

# THE DOUBLE BURDEN OF MALNUTRITION

## A Review of Global Evidence

Roger Shrimpton and Claudia Rokx

November 2012





# **THE DOUBLE BURDEN OF MALNUTRITION:**

*A Review of Global Evidence*

**Roger Shrimpton and Claudia Rokx**

**November 2012**

## Health, Nutrition and Population (HNP) Discussion Paper

This series is produced by the Health, Nutrition, and Population Family (HNP) of the World Bank's Human Development Network (HDN). The papers in this series aim to provide a vehicle for publishing preliminary and unpolished results on HNP topics to encourage discussion and debate. The findings, interpretations, and conclusions expressed in this paper are entirely those of the author(s) and should not be attributed in any manner to the World Bank, to its affiliated organizations or to members of its Board of Executive Directors or the countries they represent. Citation and the use of material presented in this series should take into account this provisional character.

Enquiries about the series and submissions should be made directly to the Editor, Martin Lutalo ([mlutalo@worldbank.org](mailto:mlutalo@worldbank.org)). Submissions undergo informal peer review by selected internal reviewers and have to be cleared by the Task Team Leader's Sector Manager. The sponsoring department and author(s) bear full responsibility for the quality of the technical contents and presentation of material in the series.

Since the material will be published as presented, authors should submit an electronic copy in the pre-defined template (available at [www.worldbank.org/hnppublications](http://www.worldbank.org/hnppublications) on the Guide for Authors page). Drafts that do not meet minimum presentational standards may be returned to authors for more work before being accepted.

For information regarding the HNP Discussion Paper Series, please contact Martin Lutalo at [mlutalo@worldbank.org](mailto:mlutalo@worldbank.org) or 202-522-3234 (fax).

# Health, Nutrition, and Population (HNP) Discussion Paper

## THE DOUBLE BURDEN OF MALNUTRITION:

### *A Review of Global Evidence*

Roger Shrimpton<sup>a</sup>  
Claudia Rokx<sup>b</sup>

<sup>a</sup>Principal author, Consultant, Health, Nutrition, and Population Unit, East Asia Pacific Human Development Sector, The World Bank, Jakarta, Indonesia

<sup>b</sup>Task Team Leader, Lead Health Specialist, Eastern Europe and Central Asia, Human Development Sector, the World Bank

Financing of this work was generously provided by the Millennium Challenge Corporation.

#### **Abstract:**

The Double Burden of Malnutrition (DBM) is the coexistence of both undernutrition and overnutrition in the same population across the life course. “Across the life course” refers to the phenomenon that undernutrition early in life contributes to an increased propensity for overnutrition in adulthood. The DBM affects all countries, rich and poor, and is a particular concern in countries with high stunting rates. The consequences of the DBM are enormous; early life undernutrition is an underlying cause associated with about a third of young child deaths. Among the survivors who become stunted during the first two years of life, their capacity to resist disease, to carry out physical work, to study and progress in school, are all impaired across the life course. Later in the life course, diet and nutrition, and especially obesity, are important underlying causes of many non-communicable diseases (NCDs), including hypertension, diabetes, cancer, stroke, and ischemic heart disease. The causes of the DBM are related to a series of changes occurring in the world called the *nutrition transition*, the *demographic transition*, and the *epidemiological transition* of countries. The variables associated with the nutrition transition and obesity epidemic can be grouped into four cross-cutting themes, which include: (i) the Health/Biological Environment; (ii) the Economic/Food Environment; (iii) the Physical/Built Environment; and (iv) the Socio/Cultural Environment. The solutions for the DBM problems are reasonably well recognized in each of its parts: undernutrition and overnutrition. However, the solutions have not been combined into an overarching policy and program framework, which together with raising awareness about the serious future implications for the low- and middle-income countries is the aim of this paper.

**Keywords:** Undernutrition, Overnutrition, Obesity, Double Burden of Malnutrition

**Disclaimer:** The findings, interpretations, and conclusions expressed in the paper are entirely those of the authors, and do not represent the views of the World Bank, its Executive Directors, or the countries they represent.

**Correspondence Details:** Claudia Rokx, Lead Health Specialist, ECSH1, World Bank, 1818 H Street N.W. Washington DC, 20433, [crokx@worldbank.org](mailto:crokx@worldbank.org)

## Table of Contents

<b>ACRONYMS AND ABBREVIATIONS</b> .....	<b>VI</b>
<b>GLOSSARY</b> .....	<b>VII</b>
<b>ACKNOWLEDGMENTS</b> .....	<b>VIII</b>
<b>EXECUTIVE SUMMARY</b> .....	<b>IX</b>
<b>PART I. INTRODUCTION</b> .....	<b>1</b>
<b>PART II. WHAT IS THE DOUBLE BURDEN OF MALNUTRITION?</b> .....	<b>3</b>
<i>DBM Key Concepts and Indicators</i> .....	3
<b>PART III. WHO DOES THE DOUBLE BURDEN OF MALNUTRITION AFFECT MOST?</b> .....	<b>5</b>
<b>PART IV. WHAT ARE THE CONSEQUENCES OF THE DOUBLE BURDEN OF MALNUTRITION?</b> .....	<b>8</b>
<i>The Potential Costs of the Long-Term Effects of DBM</i> .....	10
<b>PART V. WHAT ARE THE CAUSES OF THE DOUBLE BURDEN OF MALNUTRITION?</b> .....	<b>11</b>
<i>Nutrition, Demographic, and Epidemiological Transition</i> .....	11
<i>DBM Causality and Conceptual Framework</i> .....	11
<i>The Health and Biological Environment</i> .....	13
<i>Theories of Pathophysiology</i> .....	13
<i>The Economic/Food Environment</i> .....	15
<i>Increased Access to Food</i> .....	15
<i>Food Consumption</i> .....	18
<i>Food Processing</i> .....	20
<i>Trade and Food Subsidies</i> .....	21
<i>The Physical/Built Environment</i> .....	22
<i>The Socio-Cultural Environment</i> .....	24
<i>Social Marketing</i> .....	24
<i>Cultural Norms and Beliefs</i> .....	26
<b>PART VI. WHAT ARE THE SOLUTIONS FOR THE DOUBLE BURDEN OF MALNUTRITION?</b> .....	<b>27</b>
<i>Programmatic and Policy Interventions</i> .....	27
<i>Health/Biological Environment</i> .....	29
<i>Economic/Food Environment</i> .....	29
<i>Availability</i> .....	30
<i>Distribution</i> .....	30
<i>Improving Access to Health Food Products</i> .....	31
<i>Consumption</i> .....	32
<i>Physical/Built Environment</i> .....	32
<i>Socio-Cultural Environment</i> .....	33
<i>Cultural Norms and Beliefs</i> .....	33
<b>PART VII. WHAT IS THE COMMITMENT AND CAPACITY FOR INTERVENTION ON THE DOUBLE BURDEN OF MALNUTRITION?</b> .....	<b>35</b>
<i>Existing Global Governance Arrangements</i> .....	35
<i>Existing Global Nutrition Recommendations</i> .....	37
<i>Global Recommendations for Physical Activity</i> .....	38
<i>Increased Capacity Crucial</i> .....	38
<i>Multisectoral Coordination</i> .....	39
<i>A Framework for DBM Policy Implementation</i> .....	40
<i>Operational Research Agenda</i> .....	41

<b>PART VIII. CONCLUSIONS.....</b>	<b>43</b>
<b>REFERENCES .....</b>	<b>45</b>

#### **List of Tables**

Table 1. Comparison of Energy Expenditure between Sedentary Adults and Very Active Adults .....	22
Table 2. Multisectoral Direct and Indirect Intervention to Reduce DBM .....	28
Table 3. Recommendations for Daily Intake .....	37
Table 4. Four Overarching Pillars of the DBM Nutrition Policy Framework .....	40

#### **List of Figures**

Figure 1. Lifecycle: Proposed Causal Links .....	1
Figure 2. Growth Faltering in Young Children .....	4
Figure 3. Past and Projected Prevalence of Overweight (BMI> 25kg/m <sup>2</sup> ) in Selected OECD Countries.....	5
Figure 4. Prevalence of Obesity (BMI>30) and Overweight (BMI>25) in Adult Males and Females in 1980 and 2008 .....	6
Figure 5. The Short-Term and Long-Term Effects of Early Nutrition .....	8
Figure 6. NCD Deaths in Low- and Middle-Income Countries.....	9
Figure 7. Causes: Analytical Framework Based on the UK Foresight Project on Obesity 2007.....	12
Figure 8. Changes in Historic and Projected Composition of Human Diet and the Nutritional Value.....	15
Figure 9. FAO Food Price Index, 2008-2011 .....	16
Figure 10. Changes Overtime in Consumption of Calories from Fat .....	19
Figure 11. Food Availability in the USA 1910-2006 .....	21
Figure 12. Growth of Rural and Urban Populations in Developing and Developed Countries .....	23
Figure 13. Age Standardized Prevalence of Insufficient Physical Activity in Adults 15+ Years by WHO Region and World Bank Income Group, 2008.....	24
Figure 14. Scatter Plot of Age at First Marriage and Low Birth Weight by Region .....	34
Figure 15. The Double Burden of Malnutrition: Causes and Effects across the Life Course .....	43

#### **List of Boxes**

<b>Box 1. The Biological Relationship between Obesity, the Metabolic Syndrome, and NCDs.</b> Error! Bookmark not defined.	
<b>Box 2. Speculative Trading and Rising Food Prices .....</b>	<b>17</b>
<b>Box 3. Criticisms of the Food Pyramid Based Dietary Guidelines .....</b>	<b>25</b>
<b>Box 4. High Level Nutrition Coordination and Governance in Brazil.....</b>	<b>39</b>

## ACRONYMS AND ABBREVIATIONS

AAFP	American Academy of Family Physicians	IMF	International Monetary Fund
AAP	American Academy of Pediatrics	IOM	Institute of Medicine
ACP	American College of Physicians	IRS	Internal Revenue Service
AHA	American Heart Association	LACAs	Landscape Analysis Country Assessments
ANA	American Nurses Association	LBW	Low Birth Weight
BMI	Body Mass Index	LDCs	Least Developed Countries
BMR	Basal Metabolic Rate	LIFDCs	Low Income Food Deficit Countries
CAADP	Comprehensive Africa Agriculture Development Program	LMICs	Low and Middle Income Countries
CCTs	Conditional Cash Transfers	LNS	Lancet Nutrition Series
CFA	Comprehensive Framework for Action	MCU	Maternal and Child Undernutrition
CIT	Commodity Index Traders	MDGs	Millennium Development Goals
CMS	Centers for Medicare and Medicaid Services	NAFTA	North America Freed Trade Agreement
CONSEA	National Council on Food and Nutrition Security (Brazil)	NCDs	Non-communicable diseases
CSOs	Civil Society Organizations	NFSI	Nutrition Friendly Schools Initiative
CTs	Cash Transfers	NGOs	Nongovernmental Organizations
CVD	Cardio-Vascular Disease	NHD	Department for Nutrition in Health and Development
DPAS	Global Strategy on Diet, Physical Activity and Health	NPAN	National Plans of Action for Nutrition
DBM	Double Burden of Malnutrition	NSPs	Non-Starch Polysaccharides
FAO	Food and Agriculture Organization of the United Nations	OECD	Organization for Economic Co-Operation and Development
FDA	Food and Drug Administration	PA	Physical Activity
FOAD	Fetal Origins of Adult Disease Hypothesis	PCM	Protein Calorie Malnutrition
FPI	Food Price Index of the FAO	SAPs	Structural Adjustment Programs
GATT	General Agreement on Tariffs and Trade	SCOWT	Stunted Child Overweight Mother
GNP	Gross National Product	SES	Socioeconomic Status
GRAS	Generally Regulated as Safe	SUN	Scaling Up Nutrition
GSCI	Standard & Poor's Goldman Sachs Commodity Index	TEF	Thermic Effect of food
HAZ	Height for Age Z-Score	TTL	Task Team Leader
HDL-C	High-Density Lipoprotein Cholesterol	US\$	United States Dollar
HFCS	High-Fructose Corn Syrup	USDA	United States Department of Agriculture
HNP	World Bank Health, Nutrition and Population	WAZ	Weight for Age Z-Score
ICN	International Conference on Nutrition	WC	Waist Circumference
		WHA	World Health Assembly
		WHO	World Health Organization
		WHR	Waist-to-Hip Ratio
		WHZ	Weight for Height Z-Score
		WIC	Women, Infants and Children
		WTO	World Trade Organization

## GLOSSARY

Technical Term	Definition
<i>Acute phase proteins</i>	A class of proteins whose plasma concentrations increase or decrease in response to inflammation.
<i>Adiponectin</i>	A hormone produced by adipose (fat) tissue that influences the metabolism of lipids and glucose.
<i>Adiposity</i>	The quality or state of being fat.
<i>Atherogenic</i>	Tending to promote the formation of fatty plaques in the arteries.
<i>Atherosclerotic lesions</i>	A deposit or degenerative accumulation of lipid-containing plaques on the innermost layer of the wall of an artery.
<i>Chemokines</i>	Cytokines with various immuno-regulatory functions, including attracting white blood cells to sites of infection.
<i>Cortisol</i>	Known more formally as hydrocortisone, it is a steroid hormone that is released in response to stress and a low level of blood glucocorticoids.
<i>Cytokines</i>	Substances, such as interferon, interleukin, and growth factors, that are secreted by certain cells of the immune system and have an effect on other cells.
<i>Disaccharides</i>	Sugars whose molecules contain two monosaccharide residues.
<i>Dyslipidaemia</i>	High triglyceride and low LDL cholesterol levels in blood.
<i>Epigenetic</i>	Resulting from external rather than genetic influences.
<i>HDL cholesterol</i>	High-density lipoproteins, also known as the “good” cholesterol.
<i>Hydrolysis</i>	The chemical reaction of a compound with water, usually resulting in the formation of one or more new compounds.
<i>Hypercholesterolemia</i>	High blood cholesterol levels.
<i>Hyperglycaemia</i>	High blood sugar levels.
<i>Hypertension</i>	High blood pressure.
<i>Hypertriglyceridemia</i>	High blood levels of triglycerides, the most abundant fatty molecule in most organisms.
<i>Impaired glucose tolerance</i>	A pre-diabetic state of hyper-glycaemia that is associated with insulin resistance and increased risk of cardiovascular disease.
<i>Inflammatory state of obesity</i>	A low-grade, chronic inflammation orchestrated by metabolic cells in response to excess nutrients and energy
<i>Insulin resistance syndrome</i>	A name for a group of risk factors that occur together and increase the risk for coronary artery disease, stroke, and type 2 diabetes.
<i>Ischaemic heart disease</i>	A disease characterized by reduced blood supply to the heart.
<i>LDL cholesterol</i>	Low-density lipoproteins also known as the “bad” cholesterol.
<i>Leptin</i>	A protein hormone that plays a key role in regulating energy intake and energy expenditure.
<i>Metabolic syndrome</i>	Comprises a group of risk factors including abdominal obesity, dyslipidaemia, hypertension, and impaired glucose tolerance.
<i>Monosaccharide</i>	Sugars (e.g., glucose) that cannot be hydrolysed to give a simpler sugar.
<i>Myocardial infarction</i>	Irreversible injury to the heart muscle (heart attack).
<i>Obesogenic</i>	Factors tending to make individuals fat, such as environments that promote decreased physical activity and/or increased intake of energy dense foods.
<i>Pathophysiological</i>	Changes or alterations in function that accompany a particular syndrome or disease.
<i>Postprandial</i>	During or relating to the period after a meal.
<i>Stunting</i>	Excessively short, or below minus two standard deviations from median height for age of reference population.
<i>Underweight</i>	Below minus two standard deviations from median weight for age of reference population.
<i>Wasting</i>	Excessively thin, or below minus two standard deviations from median weight for height of reference population.
White adipocytes	White fat cells.
White adipose tissue	White fat.

## ACKNOWLEDGMENTS

Roger Shrimpton prepared this paper under the guidance of Claudia Rokx, Lead Health Specialist, ECSH1, and Leslie Elder, Senior Nutrition Specialist, HDNHE (World Bank). Puti Marzoeki, Senior Health Specialist, EASHH, and Darren Dorkin, Senior Operations Officer, EASHH (World Bank), provided overall support. The team is grateful for the valuable technical assistance from Sonia Blaney (UNICEF) and Rebekah Pinto (World Bank). Rosemary Esber and Andrea Spray edited the paper and developed the glossary and Christina Sukmawati formatted the paper.

Peer reviewers were Grahame Dixie, Senior Agribusiness Specialist, ARD (World Bank), Chizuru Nishida, Nutrition Policy and Scientific Advice Coordinator (WHO), and Philip James, President, International Association for the Study of Obesity (IASO).

The work was conducted under the sector management of Juan-Pablo Uribe and Toomas Palu for the East Asia Pacific Region (World Bank).

The authors are grateful to the World Bank for publishing this report as an HNP Discussion Paper. This work is financed by a grant from the Millennium Challenge Corporation under the Indonesia MCC Initiative. Dr. Shrimpton is Adjunct Professor at Tulane University where he teaches a course on the Double Burden of Malnutrition in the Masters in Public Health degree.

## EXECUTIVE SUMMARY

**The Double Burden of Malnutrition (DBM) is the coexistence of undernutrition and overnutrition in the same population across the life course.** Indeed, most governments have populations that are subject to both nutrient “excesses” and “deficiencies,” and therefore need to plan and implement programs to reduce their prevalence. The DBM concept also recognizes that undernutrition early in the life course contributes to an increased propensity for overnutrition in adulthood.

**The DBM affects all countries, rich and poor.** At the population level, women are most affected by the DBM; most countries have more overweight than underweight women. The prevalence of DBM at the household level, with stunted children coexisting with overweight/obese women, is generally below 10 percent and is mostly commonly found in Latin American countries. At the individual level, the most common form of DBM seems to be energy overnutrition and iron deficiency, a combination that is found even in the United States. Definitions of overweight and obesity are defined based on their relationship with risk of diseases. The risk of mortality and morbidity increases considerably above a Body Mass Index (BMI) of 25. The risk varies by region, however, it may increase among Asians with a BMI as low as 21. These variations indicate that the risks of cardiovascular diseases are associated with a much more invisible type of “fatness” in Asian populations. Visceral or abdominal obesity, best measured by waist circumference, is of particular concern with regard to the development of insulin resistance or type 2 diabetes.

**The consequences of the DBM are enormous.** Early life undernutrition is an underlying cause associated with about a third of young child deaths. Among the survivors that become stunted in the first two years of life, their capacity to resist disease, to carry out physical work, to study and progress in school, are all impaired across the life course. Later in the life course, diet and nutrition, and especially obesity, are important underlying causes of many non-communicable diseases (NCDs), including hypertension, diabetes, cancer, stroke, and ischemic heart disease. NCDs are responsible for the majority of deaths worldwide and are disproportionately high in LMICs where nearly 80 percent of NCD deaths occur. Nearly half of NCD deaths in 2008 were caused by cardiovascular disease (CVD). The metabolic syndrome, in which abdominal obesity and type 2 diabetes play a central role, is associated with a doubling of cardiovascular disease risk. The costs of treating the metabolic syndrome are considerable and growing, consuming increasingly larger proportions of health budgets in both LMICs, and higher income countries.

**The causes of the DBM are related to a series of changes in the world called the *nutrition transition*,** which is preceded by countries’ *demographic transition* and the *epidemiological transition*. A similar transition, called the “*secular trend*,” has occurred at a more leisurely pace during the last two centuries in the rich or “developed” countries, causing *inter-generational* increases in height of about 1cm a decade. In the last two decades, and especially in the more prosperous LMICs, this process of change seems to have speeded up due to the global obesity epidemic, and is now occurring in most LMICs as *intra-generational* changes. The variables associated with the nutrition transition and obesity epidemic can be grouped into the following four crosscutting themes:

- 1) **The Health/Biological Environment.** The global population has tripled in the last five decades, accompanied by the *demographic transition* with falling fertility and populations getting older, and associated with an *epidemiological transition* as NCDs replace infectious diseases as the main cause of death. Increasing proportions of those that survive constrained fetal and young child growth have increased potential for overweight, obesity, and diabetes in later life, with a greater risk of CVD. This so-called “*metabolic programming*” or “*thrifty phenotype*” phenomenon seems especially common in Asians. The *food transition* described below also means that people with constrained early child growth are more likely to accumulate fat later in

the life course, especially if they find themselves in a more “obesogenic” environment. Appetite mechanisms that evolved for low energy density foods during hunter-gatherer times are overwhelmed with the high energy density “processed foods” common in the modern western diet, especially when they are eaten frequently as “snacks.” Furthermore, these appetite mechanisms seem to be based in fat deposits, which try to maintain such reserves once created, making weight loss a challenge.

- 2) **The Economic/Food Environment.** Incredible increases in individual wealth and food production has occurred in a short period. Global economic activity grew fifty times and individual wealth ten times in the last century. Food production grew 20 percent more than population growth, largely due to the “*green revolution*” together with the industrialization and globalization of the food chain. With global trade in food now amounting to 10 percent of all global trade, consumption patterns are becoming increasingly “westernized” across the globe. A third of the total cereal production is now used to feed livestock, with meat and milk consumption doubling in LMICS in the three decades to 2000. The vast majority (around 80 percent) of the global population is reliant on just four staple foods, namely wheat, rice, maize, and potatoes, which are transformed into thousands of processed foods, the majority of which can be eaten directly or with little preparation. The saturated fat and refined sugar content of processed foods makes them considerably more “obesogenic” than unprocessed foods. This *food transition*, whereby an increasing proportion of the diet comes from animal and/or “ultra-processed” foods, is being accelerated by a radical change in the global food marketing and distribution system, led by supermarket chains penetrating into LMICs. Trade liberalization through WTO has facilitated these changes, while allowing subsidies in the EU and USA to keep processed food prices low. LMICs, and especially the food dependent ones, are most affected by the recent hikes in food prices, however, and processed food consumption is more likely to increase as a consequence. In the industrialized countries, obesity is a disease of poverty in part because “healthy diets” are the most expensive. Many now question the efficiency of the current global food system, which is not only harmful in terms of its health effects, but also negatively impacts on global warming and the sustainability of development.
- 3) **The Physical/Built Environment.** These factors influence individual behavior, as well as the type, frequency, and intensity of activity. Already a half of the global population is urban. With urbanization, people expend less energy at work and in the home. They are also increasingly away from their home and dependent on purchasing their food either in the street or in a restaurant, which is likely to be ultra-processed and easy to prepare/consume. Space to exercise by walking, biking or playing games may be difficult to find, especially in the poorer urban districts.
- 4) **The Socio/Cultural Environment.** The media, education, peer pressure and culture all influence a person’s individual drive for particular foods and consumption patterns, or physical activity patterns or preferences. In rural areas, cultural practices still favor child marriage in many countries, thus contributing to the maintenance of child stunting levels. In urban areas, girls are more likely to finish school and marry later. However, children are increasingly passive in their leisure time, especially watching TV and playing computer games. The food industry spends US\$40 billion a year on advertising, most of which promotes the consumption of ultra-processed foods. Transnational soft drink and fast food companies extensively market their products worldwide, especially to children and youths.

**The solutions for the DBM problems are reasonably well recognized for each of its parts: undernutrition and overnutrition. But the solutions have not been coordinated into an overarching policy and program framework.** The principal body that provides policy guidance for programs is the World Health Assembly (WHA) of the World Health Organization (WHO). Normative policy guidance in food safety is provided jointly by WHO and FAO through the Codex Alimentarius Commission. The WHO has made numerous policy recommendations for maternal and child undernutrition, albeit split up by nutrient and/or intervention focus, with recommendations on breastfeeding, complementary feeding, and anemia control, for example. There are also policy recommendations on nutrient intake and physical activity, with agreed goals for nations to pursue with regard to overnutrition. Internationally agreed action plans also exist for reducing NCDs, but these include obesity as a risk factor not as an NCD. Most recently, the WHA has urged all member states to scale up programs to control malnutrition in all of its forms.

**While many countries have policies for undernutrition and overnutrition, as well as for diet-related non-communicable diseases, far less common are adequately funded large-scale programs for these conditions.** The provision of program guidance for the DBM is again extremely fragmented, with no overarching framework guiding implementation. The growing global movement to Scale Up Nutrition (SUN) aims to help LMICs improve and increase nutrition programs to reduce maternal and child undernutrition. Over time, the SUN movement should be built upon and strengthened to include nutrition program elements to reduce the DBM across the life course. Reducing maternal and child undernutrition (MCU) is the first step in preventing the DBM. This paper proposes a framework that describes the evidence-based direct and indirect program interventions for overnutrition and undernutrition at different stages of the life course. The interventions include those to be delivered directly through the health service, through the education system, in the workplace, and indirectly through fiscal policies and financial incentives.

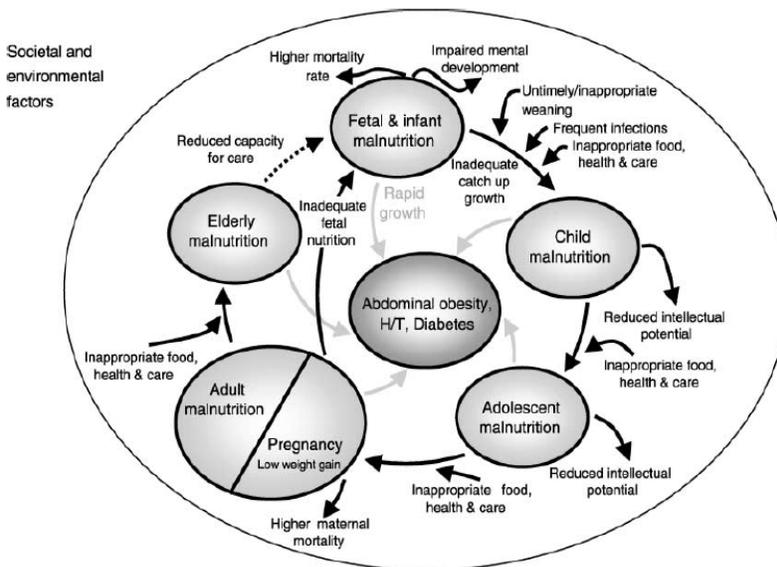
**Most countries have limited capacity to deliver the wide variety of interventions necessary to reduce the DBM or the governance mechanisms for coordinating effective multisectoral programs.** The capacity to implement nutrition interventions is very limited in most LMICs. Moreover, the existing capacity is generally restricted to undernutrition programs implemented through the health service. The SUN movement's recommended nutrition programming and other nutrition programming necessary to reduce the DBM across the life cycle require a multisectoral approach. To implement those programs successfully, a high-level coordination mechanism needs to be established with the capacity to allocate budgets to critical sectors. Nutrition governance mechanisms may exist in some LMICs, but few if any of them provide for approving budgets and wielding any real authority. No country seems to have established governance mechanisms for nutrition that cover the DBM and include all necessary aspects, including food security, food safety, nutrition, and diet-related communicable diseases. The SUN framework, which calls for a coordinated, multi-stakeholder approach, with true country ownership, one policy framework, and one national coordinating body, needs to be consolidated over time to reduce the DBM in LMICs. A nutrition policy framework for the DBM is described in this paper, realizing that it will take time and effort for a country to achieve this level of multisectoral organizational complexity.

## PART I. INTRODUCTION

The double burden of malnutrition (DBM) concept first emerged in 1992 at the International Conference on Nutrition (ICN) held by the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO). The DBM was presented as a “new paradigm,” recognizing that separating the treatment and/or prevention of nutritional deficiencies and excesses was no longer sensible, given that most countries were dealing with both problems simultaneously.

