with alternative nutritional profiles – the stunting, the overweight and all other children - as a means to extrapolate the deterministic pattern of this unique concomitant nutritional burden.

Although household surveys have been used for demographic and health research within Albania, a gap in realising the full potential of such data has been noted in Albania (Narazani 2012; Harhay et al. 2012; Gjonça et al. 2010; Kent 2010; Tomini 2012). As a result, there has been a failure to produce a wide, in-depth, research portfolio on demographic and health indicators in Albania, especially in relation to child malnutrition (Lerch & Wanner 2008). In particular, to the author's knowledge, the most recent household survey - the ADHS - has not been used to analyse the nutrition of under-fives.

There is a commitment to increasing the volume and quality of research in Albania. This is reflected by the National Strategy for Development and Integration (NSDI) and the Developing Demographic and Social Statistics in Albania (DESSA) programme. NSDI is a government approved strategic framework, developed to establish and monitor long-term social and economic development goals established in 2007. Data for the NSDI programme primarily come from the Albanian National Institute of Statistics, which explicitly calls for transparent and publicly available research. In addition, from 2007 the DESSA programme began an assessment of the quality of currently available data in Albania. In particular, an assessment of the 2001 Census data was conducted (INSTAT et al 2010; Lerch & Wanner 2008). This is important for this research, as it is the 2001 census data that has been used to formulate the sampling framework for all household surveys since its collection – including the ADHS. These commitments to improving Albanian data allow for a critical assessment of the quality of the ADHS, discussed below, which will be shown to be the highest quality data available for research on child nutrition in the country today.

7.1.1 Demographic and Health Surveys

The Demographic and Health Surveys are nationally representative surveys that provide data on a variety of key health indicators, including population, health and nutrition in developing countries. The DHS were designed with the intention of providing a baseline to inform health policy within countries through the analysis of the surveys. Within the DHS are standardised core questionnaires. The use of a standardised core questionnaire within the DHS enables in-depth comparative analysis. The DHS results can be used to provide information on global trends, international cross-country comparisons as well as within-country comparisons across time (Manesh, Sheldon et al. 2008).

The Demographic and Health Surveys provide a wide range of data for the analysis of child nutrition, including biological health indicators and socioeconomic maternal and household characteristics. The DHS are a vital resource for research on population, health and nutrition - at times being the only source of reliable data for populations. There have been six phases of the DHS to date, with improvements in validity and reliability being implemented at each successive phase. Emphasis is placed upon intensive training of interviewers, data-processing to ensure high response rates, consistency in data collection and methods to control other areas of non-sampling error for all DHS. As a result, the DHS are considered to be a source of high quality data and have consistently high response rates (ICF Macro 2010; Machiyama 2010; Manesh et al. 2008).

The ADHS 2008-09 is the first and only DHS to be conducted in Albania. It is a Phase-V DHS survey, the most advanced phase of surveys implemented at the time the survey was conducted. The ADHS is nationally representative of the Albanian population and was conducted between October 2008 and April 2009. With the technical assistance of ICF Macro, the ADHS was conducted by the INSTAT and the Institute of Public Health (IPH) in Albania. The ADHS is also the most recent nationally representative sample survey conducted in Albania that collects data on child nutrition.

7.1.2 Sample Design

As a whole, the ADHS yielded a sample of 7,584 women and 3,013 men aged 15-49 who were interviewed, in 7,999 households (98% response rate). The data was collected using a two-stage sample design enabling urban and rural as well as regional-level analyses to be conducted (INSTAT et al. 2010). Three standard DHS questionnaires were administered for the ADHS – the Household Questionnaire, the Women's Questionnaire and the Men's Questionnaire. This analysis utilises data from the household and women's questionnaires only.

The household questionnaire collects data on demographic and socioeconomic characteristics of all household members as well as on the socioeconomic conditions of the household as a unit. The information collected includes age, sex and educational attainment of household members as well as material assets that the household possesses.

The women's questionnaire details background characteristics of women including age, marital status and educational attainment. It also provides data on reproduction, family planning, health care utilisation and behaviours and women's status. Of particular importance to this research, the women's questionnaire has a key role in identifying women with living children that were born within the five years preceding the survey – the individual unit for this research. Through these women, data on the children is collected - including age, sex, health status, vaccination records and feeding practices - by proxy reportage. Additionally, women are asked to consent to biomarkers being collected for the children under-five, including blood samples, height and weight and blood pressure readings. It is the collection of age, height and weight data that has enabled the construction of anthropometric indices for under-fives in Albania, a central requirement for this research.

7.1.3 Data Quality and Sample Bias

Considerations concerning the reliability of Albanian data have been central to many conversations undertaken with demographers and public health researchers that work with Albanian data. There are two key issues addressed in this section - the sampling frame of the ADHS, missing cases and 'the missing children of Kolonjë'.

Of particular concern with regards to data quality is the sampling frame upon which the samples are based. A poor sampling frame can undermine the nationally representative aim of the survey, lead to biased results thus impeding inference to the population as a whole and diminishing the value of any policy implications of the research.

The ADHS is the latest household sample survey to be conducted concerned with child health, following the Living Standards Measurement Surveys of 2008, 2005 and 2002, the UNICEF Multiple Indicator Cluster Surveys of 2005 and 2002 and the Reproductive Health Survey of 2002. Each of these surveys, including the ADHS, utilise census data from 2001 for the enumeration areas. A report by DESSA specifically proposed that this framework be updated in 2008, particularly given the massive internal (and international) migration and increase in construction of (often uninhabited) residential properties since 1991. In 2001, 25% of all dwellings had been built since the onset of transition (Lerch & Wanner 2008; Dalakoglou 2010; INSTAT 2004). In the light of this, it is fortuitous for this research that the LSMS 2008 was conducted prior to the ADHS. During the first stage of sample selection for the LSMS 2008, all 450 enumeration areas, based upon the 2001 census, were updated through visits to each area. Recording of all structures built (both residential and other) was undertaken and the number of households within each residential structure documented (ICF Macro et al. 2010). As a result, the ADHS is currently the most reliable survey containing the necessary anthropometric data on Albania.

An additional source of potential bias has been identified. Once accounting for the flagged and missing cases, 1 of the 36 administrative districts in Albania has no cases – Kolonjë. There are two primary sampling units (PSU) that belong to the district of Kolonjë – 192 and 193. Whilst there are no children under-five recorded in the 193 PSU, there were 2 reported in the 192 PSU. For the latter PSU, however, both cases were 'flagged' as containing biologically implausible data for use in the calculation of anthropometric indicators, and were thus excluded from theses analyses. These two cases belong to separate households but did have their measurements taken by the same interviewer, which could be the source of the bias.

However, it should be noted that Kolonjë is an area of Albania with the lowest proportions of children age 0 to 14 and highest proportion of the elderly, which explains why there were only two cases surveyed. It is, however, unfortunate that this has led to the exclusion of an entire district of Albania - due to both suffering from error in anthropometric data collection or inputting (INSTAT 2001). As the WHO recommends the exclusion of flagged cases, the district of Kolonjë will not appear in the analyses.

7.1.4 Summary

This section has emphasised how the ADHS is the most recent, reliable and well-specified data source pertaining to research on child nutrition in Albania. As a result, the ADHS is the selected data source for this research. The next section details the selection and construction of variables for the analysis of the ADHS. Following on from this, the third section focuses on the methodology used to analyse these variables.

7.2 Variable Selection and Construction

This section details the independent and dependent variables for the analysis on the individual level determinants of stuntingoverweightness.

For the individual level analysis 7 dependent variables are used, all of which are based upon the anthropometric indicators. As will be explained further, when the methodology for the analysis is described, the analysis for the determinants of stuntingoverweightness at the individual level will become increasingly more complex – beginning with descriptive statistics, to logistic regression models and finally multinomial models.

Using the anthropometric indicators, 6 binary variables are constructed for use as dependent variables in the logistic regression models. Using these indicators, three binary dependent variables are used to compare stuntedoverweight children, separately, with their stunted (SOVS), overweight (SOVO) and not malnourished (SOVNOT) contemporaries. SOVS indicates a child as stuntedoverweight==1 or stunted==0, SOVO indicates stuntedoverweight==1 or overweight==0 and SOVNOT stuntedoverweight==1 and not malnourished==0.

For a comprehensive understanding of the nutritional profile of under-fives in Albania, three further binary dependent variables, allowing other comparisons across the other nutritional groups, are also used in the analysis. The variable SVO indicates whether a child is stunted(==1) or overweight(==0), the variable SVNOT indicates whether a child is stunted(==1) or not malnourished(==0) and the variable OVNOT indicates whether a child is overweight(==1) or not malnourished(==0).

Additionally, an unordered categorical dependent variable for use in a multinomial regression models was created (NUTRITIONALSTATUS). This variable has categories for all four nutritional outcomes of concern. NUTRITIONALSTATUS takes on the value 0 for not malnourished, 1 for stunted, 2 for overweight and 3 for stuntedoverweight individuals.

At this stage, it is important to note that there were some missing anthropometric data for children under-five that restricted the sample of children identified in the ADHS sampling frame. The limiting factor for the sample size was the need to have age, sex, height and weight data to create the anthropometric indices of weight-for-height and height-for-age in order to classify individuals as either stunted, overweight, stunted-overweight or other. Of the 1616 cases, 89 were missing key data on height and weight. For the 1527 remaining, 147 cases contained data that was considered to be out of the plausible limits for height or weight; cases with such implausible data were flagged and dropped from the analyses. This is common practice when creating anthropometric indices, which as explained in Chapter 4 are based upon the WHO 2006 growth reference standards. However, this led to a large reduction in the sample available by 12.84%. The sample for under-five nutritional status in Albania of these 1380 cases is presented below in table 7.1.

Table 7.1 Nutritional Status for Under-Fives in Albania

Nutritional Status	#	%	Cum. %	% (weighted)
Not	849	61.52	61.52	68.13
Stunted	161	11.67	73.19	10.21
Overweight	251	18.19	91.38	12.62
Stunted-overweight	119	8.62	100	9.04
Total	1,380	100.00	100.00	100.00

As 236 cases were dropped due to missing or implausible anthropometric data, an assessment of the 'missingness' was conducted. There are several plausible reasons for missing cases or implausible values that can occur in data collection – namely the mother refused permission for a child's measurements to be taken, the child was not present to be measured at interview or the interviewer did not collect the data correctly (either height, weight or age) leading to measurement error. For 10 cases, the mother refused permission to be measured, for 226 cases missing or implausible anthropometric data was found. This is likely due to measurement error – and as such a random intercept model was run and compared to an empty model (no intercept) – to see if children with missing or implausible anthropometric data were clustered within interviewers. This would suggest that there were some interviewers whereby greater levels of missing or implausibility were found and provide an indication of measurement error as the possible cause. The details of a random intercept model are not discussed in depth here – as they are covered in section 7.3.3, but essentially, if a log likelihood ratio test, conducted on the two nested models (with intercept for interviewer and without) is significant then there is an indication of nesting of missingness/implausibility within interviewers. The results show there were 37 interviewers involved in the collection of anthropometric data, with an average group size of interviewees and children ranging from 4 to 71 (average group size: 41.4). The results of the log likelihood ratio test produced a χ^2 value of 26.23 ($p=<0.000$) indicating the missing/implausible data is clustered among interviewers and supporting the hypothesis that this missing data is due to measurement error in the most part. This is an issue with the quality of the data and is a limitation of the research – this is addressed further in Chapter 9. As will be seen, the sample size in Albania was small initially and missing data has restricted it further, this in the most part led to the failure of planned multilevel models to run (see section 7.3.3) and as a result the results from the analysis of Albania, although as robust as possible given the limitations of the data, should be used cautiously.

The sample was then further constrained in line with the literature review and conventional practice for the analysis of the nutritional status of under-fives – by removing all cases of those aged <6months. The underlying rationale for this sample limitation rests upon the distinction, as described in Chapter 6, between the determinants of nutritional status of under-fives for those under six months and those over six months. This led to a further reduction in the sample size by 185 cases, resulting in an available sample of the dependent variable for analysis of 1,195 as presented in table 7.2.

Table 7.2 Final Sample for Analyses by Nutritional Status

Nutritional Status	#	%	Cum. %	% (weighted)
Not	785	65.69	65.69	68.46
Stunted	146	12.22	77.91	10.11
Overweight	156	13.05	90.96	13.36
Stuntedoverweight	108	9.04	100	8.07
Total	1,195	100.00	100.00	100.00

In addition, any cases with missing values on independent variables (which are described in sections 7.2.1 to 7.2.3) were dropped[67]; this led to a further exclusion of 26 cases. Table 7.3 outlines the dependent variables for the analysis with their respective sample sizes by group. Due to the nature of the dependent variables, being either binomial or polytomous, two different regression models are employed – logistic for the former and multinomial for the latter. These models are described in part 7.3, with section 7.3.2.1 describing the model building strategy.

[67] This was decided to be the best course of action, due to the limited sample size computation of missing values was not considered a viable option.

Table 7.3 Dependent Variables for Analysis

Dependent Variable	Categories	Size of Groups	Total Cases	Distribution	Regression Model
SOvS	Stuntedoverweight==1 Stunted==0 (ref)	107 144	254	Binomial	Logistic
SOvO	Stuntedoverweight==1 Overweight==0 (ref)	107 154	264	Binomial	Logistic
SOvNOT	Stuntedoverweight==1 Not==0 (ref)	107 764	893	Binomial	Logistic
SvO	Stunted==1 Overweight==0 (ref)	144 154	302	Binomial	Logistic
SvNOT	Stunted==1 Not==0 (ref)	144 764	931	Binomial	Logistic
OvNOT	Overweight==1 Not==0 (ref)	154 764	941	Binomial	Logistic
Nutritional Status	Stuntedoverweight==1 Stunted==2 Overweight==3 Not==0 (ref)	107 144 154 764	1169	Polytomous	Multinomial

As explained in Chapter 6, the independent variables for the analysis are those that describe the distal and proximate determinants of health. The distal variables include variables describing the wider socioeconomic context within which a child resides. Variables describing the proximate determinants cover the areas of maternal characteristics, environmental contamination, child characteristics, nutritional availability and health behaviours of the mother.

As previously mentioned, the ADHS data and methodology employed will enable a comparison across the four nutritional outcome groups of interest to this research – stunted, overweight, stuntedoverweight and those who are not malnourished. As a result the selection and construction of variables has had to consider their relevance to all the four nutritional outcomes among under-fives with which this research is concerned. Their selection and construction is detailed below – they are detailed by level. Section 7.2.1 details individual (child) level variables, 7.2.2 details maternal-level variables and 7.2.3 details household-level variables selected for the analysis.

7.2.1 Individual-Level Variables

The individual of study is a child, currently living, age 6-59 months at the time of implementation of the ADHS.

There are four child-level variables included in the analyses, as they describe characteristics that have been shown to be significant in the study of child nutritional outcomes – age (AGE), sex (SEX), birth order (BIRTHORDER) and whether the child has anaemia (ANAEMIA) (Sen and Sengupta 1983; Uthman 2008; Biswas and Bose 2010; Checkley et al. 2008; Adair and Guilkey 1996).

The first variable to be described is AGE. For this analysis, AGE is a categorical variable for individuals aged 6-11, 12-23, 24-35, 36-47 and 48-59 months. This categorisation of age in this analysis is a departure from that conventionally used in research on both stunting and overweightness in under-fives and is justified below. The majority of research on child health categorises age into three groups 6-11 months, 12-23 months, 24-60 months. The rationale for this is to capture the age variation in the risk of stunting. As described in the literature review, 24 months is considered a threshold for its development (Adair and Guiley 1996; Checkley et al. 2008; Biswas and Bose 2010). However, a recent study by Biswas and Bose has shown a sex differential in stunting at 4 years of age – with females more likely to be stunted than males (2010). In addition, Matijasevich et al. showed increased risk overweightness among children of 4 years of age when compared to those aged 1 year and 2-3 years (2012). Given the lack of research on stuntingoverweightness, there are no conventional thresholds for age in the analysis of this nutritional outcome. Moreover, given the duality of the nutritional burden for stuntedoverweight children AGE is categorised to reflect the age variability of both stunting and overweightness. Thus, following the identification of recent research on the importance of ages 1, 2-3, and 4 years on nutritional outcomes, AGE was categorised as described above.

The second individual-level variable is SEX. Sex differences in health outcomes among children have been widely discussed in the literature review. Differentials by sex have been reported for both stunting and overweight among under-fives. However, they have also been contested (Bhiyu 1983; Chen et al. 1981; Ahmed 1977; Sen and Sengupta 1983; Arnold et al. 1998; Uthman 2008; Wamani et al. 2007; Wisniewski and Chernausek 2009). Given this, it will be important to control for child sex in this analysis, to contribute to the literature on sex differentials in nutritional outcomes. This is particularly important for stuntedoverweight children. Given the limited amount of research on stuntedoverweight children, the research on sex differentials in stuntedoverweight children is currently underdeveloped. To fill this gap and to explore sex differentials in nutritional outcomes, and particularly stuntingoverweightness in Albania, the binary variable SEX is used, where SEX==1 indicates a female child, 0 a male.

As birth order has been shown to be an important determinant of child health and nutritional outcomes in under-fives, the variable BIRTHORDER is tested in the analysis. BIRTHORDER indicates whether the child is a first order birth, a high order birth (≥4) or otherwise (Singh et al. 2011; Cardwell et al. 2011; Swamy et al. 2012; Wells et al. 2012; Myrskylä et al. 2013).

In the next section the maternal-level variables for the analysis are described.

7.2.2 Maternal-Level Variables

Maternal-level variables describe the characteristics of the mother, their health care utilization and behaviours, as well as their socioeconomic status. These are key factors that have been shown to be important for the development of child malnutrition; the evidence for this is outlined in Chapter 6.

Proximate, maternal factors that were highlighted in Chapter 6 to be important determinants of nutritional outcomes in children, include maternal age at birth of child (AGE), parity (PARITY), the mother's body mass index (BMI) and the height of the mother (HEIGHT). Additionally, a variable indicating whether the mother has anaemia or not is utilised (MATERNALANAEMIA).

The literature highlighted the importance of maternal age for child nutritional outcome, particularly at the ends of the distribution of the reproductive age ranges - younger and older mothers (McAnarney 1987; Fraser et al. 1995; Barker 1997; Finlay et al. 2011). In order to create the categorical AGE variable, I had to define a 'young' and 'old' mother.

Research has conventionally defined young mothers, particularly within a low and middle income country context, as those <20 years (Friede et al. 1987; Geronimus et al. 1994; Haldre et al. 2007; Chittleborough et al. 2011). However, this categorisation is not well specified for the context of Albania, as very few births occur before age 20. Additionally, recent research has shown increased risk of poor nutritional outcomes among children born to mothers in their early 20s (Finlay et al. 2011).

For older mothers, studies show there is an increased risk of poor health outcomes, low birthweight (<2500g) and macrosomia (birthweight >4000g) among children born to mothers aged 35 years or older (Rosenberg et al. 2005; Cleary-Goldman et al. 2005; Li et al. 2012; Guelinckx et al 2008). Again, given the limited research on stuntingoverweightness, there are no firm precedents in the effect of maternal age on risk of such anthropometric failure, and the construction of the variable relies upon studies focussed upon under and overnutrition in under-fives. As a result, AGE is categorised into three groups: young (<25), old (>34) and other.

PARITY is a categorical variable used to explore the effects of maternal parity on stuntingoverweightness, as parity has been found to be associated with both stunting and overweightness in under-fives (Barker 1997; Juntunen et al 1997; Babinski 1999; Toohey et al. 1995; Abena Obama et al. 1995; Melesh 1986; Seidman et al. 1991; Ozumba and Igwegbe 1992). To explore the varying effects different levels of parity have on child outcomes, studies conventionally categorise parity as ‘primi’ (parity of 1), ‘high’ (>4) or other. This categorisation was used for PARITY.

The literature review highlighted the impact of maternal nutrition on nutritional outcomes in under-fives. Maternal nutrition is captured using the variables BMI, HEIGHT and MATERNALANAEMIA. These variables were selected and constructed in line with previous research on nutritional outcomes in under-fives (Özaltin et al. 2010; Bhalotra and Rawlings 2011; Lee et al 2010; Adair and Guilkey 1996; Uthman 2008).

Body Mass Index (BMI) is an index constructed using the height and weight of an adult; it is considered the primary indicator of adult nutritional status (WHO 2006; Uthman 2008; Bhalotra and Rawlings 2011; Fernald and Neuman 2007). The variable BMI is constructed based upon the international classifications of adult underweight (BMI<18.5), overweight (>25.00) and other (normal range 18.5-24.99) (WHO 1995; WHO 2006).

MATERNALANAEMIA is a binary variable to indicate whether the mother is currently anaemic (mildly, moderately or severely) or otherwise. Blood samples collected in the ADHS are analysed to determine anaemic status based on haemoglobin levels (HB g/l), adjusted for altitude and then categorised into mild, moderate or severe anaemia according to the WHO international recommendations. Women are classified as severely anaemic with Hb g/l at <80, moderately at 80-109 and mildly 110-119; Pregnant women are classified as severely anaemic if Hb g/l is <70, moderately at 70-99 and mildly at levels 100-109 (WHO 2011; WHO 1989). For the weighted sample this classification showed 2.42% of women were moderately anaemic, 19.33% mildly and 78.25% not (WHO 2011). Recent studies have highlighted that ‘mild’ anaemia is considered a misnomer, as clinical tests show that anaemia, at any level of severity, is indicative of already advanced iron deficiency (WHO 2011). Thus the binary variable MATERNALANAEMIA was derived from the HB g/l data to indicate the presence of mild/moderate anaemia (21.75%) or otherwise (78.25%).

As the literature showed, maternal height can reflect chronic malnutrition in the early life of the mother, which can impede the environment of the foetus (Martorell et al. 1994; Kar et al. 2008; Deaton 2007; Fung 2009). Internationally, maternal short stature is defined using a threshold height <145cm, however, it is also considered context specific. Deaton (2007) showed that African women are the tallest in the developing world but grow up in an environment of chronic deprivation, suggesting a need to consider relative height within the region as opposed to using a standard cut-off. (Lee et al 2010; Hernández-Díaz et al 1999; ACC/SCN 1992). In the light of this, the categorical variable HEIGHT is constructed through separating maternal height into quintiles.

Health care utilization and behaviour variables include the knowledge and use of oral rehydration therapy (OR), whether the mother has visited a health facility in the last 12 months when ill (HEALTHFAC) and whether the mother had the recommended number of antenatal visits prior to the birth of their last child (ANTE).

Maternal-level health care utilization and behaviour variables are captured using the variables OR, HEALTHFAC and ANTE. OR variable is a binary variable indicating knowledge, or knowledge and use of oral rehydration salts (==1) or otherwise (==0). HEALTHFAC is a variable created to indicate whether a mother has sought treatment when sick in the last 12 months (==1) or otherwise (==0). Health utilization during pregnancy is extremely important for birth outcomes and subsequent child health. The binary variable ANTE in this sample is used to describe whether a woman has received the recommended number of antenatal visits (at least 4) or not before her last live birth (WHO 2012; Overbosch et al. 2004). Research has shown that antenatal visits are highly consistent across births for women and thus can provide an indication of the antenatal care for individuals of lower order births with the same mother in this analysis (Magadi et al. 2000).

EDUCATION is a variable used as a maternal-level variable, indicating both the educational attainment of a child's mother as well as socioeconomic status. Additionally, it can indicate greater autonomy and empowerment of a mother. The variable

EDUCATION for use in the analysis is a categorical variable, indicating the level of education of the mother. EDUCATION has three categories of education level – (1) none or primary, (2) secondary and (3) tertiary.

7.2.3 Household-Level Variables

Household-level variables used in this analysis describe the environmental context of nutritional availability within the household and the socioeconomic context of the household. These are key proximate and distal factors, consistently shown to be important for nutritional outcomes in children. The variable describing the environmental context of the household in which the child resides, includes the safe disposal of stools in the household (STOOLS), the use of solid cooking fuels (FUEL), the use of an improved water source (WATER) and the use of improved sanitation (TOILET). The variable on the presence of adequately iodized salt (SALT) provides further indication of the nutritional situation of the household. The socioeconomic and traditional contexts of the household are described using variables indicating the sex of the household head (SEXHH), the presence of an extended family in the household (THREEGEN) and the relative wealth of the household (WEALTH).

In this research, the environment variables aim to capture the environmental context of infectious diseases. This is achieved through the introduction of variables signifying high risk household infrastructure – those facilitating the transmission of infectious diseases (Oppong and Harold 2010; Behm 1991; Levine and Levine 1995; Pongu, Ezzati et al. 2006). These variables are STOOLS, FUEL, WATER and TOILET.

A binary variable STOOLS indicates whether the last stools of the youngest child were disposed of safely (==1) or otherwise. In line with the WHO & UNICEF Joint Monitoring Programme for Water Supply and Sanitation classifications on safe disposal of children's stools – 'safe' includes the child using a toilet/latrine (48.74%), the stools being put/rinsed into a toilet/latrine (7.51%) or the stools being buried (1.47%); 'unsafe' disposal includes the stools being put/rinsed into a drain/ditch (17.1%), thrown in garbage (39.1%), left in open/not disposed of (0.35%) and other (1.11%) (WHO & UNICEF 2003-2013).

A binary variable FUEL describes whether or not a child is exposed to indoor air pollution in the household (including carbon dioxide, carbon monoxide, methane and nitrogen dioxide) as a result of solid fuel use (Pope et al. 2010; Bassani et al. 2010; WHO 2006). Air pollution is related to increased risk of respiratory syndromes and can fuel the dialectical relationship between morbidity and malnutrition. Solid fuels are wood, dung, agricultural residues and coal (WHO 2006; Rehfuess et al. 2006).

The binary variable WATER is constructed based upon the WHO classification of improved/non-improved water sources. An improved water source is described as one that is adequately protected from external contamination. In the ADHS these include piped water into dwelling, yard or plot, public tap or standpipe, tubewell or borehole, protected spring, protected dug well, rainwater collection and bottled water (only when the household was using an improved water source for cooking and personal hygiene) (WHO 2012; ICF Macro 2010; WHO & UNICEF 2003-2013). 'Unimproved' water sources include unprotected dug well, unprotected spring, cart with small tank or drum, tanker truck, surface water (river, dam, lake, pond, stream, canal, and irrigation channel) and bottled water (WHO 2012; ICF Macro 2010; WHO & UNICEF 2003-2013).

