sightandlife

CRISIS AND OPPORTUNITY OF THE DOUBLE BURDEN

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Welcome

The Double Burden or The New Norm

In his recently published book *Factfulness*, the late Dr Hans Rosling beautifully compares people's different standards of living to levels of a computer game whereby everyone wishes to move from Level 1 (living on US$1 per day), to Level 2 (living on US$4 a day) and Level 3 (living on US$16 a day), all the way to Level 4 (living on more than US$32 a day).[1] While 200 years ago, 85 percent of the world was living in extreme poverty, on Level 1 today, the vast majority of people are spread out in the middle, across Levels 2 and 3, thanks to remarkable improvements in health, education, water and sanitation, hygiene and economic growth, among many other factors.[1]

Although there is still a long way to go, it is important to celebrate these developments while keeping sight of the challenges ahead. It was only three years ago that the optimist in each one of us applauded the soaring progress by many countries towards achieving the Millennium Development Goal of eradicating extreme poverty and hunger. In recent decades, as low- and middle-income countries made economic advances and underwent the nutrition transition, their undernutrition rates declined (despite the latest increase in the past two years as confirmed in the 2017 and 2018 SOFI report). Yet here we are, grappling with the inconvenient truth that 462 million people are underweight,[2] that over 2 billion people are overweight or obese, and that this latter estimate is used to describe the number of people who suffer from hidden hunger.[3] These different forms of malnutrition can coexist within countries and communities, within households, and even within the same person over their lifetime. The double burden of malnutrition has become the new norm in many parts of the world.

An unparalleled opportunity

The data is alarming. While more than one in eight adults in the world is obese, one in three women of reproductive age is anemic.[3] We trust that this issue of *Sight and Life* magazine will sufficiently expose our readers to additional and similar data reflecting this trend. Yet, in the midst of all this, optimism screams at us: global attention to addressing the multiple forms of malnutrition is unparalleled.

The nutrition policy arena has made laudable efforts in providing a space to bring all forms of malnutrition onto the policy agenda. Although the double burden remains a largely untapped area for integrated action, there are opportunities to act. The Decade of Action on Nutrition, which calls for coordinated action through coherent and cross-cutting policies, initiatives and programs, represents a unique entry-point to comprehensively address the double burden of malnutrition.[4]

In recent years, several major global policy developments – including the G20 meeting in Berlin in 2017, the G7 Agricultural Ministerial meeting in Bergamo and the Global Nutrition Summit in Milan – amplified the opportunity of using a food-systems approach to tackle the multiple challenges of hunger, obesity, climate change, jobs, inequality and growth, and helped to maintain momentum towards creating a sustainable future.[5] Progress toward the 2030 Agenda for Sustainable Development continues, as the United Nations Statistical Commission formally adopted the indicator framework to track progress on meeting the Sustainable Development Goals (SDGs).

> "Key questions remain unanswered"

Key questions, however, remain unanswered, and a lack of scientific consensus is slowing down governments, businesses and civil society actors who want to take action. In this light, the EAT-Lancet Commission on Food, Planet, Health is taking on these challenges and will soon provide a scientific consensus to the global community and offer solutions as to how all actors can provide populations with healthy diets from a sustainable food system. The International Symposium on Understanding the Double Burden of Malnutrition for Effective Interventions organized by the International Atomic Energy Agency (IAEA) in December 2018 in Vienna is another event that will provide further direction on the epidemiology, biology, assessment, interventions and policy implications for the double burden.

We hope that you will find this issue of *Sight and Life* magazine useful and thought-provoking. The aim of this publication has always been to provide a space to share new knowledge and

insights and to stimulate discussion rather than to solely provide answers and solutions. This special edition on the double burden seeks to bring all actors to the table and, more importantly, to include new voices in the discourse.

Beyond business as usual

Let us introduce you to Joy. She is 21 and lives with her three children and husband in the fishing village of Nyanyano in Ghana. Her husband is a fisherman who spends most of the month away from the village. Joy works selling fried food on the street. Her three children are malnourished, and her oldest child has suffered from an eye infection for two years without medical treatment. She feels alienated and alone. She cannot afford to take her children to hospital for treatment or get the food supplements the nurse recommends. The local clinic serves a population of 40,000 with just a handful of community nurses. Most children never visit the center because of the stigma it brings.

In the same village, Ana, aged 40, lives with her six children in a two-bedroomed house. Her husband left two years ago, and she is the sole provider. She earns her living by selling fruit at her market stall – fruit she and her family never eat, as it is their main source of income. Long hours and economic constraints result in her buying food that is available, convenient and cheap. Unfortunately, this often means consuming foods high in fat, salt and sugar and low in vitamins and minerals. Due to her increased weight gain, she now struggles to stay on her feet all day, and work is becoming more difficult. She fears for her family's source of income and worries about her future health bills.

> "As public health professionals, we must challenge ourselves to work differently"

The statistics for both women are bleak, their problems complex. But finding solutions to the multiple burdens of malnutrition that Joy and Ana are experiencing is the new norm. As public health professionals, we must challenge ourselves to work differently, be innovative, make alliances outside the normal sphere and shift mindsets to become more agile and flexible in our approach. Those of us working in under- and over-nutrition are often separated, working in silos and apprehensive about straying too far from our fields of professional expertise. This is a contradiction that inhibits the generation of new ideas, solutions and cross-learning. The many burdens of malnutrition and its consequences are influencing the well-being and economic resilience of regions, countries, communities and individuals. Solutions require concerted action.

Unfortunately, no single solution or 'one-size-fits all' approach exists due to the many factors that exacerbate this public health issue. In our 'Food for Thought' piece, we reflect on the importance of science in the discussion. Consolidated data on the global landscape to understand its magnitude and extent, the impact of climate change and mass urbanization, food and agricultural systems, legislation, consumer behavior and the role of the private sector are areas we need to understand to ensure the problem is not viewed in isolation.

Engagement with the food industry is often given lip service, but examples of real collaboration are rare. With a lack of trust, due particularly to the marketing of unhealthy foods to children and the lack of adherence to the breastfeeding code, relations are strained. However, sustainable, lasting solutions to the double burden of malnutrition require us to engage the food industry through a sharing of goals. Food companies have technical and marketing experience and expertise that can support the development of affordable, nutritious foods, particularly for consumers at the base of the pyramid. These relationships should be managed through incentives and regulatory frameworks that support healthy eating principles.

Low- and middle-income countries are continuing to tackle undernutrition while finding themselves increasingly challenged to fight growing rates of overweight and obesity. These countries cannot afford to ignore the potential of unhealthy diets. A food system that is efficient in delivering healthy food to all at an affordable price, in all situations, is required. High-income countries have seen the cost and consequences of not recognizing this sooner. Current estimates suggest that malnutrition costs the global economy US$3.5 trillion a year – 11% of the world's GDP.[6]

In this issue

We would like to thank all our contributors, who have very kindly shared their insights and research. We begin by hearing Alessandro Demaio's thoughts on how the global community can come together through integrated action on the double burden of malnutrition. If you are interested in hearing about how key stages in people's lives have relevance for their health, read Chandni Maria Jacob and Mark Hanson's article examining how a life-course approach to policy design can help prevent childhood malnutrition. To understand further the unique challenges presented in different contexts, read Simón Barquera, Mariel White and Norma Buenrostro's synopsis from Latin America, while Regina Moench-Pfanner, Jeyakumar Henry and Klaus Kraemer provide the view from Asia. If you would like to appreciate how to identify interventions that can have the greatest impacts, we recommend you review the findings of Indira Bose, Saskia de Pee and colleagues from their 'Fill the Nutrient Gap' analysis in Cambodia, Lao PDR and Tajikistan. What does a double- or triple-duty action look like? Rafael

Pérez-Escamilla and Sofia Segura-Pérez provide the rationale for breastfeeding as an important example of triple-duty action in the context of the double burden of malnutrition.

Don't miss Jessica Renzella and Elyse Franko-Filipasic's enlightening article on the value of community-centered approaches in addressing an issue as complex as the double burden. To dive into some of the science behind the complexity, read Hélène Deslile's piece on the frequent co-occurrence of nutritional deficiencies and cardiometabolic risk markers. For a compelling call to action on the role of double-duty actions in addressing the double burden, do read Corinna Hawkes' article. Within the theme of breaking out of our silos, let Jessica Fanzo and Paul Newnham convince you of the importance of addressing capacity challenges and engaging new voices in the nutrition fight, respectively. Hear the private sector's voice and learn about FRESH's approach from the contribution of Alison Cairns, and if you are interested in finding out how to get consumers to choose fruit and not fries, Marti van Liere and Valerie Curtis share their insights. Last but not least, we are extremely pleased to feature one of Peru's leading chefs, Arlette Eulert Checa, in our 'Day in the Life' interview, offering the inspiring example of how she uses her skill and passion for food to improve the diets of all Peruvians.

> "The challenges present a unique opportunity for mutual learning and collaboration"

Despite the bleak outcomes that regions, countries, communities and individuals are currently facing, one must acknowledge that the challenges posed by undernutrition, overweight and obesity along with diet-related noncommunicable diseases present a unique opportunity for mutual learning and collaboration between the global North and South, as every country in the world is affected by one or more forms of malnutrition.

We very much hope you will enjoy this new issue of *Sight and Life* magazine, and trust that it will stimulate new ways of thinking that pave the way for meaningful and lasting change.

References

01. Rosling H, Rönnlund AR, Rosling O. Factfulness: ten reasons we're wrong about the world – and why things are better than you think. New York, NY: Flatiron Books; 2018.
02. WHO. 2018. Key facts [Online]. Available at: www.who.int/news-room/fact-sheets/detail/malnutrition (Accessed 19 November 2018).
03. FAO, IFAD, UNICEF, WFP, WHO. The state of food security and nutrition in the world 2018. Building climate resilience for food security and nutrition. Rome: FAO; 2018.
04. Demaio AR, Branca F. Decade of action on nutrition: our window to act on the double burden of malnutrition. BMJ Glob Health. 2018;3(Suppl 1).
05. International Food Policy Research Institute. 2018 Global food policy report. Washington, DC: IFPRI; 2018.
06. Starling S. Malnutrition costs 11% of the worlds GDP: Global Nutrition Report. 2018. Internet: www.nutraingredients.com/Article/2014/11/14/Malnutrition-costs-11-of-world-s-GDPGlobal-Nutrition-Report (accessed 29 October 2018).

With warm regards,

Breda Gavin-Smith
Global Public Health Nutrition Manager, *Sight and Life*

Kesso Gabrielle van Zutphen
Knowledge and Research Specialist, *Sight and Life*

Glossary

Metabolic syndrome[1]

The metabolic syndrome is a cluster of the most dangerous heart attack risk factors: diabetes and raised fasting plasma glucose, abdominal obesity, high cholesterol and high blood pressure. This 'clustering' of metabolic abnormalities that occur in the same individual appears to confer a substantial additional cardiovascular risk over and above the sum of the risk associated with each abnormality. The International Diabetes Federation's (IDF) definition of the metabolic syndrome addresses both clinical and research needs and stipulates that for a person to be defined as having the metabolic syndrome they must have central obesity plus any of two of the following factors: raised triglycerides, reduced HDL cholesterol, raised blood pressure and raised fasting plasma glucose.

Thrifty genotype hypothesis[2,3]

In 1962, geneticist James Neel proposed the thrifty gene hypothesis, providing a potential explanation for the rise in type 2 diabetes. The theory proposes that through natural selection we evolved to be efficient in the intake and utilization of fuel as these were beneficial human modifications. However, during the past century, the transition to an excess of food and limited physical activity has created a situation where our previously advantageous thrifty genes now make us susceptible to diabetes and obesity. "This thrifty genotype is suggested to lead to metabolically disadvantageous phenotypes" (Southam et al.).

Thrifty phenotype[4]

The thrifty phenotype hypothesis is concerned with the influence of nutritional programming on disease in later life. It proposes an association between poor fetal and infant growth and the subsequent development of type 2 diabetes and the metabolic syndrome, and that inadequate nutrition in early life produces permanent changes in glucose-insulin metabolism. These changes comprise reduced capacity for insulin secretion and insulin resistance, which, together with the effect of obesity, aging and physical inactivity, are significant factors in determining type 2 diabetes.

Double burden of malnutrition[5]

The double burden of malnutrition is characterized by the coexistence of undernutrition along with overweight and obesity, or diet-related noncommunicable diseases (NCDs), within individuals, households and populations and across the life course. This double burden of malnutrition can exist at the individual level (for example, obesity with deficiency of one or various vitamins and minerals, or overweight in an adult who was stunted during childhood), at the household level (when a mother may be overweight or anemic and a child or grandparent is underweight) and at the population level (where there is a prevalence of both undernutrition and overweight in the same community, nation, or region).

Triple burden of malnutrition[6]

The triple burden of malnutrition is a term that refers to the coexistence of overnutrition, undernutrition and micronutrient deficiencies within individuals, households and populations.

Double-duty actions[7]

Double-duty actions include interventions, programs and policies that have the potential to simultaneously reduce the risk or burden of both undernutrition (including wasting, stunting and micronutrient deficiency or insufficiency) and overweight, obesity, or diet-related NCDs. Reflecting the shared drivers and platforms of contrasting forms of malnutrition, double duty can be achieved at three levels: through doing no harm with regard to existing actions on malnutrition; by retrofitting existing nutrition actions to address or improve new or other forms of malnutrition; and through the development of *de novo*, integrated actions aimed at the double burden of malnutrition.

Life-course perspective[8]

The life-course perspective highlights a time-based and social perspective, looking across an individual's or a population's life experiences, and also across generations, to understand current patterns of health and disease. It recognizes that both past and present experiences are shaped by the wider social, economic and cultural context.

Nutrition transition[9]

Over the past three centuries, the pace of dietary change appears to have accelerated to varying degrees in different regions of the world. The concept of the nutrition transition focuses on large shifts in diet and activity patterns, especially their structure and overall composition. These changes are reflected in nutritional outcomes, such as changes in average stature and body composition. Furthermore, dietary and activity pattern changes are paralleled by major changes in health status and by major demographic and socioeconomic changes. This shift towards increased obesity and NCDs is only the latest pattern of this transition (**Table 1**).

TABLE 1: The stages of the nutrition transition[10]

Characteristic	Stages		
	Pre-transition	Transition	Post-transition
Diet (prevalent)	Grains, tubers, vegetables, fruits	Increased consumption of sugar, fats and processed foods	Processed foods with high content of fat and sugar; low fiber content
Nutritional problems	Undernutrition and nutritional deficiencies predominate	Undernutrition, nutritional deficiencies and obesity coexist	Overweight, obesity and hyperlipidemia predominate

Double burden of disease[11,12]

The double burden of disease is characterized by the coexistence of communicable (infectious disease) and NCDs. This double disease burden is a common characteristic of low- and middle-income countries fighting infectious diseases such as malaria and tuberculosis of 80% of all cardiovascular-disease-related deaths.

Triple burden of disease[13]

The triple burden of disease refers to the existence of both communicable and NCDs together with health risks associated with globalization, such as mental health, injuries and sociobehavioral conditions.

Anthropocene[14]

Anthropocene relates to the current geological age, in which it is believed that Earth has been significantly altered through human activity. This human activity has impacted climate and the environment.

References

01. International Diabetes Federation. The IDF consensus worldwide definition of the metabolic syndrome. Brussels: International Diabetes Federation; 2016.
02. Southam L, et al. (2009). Is the thrifty genotype hypothesis supported by evidence based on confirmed type 2 diabetes- and obesity-susceptibility variants? Diabetologia. 2009;52(9):1846–51.
03. Gosling AL, et al. (2015). Pacific populations, metabolic disease and 'just-so stories': a critique of the 'Thrifty Genotype' hypothesis in Oceania. Ann Hum Genet. 2015;79(6):470–80.
04. Hales CN, Barker DJP. (2001). The thrifty phenotype hypothesis: type 2 diabetes. Br Med Bull. 2001;60(1):5–20.
05. WHO. The double burden of malnutrition: policy brief. Geneva: WHO; 2017.
06. Pinstrup-Andersen P. Agricultural research and policy for better health and nutrition in developing countries: a food systems approach. Agricultural economics. 2007;37(s1):187–98.
07. WHO. Double-duty actions for nutrition: policy brief. Geneva: WHO; 2017.
08. Ben-Shlomo Y, Kuh D. A life-course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. Int J Epidemiol. 2002;31(2):285–93.
09. Popkin, BM. Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases. Am J Clin Nutr. 2006;84(2):289–98.
10. FAO, IFAD, UNICEF, WFP, WHO. The state of food security and nutrition in the world 2018. Building climate resilience for food security and nutrition. Rome, FAO; 2018.
11. Kushitor MK, Boatemaa S. The double burden of disease and the challenge of health access: Evidence from Access, Bottlenecks, Cost and Equity facility survey in Ghana. PLOS ONE. 2018;13(3):e0194677.
12. Marshall, SJ (2018) Developing countries face double burden of disease. Bulletin of the World Health Organization. Internet: www.scielosp.org/article/bwho/2004.v82n7/556-556/ (accessed 12 September 2018).
13. Frenk J, Gomez-Dantes O. The triple burden. Disease in developing nations. Harvard Int Rev. 2011;33:36–40.
14. Myers J. What is the Anthropocene? And why does it matter? 2018. Internet: www.weforum.org/agenda/2016/08/what-is-the-anthropocene-and-why-does-it-matter/ (accessed 13 September 2018).

When Biological Systems Meet Food Systems

Klaus Kraemer
Managing Director, *Sight and Life,* Basel, Switzerland;
Johns Hopkins Bloomberg School of Public Health,
Baltimore, MD, USA

> "A good means to discovery is to take away certain parts of a system to find out how the rest behaves"
>
> *Georg Christoph Lichtenberg (1742–99)*
> *German scientist, satirist and philosopher*

Despite substantial global and national mitigation strategies, malnutrition in all its forms, from undernourishment and micronutrient deficiencies to overweight and obesity and related noncommunicable diseases (NCDs), is still on the increase. In a recent workshop on food safety and healthy diets organized by the Academy of Sciences of the Vatican, FAO Director-General José Graziano da Silva highlighted the fact that by now a frightening 2.6 billion people are overweight and obese. Moreover, the United Nations General Assembly in September 2018 dedicated a full day to a high-level meeting on the prevention and control of NCDs. Da Silva sees unhealthy diets – composed of foods that are dense in energy, fat, sugar and salt – as the most important factors behind the "global pandemic of obesity." The Sustainable Development Goals (SDGs) aim to eliminate malnutrition, including overweight, by 2030. Without a miracle, the achievement of this objective is highly unlikely in the dozen years before that date.

> "Without a miracle, the elimination of malnutrition by 2030 is unlikely"

The risk of neglecting human biology

Without any doubt, the situation is dire, unsustainable, and requires action by all actors in the food system. Traditional food systems are characterized predominantly by stunting, wasting and micronutrient deficiencies and less by the prevalence of overweight. Modern food systems are dominated by overweight, obesity and NCDs. But can food systems and food environments be changed simply by educating consumers, persuading the food & beverage industry to reformulate products, imposing sugar taxes, and regulating front-of-the pack labeling and product marketing? These efforts crowd the current discourse in national and international nutrition circles, but don't we run the risk of neglecting human biology in our quest to eradicate the double – or even triple – burden of malnutrition?

Nutritional and psychological well-being

Nutritional and psychological well-being go hand in hand. Poverty and household food insecurity lead to stress, anxiety and depression. Recognizing this, the charity GiveDirectly provides 'basic income' to those in need without any restriction. Between 2011 and 2013, GiveDirectly provided unconditional cash transfers to extremely poor households in western Kenya. The average transfer corresponded to almost two years of per capita expenditure.