Moreover, new evidence suggested that maternal and fetal undernutrition increased susceptibility to overnutrition and diet-related non-communicable diseases (NCDs) in adulthood. Consequently, the understanding of the causal links to obesity evolved to reflect the double burden causality across the “life course” (Darnton-Hill et al 2004) (Figure 1).

Figure 1. Lifecycle: Proposed Causal Links



Source: Darnton-Hill et al 2004

nutrition, but to review the global literature about the phenomenon of their coexistence.

In November 2002, the World Bank and the WHO organized an expert consultation workshop regarding the food policy options to prevent and control nutrition-related NCDs (World Bank, 2002). The purpose of the workshop was to explore how food policy changes could contribute to the prevention and control of nutrition-related NCDs, to identify research priorities, and to inform an agenda for further action. This paper makes a clear case for public action, especially in food policy, and raises the moral imperative for “warning” developing countries about the consequences of an accelerated introduction of a Western-type diet. From the mid-19<sup>th</sup> century through the 1950s, when the consumption of the Western-type diet<sup>1</sup> increased, accompanied by industrialization, it evolved without a full

<sup>1</sup> Western-type diet is often defined as a diet high in saturated fats, red meats, “empty” carbohydrates—junk food—and low in fresh fruits and vegetables, whole grains, seafood, and poultry. The Western diet has been linked to hypertension, heart disease, hypercholesterolaemia, diabetes, obesity, and colorectal cancer (medical dictionary).

Twenty years later, the magnitude of the global DBM problem continues to increase, with few examples of the trend reversing or even reducing. Because the DBM is linked to the burgeoning NCD problem threatening all low- and middle-income countries (LMICs), public health practitioners have called for countries to respond to the DBM as “a common agenda.”

This paper assesses the global evidence for the DBM. It is part of an ongoing effort to raise the awareness about the DBM and its consequences, as well as the rapid increase in the number of people affected. The intention is not to present new data on the existence of either undernutrition or over

understanding of the diet's consequences on human health. Now, the consequences of the Western diet are very well known and cannot be ignored, nor can the perils of adopting the Western diet in the developing world. The findings and recommendations of the 2002 workshop were adopted into the Global Strategy on Diet, Physical Activity, and Health.

**A decade after the 2002 workshop, this background paper updates food policy by expanding options and following a multisectoral framework.** It is intended to build on the 2002 recommendations and further develop a research agenda on nutrition-related NCDs, which continues to be very limited. This paper goes beyond the 2002 paper by highlighting the lack of necessary capacity to raising awareness and the need for prevention in developing countries to further the nutrition agenda.

**An Indonesia-specific paper on the DBM, produced under the same initiative as this paper and by the same team, identified concrete nutrition interventions for Indonesia.** A number of policy options, requiring multisectoral collaboration, were identified and are being considered for piloting in the cities of Jakarta and Surabaya. As a first step towards future evaluation, the fiscal implications of the DBM for these cities would be estimated.

The intended audience for this research, in addition to the World Bank, includes policy and decision makers, academics and government technical staff and other institutions from a broad range of backgrounds and sectors.

**This report specifically will address the following questions:**

- Twenty years later, what more do we know about the DBM?
- What exactly is the DBM, and how can we measure it?
- What are the causes of the DBM?
- Who is most affected by the DBM, and what are its consequences?
- How do we prevent and mitigate the consequences?
- What capacity is necessary to address the DBM problem?

**This paper does not attempt to provide an exhaustive and systematic review of all new information and evidence, given that new information is issued almost daily.** Nevertheless, this paper reflects the relevant literature to date. As the DBM is an emerging phenomenon, our understanding is rapidly evolving. Also, a large part of the literature on obesity and overweight comes from developed countries, which may potentially limit the extent to which it can be generalized to the LMIC context. However, at the same time, the discussion may also serve as a warning to LMIC and provide ideas for their governments to avoid the growing problems with the DBM. The many technical terms in this paper and their definitions and/ or explanations can be found in the glossary.

## PART II. WHAT IS THE DOUBLE BURDEN OF MALNUTRITION?

**The double burden of malnutrition (DBM) is undernutrition, including micronutrient deficiencies, coexisting with overnutrition: overweight and obesity.** Malnutrition refers to nutritional excesses of macronutrients and micronutrients as well as deficiencies (WHO 1995). Undernutrition is the result of insufficient intake, poor absorption, and/or poor biological use of the nutrients. This can result in impaired body functions, impaired growth, and underweight. Overnutrition is the result of excess or imbalanced nutrient intakes, which can result in impaired body functions, as well as overweight and/or obesity. The individual suffers negative consequences from either form of malnutrition, but so does the nation's economy due to lost GDP and higher health care costs.

**The DBM occurs in populations, households, and individuals.** At the global level, while 17 percent of preschool children are underweight, 33 percent suffer from iodine deficiency, 40 percent of women of reproductive age have anemia (UNSCN 2010), while already 25 percent of the global population is overweight (Finuncane et al. 2011). Nutritional insults such as low birth weight, underweight, and stunting (low height for age) during critical periods of fetal and young child development produce lifelong consequences (Tanner 1978). These consequences include the decreased likelihood of finishing school and reduced economic activity later in the life course (Victora et al 2008). It is increasingly recognized that constrained growth early in life is linked to increased risk of overweight and obesity later in life in an environment where food availability is not constrained (Barker 1998).

**This report merges research from undernutrition and overnutrition into a continuum.** Undernutrition and overnutrition are complex problems with complex causes and consequences. The following section presents the key concepts that will be referred to in the remainder of the report.

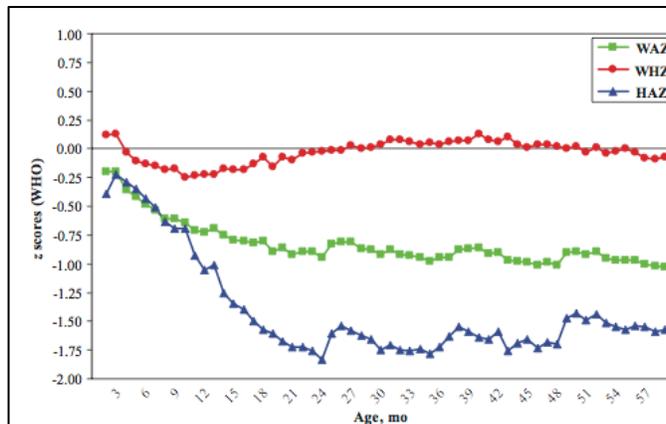
### DBM Key Concepts and Indicators

**Malnutrition refers to nutritional excesses as well as deficiencies (WHO 1995).** For many decades, the term “malnutrition” has commonly but wrongly been used to mean undernutrition. This misnomer derives from the focus of early nutrition research on determining the causes of protein calorie malnutrition (PCM), as child undernutrition was then called (Waterlow 1972). The WHO has used the term “malnutrition in all of its forms” for the last two decades.

- **Undernutrition** is the result of insufficient intake, poor absorption, and/or poor biological use of the nutrients, which can result in impaired body functions, impaired growth, and underweight.
- **Growth faltering.** Adult height is largely determined by two years of age, and is therefore a reflection of nutritional status during this early period—the first 1,000 days of life (Figure 2). Brain growth during this critical “window of opportunity” is compromised by both maternal and child undernutrition. Average child height growth after the second year of age is the same in all populations. Therefore, differences in child growth across populations are primarily due to environmental differences rather than genetic ones.
- **Micronutrient malnutrition** is the result of insufficient intake and or absorption of crucial micronutrients, such as Vitamin A, iron, iodine, and zinc, which can contribute to life-threatening conditions.
- **Overnutrition** is the result of excess or imbalanced nutrient intake, which can result in impaired body functions as well as overweight and/or obesity.
- **Obesity** is a disease associated with impaired functions related to alterations in the metabolism of steroid hormones, metabolic alterations including lipid and glucose levels, and increases in the turnover of free fatty acids that lead to insulin resistance syndrome (Seidell et al 1994, Turcato et al 2000, Rose et al 2002 and Eckel et al 2002). In addition, excess fattiness has been linked to impaired immune function as a result of increased *cortisol secretion*, a steroid hormone released in response to environmental and psychological stress (Stallone 1994).

The WHO recommended bodyweight classifications include degrees of underweight and gradations of excess weight or overweight that are associated with increased risk of some non-communicable diseases (WHO 2000). Nutritional status is most commonly measured by anthropometry in comparison to international growth standards, for example, stunting (height-for-age), wasting (weight-for-height), underweight (weight-for-age) for infants and children, and body mass index (BMI) for adults. Classifications for undernutrition are calculated as z-scores with cut-off of  $<-2$  z considered moderate and  $<-3$  z severe stunting, underweight or wasting respectively.

Figure 2. Growth Faltering in Young Children



Source: Victora et al (2010).

There is considerable debate over which indicator is best to use in what context. For example, the Millennium Development Goals (MDGs) are measured in terms of underweight, which is believed to be a reflection of overall nutritional status, although stunting is believed to be a better reflection of long-term undernutrition and reflects growth faltering. There has also been debate over the appropriate reference group to use in international standards. The original reference group derived from babies in the United States. In 2006, the WHO issued new growth standards calculated from samples derived from diverse ethnicities, which adopted recommended practices, such as breastfeeding and no smoking.

The classifications for overnutrition are calculated as weight in kilograms divided by height in meters squared ( $\text{kg}/\text{m}^2$ ). The proposed BMI cut-off points were overweight grade 1: 25.0–29.9  $\text{kg}/\text{m}^2$ , overweight grade 2: 30.0–39.9  $\text{kg}/\text{m}^2$ , and overweight grade 3:  $>40.0$   $\text{kg}/\text{m}^2$ . Although these are the most widely used categories for overweight and obesity, there have been some modifications in recent years. In 1997, a WHO expert consultation proposed an additional subdivision at a BMI of 35.0–39.9  $\text{kg}/\text{m}^2$ , recognizing that the options for managing obesity differ above a BMI of 35  $\text{kg}/\text{m}^2$ .

The indicators and cut-offs used for defining overweight/obesity and predicting the risk of cardiovascular disease in LMICs may need to be further revised. The waist-to-hip ratio (WHR) was found to be better than BMI for predicting the risk of type 2 diabetes in the Taiwanese population (Cheng et al 2010). Studies in Kerala, India have revealed that while only a third of the population was overweight, at least a half had *dyslipidaemia*, and that *anthropometric* measures like BMI and waist circumference were only modest in predicting biochemical risk factors of non-communicable diseases (NCDs) (Thankappan et al 2010). There is emerging evidence to support the recognition of lower BMI cut-offs for populations that had very high stunting levels over the past decades (see next section).

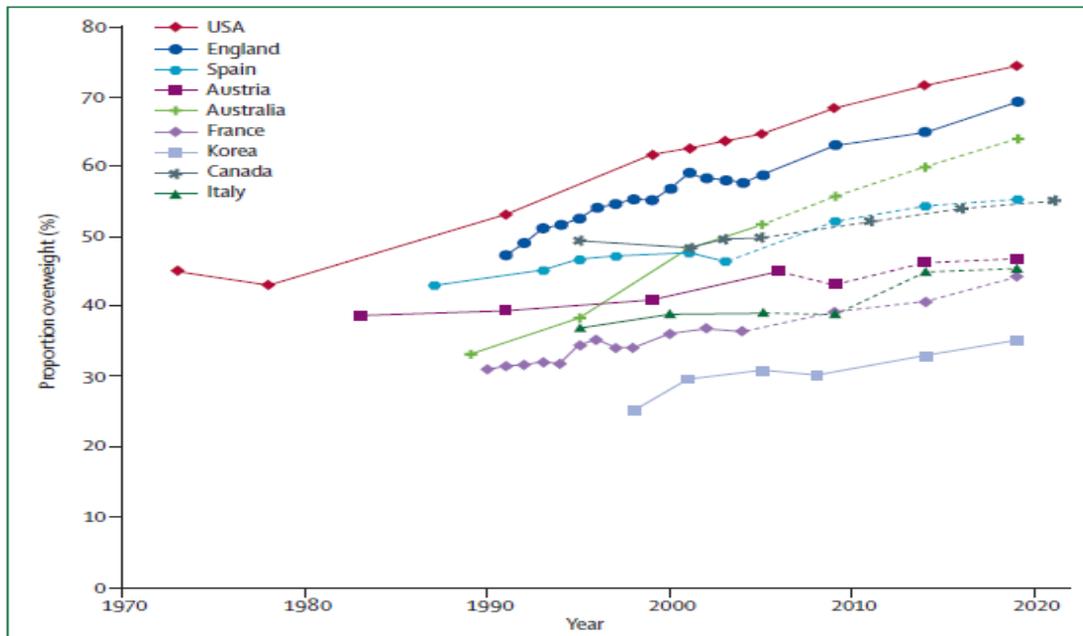
For LMICs in rapid transition, calf *anthropometry* may be a better predictor of cardiovascular risk (Sivasankaran et al 2011). A review of the literature concerning the appropriateness of indicators for defining excess body weight found that measures of *central obesity* were more strongly associated with diabetes than was BMI. This was not the case for hypertension and *dyslipidaemia*, however, which were similar for BMI, waist circumference (WC), and WHR (Huxley et al 2010). Further research and development is needed to improve the effectiveness of indicators for monitoring the increased risks for NCDs.

## PART III. WHO DOES THE DOUBLE BURDEN OF MALNUTRITION AFFECT MOST?

**Undernutrition is not only a phenomenon of low- and middle-income countries (LMICS), and overnutrition is not just a rich country's problem. DBM affects all countries.** Currently, 25 percent of the global population is overweight (Finuncane et al 2011). About one-third of the population still suffers from iodine deficiency, 40 percent of women of reproductive age have anemia, and 17 percent of preschool children are underweight (UNSCN 2010). Often these conditions occur at the same time in the same population, in the same household, and even in the same individual. At present, overnutrition and undernutrition coexist in most countries (Gillespie and Haddad 2001, FAO 2006).

**Furthermore, in most LMICS, overweight seems to be increasing faster than underweight decreases (Popkin, 2001).** In most developed countries over the last century, final adult height has increased by approximately one centimeter per decade (Malina 2004). However, the *secular trend* has ceased in the United States with adult height now decreasing (Komlos and Baur 2004), and the population going from being the tallest in the world to being among the most overweight (Komlos and Lauerdale 2007). The obesity epidemic has developed only recently in industrialized countries. Rates of obesity were generally well below 10 percent prior to 1980. Since then, rates have doubled or tripled in many countries, and in almost half of OECD countries, 50 percent or more of the population is overweight (Figure 3).

**Figure 3. Past and Projected Prevalence of Overweight (BMI > 25kg/m<sup>2</sup>) in Selected OECD Countries**

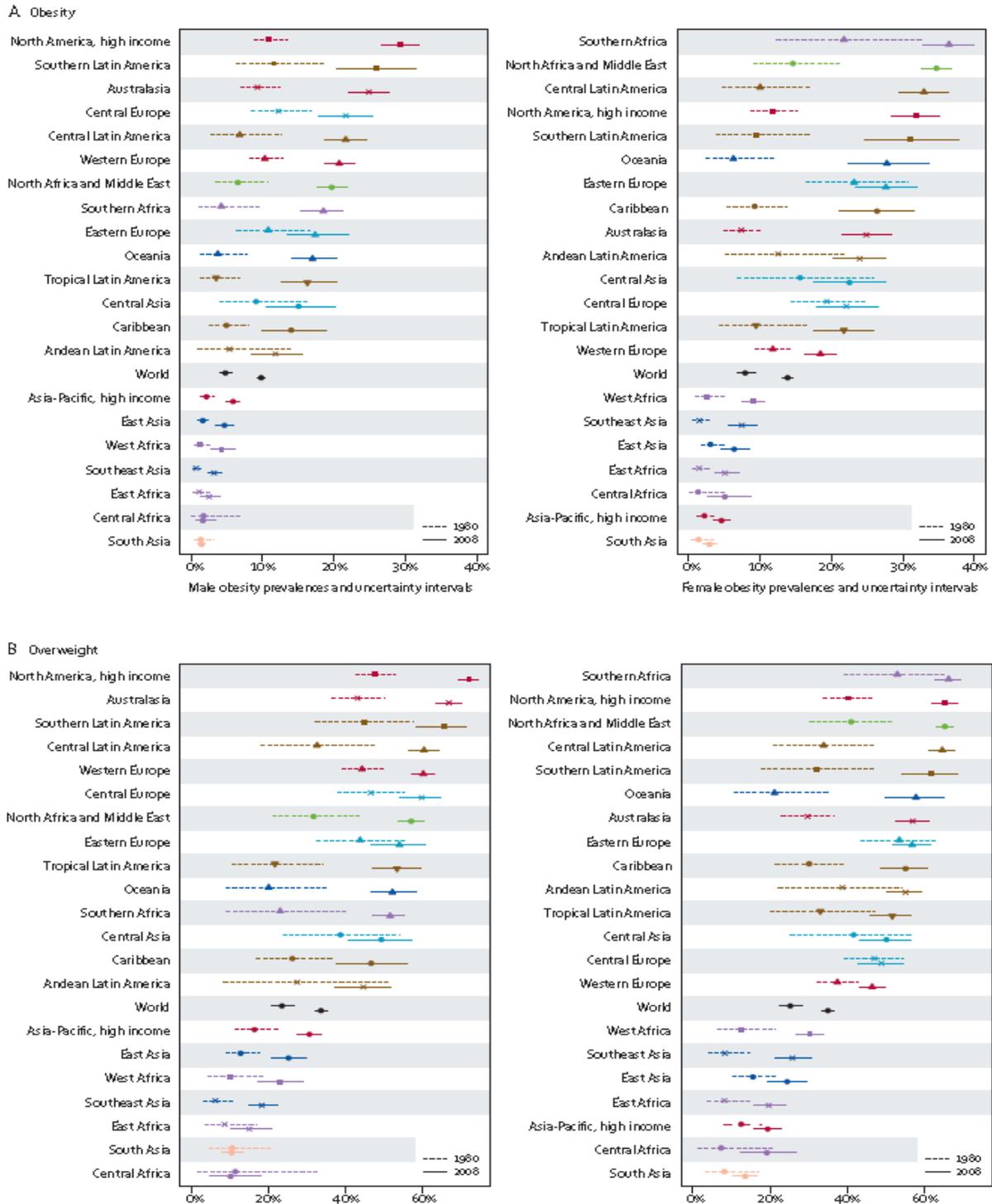


Source: Sassi 2011.

**While globally, obesity has doubled in the last three decades, it has tripled in LMICS in just two decades (WHO 2011).** Figures 4 A and B illustrate the rapid increase in obesity, BMI > 30, and

overweight in the WHO-defined regions, including where fast-growing LMICs are located (Finucane 2011).

**Figure 4. Prevalence of Obesity (BMI>30) and Overweight (BMI>25) in Adult Males and Females in 1980 and 2008**



Source: Finucane 2011

**At the population level, the DBM is most commonly found among women.** The proportion of overweight women exceeds the proportion of underweight women in most developing countries, in urban and rural populations (Mendez et al 2005). Furthermore, as national income increases, the burden of obesity tends to shift towards lower socioeconomic groups, with this shift occurring at a lower level of income for women than men (Monteiro et al 2004). The crossover to higher rates of obesity than of underweight among women of low socioeconomic status (SES) groups is found at a GNP per capita of about US\$2,500, the mid-point value for LMICs.

**In high-income countries, obesity is more common in the lower socioeconomic strata of society, while in LMICS, it remains concentrated in higher income groups.** A decade ago, obesity in women was considered to be a serious problem in all regions of the world, except Sub-Saharan Africa, China, and South Asia (Martorell et al 2000). Although the prevalence of underweight among women of reproductive age has remained high in Bangladesh, Nepal, and India, the prevalence of overweight and obesity increased in all three countries from 1996 to 2006. In India 10.6-14.8%, Nepal 1.6-10.1%, Bangladesh 2.7-8.9%. (Balarajin and Villamour 2009). Across 54 LMICs, higher BMI (using the >25 BMI cut-off) and overweight in women remains concentrated in higher socioeconomic groups, but is growing rapidly (Subramanien et al 2011).

**Recently, most Asians living in Asia have been found to have more body fat than Caucasians with the same body mass index (BMI).** The associated health risks at the same BMI are greater in Asians than in Caucasians (WHO 2004). Due to the higher associated health risk, the cut-off for defining overweight and obesity for Asian populations is 23 kg/m<sup>2</sup> for overweight and 27 kg/m<sup>2</sup> for obesity, respectively (WHO 2004). More recent work suggests the BMI cut-off for overweight in the Asia Pacific region should be  $\geq 21$  (Lee et al 2011). At the same time, the highest number of stunted children also live in Asia.

**The coexistence of maternal overnutrition and child undernutrition in the same household was observed three decades ago.** Adult overweight and child underweight were first shown to coexist in the same households in Brazil (11 percent), China (8 percent), and even Russia (6 percent) (Doak et al 2000). Studies during the seventies in Manaus in the Brazilian Amazon found 60 percent stunting in preschool children, as well as 60 percent maternal anemia (Giugliano et al 1978), together with 30 percent maternal overweight/obesity (Shrimpton 1979). A national food and nutrition survey in Guiana in 1976 found 60 percent of preschool children to be underweight, while 60 percent of mothers were overweight/obese (PAHO 1976). The 36 countries where both maternal undernutrition and overnutrition occur in the same country also have high rates of child stunting (>20 percent). In fact, these countries make up 90 percent of the global burden of child stunting, occurring at the same time as high levels of obesity.

## PART IV. WHAT ARE THE CONSEQUENCES OF THE DOUBLE BURDEN OF MALNUTRITION?

The problems associated with the double burden of malnutrition are considerable, and many are manifest across the life course. Undernutrition has long been a concern. Now, a rising concern for LMICs is the impact of early undernutrition on metabolic programming or Fetal Origin of Adult Disease (FOAD). Metabolic programming is the phenomenon whereby the unborn fetus adapts to a nutrition deficient environment because of the mother's malnutrition. This may become problematic when the child grows up in a food-abundant or obesogenic environment as this mismatch can lead to obesity and NCDs, which already account for most of the mortality in LMICs. As such, the DBM is both a consequence of early undernutrition and a cause for other diseases. This section reviews the current knowledge about the consequences of the DBM, encompassing the consequences of undernutrition, overnutrition, and the combination of undernutrition and overnutrition.

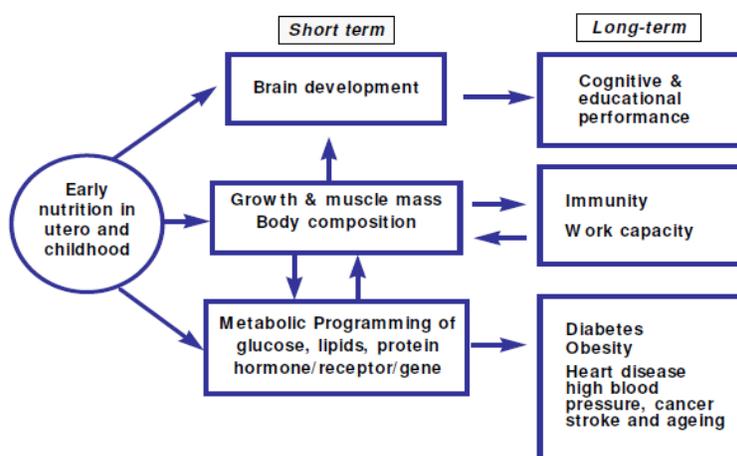
In the short-term, maternal and child undernutrition are estimated to be associated with between a half (Ezzati et al 2004) and a third (Black et al 2008) of global child deaths. The contribution of undernutrition to child mortality varies by disease, being highest for diarrheal diseases (73 percent), and close to half for pneumonia, measles, and severe neonatal infections (Mathers et al 2009). As countries develop and progress, the household environment improves through better water and sanitation, and reduced indoor household smoke exposure. Additionally, due to increased vaccine coverage, more infants will survive beyond their first year, despite having suffered undernutrition.

For those infants that survive, undernutrition's damage during early life carries across the life course (see Figure 5). Final adult height, which is largely determined by age two, reflects the nutrition quality during the early period of life (Victora et al 2010). Children's height at two years of age is considered the best indicator of the quality of a nation's future human capital. Maternal and child undernutrition in early life compromise brain growth, resulting in a child's decreased likelihood of finishing school and reduced economic success later in life (Victora et al 2008).

The costs of child undernutrition in the Asia region were estimated at 2 or 3 percent of GDP based on conservative assumptions related only to lost productivity (Horton 1999). Earlier work suggesting

that half of the economic growth of the United Kingdom between 1800 and 1980 is attributable to the improved nutrition of the workforce could be a conservative estimate, as the author claimed (Fogel 2004).

**Figure 5. The Short-Term and Long-Term Effects of Early Nutrition**

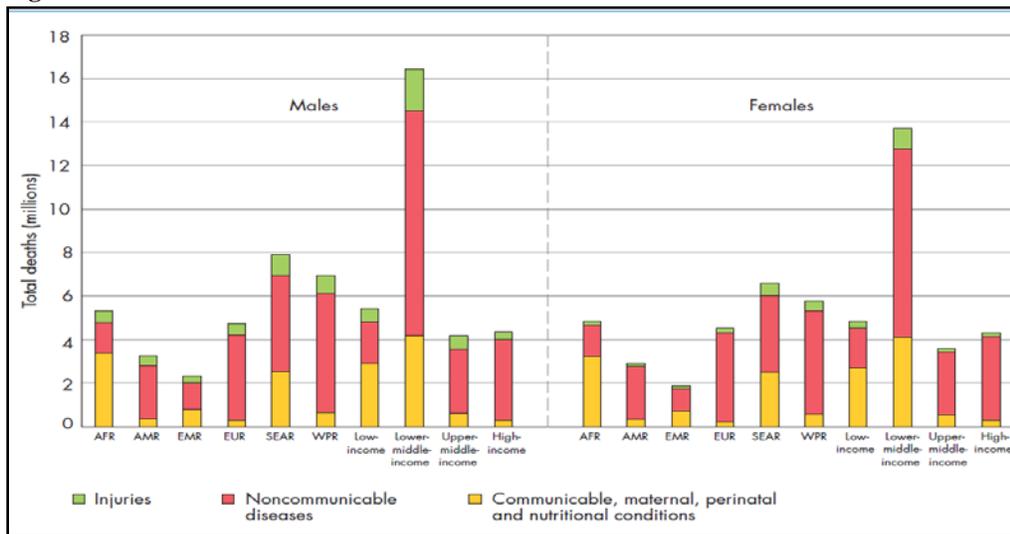


Source: James et al 2000.

**Constrained fetal growth produces increased risk for NCDs later in life (see Figure6),** based on the fetal origin of adult disease (FOAD) hypothesis. This theory, supported by research, asserts that biological processes in the human body enable the unborn fetus to adapt to the expected environment outside the womb. If a child is born from a mother who did not have an adequate diet

while pregnant, the baby may have programmed him/herself for life to such an environment.

**Figure 6. NCD Deaths in Low- and Middle-Income Countries**



Source: WHO 2011

The implications of FOAD are that the body would continue to expect a nutrient deficient environment and cope differently than a child born with a sufficiently nourished mother when confronted with a nutrient sufficient—and nowadays even abundant environment—a so-called obesogenic environment. This altered adaptation may lead a child to overweight, obesity and diabetes in later life. The double burden results from a mismatch between the environment of the womb and that of the world outside.