The binary variable TOILET is based upon the WHO classification of improved/non improved sanitation facilities. An improved sanitation facility adequately and hygienically separates, and thus prevents, contact of human users with human excreta (WHO/UNICEF 2012). Improved sanitation facilities include those with sewer connections, septic system connections, pour-flush latrines, ventilated improved pit latrines and pit latrines with a slab or covered pit (==1). Unimproved sanitation facilities include pit latrines without slabs or platforms or open pit, hanging latrines, bucket latrines, open defecation in fields, forests, bushes, bodies of water or other open spaces, or disposal of human faeces with other forms of solid waste and any sanitation facility that is either public or shared with another household (WHO/UNICEF 2012).

At the household-level, SALT, a binary variable that will indicate the presence of (in)adequately iodised salt in the household, was created. International recommendations state that salt should have a minimum of 15ppm iodine (Joost 2003). Among children in households with women who had a live birth in the last five years, 8.47% were in a household with 0ppm iodine found in the households salt, and 13.91% in household with >0ppm but <15pmm iodine – this was converted into the variable SALT indicating inadequately iodised salt (<15ppm iodine)(==1) or otherwise.

In order to operationalise traditional values and norms at the household-level, two variables were used. The first indicated the sex of the head of the household (SEXHH). SEXHH is a binary variable indicating whether the head of the household is female (==1) or otherwise (==0). Given the prevalent patriarchal values within Albania, a female head of house marks a disjuncture from traditional values and cultural norms and would be expected to be protective against child malnutrition. The mechanisms for this are considered to be due to greater female empowerment and autonomy, leading, in particular, to better health care behaviours protective against malnutrition for a child. THREEGEN is a binary variable describing the presence of an extended family within one household, defined by the presence of three or more generations of the same family (==1) or otherwise. Extended families are indicative of traditional values and norms within Albania.

To describe the socioeconomic context of the household in which children in the sample are residing, an asset index was constructed. WEALTH is a categorical variable derived from scores on the asset index being collapsed into three groups – poorest 20%, richest 20% and the other 60%. The asset index is created, separately for rural and urban households[68], by using dichotomous indicator variables for the presence of the

[68] This is an improvement to the original technique proposed by Filmer and Pritchett (2001). The Filmer and Pritchett method has a notable problem with construction of the index in this way is that it suggests assets would have the same value in both urban and rural areas – which is a problematic assumption. A far better assumption is that there is a difference in wealth distribution across rural and urban areas. In order to overcome this, the asset index is created separately for the urban population and then for the rural population (Rutstein & Macro International Inc. 2008)

following assets within a household – the possession of a radio, television, mobile telephone, non-mobile telephone, video/DVD player, tape/CD player, refrigerator, freezer, washing machine, dishwasher, microwave, sofa, armoire, electric radiator, generator, sewing/knitting machine, air conditioner, water boiler, computer, satellite dish, watch, bicycle, animal drawn car, motorcycle or scooter, car or truck, tractor, boat with motor, agricultural land, farm animals and a bank account. Principal components analysis (PCA) was then conducted upon these dichotomous variables, a data reduction technique to replace correlated variables with uncorrelated components. The first principal component is retained, which explains the largest proportion of the total variance and the weights from this component are used to generate an (standardized) asset score for each individual. At this stage, in line with DHS recommendations, the index is summed by household, thus providing a weighted score for each individual within a household in the population. Households are then ranked and divided into quintiles based values. These are then transformed into the categorical variable WEALTH with three groups (poorest 20%, richest 20%, and other 60%).

As the wealth indexes were computed separately for rural and urban areas, not only should WEALTH be introduced into the model, but an interaction term for WEALTH and URBAN should be utilised. This variable, WEALTHxURBAN is required as WEALTH now indicates relative wealth with respect to either rural or urban areas. A further discussion of this is found in Chapter 8, as the interaction term was not actually found to be significant and not included in the final multinomial model.

7.3 Part Three: Methodology

This section describes methodologies employed to analyse the determinants of stuntingoverweightness, stunting, overweightness and non-malnourishment in Albania. The methods used for these analyses are logistic and multinomial regression models. Following a discussion of the methodology employed that produced the results of Chapter 8 (sections 7.3.1 and 7.3.2), a discussion on the multilevel modelling that was planned for this research, the reasons it was not utilised and the implications of this are discussed.

In the absence of multilevel models, single level regression models were methods employed for this analysis are regression analyses. Regression analyses can be multivariate in nature and thus allow for the examination of a number of independent variables' association with the dependent variable of interest – in this case nutritional outcomes among under-fives. They are particularly useful as they evidence the effect of an individual variable on the outcome whilst controlling for all other variables (Agresti& Finlay 2008; Stolzfus 2011; Bewick et al. 2005; Aldrich et al. 1984).

As explained earlier, there are seven dependent variables for the individual level analyses, (binary variables SOVS, SOVO, SOVNOT, SVO, SVNOT and OVNOT) and one categorical (NUTRITIONALSTATUS). The six binary dependent variables enable a comparison of one nutritional group directly with another – for example the stuntedoverweight compared to the stunted. The categorical dependent variable enables simultaneous comparisons across all four nutritional statuses of interest. Both logistic and multinomial regression models were employed as part of an increasingly complex modelling strategy that is discussed further in section 7.3.2. Prior to a discussion of this modelling strategy, logistic and multinomial regression models are described.

A regression analysis, where the dependent variable is a binomial distribution which takes the value 1 or 0, can be performed using a logit transformation. For a dependent variable that has more than two discrete categories, in this case NUTRITIONALSTATUS, a multinomial logistic regression analysis can be performed.

This regression model is an extension of the generalised logistic model that allows for simultaneous modelling of a set of binary logistic models. These models are described below.

7.3.1 Description of the Logistic Regression Model

Logistic regression is used to model a binary dependent variable via the logit function. The logit function enables the probability γ=1 to be transformed, allowing for a probability no longer constrained from 0 to 1, but ranging from -∞ to +∞. This is done by taking the inverse of the log of the odds of γ=1. That is,

$$\text{Logit}(\Pr(\gamma=1)) = \left(\frac{\Pr(\gamma=1)}{1-(\Pr(\gamma=1))} \right)$$

In performing this transformation, the dependent variable Y can now be assumed to be a linear function of the independent variables,

$$\text{Logit}(\Pr(\gamma=1) = \alpha_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots \beta_p x_i$$

where α_0 represents the intercept, β_p represents the weighted value of each independent variable separately, their coefficients (β_p) determining the slope of regression line. For ease of interpretation, the logits can be transformed back into probabilities by

$$\Pr(\gamma=1) = \frac{\exp(\text{logit})}{1+\exp(\text{logit})}$$

(Where Pr is the probability)

Logistic regression models are estimated using a procedure known as 'Maximum Likelihood Estimation' (MLE). MLE is a procedure that allows iterative cycles during estimation to ensure the parameters of the model provide a linear combination of independent variables with the greatest likelihood of detecting the observed outcome in the data.

There are a number of assumptions inherent to the logistic regression model. 1) The error terms, and thus the observations, are independent, 2) the independent variables are independent from each other (absence of multicollinearity, 3) there is a linear relationship between the independent variables and the logit of the odds of the outcome occurring.

7.3.2 Multinomial model

The multinomial logistic regression model is an extension of the logistic model. It is used to model dependent variables that are polytomous in nature – having more than two discrete responses. In this instance, the four nutritional outcome responses are not malnourished (==0), stunted(==1), overweight(==2) and stuntedoverweight(==3), these responses are treated as nominal responses – there is no ordering to them. The base category for each of the logits is the 'other' – the largest group of children under-five. These children are not stuntedoverweight, stunted or overweight. The multinomial model used here thus relies upon 3 logit transformations. For the specific analysis conducted in this thesis they are:

Logit (Stunted) = Log(Pr(Stunted)/Pr(Other))

Logit (Overweight) = Log(Pr(Overweight)/Pr(Other))

Logit (Stuntedoverweight) = Log(Pr(Stuntedoverweight)/Pr(Other))

By simultaneously estimating the model, the multinomial logistic model provides the opportunity to explore each non-reference category of the dependent variable (stunted, overweight and stuntedoverweight) against the reference category (not malnourished) as a linear function of the independent variables. Thus

$$\text{Log}(\Pr(j)/\Pr(0)) = \alpha_{(j)} + \beta_{1(j)}x_1 + \beta_{2(j)}x_2 + \ldots \beta_{p(j)}x_i$$

(Where j indicates the three different, non-reference, categories)

The multinomial logistic model used in this thesis will have the same independent variables across all logit transformations. The binary logistic regressions will ensure that variables specific to each nutritional group are included in the multinomial models to ensure meaningful independent variables are used and to prevent omission bias. As with the binary logistic regression models, in multinomial logistic regression models the logits can be transformed back into probabilities after estimation to give predicted probabilities at different specified levels of the explanatory variables, for example, for stunted individuals:;

$$\Pr(\gamma=\text{stunted}) = \frac{\exp(\gamma(\text{stunted}))}{1+(\exp(\text{logit}(\text{other})) + \exp(\text{logit}(\text{stunted})) + \exp(\text{logit}(\text{overweight})) + \exp(\text{logit}(\text{stuntedoverweight})))}$$

As with the binary logistic models, for multinomial models MLE is used to estimate the model. In an extension to the assumptions of the binary logistic models, one key assumption of the multinomial model is the Independence of Irrelevant Alternatives (IIA). This assumption states, as an example, that odds of stunting does not depend on any other alternative outcome such as overweightness. For research on stuntingoverweightness this is an interesting assumption, given the unknown development trajectory of stuntingoverweightness – does stunting come first then overweightness, or do stunting and overweightness develop concurrently within an individual? However, in this case, the categories of nutritional status are discrete outcomes and being stunted is not considered a 'substitute' for stuntedoverweight but is a distinct nutritional profile in itself, fulfilling the requirements of IIA (Long and Freese 2006).

7.3.2.1 Model Building Strategy – Individual, Maternal and Household Level

The fundamentals of logistic regression and multinomial regression models to be employed have been described above. In this section modelling strategy is explained and the dependent variables for the analysis are presented.

The aim of the model building strategy is to produce the most parsimonious model whilst maintaining goodness-of-fit (Pitt & Myung 2002 cited by Vanderkerckhove et al. *(in press)*). Model parsimony, in is essential form, is the aim to produce a model that adequately describes the relationships in the data and reflects the overall theoretical model driving the research with the fewest number of parameters (Cheung & Rensvold 2001). Parsimony error occurs when too few parameters are specified, missing key relationships in the data and, further, also if too many parameters are specified. Both of these errors can lead to poor predictive quality of the models and lead to unreliable and invalid conclusions to be drawn from the models (Cheung & Rensvold 2001; Vanderkerckove et al. (*in press*)). Goodness-of-fit is a statistical concept - it relates to how close the probability distribution of a model fits the observed data (Compano & Salvatore 2006). Thus the trade-off in regression modelling is getting a model with enough parameters that adequately describes the observed data, but does not suffer from parsimony error. These elements were central to the composing the model building strategy for the study on Albania.

Firstly, the theoretical framework was utilised to decide upon the variables to be utilised in the models (Chapter 6; Chapter 7, Section 7.2). Secondly, the regression models had to be correctly specified to reflect the distribution of the dependent variables. As noted in section 7.3.2, the key dependent variable of interest is polytomous in nature – a categorical variable (NUTRITIONAL STATUS) that identifies whether a child is stunted, overweight, stuntedoverweight or otherwise. The variables to be operationalised in this analysis were large in number, and could lead to poor model parsimony, particularly for a multinomial model, which has more parameters due to the need to estimate three logistic models at once. The multinomial model is a preferred model, as it maintains the consistency of the sample and enables the concurrent estimation for each logit model. However, the concern is that in the multinomial model might be over-specified for a sample size of 1169. Thus, logistic regression models were run initially as a base for comparison in terms of results prior to the extension of the model to the multinomial model.

For the logistic models, a forward stepwise selection modelling process was employed. Goodness-of-fit statistics were utilised to examine the introduction of more variables (thus reduction of model parsimony) with the improved fit of the observed data but testing nested models. Maximum Likelihood Estimation (MLE) is used for fitting logistic models in STATA and as a result, the forward stepwise selection criteria of variable inclusion is based on Wald tests of the coefficients where $p<0.05$. Each independent variable is tested at each stage and the one that results in the smallest p-value in introduced into the model. This process continues until no variables are found to significantly improve the fit of the model. This occurred for each binary dependent variable (SOvS, SOvO, SOvNOT, SvO, SvNOT, OvNOT). In addition to the selection process, further goodness-of-fit tests were used on the logistic regression models – this is particularly important as it can be easier to identify outliers from a logistic regression than in the multinomial. For the logistic models the Hosmer-Lemeshow is used. The test is a 'goodness of fit' test that provides a chi-square significance test for whether the number of observed cases where $\gamma=1$ (conditional on the independent variables 'x') matches those predicted. It tests the null hypothesis, that there is no difference between the observed and predicted values. If the null hypothesis fails to be rejected ($p>0.05$), the model is said to adequately fit the data. The predictive ability of the model can be assessed further by generating a ROC (Receiver Operating Characteristic Curve) which plots 1-specificity against sensitivity, thus greater predictive ability of the model is identified by a greater area of the graph being below the curve (closer to 100%). If the model was predicting $\gamma=1$ at random, the area under the curve would be 50% of the total area of graph. Final concerns for the logistic model include outliers and multicollinearity. The statistical software used to fit the models, STATA, automatically flags any collinearity between independent variables and excludes one of them from the model estimation. To assess any outliers – influential cases - the lvr2plot in STATA is used (leverage vs R2 plot). This provides a visualisation of any influential cases that may have 'high leverage' and thus have a disproportionate effect on the regression line - distorting the results inferred to the population of Albania. This would undermine the validity of the results.

These results from the logistic regression served as a basis from which to compare the multinomial models which were then fitted – again using forward stepwise selection. Once modelled, if a large amount of consistency in the results is found between the logistic and multinomial, then the final multinomial model can be considered to be one which adequately models the observed data, despite the increased parameters. The utility of running logistic regressions in combination with a multinomial is that there are few goodness-of-fit or model diagnostic tests for a multinomial model. One test considered was for the Independence of Irrelevant Alternatives, this test provides an indication of whether the polytomous dependent variable is correctly determined – or if some of the categories are irrelevant potentially biasing the results. The issue for a multinomial model however, is that tests for IIA are not considered very reliable, with, Long & Freese advising against the utilisation of these (2006). As such there is reliance on the diagnostics of the logistic models, even though the final model of interest in this study is the multinomial.

It was the multinomial model that was taken as the final model for the analysis of the ADHS. As noted earlier in the Chapter multilevel modelling had been planned but was not able to proceed. The next section details the reasons behind this – both motivations for use, why the modelling was not successful and the implications of this.

7.3.3 Multilevel Modelling

As noted in the introduction to this chapter, multilevel modelling was the planned strategy for the analysis of the ADHS data but reliable models were not obtained.

The ADHS data is hierarchical in nature; children are clustered within mothers, within households and within communities. In this sense, this is an artefact of the sampling strategy employed in DHS samples where, within households all children to mothers aged 15-49 are selected for completion of the children's questionnaire – which includes the collection of anthropometric measurements.

In addition, the theoretical framework employed in this research to elucidate the determinants of stuntingoverweightness among children is also hierarchical in nature. Determinants are considered to operate at the individual level (child), at the maternal level, the household level, the community level and the societal level. As a result, multilevel modelling, a statistical tool that can explore such multilevel relationships was planned.

With regards to the methodological need for multilevel modelling, it has been noted that the multistage nature of the sampling strategy used in the ADHS led to hierarchically structured data, with individuals clustered within households within communities (the PSUs). Analyses failing to account for the potential resultant intraclass correlation could underestimate the standard errors of the regression coefficients causing Type I Errors (false positives) diminishing the reliability of the results (Bartholomew et al. 2008: 325). In essence, an independent variable could be found to be significantly associated with stuntingoverweightness due to this clustering, when it is not – which could give rise to ineffectual policy recommendations.

The introduction of a random intercept takes in the hierarchical nature of the multilevel ADHS data. For the ADHS data, a random intercept is tested at the maternal, household and community-level to see if the data is clustered to an extent that a random intercept is required to account for this. A random intercept model allows for the variance in the dependent variable to be explained at both the individual and higher order (or orders) level (dependent upon the number of levels the data contains). A random intercept (designated as U_{ij}) means the fitted values of Y can take a different value for each higher level cluster (such as mothers, households or communities). This is important and highly likely in many situations in child health research – for example all children born to a particular mother ('mother A') may have higher odds of being stunted than other children. The random intercept allows for this to be modelled - where the intercept for children from mother A who differs from the overall intercept.

The need for a random intercept can be tested utilising 'log-likelihood ratio' tests which test whether between-cluster variance is zero. Log-likelihood ratio tests for 'empty models' for each of the dependent variables (models with no independent variables) were run to test the null hypothesis that the between-cluster variance is zero (H0: $\psi = 0$) for models separately introducing a random intercept for household, a random intercept for community, and the two random intercepts for both household and community (Snijders and Bosker 1999). The models were fitted in STATA 11.2, utilising the 'xtmelogit' command for the three binary dependent variables 'stunted', 'overweight' and 'stuntedoverweight' (see Appendix VII).

For the multinomial response variable, the 'mlogit' (multinomial link function) will be utilised in the 'GLLAMM' (Generalized Linear Latent and Mixed Models) programme for STATA (Rabe-Hesketh, Skrondal et al. 2004). For the multinomial models, with different random intercepts, the models were compared using the test statistic DIC (deviance information criterion). Lower values of DIC are considered to suggest an improved model. The value of the difference between DICs of nested models that determines a better specified model is contested, although a difference of 10 is generally accepted (van der Linde 2005). The results for three random intercepts (mother, household and community) are displayed in Table 7.4. An empty model was run (no random intercept, no independent variables), then three further models were run, each with a separate intercept for mother, household and community respectively.

Table 7.4 DIC for Multinomial Models with Random Intercept at Different Levels

Random Intercept Tested	DIC
None (empty model)	2395.15
Mother	2394.87
Household	2394.98
Community (designated by the primary sampling unit in the ADHS)	2394.3

The results show that the DIC does not decrease substantially with each random intercept tested. Usually, this would be enough to suggest that there is no clustering in the data and that the standard errors for regression coefficients should not be affected. However, it should be noted that the sample size for this analysis is small (n=1169) and this could affect results.

Of particular interest are the number of groups at each level (mother, household, community) and the group membership of these groups (number of children in each group). For example, there are 1169 children and 1049 mothers, with group size range from 1.0 to 4 (average 1.1). There are 1036 households, with group size of children in households ranging from 1.0 to 4 (average 1.2). Finally, there are 394 communities, with group size ranging from 1.0 to 12.0 (average: 3.0). These group memberships are very small and this could result in large standard errors leading to invalid conclusions drawn from the models (DeSarbo 2000).

On the weight of these models, their DIC and the small group memberships, it was concluded that it was not possible to accurately model data using a multilevel model. This, in many ways, is a function of the small sample size of the ADHS – and this key limitation is highlighted in Chapter 9. Here, however, it should be noted that the inability to utilise the multilevel models means that the data structure not be accounted for – an issue of methodology, but also key substantive insights will not be able to be made. Notably, a random intercept enables the variance in Y to be partitioned across levels. For example, the variance in child malnutrition in Albania explained at the individual level compared to the maternal, household or even community level could be determined if such models were successful. This would provide key insights into the nature of determinants of malnutrition – be it biological and proximate (that of the individual) and wider structural determinants. Furthermore, owing to the small sample size, random coefficients (where the coefficient an explanatory variable is allowed to across groups) are also not possible. This means the analysis will lose out on key substantive insights about the determinants of child malnutrition in Albania – whether, for example, having higher levels of maternal education is more protective against child malnutrition in rural areas compared to urban areas. These are key limitations of the analysis of this research. This does not preclude the validity or usefulness of the results of single level regression models, particularly as robust standard errors can be employed (to adjust standard errors for potential clustering) but does mean the analysis is not as robust or as substantively insightful as it would have been were multilevel modelling employed.

7.4 Summary

This chapter has detailed the data and methodology to be used in order to assess the determinants of stuntingoverweightness within Albania. The results of the analyses aim to provide the means to identify how stuntedoverweight children differ from their stunted and overweight peers but also who the stuntedoverweight are and what their lives look like. From this targeted intervention strategies can start to be formulated for these 'hidden' children.

Chapter 8: The Individual, Maternal and Household Level Determinants of Stuntingoverweightness in Albania

This chapter outlines the results of the individual, maternal and household level analyses of the determinants of stuntingoverweightness in Albania. The results of the planned analyses described in Chapter 7 are presented here.

The literature review of Chapters 2 & 6 revealed a rich expanse of research regarding the determinants of stunting and, more recently, overweightness in Low and Middle Income Countries. However, research is sparse concerning stunting or overweightness in contexts where both these malnutrition problems are prevalent among the under-five population. Furthermore, studies specifically focussing on stuntedoverweight children in contexts of highly diverse nutritional profiles are extremely scarce. The aim of the analysis was to uncover 1) the determinants of stuntingoverweightness in Albania and 2) what distinguishes the stuntedoverweight from other child nutritional outcomes in Albania. In doing so, these results are able to shed light on the consistently overlooked stuntedoverweight children.

Part 8.1 of this chapter presents the descriptive results and the final multinomial model emanating through the stepwise model selection process. Part 8.2 of this chapter discusses the determinants of stuntingoverweightness. A summary of results is presented in part 8.3.

8.1: Descriptive Statistics for Independent Variables included in the Model as a Result of Stepwise Model Selection

This section presents descriptive statistics for the independent variables that were found to be significantly associated with stuntingoverweightness in the regression model emanating from the stepwise modelling process. Based upon the theoretical framework for this analysis presented in Chapter 6, the variables are necessarily multilevel and multidimensional. For ease of understanding these variables are presented by the level at which they operate – thus there are 'individual-level'[69] variables, 'maternal-level' variables and 'household-level' variables. Among these levels, the variables can be both proximate and distal – and these dimensions will be referred to during the discussion of the results. Descriptive statistics for the individual-level variables are presented in section 8.1.1, maternal-level variables in 8.1.2 and household-level variables in 8.1.3. Additionally, descriptive statistics for regional differences in nutritional outcomes are presented in 8.1.4.

8.1.1 Descriptive Statistics for Individual-level Variables found to be Significantly Associated with Stuntingoverweightness in the Regression Analyses

For the individual-level variables, three variables were found to be significantly associated with stuntingoverweightness in the regression models derived from the analyses. These variables were SEX, AGE and BIRTHORDER and descriptive statistics for them are presented in Table 8.1. Age and birth order are considered proximate determinants of child malnutrition. However, there are questions concerning sex differences in malnutrition. There is an argument that, where sex differences are

[69] Where the child is the individual

found in malnutrition, they are socio-cultural in nature (thus distal) and not actually due to fundamentally different biological susceptibility to malnutrition (proximate) (Sommerfelt & Arnold 1998, Marcoux 2002). At any rate, there is no evidence for or against the role of sex as fundamentally biological or behavioural for stuntedoverweight children. This will be discussed further in part 8.2.

Table 8.1 Descriptive Statistics for Individual-level Variables SEX, AGE and BIRTHORDER by Nutritional Status in the Sample

		Total Sample	Stunted overweig ht	Stunted	Overw eight	Other[70]	F[71] (p-value)
Child Sex (SEX)	Female	50.38	62.52	48.91	44.26	50.34	2.10 (0.099)
	Male	49.62	37.48	51.09	55.74	49.66	
Child Age (AGE)	6-12 months	7.77	15.1	11.81	2.64	7.29	2.34 (0.009)
	1 Year	19.15	15.77	28.81	25.66	16.86	
	2 Years	20.96	18.37	22.58	18.22	21.56	
	3 Years	23.2	25.24	22.91	24.5	22.74	
	4 Years	28.92	25.52	13.89	28.98	31.55	
Birth Order (BIRTHOR DER)	2-4	54.81	62.85	53.4	58.55	53.32	2.73 (0.01)
	First	33.22	21.62	26.27	34.07	35.47	
	High (4+)	11.97	15.53	20.33	7.38	11.2	
Total		100.00	8.2	10.13	13.33	68.34	-

[70] As noted in Chapter 7, 'other' refers to both non-malnourished (in terms of growth faltering malnutrition) and wasted children (that are not also stunted). As previously noted, the analyses were conducted including wasted children as a separate group and also controlling for wasting. Wasting, when controlled for in the model, was not found to be significantly associated with any other nutritional outcomes. Additionally, when included as a separate outcome group in the multinomial analysis, no change was seen in the direction of the results for stuntingoverweightness, stunting, overweightness and non-malnourished – however, there were concerns that the model was over specified when having 5 for the categories dependent variable in the multinomial model. Additionally, wasting necessarily indicates sudden, acute changes in malnutrition status and is more likely reflective of morbid status within Albania and is not thought to represent the 'typical' circumstances and experiences of the majority of children in Albania today.

[71] When using the SVY command in STATA, the Pearson χ^2 is uncorrected and does not take into account the survey design, the SVY:tabulate command automatically corrects the Pearson χ^2 for the survey design using the Rao and Scott (1984) second-order correction and converting it to an F-statistic for use in a test of independence (STATA 1985-2009).

Chapter 6 highlighted that there is limited evidence of consistent sex bias in child malnutrition, generally[72], across populations, although there is evidence here that there are sex differentials in stuntingoverweightness. Among the sample of 1169 under-fives, 50.38% are female, 49.62% male. There is no statistically significant relationship found in a bivariate relationship between child sex and nutritional status.

This coincides with the body of literature espousing the inconsistency of sex biases in malnutrition (Haddad et al. 1996, Marcoux 2002). Interestingly, however, the relationship between stuntingoverweightness and SEX is found to be significant in the regression models, controlling for other variables[73]. This relationship will be elaborated upon further in Section 8.2, where the regression model results are discussed.

For AGE, the bivariate analysis did reveal a statistically significant relationship with nutritional status (F 2.34, p 0.009). The distribution of age by nutritional outcomes within the sample is presented in Table 8.1 and Figure 8.1. Among the youngest age group in the sample (6-12 months), the majority of children suffering from malnutrition are either stuntedoverweight (44.44% of malnourished 6-12 months olds) or stunted (42.94%), come age 1 this appears to shift to overweightness (44.84%).