Researchers from Princeton University evaluated the program. The cash transfers had positive effects on happiness, life satisfaction, stress levels and depression. The glucocorticoid cortisol (a stress hormone) was found to be lower when transfers were made to the wife rather than the husband, when a lump sum was given rather than monthly installments, and when the payment was large rather than small. Most cells in the body have cortisol receptors. Cushing syndrome – a disease involving chronically elevated cortisol levels caused by a tumor of the pituitary or adrenal glands – is characterized by weight gain (predominantly in the face and abdomen), diabetes, hypertension and suppressed immune function.

Harvard University behavioral biologist Katie Hinde and colleagues studied 108 nursing rhesus macaque mothers. Some macaque mothers delivered significant levels of cortisol to their babies through their milk. Milk high in cortisol made babies put on weight faster, become nervous and develop a less confident temperament. Interestingly, lower parity correlated with higher milk cortisol levels. Shaping the phenotype of the offspring via the transmission of biologically active compounds (including glucocorticoids) into breastmilk has been designated as 'lactational programming.' Other factors in lactational programming are, for instance, leptin, ghrelin and adiponectin, which are also known to affect satiety, metabolism and adiposity.

Early-life programming of overweight and NCD risk

Early-life programming of overweight and NCD risk does not start

with breastfeeding. Fetal exposure to maternal glucocorticoid cortisol also increases risk of adiposity in early life after birth. Glucocorticoids could even be an underlying mechanism – or, indeed, *the* underlying mechanism – of early-life programming, leading to fetal growth retardation (small-for-gestational age [SGA], stunting), adiposity and increased NCD risk in adulthood. Epigenetic modifications, especially methylation, which can change gene expression, have also been implicated in fetal programming. Developmental Origins of Health and Disease (DOHaD) is now a field of intense research that links undesirable early-life exposures (pre- and post-natal) – and poor nutrition and micronutrient deficiencies in particular – to a higher risk of NCDs, which is further compounded by rapid weight gain after birth. There is an urgent need to better understand the role of DOHaD in adiposity and NCD risk for low- and middle-income countries and how this relates to the respective food systems and environments.

The gut microbiota has also been implicated in the development of overweight and obesity. Overweight people have a lower diversity of gut microorganisms than people of normal weight. This lower diversity causes a microbial imbalance (dysbiosis) in the intestine. It appears that microbiota dysbiosis enhances diet-induced obesity and metabolic complications by a number of mechanisms including immune function, energy metabolism, changes in gut hormones and inflammation. Dietary factors such as fiber, carbohydrates, protein and fats affect the abundance of different microorganisms in the gut. With this in mind, isn't the gut microbiota another important target for addressing the global malnutrition burden? It should be observed that we will need to better understand how dietary factors interact with the good and bad bugs in our intestines in order to effectively explore this relationship.

> "Isn't the gut microbiota another important target for addressing the global malnutrition burden?"

Elsewhere in this edition of *Sight and Life* magazine, we report about the Asian phenotype with relatively low body mass index (BMI), increased body fat and a high risk of central adiposity and metabolic syndrome (see Time to Recalibrate Nutrition Improvement Strategy? on page 64 of this issue). I was intrigued by a study from rural Bangladesh in which women had excess adipose tissue at substantially lower BMI compared with non-South Asian populations. A BMI of 21 kg/m² identified subjects of >30% body fat. This calls into question the validity, at least for the Asian context, of higher cut-off points established by the WHO.

Discovery science

In *Sight and Life* 29(1), 2015, Dr Andrew Prentice states, "I strongly believe that discovery science will lead us more quickly to effective interventions than continuing to feel our way in the dark with trial after trial." Prentice goes onon: "We are seduced by the possibility of a silver bullet that will provide a quick fix."

> "Our biological and metabolic knowledge of malnutrition is still too sketchy"

I can only concur with Dr Prentice: our biological and metabolic knowledge of malnutrition in all its forms is still too sketchy. We now possess the technologies (e.g., omics) to amplify discovery research. We must explore how the human genome and epigenome interact with the food system and environment to shape the phenotype. Only a better understanding of these interactions will fast-track our efforts to overcome malnutrition in all its forms. This is where the biological systems meet the food systems, as well as the related cultural and socioeconomic systems. Given the importance of the biology of the first 1,000 days for establishing physical, mental, health, economic and socioemotional well-being for the whole life course, I wonder why we don't focus more closely on these interactions.

Correspondence: ***Dr Klaus Kraemer,***
Managing Director, Sight and Life, PO Box 2116, 4002 Basel, Switzerland ***Email:*** *klaus.kraemer@sightandlife.org*

References

- FAO. Trade and consumption of cheap junk food are an obstacle for healthy diets. Rome: FAO; 2018.
- Haushofer J, Shapiro J. The short-term impact of unconditional cash transfers to the poor: experimental evidence. Q J Econ. 2016 Nov;131(4):1973–2042.
- Mandy M, Nyirenda M. Developmental Origins of Health and Disease: the relevance to developing nations. J Clin Endocrinol Metab. 2017;102(4):1366–74.
- Shaikh S, Jones-Smith J, Schulze K, Ali H, Christian P, Shamim AA, et al. Excessive adiposity at low BMI levels among women in rural Bangladesh. Nutritional Sci. 2016;5(e11):1–9.
- Karakochuk CD, Whitfield KC, Green TJ, Kraemer K. The biology of the first 1,000 days. Boca Raton, FL: CRC Press; 2018.
- Hinde K, Skibiel AL, Foster AB, Del Rosso L, Mendoza SP, Capitanio JP. Cortisol in mother's milk across lactation reflects maternal life history and predicts infant temperament. Behav Ecol. 2015 Jan–Feb; 26(1): 269–281. Published online 31 October 2014. doi: [10.1093/beheco/aru186].

Drivers of the double burden of malnutrition across the life course

BEHAVIORAL
Lifestyle and habits
Psychological factors

OVERW
OBES

Maternal obesity, excess weight gain, gestational diabetes, epigenetic changes, postpartum weight retention.

High birthweight, premature birth, maternal overweight.

PRECONCEPTION
PRECONCEPTION
PREGNANCY
POSTPARTUM

BABY

Low weight gain, inadequate food intake, poor appetite or loss of appetite, food insecurity, inadequate fetal nutrition.

Low birthweight, premature birth, maternal undernutrition.

UNDER

SOCIAL AND DEMOGRAPHIC
Socioeconomic disadvantage & poverty
Food insecurity

BIOLOGICAL
Inheritability
Epigenetics
Early life experience

EIGHT
ITY

Rapid catch-up growth, no breastfeeding, less exposure to healthy foods and flavors, food insecurity, stunting.

Continued excess weight gain, unhealthy diet, low physical activity, obesity & related health problems.

Low-paid, repetitive jobs with inflexible opportunities for physical activity, less encouragement and social support.

CHILD

ADOLESCENT

ADULT

Untimely or inadequate feeding; frequent infections; inadequate food, health and care.

Reduced capacity for physical labor.

Reduced capacity for physical labor, lower educational attainment, restricted economic potential.

WEIGHT

ENVIRONMENTAL
Food supply and systems
Food portion sizes and cost
Cultural and social aspects
Urban and built environment
Trade and trade policies

Addressing the Double Burden of Malnutrition as both Crisis and Opportunity

Alessandro Demaio
EAT Foundation, Oslo, Norway;
The Sandro Demaio Foundation, Northcote, Australia

Approximately 2 billion people in the world are micronutrient-deficient, while more than 2 billion are overweight or obese

Amidst rapid economic growth, cultural globalization, urbanization and the homogenization and commodification of food systems, human diets are dramatically changing. The result? Contrasting and multiple forms of simultaneous malnutrition have become our new normal in the age of the Anthropocene. The intersection of undernutrition with overweight, obesity and diet-related noncommunicable diseases (NCDs) has become known as the double burden of malnutrition.

Today, no country is immune from this complex coexistence of malnutrition. An estimated half of the global population are malnourished: 815 million adults go hungry each day, and approximately 2 billion are micronutrient-deficient; at the same time, more than 2 billion are overweight or obese.[1] Among the most sobering consequences of malnutrition is that almost one in four of the world's children under five years continue to be permanently stunted, thus limiting their lifelong health, social and economic potential.[2]

> "Contrasting and multiple forms of simultaneous malnutrition have become our new normal"

Understanding the double burden and its drivers

The relationships between undernutrition and overweight, obesity and NCDs are complex. Manifesting at three different scales of population and two temporal dimensions, multiple forms of malnutrition may occur simultaneously or at different stages over the life course of individuals, in households and across populations. For an individual, the double burden may take the form of a micronutrient deficiency alongside obesity or type 2 diabetes, or overweight in a once-stunted adolescent. For a household or community, it may appear as nutritional anemia in a mother with a wasted child or an overweight grandparent.[3] Stubborn levels of undernutrition persist in communities, regions and nations even as overweight and obesity, with their associated NCDs, continue to skyrocket. Countries and regions undergoing unprecedentedly rapid transitions in nutrition are often hit hardest. South East Asia, for example, is home to nearly half of the global double burden of stunting and overweight.[4] Meanwhile, nations such as Mexico endure stubborn declines in stunting while overweight and obesity already affect more than 70% of the adult population.[5]

The contradictions of the double burden originate in the complexity and rapid change that characterize today's world. As our global society becomes more interconnected as well as more

Young children showing clear signs of malnutrition at the UNHCR Refugee Camp in Kakuma, Kenya

The nutrition transition has led to a total rewriting of global epidemiology and the rise to dominance of diet-driven NCDs

urban, there have been profound changes to dietary patterns, consumption behaviors and energy expenditure. These shifts in both the quantity and quality of diets over just the past century have seen a total rewriting of global epidemiology and the rise to dominance of diet-driven NCDs.

From the pattern of infectious and undernutrition-related diseases that prevailed earlier, NCDs have become the main burden in almost every nation. At the same time, we are in the midst of a linked and unprecedented demographic change as high fertility, high mortality and relatively large proportions of young people give way to populations characterized by reduced fertility rates, longer lifespans and increasing proportions of elderly. Yet even this does not encompass the full extent of the metamorphoses now reshaping our world. These transformations occur in the context of shifting food systems that now drive and are in turn threatened by changing climates, ecosystem destruction and natural resource depletion. This is all linked to, and is also shaping, human nutrition outcomes.

In high-income countries, much of this change occurred over the past 200 years in a gradual, near-linear fashion, leading to incremental and controlled increases in both human height and lifespan. In low- and middle-income countries, this has happened suddenly, in a matter of decades rather than centuries. The compressed timespan of these processes has led to intra-generational divergence and contrasting yet simultaneous forms of malnutrition, reflecting the effect of altered food environments, diets and behaviors. But while the drivers of the double burden of malnutrition are varied and often insidious, their effects present a clear case for urgent action.

> "While the drivers of the double burden of malnutrition are varied and often insidious, their effects present a clear case for urgent action"

Assessing the double burden's true cost

What is the economic impact of the double burden on individuals, communities and entire populations? By increasing the costs of healthcare, reducing productivity and slowing economic growth globally, the double burden creates barriers to socioeconomic development and perpetuates cycles of poverty and ill health. And as the burden of malnutrition is only projected to increase, the direct and indirect macro- and microeconomic costs become unsustainable.

The current losses already incurred by national, regional and global economies are astounding. Obesity costs the global economy US$2 trillion per annum, while undernutrition and micronutrient deficiencies account for an additional US$2.1 trillion.[6] In the United States alone, US$190 billion was spent on obesity-related healthcare in 2005,[7] and obesity accounted for national productivity losses amounting to US$8 billion.[8] In Malawi, child undernutrition drained the country of US$597 million, where losses in productivity accounted for 90% of the sum.[9] At the microeconomic level, individuals and households also incur high personal costs as a result of the double burden. Obese individuals spend an average of US$2,741 more than their normal-weight counterparts on medical care in the United States.[7] In Rwanda, stunted children's average schooling achievements are 1.1 years lower.[9] By 2030, the costs of NCDs are projected to exceed US$30 trillion or 48% of the global GDP in 2010.[10]

> "By 2030, the costs of NCDs are projected to exceed US$30 trillion"

Seizing the opportunity for an integrated response

The double burden undoubtedly amounts to a major global challenge. At the same time, it also represents a chance to reshape our approach to malnutrition. The intersection of confounding forms of malnutrition calls for renewed focus and intervention, especially for integrated policies and programs as well as a framework for solutions to end malnutrition in all its forms. This

is the time to build on the work already done in order to achieve a new development agenda. As we continue to transition from an emphasis on undernutrition under the auspices of the Millennium Development Goals towards a broader focus on nutrition guided by the Sustainable Development Goals (SDGs), we must harness the double burden to link well-established initiatives with emerging innovations. Emphasizing common or 'double-duty' actions that address the rising burden of overweight, obesity and NCDs without losing momentum on undernutrition will be key to achieving the SDGs, leaving no one behind.

> "The ongoing UN Decade of Action on Nutrition mandates an integrated response to undernutrition, overweight, obesity and diet-related NCDs"

Planning for success with new tools

Such approaches give us tools to address malnutrition in all the forms it appears today. The ongoing UN Decade of Action on Nutrition, for example, mandates an integrated response to undernutrition, overweight, obesity and diet-related NCDs. In January 2019, the EAT-Lancet Commission's report will for the first time define clear scientific targets for reference diets that are healthy and sustainable – for people and planet. These will in turn serve as guidance for science-based policies aimed at global food systems transformation. Likewise, the upcoming Lancet Series on the Double Burden of Malnutrition will present the best available evidence on progress and areas for improvement. Finally, in April 2019, UNICEF's latest State of the World's Children report will present insights on healthy diets based on sustainable food systems that can tackle malnutrition early on in children. Taken together, all of these initiatives can amplify our efforts to combat the global scourge of malnutrition.

Conclusion

Moving towards healthier and more sustainable diets is essential for breaking intergenerational cycles of poverty, ill health and poor nutrition, while also addressing concomitant and compounding environmental threats.[11] No country today is immune from malnutrition. The double burden of malnutrition poses a significant public health challenge that is also a timely and important opportunity for integrated action. As a cross-cutting determinant for health, environmental and development challenges alike, nutrition holds the powerful potential to accelerate the collective achievement of key global goals and targets. These include the SDGs, the commitments of the Rome Declaration on Nutrition, the Global Nutrition Targets 2025, the Paris Climate Agreement, the Global Action Plan for the Prevention and Control of NCDs, and critical improvements in maternal, infant and young child health more generally. Unless we solve the global malnutrition crisis, we will fail to achieve these collective ambitions. It is high time we fully commit ourselves to addressing and ending this crisis, once and for all.

Correspondence: ***Dr Alessandro Demaio,***
MBBS MPH PhD, CEO, EAT Foundation and Founder,
Sandro Demaio Foundation, Kongens gate 11, 0153 Oslo, Norway
Email: *sandro@eatforum.org*

References

01. FAO, IFAD, UNICEF, WFP, WHO. The state of food security and nutrition in the world 2017. Building resilience for peace and food security. Rome: FAO; 2017:119.
02. UNICEF, WHO, World Bank Group. Levels and trends in child malnutrition. Key findings of the 2018 Edition of the Joint Child Malnutrition Estimates. Geneva: WHO; 2018.
03. Doak C, Adair LS, Bentley M, Monteiro C, Popkin B. The dual burden household and nutrition transition paradox. Int J Obesity. 2005;29(1):129–36.
04. Haddad L, Cameron L, Barnett I. The double burden of malnutrition in SE Asia and the Pacific: priorities, policies and politics. Health Policy Plan. 2015 Nov 1;30(9):1193–206.
05. Leroy JL, Habicht JP, González de Cossío T, Ruel MT. Maternal education mitigates the negative effects of higher income on the double burden of child stunting and maternal overweight in rural Mexico. J Nutr. 2014 May 1;144(5):765–70.
06. FAO. The state of food and agriculture 2013. Rome: FAO; 2013:114.
07. Cawley J, Meyerhoefer C. The medical care costs of obesity: an instrumental variables approach. J Health Econ. 2012;31(1):219–30.
08. Orciari M. The cost of obesity. World Economic Forum. 17 November 2014. Internet: www.weforum.org/agenda/2014/11/the-cost-of-obesity/ (accessed 27 July 2018).
09. AUC, NEPAD, WFP, UNECA. The cost of hunger in Malawi: social and economic impacts of child undernutrition in Malawi – implications on national development and vision 2020. Addis Ababa: WFP; 2015:76.
10. Bloom DE, Cafiero ET, Jané-Llopis E, Abrahams-Gessel S, Bloom LR, Fathima S, et al. The global economic burden of non-communicable diseases. Geneva: World Economic Forum; 2011:48.
11. Korenromp E, Wüstefeld M. Nutrition targets and indicators for the post-2015 Sustainable Development Goals: accountability for the measurement of results in nutrition – a technical note. Rome: UNSCN; 2015:41.

science
Research-based evidence

A Life-course Approach for Influencing Policies to Prevent Childhood Malnutrition

Chandni Maria Jacob
Academic unit of Human Development and Health, Faculty of Medicine, University of Southampton, UK, and Institute of Developmental Sciences, University of Southampton, UK

Mark Hanson
Academic unit of Human Development and Health, Faculty of Medicine, University of Southampton, UK; Institute of Developmental Sciences, University of Southampton, UK; NIHR Southampton Biomedical Research Centre, University Hospital Southampton NHS Foundation Trust, University of Southampton, UK

- Taking a life-course perspective to tackle malnutrition emphasizes its intergenerational effects and has important implications for the prevention of NCDs, but requires long-term investment and political commitment.
- Intervening in the preconception period is key to improving nutritional status and health behaviors in young people and adolescents and to preventing transmission of risk to the next generation.
- Adopting a combination of top-down approaches through policy initiatives and bottom-up engagement of key stakeholders such as young people is recommended to prevent malnutrition over the first 1,000 days of life.

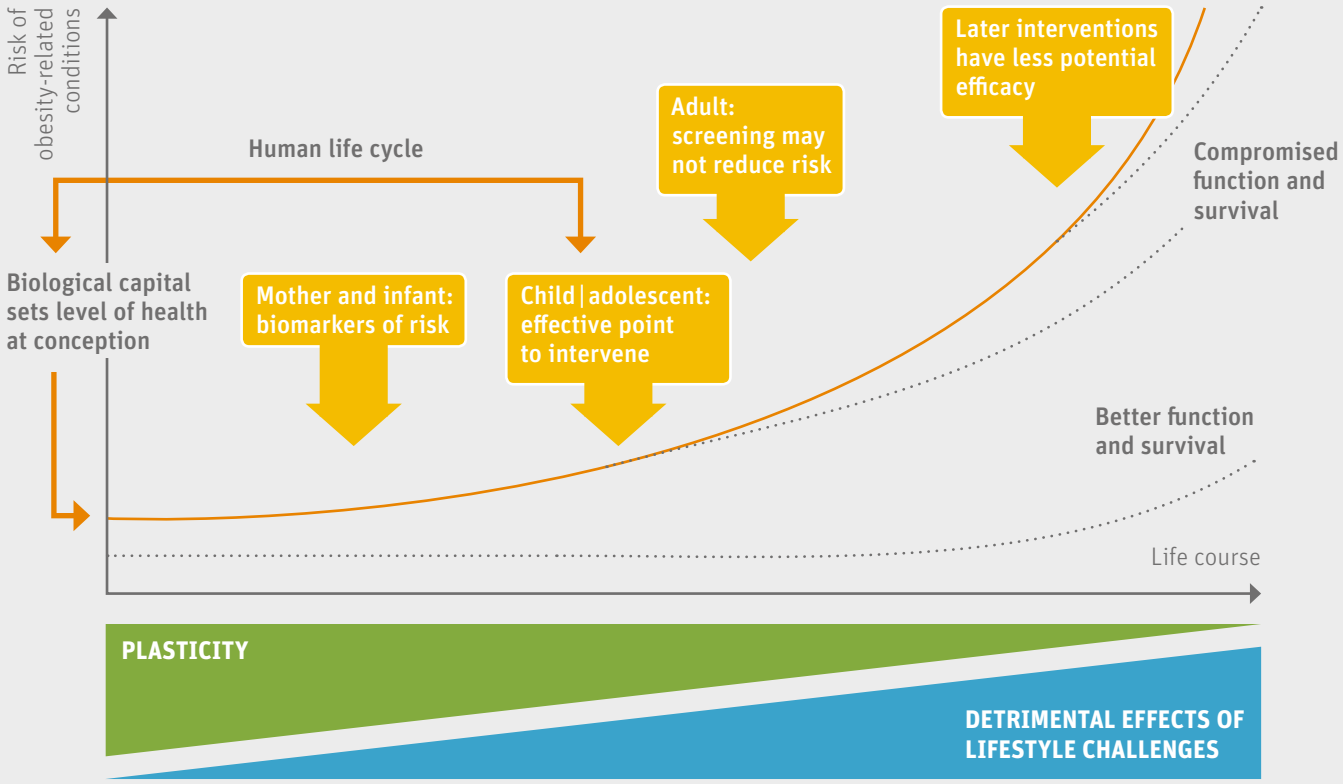
Key messages

- Globally, one in three people suffer from some form of malnutrition, a double burden ranging from undernutrition to excessive consumption of highly processed unhealthy foods, which has enormous health, economic and social consequences.
- During early childhood, nutritional status is an important determinant of health, and malnutrition can impair growth and neurocognitive development, predispose to obesity and increase the risk of later noncommunicable diseases (NCDs).