**Obesity is a disease. Fundamentally, obesity is a problem of energy imbalance, which only develops when energy (food) intake exceeds total energy expenditure.** The mismatch between the fetal period and later life food environments accentuates this imbalance. Differences between energy intake and expenditure are primarily buffered by changes in the amount of fat deposited. These fat deposits around the abdomen are the source of hormones that play an important role in the regulation of energy balance. Inflammation-related proteins are also released by fat cells. The inflammatory state of obesity is believed to play a key causal role in the development of type 2 diabetes and the metabolic syndrome (see Box 1) (Trayhurn 2007).

**Overweight and obesity (diet and nutrition) are important underlying causes of the metabolic syndrome and NCDs (WHO 2003).** NCDs were responsible for 63 percent of the 57 million deaths that occurred worldwide during 2008. They are disproportionately high in LMICs, where nearly 80 percent of NCD deaths occurred (Figure 6) (WHO 2011). The leading causes of NCD deaths in 2008 were cardiovascular disease (48 percent), cancers (21 percent), respiratory diseases (12 percent), and diabetes (4 percent). Furthermore, 44 percent of all NCD deaths occurred before the age of 70, and in LMICS, this ratio was higher (48 percent) than in high-income countries (26 percent). In 2008, the highest proportion of NCD deaths among people under age 70 was attributable to cardiovascular diseases (39 percent), followed by cancers (27 percent). Chronic respiratory disease, digestive diseases, and other NCDs were together responsible for approximately 30 percent of deaths, and diabetes was responsible for 4 percent. As populations in LMICS age and longevity increases, NCD deaths are projected to increase and will become the most dominant cause of mortality in most countries by 2030.

## **The Potential Costs of the Long-Term Effects of DBM**

**The costs of treating the metabolic syndrome are considerable and growing, even in LMICS.** A decade ago, the cost of treating CVD in South Africa was already eating up to 25 percent of all health care spending (2-3 percent of GDP) (Pestana et al 1996). Few LMICS have data on the metabolic syndrome; more data on the costs of the various components of the metabolic syndrome is available in rich countries, such as the United States. The metabolic syndrome was present in almost half of a population-based study of the elderly in the United States (Curtis et al 2007), and the total costs to Medicare were 20 percent higher among participants with the metabolic syndrome.

**Across the whole US population, overweight and obesity costs were recently estimated to be \$147 billion or 9.1 percent of health care expenditures (Finkelstein et al 2009), and hypertension cost US\$109 billion a decade ago (Hodgson and Cai 2001).** The total cost of diabetes in the United States in 2007, after factoring in the additional costs of undiagnosed diabetes, pre-diabetes, and gestational diabetes was estimated at US\$218 billion (American Diabetic Association 2008). The direct and indirect costs of CVD in the US were estimated at US\$368 billion in 2004 (American Heart Association 2003), with 1 in 3 adults having CVD, and 36.3 percent of all deaths having CVD as the leading cause of death among men and women in 2008 (Rosamund et al 2008). Health expenditures continue to outpace economic growth in most OECD countries, with medical costs accounting for almost 20 percent of GDP in the United States, far higher than any other nation (OECD 2011).

**The World Economic Forum suggests that NCDs will cost more than US\$30 trillion globally over the next 20 years.** This would represent 48 percent of global GDP in 2010 and push millions of people below the poverty line (Bloom et al 2011). Together with the cost of undernutrition, these costs represent an important percentage of any country's GDP. Moreover, it is a fast growing and unnecessary cost.

## PART V. WHAT ARE THE CAUSES OF THE DOUBLE BURDEN OF MALNUTRITION?

The DBM's underlying causes are related to a series of historic changes affecting societies. These changes are known as the *nutrition transition* (Popkin, 1998), *the demographic transition*, and *the epidemiological transition*." People have gone from being hunters and gatherers to sedentary consumers. High fertility and early death are being replaced by low fertility and aging populations. Communicable disease burdens are being overtaken by non-communicable disease burdens.

The world's population is also growing in numbers. It has grown in height as well, and now, it is growing in size. Over the last century, final adult height increased by approximately 1 cm per year in most developed countries. In some countries, such as the United States, this trend is being replaced by a growth in the width of its population. In most countries, obesity rates are increasing, and in almost half of OECD countries, 50 percent of the population is now overweight. For LMICs, this is becoming the pattern as well.

### Nutrition, Demographic, and Epidemiological Transition

Two centuries after the industrial revolution began, the global population has sky rocketed. The world's population was less than one billion for most of the last ten thousand years, since man first relied on farming for food. Only in the last two hundred years with the industrial revolution did the global population begin to increase rapidly and pass one billion. From two billion in 1950, the world population more than doubled to 7 billion in 2011. It is projected to reach nine billion before plateauing in 2050 (UNFPA 2011). The majority of the global population is located in Asia and Africa, and this is where all of the projected population growth will occur over the next four decades.

Underlying the massive increase of the global population has been a corresponding change in its composition. As countries develop from a pre-industrial to an industrialized economic system, along with improvements in hygiene, sanitation, and increased access to health services, there is a demographic transition from high birth and death rates to low birth and death rates. As a result, the average global family size has declined by half since 1950, and the proportion of older persons relative to the rest of the population has increased considerably. Projections are that by the year 2050, 25 percent of the global population will be aged 60 or over. Although fertility rates in the developing countries as a whole were reduced from 5 in the seventies to less than 3 today, it was still 4.8 in the LDCs in 2005, and in the LDCs of Sub-Saharan Africa it was 5.8 (UN Population Division 2009). Both the overall population growth and its composition changes have major implications for food consumption, production and distribution, driving important policy decisions regarding quantity, type, and quality of food.

Because of the *epidemiological transition*, more children survive to reach adulthood and adults live longer. Improvements in environmental factors, such as hygiene and sanitation, and indoor household smoke exposure, and access to health services (for example, immunization coverage), are driving the replacement of infectious diseases by non-communicable diseases (NCDs) as the most common cause of disability and mortality. NCDs occurring later in the life course emerge as the more common cause of morbidity and mortality, for example, cancer and cardiovascular diseases.

### DBM Causality and Conceptual Framework

Understanding the causality of DBM is not an easy task (Ben-Shlomo and Kuh 2002). The conceptual framework proposed by UNICEF in 1990 for analyzing the causality of child undernutrition is widely accepted and used globally. However, it is not easily adapted to analyzing the causality of both

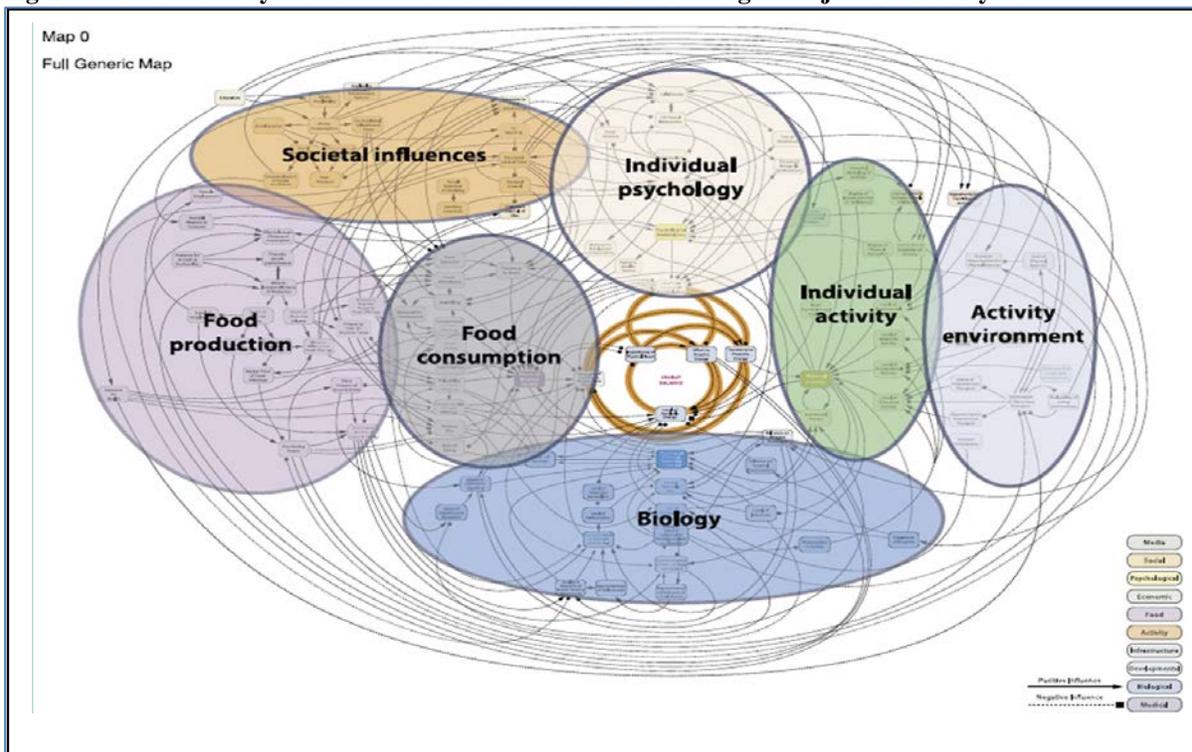
forms of malnutrition across the life course; especially considering that early undernutrition increases the risk of overnutrition later in the life course. The difficulty is separating out the joint neighborhood effects of exposure to parent and offspring, as well as the sensitive periods later in the life course when some degree of mitigation may be possible.

**Various models have been proposed for trying to understand the causality of obesity.** These models examine how both human biology and the environment affects behavioral patterns and body composition (Swinburn and Raza 1999, Friel et al 2007). They include considering individual level factors as well as the socio-political, socio-cultural, socioeconomic, and socio-environmental contexts. A system map of obesity developed by the Foresight project in the United Kingdom (see Figure 7) has over 100 variables with either direct or indirect influence on energy balance (Butland et al 2007). These variables can be grouped into four crosscutting themes and will be used to guide the rest of this paper. They include:

1. The Biological/Health Environment: an individual’s starting point, the influence of genetics and ill health;
2. The Economic/Food Environment, including factors which influence the availability and quality of food near to home, as well as economic access to food which influences consumption;
3. The Physical/Built Environment, including factors influencing individual activity behavior, as well as the type, frequency, and intensity of activity;
4. The Socio-Cultural Environment, including the influence of media, education, peer pressure or culture and how these affect a person’s individual drive for particular foods and consumption patterns, or physical activity patterns or preferences.

**The evidence available in the literature for each of these four groups is described and analyzed.** While each of these themes influences the DBM, they are not necessarily dependent on each other, especially since they may be influential at different times across the life course. This also implies that interventions will need to be considered separately for each of these four groupings.

**Figure 7. Causes: Analytical Framework Based on the UK Foresight Project on Obesity 2007**



## The Health and Biological Environment

**The Health/Biological Environment is an individual's starting point, and includes the influence of the health services and the burden of diseases, as well as the individual metabolic and genetic influences.** The health system focus has long been on treatment rather than prevention, even though preventive interventions have proven much more cost effective (Sheller-Kreinsen et al, 2009). In part, this focus can be explained by the fact that health systems in general are built to address acute care, are often hospital based, and rarely focus on patient self-management education. The latter is an important part of chronic disease care and prevention. Healthy life styles from an early age are a major contributor to preventing and lowering the risk of NCDs. In addition, pharmacological research has resulted in effective and innovative treatments of the metabolic syndrome. In OECD countries, there has been a reduction in mortality due to NCDs such as *hypertension*, type 2 diabetes, and *dyslipidaemia* through lifestyle changes as well as medication (Sassi 2010).

### Theories of Pathophysiology

**The effects of the nutrition transition and the emergence of the DBM problems may also be influenced by genetic disposition of the populations concerned.** In other words, genetic factors could endow individuals to efficiently collect and process food and to deposit fat during periods of food abundance. This has been called the “*thrifty genotype*” hypothesis (Neel 1962). A genotype is the genetic constitution of an organism. Genetic traits not only affect metabolic capacity to store energy, but also affect people's perceptions of hunger and satiety. Multiple studies of families, adoptees, twins, and most powerfully, adopted twins have all confirmed that heritable factors are likely to be responsible for 45–75 percent of the inter-individual variation in body mass index (Farooqi and O'Rahilly).

**However, currently little evidence exists that the ancestral genomes of native Asian or African populations carry particular risk genes<sup>2</sup> for obesity.** Although in certain populations obesity may be related to one gene locus, the vast majority of obesity is related to more than one gene locus, reflecting the many different environmental situations that humans have adapted to in the last ten thousand years (Choquet and Weyne 2011). One useful way to think about the relation of genes with obesity was expressed by George Bray when he said, “*the genetic background loads the gun, but the environment pulls the trigger*” (Bray 2004). The sudden rise of obesity prevalence during the past few decades clearly cannot be accounted for by population genetic changes. Epigenetic contributions to obesity will need to be addressed through minimization of the environmental triggers, rather than manipulation of the genetic guns (Swinburn et al 2011).

**The “*thrifty phenotype*” hypothesis posits that constrained fetal growth is strongly associated with a number of chronic conditions, including the metabolic syndrome later in life (Hales and Barker 1992).** The fetal environment (womb) can be constrained by dietary factors (lack of adequate food), as well as by environmental factors, such as smoking, teenage pregnancy, and malaria, among others. The fetus at this stage of development can adapt to its environment (fetal programming), and expects the same environment once born (Gluckman et al 2005). This programming is dangerous if an environmental mismatch occurs. Also known as the *fetal origins of adult disease* (FOAD) theory, it suggests that part of the DBM problem is due to a mismatch between the womb's environment and that of the world into which the child is born (Barker 1990). The theory is confirmed by food supplementation trials during pregnancy and early childhood in undernourished Guatemalan populations. The food supplementation represented a more food abundant environment, which led to increased risk factors for cardiovascular

---

<sup>2</sup> More specifically called risk alleles. An allele is one member of a pair of genes occupying a specific spot on a chromosome that controls the same trait.

disease (blood pressure, glucose clearance, and dyslipidaemia) during adulthood (Stein et al 2006). Impaired fetal and infant environment can lead to greater risk of fat deposits in the abdomen area and metabolic compromise in later life (Ong 2006).

**Humans are living in a nutritional environment that differs considerably from the environment for which our genetic constitution was selected.** For Asia in particular, and especially among its very stunted populations that are migrating from rural to urban areas, the risks of such a mismatch are greatly increasing. As a result of the rapid economic development and urbanization in most LMICS, babies born with low birth weight due to poor maternal nutrition and stunted children subjected to constrained growth during the fetal and infant period are likely to experience accelerated growth during the rest of their childhoods. This accelerated weight growth during childhood increases the risks of obesity and NCDs later in the life course (Victora et al 2008). Risks of a “mismatch” are even greater in Asia, since Asian populations—even newborn babies (Modi et al 2009)—can have twice the level of body fat as Caucasians with the same level of BMI (Deurenberg et al 2002, Liu et al 2011).

**A third of babies born in South Asia have very high rates of low birth weight (UNSCN 2010), making South Asia a potential time bomb for NCDs.** Babies born with a birth weight lower than 2,500 grams are considered to be low birth weight (LBW), placing them at considerable risk of serious negative consequences. They are at higher risk of mortality because of a compromised immune system and are likely to be stunted by age two. Maternal malnutrition, teenage pregnancies, and females of small stature (due to stunting and malnourishment) are most likely to give birth to LBW babies. The proportion of LBW babies born in Asia is higher than in the rest of the world: India 32 percent and Pakistan 28 percent, while the global average is 15 percent (WHO, World Health Statistics, 2012).

**The linkage of poor birth weights with the poor status of women, and especially of young adolescent girls, is rarely sufficiently emphasized.** In India, nearly half (43 percent) of young women are married before they are 18, the legal marriage age. Around a quarter (22 percent) of these young child brides have their first baby before they are 18 (Moore et al 2009). The risks of stunting, diarrhea, and anemia diminish significantly, as a woman delays her first birth to age 27-29 years, regardless of socioeconomic status (Finlay et al 2011).

**Qualitative micronutrient deficiencies in the Asian diet during pregnancy further increase the risk of metabolic syndrome later in the life course.** Vegan diets, so common in Asia, are associated with vitamin B12 deficiency. The prevalence of deficient and marginal values for B12 is commonly reported as 40 percent in Latin America, and 70 percent or more in Africa and Asia (Allen 2009). Low vitamin B12 levels in a pregnant woman, especially if she is folate replete, are associated with increased insulin resistance in their offspring at six years of age, as well as increased obesity (Yainik et al 2008). The standard regime for treating maternal anaemia in India, as elsewhere, is to provide iron and folic acid tablets, but without providing B12, thus potentially further contributing to the aforementioned mismatch.

**The appetite mechanisms that evolved in our ancestors may not be suited to dealing with modern Western eating patterns (Prentice and Jebb 2003, Leidy et al 2010).** Our ancestors subsisted on a mixed diet mostly composed of fruits, nuts, vegetables, and game gathered in the forest. Nowadays, high energy density “convenience foods” are more common, and often eaten as snacks between meals. A small extra amount of energy, as little as 100 kcal if consumed every day, can lead to the gradual accumulation of fat, which eventually becomes overweight, and then obesity (Hall et al 2011).

**Once obese, the difficulty is not just losing that weight, but keeping it off.** For example, some six hundred European subjects that lost 12kgs during six months of dieting regained 10kgs over the next eighteen months, unless they took an appetite suppressant (James et al 2000). It seems that the body becomes used to having those extra fat reserves and continues to try to maintain them (Rosenbaum and Leibel 2010, Sumithran et al 2011, Rosenbaum et al 2010). A biological explanation may be that fat

deposits are not only glands involved in regulating energy balance, but seem to become involved in maintaining themselves once established, by changing the signals to the brain.<sup>3</sup>

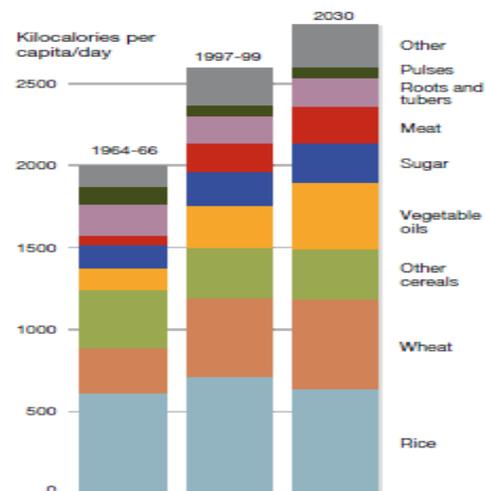
## The Economic/Food Environment

**The world has experienced economic growth over the past century unseen before in the history of humanity.** While the global population has increased six fold since the industrial revolution began in Europe just over a hundred years ago, per capita income has increased nine fold (Sachs 2005). However, economic growth has been highly uneven. Today there is a twenty-fold gap between the world’s richest economy, the United States’, and the poorest region of Africa, compared to a fourfold difference a century ago (Gosh and Chandradekhar 2008). Since 2000, new driving forces have rapidly defined the global food system, including income growth, climate change, and the increased production of biofuels motivated by higher oil prices.

**Increasing wealth has been accompanied by a relative per capita increase in global food availability.** The supply of calories for human consumption increased over 20 percent from the early sixties to the late nineties, while the population almost doubled (FAO 2002). Global food production has outpaced rising demand during the last four decades, based on FAO calculations using food balance sheet data (see Figure 8). Average food consumption rose from 2,360 kcal per person per day in the mid-1960s to 2,800 in the late nineties. The world population will be increasingly well fed with 3,050 kcal per person per day available by 2030. Food availability is expected to rise in developing countries, closing the gap between developing countries (3,000 kcal per person per day) and industrialized countries (3,500 kcal per person per day).

**The remarkable increase in global food production over the past fifty years was possible mainly due to the “Green Revolution” in agriculture.** During the 1940-1970s, adoption of crop rotation, the mass production and use of petroleum-based fertilizers and chemical pesticides, the use of petroleum driven machinery, expanded irrigation, and the introduction of genetically superior, disease-resistant cultivars (cultivated crops) were introduced. Together, this led to an unprecedented increase in food production.

**Figure 8. Changes in Historic and Projected Composition of Human Diet and the Nutritional Value**



Source: FAO 2011.

## Increased Access to Food

**Supermarkets are expanding beyond their original niches.** They are moving from serving large and wealthy countries to small and poor countries, from metropolitan areas to rural towns, and from targeting the upper/middle class to the poorer working class. The emergence of supermarkets in developing countries amounts to a radical change in the global food marketing and distribution system (Reardon and Berdegue 2002). Structural changes in the food distribution system, which took fifty years to unfold in the United States, have taken place in little more than a decade in Latin America. In 2000, supermarkets encompassed roughly 60 percent of the national retail sector in South America and Mexico, up from 15

<sup>3</sup> The process happens with fat deposits (adipocytes or fat cells) starting to act as glands and changing the hypothalamic response to the hormone leptin. Leptin interacts with areas of the brain that control hunger and behavior and signals that the body has had enough to eat.

percent in 1990. Unlike higher income countries, where supermarkets are often the principal, if not only, source of fruits and vegetables (Larson et al 2009), in LMICs, supermarkets are often distribution channels for cheap, unhealthy snacks and “junk” food, and venues for fast food chains. The expansion of supermarkets extends beyond Latin America, with East and Southeast Asia lagging only five to seven years behind (Reardon et al 2003).

**“Supermarketization” may evolve advantageously to address DBM.** The processes of “supermarketization” in the developing world are similar to that which occurred in the developed world. However, because the pathways are well understood now, the processes are much accelerated, which may be an advantage. Initially, supermarkets focus on processed food and food products. However, soon they aspire to selling fresh products, which carry the highest margins. In doing so, they also raise quality and food safety standards. The modern retail sector may assist in accelerating these positive trends.

**The urban demand for food in emerging markets is expected to more than double.** It will be responsible for almost the entire growth in global food demand, spiking from about 40 percent of global food demand to some 60 percent by 2050. According to World Bank estimates, the urban food market in Africa will expand fourfold in the next 20 years (World Bank et al 2010). The urban population’s diets, food basket, and eating habits are changing rapidly..

**Increasing amounts of time are spent outside the home and in local transport systems, leading to increased consumption of foods from outside the home.** These include “snack foods” from the food industry, “street foods” or meals in restaurants. According to Nestle (2007), food consumption outside the home increased from one-third to half of daily calorie-intake. The aphorism “Cash Rich: Time Poor” can not only be applied to urban consumers in the developed world, but is increasingly applicable to urban populations in developing countries, although with less emphasis on the cash rich!

**The term “food desert” was coined in the late 1990s in the United Kingdom to describe low-income neighborhoods with poor access to fresh and affordable food** (Wrigley 2002). Major changes in food retail systems in the UK during the sixties led to the rapid growth of supermarkets in out-of-town locations, which in turn led to the decline of local shops and traditional markets. Those without a car or access to public transport could not get to supermarkets and hence access fresh fruit and vegetables.

**Figure 9. FAO Food Price Index, 2008-2011**



Source: FAO 2011.

Research in the USA over the last decade as to why overweight and obesity was more common amongst the poor revealed that poor neighborhoods had little or no access to large grocery stores that offer fresh and affordable foods needed to maintain a healthy diet. Instead, they had access to fast food restaurants and convenience stores that only stock non-perishable foods, many of which are ultra-processed and high energy density (Drewnowski and Specter 2004). Different studies showed that other factors could limit access to healthy foods, including unsafe neighborhoods for walking, being a single parent, and lack of time to prepare meals due to busy work schedules (Rose and Richards 2004). Recent reviews of the literature confirm that Americans with better access to healthy foods, from supermarkets or neighborhood food stores, consume more fresh produce and healthy food items and have lower risks of obesity and other diet-related chronic diseases (Treuhft and Karpyn 2010).

**High food prices disproportionately affect LMICs.** LMICs paid 30 percent more for food in 2011 than 2010, compared to rich nations, whose food imports were expected to rise by only 20 percent. LMICs' expenditures on imported food account for roughly 18 percent of all import expenditures, compared to the 7 percent global average. Household-level consequences of increases in food prices are most acutely felt in low-income food deficit countries (LIFDCs), where a 50 percent rise in staple food prices causes a 21 percent increase in total food expenditure, increasing food expenditures from 50 percent to 60 percent of income. In a high-income country, this rise in prices causes a 6 percent rise in retail food expenditure with income expenditure on food rising from 10 percent to 11 percent (Trostle 2008).

**Global food price increases are due to several factors, including the increase in oil prices and competition for cereals to use as biofuel and for livestock feed, among others.** The Food Price Index (FPI) of the FAO, a measure of the monthly change in international prices of a basket of food commodities, fell steadily after the 1974 oil crisis that facilitated two decades of cheaper food. However, in 2007, the FPI jumped 26 percent, followed by another 24 percent increase in 2008, also linked to increases in oil prices. The cost of food reached an all-time high in early 2011, with the FPI at twice the level it was a decade prior (Figure 8). Globally, 660 million tons of cereals are used as livestock feed each year, representing just over a third of total world cereal use. Although corn provides the US with less than 1 percent of its biofuel energy, corn has a much larger effect on global food availability. Although subsidies for converting corn to ethanol were stopped in December 2011, the US federal government still guarantees demand for 37 percent of the national corn crop for conversion to ethanol. In addition, the rise in price of agricultural inputs and demands on water and land resources increases food prices. Lastly, although less clear in terms of influence, speculative trading may play a role (see Box 2).

#### **Box 2. Speculative Trading and Rising Food Prices**

**There is considerable debate on whether speculation stabilizes or destabilizes high price episodes of food commodities (World Bank 2011).** Some analysts argue that the influx of financial investors in commodity futures markets has scant impact on market prices. Other analysts stress that the large amounts of money invested in commodity futures by financial investors has amplified price movements to an extent that cannot be explained by market fundamentals (Lagi et al 2011).

**The impact of the Commodity Index Traders (CIT) “roll cycle” from the fifth to ninth business day of each month is of particular concern.** During this period, funds tracking Standard and Poor's Goldman Sachs Commodity Index (GSCI) must roll forward their expiring futures contracts, which systematically distorts forward commodities' futures price curves, contributes to speculative “boom/bust” cycles by changing the incentives of producers and consumers of storable commodities, and sends misleading and price signals to the market (Frenk and Wallace 2011).

**Investor speculation on the agricultural futures market is a consequence of the deregulation of commodity markets by US Congress's Commodity Futures Modernization Act of 2000.** In the last five years alone, the total assets of financial speculators now dominate these markets, holding over 60 percent of assets as compared to just 12 percent fifteen years ago (Worthy 2011).

**More research is needed to clarify these issues to assist regulators in determining whether regulatory responses are needed and the nature and scale of those responses.**

**The food price increases over the last two years have fundamentally changed thinking about agriculture and rural development.** Initially, the primary concern was the 70 percent of rural poverty. Consequently, attention focused on increasing the flow of income into the rural economy. After years of food prices falling in real terms, they now appear to be set at a significantly higher level. There is now also a need to shift from focusing only on the rural economy to delivering food to the urban poor at sensible prices, particularly the staple foods. Part of that equation is removing unnecessary costs from the food supply chains. An example of doing this is through the use of supermarkets' modern food chains Reports at the cutting edge of commercialization of farming, comparing India, China, Vietnam, and

Bangladesh, show that disintermediation is increasingly happening. So instead of products cascading through the hands of multiple middlemen, resulting in high aggregate margins as well as a very significant post-harvest losses, the larger trucker trades are increasingly buying directly from farmers in rural areas, often facilitated by cell phone. Multiple new ways and channels are emerging to market products, in this case rice and potatoes. Food City, the largest supermarket chain in Sri Lanka with about 16 percent of the grocery market, has shown that with improved logistics, direct purchases, and reduced post-harvest losses, that it can undercut the prices of fresh fruits and vegetables in traditional markets.