From ages 1 to 5 years there is a downward trend in the proportion of children with malnutrition experiencing stunting, but an increase in children who are stuntedoverweight. This, descriptively, could suggest that beyond 24 months stuntingoverweightness develops sequentially – children already stunted become overweight, increasing the prevalence of stuntingoverweightness. However, this will be

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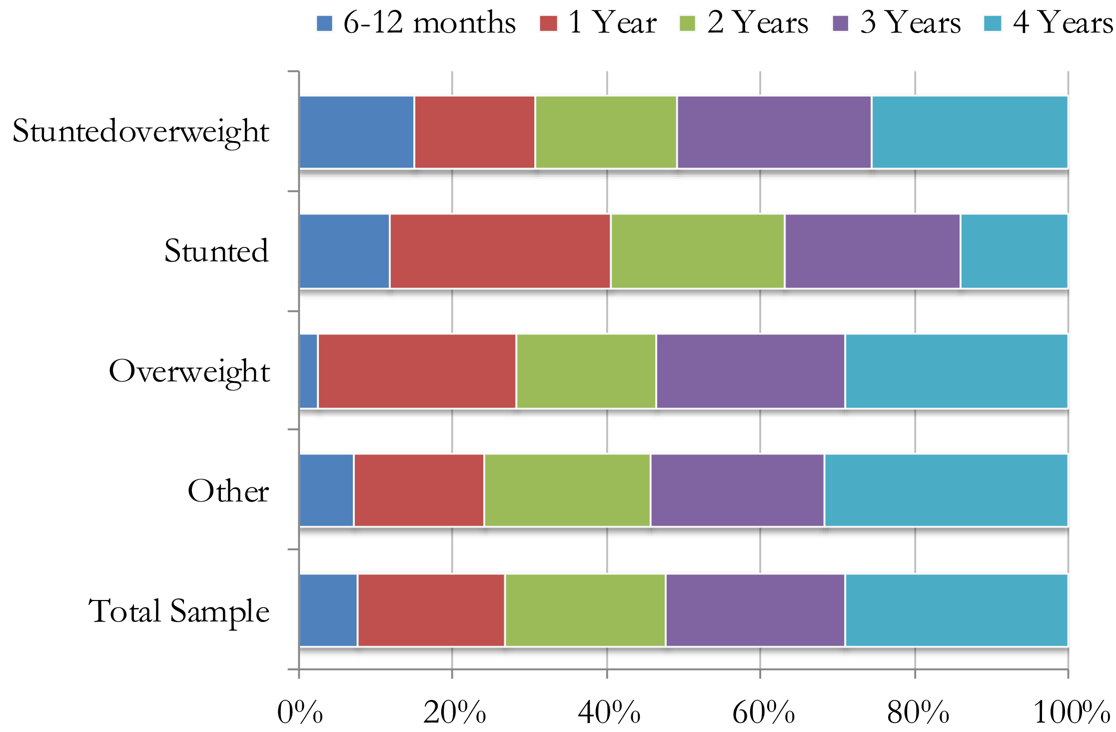
72 This evidence of no sex bias is based upon studies focusing upon stunted, overweight and wasted children – not stuntedoverweight children

73 These are the other variables explored in this part of the chapter 9.1

considered further in parts 8.2 and 8.3 of this chapter, when other proximal and distal factors are controlled for[74].

Figure 8.1 Distribution of AGE by Nutritional Status among Under-Fives in Albania 2008-09



There is statistically significant difference in BIRTHORDER and nutritional status in the sample at the 5% level (F 2.73, p 0.01). Within the whole sample, 33.22% of children were first order births, whilst 11.97% were high order births (4 or more). In line with previous research, stunted children have the highest proportion of high order births (4+) (Frost et al. 2005). The proportion of first order births is highest among overweight children. There has been limited indication in research of increased risks of

[74] In particular an assessment of the age distribution of stuntingoverweightness will be considered in the light of the two theories for the development of stuntingoverweightness that have been proposed in Chapter 6 – the theories of concurrent[74] or subsequent[74] development of stuntingoverweightness.

overweightness among first order births in LMICs[75]. However, a study in Japan showed that the risk of overweightness was greater among males of lower birth order births (Wang et al. 2007). As previously emphasised, there is very little research on stuntedoverweight children. It seems interesting, however, that stuntedoverweight children are concentrated among 'mid' birth orders of 2-4, not birth orders conventionally considered 'at-risk' for the development of either stunting or overweightness separately and this will be considered further in the discussion of the regression results.

8.1.2 Descriptive Statistics for Maternal-level Variables found to be Significantly Associated with Stuntingoverweightness in the Regression Analyses

In this section descriptive statistics for maternal-level variables by nutritional status are presented (Table 8.2). Proximate determinants at the maternal-level found to be significantly associated with stuntingoverweightness in the regression analyses were the variables BMI and HEIGHT. Distal maternal-level variables found to be significantly associated with stuntingoverweightness in the regression analyses were the variables EDUCATION (maternal education) and OR (heard of/used oral rehydration therapy).

[75] If anything, the weight of evidence in research is that higher order births increase the risk of overweightness among under-fives in LMICs

Table 8.2 Descriptive Statistics for Maternal-level Variables BMI, HEIGHT, EDUCATION and OR by Nutritional Status among Under-fives in Albania

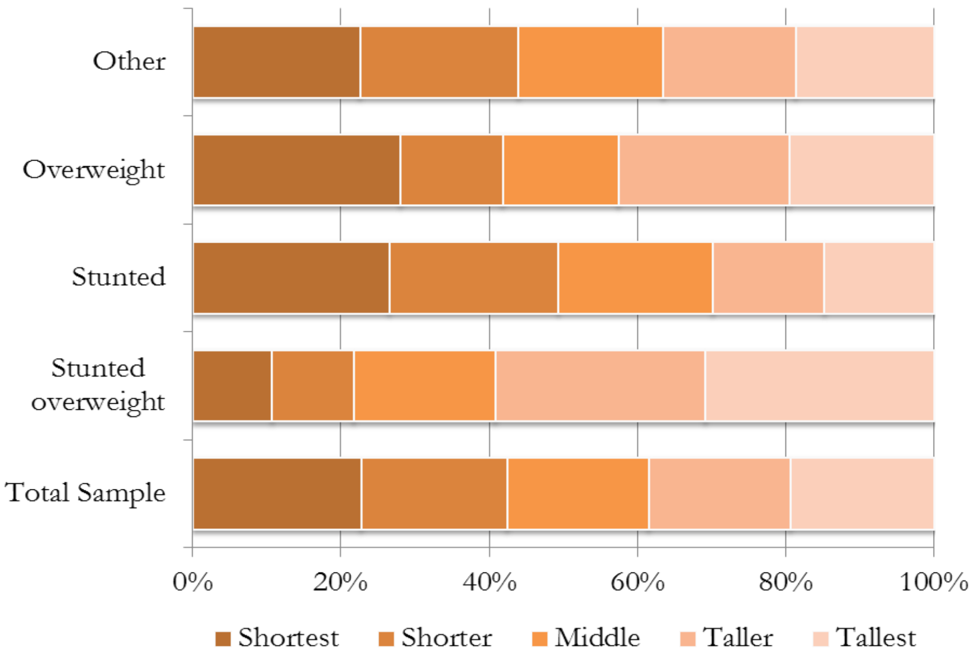
		Total Sample	Stunted overweight	Stunted	Overw eight	Other	F statistic (p-value)
BMI (Body Mass Index)	Normal	54.41	49.93	56.5	54.89	54.11	1.52 (0.18)
	Low <18.5	1.83	4.5	4.75	0.86	1.27	
	High >24.9	44.06	45.57	38.76	44.25	44.63	
HEIGHT (Maternal Height Quintiles)	Ref: shortest	22.69	10.7	29.48	28.02	22.53	1.96 (0.03)
	Shorter	19.67	10.98	22.81	13.75	21.4	
	Middle	19.08	19.1	20.86	15.59	19.5	
	Taller	19.12	28.31	15.07	23.14	17.84	
	Tallest	19.44	30.91	14.82	19.51	18.74	
EDUCATION (Maternal Education Levels)	Ref: primary	66.83	74.02	68.12	60.76	66.96	2.15 (0.048)
	Secondary	24.69	22.72	27.55	23.89	24.66	
	Tertiary	8.48	3.27	4.33	15.35	8.38	
OR (Oral Rehydration)	Heard of/Used	83.0	86.26	80.58	91.34	81.34	2.27 (0.08)
	other	17.0	13.74	19.42	8.66	18.66	
Total		100.00	8.2	10.13	13.33	68.34	-

There is no statistically significant relationship between nutritional status and BMI (F 1.52, p 0.18), unless other variables are controlled for. This is discussed further in part 8.2.

There is a significant difference in maternal height across the nutritional groups of under-fives in the sample (F 1.96, p 0.03). Figure 8.2 displays maternal height by nutritional groups and for the total sample of under-fives in Albania. Interestingly, stuntedoverweight children appear to have the tallest mothers, with the highest proportion of the tallest 20% of mothers (30.91%). Overweight children have the largest proportion of shortest mothers (28.02%), with stunted children having a similarly large proportion of the shortest mothers (26.48%) Stunted children also have the lowest proportions of taller and tallest mothers combined (29.89%).

Maternal height indicates two factors key to this analysis: 1) the genetic potential of the child in terms of their height; and 2) the past nutritional insults of the mother – both of which can impact upon the nutritional status of the children. Given the fact that stunted children tend to have shorter mothers (consistent with both key factors associated with completed maternal height), the observation of stuntedoverweight children having taller mothers comparative to all other children under-five in Albania is inconsistent. As mentioned in Chapter 6, there is a potential interaction between maternal height and region in Albania – as the taller Ghegs tended to be concentrated in poorer socioeconomic regions of Albania – and this could explain this counterintuitive result. This issue will be discussed further when assessing the regression results for this analysis – as when controlling for other variables, it may well be that the relationship between maternal height and stuntingoverweightness changes.

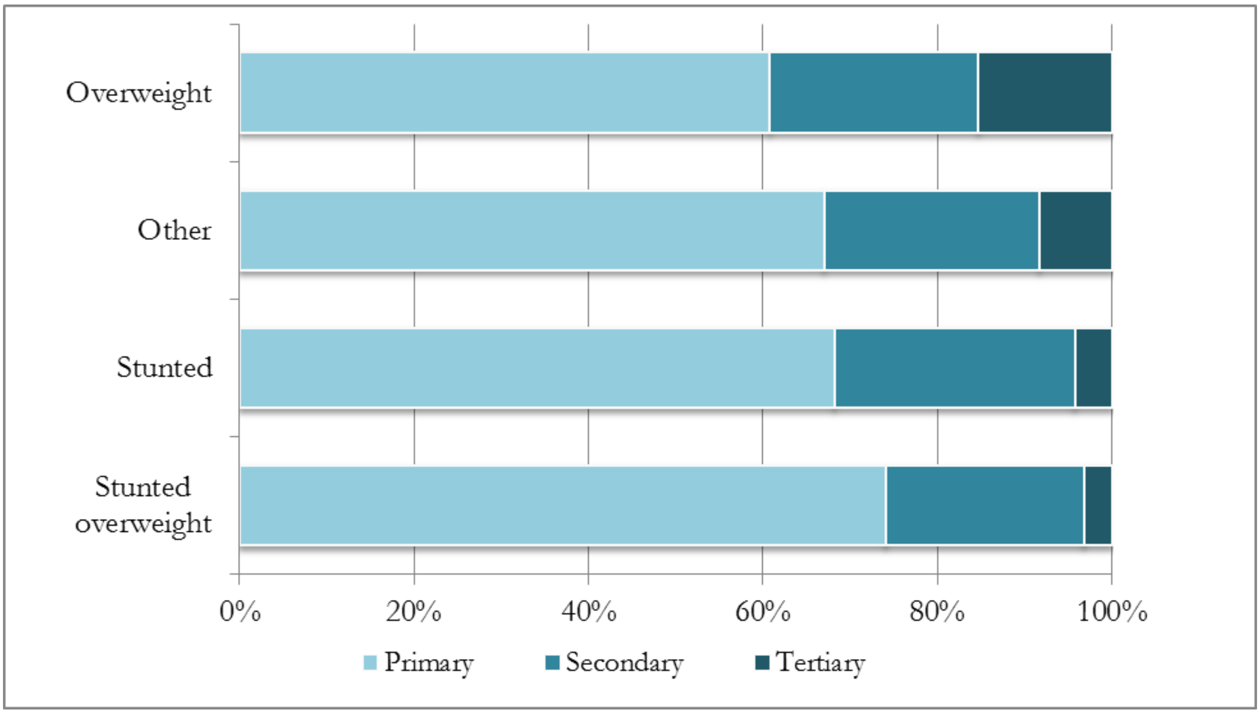
Figure 8.2 Maternal Height by Nutritional Groups and for Total Sample



With respect to maternal education, the bivariate analysis shows a statistically significant relationship between maternal education and nutritional outcomes among children in Albania (F 2.15, p 0.048).

Within the sample, 66.96% of the mothers of under-fives have primary education, 24.66% have secondary and 8.38% have tertiary education. Interestingly, there is a gradient in maternal education where stuntedoverweight children have the least educated mothers, followed by stunted children, 'other' children, then overweight children. The distribution of maternal education across nutritional status is depicted in Figure 8.3.

Figure 8.3 Maternal Education by Nutritional Status



Among stuntedoverweight children, only 3.27% of mothers have tertiary education, with the majority having incomplete primary or primary education only (74.02%). Compared to the stuntedoverweight, stunted children have a higher proportion of mothers with both secondary education (27.55%) and tertiary education (4.33%). The concentration of the most educated mothers among overweight children is indicative of a population in the midst of its nutrition transition, where overweightness (in this case of the child) is concentrated among higher socioeconomic groups.

In Albania, among overweight under-fives, 15.35% have mothers with tertiary education and 23.89% have mothers with secondary education. Although 'other' children have a greater proportion of mothers with secondary education (24.66%), they have a lower proportion of mothers with tertiary education (8.38%) and a higher proportion of mothers with incomplete or complete primary education (66.96%). This likely indicates that, within the Albanian context, greater maternal socioeconomic status, and in particular maternal education, is protective against undernutrition and stuntingoverweightness, but increases the risks of overnutrition among children – this will be discussed further in section 8.2.

Across nutritional groups, overweight children have the highest proportion of mothers that have heard of or used oral rehydration therapy (91.34%), whilst stunted children have the lowest (80.58%). However, in the bivariate analysis no statistically significant difference across nutritional outcomes is found (F 2.27, p 0.08).

In the next section, the household-level variables are described.

8.1.3 Descriptive Statistics for Household-level Variables found to be Significantly Associated with Stuntingoverweightness in the Regression Analyses

Three variables for household characteristics were found to be significantly associated with stuntingoverweightness in the regression model. These were the type of water source used (WATER), household wealth (WEALTH) and whether there was an extended family in the household (THREEGEN) (Table 8.3). The latter two variables (WEALTH and THREEGEN) are distal variables and impact upon nutritional outcomes through proximate determinants of malnutrition. However, WATER is a variable that could signify both proximate and distal determinants. A lack of an improved water source is indicative of an environment ripe for the transmission of infectious diseases, potentially increasing the risk of morbidity and thus directly impacting upon the malnutrition status of an individual. Additionally, WATER could be indicative of poor household infrastructure and thus a poorer household.

Table 8.3 Household Characteristics by Nutritional Status

		Total Sample	Stunted overweight	Stunted	Overweight	Other	F statistic (p-value)
WATER (Using Improved Water Source)	Yes	87.42	77.14	85.62	93.16	87.8	3.15 (0.027)
	No	12.58	22.86	14.38	6.84	12.2	
WEALTH Wealth Quintiles	Ref: Other 60%	47.4	42.53	55.64	51.98	45.87	1.36 (0.23)
	Poorest 20%	44.96	49.21	39.61	43.62	45.5	
	Richest 20%	7.64	8.26	4.75	4.39	8.63	
THREEGEN Extended Family in HH	Yes	59.37	48.17	62.81	54.95	61.07	1.73 (0.16)
	No	40.63	51.83	37.19	45.05	38.93	
Total		100.00	8.2	10.13	13.33	68.34	-

The highest proportion of children living in a household without an improved water source are stuntedoverweight children, of whom 22.86% do not have access to an improved water source in their household. This compares to 14.38% for stunted and 6.84% for overweight children. This difference is significant at the 5% level (F 3.15, p 0.027).

Within the sample, stuntedoverweight children appear most concentrated among the poorest households (49.21%) as well as the richest households (8.26%) when compared to their overweight (43.62% and 4.39% respectively) and stunted children (39.61% and 4.75% respectively). However, in a bivariate analysis no statistically significant relationship between WEALTH and nutritional outcomes was found (F 1.36, p 0.23).

With respect to THREEGEN, the highest proportion of children living in a household with an extended family exists within stunted children (62.81%), while the lowest proportion is present among stuntedoverweight children (48.17%). This was expected as extended families within households are considered indicative of more traditional household structures and values, with patriarchal values being reflected in skewed sex ratios at birth in Albania (Guilmoto & Duthie 2013). In the bivariate analysis, however, no significant relationship between extended families in a household and child nutritional status was found (F 1.73, p 0.16).

8.1.4 Descriptive Statistics for Regional Variations in Nutritional Outcomes among Under-Fives, Significantly Associated with Stuntingoverweightness in the Regression Analyses

The final variable to be outlined here is REGION. As noted in Chapter 6 and 7, REGION represents the four key regions in Albania – the coastal, central, northeast and Tirana – which differ both in agro-ecological terms and development, with the northeast being the least developed region.

A bivariate analysis found a statistically significant relationship between region and nutritional outcomes among children (F 2.13, p 0.036) (Table 8.14). In total, the coastal region has the highest burden of all three forms of growth faltering malnutrition focused upon in this research – stuntingoverweightness, stunting and overweightness.

Table 8.4 Region by Nutritional Status

		Other	Stunted	Overweig ht	Stuntedover weight	F Statistic (p-value)
Region	Coastal	72.55	10.6	8.57	8.28	2.13 (0.036)
	Central	67.04	8.85	16.82	7.29	
	NE	59.77	17.14	12.49	10.6	
	Tirana	70.86	7.49	12.67	8.98	
Total		68.36	10.12	13.32	8.2	100.00

The majority of stuntedoverweight children live in the coastal region (36.29%), followed by Tirana (27.75%). These are areas known to have higher levels of development within Albania. They are considered to be relatively more 'westernized' than the central and northeastern regions, particularly in terms of their diet (Buonomo et al. 2005). Additionally, these regions are the main 'absorbers' of internal migrants in Albania – from the NE and central regions (INSTAT 2004 cited by Gjonça et al. 2008; Institute of Statistics., et al., 2010). These regions are known to have experienced poorer socioeconomic conditions (both in the past and today) than Tirana and the coastal region (Gjonça 2001). Based on this, it seems apparent that stuntingoverweightness is linked to socioeconomic development – thus behavioural factors have a key part to play in its development. Whether these effects lead to concurrent or subsequent development of stuntingoverweightness, however, is unknown. At this stage I propose three possible explanations for this regional pattern of stuntingoverweightness.

Firstly, the reason for the existence of stuntedoverweight children in these more developed areas could be that they are the poorer echelons of society living in these areas, but access to the 'junk foods' (evidenced in the Buonomo et al. report) has led to what is currently an energy-dense diet (2005).

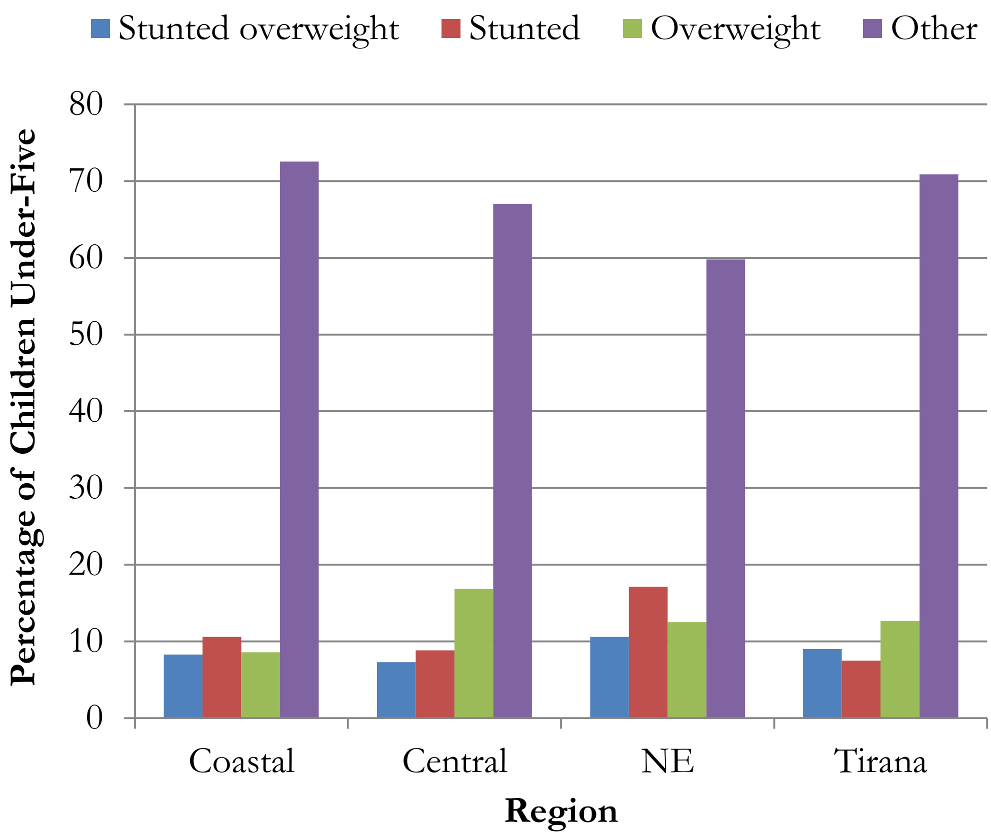
Another explanation could be that stuntedoverweight children are children that have recently moved from the NE and central regions – chronically malnourished and now in an area that is more developed, consuming diets with excessive quantities of macronutrients. If this were the case, this would also suggest the 'subsequent' developmental trajectory for stuntingoverweightness and, possibly, that stunting confers a susceptibility to overweightness that leads to stuntingoverweightness. Such an explanation could suggest that the developmental adaptations integral to the FOAD hypothesis act far earlier in the life course than currently thought.

A third explanation is that stuntedoverweight children in the coastal region and Tirana are the offspring of parents from the northeast. Due to their parents', and particularly their mothers', poor early life conditions, these children are seeing an intergenerational effect that is leading to the development of stuntingoverweightness. The mechanisms through which this could occur, however, are unknown.

With respect to stunting, the highest proportion of stunted children also inhabits the coastal region. However, the biggest proportion of stunting of all children is found in the northeast. This reflects the consistently lower levels of socioeconomic development found in the northeastern region of Albania.

The greatest number of overweight children resides in the coastal region – consistent with Buonomo et al.'s findings on the increasing 'westernized' diet of this region. However, from a regional perspective overweightness is proportionally the largest form of growth malnutrition occurring (relative to other forms) in the central region. Why the central region is more likely to contain overweight rather than stuntedoverweight or stunted children is currently unknown.

Figure 8.4 Distribution of Nutritional Status by Region among Under-Fives in Albania (% of Under-Fives)



In the next section of this chapter, Section 8.2, the results of the regression modelling are presented and discussed. The discussion focusses on stuntedoverweight children and how they differ from their stunted, overweight and non-malnourished peers.

8.2: Regression Results for Independent Variables included in the Model as a Result of Stepwise Model Selection

In this section, the results for the multinomial regression analysis are presented and interpreted – focussing on the distinguishing characteristics of the stuntedoverweight. The results will be discussed, as before, by level of variable – although cross-level interactions will be discussed where necessary. Section 8.2.1 focusses on the effects of individual-level variables, 8.2.2 the maternal-level variables, 8.2.3 household-level variables and 8.2.4 region.

Table 8.5 displays the multinomial regression model derived from the multistage model building strategy that was described in Chapter 7. The multinomial model was estimated using the base category 'non-malnourished' (the largest group). However, post estimation, the user-written command 'listcoef' was used to obtain coefficient estimates for the independent variables for all combinations of the logit models that comprise the multinomial model.

In addition, Table 8.6 provides the marginal effects at means (MEMs) of independent variables on the probability of being stuntedoverweight, stunted, overweight or other. MEMs show the effect an independent variable has on the probability of being stuntedoverweight (or stunted, overweight or other) - holding all other variables at means. MEMs can thus provide a means to show the differential effects of variables across nutritional groups in Albania and can provide a more intuitive way to compare results. At times, the focus will be on how a categorical variable varies specifically for stuntedoverweight children. A particular example of this is age. In this situation, predicted probabilities are presented as they provide a means to show the effect of the categorical variable, in this case age, overall and not just in relation to the reference category of the variable.