The double burden of malnutrition

It is estimated that nearly a third of the world's population suffers from at least one form of malnutrition: wasting, stunting (short for age), vitamin and mineral deficiency, overweight or obesity and diet-related noncommunicable diseases (NCDs).[1] While remarkable improvements in nutrition have been achieved in low- and middle-income countries (LMICs) over the past few decades, with economic growth and urbanization, undernutrition has been followed by wider consumption of diets associated with high-income Western countries, which are often highly processed and rich in fat, sugar and salt and poor in fiber and micronutrients.[2,3] Along with rapid changes in lifestyle, this has led to an increase in NCDs such as diabetes and

FIGURE 1: Risk of NCDs and obesity increases throughout the life course as a result of declining plasticity (green triangle) and the resulting accumulative effects of inadequate responses to new challenges (blue triangle). The trajectory for risk is set much earlier, being influenced by factors such as the mother's diet and body composition before and during pregnancy, as well as fetal, infant and childhood nutrition and development. Interventions in the preconception period confer a triple benefit: on young people today, for their future health, and for the health of their future children.



cardiovascular disease in LMICs.[4] Mortality due to NCDs is projected to increase in LMICs along with the incidence of overweight and obesity.[5,6]

Globally, an estimated 155 million children are chronically undernourished while 41 million under the age of five are overweight or obese (2016 WHO data).[1] Nearly two-thirds of the world's obese people live in LMICs,[2] and the prevalence of childhood obesity is increasing rapidly in these countries. The incidence of infectious diseases is further worsened by poor nutrition, and the coexistence of NCDs and infections (including TB and HIV) threatens both health and economic progress in LMICs.[7] Thus, the double burden of malnutrition (a term now used for both over- and undernutrition) is a global challenge, within individuals, households and populations and across the life course.[3] For example, at the household level in South Africa and Brazil, stunting among children was found to coexist with overweight and obesity in mothers.[8] Similarly, at a population level, great disparities are observed in nutritional status within countries. In the Philippines, 27% of children below the age of five were underweight, and 25% of women were overweight or obese.[9]

Although reducing malnutrition is specifically addressed in Sustainable Development Goal 2 (SDG2, Zero Hunger), it underlies all SDGs[10] and the commitments of the Rome Declaration on Nutrition within the UN Decade of Action on Nutrition (2016–2025).[11]

> "The challenge of malnutrition calls for a multidisciplinary approach that targets multiple underlying factors"

The need for a life-course perspective

The challenge of malnutrition calls for a multidisciplinary approach that targets multiple underlying factors. Key stages in people's lives have particular relevance for their health, and the life-course approach acknowledges the importance of these stages.[12] The life-course perspective highlights a time-based and social perspective, looking across an individual's or a population's life experiences and also across generations, to under-

Young couples hold their current and future health, as well as that of the next generation, in their hands

stand current patterns of health and disease. It recognizes that both past and present experiences are shaped by the wider social, economic and cultural context. As the incidence of NCDs rises in the later part of life, interventions have often targeted this period. However, studies based on the life-course approach and the Developmental Origins of Health and Disease (DOHaD) concepts[13] have shown that the trajectory of risk established in early life influences the responses of an individual to later challenges, such as living in an obesogenic environment. This explains why interventions targeting middle-aged people to prevent NCDs can be less effective (**Figure 1**).[14] Adopting such a 'pathway dependency' perspective allows the identification of individuals who are at higher risk earlier and thus targeting early preventive interventions to those who most need them. The use of a life-course approach aligns with efforts to meet the SDGs and has been recommended for incorporation into the areas of policy and investment, health service systems and monitoring and surveillance programs.[15]

The first 1,000 days

There is accumulating evidence that alterations in the expression of genes by epigenetic processes, rather than fixed genetic effects, can pass the risk of overweight, obesity and NCDs across generations.[16] Together, these studies provide the basis for the rapidly growing field of DOHaD. DOHaD research has shown that low birth weight (LBW) is associated with greater risk of later NCDs,[17] of particular relevance to LMICs such as India, where LBW is common and is linked to insulin resistance in children along with adverse total serum cholesterol and low-density lipoprotein cholesterol levels.[18] Similarly, maternal vitamin B_{12} deficiency also predicted higher adiposity and insulin resistance in children.[19] At the other end of the spectrum, maternal obesity, excess weight gain during pregnancy and short duration of breastfeeding are also linked with childhood obesity and later NCDs.[20] DOHaD processes thus operate to pass a risk of poor health between generations at multiple levels of the nutritional transition and form a key factor in the double burden of malnutrition.

> "DOHaD processes form a key factor in the double burden of malnutrition"

In addition to its effects on mortality and morbidity, malnutrition also affects childhood cognitive and emotional development, reducing school-readiness and subsequent academic achievement and leading to reduced economic productivity and human capital.[21,22]

While addressing this challenge seems daunting, there is a relatively constrained period in which action is needed – the first 1,000 days of life from conception, through pregnancy, and until the child is two years of age. However, as many women do not contact healthcare professionals until the end of the first trimester of pregnancy, or not at all in some low-resource settings, it is necessary to consider interventions before the 1,000 days start, in the preconception period of the life course.[23] This is important because, while studies have suggested that targeting pregnancy and preconception periods increases nutrition awareness and influences dietary habits,[24] well-designed RCTs starting in pregnancy have not been effective in improving pregnancy-related outcomes, although they do help to prevent excess weight gain in pregnancy.[25,26]

> "Addressing malnutrition is particularly urgent in adolescents and young adults"

Preconception interventions

Addressing malnutrition is particularly urgent in adolescents and young adults, to ensure the best possible start in life for the developing embryo, fetus and infant over the first 1,000 days. This applies across the nutritional range, from maternal undernutrition, especially in teenage mothers, to obesity, which is of growing concern due to the accompanying increased risk of gestational diabetes, hypertension and adverse birth outcomes.[25] It is essential that preconception services are incorporated into a continuum from childhood to antenatal care, involving both partners and linked to interventions to promote school attendance in young girls, and the planning of first and subsequent pregnancies.[27]

The importance of preconception interventions to prevent NCDs has also been identified as a core component of the strategy by the World Health Organization's (WHO) Commission on Ending Childhood Obesity.[28] This includes improving parents' lifestyle before conception, maternal health and nutrition before and during pregnancy, treatment of gestational diabetes, supporting breastfeeding and improving infant feeding practices. Large-scale food fortification programs (folic acid, iron and other micronutrients) have been used in LMICs; however, they do not always consider maternal and child health outcomes while evaluating effectiveness.[29] Current initiatives to address malnutrition are often limited to supplementing specific nutrients or improving calorific intake, but providing balanced protein energy supplementation has shown promise in improving maternal and neonatal outcomes in LMICs.[29] Similarly, while multiple micronutrient (MMN) supplementation starting during pregnancy can address maternal nutritional deficiencies, there are gaps in the evidence for its benefit for maternal and perinatal outcomes, and it does not necessarily improve childhood outcomes.[30–32] Furthermore, studies of MMN supplementation starting before conception have not yet achieved long enough follow-up to assess the effect on outcomes in the next generation.[26,29]

The World Health Organization's policy brief on double-duty actions for nutrition recommends a set of interventions, policies and programs to support efforts to tackle both forms of malnutrition simultaneously.[33] These include the protection and promotion of exclusive breastfeeding, improving maternal nutrition through antenatal programs, addressing environmental drivers and strengthening marketing regulations. There is a need to extend this initiative to reduce malnutrition before conception and throughout the first 1,000 days of life for the child.

Engaging key stakeholders

The focus of programs to improve malnutrition has shifted globally, from preventing hunger by providing calories towards improving diet quality and addressing the global double burden of malnutrition.[11] Although efforts to address parental risk factors in the preconception period such as smoking and excess alcohol intake are well established, initiatives to improve diet before pregnancy are lacking, highlighting the need to review current population-based strategies and policies that aim to improve nutritional status to include preconception women.

"Mere provision of health information may not improve the nutritional status of populations"

Studies investigating the management of obesity and NCDs have shown that mere provision of health information may not improve the nutritional status of populations. Hence, starting early in the life course by engaging young people and future parents, before and during the development of preconception programs, is crucial. A change in attitudes and increased motivation form an essential part of empowering individuals to change behavior. Such 'bottom-up' activities are being tested in community settings in high-income and LMIC settings.[25] The LifeLab program in Southampton, UK,[34] is a good example of a school-based intervention in a high-income setting aimed at developing adolescents' motivation for improving their diet and physical activity levels through hands-on engagement with current science. The program also emphasizes the benefits for their future children and provides support for behavior change. A focus on achieving optimal nutrition and cardio-metabolic fitness, as opposed to simply managing weight, is important in motivation. Extending this approach calls for a social movement that aims to optimize nutritional status and health behaviors before conception. This needs to be complemented by 'top-down' approaches through policy initiatives by central and local governments. A broad range of healthcare practitioners and community health workers need to be engaged in providing a continuum of care before, during and after pregnancy, and with couples with and without the intention to conceive.[27] To influence policy, health information producers (e.g., researchers) need to engage with key stakeholders such as policymakers to provide the best available evidence that can be incorporated into national programs to reduce the double burden of malnutrition.

"Researchers need to engage with policymakers"

Providing multicomponent intervention packages that recognize the socioeconomic and cultural drivers of malnutrition in different countries – commencing in the preconception period and sustained through pregnancy and infancy and into childhood – is essential to prevent the passage of malnutrition to the future generations. Cultural barriers and poverty influence people's capacity to choose healthy diets, calling for effective policy-making using a systems approach. Multisectoral collaboration is needed to broaden strategies to improve preconception health by addressing the wider socioeconomic determinants of health. Productive avenues for addressing the double burden of malnutrition include: developing evidence-based and implementation-focused dietary guidelines; integrating policies for overnutrition with those for undernutrition; supporting social policies to improve gender equality and women's health; and

supporting the implementation of urban food policies as outlined by the WHO[33] in preparing for the Decade of Action on Nutrition. All will assist with achieving the SDGs and thus confer far-reaching long-term benefits.

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Correspondence: *Dr Chandni Maria Jacob,*
Institute of Developmental Sciences, Mail point 887, Southampton General Hospital, Tremona Road, Southampton SO16 6YD, UK
Email: *C.M.Jacob@soton.ac.uk*

References

01. WHO. Malnutrition key facts 2018. Internet: www.who.int/news-room/fact-sheets/detail/malnutrition (accessed 10 August 2018).
02. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2014 Aug 30;384(9945):766–81.
03. WHO. The double burden of malnutrition: policy brief. Geneva: WHO; 2016.
04. Popkin B, Adair L, Ng S. Global nutrition transition and the pandemic of obesity in developing countries. Nutrition Res. 2012 Jan 1;70(1):3–21.
05. Mathers C, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. PLOS Medicine. 2006 Nov 28;3(11):e442.
06. Abegunde DO, Mathers CD, Adam T, et al. The burden and costs of chronic diseases in low-income and middle-income countries. Lancet. 2007 Dec 8;370(9603):1929–38.
07. Remais JV, Zeng G, Li G, Tian L, Engelgau MM. Convergence of non-communicable and infectious diseases in low-and middle-income countries. Int J Epidemiol. 2012 Oct 13;42(1):221–7.
08. Doak CM, Adair LS, Bentley M, Monteiro C, Popkin BM. The dual burden household and the nutrition transition paradox. Int J Obes. 2005 Jan;29(1):12–36.
09. FAO. The double burden of malnutrition. Case studies from six developing countries. Rome: FAO; 2006.
10. Rockström J, Sukhdev P. How food connects all the SDGs. Stockholm Resilience Centre. Internet: www.stockholmresilience.org/research/research-news/2016-06-14-how-food-connects-all-the-sdgs.html (accessed 10 August 2018).
11. WHO, FAO. United Nations Decade of Action on Nutrition 2016–2025. Rome: FAO; 2016.
12. Ben-Shlomo Y, Kuh D. A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. Int J Epidemiol. 2002 Apr;31(2):285–93.
13. Gluckman PD, Hanson MA, Buklijas T. A conceptual framework for the developmental origins of health and disease. J Dev Orig Health Dis. 2010 Feb;1(1):6–18.
14. Darnton-Hill I, Nishida C, James WPT. A life-course approach to diet, nutrition and the prevention of chronic diseases. Public Health Nutr. 2004;7(1a):101–21.
15. Kuruvilla S, Sadana R, Montesinos EV, et al. A life-course approach to health: synergy with sustainable development goals. Bull World Health Organ. 2018;96(1):42–50.
16. Godfrey KM, Gluckman PD, Hanson MA. Developmental origins of metabolic disease: life course and intergenerational perspectives. Trends Endocrinol Metab. 2010;21(4):199–205.
17. Darnton-Hill I, Nishida C, James WP. A life course approach to diet, nutrition and the prevention of chronic diseases. Public Health Nutr. 2004 Feb;7(1a):101–21.
18. Bavdekar A, Yajnik CS, Fall CH, Bapat S, Pandit AN, Deshpande V, et al. Insulin resistance syndrome in 8-year-old Indian children: small at birth, big at 8 years, or both? Diabetes. 1999 Dec 1;48(12):2422–9.
19. Yajnik CS, Deshpande SS, Jackson AA, Refsum H, Rao S, Fisher DJ, et al. Vitamin B12 and folate concentrations during pregnancy and insulin resistance in the offspring: the Pune Maternal Nutrition Study. Diabetologia. 2008 Jan 1;51(1):29–38.
20. Robinson SM. Preventing childhood obesity: early-life messages from epidemiology. Nutr Bull. 2017 Sep;42(3):219–25.
21. Daelmans B, Darmstadt GL, Lombardi J, Black MM, Britto PR, Lye S, et al. Early childhood development: the foundation of sustainable development. Lancet. 2017 Jan 7;389(10064):9–11.
22. Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L, et al. Maternal and Child Undernutrition Study Group. Maternal and child undernutrition: consequences for adult health and human capital. Lancet. 2008 Jan 26;371(9609):340–57.
23. Hanson MA, Bardsley A, De-Regil LM, Moore SE, Oken E, Poston L, et al. The International Federation of Gynecology and Obstetrics (FIGO) recommendations on adolescent, preconception, and maternal nutrition:"Think Nutrition First". Int J Gynaecol Obstet. 2015 Oct;131:S213–53.
24. Szwajcer EM, Hiddink GJ, Koelen MA, van Woerkum CM. Nutrition awareness and pregnancy: implications for the life course perspective. Eur J Obstet Gynecol Reprod Biol. 2007 Nov 1;135(1):58–64.
25. Hanson M, Barker M, Dodd JM, Kumanyika S, Norris S, Steegers E, et al. Interventions to prevent maternal obesity before conception, during pregnancy and post partum. Lancet Diabetes Endocrinol. 2017 Jan 1;5(1):65–76.

26. Ramakrishnan U, Grant F, Goldenberg T, Zongrone A, Martorell R. Effect of women's nutrition before and during early pregnancy on maternal and infant outcomes: a systematic review. Paediatr Perinat Epidemiol. 2012 Jul 1;26:285–301.
27. Barker M, Dombrowski SU, Colbourn T, et al. Intervention strategies to improve nutrition and health behaviours before conception. Lancet. 2018;391(10132):185–64.
28. WHO. Report of the Commission on Ending Childhood Obesity: implementation plan: executive summary. Geneva: WHO; 2017.
29. Dean SV, Lassi ZS, Imam AM, Bhutta ZA. Preconception care: nutritional risks and interventions. Reprod Health. 2014 Dec;11(Suppl 3):S3.
30. WHO. WHO recommendations on antenatal care for a positive pregnancy experience. Geneva: WHO; 2016.
31. Smith ER, Shankar AH, Wu LS, Aboud S, Adu-Afarwuah S, Ali H et al. Modifiers of the effect of maternal multiple micronutrient supplementation on stillbirth, birth outcomes, and infant mortality: a meta-analysis of individual patient data from 17 randomised trials in low-income and middle-income countries. The Lancet Global Health 5.11 (2017): e1090–e1100.
32. Haider BA, Bhutta ZA. Multiple-micronutrient supplementation for women during pregnancy. Cochrane Database of Systematic Reviews 2017, Issue 4. Art. No.: CD004905. DOI: 10.1002/14651858.CD004905.pub5.
33. WHO. Double-duty actions for nutrition: policy brief. Geneva: WHO; 2017.
34. Woods-Townsend K, Leat H, Bay J, Bagust L, Davey H, Lovelock D, et al. LifeLab Southampton: a programme to engage adolescents with DOHaD concepts as a tool for increasing health literacy in teenagers – a pilot cluster-randomized control trial. J Dev Orig Health Dis. 2018 Oct;9(5):475–80.

The Double Burden of Malnutrition

A Latin American perspective

Mariel White, Norma Buenrostro, Simón Barquera
Instituto Nacional de Salud Pública, Centro de Investigación en Nutrición y Salud, Cuernavaca, Mexico

Key messages

- Lifestyles in Latin America have experienced significant changes in the last decades as a result of technological advances, free trade and acculturation, among other things; these factors have had a profound impact on food systems and consumption patterns, resulting in diets that are ultraprocessed and high in sodium, saturated fats and sugar.
- The double burden of malnutrition, which is the coexistence of undernutrition and overweight, remains high in Latin America; despite greater caloric intake, undernutrition persists, as overweight and obesity do not protect against micronutrient deficiencies.
- Factors that have exacerbated or failed to mediate undernutrition and obesogenic environments include lack of marketing regulation for junk food and infant formula, poor promotion of exclusive breastfeeding, insufficient fiscal measures and industry interference in nutrition and public health policies, among others.
- Although Latin America has designed and created many solutions to tackle the double burden of malnutrition, much work is needed to adequately address all forms of malnutrition without causing unintended adverse effects.
- Strategies to reduce the double burden of malnutrition should consider sustainable food systems, with a focus on providing economic and social access to water and nutritious foods, while discouraging the consumption of ultraprocessed products through fiscal measures, marketing regulations and infrastructure that promotes and facilitates active living and physical activity.

Increasingly, dietary patterns are moving away from natural, nutrient-rich foods

Introduction

In the past decades, the world has seen a series of nutrition, epidemiologic and demographic changes that have occurred at different paces. In wealthy countries, these transitions have been almost linear. However, in middle-income countries – and some low-income countries, too – there has been overlap, resulting in a simultaneous burden of under- and overweight, referred to as the double burden of malnutrition.[1] Latin American countries largely fall into this category and have seen their traditional lifestyles completely transformed. Advances in industrialization, agriculture and globalization have dramatically influenced patterns of food production and consumption, which have moved away from natural, nutrient-rich foods to those high in sodium, saturated fats and sugar.