## Food Consumption

**The increasingly large-scale global trade of food and the industrialization of the food chain over the last two decades are changing what we eat, the way we eat, and where we eat, which is contributing to the DBM and rising tide of NCDs (Popkin 2006).** Food availability and consumption patterns have become increasingly similar throughout the world. Information obtained from food balance sheets in 1990-92 indicate that the share of dietary energy coming from vegetable sources was 90 percent in developing countries and 71 percent in developed countries, cereals provided 60 percent and 30 percent, and meat and fish provided 6 percent and 14 percent, respectively. However, in 2002, meat consumption in developing countries had risen from 10 kg per person annually in 1964-66 to 26 kg in 1997-99, and was projected to rise to 37 kg per person per year in 2030 (FAO 2006). Global consumption of milk and dairy products have also risen rapidly, from 28 kg per person per year in 1964-66, to 45 kg in 1997-99, and are projected to rise to 66 kg in 2030 (FAO 2006).

**Since the 1950s, expanding sales and the consumption of bread and other baked goods have been central to adopting a “Western” diet.** This trend is expected to continue and may even accelerate, driven by a growing internationalization of food distribution systems. The spread of supermarkets and rapid urbanization are major factors behind that diffusion. The export of US processed foods is growing fastest in countries where supermarkets are growing fastest, lending credence to the assertion that supermarkets in developing countries are an important outlet for promoting US agriculture products (Tandon et al 2011).

**Westernization of the global diet produces negative consequences for human health and for the environment (Kearney 2010, Woods et al 2006, Carlsson et al 2009).** Agriculture production systems contribute around 13.5 percent of global greenhouse gas emissions and about half of this comes from meat and dairy production. A more “Mediterranean” type diet is believed to provide benefits to population health and to the environment (Millward and Garnett 2010, Oosterveer and Sonnenfeld, 2012).

**Chemical food additives are used to make processed foods look, smell, and taste better, as well as to improve their shelf life.** These include a large assortment of colorings, preservatives, antioxidants, emulsifiers, stabilizers, anti-caking agents, and flavor enhancers. In 2000, the food industry spent US\$20 billion on such additives, and the average consumption was 7kg per person a year in industrialized countries (Millstone and Lang 2003). There are 4,500 flavoring agents and 13 sweetening agents besides sugar, with an estimated annual global market worth US\$3.6 billion, and US\$2.5 billion, respectively. The number of new approved food additives has grown considerably in the United States since the mid-nineties. During this time, the role of the Food and Drug Administration (FDA) changed from doing its own food safety research to relying mostly on the research conducted by manufacturers themselves. This change is generally regarded as having limited public input (Neltner et al 2011).

**Dietary diversity is decreasing with 80 percent of the population relying on just four staple foods.** Eighteen plants are used as staple foods globally, although over 80 percent of the global population relies on just four: wheat, rice, maize, and potatoes (Henry and Heppel 1998). This is compared with the thousands of foods that comprised the hunter-gatherer diet on which humans evolved. With the addition

of many chemicals, these four staple foods are transformed into a vast array of processed food products, with more than 1,500 produced from wheat alone.

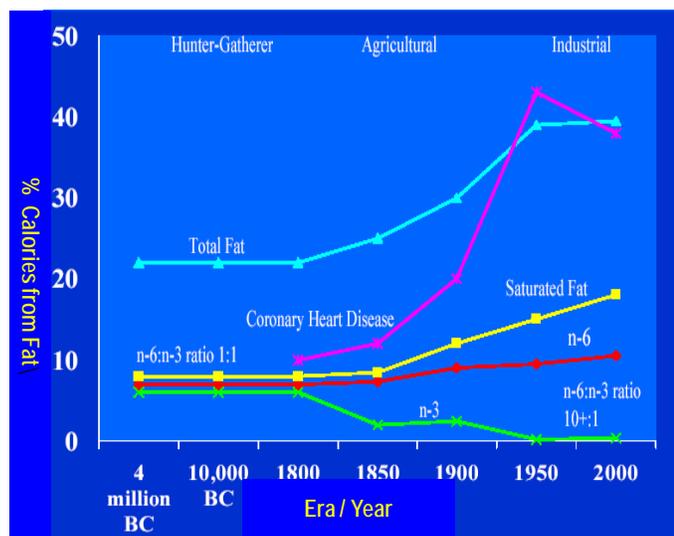
**One important change is the global decrease of exclusive breastfeeding and suboptimal breastfeeding.** It has been long known that exclusive breastfeeding for the first six months of life has enormous benefits for both mother and child. More recent research also suggests that exclusive breastfeeding during early months is central to the mechanism by which breastfeeding protects against later obesity (Singhal and Lanigan 2007). Future growth seems to be programmed during the first six months of life, when normal growth in exclusively breastfed babies is much slower than in bottle-fed ones. Furthermore, there is a dose–response effect for the prevention of obesity, since a longer duration of breastfeeding is associated with lower tendency to later obesity. The risk of being overweight is 20 percent greater in exclusively bottle-fed than exclusively breastfed infants during the first six months of life (Singal and Lanigan 2007). In the period 2005-2009, it was estimated that just 36 percent of infants in developing countries were exclusively breastfed until six months of age. By region, this ranged from just 23 percent in West and Central Africa, to 47 percent in East and Southern Africa (UNICEF 2011). Suboptimal breastfeeding, especially non-exclusive breastfeeding in the first six months of life, results in 1.4 million deaths and 10 percent of the disease burden in children younger than five years.

**As babies turn into toddlers and further develop tastes and preferences, providing them with healthy choices is key.** However, as happened in the industrialized countries, mothers and caretakers have less and less time to spend cooking wholesome foods and shopping for healthy choices. In addition, as discussed in subsequent sections, young children spend more and more time watching commercials including for many processed foods and snacks, which contribute to DBM.

**The type of carbohydrate in the diet has changed, with decreases in complex carbohydrates such as starchy foods (for example, whole grain cereals and legumes) and an increase in refined sugar.** Sugar consumption has increased fifty fold in industrialized countries, with upwards of 15 percent of energy intake now coming from refined sugar. The majority of this sugar is “hidden” in processed foods and drinks, rather than added to food by the consumer. High-fructose corn syrup (HFCS), a type of sugar, is of particular growing concern.

**While fat content has increased over the last few centuries, the quality of dietary fat has steadily deteriorated** (Figure 10). It is not only the amount of fat consumed, it is the type of fat that that is important as well. Dietary changes associated with the adoption of the Western diet affect the type of fat—more of the unhealthy saturated and less of the more healthy unsaturated fat—found in traditional diets. Industrial *hydrogenating* of liquid unsaturated fats, such as soy and corn oil, to make them into solid *saturated fats* has facilitated mass production of cheap snack foods. The *hydrogenation* process can lead to the formation of harmful *trans-fats*, which increase the risk of cardiovascular disease. Dietary changes also affect dietary quality by changing the *antioxidant* content of food (Simopoulos 2006). Antioxidants, such as Vitamin A,

**Figure 10. Changes Overtime in Consumption of Calories from Fat**



Source: Simopoulos 2006.

C, and E, are substances that rid the body of damaging by-products, e.g., from digesting saturated fats.

**Not only are unsaturated fats being replaced by saturated fats, the type of *unsaturated fat* consumed has changed.** The ratio of *omega-6 fatty acids* to *omega-3 fatty acids* has increased from 1:1 to greater than 15:1 over the past two centuries (Simopoulos 2006). This change is related to the increased consumption of meat of intensively reared animals fed on grain (rich in *omega-6 fatty acids*) instead of grass (rich in *omega-3 fatty acids*) (McAfee et al 2011).

## Food Processing

**Nearly all food requires processing to be eaten.** Categorizing food in terms of its degree of processing is a new and important concept in understanding the potential *obesogenicity* of diets (Monteiro 2010).

- **Group 1 - Unprocessed or minimally processed foods:** Involves the removal of inedible fractions, grating, squeezing, drying, parboiling, fermentation (non-alcoholic), pasteurization, freezing, wrapping, and bottling for example;
- **Group 2 - Processed culinary or food industry ingredients:** Involves the extraction and purification of components of single whole foods for use as culinary or food industry ingredients through pressing, crushing, milling, refining, hydrogenation, *hydrolysis*, extrusion, and use of enzymes and additives;
- **Group 3 - Ultra-processed “convenience” foods:** Involves combining Group 2 ingredients with Group 1 ingredients through baking, battering, frying, curing, smoking, and pickling to create durable, accessible, convenient, and palatable drinks and/or ready-to-eat or ready-to-heat food products such as vegetable oils, margarine, butter, whey, cream, lard, sugar, sweeteners, salt, flours, raw pastas and noodles, high fructose corn syrup, and gums.

**Group 3 ultra-processed foods require both little effort to prepare and less energy by the human body to digest.** Group 3 ultra-processed foods require little if any preparation before cooking, and can be eaten as purchased or after reheating. They are most suited to snacking due to their high *energy density* and high *glycemic index*. High *glycemic index* foods are those that cause a high and prolonged *glucose level* in the blood stream, and are believed to enhance *insulin resistance*, which may result in diabetes (Raj et al 2009). Furthermore, Group 3 presents a “*double whammy*” in that the *metabolic cost*, the energy used by the human body to digest food, is only half that of whole foods (Barr and Wright 2010).

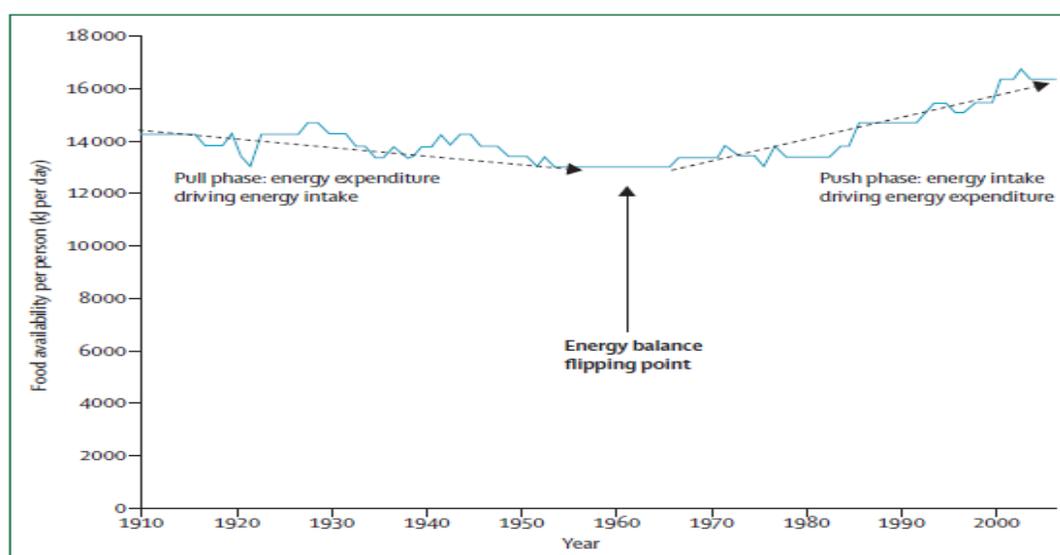
**Ultra-processing of foods is not the problem per se; it is the increasing consumption of Group 3 ultra-processed foods compared to the other food groups.** All over the world, Group 1 and Group 2 foods are being displaced by Group 3 ultra-processed foods. In Brazil, ultra-processed foods contributed a third of dietary energy in 2003 (Monteiro et al 2011). In the UK, eight ultra-processed products such as bread, cakes, pastries, confectionery, biscuits, processed meats, cheeses, and soft drinks, together supply almost half of total household purchased calories (DEFRA 2008). In the US, the five most commonly consumed foods are “regular” sugared soft drinks, cakes and pastries, burgers, pizzas, and potato chips (Block 2004).

**Food prices may result in a growing consumption of Group 3 foods at the expense of Group 1 foods.** Global food price increases will likely result in Group 1 foods becoming increasingly expensive, while Group 3 ultra-processed foods, made by largely subsidized food supply chains, will become comparatively cheaper. Unless preventive measures are taken, Group 3 ultra-processed foods will be more attractive, even to the poorest segments of LMICs. *Energy dense* foods composed of refined grains, added sugars, or fats are the lowest cost option for the consumer (Drewnowski and Spender 2004). That obesity is more common in the poorer segments of developed countries is most likely because high energy density “fast foods” are cheaper to buy and/or easier to prepare than more healthy foods, such as fruits and vegetables (Drewnowski and Darmon 2005). Poor people spend 50 to 70 percent of their income on food and have little capacity to adapt as prices rise and wages for unskilled labor fail to adjust accordingly. To cope, households limit their food consumption, shift to even less-balanced diets, and

spend less on other goods and services that are essential for their health and welfare, such as clean water, sanitation, education, and health care (Von Braun 2008).

**The sudden explosion of obesity that is now engulfing most countries in the world began just thirty years ago.** Swinburn and colleagues postulate that an energy balance flipping point occurred only within the last century in most high-income countries (Swinburn et al 2011). There are two distinct phases with the so-called “move less, stay lean” phase (1910–60), characterized by decreasing physical activity levels and energy intake, and a population that remained lean; and the subsequent so-called “eat more, gain weight” phase from 1960 onwards, characterized by increasing energy intake and a concomitant rise in population weight (Figure 10). Food supply data from the US lends support to this flipping point hypothesis, and the loss-adjusted availability of corn products in particular has been shown to be associated with the rising obesity trend (Shao and Chin 2011). A recent dietary intake study in US adults over a four year period found their average annual 1.5kg weight gain is most strongly and positively associated with the intake of potato chips, potatoes, sugar sweetened beverages, and most negatively associated with the intake of vegetables, whole grain, fruits, and nuts (Mozaffarian et al 2011).

**Figure 11. Food Availability in the USA 1910-2006**



Source: Swinburn et al 2011, Lancet Obesity Series 1.

## Trade and Food Subsidies

**Food is a major component of international trade, accounting for 10 percent of all global trade (WTO 2010).** The global aggregate value of agricultural exports is expected to reach a record US\$1.29 trillion in 2011. Since the early seventies and the development of the “Washington Consensus” on the conditionality for Structural Adjustment Programs (SAPs) from the International Monetary Fund (IMF), LMICs have been increasingly encouraged to open up to free trade, privatize national industries, and reduce state support to local agricultural production (Weis 2007). The conditionality for structural adjustment was the precursor to the conditions of free trade agreements, including the General Agreement on Tariffs and Trade (GATT) and the North America Free Trade Agreement (NAFTA) through the World Trade Organization (WTO). Agreement based on agricultural sector trading has been a blocking point in successive Doha Rounds of the WTO.

**Trade liberalization affects the availability and consumption of meat, dairy products, and processed foods by removing barriers to foreign investment in food distribution and other types of**

**food retail (Thow and Hawkes 2009).** Multinational fast-food outlets have made substantial investments in middle-income countries. Multinational food corporations (franchises and manufacturers) such as KFC, McDonalds, Kraft, and Nestle are all drivers of the fast-food market, processed foods, and the Western lifestyle (Hawkes 2005).

**Grassroots farmer’s movements consider the inclusion of food among commodities that have been subject to free trade agreements to be against the interests of most LMICs.** They argue that it would threaten the future of their farming communities as well as their public health and nutrition (Rosset 2007). An ever-increasing proportion of the urban diet, especially in Africa, is being fed by imports for products like rice, wheat, chicken and fish. This is concerning. This trend is choking off potential cash flow into rural areas, changing eating habits to imported products, and causing ongoing and accelerating outflow of foreign exchange.

**Free trade has resulted in most LMICs increasing food imports.** Imported foods are cheap because of continued state support to the industrial agriculture sector in rich countries, the so called “dumping” of cheaper food commodities onto the world market. In 2010, while the European Union paid out €9 billion (almost US\$50 billion) on direct agriculture subsidies, the United States government spent US\$21.3 billion to subsidize mainly large-scale farmers (Ortiz et al 2011). In the last fifteen years, US\$16.9 billion went into subsidizing just four common food additives—corn syrup, high-fructose corn syrup (HFCS), cornstarch, and soy oils. These subsidies contribute to making wheat- and maize-based processed food products cheaper. Americans’ tax dollars are directly subsidizing junk food ingredients (Russo 2011). Aside from commodity crops, other agricultural products receive very little in federal subsidies, with only US\$262 million spent since 1995 subsidizing apples, which is the only significant federal subsidy of fresh fruits or vegetables.

## The Physical/Built Environment

**The Physical/Built Environment includes factors that influence individual activity behavior.** They include the type, frequency, and intensity of physical activity, as well as access to “healthy” food. Energy balance depends on regulating intake and expenditure. The key variable of energy expenditure is physical activity. As illustrated in Table 2, basal metabolic rate and the thermic effect of food are constant and cannot be changed. Modifying physical activity is an essential element of energy expenditure in terms of achieving energy balance, and or losing weight, especially in an environment where the food available is predominantly energy dense. Exercising contributes to losing weight but needs to be accompanied by reduction in calorie intake.

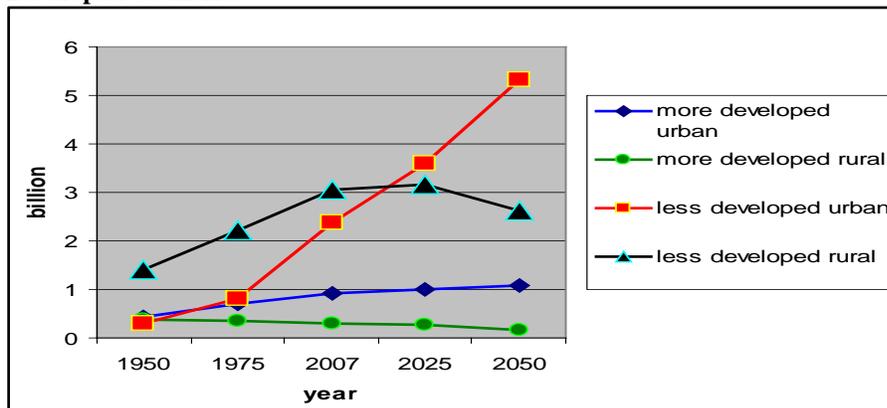
**Table 1. Comparison of Energy Expenditure between Sedentary Adults and Very Active Adults**

Component	Definition	Sedentary adults	Very active adults*
Basal metabolic rate	Energy the body uses to keep basic functions (brain, heartbeat, etc.)	60%	40%
Thermic effect of food	Energy used to digest food	10%	10%
Physical Activity	Energy used for physical activity	30%	50%

\*Very active adults are close to being athletes

Source: Shils, M.E., J. Olson, M. Shine and A.C. Moss (1999) *Modern Nutrition in Health and Disease*, ninth edition

**Figure 12. Growth of Rural and Urban Populations in Developing and Developed Countries**



Source: UN Population Division 2009.

projected to be living in the urban areas of countries that are currently considered developing, and just less than a third of the global population will live in rural areas (UN Population Division 2009).

**With urbanization, the risk of overweight and obesity increases because of many lifestyle changes.** People become increasingly sedentary and dependent on purchasing their food instead of growing it themselves (Popkin 1998). With people moving from rural to urban areas comes a shift of the workforce away from agricultural and towards manufacturing and service employment. This is often accompanied by a reduction in energy expenditures of men at work and of women in agriculture. With industrialization came kitchen stoves and coal followed by kitchen tools and electricity, all of which have contributed to reducing people’s domestic workload. With the advent of machines, a vicious circle was created with people getting less and less exercise because of the machines they can use. The production of machines has increasingly created jobs for people and become an important component of economic growth. However, a consequence is that the activity environment has increasingly been developed to facilitate the use of exercise saving machines. A complementary shift in diet and eating habits to compensate for the reduced energy needs did not take place. On the contrary, an increase in energy intake is happening.

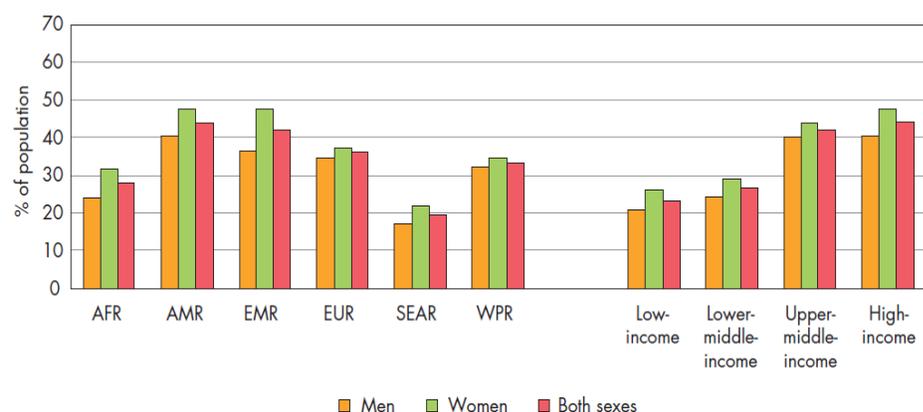
**In urban areas, people increasingly have few places to get exercise.** The availability, accessibility and convenience of destinations and facilities, as well as the general functionality and aesthetics of the neighborhood, such as the presence of sidewalks and traffic conditions, are associated positively with various levels of physical activity (McCormack et al 2004). Unfortunately, urban planners tend to give priority to car usage, with the car being seen and promoted in the media as the ultimate status symbol. Furthermore, car sales are an important economic indicator.

**Urbanization is also related to changes in time allocation and leisure activities.** Leisure increasingly becomes passive, with people watching TV or playing computer games instead of having physical exertion by playing a ball game. Independent of exercise levels, sedentary behaviors, especially TV watching are associated with significantly elevated risks of obesity and type 2 diabetes (Tremblay et al 2011, Inoue et al 2012).

**WHO recently estimated that globally between a quarter and a half of adults do not get enough exercise (see Figure 12, WHO 2011).** Women tend to get less activity than men do. LMICS still are more active than higher income countries, but they are catching up, especially given the very rapid urbanization. Less than 30 minutes of moderate activity five times a week or less than 20 minutes vigorous activity three times a week is considered too little physical activity.

Most of the future global population growth will occur in the urban areas of developing countries where the risk of overweight and obesity seems higher. The proportion of the global population living in urban areas surpassed those living in rural areas in 2009 (see Figure 12). By 2050, the majority of the global population or just over 5 billion people are

**Figure 13. Age Standardized Prevalence of Insufficient Physical Activity in Adults 15+ Years by WHO Region and World Bank Income Group, 2008**



Source: WHO 2010 NCD Status Report.

**Urbanization and environmental factors influence growth during the fetal and infant period as well.** Urbanization has both positive and negative influences on fetal growth. Negative influences leading to constrained growth can be caused by a multitude of non-income and/or food security related factors such as environmental hazards. Environmental factors that can limit fetal and infant growth include smoke, be it cigarette or indoor house smoke. Expecting mothers and infants are less exposed to toxins such as pesticides either coming from the diet or through exposure in the fields in urban areas (WHO 2006). Construction of urban infrastructure and dwellings has to comply with building regulations, which determine the need for sanitation, clean water, and smoke-free households with chimneys. However, the latter is adhered to often only once a country reaches a certain level of development. Many LMICs still have a very high number of slum-dwellers exposed to many hazards instead.

## The Socio-Cultural Environment

**The Socio-Cultural Environment considers the influence of media, education, peer pressure or culture and how these affect an individual’s drive for particular foods, consumption patterns, or physical activity patterns or preferences.**

## Social Marketing

**Many national governments have developed dietary recommendations that are communicated to the public via social marketing campaigns aimed at mobilizing behavior change.** These campaigns typically make use of mass media channels, and involve the production of materials that visually depict recommendations in a locally relevant, compelling, and understandable way. For example, the US Department of Agriculture (USDA) originated the “Food Guide Pyramid” in 1992 to determine the content of school lunches, as well as the food distributed through welfare channels. The food pyramid was adopted or adapted for use in many countries. However, twenty years later, a number of flaws (see Box 3) were identified in light of the growing obesity epidemic, which led to the food pyramid being replaced by the new MyPlate campaign. MyPlate is divided into four slightly different sized quadrants, with fruits and vegetables taking up half the space, and grains and protein making up the other half. The vegetables and grains portions are the largest of the four

**Food labels that describe the nutrition content of foods can, in theory, permit the more discerning consumer to make more informed purchases.** Food labels include “front of pack” labeling, nutrition facts panel, and menu labels. Nutrition labels on prepackaged foods, which are among the most prominent sources of nutrition information, are perceived as highly credible sources and many consumers use

nutrition labels to guide their selection of food products (Campos Doxey and Hammond, 2011). Evidence also shows a consistent link between the use of nutrition labels and healthier diets. However, the use of labels varies considerably across subgroups, with lower use among children, adolescents, and older obese adults. Labels are most used by educated and richer segments of the population. Research also shows that the nutrition facts panel is often difficult for people to understand. Poorly designed labels can make it difficult for individuals to make smart decisions. In addition, concern has been raised about the false healthy claims that largely go unchallenged, often until serious damage is done. Evidence for the effectiveness of “front of pack” labeling in terms of producing weight loss for example, is still weak however (Campos Doxey and Hammond, 2011).

**However, for every 1 million spent on public education, the food industry spends 1 billion on advertising.** As revealed by a US consumers union report, US\$9.55 million is spent on communications for the Federal and California “5 A Day” programs to encourage eating five or more servings of fruit and vegetables each day (Consumers Union 2005). In contrast, the food, beverage, and restaurant industries spent US\$11.26 billion largely promoting energy dense Group 3 ultra-processed foods in 2004, overwhelming the government’s health message.

### **Box 3. Criticisms of the Food Pyramid Based Dietary Guidelines**

- Addressed “what to eat” without regard to “how much to eat.”
- Aimed at limiting fat intake, but with no differentiation between types of fats, the benefits of the “good” *unsaturated fats* were forgone (Willet and Skerret 2005).
- Recommended increased consumption of starchy foods, and in particular grains (cereals) and cereal products, with little or no consideration given to the benefits of reducing intake of refined carbohydrate diets (Hite et al 2010).
- Gave preference to “minimally processed,” “high-fiber” or “wholegrain” foods. However, the cereal part of the pyramid does not differentiate between the types of processing that the cereal and/or starches have been subject to, and whether they are Group 3 ultra-processed foods (Monteiro 2011).
- An over emphasis on some of the food groups, such as meat, milk, and bread for instance, is said to have been the result of industry pressure (Nestle 2002).
- As a result of lobbying, potatoes have been classified as vegetables (Reyes 2008), and more recently even pizza was classified as such by the US Senate (Linkins 2011).

**Underlying the potentially significant impact that marketing has on the DBM, both in positive and negative directions, is the natural process of brain development.** Children are vulnerable to marketing messages during the most important period for establishing positive nutrition habits. Before the age of 12, the brain is only capable of straight processing of facts without filtering, which comes with maturity. Abstract thinking begins between 12 and 14 years of age (Dosenbach et al 2010), with full maturity only achieved by around 18 years of age. Children therefore lack the capacity to make sound judgments and counteract marketing messages (James 2011).

**The food industry spends US\$40 billion a year on advertising food, much of that directed at children, most of which promotes the consumption of Group 3 ultra-processed foods.** Multinational soft drink and fast food companies extensively market their products worldwide, especially to children and youth (Hawkes 2002), using highly effective marketing techniques to encourage regular consumption, repeat purchases, and brand loyalty. There are many global efforts aimed at regulating the marketing of food to children, mostly through industry self-regulation. However, by and large, the marketing of food to children in developing nations goes unchecked (Hawkes 2007).