Table 8.5 Multinomial Regression Results for the Nutritional Outcomes among Under-Fives in Albania (Relative Risk Ratios)

		Stunted-overweight over Stunted		**Stunted-overweight over overweight**		**Stunted-overweight over OTHER**		**Stunted over Overweight**		**Stunted over Other**		**Overweight over Other**	
		RRR	*SE*	RRR	*SE*	RRR	*SE*	RRR	*SE*	RRR	*SE*	RRR	*SE*
Child Sex	Female	1.89*	0.60	2.34**	0.70	1.75*	0.42	1.24	0.38	0.92	0.22	0.75	0.16
Child Age	Ref: 6-12 months	1.0		1.0		1.0		1.0		1.0		1.0	
	1 Year	0.37	0.23	0.08**	0.06	0.36	0.19	0.21*	0.15	0.98	0.52	4.78**	2.79
	2 Years	0.63	0.31	0.14**	0.09	0.37	0.18	0.22*	0.14	0.58	0.25	2.62	1.44
	3 Years	0.73	0.45	0.12**	0.09	0.43	0.23	0.17**	0.12	0.58	0.26	3.47*	2.01
	4 Years	1.18	0.70	0.09***	0.06	0.27**	0.13	0.08***	0.06	0.23**	0.12	2.85	1.59
Birth Order	2-4	1.0		1.0		1.0		1.0		1.0		1.0	
	First	0.86	0.32	0.65	0.25	0.57	0.17	0.75	0.25	0.66	0.19	0.87	1.95
	High	0.58	0.26	1.90	0.92	1.12	0.42	3.25**	1.48	1.91*	0.62	0.59	0.21
BMI		1.0		1.0		1.0		1.0		1.0		1.0	
	Low	0.86	0.86	8.21*	8.27	4.42	3.78	9.52*	9.06	5.13*	4.05	0.54	0.35
	High	1.54	0.52	1.22	0.40	1.14	0.33	0.79	0.27	0.74	0.20	0.94	0.21
Using Improved Water Source	Yes	0.46	0.20	0.22**	0.10	0.37**	0.14	0.47	0.21	0.80	0.29	1.69	0.61
Oral Rehydration	Heard of/Used	1.46	0.73	0.68	0.40	1.67	0.80	0.47	0.21	1.14	0.39	2.45*	0.90

Maternal Height Quintiles	Ref: shortest	1.0		1.0		1.0		1.0		1.0		1.0	
	Shorter	1.47	0.87	2.67	1.67	1.24	0.67	1.82	0.92	0.84	0.28	0.46	0.19
	Middle	2.60	1.28	3.54**	1.70	2.15	0.84	1.36	0.64	0.83	0.30	0.61	0.21
	Taller	7.50***	3.97	4.87***	2.46	4.39	1.86	0.65	0.31	0.59	0.22	0.90	0.30
	Tallest	7.15***	3.79	5.83**	3.28	4.12*	1.79	0.82	0.44	0.57	0.24	0.70	0.25
Wealth	Ref: Other 60%	1.0		1.0		1.0		1.0		1.0		1.0	
	Poorest 20%	1.92	0.64	1.27	0.42	1.21	0.31	0.6617	0.19	0.63*	0.13	0.95	0.23
	Richest 20%	3.70*	1.96	2.73	1.63	1.19	0.53	0.74	0.45	0.32**	0.14	0.44	0.19
Region	Ref: coastal	1.0		1.0		1.0		1.0		1.0		1.0	
	Central	0.99	0.53	0.71	0.32	0.70	0.31	0.72	0.34	0.71	0.27	0.99	0.32
	NE	1.63	0.64	1.59	0.67	1.46	0.44	0.98	0.37	0.90	0.27	0.92	0.27
	Tirana	4.11**	2.18	2.47*	1.07	1.49	0.51	0.60	0.28	0.36*	0.14	0.60	0.20
Education	Ref: primary	1.0		1.0		1.0		1.0		1.0		1.0	
	Secondary	0.52	0.19	0.67	0.23	0.72	0.20	1.28	0.46	1.37	0.36	1.07	0.28
	Tertiary	0.35	0.32	0.11**	0.87	0.22	0.16	0.32	0.18	0.63	0.31	1.95*	0.63
Extended Family in HH	Yes	0.55	0.20	0.78	0.27	0.61	0.17	1.40	0.50	1.10	0.33	0.78	0.18
N								1169					

Table 8.6 Marginal Effects of Independent Variables on the Probability of Different Nutritional Outcomes among Under-Fives in Albania, holding all other variables at means (MEMs)

		Stuntedoverweight	Stunted	Overweight	Other
Child Sex	Female	0.034**	-0.006	-0.034	0.007
Child Age	Ref: 6-12 months				
	1 Year	-0.052***	-0.021	0.244**	-0.171
	2 Years	-0.048***	-0.043*	0.141	-0.050
	3 Years	-0.045**	-0.047*	0.185*	-0.092
	4 Years	-0.060***	-0.096***	0.157*	-0.001
Birth Order	Ref: 2-4				
	First	-0.027*	-0.027	-0.007	0.060**
	4+	0.005	0.067*	-0.055**	-0.018
BMI	Ref: Normal				
	Low	0.114	0.202	-0.077**	-0.239
	High	0.009	-0.023	-0.005	0.018
Using Improved Water Source	Yes	-0.082**	-0.015	0.056**	0.040
Oral Rehydration	Heard of/Used	0.020	0.001	0.073***	-0.094**
Maternal Height Quintiles	Ref: shortest				
	Shorter	0.018	-0.008	-0.068**	0.058
	Middle	0.059*	-0.014	-0.051*	0.007
	Taller	0.133**	-0.044**	-0.022	-0.067
	Tallest	0.128**	-0.043*	-0.043	-0.042
Wealth	Ref: Other 60%				
	Poorest 20%	0.013	-0.036**	-0.002	0.024
	Richest 20%	0.020	-0.057***	-0.063**	0.100**
Region	Ref: coastal				
	Central	-0.017	-0.023	0.004	0.036
	NE	0.025	-0.009	-0.010	-0.006
	Tirana	0.033	-0.062***	-0.044	0.072*

Education	Ref: primary				
	Secondary	-0.019	0.027	0.006	-0.014
	Tertiary	-0.052***	-0.033	0.102**	-0.017
Extended Family in HH	Yes	-0.027*	0.012	-0.023	0.038
N			1169		

8.2.1 The Individual-Level Determinants of Stuntingoverweightness

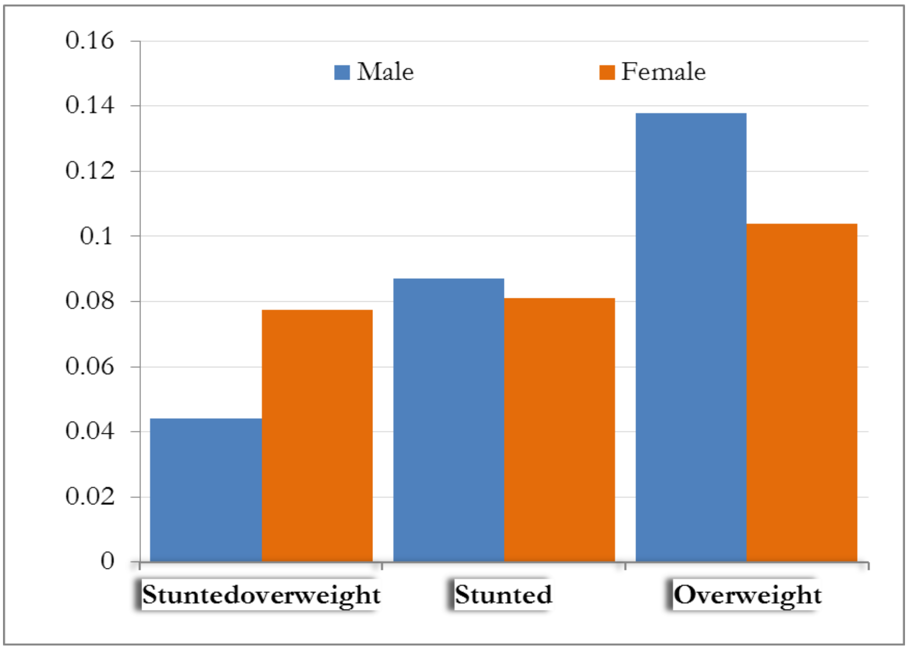
In the multinomial model, child sex, age and birth order are found to be statistically significant factors associated with an increased risk of being stuntedoverweight among under-fives in Albania.

The descriptive statistics showed that no relationship exists between child sex and malnutrition outcomes in Albania. However, in a multinomial model the effect of child sex on the risk of stuntingoverweightness is unmasked. The results show that being female increases the risk of being stuntedoverweight.

Figure 8.7 shows the predicted probability of being stuntedoverweight, stunted or overweight by sex among the population of under-fives in Albania. The graph clearly shows the female bias for stuntingoverweightness, which is at odds with both stunting and overweightness, where, generally, no significant sex bias in malnutrition is found.

This is supported by the MEMs. The MEMs show the effect of being female as opposed to male on the probability of each nutritional outcome holding all other variables at means (Table 8.6). Holding all other variables at means being female (as opposed to male) increases the probability of being stuntedoverweight by 3.4%.

Figure 8.7 Predicted Probability of Nutritional Group by Child Sex



This sex bias exists even when comparing the risk of stuntingoverweightness directly to specific nutritional outcomes in Albania. The RRRs show that for stunted children, being female over male increases the risk of being stuntedoverweight by 1.89 times. For overweight children the risk is 2.34 times higher and for children that are not malnourished the risk is 1.75 times higher, controlling for all other variables.

From these results we can see that regardless of the comparison group (the whole sample, overweightness, stunting or other) there is a consistently increased risk of stuntingoverweightness for female children. This is an interesting result, particularly within the context of the literature on sex bias in malnutrition more generally. The literature is necessarily focussed on under- and overnutrition, as opposed to paradoxical concurrences of malnutrition such as stuntingoverweightness – because these paradoxical nutritional insults are rarely recognised. The main argument in the literature is that there is no consistent sex bias in malnutrition found which is used to reject the notion that there is a fundamental biological susceptibility for females to malnutrition (Marcoux et al. 2002). In contexts where sex differences in malnutrition have been found they have been attributed to behavioural factors; the differential treatment of female children ascribed to particular cultural norms and values (Sommerfelt & Arnold 1998). In the regression model, REGION (region of Albania) and THREEGEN (extended families in the household) were introduced to control for traditional values that have been linked to differential health care behaviours towards female children in Albania through the observation of regional variations in sex ratios at birth (Guilmoto & Duthie 2010). Controlling for traditional values, there is no sex difference seen between stunting and overweightness in Albania – which conforms with the current literature on child malnutrition. With respect to stuntingoverweightness, however, this sex bias exists even controlling for REGION and THREEGEN. This suggests that there are biological mechanisms involved in the development of stuntingoverweightness, with females biologically more susceptible.

With respect to age, it was highlighted in the Chapter 6 that the risks of stunting and overweightness vary by age. The predicted probabilities of being stunted, overweight or stuntedoverweight within Albania by age are presented in Table 8.8. As displayed in Figure 8.9, there are clear differences in the probability of each form of malnutrition by age.

Table 8.8 Predicted Probability of being Stuntedoverweight, Stunted and Overweight by Age

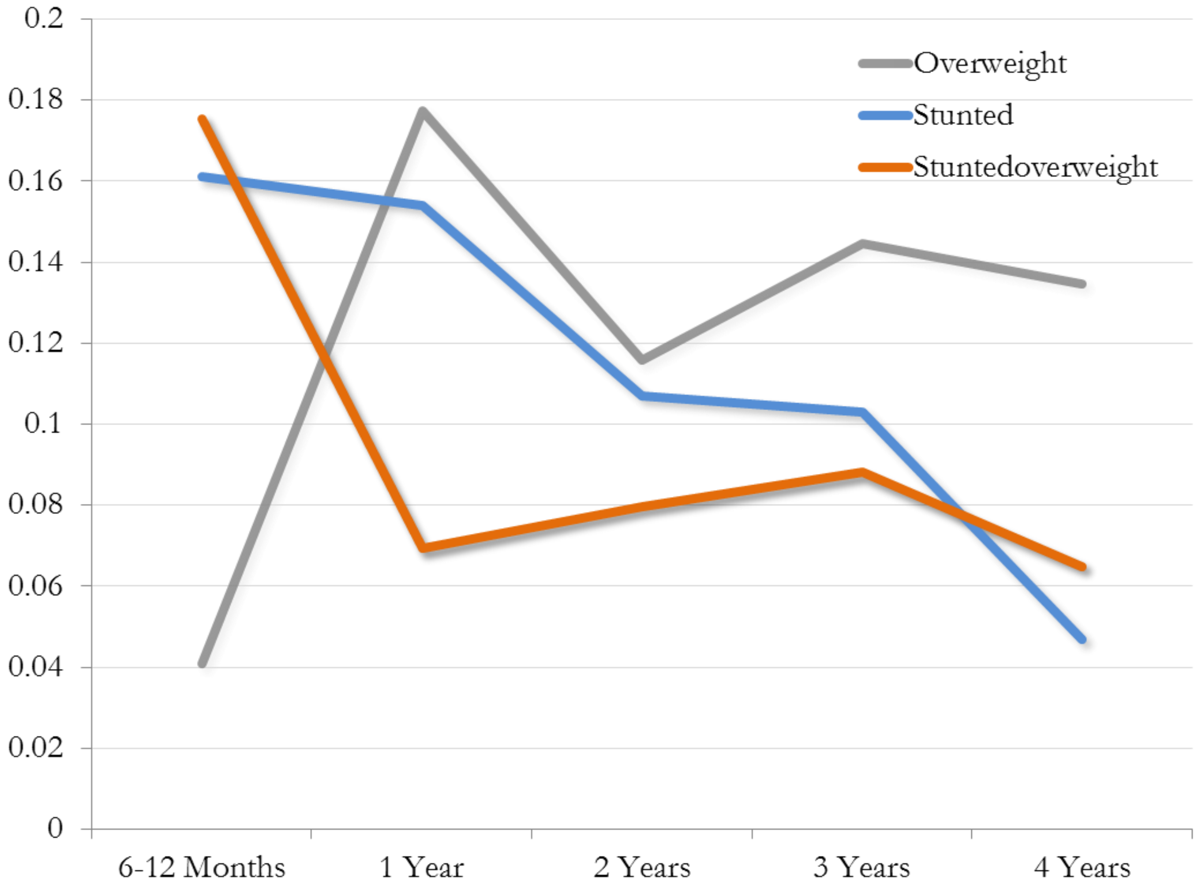
	Stuntedoverweight (se)	Stunted (se)	Overweight (se)	Other
6-12 Months	0.175***	0.161**	0.041*	0.623***
	(0.048)	*(0.048)*	*(0.02)*	*(0.068)*
1 Years	0.069***	0.154***	0.177***	0.600***
	(0.019)	*(0.034)*	*(0.034)*	*(0.043)*
2 Years	0.08***	0.107***	0.116***	0.697***
	(0.016)	*(0.023)*	*(0.023)*	*(0.036)*
3 Years	0.088***	0.103***	0.145***	0.665***
	(0.024)	*(0.018)*	*(0.028)*	*(0.036)*
4 Years	0.065***	0.047***	0.135***	0.753***
	(0.012)	*(0.013)*	*(0.021)*	*(0.027)*

$^*p<0.05$, $^{**}\ p<0.01$, $^{***}\ p<0.001$[76]

The probability of stunting is highest among earlier ages under-fives in Albania. This coincides with the literature that suggests stunting develops by the age of 2 (Shrimpton et al. 2001). For overweightness, the literature suggests one of the key stages for the development of overweightness is early infancy. This is paralleled in the results for Albania as the probability of being overweight increases greatly between ages 6-12 months, with the highest probability of being overweight in Albania occurring at the age of 1 (Dietz 1994).

[76] P-value for Z-statistic from Z-test of estimates of predicted probabilities

Figure 8.9 Predicted probabilities for Stuntingoverweightness, Stunting and Overweightness by Age among Under-Fives in Albania



Stuntingoverweightness and its incidence across the early years of a child's life has not yet been document. However, these results show that early infancy is a period of high risk for the development of stuntingoverweightness. Following this peak, there is a decline in the probability that then increases up to 3 years of age – where the next-greatest probability of being stuntedoverweight occurs. This is an illuminating result as it indicates there is one key 'at risk' periods for the development of stuntingoverweightness – the first 6 months of life. A particularly interesting question to arise from this result is how stuntingoverweightness develops varies by age. For example, is stuntingoverweightness that develops in infancy evidence of a 'concurrent' developmental trajectory, whilst in later years we are seeing a 'subsequent' or 'sequential' developmental trajectory?

Another interesting feature in the age distribution is the interplay between the different forms of malnutrition presented here. The sharp decline in the probability of being stuntedoverweight between 6-12 months and 1 year is directly opposed to the rise seen in the probability of overweightness. It is arguable that the stuntedoverweight children between 6 and 12 months of age months 'grow out' of their early age stunting but remain overweight. The inverse relationship seen between stuntingoverweightness and overweightness would therefore indicate the same individuals who were once stuntedoverweight become solely overweight. In the absence of longitudinal data, it is not possible to clarify this proposition – but it is a clear avenue for future research into stuntingoverweightness. Additionally, if this were the case, there are key questions to be asked about how stuntedoverweight children move on to meet a healthy 'height-for-age' in a context of overnutrition. Answering this question could open up strategies for the alleviation of a low height-for-age in early childhood for both stuntedoverweight and stunted children.

As a further caveat to the analysis, an interaction between AGE and SEX was tested to see if the risk of stuntingoverweightness varies by age – as research has shown that gender bias in other forms of malnutrition can vary by age (Biswas & Bose 2010). However, the interaction term was not found to be statistically significant, indicating that the effect of the female bias does not vary by age. In fact, female children are at greater risk of stuntingoverweightness at all ages.

With respect to BIRTHORDER, the descriptive statistics showed a statistically significant relationship with nutritional outcomes across age. Descriptively, it appeared that stuntingoverweightness was concentrated among birth orders 2-4 and was not associated with birth orders normally considered of risk – first order and high order (≥4) births. This was not reflected in the multinomial regression results. When compared to each other, nutritional outcomes defined by the model (stunting, overweightness and other) show no statistically significant difference between birth order and risk of being stuntedoverweight (Table 8.5). However, assessing the MEMs shows that having been a first order birth increases the probability of being stuntedoverweight, holding all other variables at means (Table 8.6). This is a distinctive result when compared to the stunted and the overweight under-fives in Albania – as the development of these two forms of malnutrition is at higher risk among high order births. Chapter 6 highlighted how being born to a mother of high parity (≥3 live births) and thus a high birth order is actually found to be associated with an increased risk of low birthweight. At the same time, research has shown that low birth weight can increase the risk of both stunting and overweightness over the life course. The association between low birth order and risk of stuntingoverweightness is another clear distinctive characteristic of individuals suffering this paradoxical MNI.

Before moving on to maternal-level variables and the relationship within stuntingoverweightness, a note is made on variables that were not found to be significant in the analyses.

Chapter 6 highlighted that the length of the preceding birth interval can have adverse effects on the health of a child. Short birth intervals (<24 months) have been shown to increase the risks of low birthweight, prematurity and foetal wastage (Kramer 1987; Potter et al. 1965). Of particular concern for malnutrition is the increased likelihood of low birth weight. In this analysis neither birth weight nor preceding birth intervals were found to have a significant impact upon the risk of stuntingoverweightness. Moreover, there was no significant relationship between these variables and the risk of stunting, overweightness, stuntingoverweightness or otherwise in Albania. This was true both in bivariate analyses and multivariate analyses. As an additional note, incidence of anaemia within a child was not found to be significant with stuntingoverweightness, or indeed any other nutritional incomes. It had been hypothesised that stuntingoverweightness may develop concurrently due to energy-dense, micronutrient-poor dietary intake – but the absence of an increased risk of anaemia among stuntedoverweight children does not support this hypothesis. However, anaemia is only one type of micronutrient deficiency and this result cannot be used to completely reject this theory of a development pathway for stuntingoverweightness.

8.2.2 Maternal-Level Determinants of Stuntingoverweightness

Chapters 6 and 7 outlined the maternal level variables that would be utilised in the analyses. The results from the multinomial regression model showed maternal BMI (BMI), maternal height (HEIGHT) and maternal education (EDUCATION) to be significantly associated with stuntingoverweightness.

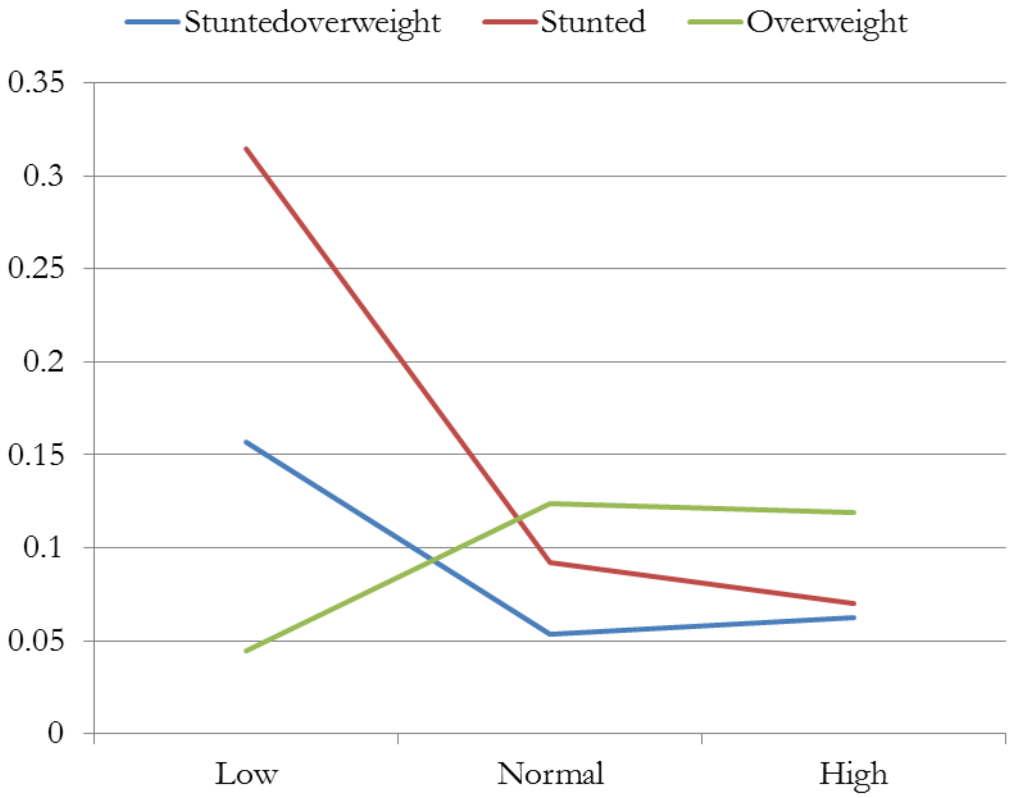
As noted in the literature review, maternal BMI typically has an inverse relationship with child stunting, but is positively associated with overweight children. Of the limited research that has studied the determinants of stuntingoverweightness there was one study, in Mexico, that showed a positive association between maternal BMI and stuntingoverweightness (Fernald & Neufeld 2007).

Among the whole sample, the predicted probability of being stuntedoverweight is highest where BMI is low (indicating maternal undernutrition) (0.157; Table 9.10). There is also a higher probability of stuntingoverweightness when a mother has a high BMI (relative to a 'healthy' BMI) (0.062; Table 9.10; Figure 9.11). These results in part support the research of Fernald & Neufeld on stuntedoverweight children in Mexico. However, it is clear that across the whole sample the probability is far higher among children whose mothers have low BMI.

Table 8.10 Predicted probability of Nutritional Outcomes by Maternal BMI

BMI	Stuntedoverweight	Stunted	Overweight	Other
Low	0.157**	0.314**	0.044**	0.485***
Normal	0.053	0.092	0.124	0.731**
High	0.062**	0.070**	0.119**	0.748***

Figure 8.11 Maternal BMI and probability of being stuntedoverweight, stunted and overweight



Using the RRRs and MEMs to compare the effect of maternal BMI across nutritional outcomes in Albania highlights further nuances. Notably, there is no significant MEM of BMI on the probability of stuntingoverweightness of both a low or high BMI (relative to a normal BMI) when all other variables are held at their means (Table 8.6). However, there is a significantly higher risk of a child being stuntedoverweight as opposed to overweight if their mother has a low BMI (relative to a BMI in the 'normal' range). This is a key result, as it enables us to understand what distinguishes stuntedoverweight children from their overweight peers. Compared to the overweight, stuntedoverweight children are actually more likely to have a mother that is undernourished. This result could be indicative of both a proximate and distal effect. Chapters 2 and 6 highlighted the intergenerationality of malnutrition and that maternal health and nutrition have key implications for health outcomes among children. There is clear relationship between poor maternal nutrition and greater risk of low birth weight among infants, which is suggestive of intrauterine growth retardation that is likely to continue across the early years of an affected child's life. Poor maternal nutrition has also been linked to developmental responses of the foetus intrauterine that affect the way they metabolise key macronutrients – notably fats. In doing so, a child is at greater risk of poor health outcomes across their life course – and interestingly at greater risk of overweightness and obesity (as well as related disorders) in adulthood, as the adaptations that occurred aiming to prepare the foetus for an environment of undernutrition become maladaptive when nutritional availability improves.

Indirectly, however, it could be that low BMI is actually representative of the wider socioeconomic environment of the mother and thus the context in which the child lives and is growing. In this instance, it could be argued that the effect of low BMI on increasing stuntingoverweightness when compared to overweightness is indicative of differential nutrient availability, health care behaviours and environments that are leading to stuntingoverweightness in a child. The mechanisms through which this might occur are currently unknown but one proposed mechanism is through energy dense foods (causing overweightness) that are also nutrient poor (leading to stunting).

However, in the model the wider socioeconomic environment is controlled for – using EDUCATION (maternal education), WATER (access to improved water source), WEALTH (household asset index) and REGION (as levels of development in Albania have been shown to vary regionally). Yet BMI is still distinguishing between stuntedoverweight and overweight children beyond these variables. Additionally, OR (knowledge/use of oral rehydration therapy) is controlled for in the model to indicate health care behaviours and knowledge particularly pertinent to child malnutrition, yet BMI still has an independent effect above and beyond OR. Moreover, traditional values are controlled for using THREEGEN and again BMI still independently explains some of the variance in the risk of stuntingoverweightness compared to overweightness. Given the lengths that have been taken to control for the wide range of factors affecting child malnutrition status, the strength of the evidence is that there is an independent effect of maternal nutritional status that distinguishes between stuntedoverweight and overweight children, and that this goes beyond issues of socioeconomic status and the related environment and behavioural factors that impact upon child nutrition. From this evidence, I suggest that we are seeing an indication of a biological effect – perhaps even evidence that the 'foetal origins of adult disease' are actually seen much earlier in the life course – manifesting as stuntingoverweightness. To clarify, poor nutrition of the mother during gestation has led to developmental changes that increase a child's susceptibility to being both stunted and overweight concurrently.