"Latin American countries have seen their traditional lifestyles completely transformed"

Countries that in the past were successful producers have adopted an international trade model to export their products. This has contributed to economic development but has also had a profound impact on the food system. For example, 45% of food demand was covered by imports in Mexico in 2012.[2] This outward growth model has also stimulated a phenomenon referred to as acculturation, caused by the importation of the culture and eating habits of North American countries where overweight and obesity had already taken off. In fact, ultraprocessed foods now comprise the main food supplies in high-, middle- and lower-middle income countries,[3] creating obesogenic environments that discourage healthy eating due to many factors, such as high availability of junk food and cultural practices that make consuming unhealthy food normative and, oftentimes, preferable.

An analysis of 29 studies found three predominant drivers of this transformation: lifestyle alterations, urbanization and economic development and policy changes.[4] Factors that have exacerbated or failed to mediate these changes include lack of marketing regulation for junk food and infant formula, poor promotion of exclusive breastfeeding, insufficient fiscal measures and industry interference in nutrition and public health policies, among others.

"There is a common misconception that being overweight or obese protects against micronutrient deficiencies"

Nonetheless, with greater caloric intake, populations gained intergenerational increases in weight and height, which was accompanied by an increase in obesity and chronic diseases.[5] There is a common misconception that being overweight or obese protects against micronutrient deficiencies. However, in countries undergoing the nutrition transition – middle- and lower-middle-income countries – the defining factor is diet quality, as the odds of anemia have been found to be similar across body mass index (BMI) groups in women.[6]

The double burden of malnutrition can be present at the individual, household and population level. A common example of the double burden of malnutrition consists of an overweight or obese mother with a stunted child – a widespread condition in many Latin American households, with a prevalence of up to 20% in Guatemala, 13.1% in Ecuador and 8.4% in Mexico. Of Latin American countries, stunting prevalence is lowest in Chile (1.9%) and highest in Guatemala (48%), with countries such as Mexico and Uruguay falling between 10% and 14%.[7] An estimated 4 million children in Latin America and the Caribbean are stunted, 1 million wasted and 6 million overweight. While stunting saw a 40% reduction from 2000 to 2016, rates of overweight have only increased.[8] Even more, prevalence of overweight and obesity among adults is as high as 83% in Costa Rica and 72% in Mexico. [9,10]

Malnutrition in all its forms is a public and economic health problem due to loss of productivity across the life course. For example, it is estimated that the combined impact of the double burden of malnutrition represents a net loss of gross domestic product (GDP) of 4.3% in Ecuador and 2.3% in Mexico.[11] Furthermore, studies show that cardiovascular disease, which is linked to nutrition and diet,[12] is estimated to cause 4.7 lost days of work per year; of those who suffer from a cardiovascular disease event, only 37% return to work 30 days after the event.[13] Similarly, in Mexico, dietary risks accounted for over 10% of disability-adjusted life years (DALYs) in 2013, making diet a relevant determinant for quality of life.[14]

Victories and opportunities for action

Despite these challenges, Latin America has a strong potential to find creative solutions to tackle the double burden of malnutrition that are not necessarily technologically based. For instance, Chile created its own front-of-pack-labeling (FOPL) system that includes warning labels indicating the product is high in sodium, saturated fats, or sugar. Evaluations of this system indicate high levels of comprehension and acceptance among children and adults who had no prior knowledge of it.[15] Chile was the first country in the world to approve the warning label and make it obligatory, while a growing number of countries have adopted or are attempting to adopt similar or alternative systems. On the other hand, the Guideline Daily Amount (GDA) labeling system (designed by the food industry) has low use and understanding, even among people who are college-educated.[16,17] In fact, a nationally representative survey in Mexico found that only 13.8% of the population considers the GDA 'very understandable.'[16]

In another case, Brazil was able to reduce its stunting prevalence among children under five from 37% in 1975 to only 7% in 2007 and to increase exclusive breastfeeding of infants under six months from 4.7% in 1986 to 37% in 2006.[18]

Sugar-sweetened beverages are a common component of obesogenic environments in Latin America

Mexico pioneered the implementation of social protection systems, such as conditional cash transfers (CCTs), in 1997, followed by Brazil in 2003. In an analysis of CCT implementation in Latin America, 18 programs were considered nutrition interventions. Three examples of successful CCT programs are Bolsa Família in Brazil, Familias en Acción in Colombia and PROSPERA in Mexico, which aimed to provide food security and improve nutrition levels through the distribution of food supplements and health education.[19,20] These three programs were similar in their aims and coincided in important ways: high national coverage, political commitment and secure funding. Monitoring and evaluation systems found increases in child birthweight and decreased child morbidity, with some improvements in anemia. A creative component of these CCT programs is that they connected their participants with other social initiatives to reduce poverty.

"Mexico was a front-runner in 2014 when it became the first country in Latin America to impose a tax on sugar-sweetened beverages"

In addition, Mexico was a front-runner in 2014 when it became the first country in Latin America to impose a tax on sugar-sweetened beverages. Chile has already followed suit, and many countries around the world are working towards implementation.

Nonetheless, although these are public health victories, there are missed opportunities to reallocate tax gains or increase investment in health policies. Although most Latin American countries acknowledge malnutrition as a national issue and have implemented social protection programs such as CCTs, significant work remains to be done to evaluate, monitor and improve targeting to scale up interventions and adopt evidence-based policies. Other challenges involved in tackling malnutrition include: improving coordination within government; implementation of nutrition-specific interventions throughout the life course (with particular attention to exclusive breastfeeding); regulation of obesogenic environments; partnerships between government and civil society to strengthen awareness and promotion campaigns; incomplete/inconsistent data collection; and insufficient use of data for decision-making.[20]

Solutions

Undoubtedly, the strategies to reduce the double burden of malnutrition should aim to reinforce food systems that are sustainable and nutrition-sensitive, with a focus on providing economic and social access to water and nutritious foods, in terms of both quantity and quality.[21] The management of these food systems must go hand in hand with discouraging the consumption of unhealthy ultraprocessed products through fiscal measures, marketing regulations and infrastructure that promotes and facilitates active living and physical activity. Moreover, increasing investment should also be on the table, as investing in nutrition delivers high benefits (reducing mortality and morbidity, increasing productivity and reducing costs). Specifically, interventions during the first 1,000 days of life have demonstrated cost-effectiveness: for every dollar invested in nutrition, there is a US$30 pay-off in health and education.[22] Interventions to prevent and

Cities that create spaces for physical activity facilitate and encourage active living

control nutrition-related diseases have the potential to provide economic, social and health gains to all levels of society.

Conclusion

Over the past decades, Latin American countries have seen their traditional surroundings completely transformed and saturated with ultraprocessed foods. While obesity thrives, undernutrition persists. Creative solutions to address malnutrition designed by Latin American countries include an FOPL warning system, exclusive breastfeeding campaigns, taxation of sugar-sweetened beverages and junk food, and CCT programs, among others. Nonetheless, more investment is needed to address all forms of malnutrition and improve monitoring and evaluation systems. In addition, urgent action to prevent industry interference is needed to protect communities, and particularly children, from unethical marketing practices and misleading information.

To implement these changes, Latin America must confront special challenges, given its heterogeneity in ethnic identity and socioeconomic status. By way of illustration, prevalence of the double burden of malnutrition is often higher in indigenous populations and poor rural areas.[23] These kinds of disparities require targeted strategies, considering geographic dispersion and accessibility to services, healthy foods and safe drinking water. An obstacle to enacting these strategies includes limited resources: Latin American countries have fewer financial resources than high income countries and invest less of their GDP in health.

Double-duty programs with a focus on solving all forms of malnutrition should be adopted to avoid causing 'inadvertent' harm.[24] An example is addressing undernutrition without encouraging unhealthy eating or overeating. Nutrition programs and interventions must consider the nutrient quality of the foods they provide to their beneficiaries. Although foods high in calories lead to weight gain, micronutrient deficiencies can endure among those who are overweight. Moreover, continuous consumption of ultraprocessed foods alters a household's or community's food culture, turning them into 'basic' products.[25] An added challenge is designing and implementing nutrition interventions or programs in ways that are sustainable. For instance, investing in sanitation infrastructure to provide access to water is more sustainable and efficient than distributing plastic water bottles. These kinds of approaches allow for natural resources to meet society's present and future needs.

Correspondence: ***Mariel White,***
Avenida Universidad No. 655 Col. Santa Maria,
Ahuacatitlan, Cuernavaca, Morelos, Mexico, CP 62100
Email: *cinys42@insp.mx*

References

01. WHO. The double burden of malnutrition: policy brief. Geneva: World Health Organization; 2017.
02. Garza-Montoya BG, Ramos-Tovar ME. Cambios en los patrones de gasto en alimentos y bebidas de hogares mexicanos (1984–2014). Salud Publica Mex. 2017;59(6, nov–dic):612.
03. Monteiro CA, Moubarac JC, Cannon G, Ng SW, Popkin B. Ultra-processed products are becoming dominant in the global food system. Obes Rev. 2013;14(S2):21–8.
04. Min J, Zhao Y, Slivka L, Wang Y. Double burden of diseases worldwide: coexistence of undernutrition and overnutrition-related non-communicable chronic diseases. Obes Rev. 2018;19(1):49–61.
05. Shimpton R, Rokx C. The double burden of malnutrition – a review of global evidence. Health, Nutrition and Population (HNP) discussion paper. Washington, DC: World Bank; 2012.
06. Eckhardt CL, Torheim LE, Monterrubio E, Barquera S, Ruel MT. The overlap of overweight and anaemia among women in three countries undergoing the nutrition transition. Eur J Clin Nutr.2008;62(2):238–46.
07. Rivera JA, Pedraza LS, Martorell R, Gil Á. Introduction to the double burden of undernutrition and excess weight in Latin America. Am J Clin Nutr. 2014;100(6):1613S–16S.
08. UNICEF, WHO, World Bank Group. Levels and trends in child malnutrition. New York, NY/Geneva/Washington, DC: UNICEF, WHO, World Bank Group; 2014.
09. datosmacro.com. Costa Rica – Población. 2016. Internet: https://datosmacro.expansion.com/demografia/poblacion/costa-rica (accessed 14 August 2018).
10. Shamah-Levy T, Cuevas-Nasu L, Gaona-Pineda EB, Gómez-Acosta LM, Morales-Ruán MdC, Hernández-Ávila M, et al. Sobrepeso y obesidad en niños y adolescentes en México, actualización de la Encuesta Nacional de Salud y Nutrición de Medio Camino 2016. Salud Publica Mex. 2018;60(3, may–jun):244.
11. Fernández A, Martínez R, Carrasco I, Palma A. Impacto social y económico de la doble carga de la malnutrición: modelo de análisis y estudio piloto en Chile, el Ecuador y México. Santiago: UN; 2017.
12. Getz GS, Reardon CA. Nutrition and cardiovascular disease. Arterioscler Thromb Vasc Biol. 2007;27(12):2499–2506.
13. Chaker L, Falla A, van der Lee SJ, Muka T, Imo D, Jaspers L, et al. The global impact of non-communicable diseases on macro-economic productivity: a systematic review. Eur J Epidemiol. 2015;30(5):357–95.
14. Gómez-Dantés H, Fullman N, Lamadrid-Figueroa H, Cahuana-Hurtado L, Darney B, Avila-Burgos L, et al. Dissonant health transition in the states of Mexico, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2016;388(10058):2386–402.
15. De la Cruz-Góngora V, Torres P, Contreras-Manzano A, de la Mota AJ, Mundo-Rosas V, Villalpando S, et al. Understanding and acceptability by Hispanic consumers of four front-of-pack food labels. Int J Behav Nutr Phys Act. 2017;14(1):1–12.

16. Shamah T, Cuevas L, Gaona E. Encuesta Nacional de Salud y Nutrición de Medio Camino 2016: Informe final de resultados. Inst Nac Salud Pública. 2016;2016:151.
17. Stern D, Tolentino L, Barquera S. Revisión del etiquetado frontal: análisis de las Guías Diarias de Alimentación (GDA) y su comprensión por estudiantes de nutrición en México. Inst Nac Salud Publica. 2013;53:37.
18. Boccolini CS, Boccolini PMM, Monteiro FR, Venâncio SI, Giugliani ERJ. Breastfeeding indicators trends in Brazil for three decades. Rev Saude Pública. 2017;51:108.
19. Barquera S, Rivera-Dommarco J, Gasca-García A. Políticas y programas de alimentación y nutrición en México. Salud Publica Mex. 2001;43(5):464–77.
20. Galicia L, de Romana DL, Harding KB, De-Regil LM, Grajeda R. Tackling malnutrition in Latin America and the Caribbean: challenges and opportunities. Rev Panam Salud Publica. 2016;40(2):138–46.
21. International Food Policy Research Institute. 2018 Global food policy report. Washington, DC: IFPRI; 2018.
22. Blake-Lamb TL, Locks LM, Perkins ME, Woo Baidal JA, Cheng ER, Taveras EM. Interventions for childhood obesity in the first 1,000 days. A systematic review. Am J Prev Med. 2016;50(6):780–9.
23. Ramirez-Zea M, Kroker-Lobos MF, Close-Fernandez R, Kanter R. The double burden of malnutrition in indigenous and nonindigenous Guatemalan populations. Am J Clin Nutr. 2014;100:1644–51.
24. Hawkes C, Demaio AR, Branca F. Double-duty actions for ending malnutrition within a decade. Lancet Glob Heal. 2017;5(8):e745–e746.
25. FAO. Trabajo estratégico de la FAO. Para una alimentación y una agricultura sosentibles. Rome: FAO; 2017.

Consumption of Empty-calorie Snack Foods Raises Cost of Nutritious Diet

Results from Fill the Nutrient Gap analysis in Cambodia, Lao PDR, Tajikistan and Ecuador

Indira Bose
Cambodia Country Office, World Food Programme, Phnom Penh, Cambodia

Amy Deptford, Giulia Baldi, Frances Knight, Pierre Momcilovic, Neil Mirochnick, Natalie West
Nutrition Division, World Food Programme, Rome, Italy

Lina Badawy
Regional Bureau Cairo, World Food Programme, Egypt

Saskia de Pee
Nutrition Division, World Food Programme, Rome, Italy; Friedman School of Nutrition Science and Policy, Tufts University, Boston, MA, USA; Human Nutrition, Wageningen University, the Netherlands

Key messages

- Meeting nutrient needs is essential for good health throughout the life cycle, but nutritious diets are often not affordable in low-resource settings.
- Over the last three decades, there has been a significant increase in the access to, and consumption of, unhealthy snack foods in low- and middle-income countries. Fill the Nutrient Gap analyses in Asia and Latin America demonstrate that such high-energy, low-nutrient-density foods contribute to overnutrition by exceeding energy requirements and increase the likelihood of micronutrient deficiencies by making it more expensive to meet nutrient needs using diets based on local foods.
- Fill the Nutrient Gap analysis can act as a powerful advocacy tool to demonstrate the economic and health implications of unhealthy snack food consumption. It can also inform discussions regarding the regulation of the composition and marketing of processed snack foods with low nutrient density and high sugar and/or fat content.
- Processed foods vary in form and nutrient content, so they can have positive and negative implications on diets. Unhealthy processed foods, including snack foods, contribute to the increasing prevalence and severity of overweight/obesity and NCDs, often in populations where micronutrient deficiencies and related health consequences continue to exist. Fortified processed foods can potentially make nutritious diets more affordable and convenient for people who may otherwise find it challenging to meet nutrient needs.

Introduction

The past three decades have witnessed a global shift in dietary patterns and a rapid change in food environments, driven by factors such as urbanization and economic and industrial development. This shift has led to a rising demand for, and increased availability of, unhealthy processed convenience foods, in addition to an increasing tendency towards more sedentary lifestyles. Consequently, many countries, including low- and middle-income countries, are experiencing a nutrition transition, with a concerning increase in the prevalence of overweight and obesity and noncommunicable diseases (NCDs). In many of

Snack foods on display in a local shop in Guatemala.

these low- and middle-income countries, however, the prevalence of undernutrition remains high. The problem is therefore twofold, and these countries are challenged by the double burden of malnutrition.[1,2]

For good health and nutritional status, it is essential to meet nutrient intake requirements. These requirements vary according to an individual's size, age, sex and biological status.[3,4] Nutritional needs are particularly high during periods of rapid growth such as during the complementary feeding stage (6–23 months of age) and during adolescence.[5] To meet these needs, diverse diets that contain nutrient-dense foods are required, such as specific fresh foods and fortified foods. In low-income settings, for many people, diets that would meet their nutrient needs are not affordable, as nutrient-dense foods are too expensive or may not be widely available.[6,7] Meeting nutrient needs becomes even more of a challenge in areas where the shift in dietary patterns has occurred; the opportunity cost of preparing nutritious, diverse meals is considered, given the high workloads and other time demands on caregivers, particularly in low-resource settings. In such settings, limited access to cold storage also adds an additional time burden, as more frequent trips to the market are required to purchase fresh foods. Unhealthy processed foods that are high in sugar or fat can have much lower opportunity costs, as they are often much cheaper than nutrient-dense foods[8] and do not require the same level of preparation or storage. These foods are also often highly desirable due to taste preferences and attractive packaging, and in some communities these foods are considered to be representative of higher status.

> "Processing can offer the opportunity to fortify commonly consumed foods to increase their nutritional value"

Processed foods come in many different forms and nutrient contents, so not all necessarily have negative consequences for health and nutrition. In fact, processing can offer the opportunity to fortify commonly consumed foods to increase their nutritional value and provide a more convenient and affordable option for people to obtain diets that meet their nutrient needs.[9] Processing foods can also help to improve shelf life and control for food safety issues. Companies may, however, also use a 'fortified' branding claim to make unhealthy foods seem healthier. In many countries, the regulation around processed and snack foods is fairly weak. This enables the marketing of unhealthy snack foods to be deliberately misleading or confusing, and allows these foods to be more easily available and affordable than nutritious alternatives. A situation analysis is required in these instances to increase

awareness among different stakeholders, inform decision-making for regulators and guide actions by public- and private-sector actors involved along the value chain. Strengthened situation analysis enables them to better assess the availability and composition of unhealthy snack foods and the possible impact of these on health and nutrition, and to make decisions to improve the situation accordingly. The Fill the Nutrient Gap (FNG) analyses[10,11] (see **Box 1** for a brief explanation of the methodology of the FNG) in several countries have included a review on snack food consumption and how it impacts the cost of nutritious diets for key vulnerable target groups, especially children under two years, primary school–aged children and adolescents. This article reports the findings of this analysis in Cambodia,[12] Lao PDR,[13] Tajikistan,[14] and Ecuador.[15]

BOX 1: Fill the Nutrient Gap

The FNG analysis is used to identify which nutrition-specific and nutrition-sensitive interventions are most appropriate for a given context to improve nutrient intake – inadequate nutrient intake being one of the two direct causes of malnutrition (the other being disease). Any intervention should ultimately result in an improvement in nutrient intake.

The analysis has been developed by the WFP with technical support from the following research institutes: the University of California, Davis; the International Food Policy Research Institute (IFPRI) (Washington, DC); Epicentre (Paris); Harvard University (Cambridge, MA); Mahidol University (Bangkok); and the United Nations Children's Fund (UNICEF).

FNG provides a framework for strengthened situation analysis and multisectoral decision-making that identifies context-specific barriers to adequate nutrient intake among specific target groups. It engages different sectors to propose cost-effective strategies to overcome barriers. FNG has been used in more than 13 countries to date, across Asia, Latin America and sub-Saharan Africa. FNG combines review of secondary data and information with linear programming analysis using the Cost of the Diet (CotD) software developed by Save the Children UK.[16] The FNG analysis considers a range of factors that reflect or affect dietary intake, including local malnutrition characteristics; the enabling policy environment; the type and availability of nutritious foods in local markets; the affordability of nutritious foods; nutrient intake; local practices; and cost optimization.

The consolidated information is analyzed and the findings are reviewed by a multisectoral group of stakeholders, at relevant levels, to come to a shared understanding of the issues, context and solutions. Through this consultation process, context-specific optimal policy and program actions, including possible entry points for interventions, are jointly identified for different sectors, for example, health, social protection and across the food system, and stakeholders from the public and private sectors.