**Indonesia reported that 16 percent of children watched over eight hours of television per day, and that for each hour of children’s programming, there were 15 minutes of advertising.** Food advertising was dominant. The majority of children in Indonesia love watching TV advertisements (61

percent), which they thought informed them about product quality/features (75 percent), and updated them about new products (91 percent). While 75 percent of parents in Indonesia based their buying decisions on their own judgment, and only 33 percent said these were influenced by advertisements, 58 percent said they were influenced by their children (Escalante de Cruz 2004). Indonesian advertising control is solely based on a “complaint feedback” mechanism. Reviews carried out under the remit of WHO confirmed that the findings of the Consumer International surveys, such as the one reporting on Indonesia, are applicable and relevant to most countries across the globe.

**Global reviews carried out by the WHO confirm that marketing of foods is practiced in most countries, principally through television (Cairns et al 2009).** Television is an increasingly pervasive media in most LMICs. A multi-country survey of the influence of television advertisements on children reported that advertising to children was widespread across the countries surveyed, and that while all six countries had common core food-based messages in national nutrition guidelines, the diet actively being promoted on television goes in the opposite direction (Escalante de la Cruz et al 2004). In all six countries surveyed, piecemeal legislation exists alongside self-regulation codes and punitive measures could be taken against those that violate such codes. However, only in the Philippines was there provision for suspension or retraction of licenses to advertise.

### **Cultural Norms and Beliefs**

**Where modern communication media has not yet fully penetrated, especially in rural areas of LMICs, traditional socio-cultural practices prevail.** Many of these practices contribute to maternal and early child undernutrition. For example, gender-related cultural practices are largely determined by cultural norms and encompass many factors that influence the nutritional status of the child, including age of first pregnancy (and thereby fetal growth) and parity. Age at marriage is highly correlated with age at first birth. Adolescent and child marriage continues to be a strong social norm in the developing world, particularly in Central and West Africa, and South and Southeast Asia. As mentioned earlier, in many LMICs, 40 percent of first pregnancies occur whilst the mother herself is still a child (<18y) (Shrimpton 2010). Increased median age at marriage is associated with lower incidence of LBW in Africa and Asia and overall (UNSCN 2010). Moreover, the development of maternal obesity in mothers over twenty years of age seems to be related to teenage pregnancy and parity.

**Without realizing the associated problems of LBW babies, women in some cultures are so concerned with surviving the ordeal of childbirth that they purposely eat very little (Devries 1987, Reidel 1982, Richardson and Guttmacher 1967, Blaffer 1999).** This practice by pregnant women is called “eating down.” By eating less, they hope to have a smaller baby that will be easier to deliver. This practice has been observed around the world. In Bangladesh, pregnant women are encouraged not to eat too much so that their baby will be small and more likely to be born without difficulty. Other cultures across the world (the Enga of Papua New Guinea, the rural Malays, the Ainu of Japan, and the Maya from Guatemala) try to achieve the same objective through encouraging pregnant women to work hard and do lots of heavy physical exercise in the last few months of pregnancy, rather than by eating less. Similarly, in Nepal, women are aware that smoking stunts a baby’s growth, so some women intentionally continue to smoke during pregnancy in the hope of producing a smaller baby. There are also cultures where pregnant women are given extra food. There are many examples of cultural beliefs and practices that have serious negative consequences for exclusive breastfeeding and its subsequent negative impact on nutritional status of the newborn. It may have made sense in the past when it was probably “normal” for young girls to get pregnant as soon as they menstruated and before their hips properly broadened. This is still the custom in many places, such as South Asia (India; Bangladesh, Nepal) and West Africa (Niger) for examples. Young girls don’t reach full maturity (fully become women) until at least after 18 years of age.

## PART VI. WHAT ARE THE SOLUTIONS FOR THE DOUBLE BURDEN OF MALNUTRITION?

**Without interventions, the burden of NCD risk associated with DBM is likely to be greater in LMICs in the future than it was in developed countries.** Because the consequences of the DBM differ by location and population, predicting the changing dietary patterns and living conditions in low- and middle-income countries (LMICs) is difficult. However, current trends suggest that increasing numbers of stunted individuals will move from rural to urban areas where their exercise levels will decrease and their diets will become more *energy dense*.

**This section reviews the existing interventions and programs that affect the DBM.** The global recommendations, policies, and policy advice developed over the years are discussed, as well as efforts to implement interventions and the necessary capacity.

### Programmatic and Policy Interventions

**Programs for reducing the DBM need to consider both preventive and curative approaches across the life course.** In large part, the nutrition-infection complex determines how children grow and develop mentally. Later in life, diet and physical activity interactions drive the diseases we are likely to suffer during our lifespan, and ultimately, how we will age and die. These factors affect nutritional status and health during their respective stage of the life course, but also have a cumulative effect on later phases. It has been proposed that a series of such programs should cover five age groups: fetal life, infancy and childhood, adolescence, adult life, and old age (Uauy and Solomons 2006).

**Given the cumulative effect of nutrition insults both early and later in life, the protection of fetal and early childhood growth should be seen as the primary preventive interventions (Shrimpton 2006).** The first priority in reducing the DBM, especially in LMICs, must be to address maternal and child undernutrition. In this respect, efforts targeting the DBM must build on the efforts of the Scaling Up Nutrition (SUN) Global Movement to scale up proven interventions aimed at maternal and child undernutrition, not detract from them.

**Schools are the critical setting for preventing child obesity (Waters et al 2011) and reducing other chronic disease risk factors and improving fitness (Flynn et al 2006).** Schools offer the opportunity to generate healthy life skills in addition to those relating to eating a healthy diet. The Nutrition Friendly Schools Initiative (NFSI) (WHO 2006) aims to increase access and availability of healthy foods and opportunities to be physically active, and to decrease access and availability of unhealthy or “junk” foods and support healthy lifestyles. NFSI has been tested in California, USA, with some success (UCLA 2008). In LMICs, NFSI should be expanded to include micronutrient and life-skill interventions aimed at adolescents, especially to control anemia, as was achieved so successfully in Uttar Pradesh, India (Vir et al 2008).

**The Institute of Medicine (IOM) report on obesity prevention in the US proposes making schools a national focal point for obesity prevention.** The IOM recommends that schools provide quality physical education and ensure strong nutritional standards for all foods and beverages sold in or provided by the schools, as well as ensure that food literacy and skill development is part of the curriculum (Institute of Medicine, Food and Nutrition Board 2012). Intervening at preschool level and through early child development programs is important to ensure stunted children receive as much help as possible to prevent further negative consequences into adulthood.

**The workplace offers many opportunities for nutrition interventions and raising awareness.** Worksites can offer education, risk factor screenings, incentives to walk or ride a bike to work, and facilities for exercise during breaks, as well as healthy foods in cafeterias. These interventions can reduce staff sick days and health costs benefitting employers and employees. Johnson & Johnson introduced Live for Life in 1979. By the end of the program’s third year, the company saved more than US\$400 per year, per employee (Bly 1986). A recent systematic review of worksite nutrition interventions provides further support to these findings (Anderson et al 2009).

**A framework to prevent the DBM across the life course that includes both direct and indirect interventions builds on the Gillespie and Haddad’s 2001 proposals and draws on the more recent Lancet Nutrition Series reviews (Swinburn et al 2011 (see Table 2)).** Direct interventions include nutrient supplements, food supplements, nutrition education, and food fortification. Indirect interventions are those delivered at the level of the household or community, and include cash transfers, and fiscal policy instruments, as well as codes of practice concerning marketing of foods.

**Table 2. Multisectoral Direct and Indirect Intervention to Reduce DBM**

Stage of life course	Direct interventions	Indirect interventions
Conception to birth	<ul style="list-style-type: none"> <li>• Micronutrient (Iron/folate) supplements</li> <li>• Balanced protein energy supplements*</li> <li>• Deworming</li> <li>• Reduction of household/cigarette smoke</li> <li>• Presumptive radical treatment for malaria*</li> <li>• Insecticide-treated bed nets*</li> </ul>	<ul style="list-style-type: none"> <li>• Salt Iodization</li> <li>• Flour fortification</li> <li>• Oil fortification</li> <li>• Conditional cash transfer programs (with nutrition education)</li> <li>• Prevent child marriage and teenage pregnancies</li> <li>• Public Information campaigns on healthy eating</li> <li>• Fiscal food policies <ul style="list-style-type: none"> <li>• Food subsidies</li> <li>• Fat/sugar taxes</li> <li>• Levies</li> </ul> </li> <li>• Urban planning <ul style="list-style-type: none"> <li>○ Bike lanes</li> <li>○ Parks</li> <li>○ Pedestrian precincts</li> <li>○ Water and Sanitation</li> <li>○ Smoke free houses (chimneys)</li> </ul> </li> </ul>
Young children (0-5 years)	<ul style="list-style-type: none"> <li>• Exclusive breastfeeding promotion,</li> <li>• Appropriate complementary feeding promotion</li> <li>• Hand washing and hygiene interventions</li> <li>• Young child supplementation with vitamin A and zinc,</li> <li>• Management of severe acute malnutrition</li> </ul>	<ul style="list-style-type: none"> <li>• Code of marketing of breastmilk substitute</li> <li>• Conditional cash transfer programs (with nutrition education)</li> <li>• Strengthen linkages from national producers of fruit and vegetables to urban markets</li> </ul>
Children (5-18 years)	<ul style="list-style-type: none"> <li>• School-based</li> <li>• Providing healthy meals</li> <li>• Promotion and provision of daily physical exercise</li> <li>• Weekly iron supplements/deworming</li> </ul>	<ul style="list-style-type: none"> <li>• No vending machines or junk food sales in schools</li> <li>• No advertising of food aimed at children/youth</li> <li>• Food labeling <ul style="list-style-type: none"> <li>• Nutrition signposting</li> <li>• Control food claims</li> </ul> </li> </ul>
Adulthood (18+yrs)	<ul style="list-style-type: none"> <li>• Medical service provider counseling on healthy diet</li> <li>• Worksite encouragement to exercise and eat healthy foods</li> </ul>	
Elderly	Healthy aging programs	

Source: Authors, Adapted from Gillespie and Haddad 2001, Swinburn et al 2011

Because the causal factors affecting the DBM occur at different times across the life course, interventions will need to be considered separately for each of the four thematic groupings presented here: biological/health environment; economic/food environment; physical/built environment; and socio-cultural environment.

## Health/Biological Environment

**Recognizing and treating obesity as a disease is an important, if not essential, element of any national plan to prevent and control cardiovascular diseases, diabetes, and cancers.** Proponents assert that defining obesity to be a disease would remove its social stigma, afford it the same legal protections as other illnesses, and oblige medical professionals, insurers, and employers to treat obesity with the same degree of concern given other diseases. With new evidence of the role of the *inflammatory state of obesity* associated with a host of conditions linked to the metabolic syndrome, it makes even more sense to ensure that overnutrition is addressed as part of the prevention and treatment of NCDs in LMICs.

**Scale up essential nutrition interventions during the “window of opportunity,” from conception to two years.** For the fetal and early child stages of the life course, direct interventions are largely provided through the health services. If this package of essential nutrition interventions for the period of conception to two years were taken to scale in LMICs at observed levels of program effectiveness, they could prevent about one-quarter of child deaths under 36 months of age and reduce the prevalence of stunting at 36 months by about one-third. Such direct nutrition interventions programs are more likely to be successful and to be sustained if they include a community-based component (Shrimpton 1995, Gillespie et al 1996). Adequate community outreach is essential to ensure a high coverage of the continuum of care with essential nutrition interventions across the three modalities of service delivery: health-post based, periodic outreach, and community-based activities from conception through to two years of age (Kerber et al 2007).

**In addition to the benefits of breastfeeding in reducing mortality in infants, there is increasing recognition of its benefits for preventing overweight/obesity later in the life course.** Suboptimal breastfeeding, especially non-exclusive breastfeeding in the first six months of life, results in 1.4 million deaths and 10 percent of the disease burden in children younger than five years (Black et al 2008). Recent research also suggests that exclusive breastfeeding during early months is central to the mechanism by which breastfeeding protects against later obesity (Singhal and Lanigan 2007). Future growth seems to be programmed during the first six months of life, when normal growth in exclusively breastfed babies is much slower than in bottle-fed ones. Furthermore there is a “dose–response” effect for the prevention of obesity, since a longer duration of breastfeeding is associated with lower tendency to later obesity. The risk of being overweight is 20 percent greater if an infant is exclusively bottle-fed than exclusively breastmilk fed during the first six months of life.

**Incorporate and strengthen addressing overnutrition in the health care setting.** Interventions by health care providers can also be very effective, especially if they are trained to measure body mass index (BMI) and/or waist circumference (WC), so that they can detect patients who are either overweight and/or gaining weight. Even brief messages about nutrition through diet counseling can influence behavior, and the magnitude of the effect on behavior is related to the intensity of the intervention (Pignone et al 2003). A more recent meta-analysis confirmed these findings (Ammerman et al 2008).

## Economic/Food Environment

**The sudden rise of obesity prevalence during the past few decades cannot be accounted for by population genetic changes and will need to be addressed through minimization of the environmental triggers and effects of the obesogenic environment (Swinburn et al 2011).** Policies regarding the production, importation, distribution and sale of specific foods can influence their cost and

availability. Improved food supply can also be achieved through better processing and manufacturing, fortification, increasing access to healthy foods, and curtailing availability of ultra-processed foods. Steps should be taken to ensure that such interventions strengthen local food systems and favor the switch to sustainable diets (De Schutter 2011).

**Collaboration and stronger involvement with the private sector is key to controlling the environmental triggers.** The private sector has an important role in achieving many of the nutrition related MDGs. The United Nations Standing Committee on Nutrition (UN SCN) developed a private sector engagement policy in 2008 to facilitate such involvement. How to engage with big business in the pursuit of nutrition related MDGs is the subject of the latest SCN News (UNSCN 2011). Various food-related multinational companies are among the institutions supporting the SUN global movement; even though how to ensure that conflict of interest is ruled out in such cases is not yet clear.

## Availability

**Support the sustainability of the global agricultural system.** The sustainability of the global agricultural system is in great peril as it is currently organized. Meeting development and sustainability goals will require a fundamental shift in agricultural knowledge, science, and technology to account for the complexity of agricultural systems within diverse social and ecological contexts (IAAST 2009). This shift may call for changing the incentive systems for all actors along the value chain to internalize as many externalities as possible, and to recognize farming communities, farm households and farmers as producers and managers of ecosystems. The Ministerial Declaration adopted at the start of the Doha Development Round of trade negotiations on 14 November 2001 was a promising response to the anti-globalization riots of the 1990s. However, in the 10 years since the WTO pledged to deliver pro-development changes in the way it works, developing countries seem to have been completely sidelined by the global powers in the WTO deliberations (Walker 2011).

**Peri-urban agriculture is probably more important than previously thought in delivering fresh products to urban markets.** Policies need to acknowledge the role of these markets. Examples of the existence and the importance of peri-urban agriculture include the fresh green salad production on the fringes of towns in Africa, milk supply by milk walas<sup>4</sup> in South Asia from dairy produced on the outskirts of town, the entirely indigenously developed intensive catfish farming sector in Nigeria selling live catfish to buka<sup>5</sup> restaurants.

## Distribution

**Facilitate the supply of fresh products from rural areas to urban markets.** Local farming communities need to be supported to better understand, access, and feed into the expanding urban food markets. The recent rises in global food prices increased food prices in LMICs, but small-scale farmers do not seem to have benefitted from these increases (FAO 2009). Efforts to enable rural producers to fine tune their production to match changing urban eating habits and demand, especially for fruit and vegetables, could help counter the tendency to rely on food imports as well as make local diets “healthier.” This can be a deliberate process, for example, market extension and training, linked with creating networks of producers and enabling them to do market research using mobile phones. Such policies could also contribute to reducing poverty, much of which is located in rural areas, especially because small-scale production of high-value crops, such as fruit and vegetables, does not require large plots of land, which are predominantly owned by large landowners.

---

<sup>4</sup> Local vendors

<sup>5</sup> Nigerian restaurant

**Investments in infrastructure and telecommunications can help lower transaction costs and contribute to access to healthier diets.** Examples include support for rural roads, judicial investments in rural markets, and improving cell phone coverage. Currently, transport represents about 20 percent of the cost of maize in the urban wholesale markets in East Africa. Half of this is incurred in the first 25 percent of the journey. Assembly markets, access roads, cell phone coverage, and facilitating better logistics and backhauls would help lower these internal transport costs. Often these internal transport costs are higher than those of exporting nations. It is said, for example, that the cost of transporting rice from northern Ghana to the capital Accra is higher than the cost of transporting rice from Vietnam to Accra (USAID 2009).

**In South Asia, support for the emergence of farmers markets in urban locations is growing.** At these markets, farmers or their representatives sell produce directly at prices mid-way between wholesale and retail prices. Some of the more progressive countries in Southeast Asia take the view that the supermarket supply chain can well take care of itself, and therefore, they are focusing their support on raising the level and standards of the traditional “wet markets” where the bulk of fresh produce and animal proteins is purchased.

### **Improving Access to Health Food Products**

**Change relative pricing and enact fiscal policies.** Fiscal policies such as subsidies and taxes can either stimulate or reduce consumption of food and other products. Capitalist economics have been considered to have a central role in the global obesity epidemic, and economic policies are arguably the optimal target for intervention (Wells 2012). Some examples of possible actions that could be considered include:

- **Link food stamps to farmers markets.** Food stamps can be linked to the purchase of fruit and vegetables in local farmers markets. In the US, the USDA Federal nutrition assistance programs provided about US\$10 billion in support of fruit and vegetable consumption in FY 2005 (USDA 2008). These funds support USDA’s purchase and distribution of fruits and vegetables to schools, food banks, and other program providers through the Child Nutrition Programs, and participants’ purchases in the marketplace through Food Stamps, WIC, and the farmer’s market nutrition programs.
- **Consider cash transfers.** There is great international interest in and enthusiasm for cash transfers (CTs) as a more sustainable way to provide social protection than giving food aid. There are two types of CTs: unconditional cash transfers (UCTs) and conditional cash transfers CCTs. UCTs are given to poor and vulnerable people with no restrictions on how the cash is spent, and no requirements beyond meeting the eligibility criteria. In contrast, CCTs are delivered only if recipients meet certain requirements, such as that their children should be enrolled in and attending school, and/or must be immunized, etc. Effective implementation of CT programs requires adequate and sustained financing, administrative and management capacity, and political commitment. Finely targeted CCTs may be more fiscally affordable than universal transfers, but delivering these transfers every month, in full and on time presents challenges, especially where physical infrastructure and logistical capacity are constrained. Where government capacity and budget allocations for monitoring and supervision are limited, these programs can be vulnerable to “leakages” and corruption (Devereux et al 2005). Evidence of a nutritional impact of CTs is still very limited, especially beyond Latin America (Lagarde et al 2007, Manley et al 2011, Lagarde et al 2009), where the Progressa program shows some impact and is the gold standard (Sridhar and Duffield 2006, Hoddinott and Bassett 2009). Indonesia’s CCT program considers piloting stunting prevention through the CCT approach.
- **Levy fat tax.** The heavy tax on cigarettes helped reduce their consumption in many countries. In Poland, reduced subsidies on lard and butter soon after the transition to a democratic government resulted in a rapid increase in the consumption of cheaper non-hydrogenated vegetable fat. In consequence, the ratio of dietary *polyunsaturated* to *saturated fat* increased from 0.33 in 1990 to 0.56 in 1999, and mortality from CAD dropped 28 percent (Zatonski et al 2010). In Denmark, a fat tax was levied but has been abolished as people tended to resort to buying the taxed products overseas and little

effect was seen. This experience shows that much more thinking through these types of measures is needed to achieve the intended results.

- **Levy tax on sugar sweetened beverages.** A tax on sugar sweetened beverages has many proponents, and if sufficiently large (such as 20 percent) has great potential to reduce obesity as well as to raise revenues (Anreyeva et al 2011).

## Consumption

**Ban sugar-sweetened beverages in schools.** Most US states have adopted laws that regulate the availability of sugar-sweetened beverages in school settings (Mello et al 2008). In France and the UK, vending machines have either been banned in schools or are no longer filled with sugar-sweetened beverages or Group 3 ultra-processed snack foods. These interventions recognize that excessive consumption of sugar-sweetened beverages is an important driver of the current obesity epidemic in the US (Malik et al 2006), and is associated with a significantly elevated risk of type 2 diabetes (De Koning et al 2011). New York City Mayor Michael Bloomberg's ban on extra-large soda-beverages, considered controversial by some, is a good example of addressing portion size. Portion size policies were introduced in the early 20<sup>th</sup> century in France and may have had long-term positive effects on French eating habits regarding smaller portion size.

**Offer health diets.** Ensuring that only “healthy diets” are provided in all state-run institutions, for example, schools, hospitals, etc., as well as limiting access to unhealthy foods sold through vending machines, are also measures that can help improve the food supply.

**Eliminate *trans-fatty acids*.** An example of improved processing is the elimination of trans-fatty acids, which has been achieved largely by modifying the process of *hydrogenation* of vegetable oils, through legislation and by manufacturers complying with public health directives in Europe and the United States. In Mauritius, the government required a change in the commonly used cooking oil from palm oil to soybean oil, which resulted in reduced *fatty acid* intake and *serum cholesterol* levels (Uusitalo et al 1996).

## Physical/Built Environment

**Transport policy and environmental design have fundamental effects on the determinants of physical activity, and by extension influence the risk of obesity and other chronic diseases.** The availability, accessibility, and convenience of destinations and facilities, as well as the general functionality of the neighborhood (for example, the presence of sidewalks, traffic conditions) and aesthetics have been shown to be positively associated with various levels of physical activity.

**Increase opportunities for exercise.** Urban planning can play an important role in increasing opportunities for exercise. Local governments also have an important role to play, be it through creating parks and open spaces for exercise, as well as bike lanes and pavements to encourage pedestrians (Edwards and Tsouros 2006), or through policies like Let's Move, Change4Life, Action Sante or other efforts to increase active transportation (OECD, Obesity Update).

**Limit the role of automobiles.** Limiting the role of automobiles is one important area for interventions and this can be achieved through a variety of channels. These include: making private car ownership and use more expensive; raising taxes on cars as well as on fuel; introducing road tolls and congestion charges; and introducing parking fees. The fees collected can be used to improve the provision of public transportation.

## Socio-Cultural Environment

**Promote public education campaigns.** Public education campaigns to promote a “healthy diet” can be effective, especially if the intervention is direct and delivered through medical services or in schools. Healthy diets based on the food group and pyramid approaches have been much criticized, not least because during the thirty years of the food pyramids, obesity rates in the United States have soared. In an effort to restructure US food nutrition guidelines, the USDA revised them in 2010 (USDA 2010), and has now rolled out its new MyPlate program.. Innovative campaigns like “text4baby” aimed at reaching young and low SES moms with IYCF guidance are starting to be implemented by the Centers for Disease Control and Prevention (CDC) in the USA.

**Reduce marketing of foods to children.** Underlying the potentially significant impact that marketing has on the DBM, both in positive and negative directions, is the natural process of brain development that leaves children vulnerable to marketing messages during the most important period for establishing positive nutrition habits. Before the age of 12, the brain is only capable of straight processing of facts. Abstract thinking begins between 12 and 14 years of age (Dosenbach et al 2010), with full maturity only achieved by around 18 years of age. Children therefore lack the capacity to make sound judgments and counteract marketing messages (James 2011). The World Health Assembly called for national and international action to reduce the impact on children from marketing foods high in saturated fats, trans-fatty acids, free sugars, or salt.<sup>6</sup> Consumers can also be protected from aggressive marketing of unhealthy foods. Brazil, for example, banned television advertising of foods aimed at children.

**Standards and guidelines.** Standards and guidelines for food labels have been developed by, but countries across the world have considerable variation in food labeling approaches and regulations (Hawkes 2004). Currently in the United States, efforts revolve around improving food labeling by including front-of-package labeling, nutrition facts panel, and menu labels. Voluntary nutrition labeling adopted by the US food industry is considered far from ideal in many ways (Brownell 2011). The food industry has pledged to self-regulate, but stringent standards are needed if self-regulation is to be effective.

**Nutrition profile models.** WHO provides guidance for developing or adapting nutrient profile models (WHO 2011) to promote a consistent approach and coherent nutrition messages for the consumer, and ultimately to improve nutrition and public health. In accordance with these nutrient profile models, marketing claims on food labels for being “low fat” or “healthy choice” can be regulated by national food standards authorities.

## Cultural Norms and Beliefs

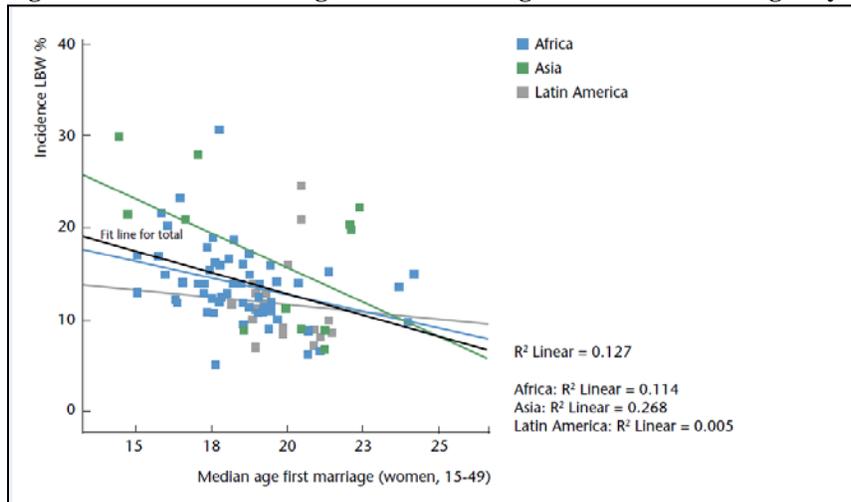
**Evidence for the effectiveness of measures to prevent child marriage and reduce teenage pregnancy to improve birth weight is not strong, but circumstantial evidence is compelling.** The evidence is not strong principally because no randomized controlled trials have been done to demonstrate effectiveness. However, adolescent and child marriage continues to be a strong social norm in the developing world, particularly in Central and West Africa, and South and Southeast Asia. Age at marriage is highly correlated with age at first birth (Figure 14) (UNSCN 2010). The relationships between median age at first marriage (reported by women aged 15-49 years) and low birth weight was examined using national estimates of each from 1997 to 2007. As shown in Figure 14, increased median age at marriage is associated with lower incidence of low birth weight overall, and in Africa and Asia. Considering the age and related size of the mother is one of the strongest determinants of birth weight. This is because young

---

<sup>6</sup> The 63rd World Health Assembly in May 2010 endorsed resolution WHA63.14.

girls have not finished growing until after eighteen years of age. Interventions to prevent child marriage and reduce teenage pregnancy would improve birth weights, for example, keeping girls in school to complete their education, as well providing them with life-skills education including family planning and explaining the benefits of delaying first pregnancy. Linking cash transfer conditionality to girls completing school is showing results especially in South Asia, (World Bank 2007). Increased completion of schooling by girls, especially at the secondary level, greatly contributes to the reduction of child marriages and of teenage pregnancies.

**Figure 14. Scatter Plot of Age at First Marriage and Low Birth Weight by Region**



Source: UNSCN 2010.