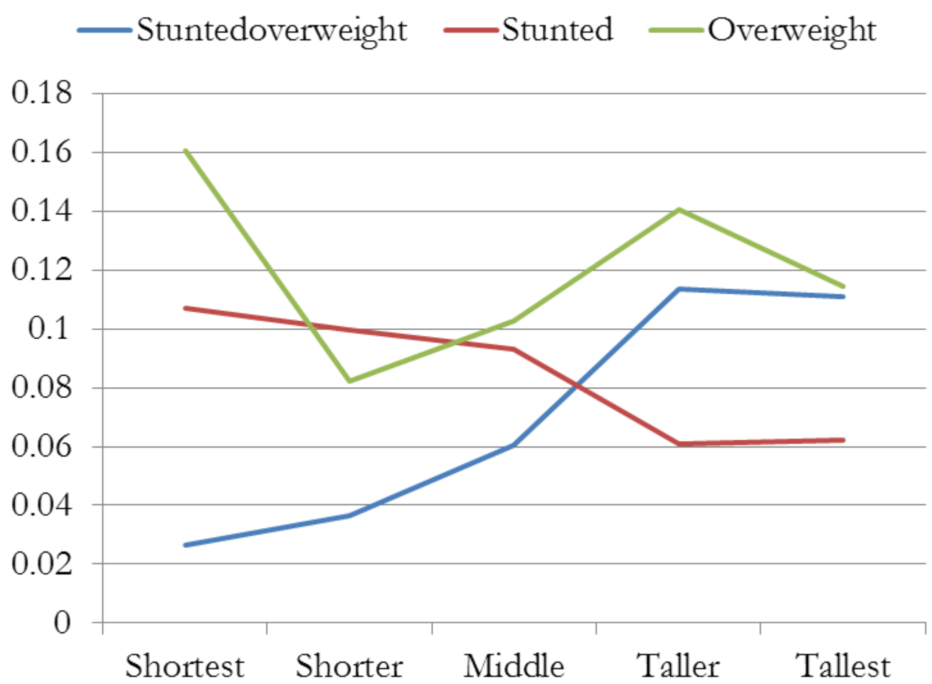
Maternal height was included in the analysis as a means to further assess intergenerationality in malnutrition. Whilst the heritability of height is considered to be ~80% (where heritability refers to the per cent of variability between people controlled by genes), realising this potential is subject to the social and environmental exposure an individual experiences – particularly in early childhood (McEvoy & Vissher 2009; Subramanian et al. 2009; Dewey & Begum 2011). Thus the relationship between maternal height and better child nutrition & growth and reduced mortality suggests better early life condition of the mother in terms of nutritional status (and by implication a better socioeconomic environment that led to this) result in a better health 'stock' of the mother that is reflected in their offspring's growth. As a result, increased maternal height should be associated with, for example, a decreased risk of stunting. No statistically significant association between overweightness and maternal height is assumed, however, as such children would be considered better able to meet their genetic potential and thus mirror the general distribution in height attributable to genetic variation.

The predicted probabilities of malnutrition by maternal height quintile are displayed in Figure 8.12. The results support the positive relationship between maternal height and better nutrition – thus the probability of being stunted reduces among children as maternal height increases.

The results of the multinomial regression models (Table 8.5 and 8.6) support this. Stunted children are more likely to have a mother in the shortest height quintile than one in the tallest two quintiles (MEM 0.044 and -0.043 respectively; Table 8.6). This underlines an intergenerationality of early childhood environments – particularly as the models control for current socioeconomic conditions. Additionally, overweight children don't appear to have a consistent relationship with maternal height (Table 8.5; 8.6)

The result for stuntingoverweightness is particularly interesting, however, and does not coincide with the current literature for either stunting or overweightness. Stuntedoverweight children are found to have consistently taller mothers – both among the whole sample and when compared directly to stunted, overweight and 'other' children (Table 8.5; 8.6, Figure 8.12). The predicted probabilities for maternal height for stuntedoverweight, stunted and overweight children are presented in Figure 8.12.

Figure 8.12 Maternal Height and Predicted Probability of Stuntedoverweight, Stunted and Overweight



This finding is counterintuitive, as it shows stuntedoverweight children are more likely to have taller mothers than all other nutritional groups (of children) in Albania even controlling for all other variables.

However, as Chapter 6 highlighted, there are unique features to height in Albania – and as such it is an 'Albanianism'. Given this, this counterintuitive result between height and stuntingoverweightness warrants further investigation. Greater clarification is required in this context particularly because this research remains one of the few studies on stuntedoverweight children. In an emerging field of research, to propose a result stating stuntedoverweight children have taller mothers, when in reality this is an Albanianism, could lead to a large body of misdirected research.

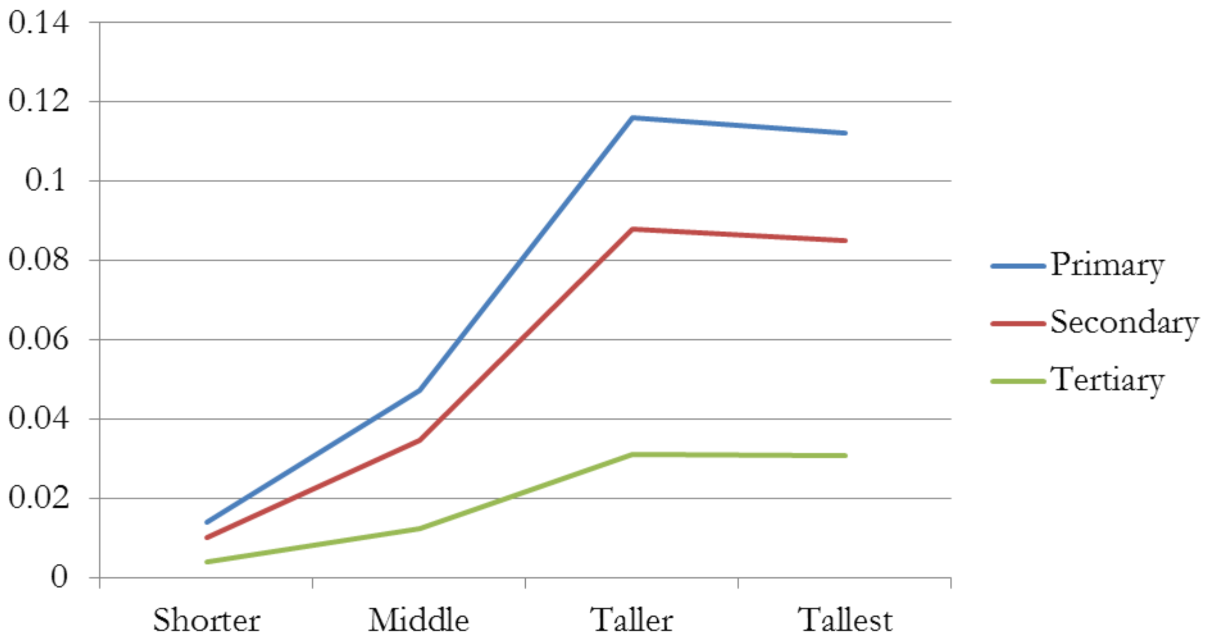
It is know that height is not normally distributed across the Albanian population due to ethnic differences in height. It had been thought that region could control for these differences – as the taller Ghegs reside in the northeastern, mountainous region (thus the epithet 'the Mountain of Giants'). But being genetically taller is not the only characteristics of individuals from these regions, as they live in areas of Albania that have consistently seen low levels of socioeconomic development and this could be having a significant impact on the developmental trajectory of their children. It had been thought that in controlling for region I could account for both socioeconomic disparities and ethnic variation in height. However, HEIGHT has both a significant and unusual effect on the risk of stuntingoverweightness despite controlling for region, so further checks need to be put in place to try and assess the reliability of such a result.

Firstly, I wanted to check that HEIGHT was not merely explaining some of the variance in nutritional outcomes by capturing the effect of the current socioeconomic conditions in which a child was living – i.e. where the child's conditions are believed to be worse than the mother's. Specifically, in this case HEIGHT is thought to better socioeconomic conditions of a mother earlier in the life course (leading to a full realisation in their height potential). However, the socioeconomic advantage of the mother in their early years is not paralleled in the child's current early years.

Stuntedoverweight children are living in environments rife for the development of stuntingoverweightness that their mothers, previously better off, did not experience in childhood. If this were the case an interaction between HEIGHT and socioeconomic status would be present. To test this hypothesis, socioeconomic status variables (improved water source, household wealth, maternal education and region) were removed from the model and then re-introduced to see if this changed the significance or impact of maternal height on the probability of being stuntedoverweight. Additionally, interaction terms were tested to assess whether the relationship between height and stuntingoverweightness varies by current socioeconomic status. No indication of an interaction was seen and none of the interaction terms were found to be significant. A disparity between early life conditions (better for the mother, worse for the child) does not seem to explain this effect of height.

A second hypothesis for the relationship between height and stuntingoverweightness could be that increased maternal height actually increases the risk of being stuntedoverweight for biological (not behavioural) reasons. Maternal height could, for example, increase the risk of stuntingoverweightness due to its impact on the development of the foetus/child – albeit through currently unidentified mechanisms. In this instance it would be expected that, at increased maternal height, socioeconomic conditions would have little or no effect on the probability of being stuntedoverweight. However, as can be seen in Figure 8.13 the effect of height does vary with maternal education. As a result, this hypothesis of a solely biological mechanism, not accounted for by other variables in the model, is rejected.

Figure 8.13 Marginal Effect of Maternal Height by Education Level on the Predicted Probability of Stuntingoverweightness, all other variables at means



Having rejected these hypotheses, I returned to reconsider the ethnic variation in height in Albania. From this perspective, ethnic differentials in HEIGHT among mothers within Albania are thought to be skewing the effect of height as an indicator of a mother's 'health stock' and associated early socioeconomic conditions. This distortion is occurring by failing to take into account that mothers from the NE are more likely to be taller, even though their past socioeconomic conditions were lower.

Before the fall of communism in Albania internal (and international) migration was severely restricted. Due to this restricted mobility prior to the fall of Communism in Albania, there is unlikely to have been much change in the geographical and ethnic distribution of height prior to the 1990s (Ghegs would still be concentrated in the NE), by which time most of the mothers in this 2008-09 sample were born (the youngest mother in the sample was 17 years of age in 2008, 6 mothers were 18 years of age).

However, in 1990 as communism was falling, the government began lifting restrictions on the movement of the population. The areas in which the Ghegs were concentrated eventually became the largest expellers of migrants following the collapse of Communism. The large scale migration within (and out of) Albania was unprecedented and could have shifted the distribution of this ethnic variation in height, but more importantly the distribution of people that had been the most socioeconomically disadvantaged in Albania. Gjonça's work on the regionality of mortality has already shown this disadvantage was reflected in health outcomes, with the NE experiencing consistently higher levels of mortality (2001). It is possible that the tall but socioeconomically disadvantaged Ghegs moved within Albania and took their poor health stocks with them. As a result of this, region would not be fully capturing long term socioeconomic disadvantage experienced by former residents of the NE that is becoming manifest in the nutritional status of their children as stuntingoverweightness.

Thus if height in itself is of importance, the effect of being from the NE should be present even when controlling for socioeconomic conditions. Therefore, the fact that people from the NE may no longer be resident of the NE but retain a 'health stock' reflective of the NE should be taken into consideration.

In order to test this, the region of the mother in 1990s is included in the model (current region was removed to avoid any issues of collinearity). Here, the MEMs for height and region in the 1990s are presented in Table 8.14.

Table 8.14 Marginal Effects at Means for Height and Region in the 1990s on Probability of Stuntingoverweightness

		MEM *(SE)*
	ref: shortest	
Maternal Height Quintiles	Shorter	0.009
		(0.017)
	Mid	0.033
		(0.017)
	Taller	0.079*
		(0.026)
	Tallest	0.086*
		(0.028)
	*ref: Coastal 1990*s	
Region 1990s	Central 1990s	0.040
		(0.025)
	NE 1990s	0.055*
		(0.023)
	Tirana 1990s	0.033
		(0.043)
N		1169

The MEMs show that, when controlling for region in the 1990s, increased maternal height still increases the probability of being stuntedoverweight (MEM 0.079 and 0.086 for taller and tallest mothers compared to shortest mothers respectively). In addition, being from the NE in the 1990s significantly increases the probability of being stuntedoverweight (MEM 0.055)

In addition, the marginal effects of region by height in the 1990s are presented (Table 8.15). If greater maternal height increases the probability of stuntingoverweightness because of ethnic disparities in height, the results should show that height only has a marginal effect when mothers are previously from the NE region.

Table 8.15 Marginal Effect of Region (compared to coastal) in 1990s by Height on Probability of being Stuntedoverweight, holding all other variables at means (MERs)

	Central 1990s (SE)	**NE 1990s (SE)**	**Tirana 1990s (SE)**
Shortest	0.009	0.028*	0.027
	(0.011)	*(0.012)*	*(0.012)*
Shorter	0.013	0.036*	0.034
	(0.015)	*(0.017)*	*(0.017)*
Middle	0.021	0.060*	0.055
	(0.023)	*(0.023)*	*(0.023)*
Taller	0.031	0.095*	0.087
	(0.038)	*(0.032)*	*(0.032)*
Tallest	0.032	0.097**	0.087
	(0.041)	*(0.035)*	*(0.035)*

The MERs show this supposition to be the case, as the effect of region in the 1990s on stuntingoverweightness is only significant by height for the mothers from the NE in the 1990s. Thus it is argued that the positive relationship between maternal height and stuntingoverweightness is apparent only due to ethnic disparities in height, observed by previous research. So there is a fundamental relationship between increased maternal height and the probability of stuntingoverweightness risk. However, as previously noted, the unusual effect of height seen in these results is an Albanianism and is unlikely to be reflected in studies on stuntedoverweight children in other contexts.

Two further maternal-level variables were found significant in the analyses – EDUCATION (maternal education) and OR (heard of/used oral rehydration therapy).

As revealed in Chapter 6, maternal education is a distal determinant of a child's nutritional status. Increased levels of maternal education have consistently been shown to have a positive outcome on a child's malnutrition. Higher levels of maternal education are indicative of better living conditions. Moreover, they empower women to have greater autonomy over household decisions and are highly correlated with health knowledge and behaviour (Bicego & Boerma 1993; Skoufias 1999; Basu & Stephenson 1999; Black et al. 1998; Marmot et al. 1995; Kaplan et al. 1996; South 1991). However, research has also shown that in LMICs undergoing their nutrition transition, higher levels of socioeconomic status could also be predictive of increased rates of obesity – although the evidence is currently contradictory.

The results of this analysis show that in Albania, there is no protective effect of maternal education on stunting (Table 9.5 & Table 9.6). This is a particularly unusual result and consistency checks were conducted to test for collinearity. The condition number was <10 indicating no issue of collinearity. When removing variables that could also explain the effects of EDUCATION (WEALTH, OR, REGION) still no significant association was found between maternal education and the risk of stunting in Albania. The result for overweightness was more consistent with the literature- where higher levels of EDUCATION increase the risk of being overweight for a child (MEM 0.102 – for tertiary education compared to primary; Table 8.6). This actually suggests that in Albania, at least, overnutrition is not yet concentrated among the poorer segments of society and remains a burden of the rich – as was the case in the past for MDCs.

For stuntingoverweightness, maternal education is protective against its development. Having a mother with tertiary education compared to primary education reduces the probability of a child being stuntedoverweight by 5.2% (Table 8.6). The effect of maternal education exists above and beyond the effects of other socioeconomic variables (notably the household asset index), further cementing its protective effect against malnutrition as something above and beyond just one of levels of wealth and material conditions. For stuntedoverweight children, the effect of maternal education is also significant even when controlling for OR (which was used to give an indication of maternal health knowledge and education) and THREEGEN (indicating traditional values). This suggests a positive effect of education in terms of female autonomy and empowerment that is not being captured in the model by any other variable.

The last variable found to be significant in the analyses was OR – although OR was not actually significantly associated with stuntingoverweightness. OR was found to have a significant and positive effect on the probability of overweightness – which further evidences a socioeconomic gradient in Albania where the richest are more likely overnourished. This is because OR is likely indicative of education, wealth, knowledge and ability to access and afford health care.

There were some key variables collected at the maternal-level that were thought to significantly impact upon the risk of stuntingoverweightness in Albania, but in fact did not. Of particular note was maternal age and variables aiming to capture nutritional quality – notably an indicator of appropriate feeding practices. Young and old maternal age have been shown to increase the risks of poor health outcomes in children – owing to intrauterine growth retardation, increased risks of congenital abnormalities and a greater risk of complications from pregnancy increasing mortality risks. However, maternal age can also be indicative of socioeconomic circumstances as older mothers delay childbearing due to, for example, higher education. Additionally, with respect to malnutrition, the key issue of maternal age would be intrauterine growth retardation. However both of these dimensions – socioeconomic status and intrauterine growth – are being explained by other variables in the model, and it is expected that this is why they were not found to be significant.

Finally, measures of nutrient availability were tested in this analysis. As explained in Chapter 7, an indicator of appropriate feeding practices was constructed at the maternal-level to specify children were being fed age appropriately based on the WHOs recommended infant and young child feeding practices. This variable was not found to be significant. I attribute this to a reliance on 24-hour dietary recall data needed to indicate appropriate feeding practices at greater ages. 24-hour dietary recall data has been found to be problematic and non-specific in analyses, particularly as they only give an indication of dietary intake over a very short period of time. I argue that it is for this reason that no significant relationship between appropriate feeding practices and stuntingoverweightness was found.

In the next section, the results for household-level determinants of stuntingoverweightness are presented.

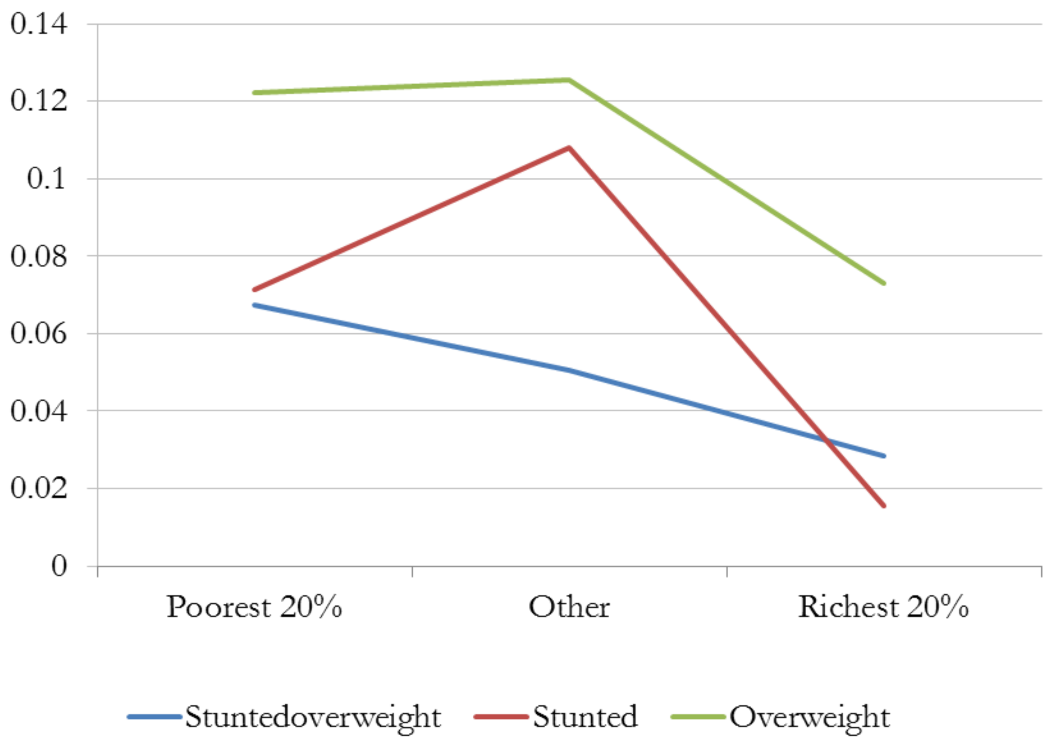
8.2.3 Household-Level Determinants of Stuntingoverweightness

Two household-level variables were found to be significantly associated with stuntingoverweightness – these were WEALTH (quintiles based upon the household asset index) and WATER (whether or not there was access to an improved water source in the household).

The RRRs show that being in the richest wealth quintile increases the risk of being stuntedoverweight over being stunted when compared to being in the mid wealth quintiles (RRR 3.70) (Table 8.5). This indicates stuntingoverweightness is associated with higher socioeconomic status than stunting. However, the MEMs for stuntingoverweightness are not significant and there are no significant differences in the probability of being stuntedoverweight, overweight or non-malnourished in the sample. This suggests that whilst increased wealth distinguishes the stuntedoverweight from the stunted, it is not an important factor for differentiating risks between the stuntedoverweight and the overweight or 'other'. Given the effect of education, which had shown that socioeconomic factors can distinguish between the stuntedoverweight and the overweight, this result was considered inconsistent.

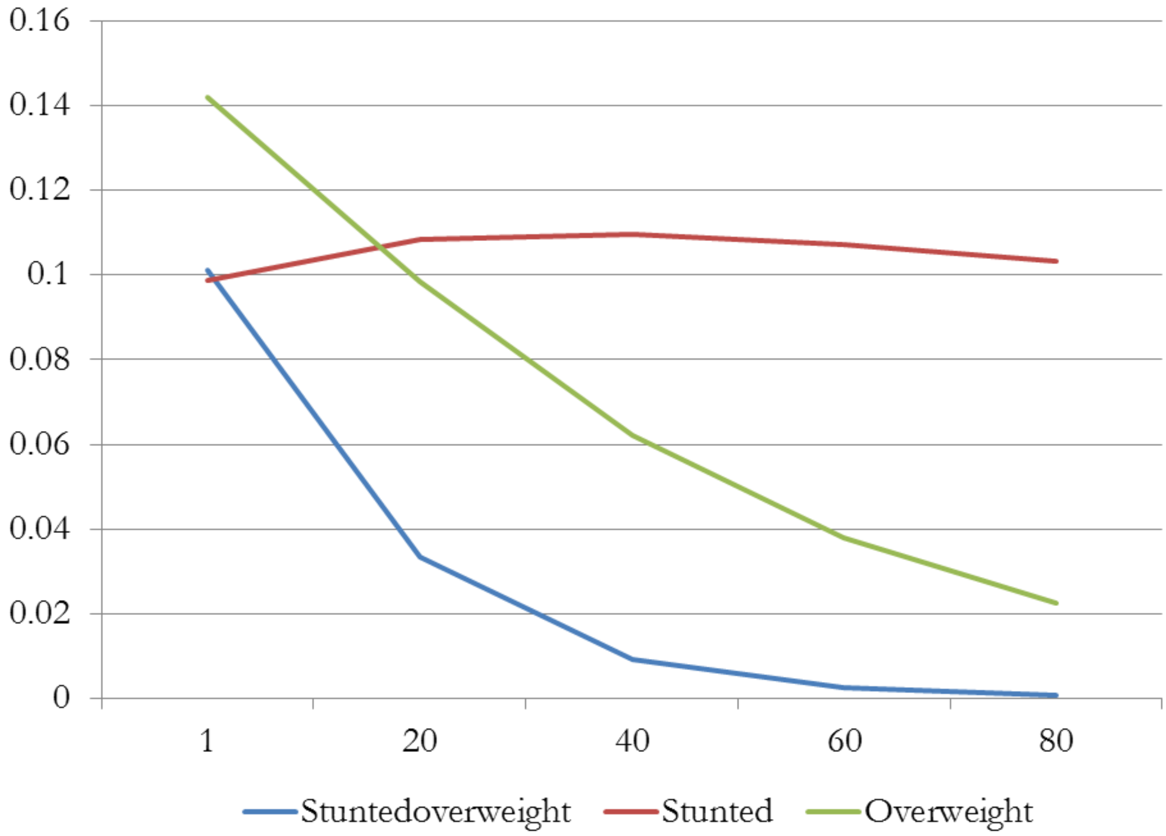
To elaborate, the probability of overweightness increased with maternal education – but according to the MEMs increased wealth decreases the probability of being overweight (tertiary education MEM -0.063 when compared to maternal primary education). Predicted probabilities for stuntingoverweightness, stunting and overweightness by wealth are presented in Figure 9.16.

Figure 8.16 Predicted Probabilities of Stuntedoverweight, Stunted and Overweight by Wealth



In order to investigate the wealth gradients in nutrition within Albania in more depth, I decided to replace the categorical wealth variable in the model with a continuous variable for the asset wealth scores. I felt this was particularly important given the controversy in the literature over what a socioeconomic gradient in malnutrition looks like among countries currently undergoing their nutrition transition. Moreover, I specifically introduced a quadratic term for the wealth scores ($WEALTHSCORE^2$) – to model the potential non-linear effect of wealth on the probabilities of nutritional outcomes in Albania. The marginal effect at means of $WEALTHSCORE^2$ is presented in Figure 8.17.

Figure 8.17 Marginal Effect of WEALTHSCORES^2 on the probability of Nutritional Status in Albania



The use of the quadratic effect shows that, in fact, the effect of wealth on stuntingoverweightness is non-linear within the Albanian context. In particular, increased wealth is only statistically significant at lower levels of wealth – and the magnitude of the effect of increased wealth at lower levels is greatest in reducing the probability of stuntingoverweightness.

These results show that there is a non-linear effect of wealth on the probability of stuntingoverweightness and overweightness – but not for stunting[77]. There are some

[77] With respect to the RRRs 1-unit increase in WEALTHSCORE^2 was found to lead to a 6.64% reduction in the risk of being stuntedoverweight compared to stunted (RRR 0.936; p 0.009). Whilst 1-unit increase in WEALTHSCORE^2 leads to a 6.67% reduction in the risk of being stuntedoverweight compared to not malnourished (RRR 0.933; p 0.001).

particularly interesting results to emanate from this analysis – notably stunting does not appear to be protected against by either maternal education or household wealth. Although the main focus of this research is on the stuntedoverweight, stunting remains a key issue for those affected and the population in which they live. It has long term consequences for an individual, their health and their development. This relationship between stunting and the factors that in other contexts can aid its reduction is concerning, and more research needs to be conducted in order to understand the nature and determinants of stunting in Albania today. Additionally, there is an inconsistent relationship between wealth, education and overweightness. Education actually increases the risk of being overweight in Albania whilst increased wealth decreases the risks – this is true controlling for all other variables. To investigate this further an interaction term between wealth and education was incorporated into the model but no significant effect on overweightness or any other variable was found. If we look at the relationship between education and wealth descriptively for overweight children, there is a clear lack of a relationship (Table 8.18).

Table 8.18 Maternal Education and Wealth for Overweight Children

		Education			
		Primary	Secondary	Tertiary	Total
Wealth	Middle	0.5252	0.337	0.6858	0.5055
	Poorest	0.4234	0.6281	0.295	0.4518
	Richest	0.0514	0.0348	0.0191	0.0427
	Total	1	1	1	1

A potential explanation for this could be that wealth generation in Albania is not currently dependent upon the level of education. Albanians are particularly entrepreneurial at this stage in their history, with new businesses regularly emerging on the streets of Tirana. Additionally, there is growing evidence that wages earned through international labour and remittances sent back to Albania are being used to invest in family businesses in Albania (Nicholson 2001). Furthermore Albania has shown consistently low enrolment levels in higher education when compared to other transition countries. Net enrolment in tertiary education in Albania in 2030 was 11%, while in Bosnia-Herzegovina it was 19%, Macedonia 23% and Montenegro 24% (Harakenaka & Thompson 2006).

As a methodological note, a comment upon the use of WEALTH, created separately for rural and urban areas is required. It was noted in Chapter 7 that an interaction term WEALTHxURBAN would be tested in the models, (with WEALTH and URBAN) also included, due to the construction of the wealth indices reflecting relative wealth within rural and within urban areas separately. In the logistic models, neither URBAN nor WEALTHxURBAN improved the model, according to the Wald Tests. Additionally, the introduction of URBAN and WEALTHxURBAN into the final multinomial model showed no significant effect upon the nutritional status of children in Albania. As a result both URBAN and WEALTHxURBAN were not utilised in the final model – this was mainly to do with model parsimony, although the results of the other explanatory variables were not affected with URBAN and WEALTHxURBAN included or otherwise.