Methods

In order to assess the impact that snack food consumption has on the cost of obtaining a nutritious diet, three types of diets were modeled using the CotD software:

1) The cheapest possible diet that only meets energy needs (EO);
2) The cheapest possible diet that meets all nutrient needs,[32] includes minimum consumption of local staples, and excludes taboo foods (SNUT); and
3) A staple-adjusted nutritious (SNUT) diet that includes the observed average consumption of commonly consumed snack foods.

The consumption of more nutrient-dense snack foods was modeled in some countries.

In each country, diets for households with five or more people, based on the average household size of that country, were mod-

A local vendor's stall in Cambodia.

FIGURE 1: The comparative daily cost in Lao kip (LAK) of an energy-only diet and a staple-adjusted nutritious diet for an average-size household in five provinces[34] in Lao PDR

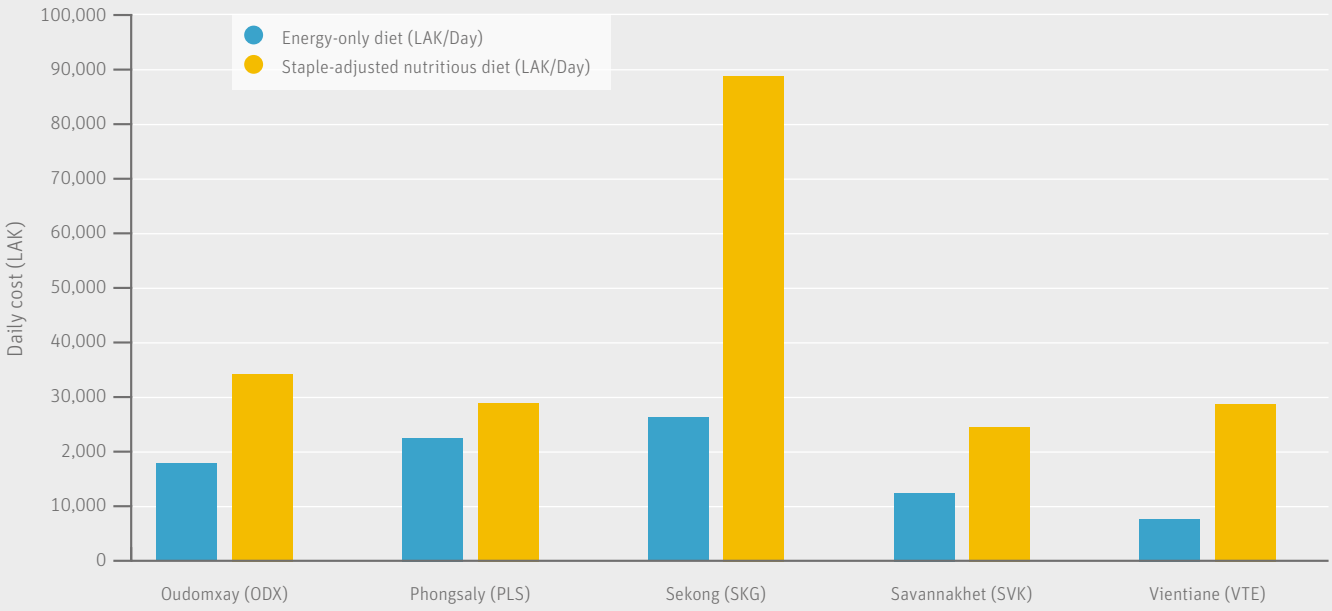
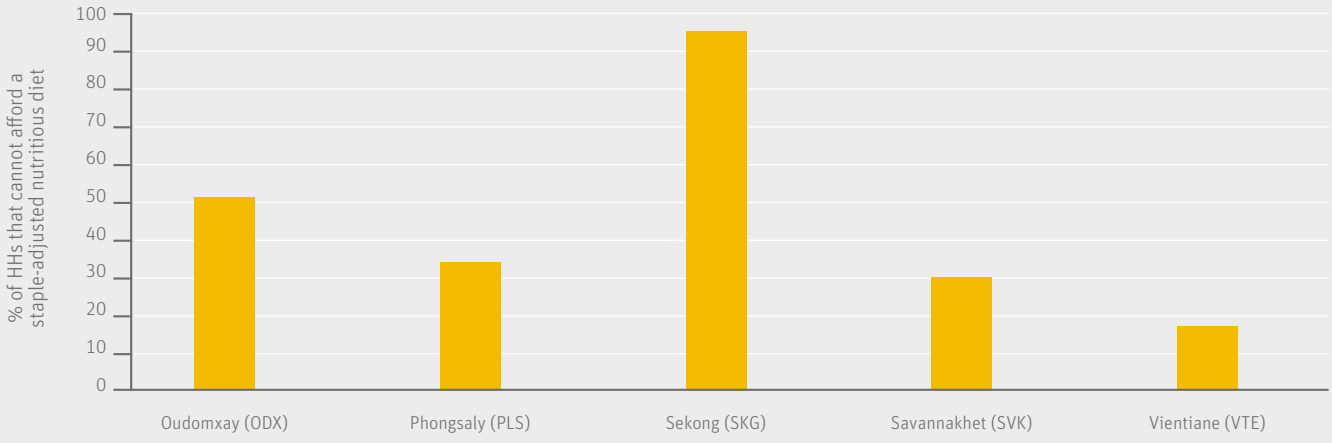


FIGURE 2: Proportion of households (HH) that cannot afford a staple-adjusted nutritious diet in five provinces in Lao PDR[35]



eled. These model households all included a lactating adult woman, an adult man, a breastfeeding child aged 6–23 months, a primary-school-aged child (6–7 years) and an adolescent girl (14–15 years). In Lao PDR, five-person households were modeled in all zones except for Oudomxay and Sekong, where the average household sizes were larger (six and seven people, respectively). In these areas, an elderly woman (over 60 years old) was included in the model household in both provinces, and in Sekong a child aged 10–11 years was also included. In Tajikistan, where average household size was six people, an elderly man (over 60 years old) was included in the household. In Ecuador, a child aged 3–5 years replaced the 6–7-year-old child in order to align with national programs. Household expenditure data from nationally representative Household Consumption and Expenditure Surveys (HCES) were used to compare to this cost of diet and assess the proportion of households that could not afford a nutritious diet.

Findings

The findings of the Fill the Nutrient Gap analyses demonstrate the high cost of diets that would be able to meet nutrient needs by comparing them to diets that would meet energy needs only. Figure 1 displays the minimum cost of a nutritious diet (SNUT)

TABLE 1: Information reviewed to conduct the snack food analysis in each country

Country	Type of information available on snack food consumption	Sources	Target group	Foods included in the model
Lao PDR	Multiple studies demonstrating high snack food consumption; supported by stakeholder consultation	Ministry of Agriculture and Forestry 2013;[19] Bouapao et al. 2016[20]	Children 6–23 months *(modeled for a child 12–23 months)*	1 portion/week of biscuit/cracker, cake, candy, potato crisps and fruit juice *(based on quantitative consumption data on children under 2 from the Cambodia study)*
Cambodia	Multiple studies demonstrating high snack food consumption; quantitative data on type of snacks and frequency of consumption by children under 2; supported by stakeholder consultation	Pries et al. 2016;[21] HKI 2011;[22] Plan International 2016;[23] SCI 2016;[24] Skau et al. 2014[25]	Children 6–23 months *(modeled for a child 12–23 months)*	1 portion/week of biscuit/cracker, cake, candy, potato crisps and fruit juice *(based on quantitative data from the ARCH study)*
Tajikistan	Detailed report on food environment; supported by stakeholder consultation; price of snack foods sampled in shops in respective regions	WHO & ISPUP 2017[26]	Children 6–23 months *(modeled for a child 12–23 months)*	1 portion/week of sweet biscuits, savory biscuits, chips (two varieties), chocolate, sunflower seeds, cake
Ecuador	Multiple studies demonstrating high snack food consumption; quantitative data on type of snacks and frequency of consumption by adolescents; supported by stakeholder consultation	Ochoa-Avilés et al. 2014;[27] ENSANUT 2012;[28] Verstraeten et al. 2016[29]	Adolescents *(modeled for an adolescent girl 14–15 yrs)*	2 models were run: 1) sugary drink (with sugar), 1 portion/week; 2) cookie, 1 portion/week & sugary drink (with sugar), 1 portion/week

in Lao PDR compared to a diet that would meet energy needs only (EO). On average, a diet that met nutrient needs would cost nearly 2.5 times the amount of a diet that only met energy needs. An even more dramatic difference was seen in the other countries: in Ecuador, a nutritious diet was over three times more expensive than the EO diet; in Cambodia, it was 3.3 times more; and in Tajikistan, it was three times more expensive.

These cost differences are indicative of how difficult it is for households to obtain nutritionally adequate diets, especially when considering that these are predominately low-resource settings.[33] The FNG non-affordability analysis further revealed that for a high proportion of the households in each of the study countries, a nutritious diet would not be affordable. **Figure 2** displays the proportion of households that would not be able to afford a nutritious diet in Lao PDR, which ranged from 17% to 95% of households. On the national level, 21% of households in Cambodia would be unable to afford a nutritious diet, 51% in Ecuador (national average) and 29% to 56% in the four regions that were analyzed in Tajikistan.[34]

In each of these countries, the secondary data and discussions with key stakeholders highlighted that the prevalence of unhealthy snack food consumption is high. **Table 1** summarizes the available information on snack food consumption in each country. To assess the impact that regular snack food consumption has on the diet of a child under two years of age, this information was modeled[35] using the CotD software (see **Table 1** for foods modeled). In some countries, such as Cambodia, consumption data on snack foods was available for children aged 6–23 months, so these specific amounts could be modeled. In other countries, precise consumption data was not available, but from secondary data and key informant information, it was possible to extrapolate a model to demonstrate the potential impact snack food consumption could have on a specific age group.

Figures 3–5 demonstrate the increase in costs to obtain a nutritious diet for a child aged 12–23 months in Lao PDR, Cambodia and Tajikistan. As displayed, regular snack food consumption resulted in diets being 1.4 times more expensive in Lao PDR and 1.7 times more expensive in Cambodia and Tajikistan. This increase in dietary costs is due to the low nutrient content of these foods, which made it more difficult for the software to meet the nutrient needs of the child.

FIGURE 3: Comparative daily cost in Lao kip (LAK) of a staple-adjusted nutritious diet and the cost of this diet with snack food consumption included for a child aged 12–23 months in five provinces in Lao PDR

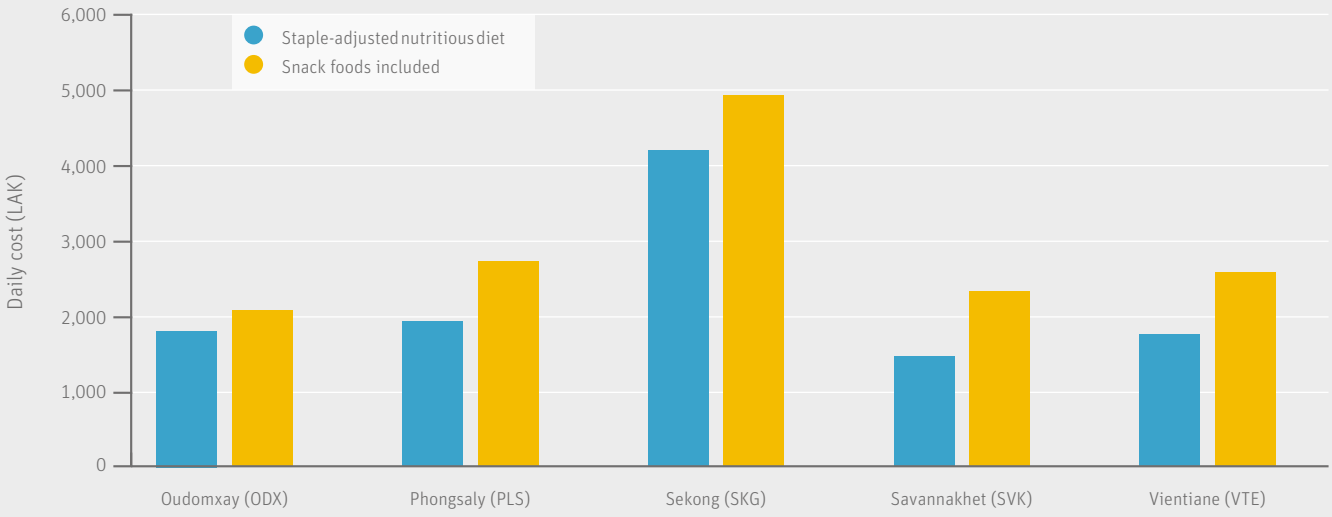
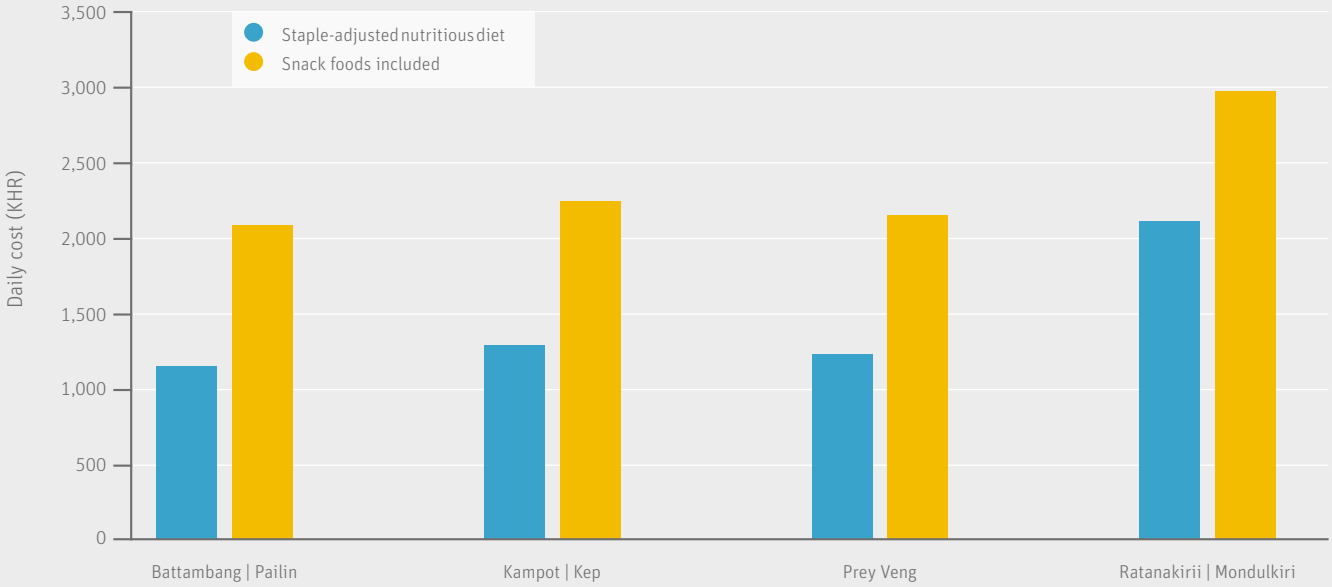


FIGURE 4: Comparative daily cost in Cambodian riel (KHR) of a staple-adjusted nutritious diet and the cost of this diet with snack food consumption included for a child aged 12–23 months in four regions of Cambodia[38]



Little data was available on the snack food consumption patterns of preschool and school-age children and adolescents for most FNG countries; however, qualitative information indicates consumption is high, if not higher, among these age groups than children under two.[17,18] In Ecuador, snack food consumption data was available for adolescents, and **Figure 6** displays the increase in the cost of a nutritious diet of an adolescent girl (14–15 years) if sugary drinks and a combination of cookies and sugary drinks were consumed on a regular basis. The results show that for an adolescent girl, regular snack consumption could increase the cost of a nutritious diet by 33% on average (sugary drink consumption alone by 7%). The results demonstrate that, as in the case of a child aged 6–23 months, unhealthy snack food consumption can make meeting nutrient needs more expensive, as the low nutrient content of high-energy foods requires the software to pick more nutrient-dense (and usually

more expensive) foods to fulfill nutrient requirements without exceeding energy requirements.

In Cambodia, a locally produced fortified food[39] intended as a healthier alternative to currently consumed snacks, is currently under development. Figure 7 displays the cost of a nutritious diet for a child aged 12–23 months if the locally produced fortified food were consumed three times a day, compared to a diet that includes unhealthy snack foods and a minimum cost nutritious diet (SNUT). As shown in the graph, while in some regions a nutritious diet that included the local fortified food would be slightly costlier than a minimum-cost nutritious diet, it would still be much cheaper than a diet that included regular unhealthy snack food consumption. In some regions (Prey Veng and Ratanakiri/Mondulkiri), the inclusion of the local fortified food reduced the cost of a nutritious diet, as this food is highly nutrient-dense. This demonstrates the potential of a 'healthier' snack food in making nutritious diets more affordable and convenient.