## PART VII. WHAT IS THE COMMITMENT AND CAPACITY FOR INTERVENTION ON THE DOUBLE BURDEN OF MALNUTRITION?

**While there are numerous examples of countries reversing NCDs, there are few examples of countries that have reversed or even reduced the trend of increasing overnutrition.** Although there is guidance for specific policies and programs targeting individual components of the DBM, they remain disparate initiatives. The lack of a single unified and comprehensive strategy to reduce the DBM can be attributed to the recentness of the DBM phenomenon and its conceptualization, and the newness of nutrition science in general. Nutrition is a relatively young science; most of what is known about nutrition was discovered in the last few decades (James 2000). In 1949, the United States' first nutrient intake recommendations included just eight vitamins and minerals; forty years later, there were 24 recommended intakes (Food and Nutrition Board 1989). The obesity epidemic affecting most nations emerged just thirty years ago, while only in the last decade have the enormous benefits of addressing undernutrition begun to be understood. In LMICS, the newness of the science of nutrition is compounded by the lack in most countries of a professional cadre of workers trained to develop, implement, and manage programs that recognize and reduce the DBM.

**To reduce the multitude of nutrition-related chronic diseases facing most LMICs over the next few decades, they will need to scale up nutrition interventions.** Until recently, the dominant development paradigm considered that undernutrition to be ameliorated by the “trickle down” of economic development. We now know that even though the costs of interventions to reduce undernutrition rapidly are relatively small (Horton et al 2009), economic development alone only reduces the problem of maternal and child undernutrition very slowly and inconsistently (Haddad et al 2002). The nutrition interventions that exist in most low- and middle-income countries (LMICs) are focused on undernutrition and limited to the health services sector.

**This section reviews the existing commitment to reduce the DBM as reflected in global policies and capacity.** Reducing the DBM, requires a broad alliance of different national and local government sectors, local leaders and councils, sport and parent-teacher associations, and clubs, nongovernmental organizations (NGOs), academics, the media, and the private sector. All need to be involved in discussions and partnerships. Even though global recommendations and policies have been developed over the years, as well as efforts to implement recommendations, there has been little concerted effort to implement the proposed recommendations. A summary of the different agencies and efforts made is included in this section as are the global recommendations to reduce the DBM. A policy framework is also developed following the four multisectoral pillars approach.

**Momentum to act in nutrition is gathering pace across the globe through the Scaling Up Nutrition (SUN) global movement (Nabarro 2010).** SUN emerged from the recognition that development funding to reduce maternal and child undernutrition has been far too small (Shekar et al 2006), especially considering the negative consequences of undernutrition in terms of mortality, morbidity, and lost human capital development. Even though the SUN global movement focuses on maternal and child undernutrition, this is one of the most important first steps that LMICs should take to prevent the DBM in the future. SUN has adopted WHA 2012 goals, which include indicators for undernutrition and overweight. Since its inception in 2010, SUN has been endorsed by over 100 international institutions.

### Existing Global Governance Arrangements

**The worldwide dramatic increase in diet-related NCDs over the last few decades has led the leading agencies for changes in diet and physical activity to issue a series of global policy recommendations.** Nonetheless, policy guidance relevant to the DBM is disparate and from numerous agencies (for example,

Ministries of Health and Ministries of Agriculture), and even from numerous departments within a single agency such as departments of nutrition and departments of non-communicable diseases. A recent analysis of the international nutrition system (Morris et al 2008) considered it “fragmented and dysfunctional”, and called for a more functional international nutrition system (Bryce et al 2008). A national nutrition system has to address overnutrition *and* undernutrition.

**The World Health Organization (WHO) issues the majority of global policy recommendations for the DBM. The WHO is the main global intergovernmental body with authority for health and nutrition.** Its work is guided by their governing body, the World Health Assembly (WHA), composed of the Ministers of Health of member states. The WHA meets annually to make policy recommendations on health and nutrition. The WHO produces technical reports by expert consultations, as well special reports such as the annual World Health Report. Although WHO yields no official regulatory authority, the agency relies on member states to embrace its recommendations. In developing nations, WHO’s standards and policies recommendations often become regulations and policies in these countries. Despite adopting the WHO recommendations, national adherence and enforcement is inconsistent.

**The Committee on World Food Security of the Food and Agriculture Organization of the United Nations (FAO) also produces global food policy.** The FAO monitors progress in the implementation of the World Food Summit Plan of Action, based on reports from national governments and international organizations. FAO provides technical support to the realization of the right to food, and has materials available on its website (FAO 2010).

**The WHO and FAO jointly provide normative policy guidance in food standards through the Codex Alimentarius Commission (Codex 2009).** The main purposes of the Codex are to protect the health of the consumers and ensure fair trade practices in the international food trade. It also promotes coordination of all food standards work undertaken by international, governmental and Non-Governmental Organizations. Codex recommendations are not officially endorsed by WHO and/or FAO, as they are best practice guidelines. Their recommendations are followed on a voluntary basis. However, the Codex is recognized by the World Trade Organization (WTO) as an international reference point for the resolution of disputes concerning food safety and consumer protection, thus lending it greater authority.

**The right to food is a human right protecting the right for people to feed themselves in dignity.** This implies that sufficient food is available, that people have the means to access it, and that it adequately meets the individual’s dietary needs (Knuth and Vidar 2011). The right to food does not imply that governments have an obligation to hand out free food to everyone who wants it, or a right to be fed. However, if people are deprived of access to food for reasons beyond their control, for example, because they are in detention, in times of war or after natural disasters, this right requires the government to provide food directly. The right is derived from the International Covenant on Economic, Social and Cultural Rights, which had 160 state parties as of May 2012.

**The International Covenant on Economic, Social and Cultural Rights recognizes the “right to an adequate standard of living.** This includes “adequate food” as well as the “fundamental right to be free from hunger.” The relationship between the two concepts is not straightforward. For example, “freedom from hunger” could be measured by the number of people suffering from undernutrition and at the extreme, dying of starvation. The “right to adequate food” is a much higher standard, including not only absence of undernutrition, but the full range of qualities associated with food, including safety, variety and dignity; in short all those elements needed to enable an active and healthy life

**In 106 countries, the right to food is applicable either via constitutional arrangements of various forms or via direct applicability in law of various international treaties.** Ten countries have adopted and nine countries are developing framework laws on food security or the right to food. These are often

known as food security laws instead of right to food laws, but their effect is usually similar. Framework laws are more specific than a constitutional provision, as they lay down general obligations and principles. However, competent authorities and further legislation, which still have to determine specific measures, should be taken.

**At the 1996 World Food Summit, governments reaffirmed the right to food and committed themselves to half the number of hungry and malnourished from 840 to 420 million by 2015.** However, the number has increased over the past years, surpassing 1 billion undernourished people worldwide in 2009. The Food Assistance Convention, which was adopted on 25 April 2012, aims at “addressing the food and nutritional needs of the most vulnerable populations.” This international treaty, relating to food assistance, includes mechanisms for information sharing and registration of commitments made towards such assistance; it entered into force on 1 January 2013.

## Existing Global Nutrition Recommendations

The WHO/FAO Expert consultation on Diet, Nutrition and the Prevention of Chronic Disease provided guidance on a range of population nutrient intake goals for use towards the development of national dietary guidelines as shown in Table 3

**Table 3. Recommendation for Daily Intake**

Dietary Factor	Goal (% of total energy unless otherwise stated)
Total Fat	16-30%
Saturated fatty acids	<10%
Polyunsaturated fatty acids (PUFAs)	6-10%
n-6 Polyunsaturated fatty acids (PUFAs)	5-8%
n-3 Polyunsaturated fatty acids (PUFAs)	1-2%
Trans fatty acids	<1%
Monounsaturated fatty acids (MUFAs)	By difference
Total Carbohydrate	55-75%
Free sugars	<10%
Protein	10-15%
Cholesterol	<300mg/day
Sodium chloride	<5g/day
Fruit and vegetables	>400g/day

Source: WHO 2003

**The recommendation for total fat intake is 20 to 30 percent of daily calorie intake.** These recommendations are formulated to include countries where usual fat intake is above 30 percent, as well as those where it may be very low, but 20 to 30 percent is considered consistent with good health. Highly active populations groups with diets rich in vegetables, legumes, fruits, and wholegrain cereal may sustain a total fat intake up to 35 percent without risk of unhealthy weight gain, but in more sedentary populations, the lower levels of intake are certainly more appropriate.

**The quantity as well as the quality of the fat consumed is also important.** It should include little or no *trans-fatty acids* and low *saturated fat* content. *Unsaturated fats* should include both *omega-6* and *omega-3 polyunsaturated fats* in a ratio no greater than 3.

Higher intakes of *free sugars* threaten the nutrient quality of the diet by providing significant energy without specific nutrients. ***Free sugars* promote a positive energy balance, and drinks rich in free sugars increase overall energy intake by reducing appetite control. Whole grain cereals, fruits and vegetables are the preferred sources of non-starch polysaccharides (NSP), and the recommended**

**intake of fruit and vegetables together with the consumption of wholegrain foods is likely to provide >20g/d of NSP (>25g/day of total dietary fiber).**

## **Global Recommendations for Physical Activity**

**One hour per day of moderate intensity activity.** The recommended goal<sup>7</sup> for physical activity that focuses on maintaining healthy body weight is for a total of one hour per day of moderate intensity activity, such as walking most days of the week. This is different from the widely recognized public health recommendation of half an hour a day of moderate physical activity, which while appropriate for the reduction of cardiovascular risk does not reduce risk for all of the other NCDs. These activity recommendations are for people that are otherwise largely sedentary. The recommendations do not take into consideration exercise provided by occupational activities, such as cleaning, for example, and are not intended for populations involved in heavy physical labor on a daily basis.

## **Increased Capacity Crucial**

**The need for guidance—not only on “what to do” but also “how to do it,”—has been widely acknowledged (Berg 1992, Brown and Dewey 1993, Jonsson 1993, Chopra and Sanders 2000, Heikens et al 2008).** However, as confirmed by the Lancet Nutrition Series (LNS), the “what” of undernutrition is reasonably well established (Gillespie et al 1996, Allen and Gillespie 2001). Similarly, there is a considerable body of experience to guide the “how” in various developmental settings across the globe (ACC/SCN 1990, ACC/SCN 1996, Mason et al 2006). Rather, it is the capacity to implement such activities—and the capacity to train health workers in how to manage and implement nutrition programs—at scale in high undernutrition-burden LMICs that is lacking (Mason et al 1999, Gillespie et al 2003).

**Evidence shows that the nutrition capacity of LMICs is limited at national and district levels (Nishida et al 2009).** Nutrition governance mechanisms may exist in many LMICs, but few if any of them approve budgets or have any real authority. LACA reports recommend improving capacity at all levels of the health system by creating Master’s degree program graduates and improving health professionals in-service training. However, few LMICs have academic centers to provide formal nutrition training. The World Public Health Nutrition Association aims to promote the development of the nutrition workforce capacity, thus offering an opportunity to standardize such processes across countries, and eventually to allow a process of professional certification (Hughes et al 2012).

**Very limited capacity exists at almost all levels of planning and implementation of nutrition interventions.** The countries of the WHO European Region agreed upon the first action plan for food and nutrition policy for 2000-2005. They recommended developing an integrated and comprehensive national food and nutrition policies to address three areas of nutrition security: public health nutrition, food safety, and sustainable food security (Robertson et al 2004). However, while legal provisions and entitlements already existed for food security and food safety in most countries in Europe, public health nutrition lagged behind. Moreover, although half of the countries had nutrition councils or bodies that provide scientific advice to politicians, less than a third had administrative structures to help ensure that such policies were implemented.

**While many countries do have a nutrition plan, there is inadequate coverage.** Just 68 percent of countries are reported to have a written policy, plan or strategy for overweight/obesity control, and only 48 percent of these are said to be operational. While many countries have national policies for undernutrition and overnutrition, few are implemented at scale. The Lancet Nutrition Series on effective

---

<sup>7</sup> The report of the 2002 joint WHO/FAO expert consultation (TRS 916).

action at the national level reported that most of the twenty countries with the highest burden of stunting had national level nutrition policies with programs to reduce maternal and child undernutrition, but few if any of these had nationwide coverage.

**Creating the capacity to deliver nutrition specific interventions through the health sector to reduce maternal and child undernutrition is the first priority.** Capacity crucial to reduce undernutrition needs to be developed in the short term, as well as to reduce the risk of diet-related non-communicable diseases (NCDs) later in the life course. However, the DBM requires a multisectoral approach, as called for by the SUN movement, which will be difficult to implement unless high-level coordination mechanisms are in place with the capacity to allocate budgets.

## Multisectoral Coordination

**Many if not most of these global nutrition initiatives propose the use of multisectoral approaches, which require coordination to articulate the various sectoral policies and program efforts.** The Commission on Nutritional Challenges of the 21<sup>st</sup> Century put improved coordination and functionality for nutrition at the center of its recommendations (James et al 2000), and considers this prioritization essential for developing more coherent national nutrition policies and programs for reducing the DBM problem. Experience with trying to implement the National Plans of Action for Nutrition (NPAN) stemming from the ICN in the early nineties also suggests that some central coordination mechanism is essential for successful implementation. The ICN provides an illustrative example of how a high-level coordinating body might be organized to facilitate the full range of programs involved in reducing the DBM across the life course.

**Few good examples exist of high-level coordination mechanisms or implementation of nutrition programs at scale.** Perhaps the most advanced nation state in this regard is Brazil, where the incidence of child undernutrition has fallen spectacularly during the last few decades, as measured by stunting in particular (Monteiro 2009). Brazil has a high-level coordinating body for oversight and broad policy setting, as well as a coordination mechanism for implementation (see Box 4). Although interventions are still largely focused on “hunger,” a plan for the prevention and control of obesity is apparently being developed.

### Box 4. High Level Nutrition Coordination and Governance in Brazil

Brazil’s Zero Hunger Strategy involves 11 ministries in partnership with civil society, which makes up the National System for Food and Nutrition Security established by law in 2006, requiring the state to enforce the universal right to food and nutrition security as a public policy. Through this system, the Government agencies at national, state, and municipal levels, together with civil society organizations, must act jointly in the formulation and implementation of policies and actions to combat hunger and promote food and nutrition security.

Monitoring the implementation of the policy and approval of the budget is carried out by a National Council on Food and Nutrition Security (CONSEA), which brings together 18 State Ministers and 36 representatives of civil society, which are directly linked to the President of the Republic. In addition, there is an inter-ministerial coordination mechanism for reaching agreement on which ministry does what and how during implementation at all levels, especially the roles of the Ministries of Health, Education and Social Welfare.

Between 1996 and 2006/07, Brazil reduced child stunting from 13.5 percent to 6.8 percent nationally, and in the Northeast, the country’s poorest region, stunting declined spectacularly from 22.2 percent to 5.9 percent. These achievements were largely due to the Zero Hunger Strategy, the cornerstone of which is a conditional cash transfer program called “Bolsa Familia,” benefiting 11 million poor families that comply with an agenda for keeping children in school and for health monitoring.

## A Framework for DBM Policy Implementation

**The rationale for public action to address DBM and influence the diet transition towards a healthier outcome was made by Haddad in 2002.** The most obvious rationale for public action was the asymmetry in information available to consumers and producers about which foods are healthy and which are not (Haddad 2002). But external effects may also be affecting the DBM, such as when health care resources are diverted from infants to middle-aged individuals. Public action to safeguard consumers from marketing influence and to ensure proper labeling is needed (Haddad, 2002).

**Efforts to implement national nutrition programs for overnutrition and undernutrition demonstrated that sectoral strategies are best grouped into four pillars** (Table 4). These four pillars are (i) sustainable food security; (ii) food safety; (iii) healthy lifestyle; and (iv) nutrition. This overarching DBM policy framework facilitates the attribution of service delivery functions within the Ministry of Health as well as across other sectors, and sets the broad responsibilities in terms of goals and strategies to achieve them (Nishida et al 2003). Both supply and demand side options are included in these four pillars.

**Table 4. Four Overarching Pillars of the DBM Nutrition Policy Framework**

Sector	Nutrition Policy Pillars			
	Sustainable Food Security	Food Safety	Healthy Lifestyle	Nutrition
Health		<ul style="list-style-type: none"> <li>• Food safety and hygiene regulations</li> <li>• Food inspections</li> <li>• Food standards</li> </ul>	<ul style="list-style-type: none"> <li>• Promotion of healthy eating</li> <li>• Limit availability of inappropriate food</li> <li>• Promotion of exercise</li> <li>• Infection control</li> <li>• Family planning</li> </ul>	<ul style="list-style-type: none"> <li>• Micronutrient supplementation</li> <li>• Nutrition education</li> <li>• Dietary guidelines</li> <li>• Nutritional surveillance</li> <li>• Baby Friendly Hospitals</li> </ul>
Public Works/ Urban Development	<ul style="list-style-type: none"> <li>• Rural roads</li> <li>• Irrigation</li> </ul>	<ul style="list-style-type: none"> <li>• Water and sanitation</li> </ul>	<ul style="list-style-type: none"> <li>• Urban bike lanes</li> <li>• Pedestrian walkways</li> </ul>	<ul style="list-style-type: none"> <li>• Smoke free home environments</li> </ul>
Agriculture	<ul style="list-style-type: none"> <li>• Food availability (food production)</li> </ul>	<ul style="list-style-type: none"> <li>• Food standards</li> </ul>		<ul style="list-style-type: none"> <li>• Locally available fruit and vegetables</li> </ul>
Education	<ul style="list-style-type: none"> <li>• School gardens</li> <li>• School meals</li> </ul>	<ul style="list-style-type: none"> <li>• Hygiene education</li> </ul>	<ul style="list-style-type: none"> <li>• Physical exercise</li> <li>• Life skills and sex education</li> </ul>	<ul style="list-style-type: none"> <li>• Nutrition education</li> <li>• Anemia control</li> </ul>
Social Welfare/ Security	<ul style="list-style-type: none"> <li>• Food Access (cash transfers)</li> </ul>			<ul style="list-style-type: none"> <li>• Conditional cash transfers</li> </ul>
Industry/ Trade/ Commerce	<ul style="list-style-type: none"> <li>• Food availability (manufacture and marketing)</li> </ul>	<ul style="list-style-type: none"> <li>• Food standards</li> </ul>		<ul style="list-style-type: none"> <li>• Food fortification</li> <li>• Locally available fruit and vegetables</li> </ul>
Public Information			<ul style="list-style-type: none"> <li>• Marketing of food to children</li> </ul>	<ul style="list-style-type: none"> <li>• Code of marketing of breastmilk substitutes</li> </ul>
Finance/ Economy	<ul style="list-style-type: none"> <li>• Food subsidies</li> <li>• Import/export restrictions</li> </ul>			<ul style="list-style-type: none"> <li>• Food taxes</li> </ul>

## Operational Research Agenda

**An operational research agenda is required to address the DBM.** Even though Haddad's 2002 paper presented a much-needed agenda for food policy options, a more comprehensive and multisectoral agenda is needed. Moreover, it is time to begin its preparation and implementation. In addition to the already posed food policy questions, potential contributions by other sectors need to be incorporated. Important operational questions of exactly how and what the consequences will be to intervene programmatically in the double burden of malnutrition have yet to be answered. Currently, (and completely logically) programmatic examples are mainly for vertical programs addressing either undernutrition or overnutrition, but *not* the DBM. Finally, capacity will need to be strengthened substantially, from training community-level health workers to graduate nutrition students in developing countries. Specific training is required to coordinate the multisectoral approach to DBM.

**Creating awareness, capacity building, and promoting preventative care in the health sector to reduce the DBM are required.** How governments and the private sector should implement preventive interventions and manage chronic disease in a health system focused on curative care requires more research, including the question of better management, cost effectiveness, and future fiscal space.

**The public works research agenda should be focused on piloting and operational research.** The impact on health of interventions such as biking paths, pedestrian lanes, smoke-free environments and better water and sanitation needs to be better understood. The outcomes are not easy to measure and may be seen only in the longer term, increasing the challenge of measurement. However, water and sanitation are clear-cut interventions that are a major contributor to reducing stunting levels in LMICs.

**Many of the food policy options and agricultural research agenda ideas remain valid from the 2002 Haddad paper.** The use of existing data to chart trends systematically in the availability of "bad" food components remains important. Estimating food price elasticities in the LMICs to link consumption of certain foods with fats and chronic disease would allow better-targeted discussions. Running more pilots and evaluations is crucial and too little has been done since it was proposed in 2002. Technical processes to make foods healthier were proposed in 2002 as well. Some trials, particularly regarding quality improvements in the area of micronutrients, are showing results. Techniques to decrease perishability of fruits and vegetables were mentioned; however, more efforts are now made to bring markets closer to people instead of relying on distribution systems. There continues to be a large need to better understand price responsiveness, the supermarketization, marketing, and income responsiveness to a range of food products. Creative thinking and collaboration with private sector companies and supermarkets is also required.

**Understanding what interventions work to reduce DBM is important; so is increased awareness in the agriculture sector.** The FAO Committee on World Food Security is developing a Global Strategic Framework for Food Security and Nutrition. It will build upon existing frameworks, such as the UN's Comprehensive Framework for Action (CFA), the Comprehensive Africa Agriculture Development Program (CAADP), and the Voluntary Guidelines to Support the Progressive Realization of the Right to Adequate Food in the Context of National Food Security (FAO 2011). Ensuring awareness about DBM in these frameworks and discussions will help raise more attention.

**Education is a very important sector to prevent and control the DBM.** Healthy lifestyles are learned early in life; adolescent girls education about teenage pregnancy, parenting, and the overall knowledge about what is healthy nutrition can be taught at school. To be effective, school management plays an important role in ensuring nutrition friendly school environments. These include an environment where healthy foods are available and junk food and sugary drinks are not easily accessible and where physical education and exercise are promoted. In LMICs, it is important to understand the school environment and to look into labor market consequences of possible changes, such as removing vendors of unhealthy

snacks from the school environment. This may have negative consequences for the vendors who could lose their livelihood. Unwanted negative externalities should be avoided, for example by providing alternatives, even subsidizing these vendors to sell more healthy foods. All this is fairly uncharted research areas.

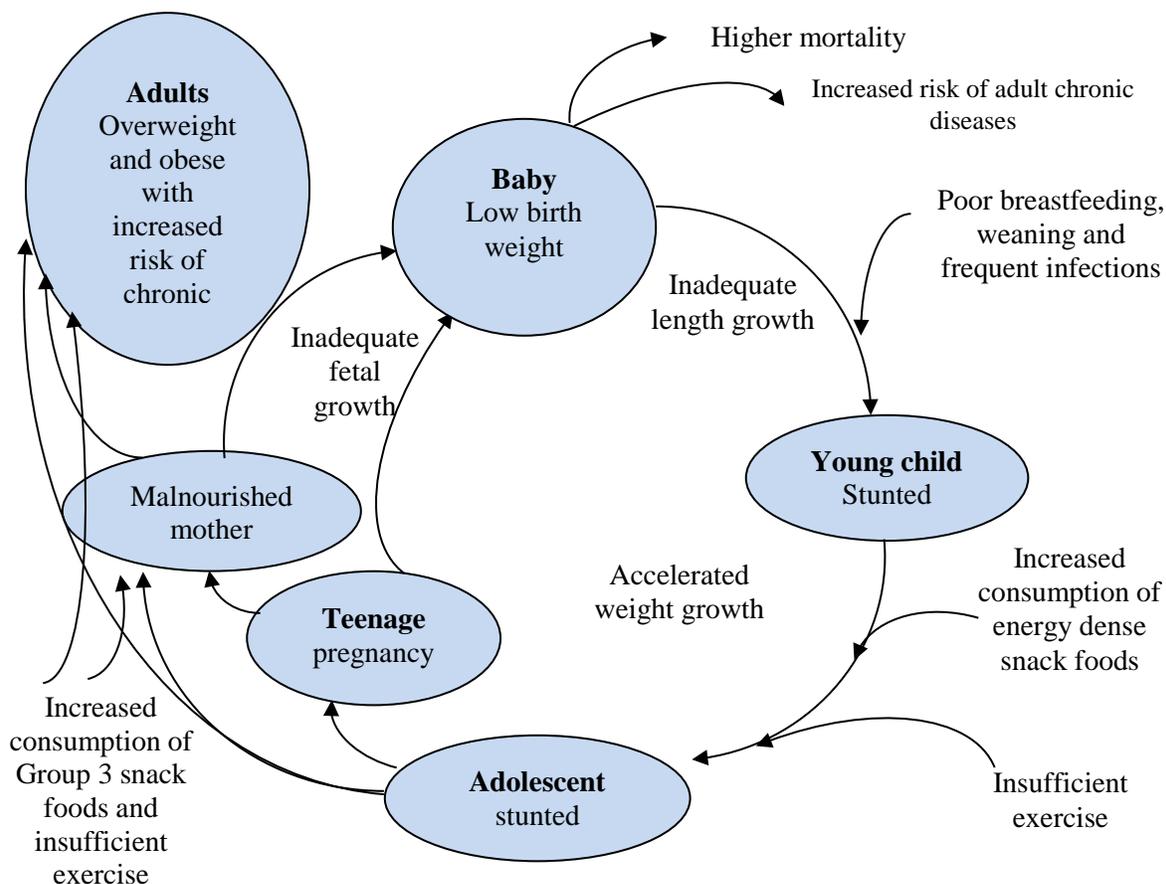
**Creating awareness, capacity building, and multisectoral collaboration are key.** AAs demonstrated by the limited number of pilots, and especially larger scale interventions, much remains to be done.

## PART VIII. CONCLUSIONS

**In the next two decades, most LMICs due to their economic growth can expect rapidly increasing levels of adult overweight and obesity, which will produce an increased burden of insulin resistant diabetes and cardiovascular diseases.** The multitude of factors that influence the development of the DBM across the life course are summarized in Figure 15, which is an “updated” version of the figure in the SCN document “Ending Malnutrition by 2020: An Agenda for Change in the Millennium.” (James et al. 2000). Figure 17 illustrates how increasing numbers of young people migrating to urban areas—stunted due to constrained fetal and young child growth in their natal rural areas—will be exposed to increasingly obesogenic urban environments.

**In just a few decades, two-thirds of the global population will reside in the urban areas of the current LMICs.** People in urban environments are becoming increasingly exposed across their life courses to relatively cheap energy dense processed foods, many of which are artificially cheap due to US and EU subsidies. Furthermore, access to healthier foods, especially fruits and vegetables, is increasingly difficult and not facilitated. In addition, most people in LMIC urban environments have decreased energy expenditures due to sedentary occupations and lifestyles, with little opportunity and/or space to get adequate exercise.

**Figure 15. The Double Burden of Malnutrition: Causes and Effects across the Life Course**



**Unless governments take urgent measures to prevent this dire chain of events by reducing their population's exposure to energy dense processed foods or by increasing/facilitating access to "healthy diets," and/or increasing exercise levels across the life course, the impact on future health expenditures will be crippling and unsustainable.**

**To take effective action, a central coordinating mechanism must be established in the Prime Minister's/President's Office or at the Treasury, or an office with the power to control policies and the budgets relevant to reducing DBM, including for example the departments of urban planning, trade and industry, business development, marketing/ public information, as well as agricultural, education, and health.**

## REFERENCES

ACC/SCN (Administrative Committee on Coordination/Subcommittee on Nutrition). 1990. "Managing Successful Nutrition Programs." Nutrition Policy Discussion Paper No. 8. Edited by Joan Jennings, Stuart Gillespie, John Mason, Mahshid Lotfi and Tom Scialfa. Geneva: UN Standing Committee on Nutrition.

\_\_\_\_\_. 1996. "How Nutrition Improves." Nutrition Policy Discussion Paper No. 15 Edited by Stuart Gillespie, John Mason and Reynaldo Martorell. Geneva: UN Standing Committee on Nutrition.