The additional household-level variable WATER is indicative of household infrastructure both in terms of wealth and disease environment (as explained in Chapter 6).

Living in a household with an improved water source reduces the risk of being stuntedoverweight. When compared to the overweight, this risk is reduced by 78%. The MEMs reflect this – where living in a household with an improved water source as opposed to otherwise significantly reduces the probability of being stuntedoverweight (-0.082) and increases the probability of being overweight (0.056) (Table 8.6). However, there is still no effect for stunted children – again emphasising the need for further research to explore stunting in Albania.

In the next section meso-level variables and their effect on stuntingoverweightness in Albania will be discussed.

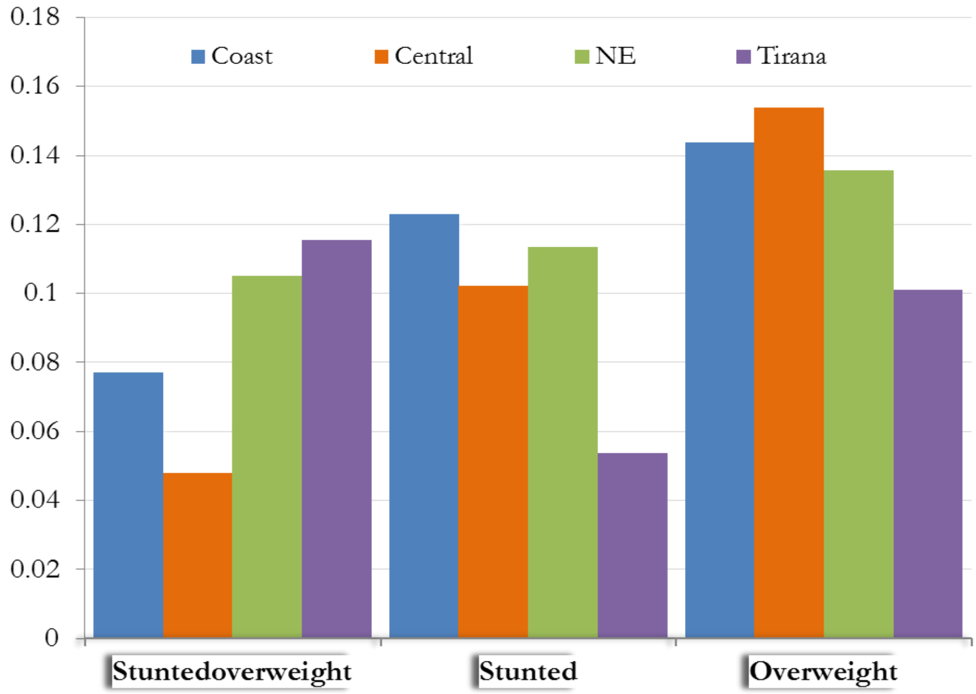
8.2.3 Meso-Level Determinants of Stuntingoverweightness

As described in Chapter 7, two meso-level fixed effects were tested for their effect on stuntingoverweightness among children in Albania – REGION (region) and URBAN (urban/rural). REGION was found to have a statistically significant association with stuntingoverweightness, but URBAN did not and thus was not included in the regression model presented here.

As described in Chapter 6, region provides a good indication of the wider socioeconomic development context in which children live. The coastal region and Tirana are considered the most developed regions in Albania, the northeast the least. In terms of development, specific factors include poorer health care and transport infrastructure in the northeast. In comparison, the coastal region and Tirana are increasingly 'Westernised' with (relatively) better transport infrastructure and access to a Mediterranean diet (Buomono et al. 2005; Gjonça 2001).

From the regression model we can see that the probability of being stuntedoverweight is greatest in Tirana (0.115) and smallest in the central region (0.047). Meanwhile, the probability of stunting is greatest in the coastal region (0.123) and smallest in Tirana (0.054). The predicted probabilities for stuntingoverweightness, stunting and overweightness are presented in Figure 8.19.

Figure 8.19 Predicted Probability of Nutritional Status by Region



This is an important finding, particularly for stunted children, as it appears living in Tirana – the most urbanised region of Albania – is conferring a health advantage to under-fives in Albania by reducing the risk of stunting. However, this is also the region where the most stuntedoverweight children live. I would hypothesise that in Tirana there is a high proportion of stuntingoverweightness development that is sequential – as it seems likely that stunted children in Albania are more likely to become concurrently overweight given the urbanised, obesogenic context a capital city in a LMICs confers. Until there is longitudinal data for children in Albania, I cannot confirm this hypothesis. Nevertheless it does seem particularly striking that the very area stuntedoverweight children are concentrated is also the one where stunted children are found in their smallest numbers.

A particularly interesting finding of this analysis on Albania is the lack of urban/rural differentials in nutritional outcomes among under-fives. This is true for stuntedoverweight children as well as stunted and overweight children. Urban and rural differentials have prevailed across health research on LMICs and the lack of a significant relationship between URBAN and any nutritional status in Albania is an anomaly in research on health in LMICs. As an initial explanation for this I refer to Albania's communist history. As noted in the literature review, there was a commitment by the communist regime to provide access to good infrastructure, health care and education for all – regardless of the level of urbanisation. It is possible that this homogony in access to resources across Albania is being reflected in the lack of urban/rural differentials in 2008-09.

However, Albania represents a population with great diversity in nutritional outcomes and inequalities have (inevitably) been increasing since the move to a market economy. If we link this finding to the results of Chapter 5, urbanisation was also not found to be significantly related to the development of stuntingoverweightness. In that analysis I highlighted how stuntingoverweightness was also an indicator of divergence in malnutrition in a population. The fact that lack of effect of urbanisation in such diverse health contexts exists both between and within populations leads to me consider this is something more fundamental. It is possible that as LMICs become more globalised, ICT and other routes to interconnectedness (such as transport infrastructure) increase, inequalities will not be between urban and rural areas any more, but prevalent across all geographic regions. It is possible that we are seeing the first stages of a flattening of urban/rural differentials. While inequality is still widening within LMICs, it is also becoming increasingly scattered across all areas of the population.

8.3 Summary

Individual, maternal and household characteristics have been found to be important for the risk of stuntingoverweightness in Albania. As would be expected, there has been no indication that stuntingoverweightness is a solely biological phenomenon, as a socioeconomic gradient in its risk has been found. Increased maternal education, wealth and improved household infrastructure all reduce the risk of being stuntedoverweight in Albania. Additionally, the analysis suggests that stuntedoverweight children are more socioeconomically advantaged than the stunted (particularly with respect to household wealth) and live in more developed areas (namely Tirana). At the same time, the stuntedoverweight fall behind their overweight counterparts in terms of socioeconomic status in Albania – as the overweight are more likely to have mothers with tertiary education and households with improved water sources.

The female sex bias in stuntingoverweightness (which holds true across all other nutritional groups) suggests a contributory role of traditional values and thus resulting sex differentials in health and feeding practices in Albania. This is thought to be leading to a greater risk of females becoming stuntedoverweight. Whilst traditional values have led to a female bias in stuntingoverweightness, increased wealth, infrastructure and maternal education are conferring positive health effects. From this perspective it seems clear that strategies aiming to increase the socioeconomic status of mothers in Albania will be a valuable tool in the reduction of stuntingoverweightness.

In the absence of longitudinal data it is not possible to determine whether stuntingoverweightness develops concurrently or sequentially (the latter being where an individual first becomes stunted, then overweight). However, the age distribution of stuntingoverweightness is concentrated among younger ages, which suggests a rapid development of stuntingoverweightness among infants. Beyond the age of 1, the risk decreases substantially and then slowly rises once more, which could indicate a separate set of risk factors for development at later ages. Moreover, there is some evidence of overlapping or transitioning of both stunted and overweight children with the stuntedoverweight. The clustering of stuntedoverweight children in Tirana, in the context of the lowest levels of stunting, suggests that we are seeing a transition from stunting among the poor in Tirana to stuntingoverweightness.

Although this analysis has not been able to determine the trajectory by which stuntingoverweightness occurs, it has raised some key questions. One of the most significant findings of this analysis is the indication that stuntingoverweightness could be an example of a rapid onset in the foetal origins of 'adult' disease – where stuntedoverweight children are seeing their foetal programming becoming maladaptive at a far earlier stage in their life course. If this were the case, it would cement the fact that rapid development is driving divergence in malnutrition – and in health.

With respect to the nutrition transition theory and the AT, the diversity in malnutrition in Albania is occurring within a context of rapid socioeconomic development. The concentration of stuntingoverweightness in Tirana, the capital of Albania, highlights the key role that changing living conditions, socioeconomic status and globalisation have to play in its development. However, in the Albanian case there is still no evidence that urbanisation is a driver of this divergence in malnutrition. Whether the flattening of urban/rural differentials in place of a peppering of inequality across the country is an Albanianism or indicative of the future of all LMICs is yet to be determined.

Chapter 9: Summary, Implications and Future Research

Stuntingoverweightness is a little understood nutritional profile. Yet this thesis has shown that it exists among under-fives in all LMICs, and that it can lead to significant misconceptions in our understanding of malnutrition. Routes to the development of stuntingoverweightness are currently unknown and a widespread failure to acknowledge stuntedoverweight children means that no attempts are being made to uncover them. Moreover, whilst we are beginning to understand the short and long term consequences of stunting and overweightness in childhood for an individual's health and development, our failure to acknowledge stuntingoverweightness in research means that no steps are being taken to understand the consequences of this phenomenon.

Ultimately, the consequences of this oversight are not only felt by stuntedoverweight children. Failure to acknowledge this particular MNI has meant that prevalence rates of stunting and overweightness are overestimated. Aggregate-level studies based on these inflated prevalence rates (inclusive of stuntedoverweight children) are bound to be compromised by their inherent failure to observe the heterogeneity between stunting and stuntingoverweightness, as well as between overweightness and stuntingoverweightness. When stunting and overweightness prevalence rates are assessed together, stuntedoverweight children are double counted – which serves only to compound this overestimation, causing research to be conducted on a hypothetical population of under-fives that in reality does not exist. Given that research, development and health arenas are becoming increasingly interested in the so-called 'double burden of malnutrition', this 'double-counting' urgently needs to be rectified.

This discussion outlines the key implications emanating out of this research. As will be shown, the observation of stuntingoverweightness necessitates reconceptualization of a number of key areas in research, notably: child stunting; child overweightness; the nutrition transition theory; the observed ‘double burden of malnutrition’; and the ‘double burden of child malnutrition’. In reconceptualising these key issues there are wide implications for research on child malnutrition and the use of anthropometric indices, as well as national and global level initiatives aiming to tackle malnutrition.

This thesis does not seek to belittle the issue of malnutrition (in either adulthood or childhood) or the genuine emergency of the pervasive and persistent nutritional insults occurring worldwide that hinder an individual’s rights to a healthy and productive life. However, in order to combat malnutrition, it must be represented accurately – and the increasing focus solely on the double burden of malnutrition at population level is severely flawed. The aim of this research, then, is to uncover the implications of stuntingoverweightness at the research and policy levels – and in doing so to bring about a positive shift in the agenda for future research.

9.1 Summary of Results

Before discussing why the results of this research are significant – as well as what contribution they can make to the study of malnutrition today – it's important to summarise its findings. This section will do so by first focusing on defining the stuntedoverweight and uncovering their determinants, before outlining the impact of stuntingoverweightness on the currently accepted DBM and DBCM.

9.1.1 Who are the stuntedoverweight?

This research identifies 'the stuntedoverweight' as children under five years of age who are concurrently stunted and overweight.

Stuntedoverweight children are found in all LMICs, although they are more concentrated in certain contexts. Namely, as the analysis of Chapters 4 and 5 showed, stuntedoverweight children are more concentrated in populations with diverging nutritional profiles – where stuntingoverweightness occurs within the population alongside child stunting, child overweightness and adult obesity. These populations tend to be at a relatively high level of development compared to countries with a lower prevalence of stuntingoverweightness. Rapid globalisation, and its effects on a population's wider socioeconomic environment and food systems, is a key factor among populations afflicted with high levels of stuntingoverweightness. Currently, these processes of development and globalisation have led to an increase in per capita calories available to the population – thus the quantity of the diet has increased. There is no indication yet, however, that the composition of the diet has changed at the national level.

The analysis of Albania showed that the stuntedoverweight are a separate group of children when compared to their stunted, overweight and non-malnourished peers. Stuntedoverweight children belong to higher socioeconomic groups than stunted children but are poorer than overweight children. Stuntedoverweight children are found in more developed areas than their stunted peers, but these are not necessarily more urbanised. Additionally, stuntedoverweight children come from households with better infrastructure than the poorer stunted. Nevertheless, the stuntedoverweight are poorer than both non-malnourished and overweight children. The analysis showed that increased maternal education, wealth and household infrastructure insulate against stuntingoverweightness – thus socioeconomically stuntedoverweight children are more similar to stunted children than to the overweight. However, there is evidence of biological and developmental factors being important to stuntingoverweightness in under-fives. There is a clear age distribution of stuntingoverweightness in Albania. Within the first five years of life, children are more likely to be stuntedoverweight at 1 and at 4 years of age. Additionally, females are at greater risk of stuntingoverweightness, as are children who have mothers that grew up in poorer socioeconomic circumstances. However, the sex bias in stuntingoverweightness may also be affected by differential cultural values and thus health care behaviours towards female children.

As there is evidence of both biological and behavioural determinants of stuntingoverweightness – and due to the cross-sectional nature of this research – it is not possible to elucidate the causes of stuntingoverweightness in this thesis. Despite this, there are still two main pathways hypothesised for its development: 1) concurrent development; or 2) overweightness develops after stunting develops. These pathways are important as they would reflect different risks to an individual and their development of stuntingoverweightness. Interestingly, the age distribution of stuntingoverweightness suggests that both pathways to development could be present within one population. It is arguable that older stuntedoverweight children reflect those who were initially stunted and then also became overweight (subsequent development), whilst younger children ~12 months old are more likely experiencing concurrent development. This hypothesis is supported by the general observation of 'normal' exclusive stunting that becomes apparent at around 2 years old, and the fact that younger stuntedoverweight reflect a departure from this normal development pattern of stunting. With respect to the development of stuntingoverweightness, this research has raised several interesting questions but further, longitudinal research is required to address them.

The key message to take from these results is that stuntedoverweight children occur in all LMICs and importantly are a group of children that behave differently from their stunted and overweight peers. They have specific biological and socioeconomic characteristics and as a result they will require specific targeted interventions.

9.1.2 What does stuntingoverweightness mean for our understanding of the DBM, DBCM and the NTT?

Chapter 4 evidenced that failing to consider stuntingoverweightness has inflated the prevalence estimates of stunting and overweightness among children in all countries; prevalence estimates that are widely disseminated to key stakeholders today. Not only have these overestimated prevalence rates been driving policy for both stunting and overweightness separately, but they have served to add weight to the emergence of a posited 'double burden of malnutrition' within populations – exemplified as either a DBM or a DBCM. Stuntingoverweightness is particularly important for the DBCM, as stunting and overweightness prevalence rates are currently created and assessed together – which means that prevalence estimates are reliant upon stuntedoverweight children that have been double counted.

In removing stuntedoverweight children from the estimates of stunting and overweightness, we are obliged to revise our understanding of the 'burden of malnutrition' faced by LMICs today. Stuntedoverweight children are a separate group of children, with specific risk factors leading them to this paradoxical malnutrition status, and must be considered separately. When considering stuntingoverweightness as a separate form of malnutrition, the concept of the DBM is void – for it misses the true diversity in malnutrition being seen in LMICs today. Additionally, the very existence of stuntingoverweightness highlights the fact that there is no actual 'DBCM' at the population level, particularly given that burdens of stuntingoverweightness are often at comparable or higher levels than either stunting or overweightness.

Moving forward, at aggregate levels, stuntingoverweightness has been shown to skew representations of overweightness in LMICs to a greater extent than stunting. This has implications for the worldwide agenda on malnutrition. Researchers and policy makers are increasingly alarmed at the rapid onset of overweightness – but are failing to recognise that many of these newly 'overweight' children are actually stuntedoverweight. In fact, the weight of the evidence is that stuntingoverweightness prevalence is rising in LMICs and will continue to do so.

The DBM and DBCM do not truly represent the nutritional profiles of LMICs today and as a result the modifications made to the original NTT need to be reassessed. The results of this thesis have led me to conclude that LMICs are currently experiencing a 'divergent burden of malnutrition'. The nutritional burdens of LMICs are diverse, but more importantly they are still undergoing processes that will, as I predict, increase this diversity. There is no longer one nutrition transition seen across populations; rather transitions follow divergent and overlapping paths that can't be categorised using traditional models.

9.1.3 Limitations of the Research

Key limitations of the research are detailed below, for both the population level analysis and the study of Albania.

9.1.3.1 Limitations of Population Level Analysis

The study on the population level analysis of stuntingoverweightness and 'burdens' of malnutrition is affected by some limitations – in terms of study design, data and methodology.

The study design was a population level cross sectional analysis for all countries with a DHS or MICS, inclusive of an anthropometric module, from 2005 onwards. Although only DHS and MICS surveys were selected for use in the research, owing to comparability of survey instruments, this led to a restricted sample both in terms of size and geography. There is an absence of Latin American countries in the sample, which have previously been shown to experience a DBM and DBCM (FAO 2006). This omission means that regression results may be biased, and key relationships between stunting, overweightness and stuntingoverweightness misrepresented, limiting the inferences that can be made from the study. Furthermore, the sample size was small (77) – while national level studies are restricted to cases owing to the geopolitical context, the small sample size again means that results are tentative.

A key limitation of the population level analysis is that it is ecological in nature and thus may suffer from ecological fallacy, where incorrect conclusions are drawn about individuals within a population owing to the use of group averages (Freedman 1999). This is perhaps the most pressing issue of the population level analysis and was a key motivation for a within-population study of Albania. For future research, the construction of a database containing pooled individual level data from national surveys is planned. This is a study design that will require a large amount of resources, but can help overcome the issue of the analysis – particularly through the use of multilevel modelling on the data.

A further limitation of the study relates to data, both in terms of availability and appropriateness. I relied upon macro-level data sourced from a variety of databases. The study was subject to a trade-off in terms of data availability and quality. In many ways this was a function of the sample size and the need to provide data for all cases in the sample to overcome issues of missingness. A particular failing in terms of data relate to inequality measures which were particularly sparse – this led to an analysis of inequality on a (further) restricted sample necessarily leading to very tentative conclusions. With the construction of a pooled database, it would be possible to create wealth (asset) based inequality measures from the survey data for each country, which would be a clear improvement to the analysis.

Beyond the availability and quality of the data, there are concerns about the operationalisation of some of the key aspects of the theoretical drivers of a population's health and food availability – notably globalisation. Globalisation is a heavily contested concept, yet appears consistently in discussions of changing population dynamics – including with respect to malnutrition. As discussed in Chapter 3 and Chapter 5, composite indices of globalisation have been constructed but remain limited in both availability and scope. The research here relied upon the use of ICT to indicate globalisation, yet this is clearly not a full representation of the concept. Furthermore, there are academics who argue, with respect to malnutrition, ICT is not always beneficial, potentially leading to the misuse and misinterpretation of information such as good infant and child feeding practices (Gillespie & Haddad 2003). It was an assumption of this research that measures of ICT could indicate comparative levels of globalisation across the countries in the sample, this is inevitably a flawed assumption and the conclusions from the study pertaining to globalisation should be interpreted with caution as a result.

As highlighted in Chapter 3, there were elements of the conceptual framework that were not operationalised. This could lead to omitted variable bias, again undermining the results of this study. Of particular note was the failure to operationalise other key aspects of 'globalisation' related to food and subsequent nutrition at the population level – trade, technology (particularly with respect to food manufacturing and agriculture) and financial (GHW 2011; Gillespie & Haddad 2003).

As a further consideration, whilst some variables were omitted, it is arguable that other variables were included in the analysis that should not have been. Of note are the variables aiming to capture the stage of the NT at which a population is, particularly controlling for female obesity rates and child overweightness. These variables are correlated (0.56) and likely explained similar variability in stuntingoverweightness prevalence across the sample. This overcorrection could have affected the standard errors, leading to type I errors in the examination of regression results.

Finally, there is a need to broaden the analysis to enable a wider discussion on the NT. The analysis makes the assumption that stuntingoverweightness is an indicator of diversity in nutrition profiles of populations. Although this assumption was justified, both in Chapters 3 and 4, there is clear scope to conduct the analyses of population level determinants of malnutrition with other indicators of child malnutrition as the outcome variables – notably stunting prevalence and overweight prevalence. The aim of such an analysis would be to highlight any differences in contributory factors dependent upon the nature of stunting and, separately, overweightness burdens. This would serve to provide a more complete picture of current NTs occurring in LMICs.

It should, however, be noted that this analysis was exploratory in nature, the research into stuntingoverweightness and its impact on our understanding of the NT is in its infancy. These limitations will serve to inform future research into this area.

9.1.3.2 Limitations of the Study of Albania

The analysis of Albania was subject to some clear limitations.

A considerable concern has arisen about the use of the Albanian DHS for the within-population analysis of stuntingoverweightness – notably given its sample size. There were two key motivating reasons for the use of Albania – the extent of the burden of stuntingoverweightness and my knowledge of health in Albania.

Most countries have 'idiosyncrasies' with respect to their health and development – Albania is perhaps an extreme case of this. Chapter 6 noted key 'Albanianisms' that were considered influential enough to require statistical controls in the modelling strategy. Whilst the acknowledgement of these Albanianisms served to improve the analysis, it is questionable how comparable the case of stuntingoverweightness in Albania is in relation to other countries experiencing high prevalence rates of it. A key result of the analysis of Albania was the underlying socioeconomic gradient in malnutrition that was found (stunting-stuntingoverweightness-other-overweightness) – it is not clear this would be the case in other countries. As a result analysis of more countries is required, particularly before any clear policy recommendations about the determinants of stuntingoverweightness can be made. Whilst the key factor of this limitation rests in study design and the selection of Albania, it is also a function of the limited research on stuntingoverweightness – an area of research in such infancy requires a large evidence base from which clear policy recommendations can be made. This is also raised in section 9.2.

Beyond the issue of Albanianisms, the analysis on the ADHS further suffered from a small sample size and a high level of missing data, severely limiting the quality of the analysis. As discussed in Chapter 7, the substantive and methodological benefits of multilevel modelling were unable to be realised and the final models should be interpreted with a high level of caution.

Despite these limitations, this research has taken the first key step in identifying stuntedoverweight children. There is now an open platform from which a much greater expanse of research must be conducted, understandings of child malnutrition re-evaluated and nutrition interventions and polices updated.

Having evidenced the existence of stuntingoverweightness, who the stuntedoverweight are and how stuntingoverweightness changes our understanding of the DBM and DBCM, the big question becomes 'how much does this matter?'

In order to show that stuntingoverweightness **does** matter, three key areas are addressed:

- The implications for agendas, policies and programmes aiming to address malnutrition
- The implications for stuntedoverweight children
- The implications for future research on malnutrition

At each juncture proposals are made on what can be done to address these implications.

9.2 Why Does Stuntingoverweightness Matter?

To frame this discussion further, reference is made to the 2013 Millennium Development Report, which states:

> *'All regions have observed reductions in stunting over this period, while the prevalence of children who are overweight, another aspect of malnutrition, is rising. An estimated 43 million children under age five were overweight in 2011, which represents 7 per cent of the global population in this age group'*

The Millennium Development Goals Report 2013

(United Nations 2013: 6)

The above statement is indicative of many of the key issues that have emanated from this thesis research. Firstly, increasing concerns are being raised about the double burden of malnutrition (both the age polarised DBM and the DBCM). The rapid rate in which overweightness is currently understood to be increasing in LMICs (particularly among children) is considered an alarming health trend that will place increasing amounts of pressure on LMICs. These pressures are already acutely felt in LMICs due to high burdens of undernutrition among children. Undernutrition threatens the future development of a population, given the effects this undernutrition will have on affected individuals into the future, across their life course.

As the passage from the Millennium Development Report highlights, indicators of stunting and overweightness are both utilised in literature concerning the double burden of malnutrition. The results of Chapter 4 have shown that, currently, prevalence rates of both stunting and overweightness include children that are stuntedoverweight. In a context of increasing concern about the levels of both stunting and overweightness, stuntedoverweight children are being double counted. This is skewing the representation of child malnutrition in LMICs today.

The results of Chapter 4 show that the prevalence of stuntingoverweightness ranges from 0.33% (Suriname 2006) to 10.42% (Egypt 2008) across LMICs. Stuntingoverweightness is observed in every single LMIC, and consequently the prevalence rates of both stunting and overweightness have been overestimated for all LMICs. This overestimation is endemic, as the vast majority of research on child malnutrition fails to exclude stuntedoverweight children from these estimates. Chapter 4 evidenced this failure to exclude stuntedoverweight children in the prevalence estimates listed for stunting and overweightness by the WHOCG&M; but this also occurs across the board in the calculation of stunting and overweightness prevalence rates, as well as its presentation and dissemination. For example, all survey reports of the household surveys used in this research (the DHS and MICS) present the aforementioned inflated prevalence rates of stunting and overweightness among under-fives that result from the inclusion of stuntedoverweight children. This research has shown that failing to account for stuntedoverweight children currently overestimates the prevalence of stunting by up to 88.54%, the prevalence of overweightness by up to 295% and the prevalence of all forms of growth faltering malnutrition (including stuntingoverweightness) among children by up to 22.28%.

The next two sections deal with the policy and research implications of stuntingoverweightness (9.2.1 and 9.2.2 respectively).

9.2.1 Policy and Nutrition

Before highlighting the key concerns of stuntingoverweightness that this research has presented, a discussion on the fundamentals of policy and interventions specific to nutrition is required.

Throughout the course of this thesis we have seen a complex interplay of proximate and distal factors determine nutritional outcomes in children. In many respects, nutritional policies and interventions aim to tackle the proximate determinants, the distal determinants or the interplay between the two as a means to improve outcomes for children.

Currently, UNICEF subscribes to a rights-based approach to tackling malnutrition (UNICEF 2014; Nathan 2008). Specifically, there are two key charters outlying the rights of an individual to adequate nutrition – the Universal Declaration for Human Rights, notably Article 25[78] and the International Covenant on Economic, Social and Cultural Rights, notably Articles 11[79] and 12[80]. In order to uphold these rights, UNICEF

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[78] **Article 25. (UDHR)**

(1) Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control.