> "The consumption of unhealthy snack foods can further increase diet costs and make it more difficult to meet nutrient needs"

FIGURE 5: Comparative daily cost in Tajik somoni (TJS) of a staple-adjusted nutritious diet and the cost of this diet with snack food consumption included, for a child aged 12–23 months in four regions of Tajikistan

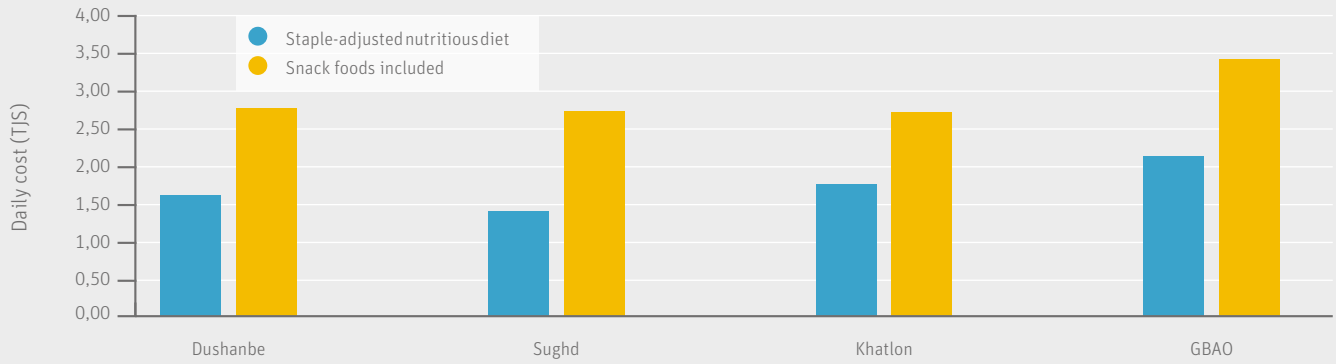


FIGURE 6: Comparative daily cost in US dollars (USD) of a staple-adjusted nutritious diet, the cost of this diet with the consumption of sugary drinks included, and this diet with cookies and sugary drinks included for an adolescent girl in 15 provinces in Ecuador

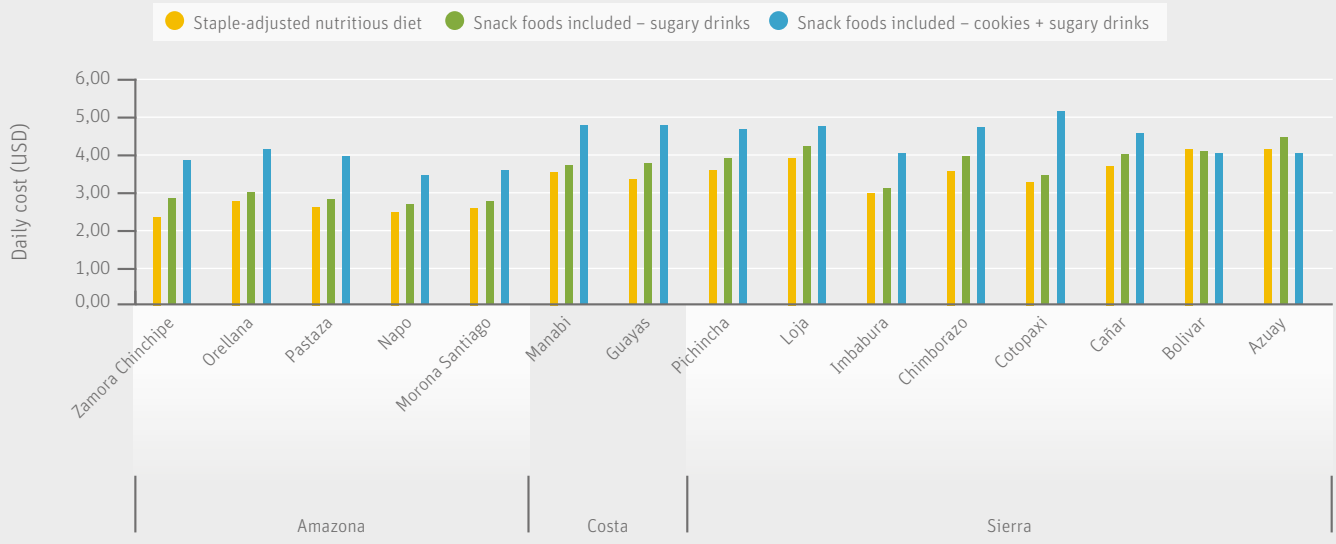
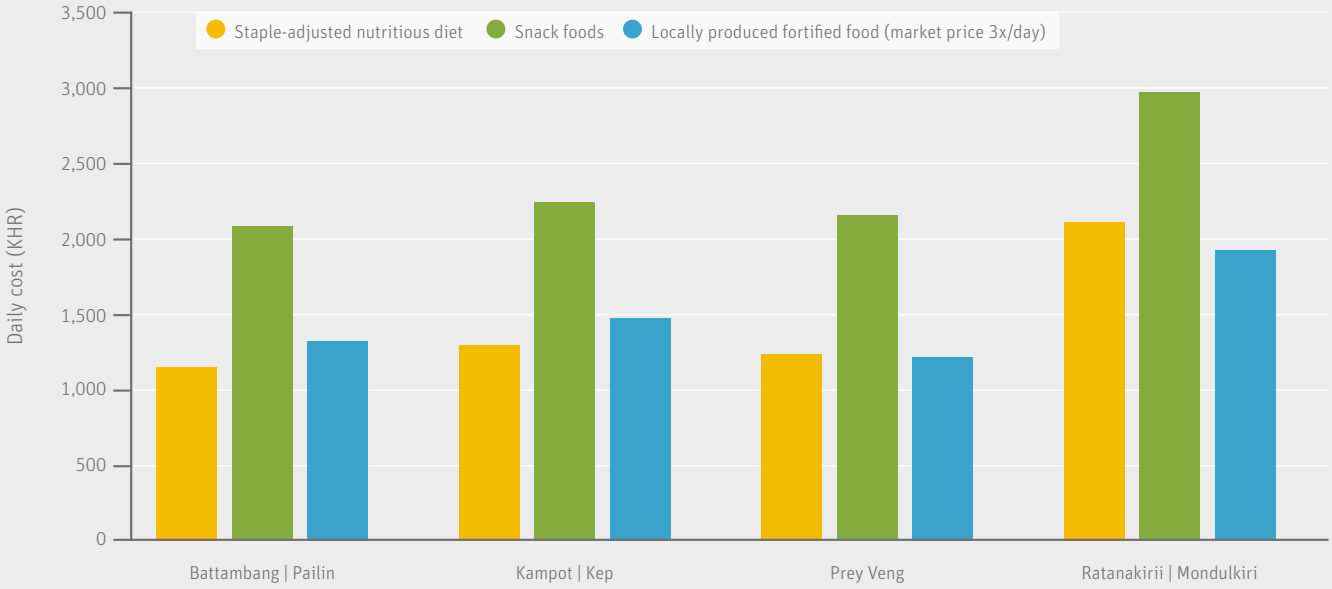


FIGURE 7: Comparative daily cost in Cambodian riel (KHR) of a staple-adjusted nutritious diet, the cost of this diet with snack food consumption included, and this diet with a locally produced fortified food consumed at market price three times per week for a child under 2 years in four regions of Cambodia



Discussion

These findings demonstrate that in low-resource settings, where it is a challenge for households to access and afford nutritious diets, the consumption of unhealthy snack foods can further increase diet costs and make it more difficult to meet nutrient needs. This further intensifies the need to regulate the marketing and sales of unhealthy snack foods and to encourage caregivers to feed children healthy foods, including snack foods that are nutrient-dense. High consumption of unhealthy snack foods and sugary drinks may prevent children from meeting nutrient needs and contribute to an increase in childhood overweight/obesity and the risk of NCDs. High snack food consumption, including consumption of sugar-sweetened beverages, is a risk for anyone in the population, not only young children, displacing micronutrient-rich foods and contributing to excess energy intake[41] and other related health issues. Little data were found on the quantities of these foods that are being consumed by older age groups, but judging from their presence in small shops and local markets, it can be assumed that they are being purchased in great quantities, which would increase the likelihood that diets are lacking in essential (micro)nutrients yet contain too much energy. This is supported by the findings from Ecuador that display the higher cost of nutritious diets for adolescents consuming unhealthy snack foods. These unhealthy dietary patterns contribute to the emergence of populations that are overnourished in terms of energy and simultaneously suffer from micronutrient deficiencies.

A volunteer with UNICEF (left) conducts data collection for a field study on the acceptability of the flavor and packaging of Num Trey (a fish snack) in Ratanakiri Province, north-east Cambodia, in May 2016 by interviewing children and parents.

Although regulation of the marketing and sales of unhealthy snack foods might help reduce their consumption, food choices are governed by factors other than cost alone, such as time, convenience, taste preferences, and aspiration.[30,31] It may not be feasible to influence habits to favor the selection of optimal diets, but as shown by the Cambodia modeling of a fortified snack food alternative, it might be possible to introduce healthier alternatives that are affordable and convenient (in terms of accessibility and shorter preparation times). If such options can be

desirable to target populations and offered at an affordable price point, there is potential to improve access to nutritious diets. Strategies coupled with context-specific social and behavioral change communication (SBCC) interventions to increase consumer awareness of what does and does not constitute a healthy diet and the importance of adequate nutritional status could improve nutrient intake.

The FNG analyses were presented during multisectorial stakeholder meetings in each of the countries mentioned, attended by actors from government, development partners, civil society, the private sector and academia. These presentations led to discussions on how to tackle the issue of high unhealthy snack food consumption and the formulation of country-specific recommendations.

In Lao PDR, the presentation of the FNG findings encouraged the government in their social behavior change communication strategy to incorporate an element that encourages caregivers to feed children healthy foods as opposed to unhealthy processed snacks, and also to raise awareness of the negative health implications of consumption of these foods by young children.

In Cambodia, the FNG analysis strengthened the existing dialogue around the role of snacks and processed food in the rise of the double burden and NCDs in the country. The need to engage more closely with the private sector to produce healthy, viable alternatives was strongly recognized during the FNG dissemination meetings. Development partners in Cambodia have since prioritized efforts to better understand consumption patterns of these foods among older children and adolescents, as well as the food environment, to provide further evidence to guide regulation and policy-making.

In Ghana, the Affordable Nutritious Foods for Women (ANF4W) partnership, now known as OBAASIMA, developed a range of Ghana-specific fortified foods for women using a quality seal. These products were then modeled as a further FNG analysis, following the original FNG analysis (disseminated in April 2016), to demonstrate the potential impact these foods could have on improving access to nutritious diets for women.

> "The Fill the Nutrient Gap analysis of snack food consumption demonstrates the impact of high consumption of unhealthy snack foods"

The Fill the Nutrient Gap analysis of snack food consumption can serve as a powerful advocacy tool to demonstrate the impact of high consumption of unhealthy snack foods on the ability to achieve optimal nutritional status. The FNG dissemination meetings are attended by stakeholders from different sectors (including actors from the public and the private sector) who would not regularly receive this type of information, and this provides them with the opportunity to engage in the dialogue and identify how their sector can contribute to resolving this issue. FNG findings can be used as a basis to advocate for stronger regulation on unhealthy snack foods, highlight the need to provide viable healthy alternatives, and ensure that consumers have access to accurate information to support their choices. The findings can also be used to stimulate public- and private-sector partnerships and coordination mechanisms such as the SUN Business Network to provide a good platform to help foster this dialogue and identify potential areas for collaboration.

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Correspondence: ***Indira Bose,***
World Food Programme Cambodia, House 108, Street 63, Sangkat Boeung Raing, Khan Daun Penh, Phnom Penh, Cambodia
Email: *indira.bose@wfp.org*

References

01. Haddad L, Cameron L, Barnett I. The double burden of malnutrition in SE Asia and the Pacific: priorities, policies and politics. Health Policy and Plan. 2015 Nov;30(9):1193–1206.
02. Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries. Nutr Res. 2012 Jan;70(1):3–21.
03. WHO. Diet, nutrition and the prevention of chronic diseases. Geneva: WHO; 2003. [World Health Organization Technical Report Series 916].
04. Nishida C, Uauy R, Kumanyika S, Shetty P. 2004. Joint WHO/FAO Expert Consultation on diet, nutrition and the prevention of chronic diseases: process, product and policy implications. Public Health Nutr. 2004 Feb;7(1a):245–50.

05. de Pee, S. Nutrient needs and approaches to meeting them. In de Pee S, Taren D, Bloem M, eds. Nutrition and health in a developing world. 3rd ed. Cham, Switzerland: Humana Press; 2017:159–80.

06. Baldi G, Martini E, Catharina M, Muslimatun S, Fahmida U, Jahari AB, et al. 2013. Cost of the Diet (CoD) Tool: first results from Indonesia and applications for policy discussion on food and nutrition security. Food Nutr Bull. 2013 Jun;34(2 Suppl1):S35–S42.

07. Geniez P, Mathiassen A, de Pee S, Grede N, Rose D. 2014. Integrating food poverty and minimum cost diet methods into a single framework: a case study using a Nepalese household expenditure survey. Food Nutr Bull. 2014 Jun;35(2):151–9.

08. Drewnowski A. 2004. Obesity and the food environment: dietary energy density and diet costs. Am J Prev Med. 2004;27(3):154–62.

09. Allen L, de Benoist B, Dary O, Hurrell R, eds. Guidelines on food fortification with micronutrients. Geneva & Rome: WHO & FAO; 2006.

10. Untoro J, Childs R, Bose I, Winichagoon P, Rudert C, Hall A, et al. 2017. Tools to improve planning, implementation, monitoring, and evaluation of complementary feeding programmes. Matern Child Nutr. 2017 Oct;13 Suppl 2. doi: 10.1111/mcn.12438.

11. Bose I, Baldi G, Kiess L, de Pee S. The 'Fill the Nutrient Gap': an approach to strengthen nutrition situation analysis and decision-making towards multi-sectoral policies and systems change. Submitted for publication.

12. Council of Agricultural and Rural Development Cambodia and WFP. 2018. Fill the Nutrient Gap Cambodia. Rome: WFP; 2018.

13. Ministry of Health Lao PDR and WFP. Fill the Nutrient Gap Lao PDR. Rome: WFP; 2017.

14. Ministry of Health Tajikistan and WFP. Fill the Nutrient Gap report, Tajikistan. In preparation.

15. Ministerio de Inclusión Económica y Social and WFP. Fill the Nutrient Gap report, Ecuador. In preparation.

16. Deptford A, Allieri T, Childs R, Damu C, Ferguson E, Hilton J, et al. Cost of the Diet: a method and software to calculate the lowest cost of meeting recommended intakes of energy and nutrients from local foods. BMC Nutr. 2017;3:26.

17. Dietary age trends by country. Global Dietary Database. Internet: https://www.globaldietarydatabase.org/dietary-age-trends-by-country.html (accessed 24 August 2018).

18. WFP. Bridging the gap: engaging adolescents for nutrition, health and sustainable development. Rome: WFP; 2018.

19. Ministry of Agriculture and Forestry. Lao PDR: risk and vulnerability survey 2012/13. Summary report. Vientiane: Ministry of Agriculture and Forestry; 2013.

20. Bouapao L, Insouvanh C, Pholsena M, Armstrong J, Staab M. Strategic review of food and nutrition security in Lao People's Democratic Republic. Vientiane; 2016.

21. Pries AM, Huffman SL, Mengkheang K, Kroeun H, Champeny M, Roberts M, et al. 2016. High use of commercial food products among infants and young children and promotions for these products in Cambodia. Matern Child Nutr. 2016 Apr;12(S2).

22. Helen Keller International. 2011. Assessment and research in child feeding (ARCH): labelling study report Cambodia. Pereira C, Feeley A, Ford R, Badham J. Assessment and research on child feeding (ARCH): labeling study report: Cambodia. Washington, DC: Helen Keller International; 2015.

23. Plan International. Baseline study on food consumption and dietary diversity in Stung Treng. 2016.

24. Save the Children. NOURISH Project: Baseline Survey report. Phnom Penh: Save the Children; 2016.

25. Skau JKH, Bunthang T, Chamnan C, Wieringa FT, Dijkhuizen MA, Roos N, et al. The use of linear programming to determine whether a formulated complementary good product can ensure adequate nutrients for 6- to 11-month-old Cambodian infants. Am J Clin Nutr. 2014 Jan;99(1):130–8.

26. WHO and Institute of Public Health of the University of Porto. FEEDcities project. The food environment description in cities in Eastern Europe and Central Asia – Tajikistan. Copenhagen: WHO Regional Office for Europe; 2017.

27. Ochoa-Avilés A, Verstraeten R, Lachat C, Andrade S, Van Camp J, Donoso S, et al. Dietary intake practices associated with cardiovascular risk in urban and rural Ecuadorian adolescents: a cross-sectional study. BMC Public Health. 2014;14:939.

28. Freire WB, Ramírez-Luzuriaga MJ, Belmont P, Mendieta MJ, Silva-Jaramillo MK, Romero N, et al. Tomo I: Encuesta Nacional de Salud y Nutrición de la población ecuatoriana de cero a 59 años. ENSANUT-ECU 2012. Quito: Ministerio de Salud Pública/Instituto Nacional de Estadísticas y Censos; 2014.

29. Verstraeten R, Leroy JL, Pieniak Z, Ochoa-Avilès A, Holdsworth M, Verbeke W, et al. Individual and environmental factors influencing adolescents' dietary behavior in low- and middle-income settings. PLOS ONE. 2016; 11(7): e0157744.

30. HLPE. Nutrition and Food Systems. A report by the high level panel of experts on food security and nutrition of the committee on world food security. Rome: HLPE; 2017. [HLPE Report 12.]

31. Herforth A, Ahmed S. The food environment, its effects on dietary consumption, and potential for measurement within agriculture-nutrition interventions. Food Security. 2015 Jun;7(3):505–20.

Notes on text

32. A diet that meets the recommended intakes of energy, protein, fat, and 13 micronutrients (vitamin A, C, B_1, B_2, niacin, vitamin B_6, folic acid, vitamin B_{12}, calcium, iron, zinc, pantothenic acid, and magnesium).

33. Tajikistan is classified as low-income; Cambodia and Lao PDR as low middle-income; and Ecuador as upper middle-income.

34. In Cambodia and Ecuador the national figure was calculated by weighing the non-affordability figures for each province by their population size.

35. The diet required to meet the nutrient needs of a child aged 12–23 months was modeled using the Cost of the Diet software.
36. The selection of provinces was based on their differing rates of stunting and their differing livelihoods, in order to develop an understanding of the diversity of the national situation in respect to access to, and availability of, nutritious foods.
37. Affordability was estimated by assessing the cost against 65% of total expenditure (a proxy estimate of the amount of expenditure spent on food for less well-off households based on national data collected in Lao PDR).
38. The selection of these regions was based on stakeholder consultation and with a view to displaying a range of areas with differing stunting rates and differing factors influencing access to, and availability of, nutritious foods.
39. UNICEF, in collaboration with the Cambodian Department of Fisheries Post-harvest Technologies, the Quality Control (DFPTQ) of the Fisheries Administration, Institut de Recherche pour le Développement (IRD) and Vissot Co. Ltd, aims to make a locally produced fortified food for young children available on the market. This food contains vitamin A, vitamin C, folate, calcium, iron, zinc, vitamin B_1, vitamin B_2, niacin, vitamin B_6, vitamin B_{12} and magnesium.
40. And other nutrients such as essential fats, amino acids and fiber, phytonutrients.

Essential Nutrient Requirements not Met by Diets High in Staple Foods

Results from the Fill the Nutrient Gap Analysis in selected countries

Amy Deptford
Nutrition Division, World Food Programme, Rome, Italy

Giulia Baldi, Indira Bose, Jane Badham, Frances Knight, Janosch Klemm
Nutrition Division, World Food Programme, Rome, Italy

Saskia de Pee
Nutrition Division, World Food Programme, Rome, Italy; Friedman School of Nutrition Science and Policy, Tufts University, Boston, MA, USA; Human Nutrition, Wageningen University, the Netherlands

Key messages

- Meeting nutrient requirements is a prerequisite for optimal health and nutritional status and requires a diverse diet.
- In resource-poor settings, households rely to a large extent on starchy staple foods to meet their energy needs. High consumption of these foods leaves limited room in the diet for the inclusion of nutrient-dense foods to meet remaining essential nutrient needs without exceeding energy requirements. Maintaining high staple food consumption when households could afford a more diverse diet may contribute to the double burden of malnutrition.
- Findings from the Fill the Nutrient Gap Analysis in three countries show that maintaining the current level of consumption of staple foods could impact the ability of households to have a nutritious diet in two ways: (1) nutrient requirements can mostly be met, but the cost of meeting these needs dramatically increases given the nutrient density of other foods needed; and (2) for certain micronutrients, requirements may be impossible to meet without exceeding energy requirements.
- These findings have been used in multiple fora to advocate for both the public and private sector to take preventative action against the double burden of malnutrition. Actions include encouraging a sustainable food systems approach to enhance nutrition throughout the food supply chain and food environment, and creating consumer demand for nutritious foods. This includes increasing the diversity of agricultural produce by supporting initiatives that promote the production of nutritious, locally adapted foods as well as fortifying staple foods to enhance their nutritional value.

Introduction

It has long been recognized that meeting nutrient requirements is a prerequisite for optimal health and nutritional status.[1] Eating a diverse and varied diet – one that includes different food groups as well as different foods within these groups – is essential for achieving an adequate intake of all essential nutrients.[2,3] However, achieving dietary diversity requires a sufficient variety

Girl cooking tortillas on a stove in Peten, Guatemala

of foods to be locally available, either through own production or within local markets; the ability to purchase these foods; knowledge of their importance for growth and development; and a desire to obtain and consume them. In resource-poor settings, dietary diversity is often difficult to achieve due to poor food availability and financial access constraints. As a result, diets in such settings tend to be monotonous, consisting predominantly of starchy staple foods.[4,5] Although a good source of energy, staples such as cereals, roots and tubers provide only a limited supply of essential (micro)nutrients. Where staple food consumption is high, e.g., providing >70% of energy needs, there is very little room left for consumption of the nutrient-dense foods necessary to meet remaining nutrient needs without exceeding energy requirements.[6]

"Achieving dietary diversity requires a sufficient variety of foods to be locally available and accessible to all"

As developing countries transition economically and the purchasing power of households increases, the creation of an enabling environment for achieving dietary diversity and meeting essential nutrient requirements becomes more critical than ever. This is particularly true in areas that have experienced rapid urbanization: although dietary diversity in such areas may have increased – for example, with the availability of more animal-source foods – diets generally also include more processed high-sugar, high-fat, and less nutrient-dense foods than they did prior to the urban and economic transition.[6–10] This, coupled with reduced physical activity as lifestyles become more sedentary, has resulted in a complex nutrition paradigm whereby undernutrition and micronutrient deficiencies coexist with overweight, obesity and diet-related noncommunicable diseases (NCDs).[11,12] Changing this paradigm requires not only individual and household behavior change but also significant changes across the food supply and value chain to ensure that sufficient, diverse nutritious foods, both fresh and processed, including fortified foods, are available and affordable, throughout different geographies and food environments within any given country.[10–12]

To ensure that the design of strategies aimed at diversifying food systems and changing consumer behavior are specific to a country's context, a thorough situation analysis is required.[13] The Fill the Nutrient Gap (FNG) analysis and multisectoral decision-making approach has been developed by the World Food Programme and its partners.