Alberti K. G. P. Z. Zimmet. 1998. *Definition, Diagnosis and Classification of Diabetes Mellitus and its Complications*. Part 1. Diagnosis and Classification of Diabetes Mellitus Provisional Report of a WHO Consultation. *Diabetic Medicine* **15**:539–553.

Alberti K. G., P. Zimmet, J. Shaw. 2005. "The Metabolic Syndrome—A New Worldwide Definition." *Lancet* **366**:1059–1062

Ali A. T., W. E. Ferris, N. H. Naran, N. J. Crowther. 2011. "Insulin Resistance in the Control of Body Fat Distribution: A New Hypothesis." *Hormone and Metabolic Research* **43**(2):77-80.

Alice Ammerman A., M. Pignone, L. Fernandez, K. Lohr, A. D. Jacobs, C. Nester, T. Orleans, N. Pender, S. Woolf, S. F. Sutton, L. J. Lux, L. Whitener. 2008. *Systematic Evidence Review Number 18: Counseling to Promote a Healthy Diet*. Rockville: Agency for Healthcare Research and Quality.

Allen L. H. 2009. "How Common is Vitamin B-12 Deficiency?" *American Journal of Clinical Nutrition* **89** (suppl): 693S–6S.

Allen L.H, S. Gillespie. 2001 "What Works? A Review of the Efficacy and Effectiveness of Nutrition Interventions." Nutrition Policy Paper 19. Geneva: UN SCN.

American Diabetic Association. 2008. "Economic Costs of Diabetes in the U.S. in 2007." *Diabetes Care* **31**: 596-615.

American Heart Association. 2003. *Heart Disease and Stroke Statistics: 2004 Update*. Dallas, Tex: American Heart Association.

Anderson L. M., T. A. Quinn, K. Glanz, G. Ramirez, L. C. Kahwati, D. B. Johnson, L. R. Buchanan, W. R. Archer, S. Chattopadhyay, P. Geetika, G. P. Kalra, D. L. Katz. 2009. . "The Effectiveness of Worksite Nutrition and Physical Activity Interventions for Controlling Employee Overweight and Obesity: A Systematic Review." *American Journal of Preventive Medicine*. **37**(4): 340–357.

Andreyeva T., F. J. Chaloupka, K. D. Brownell. 2011. "Estimating the Potential of Taxes on Sugar-Sweetened Beverages to Reduce Consumption and Generate Revenue." *Preventive Medicine* **52**(6): 413-6

Balarajin Y., and E. Villamour. 2009. "Nationally Representative Surveys Show Recent Increases in the Prevalence of Overweight and Obesity Among Women of Reproductive Age in Bangladesh, Nepal and India." *Journal of Nutrition* **139**: 2139-2144.

Barker D. J. P. 1998. *Mothers, Babies and Health in Later Life*. Edinburgh: Churchill Livingstone.

\_\_\_\_\_. 1990. "The Fetal and Infant Origins of Adult Disease: The Womb may be More Important than the Home." *BMJ* **301**: 1111.

Barr S. B and J. C. Wright. 2010. "Postprandial Energy Expenditure in Whole Food and Processed Food Meals: Implications for Daily Energy Expenditure." *Food and Nutrition Research* **54**: 5144.

Ben-Shlomo Y and Kuh D. 2002. "A Life Course Approach to Chronic Disease Epidemiology: Conceptual Models, Empirical Challenges and Interdisciplinary Perspectives." *International Journal of Epidemiology* 11:285-293.

Berg. A. 1992. "Sliding Toward Nutrition Malpractice: Time to Reconsider and Redeploy." *American Journal of Clinical Nutrition*. 57: 3-7.

Black R.E., L. H. Allen, Z. A. Bhutta, L. E. Caulfield, M. de Onis, M. Ezzati, C. Mathers, J. Rivera. 2008 Maternal and Child Undernutrition Study Group. "Maternal and Child Undernutrition: Global and Regional Exposures and Health Consequences." *Lancet*. 371 (9608): 243-60.

Blaffer Sarah Hardy. 1999. *Mother Nature; A History of Mothers, Infants and Natural Selection* United States of America: Pantheon Books.

Block G. 2004. "Foods Contributing to Energy Intake in the US: Data from NHANES III and NHANES 1999-2000." *Journal of Food Composition and Analysis* 17 (3): 439-447.

Bloom, D.E., E. T. Cafiero, E. Jané-Llopis, S. Abrahams-Gessel, L. R. Bloom, S. Fathima, A. B. Feigl, T. Gaziano, M. Mowafi, A. Pandya, K. Prettnner, L. Rosenberg, B. Seligman, A. Z. Stein, and C. Weinstein. 2011. *The Global Economic Burden of Non-communicable Diseases*. Geneva: World Economic Forum.

Bly J. L., et al. 1986. "Impact of Worksite Health Promotion on Health Care Costs and Utilization. Evaluation of Johnson and Johnson's Live for Life program." *JAMA* 256: 3235-3240.

Bray G. A. 2004. "The Epidemic of Obesity and Changes in Food Intake: the Fluoride Hypothesis." *Physiology and Behavior* 82: 115-21.

Brown K. H, K. Dewey. G. 1993. "Slipping to Scapegoating in International Nutrition." *American Journal of Clinical Nutrition*. 57: 89-91 (letter).

Brownell K. D, K. P. Koplan. 2011. "Front of Package Nutrition Labeling – and Abuse of Trust by the Food Industry?" *New England Journal of Medicine*. 364; 25: 2373-2375.

Bryce J., D. Coitinho, I. Darnton-Hill, D. Pelletier, P. Pinstrip-Andersen. 2008 "Maternal and Child Undernutrition Study Group." Maternal and Child Undernutrition: Effective Action at National Level." *Lancet* 371(9611): 510-526.

Butland B., et al. 2007. *Foresight. Tackling Obesities: Future Choices – Project Report*. Whitehall: Government Office for Science.

Cairns G., K. Angus, G. Hastings. 2009. *The Extent, Nature and Effects of Food Promotion to Children: A Review of the Evidence to December 2008*. Geneva: World Health Organization.

Campos S. J Doxey. J. Hammond. 2011. [Nutrition labels on pre-packaged foods: a systematic review](#). *Public Health Nutrition*. Aug;14(8): 1496-506. doi: Epub.

Carlsson\_Kanyama A., A. D. Gonzalez. 2009. "Potential Contributions of Food Consumption Patterns to Climate Change." *American Journal of Clinical Nutrition*. 89 (suppl): 1704S-9S.

Cheng C. H, C. C. Ho, C. F. Yang, C. H. Lai, Y. P. Liaw. 2010. "Waist-to-hip Ratio is a Better Anthropometric Index than Body Mass Index for Predicting the Risk of Type 2 Diabetes in Taiwanese Population." *Nutrition Research* 30 (9): 585-593.

Chopra M. D and D. Sanders. 2000. "Asking "How?" Rather than "What, Why, Where, and Who?" *British Medical Journal* 321: 832 (letter).

Choquet H., and M. Weyne M. 2011. "Genetics of Obesity: What have We Learned?" *Current Genomics*. 12: 169-179.

Codex Alimentarius Commission. FAO/WHO Food Standards: About CODEX. (Available at URL: [http://www.codexalimentarius.net/web/index\\_en.jsp](http://www.codexalimentarius.net/web/index_en.jsp) accessed 01 June 2009).

Consumers Union. 2005. *Out of Balance: Marketing of Soda, Candy, Snacks and Fast Foods Drowns out Healthful Messages*. San Francisco: Consumers Union.

Curtis L. H., B. G. Hammill, M. A. Bethel, K. J. Anstrom, J. S. Gottdiener, K. A. Schulman. 2007. "Costs of the Metabolic Syndrome in Elderly Individuals: Findings from the Cardiovascular Health Study." *Diabetes Care* 30: 2553–2558.

Darnton-Hill I., C. Nishida, W. P. T. James. 2004. "A Life Course Approach to Diet, Nutrition and the Prevention of Chronic Diseases." *Public Health Nutrition*. 7 (1A): 101–121.

DEFRA (Department for Environment, Food and Rural Affairs). 2008. *Expenditure and Food Survey*. London: Department for Environment Food and Rural Affairs.

De Koning L., V. S. Malik, E. B. Rimm, W. C. Willet, F. B. Hu. 2011. "Sugar-sweetened and Artificial Sweetened Beverage Consumption and Risk of Type 2 Diabetes in Men." *American Journal of Clinical Nutrition*. 93 (6): 1321-7.

De Schutter O. 2011. *Report A/HRC/19/59*. Submitted by the Special Rapporteur on the Right to Food, to the Human Rights Council as Agenda Item 3 of the 19<sup>th</sup> Session. New York: UN General Assembly.

Devereux S., J. Marshall, J. MacAskill, L. Pelham. 2005. *Making Cash Count: Lessons from Cash Transfer Schemes in East and Southern Africa for Supporting the Most Vulnerable Children and Households*. Brighton: Institute of Development Studies.

Devries, M. 1987. "Cry Babies, Culture and Catastrophe: Infant Temperament Among the Masai." In. *Anthropological Approaches to the Treatment and Maltreatment of Children*, ed N. Scheper-Hughes. Dordrecht, The Netherlands: Reidel.

Deurenberg P., M. Deurenberg-Yap, S. Guricci. 2002. "Asians are Different from Caucasians and from Each Other in their Body Mass Index/Body Fat per Cent Relationship." *Obesity Reviews*. 3(3): 141-6.

Doak C. M., L. S Adair C. Monteiro, B. M. Popkin. 2000. "Overweight and Underweight Coexists within Households in Brazil, China and Russia." *Journal of Nutrition* 130: 2965-2971.

Dosenbach N., B. Nardos A. Cohen, *et al.* 2010. "Prediction of Individual Brain Maturity Using fMRI". *Science*. 2010. 329, 1358-1361. Erratum in: *Science* 330: 756.

~~Dosenbach N., Nardos B., Cohen A, et al. 2010. Prediction of individual brain maturity using fMRI. Science 2010, 329, 1358-1361. Erratum in: Science 330: 756.~~

Drewnowski A and S. E. Spencer. 2004. "Poverty and Obesity: The Role of Energy Density and Energy Costs." *American Journal of Clinical Nutrition*. 79: 6-16.

Drenowski A., and N. Darmon. 2005. "Food Choices and Diet Costs: An Economic Analysis." *Journal of Nutrition* 135: 900-904.

Edwards P., and A. Tsouros. 2006. *Promoting Physical Activity and Active Living in Urban Environments: The Role of Local Governments* Copenhagen: WHO Europe.

Escalante de Cruz A., et al. 2004. *The Junk Food Generation: A multi-country Survey of the Influence of Television Advertisements on Children*." Kuala Lumpur: Consumers International.

Eckel R.H., W. H Barouch, A. G. Ershow. 2002. "Report of the National Heart, Lung, and Blood Institute-National Institute of Diabetes and Digestive and Kidney Diseases Working Group on the Pathophysiology of Obesity-associated Cardiovascular Disease." *Circulation* 105 (24): 2923-2928.

Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). 2001. "Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP)." *JAMA* 285: 2486-2497.

Ezzati M., A. Lopez, A. Rodgers, C. J. L. Murray eds. 2004. *Comparative Quantification of Health Risks: Global and Regional Burden of Disease Attributable to Selected Major Risk Factors*. Geneva, World Health Organization.

FAO (Food and Agriculture Organization). 2002. *World Agriculture: Towards 2015/2030*. Rome: Food and Agriculture Organization of the United Nations.

\_\_\_\_\_. 2006. *The Double Burden of Malnutrition. Case Studies from Six Developing Countries*. FAO Food and Nutrition Paper 84. Rome: FAO.

\_\_\_\_\_. 2009. *State of the Agricultural Commodity Markets. High Food Prices and the Food Crisis – Experiences and Lessons Learned* Rome: Food and Agriculture Organization.

\_\_\_\_\_. 2010. *Right to Food Methodological Toolbox*. Rome: FAO. Available online at [www.fao.org/righttofood](http://www.fao.org/righttofood) (Accessed 22 March 2010).

\_\_\_\_\_. 2011. *Committee on World Food Security: Global Strategic Framework for Food Security and Nutrition*. Rome: Food and Agriculture Organization.

Finkelstein E. A, J. G. Trogon, J. W. Cohen, W. Dietz. 2009. "Annual Medical Spending Attributable to Obesity: Payer-and-service Specific Estimates." *Health Affairs* (Millwood) 28: w822-w831.

Farooqi I. S and S. O'Rahilly. 2007. "Genetic Factors in Human Obesity." *Obesity Reviews* 8 (Suppl. 1) 37-40.

Finlay J. E., E. Ozaltin, D. Canning. 2011. "The Association of Maternal Age with Infant Mortality, Child Anthropometric Failure, Diarrhoea and Anaemia for First Births: Evidence from 55 low-and Middle-income-countries." *BMJ Open* 2: e000226.

Finucane M. M, G. A. Stevens, M. J. Cowan, G. Danaei, J. K. Lin, C. J. Paciorek, G. M. Singh, H. R. Gutierrez, Y. Lu, A. N. Bahalim, F. Farzadfar, L. M. Riley, M. Ezzati. 2011. "Global Burden of Metabolic Risk Factors of Chronic Diseases Collaborating Group (Body Mass Index).. National, Regional, and Global Trends in Body-mass Index Since 1980: Systematic Analysis of Health Examination Surveys and Epidemiological Studies with 960 Country-years and 9.1 million Participants." *Lancet*. 377 (9765): 557-67.

Flynn M. A, D. A. McNeil, B. Maloff, D. Mutaswina, M. Wu, C. Ford, S. C. Tough. 2006. "Reducing Obesity and Related Chronic Disease Risk in Children and Youth: A Synthesis of Evidence with 'Best Practice' Recommendations." *Obesity Reviews*. Suppl 1: 7-66.

Fogel R. W. 2004. Health, Nutrition, and Economic Growth. *Economic Development and Cultural Change*. 52 (3): 643-658.

Food and Nutrition Board, Institute of Medicine. 1989. "Recommended Dietary Allowances 10<sup>th</sup> Edition." Washington DC: National Academy of Sciences.

Ford E. S., L. C. McGuire, U. A. Ajani U.A, S. Liu. 2005. "Concentrations of Serum Vitamin D and the Metabolic Syndrome Among US Adults." *Diabetes Care* 28 (5): 1228-1230.

Frenk D and W. Wallace Turbeville. 2011. *Commodity Index Traders and the Boom/Bust Cycle in Commodities Prices*. Washington, DC: Better Markets Inc.

Friel S., M. Chopra, D. Satcher. 2007. "Unequal Weight: Equity Oriented Policy Responses to the Global Obesity Epidemic." *British Medical Journal* 335: 1241-1243.

Gillespie, S.G. J. Mason., and R. Martorell. 1996. "How Nutrition Improves. ACC/SCN State of the Art Series." Nutrition Policy Discussion Paper # 15. Geneva, ACC/SCN.

Gillespie S., L. Haddad. 2001. "Attacking the Double Burden of Malnutrition in Asia and the Pacific. ADB Nutrition and Development Series No. 4." Manila: Asian Development Bank.

Gillespie S., M. McLachlan, R. Shrimpton. 2003. "Combating Malnutrition: Time to Act." World Bank-UNICEF Nutrition Assessment. Washington DC: World Bank.

Giugliano, R., R. Shrimpton, D. B. Arckoll, M. Petrere Jr and L. G. Giugliano. 1978. "Diagnostico da Realidade Alimentar e Nutricional do Estado do Amazonas, 1978." *Acta Amazonica* 8 (2): Supl. 12.

Gluckman P.D., M. A. Hanson, C. Pinal. 2005. "The Developmental Origins of Adult Disease." *Maternal and Child Nutrition*. 1: 130-141.

Ghosh J and C. P. Chandrasekhar. 2008. "Global GDP Growth: a Longer View." Available at URL: [http://www.networkideas.org/news/jul2008/Global\\_GDP\\_Growth.pdf](http://www.networkideas.org/news/jul2008/Global_GDP_Growth.pdf).

Gortmaker S. L., B. A. Swinburn, D. Levy, R. Carter, P. L. Mabry, D. T. Finegood, T. Huang, T. Marsh, M. L. Moodie. 2011. "Changing the Future of Obesity: Science, Policy, and Action." *Lancet*. 378 (9793): 838-47.

Grundy S. M., H. B. Brewer, J. I. Jr., Cleeman I, S. C. Smith, Jr., C. Lenfant. 2004. Definition of Metabolic Syndrome: Report of the National Heart, Lung, and Blood Institute/American Heart Association Conference on Scientific Issues Related to Definition. *Arteriosclerosis Thrombosis and Vascular Biology* 24: e13 – 8.

Haddad L. 2002. "Background Paper to the 2002 HNP Series Paper Food Policy Options; Redirecting the Diet Transition: What Can Food Policy Do?" World Bank, Washington DC

Haddad L., H. Alderman, S. Appleton, L. Song, and Y. Yohannes. 2002. "Reducing Child Undernutrition: How Far Does Income Growth Take Us?" FCND Discussion Paper No. 137. Washington DC: IFPRI.

Hall K.D., G. Sacks, D. Chandramohan, G.C. Chow, Y.C. Wang, S.L. Gortmaker, B.A. Swinburn. 2011. "Quantification of the Effect of Energy Imbalance on Bodyweight." *Lancet* 378: 826–37

Hales C. N and D. J Barker. 1992. "Type 2 (non-insulin-dependent) Diabetes Mellitus: The Thrifty Phenotype Hypothesis." *Diabetologia* 35 (7): 595–601.

Hawkes C. 2002. *Marketing Activities of Global Soft Drinks and Fast Food Companies in Emerging Markets: A Review*. In: Globalization: Diets and non-communicable diseases. Geneva: World Health Organization.

\_\_\_\_\_. 2004. *Nutrition Labels and Health Claims: The Global Regulatory Environment* Geneva: World Health Organization.

\_\_\_\_\_. 2005. The Role of Foreign Direct Investment in the Nutrition Transition. *Public Health Nutrition*. 8, 357–365.

\_\_\_\_\_. 2007. *Marketing Food to Children: Changes in the Global Regulatory Environment*. Geneva: World Health Organization

Heikens G.T, B.C Amadi, M. Manary, N. Rollins, A. Tomkins. 2008. "Nutrition Interventions Need Improved Operational Capacity." *Lancet*. 371 (9608): 181-2.

Henry C. J. K., and N. J Heppel. 1998. "Introduction: From Foraging to Farming to Food Technology." In *Nutritional Aspects of Food Processing and Ingredients*, ed. C. J. K. Henry.Heppell N. J.,ed.. Aspen Publishers, Gaithersburg, Maryland, US.

Hite A. H., D. Richard, Feinman, G. E. Guzman, M. Satin, P. A. Schoenfeld, R. J. Wood. 2010. In "The Face of Contradictory Evidence: Report of the Dietary Guidelines for Americans Committee." *Nutrition* 26:915–924.

Hoddinott J., and L. Bassett L. 2009. *Conditional Cash Transfer Programs and Nutrition in Latin America: Assessment of Impacts and Strategies for Improvement*. Santiago: United Nations Food and Agriculture Organization (FAO).

Hodgson T. A., and L. Cai. 2001. "Medical Care Expenditures for Hypertension, its Complications, and its Comorbidities." *Medical Care*. 39: 599–615.

Holvoet P. 2008. "Relations Between Metabolic Syndrome, Oxidative Stress, and Inflammation and Cardiovascular Disease." *Verhandelingen - Koninklijke Academie voor Geneeskunde van België* 70 (3): 193-219.

Horton S. 1999. "Opportunities for Investments in Nutrition in Low-income Asia." *Asian Development Review* 17 (1-2): 246-273.

Horton S., M. Shekar, C. McDonald, A. Mahal and J.K. Brooks. 2009. *Scaling Up Nutrition: What Will it Cost?* Washington DC: World Bank.

Hughes R., R. Shrimpton, E. Recine, B. Margetts. 2012. *Empowering Our Profession*. [Commentary] *World Nutrition*, February (3-2): 33-54.

Huxley R., S. Mendis, E. Zheleznyakov, S. Reddy, J. Chan. 2010. "Body Mass Index, Waist Circumference and Waist: Hip Ratio as Predictors of Cardiovascular Risk-a Review of the Literature." *European Journal of Clinical Nutrition* 64: 16-22.

IAASTD (International Assessment of Agricultural Knowledge, Science, and Technology for Development). 2009. *Agriculture at a Crossroads*. IAASTD. Global Report. Washington DC: Island Press.

Inoue S., T. Sugiyama, T. Takamiya, K. Oka, N. Owen, T. Shimomitsu. 2012. "Television Viewing Time is Associated with Overweight/Obesity Among Older Adults, Independent of Meeting Physical Activity and Health Guidelines." *Journal of Epidemiology*. 22 (1): 50-6.

Institute of Medicine, Food and Nutrition Board. 2012. "Accelerating Progress in Obesity Prevention: Solving the Weight of the Nation." Washington DC. The National Academy Press.

James W. P. T., A. Astrup, N. Finer, J. Hilsted, P. Kopelman, S. Rössner, W. H. Saris, L. F. Van Gaal. 2000. "Effect of Sibutramine on Weight Maintenance after Weight Loss: A Randomised Trial." STORM Study Group. Sibutramine Trial of Obesity Reduction and Maintenance. *Lancet*. 356 (9248): 2119-25.

James W. P. T. 2000. "Historical Perspective." 3-12, Chapter 1 in "Human Nutrition and Dietetics," 10<sup>th</sup> Edition. eds. J. S. Garrow, W. P. T. James, and A. Ralh. Edinburgh:Churchill Livingstone.

James et al. 2000. "Ending Malnutrition by 2020: An agenda for Change in the Millennium." *Food and Nutrition Bulletin* 21:3 (supplement).

James W. P. T, K. R. Norum, S. Mitasiri, M. S. Swaminathan, J. Tagwireyi, R. Uauy, M. Haq. 2000. *Ending Malnutrition by 2020: An Agenda for Change in the Millennium*. Geneva: UN SCN.

James W. P. T. 2011. "Up to the Summit: Inglorious Paths.[Commentary] UN Summit on Non-communicable Diseases." *World Nutrition*, 2, 8: 352-399.

Jonsson U. 1993. "The Global Embarrassment of Malnutrition and the Role of Nutrition Engineers." *American Journal of Clinical Nutrition*. 58 (4): 579-80.

Kearney J. 2010. "Food Consumption Trends and Drivers." *Philosophical Transactions of the Royal Society*. B. 365: 2793-2807.

Kerber K. J., J. E. de Graft-Johnson, Z. A. Bhutta, P. Okong, A. Starrs, J. E. Lawn. 2007. « Continuum of Care for Maternal, Newborn, and Child Health: From Slogan to Service Delivery." *Lancet*. 370 (9595): 1358-69.

Knuth L., and M. Vidar. 2011. *Constitutional and Legal Protection of the Right to Food Around the World*. Rome: Food and Agriculture Organization.

Komlos J., and M. Baur. 2004. "From the Tallest to (one of) the Fattest: The Enigmatic Fate of the American Population in the 20th Century." *Economics Human Biology*. 2(1): 57-74.

Komlos J., and B. E. Lauderdale. 2007. "The Mysterious Trend in American Heights in the 20th Century." *Annals of Human Biology*: 34: 206-15

Lagarde M., A. Haines, N. Palmer. 2007. "Conditional Cash Transfers for Improving Uptake of Health Interventions in Low- and Middle-income Countries: A Systematic Review." *JAMA*. 298(16):1900-10.

\_\_\_\_\_. 2009. *The impact of Conditional Cash Transfers on Health Outcomes and Use of Health Services in Low and Middle Income Countries*. Cochrane Database Syst Rev. (4): CD008137.

Lagi M., Y. Bar-Yam, K. Z. Bertrand and Y. Bar-Yam. 2011. *The Food Crises: A Quantitative Model of Food Prices Including Speculators and Ethanol Conversion*. Cambridge MA: New England Complex Systems Institute.

Larson N. I., M. T. Story, M. C. Nelson. 2009. "Neighbourhood Environments: Disparities in Access to Healthy Foods in the US." *American Journal of Preventive Medicine* 36 (1): 74-81.

Lee C. M., S. Colagiuri, M. Ezzati, M. Woodward. 2011. "The Burden of Cardiovascular Disease Associated with High Body Mass Index in the Asia-Pacific Region." *Obesity Reviews*. 12: e454-e459.

Leidy H. J., J. W. Apolzan, R. D. Mattes, W. W. Campbell. 2010. "Food Form and Portion Size Affect Postprandial Appetite Sensations and Hormonal Responses in Healthy Non-obese Older Adults." *Obesity*. 18 (2): 293-299.

Linkins J. 2011. "How Pizza Became A Vegetable Through The Magic Of Influence-Peddling." Washington DC: The Huffington Post. 18 November 2011. Available at URL: [http://www.huffingtonpost.com/2011/11/16/pizza-vegetable-school-lunches-lobbyists\\_n\\_1098029.html?view=print&comm\\_ref=false](http://www.huffingtonpost.com/2011/11/16/pizza-vegetable-school-lunches-lobbyists_n_1098029.html?view=print&comm_ref=false) Accessed 12 December 2011.

Liu A, Byrne N. M., M. Kagawa, G. Ma, B. K. Poh, M. N. Ismail, K. Kijboonchoo, L. Nasreddine, T. P. Trinidad, A. P. Hills. 2011. "Ethnic Differences in the Relationship Between Body Mass Index and Percentage Body Fat Among Asian Children from Different Backgrounds." *British Journal of Nutrition*. 106 (9): 1390-7.

Malik V. S., B. Schulze, F. B. Hu. 2006. "Intake of Sugar Sweetened Beverages and Weight Gain: A Systematic Review." *American Journal of Clinical Nutrition*. 84: 274-288.

Malina R. M. 2004. *Secular Trends in Growth, Maturation and Physical Performance: A Review*. *Anthropological Review* 67:3-31.

Mangge H., G. Almer, et al. 2010. "Inflammation, Adiponectin, Obesity and Cardiovascular Risk." *Current Medicinal Chemistry* 17836: 4511-4520.

Manley J., S. Gitter and V. Slavchevska. 2011. "How Effective are Cash Transfer Programs at Improving Nutritional Status?" Working Paper No. 2010-18 Towson: Towson University Department of Economics.

Martorell R., L. K. Khan, M. L. Hughes, L. M. Grummer-Strawn. 2000 "Obesity in Women from Developing Countries." *European Journal of Clinical Nutrition*. 54 (3): 247-52.

Mason J. B., D. Sanders, P. Musgrove, R. Soekirman, and Galloway. 2006. "Community Health and Nutrition Programs." In *Disease Control Priorities in Developing Countries, 2nd Edition*, eds. D. T. Jamison, J. G. Breman, A. R. Measham, G. Alleyne, M. Claeson, D. B. Evans, P. Jha, A. Mills, and P. Musgrove. Washington, DC: World Bank.

Mason J., J. Hunt, D. Parker and U. Jonsson. 1999. "Investing in Child Nutrition in Asia." *Asian Development Review* 17 (1) 2: 1-32.

Mathers C., G. Stevens and M. Mascarenhas. 2009. *Global Health Risks: Mortality and Burden of Disease Attributable to Selected Major Risks*. Geneva, World Health Organization.

McAfee A. J., E. M. McSorley, G. J. Cuskelly, A. M. Fearon, B. W. Moss, J. A. Beattie, J. M. Wallace, M. P. Bonham, J. J. Strain. 2011. "Red Meat from Animals Offered a Grass Diet Increases Plasma and Platelet n-3 PUFA in Healthy Consumers." *British Journal of Nutrition*. 105 (1): 80-9.