(2) Motherhood and childhood are entitled to special care and assistance. All children, whether born in or out of wedlock, shall enjoy the same social protection.

[79] ***Article 11 (ICESCR)***

1. The States Parties to the present Covenant recognize the right of everyone to an adequate standard of living for himself and his family, including adequate food, clothing and housing, and to the continuous improvement of living conditions. The States Parties will take appropriate steps to ensure the realization of this right, recognizing to this effect the essential importance of international co-operation based on free consent.

2. The States Parties to the present Covenant, recognizing the fundamental right of everyone to be free from hunger, shall take, individually and through international co-operation, the measures, including specific programmes, which are needed:

(a) To improve methods of production, conservation and distribution of food by making full use of technical and scientific knowledge, by disseminating knowledge of the principles of nutrition and by developing or reforming agrarian systems in such a way as to achieve the most efficient development and utilization of natural resources;

(b) Taking into account the problems of both food-importing and food-exporting countries, to ensure an equitable distribution of world food supplies in relation to need.

[80] ***Article 12 (ICESCR)***

1. The States Parties to the present Covenant recognize the right of everyone to the enjoyment of the highest attainable standard of physical and mental health.

2. The steps to be taken by the States Parties to the present Covenant to achieve the full realization of this right shall include those necessary for:

(a) The provision for the reduction of the stillbirth-rate and of infant mortality and for the healthy development of the child;

(b) The improvement of all aspects of environmental and industrial hygiene;

(c) The prevention, treatment and control of epidemic, endemic, occupational and other diseases;

promotes the use of the 'Triple A Approach' to tackling malnutrition (UNICEF 2014). The 'Triple A Approach' is an iterative approach that requires continual monitoring and evaluation of malnutrition and is based upon three key elements – Assessment, Analysis and Action (figure 9.1) (UNICEF 2014; Gillespie & Haddad 2003).

Figure 9.1 The Triple A Approach

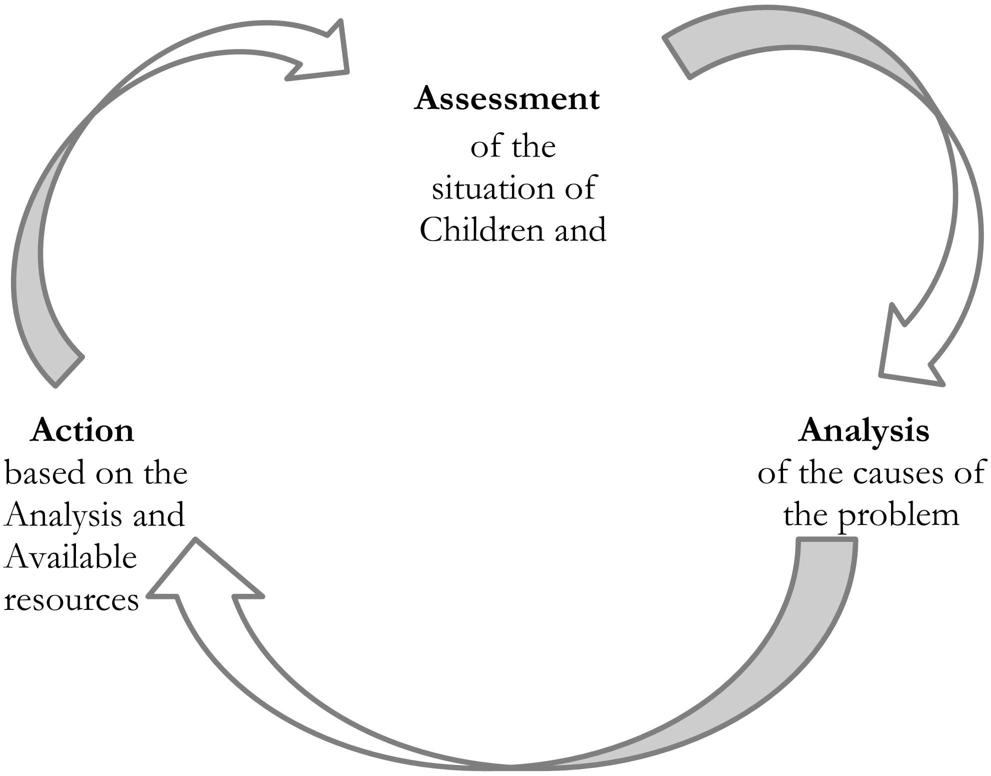

Figure adapted from Gillespie & Haddad 2003 and Jonsson (1995)

Assessment entails requires adequate assessment techniques for nutritional surveillance. Nutritional surveillance has improved overtime, with more countries and more

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(d) The creation of conditions which would assure to all medical service and medical attention in the event of sickness.

frequently. This can come in several forms, including growth monitoring at health centres, in schools, at the community level and at the district level. Nationally representative surveys such as the DHS and MICS used in this study are also integral to nutrition surveillance, which occurring more frequently and in more countries than ever before. However, underlying all of these surveillance activities remains the 'standard' tools for malnutrition assessment such as the use of anthropometric indices, micronutrient assessments, assessments of household food security and appropriate infant and young child feeding practices. The most widely disseminated and influential at the policy level, however, remains anthropometric indices which provide policy makes and key stakeholders alike an indication of the current levels of malnutrition in a population or subpopulation. Nationally representative surveys with anthropometric levels are the key tool for surveillance of nutritional outcomes at the country level. It should be noted that there has been a common consensus that nutrition surveillance is not perfect, with previous criticisms including *'low awareness of the nutrition problem, lack of consensus on the nature/causes of the problem, myths and mis-information'* (Jonsson 1995: 41). The lack of awareness of stuntingoverweightness, the clear issue void in our understanding of how stuntingoverweightness develops and the mis-information that results from failing to realise the overlap in anthropometric indices is a clear indication that these issues are still very much alive, nearly 20 years after their identification by Jonsson. It is no overstatement to highlight that if the nutrition situation is no accurately portrayed, research is being conducted on false impressions, this has clear implications for both the 'Analysis' and 'Action' elements of the Triple A Approach.

Analysis is a fundamental cornerstone in the Triple A Approach. It has been elaborated upon by Gillespie & Haddad to include not just analysis of the causes of the problem, but also the 'roles and patterns, and capacity'. The latter amendments aim to address the issues of nutrition surveillance and interventions raised by Jonsson of a failure to recognise the importance of nutrition including the lack of capacity to analyse data and a failure to disseminate findings between NGOs or community health systems to the national level (Jonsson 1995). One element of analysis that has improved since 1995 however is continued reliance on an inclusive, multilevel, multifactorial nutrition framework to elucidate the causes of malnutrition. However, the lack of analysis on stuntingoverweightness and its causes has meant that not only are stuntingoverweightness prevalence rates routinely overlooked; there is very little information on the causes of it. Moreover, the conceptual frameworks utilised in nutrition research were created prior to the identification of the DBCM or DBM (at the population level) and the acknowledgement of stuntingoverweightness – thus a re-assessment of the framework's utility to provide adequate support to researchers attempting to elucidate the determinants of malnutrition is called for.

It is the assessment and analysis of nutrition and its causes that are integral to the development of effective nutritional interventions – the 'Action' element of the Triple A Approach. Action can be both direct and indirect, tackling the proximate, distal or intermediate causes of malnutrition (Gillespie & Haddad 2003). Direct nutrition action involves those that deal directly with nutritional intake for young children. These actions can focus on, for example, breastfeeding, micronutrient supplementation, adequate complimentary feeding practices, treatment of infectious diseases (part of the malnutrition-morbidity dyad) as well as dealing with overnutrition (by, for example addressing diet composition).

For direct action to be effective, correct knowledge of the types of malnutrition affecting a population of children is required (assessment). Additionally, due to the implementation of direct interventions – which are usually community based, a means by which children can be targeted for intervention and monitored is required. This hinders on the correct analysis of the situation. The prevalence of stuntingoverweightness, documented by this research, undermines these elements and it is as a result that no action is currently being undertaken to address stuntingoverweightness among children.

Indirect action involves focussing on the underlying causes of malnutrition – at the maternal, household, community, population and international level. For stuntingoverweightness, a failure to acknowledge its existence means that the links between the wider context and a child's nutritional status are both unknown and uninitiated.

Thus, this section has shown us that overlooking stuntingoverweightness the first and arguably most fundamental element of the Triple A Approach is wholly undermined. With a heavy reliance on anthropometric indices to assess a child's nutritional status – malnutrition is not currently correctly assessed, precluding effectiveness of both analysis and action. The next sections detail explicitly why assessment is failing. The central contribution of this research is that the assessment of malnutrition needs to be re-evaluated to ensure reliable analysis and effective action to alleviate it can be achieved. The silver-lining is that the Triple A Approach was designed to be iterative and responsive to changing nutritional burdens and causes. These mechanisms need to be utilised to ensure the existing of stuntingoverweightness is realised, its monitoring is conducted, research analysis its determinants is prioritised and appropriate interventions direct, or indirect at multiple levels are implemented. This will also mean a clear commitment in policy across and within countries.

Sections 9.2.1.1 and 9.2.1.2 highlight in further detail how stuntingoverweightness is undermined by and undermines the current focus on the Triple A Approach to nutrition.

9.2.1.1 Stuntingoverweightness, the inflation of stunting and overweightness prevalence and the international agenda for malnutrition.

Flawed assessment – in terms of overestimated prevalence rates of stunting and overweightness, resulting from and causing a failure to observe stuntingoverweightness, are driving the international agenda on tackling malnutrition.

The inflated prevalence rates of stunting and overweightness are taken and disseminated internationally; thus they infiltrate the research and development arenas. These rates become the starting point and basis upon which targets for reductions in malnutrition are created. For example, intrinsic to the Millennium Development Goals is the reduction of child malnutrition. The elimination of child malnutrition is explicitly targeted in MDG1 – target 1c aims to '*halve the proportion of people who suffer from hunger*' (WHO 2013). Although weight-for-age is the official indicator used to monitor the reduction of undernutrition worldwide for the UN MDGs, its use is problematic[81] and is not considered an appropriate measurement of undernutrition. As a result, calls have been made for the use of stunting (height-for-age) to monitor progress in MDG1 (Lutter et al. 2010). Thus routinely, in reference to MDG1, the prevalence of stunting is used to evidence progress towards a reduction in undernutrition. This recourse to stunting as an indicator of undernutrition is clearly shown in the MDG Report passage above, which states that '*All regions have observed reductions in stunting over this period…*' (UN 2013: 6). Additionally, it is clear that overweightness is the selected indicator used to highlight the increasing prevalence of overnutrition among children worldwide – '*…while the prevalence of children who are overweight, another aspect of malnutrition, is rising. An estimated 43 million children under age five were overweight in 2011, which represents 7 per cent of the global population in this age group*' (UN 2013: 6). These estimates of stunting and overweightness are inflated due to the inclusion of stuntedoverweight children. Reported together, the depiction of malnutrition is further skewed as stuntedoverweight children are double counted. This thesis has highlighted a contemporary issue with the measurement of malnutrition that is fundamental to the biggest-ever drive to eliminate malnutrition and foster international development – the MDGs.

The overestimation of these two key indicators of malnutrition, and the consequent theory of a DBCM, means that strategies are increasingly being drawn up and mobilised that focus on elimination of both under- and overnutrition among children in LMICs. In September 2005 a workshop was conducted by the FAO on the back of six case studies on the 'double burden of malnutrition'[82] (2006). This workshop was still working

[81] This issues was discussed in greater detail in Chapter 2

[82] The results of this study were published in 2006 in FAO (Kennedy 2006). The double burden of malnutrition: Case studies from six developing countries. FAO Food and Nutrition Paper. Nations. Rome, United Nations. 84.

on the basis of a double burden of growth faltering malnutrition occurring within populations but not within individuals. Of research into the double burden of malnutrition, this work remains the most thorough – as it reflected the diverse ways in which a double burden of malnutrition (across individuals) can be presented at the population level – where adults, adolescents and children can be overweight or obese and children can be stunted, wasted or underweight. Not only did this research reflect greater potential diversity in the nutritional profiles of populations (beyond just the DBM or DBCM that prevails in the literature), it also highlighted that overnutrition can co-occur with micronutrient deficiencies. This was the first major study identifying paradoxical MNIs within one individual as an important part of the burdens of malnutrition faced by the world today. Importantly, however, the study failed to observe the paradoxical concurrence of two forms of growth faltering malnutrition in children – stuntingoverweightness. On the basis of the FAO research and workshop, four key recommendations were raised:

1. The development of strategies to reduce the double burden of child malnutrition
2. The development of strategies to reduce the concurrence of overweightness or obesity with micronutrient deficiencies
3. The need to promote greater awareness of the double burden of malnutrition
4. The need to improve national data collection and the analysis of the double burden of malnutrition

(FAO 2006)

This thesis does not directly deal with recommendation 2. However, it can contribute to 1, 3 and 4, all of which are inexorably interlinked.

Firstly, any attempts to develop strategies to reduce the DBCM will be hampered, as they fail to consider stuntingoverweightness. These are a group of children with a very specific form of growth faltering malnutrition that need to be separately targeted for intervention. However, the form of this intervention needs to be developed, as currently – given the endemic failure to recognising the condition of stuntingoverweightness – no practical guidelines for its prevention are available.

Secondly, attempts to promote greater awareness of the double burden of malnutrition are misplaced. LMICs are at a stage in their development where there is a great divergence observed in their nutritional profiles that results from divergent nutrition transitions. In fostering an environment focusing on false dichotomies (of under- and overnutrition) the issue of diversity is being overlooked. This will only serve to sustain malnutrition through a failure to acknowledge and thus address the true context of malnutrition today. The move to acknowledging and addressing the diversity of malnutrition is likely to be hindered by the false dichotomies perpetuating the research and development arenas.

In the promotion of the double burden of malnutrition, increasing strains have been placed on researchers, health care workers and health systems aiming to address this 'double burden'. This has been found to lead to stratified responses within one country, where one camp focuses upon the prevention and treatment of undernutrition and the other focuses upon overnutrition. So severe have the conflicts been that a recent blog post by Lawrence Haddad of the Institute of Development Studies asked if it was '*time to drop*… [the] …*double'* (2013). Haddad notes the increasing difficulty of separating agendas to address either under- or overnutrition (2013). The elimination and prevention of both these forms of malnutrition necessarily depends upon the same pool of resources and the availability of the same pathways to deliver interventions in a particular context – what differs is the nature of the intervention and the group that is being targeted. Very recently, calls have been made to address the double burden of malnutrition with a '*common agenda'* (Uauy et al 2014: 15). Uauy et al. argue that we should consider 'malnutrition in all its forms', echoing the sentiments of the United Nations Stating Committee on Nutrition's 33rd Annual Session, who also call for recognition of all forms of malnutrition – including '*underweight, wasting, stunting and overweight, as well as micronutrient deficiencies and nutrition-related chronic diseases'* (UNSCN cited by Uauy et al. 2014). The goals are admirable, as in considering all forms of malnutrition, an integrated approach to tackling malnutrition through policies and programmes can begin – alleviating the issues raised by Haddad (Haddad 2013; Uauy et al. 2014). But where do stuntingoverweightness and other MNIs (paradoxical or otherwise) stand in all of this?

It is this oversight of stuntingoverweightness and many other MNIs (beyond the scope of this research) that fuels my argument that **yes**, we should 'drop the double', **but** we should replace it with 'divergent' – and in doing so realise the kaleidoscope of malnutrition that can, and does, occur today. Additionally, the use of the term 'divergent' highlights the processes through which this kaleidoscope of malnutrition are being realised. We are seeing many nutrition transitions and resulting nutritional profiles at the population, community and individual levels and these are being realised through divergence away from the original nutrition transition. There is not **one** altered trajectory; there are **many** altered trajectories that occur as a result of this divergence. It is clear that we do not fully understand the true diversity in malnutrition today, which is why 'divergent' should be introduced as a prefix to the 'burden of malnutrition'. This is deemed necessary to serve as a reminder that malnutrition has been narrowly defined for too long leading to the marginalisation of particular groups of malnourished people, such stuntedoverweight children. When malnutrition is truly considered as 'bad nutrition' and its diversity is realised a prefix may no longer be required. As it stands, however, there is a long way to go until this realisation and as such the divergent nature of malnutrition needs to be explicitly stated.

Clearly, the results of this research – evidencing stuntingoverweightness in all LMICS – have vast implications for agendas, policies and programmes that aim to tackle malnutrition. A key and consistent issue appears to be the overestimation of overweightness among children, the prevalence of which has been inflated by up to 295% in the sample of LMICs this research analysed. This overestimation has escalated concerns of the alarming rate of increase in overweightness. This is not to say that the increasing burden of overweightness among children in LMICs is not an issue – it most certainly is, but the pace and extent of this increase has been overstated by failing to account for stuntedoverweight children. What should be of concern is not only the increase of overweightness, but also the increasing prevalence of stuntingoverweightness.

The agenda for the so-called 'double burden of malnutrition' is being formed rapidly, but it has failed to truly consider the diverse nature of malnutrition in LMICs today and as a result is building goals, policies and programmes that are not going to tackle the real problem. To overcome this issue, several strategies need to be put into place.

Firstly, as Haddad, Uauy and UNSCN realised, there is a need for a unified definition of malnutrition. It is clear that an inclusive definition of malnutrition as 'bad malnutrition' – and thus all forms of malnutrition – is required, but this definition needs to be widened to include stuntingoverweightness and MNIs.

Secondly, the nature of malnutrition and our understanding of its manifestations are changing rapidly, thus those addressing malnutrition must be able to react to and recognise new/other forms of malnutrition that are currently overlooked.

Thirdly, given the broad face of malnutrition today, policies and programmes need to be integrated and co-operative in order to make gains against malnutrition. This will be increasingly important as malnutrition continues to diverge and emerge in new forms and combinations among all socioeconomic groups and age groups in LMICs. This is very much related to the second point; to truly tackle malnutrition and integrate interventions, the wider community must be more open and responsive to identifying hidden forms of malnutrition – such as stuntingoverweightness. Stuntingoverweightness was observed in 2005 in the Limpopo province of South Africa by Mamabolo et al., who called for integration of stuntingoverweightness into research on child malnutrition. This was the same year in which the UNSCN held a workshop specifically addressing the double burden of malnutrition, yet Mamabolo et al.'s call was unanswered. An opportunity to move the agenda and research on malnutrition forward and to recognise its diversity was missed.

Integral to the three strategies above is the need for the research and development community to become increasingly aware of stuntingoverweightness. The profile of stuntingoverweightness needs to be raised and promoted to ensure gains are made for malnutrition as a whole, for stuntedoverweight children themselves and to ensure good practice in research on malnutrition.

9.2.1.2 Focussing on the Stuntedoverweight

It has been noted that stuntedoverweight children being double counted is actually due to the simple fact that they are being overlooked. In creating trends in stuntingoverweightness, this research has documented the existence of stuntedoverweight children back to 1999 (in Kazakhstan). It is highly likely, however, that stuntingoverweightness existed earlier than in 1999 and has thus been overlooked for far longer than 15 years.

Stuntingoverweightness is a unique form of growth faltering malnutrition that occurs in a distinct group of under-fives within a population that has been hidden to researchers, policy makers and the wider development agenda for too long. Millions of children are stuntedoverweight and these children are found in every single LMIC – in a wide range of contexts – each with their own specific challenges. Despite the high prevalence and wide ranging incidence of stuntingoverweightness worldwide, its causes and consequences are largely unknown. In order to aid stuntedoverweight children and prevent those at risk of stuntingoverweightness from becoming malnourished, uncovering these causes and consequences is vital.

This research has been able to show that stuntedoverweight children who are concentrated in more developed areas within countries are poorer than both the overweight and the non-malnourished. In addition, their mothers have lower levels of education. At the same time, they stand apart from their stunted peers as they are better off – particularly in terms of household wealth. It appears that the stuntedoverweight are poor but upwardly mobile. However, more research is required to elucidate the pathways through which their upwardly mobile, yet poor context is leading to their stuntingoverweightness. Importantly, the age distribution of affected children suggests there is more than one pathway to stuntingoverweightness and research needs be conducted to address these issues. A key area for research here would be the development of overweightness among children that are already stunted. Is it possible that, due to rapidly changing contexts, stuntingoverweightness that develops in such a way is evidence of rapid developmental effects, of foetal origins of susceptibility to overweightness in early childhood? Longitudinal studies are urgently required to address the development of stuntingoverweightness.

This research has contributed to the identification of stuntedoverweight children as a distinct group but more research is required to understand the causal mechanisms leading to this paradoxical growth faltering. Additionally, there is the key question of how stuntedoverweight children will be affected throughout their life course. Research has shown the severe implications and long arm of both under- and overnutrition in childhood. More needs to be done to uncover what the future for stuntedoverweight children will be. Are they going to suffer the consequences of both under- and overnutrition in childhood across their life course and thus experience a multitude of setbacks to their development – both in relation to their health and their socioeconomic development? If so, in turn, the human capital of the population and a country's eventual development will also be increasingly hindered.

This uncertain future is likely to affect more and more individuals and thus more populations to an ever greater extent, as the weight of evidence suggests stuntingoverweightness prevalence is increasing and will continue to increase.

In the last two months, three further DHS surveys with anthropometric modules were made publicly available, providing data for the Kyrgyz Republic (2012)[83], Guinea

[83] (public release date 04/02/2014)

(2012)[84] and Pakistan (2012-13)[85]. For the Kyrgyz Republic, stuntingoverweightness prevalence has increased from 2.96 in 2005 to 3.52% in 2012. In Guinea, the prevalence of stuntingoverweightness has increased by over 50% from 1.06% in 2005 to 1.59% in 2012. The clear increase in stuntingoverweightness over time cements the need to bring stuntingoverweightness and stuntedoverweight children to the foreground.

There is no previous data available for Pakistan, so trends in stuntingoverweightness cannot be presented – but there is a key finding of note. In Pakistan in 2012-13, the prevalence of stuntingoverweightness was found to be 2.29%, while the prevalence of overweightness was 0.98%. The prevalence of stuntingoverweightness is therefore more than double the prevalence of overweightness – showing that in some LMICs stuntingoverweightness is already a far greater problem than overweightness. Additionally, the case of Pakistan highlights the overstatement of the 'rapid onset' of overweightness among children – in this particular case it is not overweightness that is rising, so much as stuntingoverweightness.

Strategies must be urgently developed and employed to raise the profile of stuntingoverweightness to the wider health, research and development community. In doing so, research to establish the causes and consequences of stuntingoverweightness can be facilitated and, importantly, strategies to reduce the incidence of stuntingoverweightness and to aid those already affected can be developed.

To conduct research into stuntingoverweightness, and also reflect the true prevalence of stunting and of overweightness, some integral changes need to be made when using anthropometric indices. This is a key element of research on child malnutrition and will be explored in the next section, which details what stuntingoverweightness means for current and future research on malnutrition.

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[84] (public release date 30/01/2014)

[85] (public release date 22/01/2014)

9.2.2 Stuntingoverweightness and the future of nutrition research, policy and action

In this section, recommendations are put forward within the context of the Triple A Approach, for improving the understanding of nutrition today. Firstly, assessment is discussed, followed by analysis and action.

9.2.2.1 Assessment

The assessment of malnutrition worldwide needs to be unified, both in definition and approach. The focus of this research has shown this is particularly important for the continued misuse of anthropometric indicators.

We have seen that stuntingoverweightness has been overlooked and the 'burden of malnutrition' misrepresented in research. To overcome these issues, changes need to be made to the way we measure malnutrition.

The majority of research utilises anthropometric indicators to measure malnutrition. Chapter 2 highlighted that there are three main anthropometric indicators – weight-for-age, weight-for-height and height-for-age. These indicators are often presented as very separate, giving measures of very definite and distinctive forms of malnutrition. Methodological papers on anthropometric indicators will state that weight-for-age indicates undernutrition, weight-for-height can indicate wasting and overweightness and height-for-age can indicate stunting. Additionally, height-for-age represents chronic undernutrition, weight-for-height acute undernutrition (wasting) and weight-for-age reflects both chronic and acute malnutrition. These are presented as fundamental, unchanging and discrete indicators reflecting discrete forms of malnutrition. More often than not these 'rules' of anthropometry are accepted and research continues accordingly. But these indicators can in fact overlap, and individuals can suffer different forms of growth faltering malnutrition indicated by different anthropometric indices. There has been research on children who are both stunted and wasted, so the issue of overlap is not new. However, as a matter of course, anthropometric indices are not utilised to reflect this overlap and neither are the resulting prevalence estimates of malnutrition.

The focus of this research is the overlap between height-for-age and weight-for-height. As evidenced by this research, children are increasingly found to be both stunted and overweight at one point in time – but this will only be noticed by researchers who take the time to compare an individual's z-scores across the different anthropometric indicators. Making comparisons across indicators must become routine when using anthropometric indicators. This is fundamental to the continued use of anthropometric indices and is the fundamental adaptation to malnutrition research that I propose.

I propose that for research into child malnutrition in the future, when using anthropometric indicators, the focus should be on the use of both height-for-age and weight-for-height. Both indicators can separately reflect chronic (low height-for-age) or acute (low weight-for-age) malnutrition. When used simultaneously they can indicate a child that is both stunted and overweight. Moreover, no information is lost as weight-for-height retains the ability to indicate wasting where present; thus acute malnutrition can still be represented in research.

I have considered other propositions but these were rejected for a variety of reasons.

One potential approach would be the sole use of weight-for-age (to indicate underweight) and weight-for-height (to indicate overweightness). Weight-for-age is the official indicator for the measurement of MDG1's progress in alleviating hunger. However, weight-for-age indicates non-specific underweightness. To explain this further, weight-for-age is thought to indicate both acute and chronic malnutrition but fails to distinguish between them. For research on overweightness, the recommended indicator is weight-for-height (not weight-for-age). Thus, in contexts where both under and overnutrition are of concern, a research using weight-for-age will necessarily require the utilisation of a second indicator. Using weight-for-age and weight-for-height it would be possible to indicate a child that is acutely undernourished (low weight-for-height) but there would be no indication of chronic undernutrition. Thus, in using these indices, information on the type of malnutrition (acute or chronic) is lost. Additionally, as seen in this research, chronic undernutrition does co-exist with overweightness in all LMICs and the use of weight-for-age with weight-for-height will not be able to indicate this. Furthermore, as two indicators are being used, a researcher still needs to compare results across indicators, thus there are no gains to be made in implementation, only losses in terms of a less nuanced understanding of malnutrition.