The secondary data analysis in almost all of the FNG countries has highlighted an increasingly present double burden of malnutrition, together with a high reliance on staple food in both household diets and diets of key vulnerable groups, such as infants and young children and pregnant and lactating women. For example, in Guatemala, where 47% of children under the age of five years are stunted and 51% of women aged 15–49 are overweight or obese, it is possible to observe effects of the double burden under the same roof.[14] A study led by WFP and the Nutrition Institute of Central America and Panama (INCAP) aiming to measure nutrient intake gaps in Guatemala using dietary recall methodology found that maize tortillas, the country's main staple, provide 41% of energy requirements for children aged 12–23 months and 62% of energy for their mothers (age not defined).[15]

Using this information, it is possible to model, using linear programming, the potential impact of high staple food consumption, in the general population or among vulnerable groups, on the cost, affordability and quality of a nutritious diet with the Cost of the Diet software. The results of these analyses are used to advocate among diverse stakeholders as to the need to diversify the food supply and support consumers in purchasing and consuming a more diverse diet. This article summarizes the results of the FNG Cost of the Diet (CotD) analyses for Cambodia, Tajikistan and Guatemala.

"The Fill the Nutrient Gap analysis identifies context-specific barriers to adequate nutrient intake among specific target groups"

Fill the Nutrient Gap

The Fill the Nutrient Gap (FNG) analysis provides a framework for situation analysis and multisectoral decision-making that identifies context-specific barriers to adequate nutrient intake among specific target groups.[16] The approach was developed by the World Food Programme and technical partners[25] in 2015–16. By mid-2018, analyses had been completed in 13 countries, and they were ongoing in four as this issue of *Sight and Life* magazine was being prepared for the press.

The FNG consists of both an analytical and a policy decision-making component. The analytical component has two parts: **(1)** situation analysis using available secondary data[26] that focuses on the type and scale of nutrient intake deficits and identifies enabling and constraining factors; and **(2)** linear programming analysis, using the Cost of Diet tool developed by Save the Children UK, which assesses the costs to a household of meeting the nutrient intake recommendations of its members at the lowest possible cost, using locally available foods, and comparing that to population food expenditure distributions to estimate the proportion of households that would not be able to afford a nutritious diet.[16,17] The Cost of the Diet tool is also used to model the potential impact of both nutrition-specific and nutrition-sensitive interventions, informed by stakeholder consultation on reducing the cost of a nutritious diet for a household.

This analytical component is combined with extensive in-country stakeholder engagement, which aims to engage different sectors, and upon review of the findings, develop a consensus on the proposed strategies to address identified barriers. As such, the tool informs evidence-based decisions for context-specific policies and programming for improving nutrient intake among different target groups, including an identification of entry points such as markets, social safety nets, schools, agriculture extension services and health sector interventions.

Methods

The Cost of the Diet methodology has been described elsewhere.[17] For the analysis presented in this paper, secondary price data for more than 60 commodities were used to estimate

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Girl holding tray of bread in front of lighted oven in Najiba, Tajikistan

TABLE 1: The staple foods for three countries and number of servings per person as included in the staple-adjusted nutritious diet[22,23,24]

Country	Staple food(s)	Frequency included in the diet	
		Child under 2 years	Other household members
Cambodia	Rice	1 portion a day	1 portion a day
	Fish	1 portion a day	1 portion a day
	Morning Glory	3 portions a week	3 portions a week
Tajikistan	Wheat flour	1 portion a day	2 portions a day
	Potato	2 portions a week	3 portions a week
	Milk	1 portion a week	1 portion a week
	Cottonseed oil	5 portions a week	10 portions a week
Guatemala	Maize flour tortillas	None	1 portion a day

TABLE 2: Staple food consumption information found for three countries and the quantities used to model this consumption in the Cost of the Diet calculations, per household, individual, or vulnerable target group[15,18,19]

Country	Staple food(s)	Reported consumption	Individual(s) or household modeled	Quantity and frequency modeled
Cambodia	Rice	390 g per capita per day	Child under 2	98 g per day
			School-aged child	195 g per day
			Adolescent girl	390 g per day
			Pregnant and lactating woman	585 g per day
			Man	683 g per day
Tajikistan	Bread	151 kg per capita/y	Household	270 g per day
	Potatoes	39 kg per capita/y		65 g per day
	Oil	17 kg per capita/y		35 g per day
Guatemala	Maize flour tortillas	>12–23 month-old breastfed child receives 41% of energy from cereals	Child under 2 years	100 g per day
		>Mothers receive 62% of energy from cereals	Pregnant and lactating woman	458 g per day

the cost of a nutritious diet which, for the purpose of the FNG, is defined as the staple-adjusted nutritious diet: the lowest-cost nutritious diet[27] that includes the typical staples and excludes foods that are considered taboo and not likely to be eaten by the local population.[28] The staple foods included in the analyses, as informed by secondary data and stakeholders, for Cambodia, Tajikistan and Guatemala are summarized in Table 1.

Average household size across the three countries varied between five and six people, but for the purposes of the CotD analysis, model households always included a child between 6 and 23 months of age who received breastmilk and complementary foods, a school-aged child, an adolescent girl, a 45 kg, 30–59 year-old lactating woman with moderate activity levels, and a 50 kg, 30–59 year-old man with moderate activity levels. In Tajikistan, an elderly man was also included. Household expenditure data was compared to the cost of the nutritious diet and was used to estimate the proportion of households for which the nutritious diet was unaffordable.

Table 2 summarizes the reported consumption of the staple foods for the three countries as well as the assumptions made for the staple food model.[15,18,19] For Cambodia, the reported daily per capita rice consumption was multiplied by the household size to give the total gram amount of rice consumed by the household. This was then scaled to reflect the portion size suitable for each household member and modeled in five selected regions as prioritized by national stakeholders. For Tajikistan, three diets were calculated, and staples incrementally added: wheat flour only; wheat flour, potatoes and milk; and wheat flour,

FIGURE 1: Daily cost in Cambodian riel (KHR) of the energy-only diet and the staple-adjusted nutritious diet for a household of five people in the 19 regions of Cambodia[22]

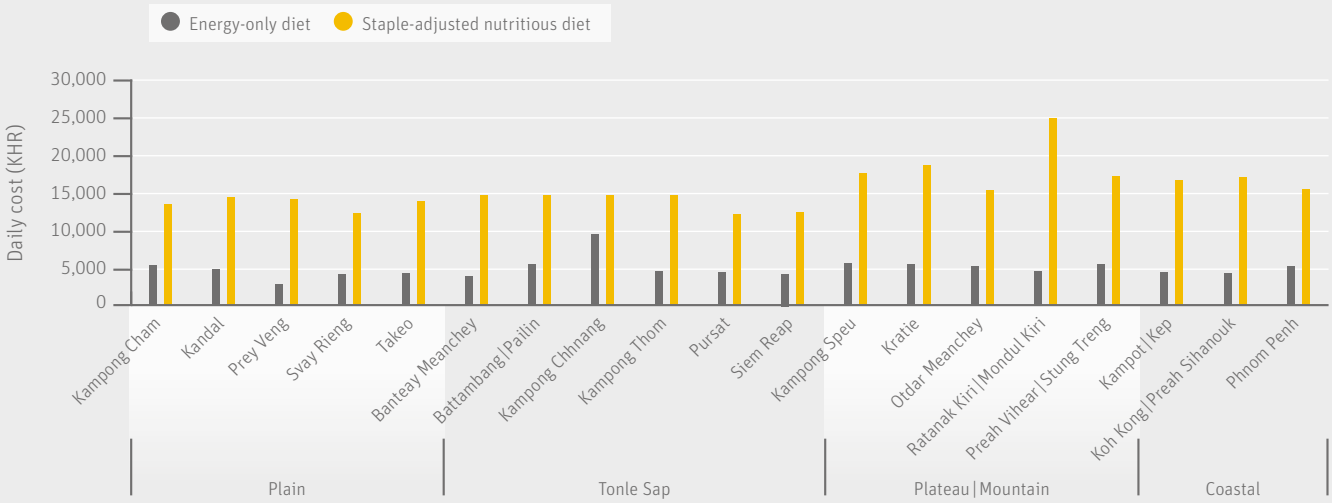
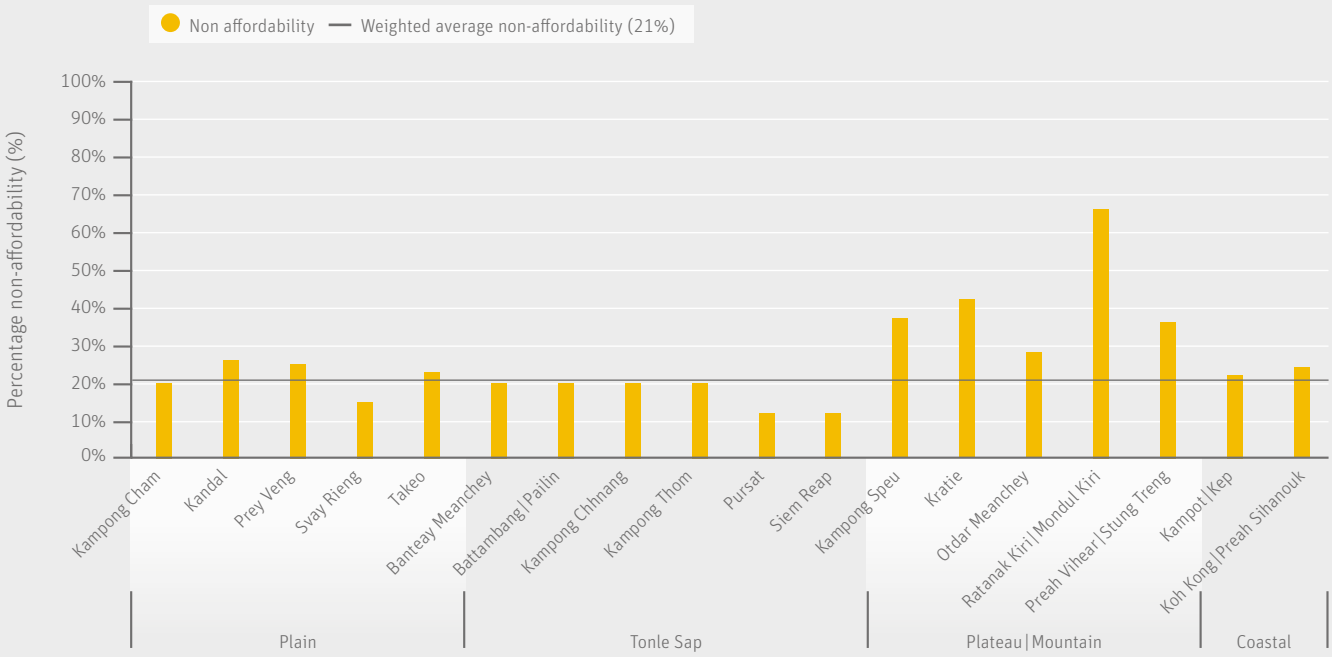


FIGURE 2: Percentage of households that could not afford the staple-adjusted nutritious diet against the weighted average of 21%. Phnom Penh was excluded as expenditure data was not available for this region.[22]



potatoes, milk, and oil. For Guatemala, consumption information for tortillas was only available for children under two years of age and the mother, expressed as a percentage contribution towards energy requirements. This data was therefore converted into grams of tortilla using the FAO/WHO Estimated Average Requirement for energy for these individuals and the nutrient composition of tortillas.[20,21]

Findings

Figure 1 shows that, for a household of five people in Cambodia, it would cost on average 3.7 times more to purchase a nutritious diet compared to a diet that meets the energy requirements of the household only.[29] Depending on the region, the cost difference would range from 2.4 times in rural Kampong Chhnang to 6.2 times in rural Ratanak Kiri/Mondul Kiri.[22]

FIGURE 3: Daily cost in Cambodian riel (KHR) of the staple-adjusted nutritious diet for a household of five people, with and without the modeled rice consumption for the two regions where it was possible for the Cost of the Diet software to calculate a nutritious diet[22]

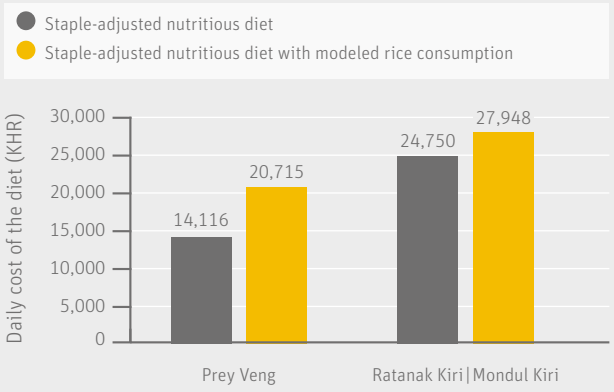


Figure 2 shows that when the cost of the staple-adjusted nutritious diet is compared to current food expenditure, an average of 21% of households would not be able to afford to purchase this diet. Non-affordability would range from 12% in rural Pursat and rural Svay Rieng to 66% in rural Ratanak Kiri/Mondul Kiri. All households would be able to afford the energy-only diet.[22]

When the current rice consumption habits were modeled, the Cost of the Diet software was only able to calculate a nutritious diet in two of the four regions without exceeding average energy requirements. Figure 3 shows that for households in rural Prey Veng, the cost of this diet increased by 46%, while in rural Ratanak Kiri/Mondul Kiri, the cost increased by 13%. This would increase non-affordability from 25% to 53% in rural Prey Veng and from 66% to 73% in rural Ratanak Kiri/Mondul Kiri. In the remaining two regions, based upon the rice consumption assumptions made, only 31%–95% of fat requirements and 60%–77% of vitamin B_1 requirements would be met for the adult man and woman (for all other nutrients, requirements could be met).

Figure 4 shows the impact of incrementally adding certain staples to the staple-adjusted nutritious diet in Tajikistan. On average, adding three portions of potato and one portion of milk a week almost doubled the cost, and adding 10 portions of oil a week also more than doubled the cost. This increased non-affordability by 29% to 56%, depending on the region, to 41% to 56%. The software was able to model diets that met nutrient needs for all individuals in the modeled household using each of the three alternatives.

In Guatemala, when current tortilla consumption was modeled for a child aged 12–23 months and a mother, the Cost of the Diet software could calculate a nutritious diet for the young child in all five zones. Figure 5 shows that the cost of this diet increased by 3%–43%, depending on the zone. For the mother, in all zones, only 34%–85% of iron requirements would be able to be met in diets containing the current level of tortilla consumption. Similarly, in zones three and four, pantothenic acid requirements would only be met by 75%–80%, and in zone four only 75% of the vitamin B_{12} requirement would be met.

Discussion

The results presented for Cambodia, Tajikistan, and Guatemala demonstrate that a high consumption of starchy staple foods could impact people's diets in two ways: (1) nutrient require-

FIGURE 4: Daily cost in Tajik somoni (TJS) of the staple-adjusted nutritious diet with and without the additional staples added for a household of six, for four regions of Tajikistan[23]

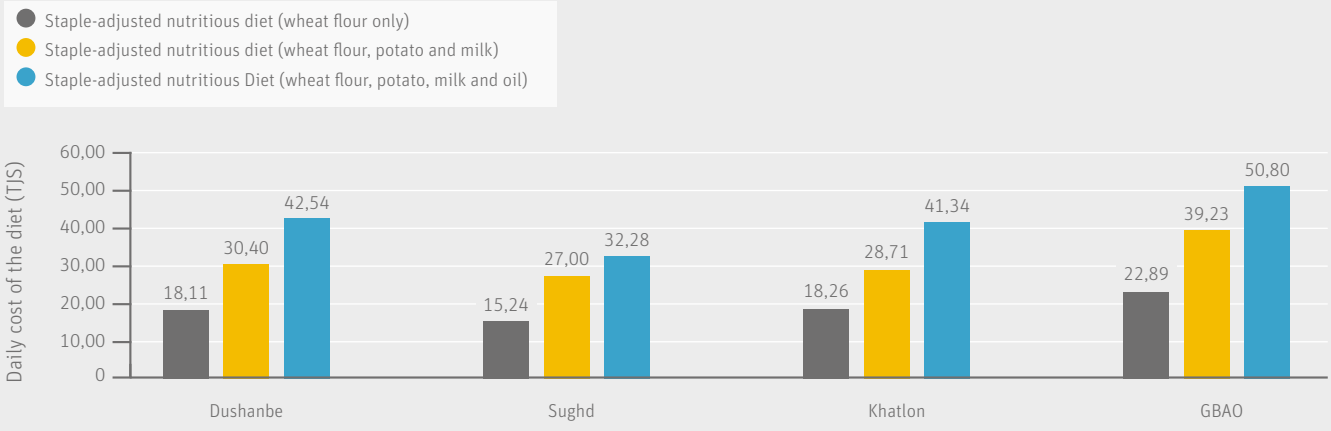
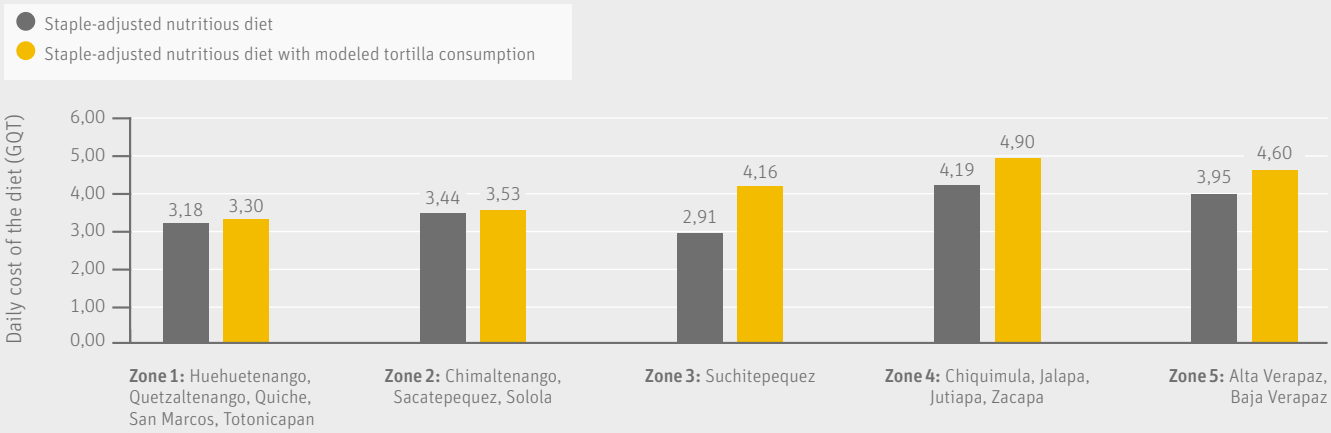


FIGURE 5: Daily cost in Guatemalan quetzal (GQT) of the staple-adjusted nutritious diet with and without the modeled tortilla consumption for a child aged 12–23 months, for five geographical zones of Guatemala[24]



ments can mostly be met, but the cost of meeting these needs dramatically increases, given the nutrient density of other foods needed; and (2) for certain micronutrients, requirements may be impossible to meet without exceeding energy requirements. These results complement literature that suggests consuming large quantities of staple foods, combined with increasingly sedentary lifestyles, is likely to result in both an insufficient intake of essential micronutrients and/or excess energy intake, increasing the risk of both micronutrient deficiencies and the double burden.[3,4,6] This situation is further aggravated by the further increased cost of a nutritious diet when staple food intake is high, and especially in countries where non-affordability of a nutritious diet (as optimized by the software) is already high.