McCormack G., B. Giles-Corti, A. Lange, T. Smith, K. Martin, T. J. Pikora. 2004. An Update of Recent Evidence of the Relationship Between Objective and Self-report Measures of the Physical Environment and Physical Activity Behaviors. *Journal of Science and Medicine in Sport*. 7(1 Suppl): 81-92.

Meas T. 2010. "Fetal Origins of Insulin Resistance and the Metabolic Syndrome: A Key Role for Adipose Tissue." *Diabetes and Metabolism* 36: 11-20.

Mello M. M., J. Pomeranz, P. Moran. 2008. "The Interplay of Public Health Law and Industry Self-regulation: The Case of Sugar-sweetened Beverage Sales in Schools." *American Journal of Public Health*. 98 (4): 595-604.

Mendez M. A., C. A. Monteiro, B. M. Popkin. 2005. "Overweight Exceeds Underweight Among Women in Most Developing Countries." *American Journal of Clinical Nutrition*. 81: 714-721.

Millstone E., T. Lang. 2003. *The Atlas of Food. Who Eats What Where and Why*. Earthscan publications, London.

Millward D. J., T. Garnett. 2010. "Plenary Lecture 3: Food and the Planet: Nutritional Dilemmas of Greenhouse Gas Emission Reductions Through Reduced Intakes of Meat and Dairy Foods." *Proceedings of the Nutrition Society*. 69 (1): 103-18.

Modi N., E. L. Thomas, S. N. Uthaya, S. Umranikar, J. D. Bell, C. Yajnik. 2009. "Whole Body Magnetic Resonance Imaging of Healthy Newborn Infants Demonstrates Increased Central Adiposity in Asian Indians." *Pediatric Research*. 65 (5): 584-7.

Monteiro C. A., E. C Moura, W. L. Conde, B. M. Popkin. 2004. Socioeconomic Status and Obesity in Adult Populations of Developing Countries: A Review. *Bulletin of the World Health Organization WHO*. 82: 940-946.

Monteiro C. A., M. H. D'Aquino Benicio, S. Konno, A. C. F. Silva, A. L. L. Lima and W. L. Conde. 2009. *Causes of the Decline in Child Under-nutrition in Brazil (1996-2007)*." *Revista de Saúde Pública* 43 (1): 1-8.

Monteiro C. M. 2010. *The Big Issue is Ultra-processing (Commentary)*. *World Nutrition*. 1 (6): 237-269.

Monteiro C. A., R. B. Levy, R. M. Claro, I. R. de Castro, G. Cannon. 2011. "Increasing Consumption of Ultra-processed Foods and Likely Impact on Human Health: Evidence from Brazil." *Public Health Nutrition*. 14(1): 5-13.

Monteiro C. 2011. *Food Guide Pyramids, and What's the Matter with Bread [Commentary]*. *World Nutrition*, January, (2-1): 22-41.

Moore A. M., S. Singh, U. Ram, L. Remez and S. Audam. 2009. "Adolescent Marriage and Childbearing in India: Current Situation and Recent Trends." New York: Guttmacher Institute.

Morris S. S., B. Cogil, R. Uauy. 2008. "Effective International Action Against Undernutrition: Why has it Proven so Difficult and What Can be Done to Accelerate Progress?" For the Maternal and Child Undernutrition Study Group. *Lancet*. 371 (9612): 608-21.

Moy F. M., A. Bulgiba. 2011. "High Prevalence of Vitamin D Insufficiency and its Association with Obesity and Metabolic Syndrome Among Malay adults in Kuala Lumpur, Malaysia." *BMC Public Health* 11: 735.

Mozaffarian D., T. Hao, E. B. Rimm, W. C. Willet, F. B. Hu. 2011. "Changes in Diet and Lifestyle and Long-term Weight Gain in Women and Men." *New England Journal of Medicine* 364: 2392-23404.

Nabarro D. 2010. *Introducing the Policy Brief: Scaling up Nutrition: A Framework for Action*. New York: United Nations. Available at URL: <http://un-foodsecurity.org/sites/default/files/April%20David%20Nabarro%20Introducing%20the%20SUN%20April%202010.pdf> (Accessed 05/04/2011).

Neel J. 1962. "Diabetes Mellitus: A "Thrifty" Genotype Rendered Detrimental by "Progress"?" *American Journal of Human Genetics* 14:353-362

Neltner T. G., N. R. Kulkarni, H. M. Alger, M. V. Maffini, E. D. Bongard, N. D. Fortin, E. D. Olson. 2011. *Navigating the US Food Additive Regulatory Program*. *Comprehensive Reviews in Food Science and Food Safety*. 10:342-368.

Nestle M. 2002. *Food Politics*. Berkeley CA: University of California Press.

Nishida C., R. Shrimpton, I. Darnton-Hill. 2009. "Landscape Analysis on Countries' Readiness to Accelerate Action in Nutrition." *SCN News*. 37: 4-9.

Nishida C., T. Mutru and R. Imperial Laue. 2003. Strategies for Effective and Sustainable National Nutrition Plans and Policies. In *Modern Aspects of Nutrition, Present Knowledge and Future Perspective*. eds. I. Elmadfa, E. Anklam and J. S. Konig . *Forum Nutr. Basel*, Karger. 56: 264-266.

OECD (Organization for Economic Co-operation and Development). 2011. *Health at a Glance 2011: OECD Indicators*. OECD Publishing. [http://dx.doi.org/10.1787/health\\_glance-2011-en](http://dx.doi.org/10.1787/health_glance-2011-en).

Ong K. K. 2006. "Size at Birth, Postnatal Growth and Risk of Obesity." *Hormone Research*. 65 Suppl 3: 65-9.

Oosterveer P., and (insert initial)D. A. Sonnenfeld. 2012. *Food, Globalization, and Sustainability*. London: Earthscan.

Ortiz I., J. Chai, M. Cummins. 2011. "Escalating Food Prices: The Threat to Poor Households and Policies to Safeguard a Recovery for All." UNICEF Social and Economic Policy Working Paper. New York: UNICEF.

PAHO (Pan American Health Organization). 1976. "The National Food and Nutrition Survey of Guyana." Scientific Publication No 323. Washington, DC: PAHO.

Pestana J. A., K. Steyn, A. Leiman, G. M. Hartzenberg. 1996. *The Direct and Indirect Costs of Cardiovascular Disease in South Africa in 1991*. *South African Medical Journal*. 86: 679–684.

Pignone M. P. A., et al. 2003. "Counseling to Promote a Healthy Diet in Adults: A Summary of the Evidence for the US Preventive Services Task Force." *American Journal of Preventive Medicine*. 24: 75-92.

Popkin B. M. 1998. "The Nutrition Transition and its Health Implications in Low-income Countries." *Public Health Nutrition* 1(1):5-21.

\_\_\_\_\_. 2001. "The Nutrition transition and Obesity in the Developing World." *Journal of Nutrition*. 131 (3): 871S-873S.

\_\_\_\_\_. 2006. "Global Nutrition Dynamics: The World is Shifting Rapidly Toward a Diet Linked with Non-communicable Diseases." *American Journal of Clinical Nutrition* 84: 289-298.

Prentice A. M., and S. A. Jebb. 2003. "Fast Foods, Energy Density and Obesity: A Possible Mechanistic Link." *Obesity Reviews*. 4 (4): 187-94.

Raj P., O. E. Okoseime, A. Rees and D. R. Owens. 2009. "Postprandial Glucose - A Potential Therapeutic Target to Reduce Cardiovascular Mortality." *Current Vascular Pharmacology*. 7: 68-74.

Reardon, T., and J. A Berdegúe. 2002. "The Rapid Rise of Supermarkets in Latin America: Challenges and Opportunities for Development." *Development Policy Review*, 2002, 20 (4): 371-388.

Reardon, T., C. P. Timmer., C. B. Barrett. and J. Berdegue'. 2003. "The Rise of Supermarkets in Africa, Asia, and Latin America." *American Journal of Agricultural Economics*. 85, 1140–1146.

Reaven G. M. 1988. "Role of Insulin Resistance in Human Disease." *Banting Lecture 1988: Diabetes* 7: 1595–1607.

Reidel Enga Birth. 1982. "Maturation and Survival: Physiological Characteristics of the Life Cycle in the New Guinea Highlands." In *Ethnography of Fertility and Birth*, eds P. MacCormack. P. Carol. 1982. Academic Press : New York.

Reyes, Raphael. 2008. "Food Pyramid Frenzy: Lobbyists Fight to Defend Sugar, Potatoes and Bread in Recommended US Diet." Washington, DC: Wall Street Journal 15 July 2008.

Richardson, S. A and A. Guttmacher. 1967. *Childbearing – its Social and Psychological Aspects*. The Williams and Wilkins Company.

Robertson, A., C. Tirado, T. Lobstein, M. Jermini, C. Knai, J. H. Jensen, A. Ferro-Luzzi, and W. P. T. James.. 2004. *Food and Health in Europe: A New Basis for Action*. WHO Regional Publications, European Series, No.96. Copenhagen: WHO Europe.

Rosamond W., K. Flegal, K. Furie, A. Go, K. Greenlund, N. Haase, S.M. Hailpern, M. Ho, V. Howard, B. Kissela, S. Kittner, D. Lloyd-Jones, M. McDermott, J. Meigs, C. Moy, G. Nichol, C. O'Donnell, V. Roger, P. Sorlie, J. Steinberger, T. Thom, M. Wilson, Y. Hong. 2008. "Heart Disease and Stroke Statistics—2008 Update: A Report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee." *Circulation*. 117: e25– e146.

Rose D., R. Richards. 2004. "Food Store Access and Household Fruit and Vegetable Use Among Participants in the US Food Stamp Program." *Public Health Nutrition* 7(8): 1081-1088.

Rose D. P., E. M. Gilhooly, D. W. Nixon. 2002. "Adverse Effects of Obesity on Breast Cancer Prognosis and the Biological Actions of Leptin (review)." *International Journal of Oncology* 21 (6): 1285-1292.

Rosenbaum M., R. L. Leibel. 2010. "Adaptive Thermogenesis in Humans." *International Journal of Obesity* (London). 34 Suppl 1: S47-55.

Rosenbaum M., H. R. Kissileff, L. E. Mayer, J. Hirsch, R. L. Leibel. 2010. "Energy Intake in Weight-reduced Humans." *Brain Research*. 1350: 95-102.

Rosset P. M. 2007. *Food is Different: Why We Must Get the WTO Out of Agriculture*. London: Zed Books.

Russo M. 2011. *Apples to Twinkies: Comparing Federal Subsidies of Fresh Produce and Junk Food*. Boston: US PIRG Education Fund.

Sachs J. D. 2005. *The End of Poverty: How We Can Make it Happen in Our Lifetime*. London: Penguin Books.

Sassi F. 2010. *Obesity and the Economics of Prevention: Fit not Fat*. Paris: OECD.

Scheller-Kreinsen, D., M. Blumel and R. Busse. 2010. "Chronic Disease Management in Europe." *Eurohealth* 15 (1).

Seidell J. C., R. Andres, J. D. Sorkin, D. C. Muller. 1994. "The Sagittal Waist Diameter and Mortality in Men: The Baltimore Longitudinal Study on Aging." *International Journal of Obesity and Related Metabolic Disorders* 18(1):61-67.

Shah A., N. Mehta, M. P. Reilly. 2008. "Adipose Inflation, Insulin Resistance and Cardiovascular Disease." *Journal of Parenteral and Enteral Nutrition J Parenter Nutr.* 32 (6): 638-644.

Shao Q, Chin K-V. 2011. "Survey of American Food Trends and the Growing Obesity Epidemic." *Nutrition Research and Practice* 5(3): 253-259.

Shekar M., R. Heaver, Y. K. Lee. 2006. *Repositioning Nutrition as Central to Development: A Strategy for Large-Scale Action*. Washington, DC: The World Bank.

Shrimpton, R., and R. Guigliano. 1979. "Consumo de Alimentos e Alguns Nutrientes em Manaus, Amazonas. 1973 1974". *Acta Amazonica* 9(1): 117 141.

Shrimpton, R. 1995. "Community Participation in Food and Nutrition Programs: An Analysis of Governmental Experiences". In *Child Growth and Nutrition in Developing Countries*. 243- 261. Eds. P. Pinstруп Andersen, D. Pelletier, H. Alderman. Ithaca: Cornell University Press.

Shrimpton R. 2010. "Maternal Nutrition and the Intergenerational Cycle of Growth Failure." 62-75. Chapter 3 in the 6<sup>th</sup> Report on the World Nutrition Situation. Geneva: UNSCN.

\_\_\_\_\_. 2006. "Lifecycle and Gender Perspectives on the Double Burden of Malnutrition and the Prevention of Diet related Chronic Disease." *SCN News* 33:11-14.

Simopoulos A. P. 1991. "Omega-3 Fatty Acids in Health and Disease and in growth and Development." *American Journal of Clinical Nutrition* 54: 438-63.

\_\_\_\_\_. 2006. "Evolutionary Aspects of Diet, the Omega-6/Omega-3 Ration and Genetic Variation: Nutritional Implications for Chronic Disease." *Biomedicine and Pharmacotherapy* 60: 502-507.

Singhal A., and J. Lanigan. 2007. "Breastfeeding, Early Growth and Later Obesity." *Obesity Reviews* 8 (Suppl. 1): 51-54.

Sivasankaran S., M. K. C. Nair, G. Babu, A. M. Zuficar. 2011. Need for Better Anthropometric Markers for Prediction of Cardiovascular Risk in Nutritionally Stunted Populations. *Indian Journal of Medical Research*. 133(5): 557–559.

Sridhar D., A. Duffield. 2006 *A Review of the Impact of Cash Transfer Programs on Child Nutritional Status and some Implications for Save the Children UK Programs*. London: Save the Children UK.

Stallone D. D. 1994. *The Influence of Obesity and its Treatment on the Immune System*. *Nutrition Reviews* 52 (2 Pt 1): 37-50.

Stein A. D., M. Wang, M. Ramirez-Zea, R. Flores, R. Grajeda, P. Melgar, U. Ramakrishnan, R. Martorell. 2006. “Exposure to a Nutrition Supplementation Intervention in Early Childhood and Risk Factors for Cardiovascular Disease in Adulthood: Evidence from Guatemala.” *American Journal of Epidemiology*. 164 (12): 1160-70.

Subramanian S. V., J. M. Perkins, E. Ozaltin, G. D. Smith. 2011. “Weight of Nations: A Socioeconomic Analysis of Women in Low-to-Middle Income Countries.” *American Journal of Clinical Nutrition*. 93: 413-421

Sumithran P., L. A. Prendergast, E. Delbridge, K. Purcell, A. Shulkes, A. Krikelos, J. Proletto. 2011. “Long-term Persistence of Hormonal Adaptations to Weight Change.” *New England Journal of Medicine* 365: 1597-1604.

Swinburn B., G. Egger, F. Raza. 1999. “Dissecting Obesogenic Environments: The Development and Application of a Framework for Identifying and Prioritizing Environmental Interventions for Obesity.” *Preventive Medicine*. 29 (6 Pt 1): 563-70.

Swinburn B. A., I. Caterson, J. C. Seidel, W. P. T. James. 2004. Diet and the Prevention of Excess Weight Gain and Obesity.” *Public Health Nutrition* 7 (1A): 123-146

Swinburn B. A., G. Sacks, K. D. Hall, K. McPherson, D. T. Finegood, M. L. Moodie, S. L. Gortmaker. 2011. “The Global Obesity Pandemic: Shaped by Global Drivers and Local Environments.” *Lancet* 378: 804–14.

Tandon S., M. R. Landes, A. Woolverton. 2011. *The Expansion of Modern Grocery Retailing and Trade in Developing Countries*. Economic Research Report No. (ERR-122), Washington, DC: US Department of Agriculture, Economic Research Service.

Tanner J. M. 1978. *Fetus into Man: Physical Growth from Conception to Maturity*. London: Open Books Publishing Ltd.

Thankappan K. R, B. Shah, P. Mathur, P. S. Sarma, G. Srinivas, M. Daivadanam, B. Soman and R. S. Vasan. 2010. “Risk Factor Profile for Chronic Non-communicable Diseases: Results of a Community-based Study in Kerala, India.” *Indian J Med Res* 131: 56-63.

Thow, A. M., and C. Hawkes. 2009. “The Implications of Trade Liberalization for Diet and Health: A Case Study from Central America.” *Global Health* 28, 5.

Trayhurn P. 2007 “Adipocyte Biology.” *Obesity reviews*. 8 (Suppl. 1): 41–44.

Tremblay M. S., A. G LeBlanc, M. E. Kho, T. J. Saunders, R. Larouche, R. C. Colley, G. Goldfield, S. C. Gorber. 2011. “Systematic Review of Sedentary Behaviour and Health Indicators in School-aged Children and Youth.” *International Journal of Behavioral Nutrition and Physical Activity*. 8: 98.

Treuhart S., A. Karpyn. 2010. *The Grocery Gap: Who has Access to Healthy Food and Why it Matters*. New York: Policy Link and The Food Trust.

Trostle R. 2008. *Global Agricultural Supply and Demand: Factors Contributing to the Recent Increase in Food Commodity Prices*. WRS-0801. Washington: Economic Research Service/USDA.

Turcato E., O. Bosello, V. Di Francesco, T. B. Harris, E. Zoico, L. Bissoli, E. Fracassi, M. Zamboni. 2000. "Waist Circumference and Abdominal Sagittal Diameter as Surrogates of Body Fat Distribution in the Elderly: Their Relation with Cardiovascular Risk Factors." *International Journal of Obesity and Related Metabolic Disorders* 24 (8): 1005-1010.

Uauy R., N. W. Solomons. 2006. *The Role of the International Community: Forging a Common Agenda in Tackling the Double Burden of Malnutrition*. SCN News 32: 24-37.

UCLA (University of California, Los Angeles) School of Public Health. 2008. Elementary Exercises: Nutrition Friendly Schools and Communities Pilot Program Case Studies. Available at [www.ph.ucla.edu/chs/nfsc](http://www.ph.ucla.edu/chs/nfsc).

UNSCN (United Nations Standing Committee on Nutrition). 2010. *6<sup>th</sup> Report of the World Nutrition Situation*. Geneva: UNSCN.

\_\_\_\_\_. 2011. "Nutrition and Business: How to Engage?" SCN NEWS 39. Geneva: UN Standing Committee on Nutrition.

UNFPA (United Nations Population Fund). 2011. *State of the World Population 2011: People and Possibilities in a World of 7 billion*. New York: UNFPA.

UNICEF (United Nations Children's Fund). 1990. *Strategy for Improved Nutrition of Children and Women in Developing Countries*. New York: UNICEF.

\_\_\_\_\_. 2011. *The State of the World's Children 2011*. New York: UNICEF.

UN Population Division. 2009. *What Would it Take to Accelerate the Fertility Decline in the Least Developed Countries?* UN Population Division Policy Brief No. 2009/1. New York: United Nations Department of Economic and Social Affairs.

USDA Food and Nutrition Service. 2008. *Increasing Fruit and Vegetable Consumption through the USDA Nutrition Assistance Programs: A Progress Report*. Alexandria: United States Department of Agriculture Food and Nutrition Service.

US Department of Agriculture, US Department of Health and Human Services. 2010. . Washington, DC: US Government Printing Office,

USAID (United States Agency for International Development). 2009. *Global Food Security Response, Ghana Rice Study*. Micro REPORT # 156.

Uusitalo,U., E. J. Feskens, J. Tuomilehto, G. Dowse, U. Haw, D. Fareed, and others. 1996. "Fall in Total Cholesterol Concentration over Five Years in Association with Changes in Fatty Acid Composition of Cooking Oil in Mauritius: Cross-Sectional Survey." *British Medical Journal* 313: 1044-46.

Victora C. G., L. Adair, C. Fall, P. C. Hallal, M. Martorell, L. Richter, H. S. Sachdev. 2008. "Maternal and Child Undernutrition: Consequences for Adult Health and Human capital." For the Maternal and Child Undernutrition Study Group. *The Lancet* 37: 340-357.

Victora C. G., M. de Onis, P. C. Hallal, M. Blössner, R. Shrimpton. 2010. "Worldwide Timing of Growth Faltering: Revisiting Implications For Interventions." *Pediatrics*. 125(3): e473-80.

Vir S. C., N. Singh, A. K. Nigam, R. Jain. 2008. "Weekly Iron and Folic Acid Supplementation with Counseling Reduces Anemia in Adolescent Girls: A Large-scale Effectiveness Study in Uttar Pradesh, India." *Food Nutrition Bulletin*. 29(3): 186-94.

Walker A. 2011. "The WTO has Failed Developing Nations." London: The Guardian Newspaper, Monday 14 November Issue.

Wang Z., and T. Nakayama. 2010. "Inflammation, a Link Between Obesity and Cardiovascular Disease." *Mediators of Inflammation*.

Waterlow J. C. 1972. "Classification and Definition of Protein Calorie Malnutrition." *BMJ* 3: 566-569.

Waters E., A. de Silva-Sanigorsky, T. Hall BJ, Brown, K. L. Campbell, Y. Gao, R. Armstrong, L. Prosser, C. D. Summerbel. 2011. "Interventions for Preventing Obesity in Children." *Cochrane Database Syst Rev*. 12: CD001871.

Weis T. 2007. *The Global food Economy: The Battle for the Future of Farming*. London: Zed Books.

Wells J. C. K. 2012. "Obesity as Malnutrition: The Role of Capitalism in the Obesity Global Epidemic." *American Journal of Human Biology*. 00:1-15.

WHO (World Health Organization). 1995. *Physical Status: Uses and Interpretation of Anthropometry*. WHO Technical Report Series, Report No. 854. Geneva, Switzerland: WHO.

\_\_\_\_\_. 2000. *Obesity: Preventing and Managing the Global Epidemic*. WHO Technical Report 894. Geneva: WHO.

\_\_\_\_\_. 2003. *Diet, Nutrition and the Prevention of Chronic Diseases*. Report of a Joint WHO/FAO Expert consultation. Geneva: WHO.

\_\_\_\_\_. 2004. "Appropriate Body-mass Index for Asian Populations and its Implications for Policy and Intervention Strategies. A WHO Expert consultation." *The Lancet* 363:157-63

\_\_\_\_\_. 2006. *Promoting Optimal Fetal Development. Report of a Technical Consultation Held in 2003 Towards the Development of a Strategy for Promoting Optimal Fetal Development*. Geneva: World Health Organization.

\_\_\_\_\_. 2006. *Nutrition Friendly Schools Initiative (NFSI)*. Available at <http://www.euro.who.int/en/what-we-do/health-topics/disease-prevention/nutrition/activities/technical-support-to-member-states/nutrition-friendly-schools-initiative-nfsi> as well as at <http://www.dur.ac.uk/school.health/orb/research/whonfsi/>.

\_\_\_\_\_. 2011. *Global Status Report on Non-communicable diseases 2010*. Geneva: WHO.

\_\_\_\_\_. 2011. *Nutrient Profiling: Report of a WHO/IASO Technical Meeting held 4-6 October 2010*. Geneva: WHO.

Willett W. C., and P. D. Skerret. 2005. "Eat, Drink and be Healthy. The Harvard Medical School Guide to Healthy Eating." New York: Free Press.

World Bank. 2002. *Food Policy options, Preventing and Controlling Nutrition Related Non-Communicable Diseases. Report of a World Health Organization (WHO) and World Bank Consultation held in Washington on November 20-21, 2002*. Washington: World Bank

World Bank. 2011. *Price Volatility in Food and Agricultural Markets: Policy Responses. A Policy Report to the G20, Including Contributions by FAO, IFAD, IMF, OECD, UNCTAD, WFP, the World Bank, the WTO, IFPRI and the UNHLTF*. Available at URL: [http://www.worldbank.org/foodcrisis/pdf/Interagency\\_Report\\_to\\_the\\_G20\\_on\\_Food\\_Price\\_Volatility.pdf](http://www.worldbank.org/foodcrisis/pdf/Interagency_Report_to_the_G20_on_Food_Price_Volatility.pdf)

World Bank, RUAF Foundation, EU. 2010. *The Growth of Cities in East Africa: Consequences for Food Supply*.

World Bank. 2007. *Conditional Cash Transfers And Female Schooling: The Impact of The Female School Stipend Program on Public School Enrollments in Punjab, Pakistan*. Policy Research paper, World Bank series, 4102.

Woods J., A. Willians, J. K. Hughes, M. Black, R. Murphy. 2010. "Energy and the Food System." *Philosophical Transactions of the Royal Society B*. 365: 2991-3006.

Worthy M. 2011. Broken Markets: "How Financial Market regulation can Help Prevent Another Global Food Crisis." London: World Development Movement. Available at URL: <http://www.wdm.org.uk/stop-bankers-betting-food/broken-markets-how-financial-regulation-can-prevent-food-crisis> (Accessed 01 07 12).

Wrigley N. 2002. *Food Deserts in British Cities: Policy context and Research Priorities*. Urban Studies 39 (11): 2029-2040.

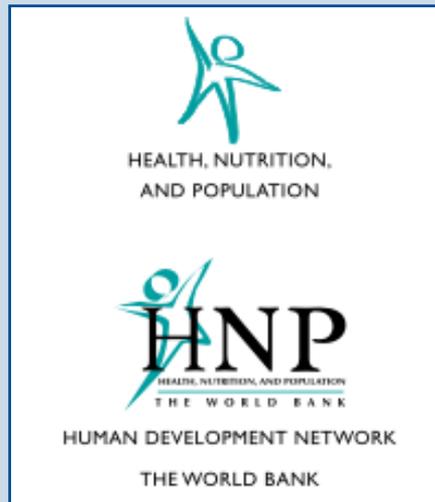
WTO (World Trade Organization). 2010. *International Trade Statistics*. Geneva: World Trade Organization.

Yajnik C. S., S. S. Deshpande, A. A. Jackson, H. Refsum, S. Rao, D. J. Fisher, et al. 2008. "Vitamin B12 and Folate Concentrations During Pregnancy and Insulin Resistance in the Offspring: The Pune Maternal Nutrition Study." *Diabetologia*. 51: 29-38.

Ye J and Keller JN. 2010. "Regulation of Energy Metabolism by Inflammation: A feedback Response in Obesity to Calorie Restriction." *Aging*. 2(6):361-368.

Zatonski et al. 1998. "Ecological Study of Reasons for the Sharp Decline in Mortality from Ischaemic Heart Disease in Poland since 1991." *BMJ* 316: 1047-1051.





#### **About this series...**

This series is produced by the Health, Nutrition, and Population Family (HNP) of the World Bank's Human Development Network. The papers in this series aim to provide a vehicle for publishing preliminary and unpolished results on HNP topics to encourage discussion and debate. The findings, interpretations, and conclusions expressed in this paper are entirely those of the author(s) and should not be attributed in any manner to the World Bank, to its affiliated organizations or to members of its Board of Executive Directors or the countries they represent. Citation and the use of material presented in this series should take into account this provisional character. For free copies of papers in this series please contact the individual authors whose name appears on the paper.

Enquiries about the series and submissions should be made directly to the Editor Martin Lutalo ([mlutalo@worldbank.org](mailto:mlutalo@worldbank.org)) or HNP Advisory Service ([healthpop@worldbank.org](mailto:healthpop@worldbank.org), tel 202 473-2256, fax 202 522-3234). For more information, see also [www.worldbank.org/hnppublications](http://www.worldbank.org/hnppublications).



## **THE WORLD BANK**

1818 H Street, NW  
Washington, DC USA 20433  
Telephone: 202 473 1000  
Facsimile: 202 477 6391  
Internet: [www.worldbank.org](http://www.worldbank.org)  
E-mail: [feedback@worldbank.org](mailto:feedback@worldbank.org)