A second approach would be to just use weight-for-height, which can indicate both wasting (low weight-for-height) and overweightness (high weight-for-height). For those that are determined to uphold dichotomies of malnutrition – under or over – this is the best approach to take as, when using weight-for-height, a child can only be malnourished if they are either wasted or overweight. However, this indicator yields no information on chronic undernutrition. Not only do we now know that chronic undernutrition co-occurs with overweightness in one individual across LMICs, but chronic undernutrition has severe implications for a child's health across the life course. As a result it is a form of malnutrition that research should indicate – hence the use of weight-for-height alone is not considered appropriate.

In the approach I propose – the use of both weight-for-height and height-for-age – both chronic and acute forms of malnutrition can be indicated. Additionally, the paradoxical concurrence of stuntingoverweightness can be observed. This approach provides the most nuanced depiction of malnutrition possible for most research, and is necessary in a context of increasing diversity in nutritional outcomes.

This approach is imperative for research on individual's nutritional outcomes and for research on the prevalence of malnutrition (in all its forms) worldwide.

In future, correct usage of anthropometric indicators – and thus the acknowledgement of stuntingoverweightness in children – is imperative. As a result of this correction, stunting and overweightness prevalence estimates can be accurately represented. Moreover, we can eliminate the issue of unobserved heterogeneity resulting from the inclusion of stuntedoverweight children in analyses conducted on either stunted or overweight children[86].

In order to achieve this proposed methodology, awareness of overlap across anthropometric indices needs to be raised. Furthermore, manuals describing how to construct prevalence estimates from anthropometric indices should be revised to ensure that double-counting does not continue into the future. A key step to aid this process would be for the WHOCG&M, MICS reports and DHS reports to begin routinely presenting estimates of stuntingoverweightness[87]. This would raise the profile of stuntingoverweightness, thereby facilitating discussions on stuntingoverweightness and the issues of overlap and double-counting in the current usage of anthropometric indices. This could only serve to be beneficial to the analysis and action so integral to the Triple A Approach.

9.2.2.2 Analysis

There is a clear gap in knowledge concerning the causes of stuntingoverweightness, both proximate and distal. This must be addressed.

As noted, a review of the conceptual framework for malnutrition is required given the existence of stuntingoverweightness and diverse burdens of malnutrition in LMICs. It is necessary for researchers to be able to clearly distinguish the different factors causing differential malnutrition outcomes among children within one country, and in terms of analysis in one sample.

The difficulties of modelling diverse nutritional outcomes has been seen in this research, with increased reliance modelling techniques requiring more parameters that can lead to overspecified and thus ineffectual analyses. There is a clear need for an open discussion on research into malnutrition in the face of diverse nutritional outcomes in a

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[86] Although the impact on results emanating from past research could still be subject to this issue

[87] And children who are both stunted and wasted

population between both researchers and key stakeholders alike – particularly those involved in the collection of data. With such a broad spectrum of malnutrition among children under-five, national surveys such as the DHS and MICS should consider further bolstering the sample of data taken from children – which will necessarily involve greater capacity and resource to undertake.

For stuntingoverweightness, in particular, far more research needs to be done in other countries, aside from Albania, to be able to determine factors contributing to its development. Furthermore, there is an urgent need for longitudinal studies to uncover the development trajectory of stuntingoverweightness. This is likely to involve the conception of new studies, designed around stuntingoverweightness. Again, this calls for great motivation from the nutrition arena – to provide the capacity, resources, finances and expertise for such studies.

9.2.2.3 Action

This research has shown that, given the absence of an acknowledgement of stuntingoverweightness, there is an absence of action. This is a product of failure to assess and analyses nutrition data appropriately. There must be a re-examination of the situation of nutrition and its causes given stuntingoverweightness. Once achieved, there will be a need to integrate these findings into existing nutritional programmes and interventions – be they direct or indirect. At the moment however, the first action to be taken is to address the international recognition of malnutrition that is failing millions of stuntedoverweight children to ensure the wider development arena are both motivated and able to act.

9.3 Summary and Future Research

This research has documented the existence of stuntingoverweightness. The observation of stuntingoverweightness has changed our understanding of malnutrition in LMICs today. Increasingly kaleidoscopic spectrums of nutritional insults are being experienced in LMICs today, as divergent trajectories of nutrition transition are experienced.

The research agenda must strive to promote and raise awareness of the diversity of nutritional profiles occurring in LMICs today. In recognising divergent transition, research must be amenable to the context in which it is being conducted. The end goal must be to aid individuals and LMICs affected by these diverging burdens of malnutrition. While we are increasingly witnessing the multifaceted nature and implications of malnutrition, one feature remains steadfast – it is preventable. It is the preventable nature of malnutrition that can and should drive the integration of policies, programmes and research – enabling them to tackle each facet robustly and cooperatively.

Millions of malnourished children – the stuntedoverweight – have consistently been overlooked, and they must now urgently be given centre-stage. The path that led them to this form of malnutrition is currently unknown and their future journey is uncertain – but by accepting the divergence of the nutrition transition and the types of malnutrition that result, we can begin to tackle their plight alongside the issues facing those still suffering from other forms of malnutrition. The crucial factor at this stage is to drive the motivation among key stakeholders to 'Re-Assess', Re-Analyse' and 'Act'.

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Appendices

Appendix I: Flagged Cases and Missingness

	Flagged Cases	% Flagged	Missing Cases	% Missing	Total Cases
Albania	236	14.6	89	5.5	1616
Armenia	92	6.2	144	9.8	1473
Azerbaijan	223	9.7	132	5.7	2297
Bangladesh	217	2.6	417	5.0	8281
Belarus	27	0.9	0	0.0	3051
Belize	117	14.7	0	0.0	796
Benin	907	6.4	937	6.7	14090
Bolivia	98	1.2	227	2.8	8091
Bosnia	194	6.0	22	0.7	3209
Burkina Faso	197	2.9	108	1.6	6837
Burundi	44	1.2	112	3.1	3606
Cambodia	108	2.8	81	2.1	3888
Cameroon	0	0.0	0	0.0	3741
Central African Republic	2457	25.0	235	2.4	9820
Chad	256	5.2	286	5.8	4926
Colombia	53	0.3	22	0.1	16044
Congo (Brazzaville)	23	0.5	153	3.4	4559
Congo Democratic Republic	291	7.6	296	7.7	3852
Djibouti	568	22.1	320	12.5	2565
Dominican Republic	203	2.0	580	5.8	10038
Egypt	1004	9.5	58	0.6	10540
Ethiopia	271	2.6	588	5.6	10480
Gabon	143	4.0	115	3.2	3594
Gambia	157	2.4	98	1.5	6641
Georgia	219	10.0	159	7.2	2196
Ghana	159	5.9	147	5.5	2685
Guinea	22	0.8	100	3.5	2880
Guinea-Bissau	1583	24.1	725	11.0	6570
Guyana	161	7.8	340	16.5	2061
Haiti	61	1.5	29	0.7	4074
Honduras	39	0.4	243	2.4	10255
India	2431	5.1	4347	9.0	48084
Iraq	1141	6.9	101	0.6	16570
Ivory Coast	86	2.5	202	5.8	3488
Jordan	90	1.4	282	4.2	6639
Kazakhstan	234	5.3	9	0.2	4424

Kenya	241	4.4	153	2.8	5490
Kyrgyzstan	125	4.2	0	0.0	2987
Lao PDR	73	1.7	169	4.0	4204
Lesotho	55	3.2	54	3.1	1732
Liberia	243	5.1	218	4.6	4785
Macedonia	347	7.6	33	0.7	4578
Madagascar	308	5.4	468	8.2	5742
Malawi	508	9.9	52	1.0	5146
Maldives	92	2.5	1270	34.2	3715
Mali	644	5.4	516	4.3	11938
Mauritania	974	10.8	309	3.4	8981
Moldova	13	0.8	73	4.7	1560
Mongolia	294	8.2	21	0.6	3568
Montenegro	225	21.0	11	1.0	1072
Morocco	17	0.3	290	5.0	5857
Mozambique	1257	10.6	98	0.8	11818
Namibia	117	2.9	168	4.2	3972
Nepal	57	2.4	0	0.0	2392
Niger	170	3.7	430	9.3	4616
Nigeria	4203	17.3	1145	4.7	24358
Palestinians in Lebanon	489	20.5	0	0.0	2381
Peru	121	1.3	286	3.0	9620
Rwanda	42	1.0	16	0.4	4133
Sao Tome e Principe	180	10.0	163	9.0	1807
Sebia	461	12.0	71	1.8	3838
Senegal	182	4.2	590	13.7	4320
Sierra Leone	254	10.5	144	5.9	2422
Somalia	938	14.7	68	1.1	6373
Suriname	377	16.0	97	4.1	2354
Swaziland	183	6.5	582	20.7	2812
Syria	1526	13.7	87	0.8	11104
Tajikistan	242	5.0	28	0.6	4823
Tanzania	161	2.2	222	3.1	7175
Thailand	416	4.4	35	0.4	9444
Timor-Leste	640	7.0	932	10.2	9116
Togo	689	16.6	80	1.9	4154
Uganda	40	1.8	104	4.7	2214
Uzbekistan	297	5.9	53	1.1	5039
Vanuatu	434	24.9	107	6.1	1741
Zambia	271	4.8	229	4.1	5621
Zimbabwe	108	2.3	354	7.4	4761

Appendix II: Estimates of Child Malnutrition

					Calculated Estimates				**WHO Presented Estimates**		
Country	Survey (d=DHS, u=MICS)	Year	Not Malnourished %	% Stunted	% Overweight	% Stuntedoverweight	wasted	Stunting	Overweight	Wasting
Albania08	d	2008	59.52	10.21	12.62	9.04	8.6	23.1	23.4	9.4
Armenia	d	2010	68.79	12.19	8.22	7.05	3.75	20.8	16.8	4.2
Azerbaijan	d	2006	64.58	16.58	4.3	8.55	5.99	26.8	13.9	6.8
Bangladesh	d	2011	49.47	40.49	0.88	0.68	8.48	41.4	1.9	15.7
Belarus	u	2005	89.54	2.13	6.34	0.62	1.36	4.5	9.7	2.2
Belize	u	2006	71.33	15.55	9.15	1.9	2.08	22.2	13.7	1.9
Benin	d	2006	48.64	36.05	2.32	6.85	6.14	44.7	11.4	8.4
Bolivia	d	2008	65.94	24.58	5.98	2.51	0.99	27.2	8.7	1.4
Bosnia	u	2006	71.44	3.16	15.68	5.99	3.73	11.8	25.6	4.0
Burkina Faso	d	2010	53.34	33.05	0.96	1.43	11.22	35.1	2.8	15.4
Burundi	d	2010	39	55.94	0.81	1.92	2.32	57.5	2.9	6.1
Cambodia	d	2010	53.29	38.13	0.69	0.96	6.93	40.9	1.9	10.8
Cameroon	d	2011	60.68	29.54	3.8	2.42	3.56	32.6	6.5	5.8
Central African Republic	u	2006	50.4	34.57	2.54	3.45	9.04	45.1	8.5	12.2
Chad	d	2004	49.26	39.97	1.15	0.98	8.64	44.8	4.4	16.1
colombia	d	2010	81.9	12.57	4.29	0.51	0.73	12.7	4.8	0.9
Congo (Brazzaville)	d	2011-12	70.32	21.71	1.93	1.4	4.64	24.4	3.3	5.9

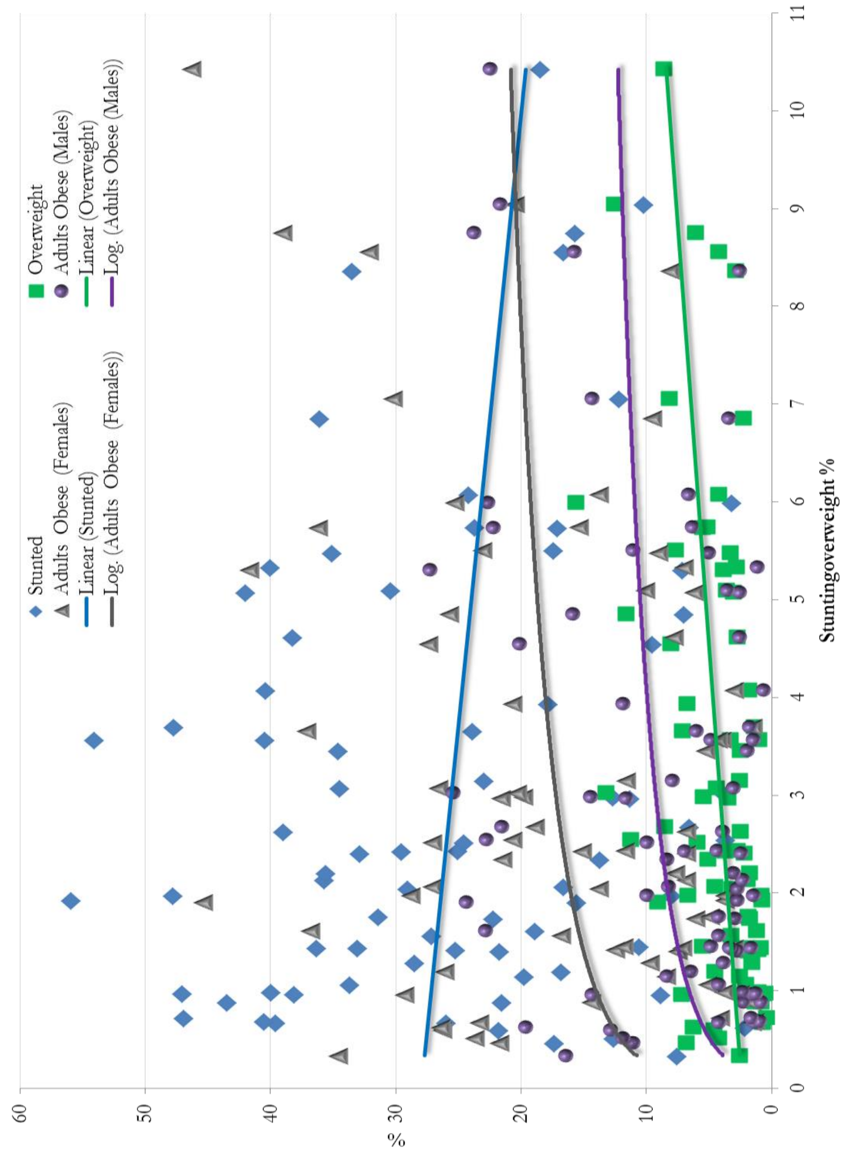
Congo Democratic Republic	d	2007	46.45	40.41	1.91	4.07	7.16	45.8	6.8	14.0
Djibouti	u	2006	40.39	24.2	4.31	6.07	25.03	32.6	13.4	26.0
Dominican Republic	d	2007	80.84	8.84	7.24	0.95	2.14	10.1	8.3	2.3
Egypt	d	2008	55.88	18.46	8.65	10.42	6.59	30.7	20.5	7.9
Ethiopia	d	2011	48.9	43.46	0.89	0.88	5.88	44.2	1.8	10.1
Gabon	d	2012	76.05	13.69	5.14	2.34	2.79	16.5	7.4	3.3
Gambia	u	2005	71.5	21.53	1.41	0.88	4.67	27.6	2.7	7.4
Georgia	u	2005	74.31	6.98	11.65	4.85	2.21	14.7	21.0	3.0
Ghana 08	d	2008	62.43	25.04	2.8	2.43	7.3	28.6	5.9	8.7
guinea	d	2005	56.84	33.67	2.13	1.06	6.29	39.3	5.1	10.8
Guinea-Bissau	u	2006	47.48	33.5	2.92	8.36	7.74	47.7	17.0	8.9
Guyana	d	2009	72.4	16.61	4.6	2.06	4.33	19.5	6.7	5.3
Haiti	d	2012	72.93	19.73	2.59	1.14	3.6	21.9	3.6	5.1
Honduras (WHO estiamtes 2005)	d	2011	72.04	21.76	4.68	0.59	0.94	29.9	5.8	1.7
India	d	2005	40.32	47.06	0.57	0.97	11.07	47.9	1.9	20.0
Iraq	u	2006	66.4	17.1	5.56	5.73	5.21	27.5	15.0	5.8
Ivory Coast		2011	62.7	28.49	1.65	1.28	5.87	28.0	2.8	7.1
Jordan	d	2007	71.85	10.13	7.1	4.25	6.67	8.3	6.6	1.6
Kazakhstan	u	2006	73.34	9.55	8.1	4.54	4.47	17.5	16.9	4.9
Kenya	d	2008	57.7	32.85	2.26	2.4	4.79	35.2	5.0	7.0
Kyrgyzstan	u	2005	78.46	11.33	3.57	2.96	3.68	18.1	10.7	3.4
Lao PDR	u	2006	48.53	46.92	0.47	0.72	3.36	47.6	1.3	7.3
Lesotho	d	2009	54.61	34.49	4.49	3.07	3.34	39.0	7.3	3.9

Liberia	d	2007	55.01	35.58	1.82	2.2	5.4	39.4	4.2	7.8
Macedonia	u	2005	79.41	6.58	8.58	2.67	2.77			
madagascar	d	2003-04	37.77	47.71	1.46	3.69	9.38	52.8	6.2	15.2
Malawi	d	2010	47.05	41.99	3.1	5.07	2.8	47.8	9.2	4.1
Maldives	d	2009	68.97	16.77	4.58	1.19	8.49	20.3	6.5	10.2
Mali	d	2006	49.55	35.72	1.99	2.13	10.61	38.5	4.7	15.3
Mauritania	u	2007	62.87	25.95	0.83	0.67	9.68	28.9	2.3	13.4
Moldova* not weighted		2005	78.43	8.01	6.72	1.97	4.88			
Mongolia	u	2005	69.59	17.82	6.78	3.93	1.88	27.5	14.2	2.7
Montenegro	u	2005	78.64	3.68	11.32	2.54	3.82	7.9	15.6	4.2
Morocco* not weighted	d	2004	60.02	17.42	7.73	5.5	9.33	23.1	13.3	10.8
Mozambique	d	2011	50.15	38.21	2.81	4.61	4.23	43.1	7.9	6.1
Namibia	d	2006	62.76	27.13	3.29	1.56	5.26	29.6	4.6	7.5
Nepal	d	2011	52	39.59	0.77	0.67	6.98	40.5	1.5	11.2
Niger* unweighted	d	2006	42.93	47.78	0.9	1.97	6.42	54.8	3.5	12.4
Nigeria	d	2008	46.04	35.1	3.34	5.47	10.06	41.0	10.5	14.4
Palestinians in Lebanon	u	2006	63.16	13.59	9.36	8.61	5.28			
Peru	d	2012	74.9	17.36	6.85	0.46	0.44	18.1		0.6
Rwanda	d	2010	50.78	40.44	3.34	3.56	1.88	44.3	7.1	3.0
Sao Tome e Principe	d	2008	56.74	23.67	5.18	5.74	8.67	31.6	11.6	11.2
Senegal	d	2010	64.82	25.21	1.16	1.41	7.4	28.7	2.8	9.8
Serbia	u	2005	76.1	3.86	13.25	3.02	3.78	8.1	19.3	4.5
Sierra Leone08	d	2008	52.78	30.38	3.69	5.09	8.06	37.4	10.1	10.5
Somalia	u	2006	52.12	36.34	2.02	1.43	8.08	42.1	4.7	13.2

Suriname	u	2006	84.95	7.54	2.6	0.33	4.58	10.7	4.0	4.9
Swaziland	d	2006	63.24	23.89	7.15	3.65	2.06	29.5	11.4	2.9
Syria	u	2006	59.77	15.7	6.12	8.75	9.66	28.6	18.7	10.3
Tajikistan	u	2005	64.22	24.66	1.64	3.1	6.39	33.1	6.7	8.7
Tanzania	d	2010	52.88	38.97	2.54	2.62	2.98	42.5	5.5	4.9
Thailand	u	2005	78.45	10.56	5.59	1.45	3.96	15.7	8.0	4.7
Timor Leste	d	2009	29.88	54.06	1.08	3.56	11.42	57.7	5.8	18.9
Togo	u	2006	61.89	22.2	1.79	1.73	12.39	27.8	4.7	16.3
Uganda	d	2011	61.26	31.41	1.97	1.75	3.61	33.7	3.8	4.8
Uzbekistan	u	2006	75.07	12.65	5.51	2.98	3.78	19.6	12.8	4.5
Vanuatu	u	2007	72.28	18.89	1.25	1.61	5.96	25.9	4.7	5.9
Zambia	d	2007	47.58	40.01	2.85	5.33	4.24	45.8	8.4	5.6
Zimbabwe	d	2010	63.33	29.07	3.22	2.04	2.35	32.3	5.8	3.1

Appendix III: Full Graph

Figure 4.16 Child Stuntingoverweightness with Child Stunting, Child Overweightness, Female Adult Obesity and Male Adult Obesity



Appendix IV Interaction Terms

Internet and Mobile, interacting with URBAN

DV: Stuntingoverweightness	**MA1**	**MA2**
Stunting	0.133***	0.128***
	0.036	0.037
Overweight	0.482***	0.452***
	0.105	0.104
Female adult obesity	1.136*	1.061*
	0.435	0.434
% Population urban	0.025	0.037
	0.02	0.026
INTERNET	-0.362	
	0.807	
INTERNET*URBAN	-0.002	
	0.012	
MOBILE		-0.006
		0.019
MOBILE*URBAN		0
		0
CONSTANT	-5.946	-5.617
	2.152	2.326
R	29.7	29.6
N	73	73

Interaction Mobile and Stunting/Overweightness/Adult Obesity (female)

	mA3	mA4	mA5
STUNTEDPC	0.111*	0.100**	0.102**
	0.043	0.037	0.037
OVERWEIGHTPC	0.500***	0.445*	0.504***
	0.114	0.209	0.114
logaof	1.013*	1.016*	0.966
	0.452	0.453	0.587
mobdiff10	-0.006	-0.017	-0.015
	0.017	0.017	0.029
Mobile*stunting	0		
	0.001		
Mobile*overweightness		0.001	
		0.004	
Mobile*adult female obesity			0.001
			0.01
(Constant)	-3.727	-3.268	-3.409
	2.104	2.181	2.362
R-squared	0.306	0.306	0.304
N	73	73	73

Appendix V – Poverty Gap

DV: Stuntingoverweightness	MA1
Stunting	0.163**
	0.047
Overweight	0.528**
	0.17
Female adult obesity	1.281*
	0.525
% Population urban	0.021
	0.025
INTERNET	2.588
	1.44
INTERNET*STUNTING	-3.541
	2.313
Poverty Gap	-0.026
	0.034
CONSTANT	-6.156*
	2.152
R	46.4
N	48

Appendix VI: Additional Macro-Level Explanatory Variables

Variable Name	Variable Description	Source
GNI_CI		**Computed using WB DataCatalog Data**
GNI_AVEI		**Computed using WB DataCatalog Data**
PROTEIN		**FAO FBS**
PROTEIN_ANIMAL		**FAO FBS**
KCAL_VEG		**FAO FBS**
KCAL_ANI		**FAO FBS**
FAT_VEG		**FAO FBS**
HEALTHEXP_PRI		**WB DataCatalog Data**
MAINS		**WB DataCatalog Data**
AGRI_PC80		**WB DataCatalog Data**
FEM_LAB		**WB DataCatalog Data**
U5MR2000		**WB DataCatalog Data**
U5MR80		**WB DataCatalog Data**
FPI		**FAO FBS**
EDU_PUB		**WB DataCatalog Data**
CARS		**WB DataCatalog Data**

Appendix VII: Multilevel Modelling

Log-likelihood Ratio Tests for the Logistic Dependent Variable 'Stunted'

Model	Random Intercept	LLR test model 'x' nested in model 'x'	Chi-Square Test Statistic	P-Value
1	none	N/A	N/A	**N/A**
2	household	1 nested in 2	0.83	**0.1805**
3	community	1 nested in 3	20.83***	**<0.0000**
4	Household and community	1 nested in 4	5.52	**0.0633**
5	**Household and community**	**2 nested in 4**	**-15.31**	**1.0000**

*p<0.05, ** p<0.01, *** p<0.001

For the binary dependent variable 'Stunted', the null hypothesis that $\psi = 0$ is rejected at the 0.1% level of significance, consequently it would be invalid to run a logistic regression analyses on the dependent variables without the inclusion of a community level random intercept. However, the inclusion of a household level random intercept did not lead to a rejection of the null hypothesis and is not a methodologically necessary model parameter in this instance. This was further checked by running a log-likelihood ratio test for model 3 (with a community level intercept) nested in model 4 (with both a household- and community level random intercept) to see if the inclusion of a household level random intercept improved the model, the results (p=1.000) indicate this is not the case, the null hypothesis was not rejected.

Log-likelihood Ratio Tests for the Logistic Dependent Variable 'Overweight'

Model	Random Intercept	LLR test model 'x' nested in model 'x'	Chi-Square Test Statistic	P-Value
1	none	N/A	N/A	**N/A**
2	household	2 nested in 1	7.84	**0.0026**

3	community	3 nested in 1	13.91***	**0.0001**
4	**Household and community**	**4 nested in 1**	**19.58**	**0.0001**

For the binary dependent variable 'Stunted', the null hypothesis that ψ = 0 is rejected for both household-level and community-level random intercepts at the 0.1% level of significance. Consequently it would be invalid to run a logistic regression analyses on the dependent variables without the inclusion of a household level and community level random intercept.

Log-likelihood Ratio Tests for the Logistic Dependent Variable 'Stuntedoverweight'

Model	Random Intercept	LLR test model 'x' nested in model 'x'	Chi-Square Test Statistic	P-Value
1	none	N/A	N/A	**N/A**
2	household	2 nested in 1	1.11	**0.1460**
3	community	3 nested in 1	9.94***	**0.0008**
4	**Household and community**	**4 nested in 1**	**42.61**	**<0.00001**

For the binary dependent variable 'Stunted', the null hypothesis that ψ = 0 is rejected at the 0.1% level of significance, consequently it would be invalid to run a logistic regression analyses on the dependent variables without the inclusion of a community level random intercept. However, the inclusion of a household level random intercept did not lead to a rejection of the null hypothesis and is not a methodologically necessary model parameter in this instance. The test has not yet been conducted for the multinomial dependent variable 'nutritionalstatus' but the results will inform the inclusion of a random intercept and subsequent analysis of the role of the household and the community.

For the models that have been completed and where the null hypothesis, that ψ = 0, was rejected, confirmation is received that it would be invalid to run logistic regression analyses on the dependent variables without the inclusion of the relevant random intercept to the log-likelihood ratio test.