Children receiving their school meal at Ta Trov Primary School in Siem Reap, Cambodia

> "Consuming large quantities of staple foods, combined with increasingly sedentary lifestyles, is likely to increase the risk of both micronutrient deficiencies and the double burden"

The results from the Fill the Nutrient Gap analyses have been used in the three countries discussed to raise awareness and stimulate national multistakeholder dialogue around the challenges to achieving optimal nutrition. Country workshops, ideally led by the national Scaling Up Nutrition movement, actively engage multiple stakeholders (government, UN agencies, non-government organizations, the private sector and academia) across different sectors (health, agriculture, social protection, gender, WASH), to develop recommendations based upon the key findings of the FNG analysis. In Cambodia, the findings have been incorporated into government policy discussions, and advocacy messages developed during the national workshop have since been shared at other national nutrition events.

The FNG analysis stimulates discussion about how much it would cost and what locally available foods would be required for a household, and for specific members of these households, to meet their nutrient requirements, compared to meeting kilocalorie requirements only. In addition, comparing the impact of current staple food consumption on the cost and quality of a nutritious diet in the context of the rising trends

in overweight and obesity strengthens advocacy efforts aimed at encouraging all sectors to take preventative action against the growing reality of the double burden of malnutrition. These results highlight the need for sustainable food systems to enhance nutrition throughout the food supply chain and food environment and the need to create consumer demand for nutritious foods. This could include increasing the diversity of agricultural produce and food processing by supporting initiatives that promote the production of nutritious, locally adapted foods as well as fortifying staple foods and foods for specific target groups to enhance their nutritional value. The affordability analysis has been particularly important in shifting mindsets that poor nutrition is a consequence of poor individual knowledge and behavior, to a greater appreciation of the need for consumers to be enabled to make healthy choices, in terms of access to, and availability of, nutritious diets. Ensuring that fresh or fortified, nutritious foods are affordable, and that demand is created, including by nutrition-sensitive social protection schemes where possible, are also important considerations.

> "These results highlight the need for sustainable food systems to enhance nutrition throughout the food supply chain and food environment"

The Fill the Nutrient Gap analysis makes an important contribution to understanding the impact of current food consumption habits on individual or household-level ability to meet nutrient requirements and provides an opportunity for countries to embed greater context-specific evidence into efforts for addressing the pressing issue of the double burden of malnutrition.

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Correspondence: ***Amy Deptford,***
World Food Programme, Via Cesare Giulio Viola 68, Parco dei Medici, 00148 Roma RM, Italy
Email: *amy.deptford@wpf.org*

References

01. United Nations Children's Fund. Strategy for improved nutrition of children and women in developing countries. New York, NY: UNICEF; 1990.
02. de Pee S. Nutrient needs and approaches to meeting them. In: de Pee S, Taren D, Bloem M, eds. Nutrition and health in a developing world. Cham, Switzerland: Humana Press; 2017:159–80.
03. Smith C, Haddad L. Reducing child undernutrition: past drivers and priorities for the post-MDG Era. World Dev. 2015;68:180–204.
04. Arimond M, Wiesmann D, Becquey E, Carriquiry A, Daniels MC, Deitchler M, et al. Simple food group diversity indicators predict micronutrient adequacy of women's diets in 5 diverse, resource-poor settings. J Nutr. 2010 Nov;140(11):2059S–69S.
05. FAO, WHO, UNU. Human energy requirements: report of a joint FAO/WHO/UNU Expert Consultation. Rome: FAO; 2001. [FAO Food and Nutrition Technical Report Series.]
06. Solomons N. National food fortification: a dialogue with reference to Asia: balanced advocacy. Asia Pac J Clin Nutr. 2008;17 Suppl 1: 20–3.
07. Haddad L, Cameron L, Barnett I. The double burden of malnutrition in SE Asia and the Pacific: priorities, policies and politics. Health Policy Plan. 2015 Nov;30(9):1193–1206.
08. Popkin B, Adair L, Ng SW. The pandemic of obesity in developing countries. Nutr Rev. 2012 Jan;70(1):3–21.
09. Prentice A. The double burden of malnutrition in countries passing through the economic transition. Ann Nutr Metab. 2018;72 Suppl 3: 47–54.
10. High Level Panel of Experts. Nutrition and food systems. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. Rome: FAO; 2017.
11. WHO. The double burden of malnutrition: policy briefing. Geneva: WHO; 2017.
12. Development Initiatives. Global nutrition report 2017: nourishing the SDGs. Bristol, UK: Development Initiatives; 2017.
13. de Pee S. Chronic malnutrition. In: Karakochuk CD, Whitfield KC, Green TJ, Kraemer K. The biology of the first 1,000 days. Boca Raton, FL: CRC Press; 2017:221–36.
14. Ministerio de Salud Pública y Asistencia Social (MSPAS), Instituto Nacional de Estadística (INE), ICF International. Encuesta Nacional de Salud Materno Infantil 2014–2015. Informe Final. Guatemala: MSPAS/INE/ICF; 2017.
15. Institute of Nutrition of Central America and Panama (INCAP) and World Food Programme. Informe Final: Determinación de brechas

nutricionales en los niños y niñas de 6 a 23 meses y sus madres. Guatemala City; 2016.

16. Untoro J, Childs R, Bose I, Winichagoon P, Rudert C, Hall A, et al. Tools to improve planning, implementation, monitoring, and evaluation of complementary feeding programmes. Matern Child Nutr. 2017;13(S2):1–16.
17. Deptford A, Allieri T, Childs R, Damu C, Ferguson E, Hilton, et al. Cost of the Diet: a method and software to calculate the lowest cost of meeting recommended intakes of energy and nutrients from local foods. BMC Nutr. 2017;3(26):1–17.
18. Inland Fisheries Research and Development Institute (IFReDI). Food and nutrition security vulnerability to mainstream hydropower dam development in Cambodia. Phnom Penh: IFReDI; 2012.
19. Karimova M, Najibulloev A. National food pricing policy in Tajikistan. Moscow: Eurasian Center for Food Security; 2017.
20. Bunch S, Calloway D, Murphy S. WorldFood dietary assessment system. Berkeley, CA: University of California; 1992.
21. FAO, WHO, UNU. Human energy requirements: report of a Joint FAO/WHO/UNU Expert Consultation. Rome: FAO; 2001. [FAO Food and Nutrition Technical Report Series.]
22. Council for Agricultural and Rural Development and World Food Programme. Fill the Nutrient Gap report, Cambodia. Phnom Penh; 2018.
23. Ministry of Health and Social Protection Tajikistan, Columbia University and World Food Programme. Fill the Nutrient Gap report, Tajikistan. Dushanbe; 2018.
24. Secretaría de Seguridad Alimentaria y Nutricional (SESAN) and World Food Programme. Fill the Nutrient Gap Report, Guatemala. Guatemala City; 2017.

Notes on the text

25. FNG technical partners: IFPRI, University of California, Davis, Epicentre, Harvard University, Mahidol University, Save the Children (developers and owner of Cost of the Diet software), and UNICEF.
26. Including nationally representative datasets, reports, and published papers on malnutrition characteristics and trends, availability and physical and economic access to nutritious foods and ongoing initiatives to improve these, food choices and preferences, and the enabling environment for nutrition.
27. A nutritious diet is defined as a diet that meets the Estimated Average Requirements for energy and the recommended intakes (FAO/WHO RNI) for protein, fat, nine vitamins, and four minerals.
28. The staple-adjusted nutritious diet (the lowest-cost nutritious diet that includes staple foods and excludes taboo foods) is not intended to reflect what individuals or households are currently eating, nor should it be used to develop food-based recommendations or dietary guidelines.
29. The energy-only diet is defined as the lowest-cost combination of locally available foods that meets an individual or household's Estimated Average Requirements for energy.

Breastfeeding

A triple-duty action in the context of the double burden of malnutrition

Rafael Pérez-Escamilla
Yale School of Public Health, New Haven, CT, USA

Sofia Segura-Pérez
Hispanic Health Council, Hartford, CT, USA

Key messages

- Breastfeeding is a triple-duty action that can help prevent undernutrition/infectious diseases and obesity/chronic diseases and improve cognitive development in the context of the double burden of malnutrition.
- Breastfeeding reduces family poverty, improves long-term human development and productivity, and is key for national development and planetary sustainability.
- Effective breastfeeding protection, promotion and support interventions are available for effective scaling-up of national breastfeeding programs but continue to be underutilized.
- Improved investments in effective scaling-up of breastfeeding protection, promotion and support in the context of the double burden of malnutrition will increase the chances of countries meeting the Sustainable Development Goals.

Why breastfeeding is a triple-duty action

The double burden of malnutrition (DBM) can be defined as the simultaneous presence of both under- and overnutrition at the individual, household and population level across the life course.[1] The world is indeed now deeply immersed in the DBM. Globally, it is estimated that 155 million children under five are stunted and 41 million are overweight.[2] Among adults, 462 million are underweight, and 1.9 billion are overweight or obese.[2] Furthermore, the DBM is characterized by widespread micronutrient deficiencies affecting both stunted and obese individuals. For example, it is estimated that iron deficiency anemia affects 246 million women of reproductive age.[2] Although stunting, obesity and micronutrient deficiencies call for nutrition-specific actions once they develop, it has recently been proposed that since they are caused by shared drivers related to the social determinants of health, well-coordinated strategies can be designed to prevent these conditions from happening.[1,2] The term 'double-duty action' in the context of the DBM refers to interventions that are capable of addressing all forms of malnutrition through well-coordinated policies and programs.[1,2] It is important, however, to recognize that there are actions that are capable not only of addressing the DBM but also of fostering early childhood development (ECD), i.e., triple-duty actions. Among these, breastfeeding stands out as a maternal-child behavior that fully meets the criteria of a triple-duty action in the context of the DBM.[3,4]

> "'Double-duty action' refers to interventions that are capable of addressing all forms of malnutrition through well-coordinated policies and programs"

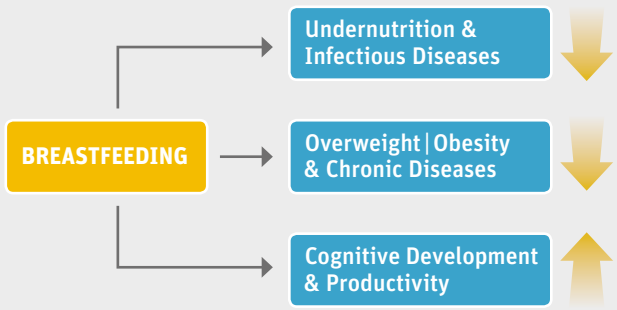
At the same time that breastfeeding has been causally linked with the prevention of infectious diseases and undernutrition, it has also been linked with a reduction in risk in the development of childhood obesity,[3] especially among those children who are more predisposed to become obese.[5] In addition, breastfeeding has been strongly linked with improved cognitive development in children, better educational attainment and higher income among adults.[6]

The triple-duty actions of breastfeeding are not surprising given how the nutritional composition and immunological factors of human milk change as a function of the developmental stage of the child as well as the specific pathogens that the infant needs to be protected against.[3]

Likewise, bioactive substances in breast milk and the process of breastfeeding help infants learn to self-regulate their energy intake and to have a hormonal profile that protects them against the risk of obesity.[7]

Mother breastfeeding in Delhi, India

FIGURE 1: Breastfeeding is a triple-duty intervention as it reduces the risks of undernutrition and infectious diseases, obesity and chronic diseases, and improves cognitive development[1–6]



Breastfeeding provides a unique maternal-infant interaction that, coupled with specific bioactive substances in breast milk, likely explains its benefits in cognitive development. Specifically, breast milk is rich in omega-3 polyunsaturated fatty acids, which are essential for the myelination of the neuronal axons – which in turn is crucial for the proper development of the central nervous system. As a result of the benefits of breastfeeding, it has been estimated that over 800,000 lives could be saved annually and that the world could save US$300 billion a year if breastfeeding practices improved globally.[3]

> "Epidemiological studies have consistently shown that breastfeeding reduces the risk of overweight and obesity and chronic diseases"

Breastfeeding also offers major benefits to women, highlighting its importance for addressing the DBM across the life course. It protects against post-partum hemorrhage, which is the major cause of death among women of reproductive age.[3] Women who do not have access to modern methods of contraception are less likely to become pregnant if they breastfeed, especially if they breastfeed exclusively during the first six months after birth.[8] In addition, epidemiological studies have consistently shown that breastfeeding reduces the risk of overweight and obesity and chronic diseases including type 2 diabetes, as well as breast and ovarian cancer in women.[3] It has been hypothesized that the reduction of some chronic diseases among women is the result of breastfeeding leading to a resetting of glucose and lipid maternal metabolism to the way it was before pregnancy, i.e., the metabolic 'reset hypothesis.'[9]

Scaling up breastfeeding programs in the context of the double burden of malnutrition

In spite of being considered a highly cost-effective action by international health and development organizations such as the WHO and the World Bank,[10] breastfeeding continues to attract relatively little investment[11,12] and the scaling-up of breastfeeding protection, promotion and support programs is still happening only to a very limited extent globally. This is very surprising, given how central breastfeeding is to the WHO/UNICEF Global Nurturing Care Framework for Early Childhood Development[13] – designed to offer well-coordinated high-quality health, nutrition, responsive parenting, early stimulation and initial education, and safety and social protection services for all families with infants and young children – and, at the end of the day, for achieving each and all of the Sustainable Development Goals (SDGs).[14] My research team hypothesized that this is likely the result of a lack of knowledge on how to effectively scale up breastfeeding protection, promotion and support programs in the real world.[15] This led to the development of the Breastfeeding Gear Model (BFGM), which is based on a Complex Adaptive Health Care Systems framework,[16,17] a major systematic review of the breastfeeding scaling-up literature and interviews with key informants with experience in the area.[18] The BFGM is key for addressing the DBM given the proven benefits that breastfeeding offers for the prevention of both undernutrition and infectious diseases as well as obesity and chronic diseases.

Analogous to an engine, the BFGM is formed by a central coordinating gear and seven peripheral gears, all of which need to communicate and be in synchrony with each other under the steering of the central master coordinating gear. The BFGM postulates that evidence-based advocacy (gear one) is needed to generate the political will (gear two) that is crucial to assign a top priority to breastfeeding in the policy agent, which in turn is needed to facilitate the enactment and enforcement of legislation including the WHO Code of Marketing of Breastmilk Substitutes[19] and maternity protection (gear three). Legislation is needed to release and sustain the financial resources (gear four) needed to train the workforce and implement evidence-based programs at the facility (e.g., Baby Friendly Hospital Initiative[20]) and community (e.g., breastfeeding peer counseling[21,22] levels [gear five]). Successful national breastfeeding programs have also relied on effective behavior change communication campaigns[23] (gear six), and operational research is needed to understand barriers and facilitators for the scaling-up process (gear seven). The BFGM recognizes that sound management information and governance systems need to be in place for the master or coordinating gear (gear eight).

As postulated by the BFGM and verified through the Becoming Breastfeeding Friendly (BBF) initiative,[24–29] the pathways for scaling up breastfeeding programs are likely to be different across social, political and cultural contexts.

Nevertheless, in the context of the DBM it is important that such programs be well coordinated with national strategies designed to prevent and address undernutrition, infectious diseases, micronutrient deficiencies, overweight/obesity, chronic diseases and early childhood development.[30] This approach will require strengthening the breastfeeding workforce across sectors and programs.

PROSPERA conditional cash transfer (CCT) program

A case in point is the PROSPERA conditional cash transfer (CCT) program in Mexico, which serves 6.1 million low-income households. PROSPERA provides cash to low-income families as long as they meet certain conditions, including keeping the children in school, attending prenatal care, bringing infants and young children to be immunized, and having family members attend medical screenings and check-ups. PROSPERA operates in the context of a middle-income, highly inequitable country with one of the highest rates of obesity and type 2 diabetes in the world.[31] Studies have found that, whereas the program is preventing stunting and infectious diseases among young children, at the same time it may be fostering overweight/obesity among family members in the recipient households through the use of some of the extra income to purchase more sugar-sweetened beverages and energy-dense foods of low nutritional value.[31] In addition,

FIGURE 2: The Breastfeeding Gear Model for the scaling-up of breastfeeding protection, promotion and support programs. Adapted with permission from the author.[18]

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Mothers taking their children to the local community health clinic in Bolivar, Colombia

PROSPERA may be benefitting the cognitive development of children through improved nutrition, healthcare, and schooling[32] and is now investing in the breastfeeding training of healthcare providers and breastfeeding counselors.[33] However, current national infant and young child nutrition and early childhood development strategies have not positioned breastfeeding as a strategic triple-duty action in the context of the DBM as part of PROSPERA. This may represent a major loss of opportunity for this program, in which the Mexican government invests US$ 5.6 billion per year.[32]

Because CCTs such as PROSPERA focus on the family as a whole across the life course and have in place strong coordination among the social protection, healthcare and education sectors, it is important that they be considered as unique platforms for integrating and coordinating breastfeeding protection, promotion and support programs across sectors and programs.

Following the family-centered life-course approach being strongly endorsed by the WHO/UNICEF Global Nurturing Care Framework for Early Childhood Development,[13] well-monitored referral and counter-referral systems could be designed so that prenatal, perinatal and postnatal health services communicate with each other and properly address the breastfeeding needs of their clients. In addition to strengthening the communication across maternal-child health services, personnel working as part of infant feeding or chronic disease screening/management programs can make families aware of the links between breastfeeding, obesity and chronic diseases, and of services available to support breastfeeding, prevent the onset of obesity, and improve the self-management of chronic diseases such as type 2 diabetes in their communities. This healthcare systems' strengthening approach to position breastfeeding as being central for addressing the DBM could provide much needed synergy for other maternal-child nutrition programs including comple-

mentary feeding, young child feeding, adolescent and prenatal nutrition and micronutrient initiatives across the life course, as well as for integrated early child development programs.

"Breastfeeding is a triple-duty action in the context of the DBM, as it helps prevent child malnutrition in all its forms and fosters cognitive development"

Conclusions

The evidence presented in this article leaves no doubt that breastfeeding is a triple-duty action in the context of the DBM that can help prevent child malnutrition in all its forms while simultaneously advancing early childhood development[4] and which also helps protect against the development of obesity-related chronic diseases in women. Therefore, breastfeeding is crucial to protect the health and food security of families and to foster national development globally. In addition, breastfeeding is also central to the sustainability of our planet, given the millions of tons of waste from the formula industry derived from cans and plastic bottles, the major emissions of methane (a greenhouse gas) from dairy cattle, as well as the massive use of fossil fuels in the processing, transportation and storage of infant formula and the excessive use of water: 4,000 liters of water are needed to produce 1 kilogram of dry infant formula.[11] Indeed, it is difficult to imagine how countries can meet the SDGs if they do not improve investments in the effective scaling-up of breastfeeding programs. We know the kind of lactation management and social support that is needed to make breastfeeding work, and we have learned many lessons from countries that have successfully scaled up their breastfeeding programs. Therefore, when it comes to breastfeeding as a major triple-duty action in the context of the DBM, inaction with regard to investments to scale up effective breastfeeding, protection, promotion and support programs globally is no longer justifiable.

"We know the kind of lactation management and social support that is needed to make breastfeeding work"

References

01. Perez-Escamilla R, Bermudez O, Buccini GS, et al. Nutrition disparities and the global burden of malnutrition. BMJ. 2018;361:k2252.
02. WHO. Double-duty actions. Geneva: WHO; 2017.
03. Victora CG, Bahl R, Barros AJD, et al. Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. Lancet. 2016;387(10017):475–90.

Young woman breastfeeding in Bolivar, Colombia

04. Britto PR, Lye SJ, Proulx K, et al. Nurturing care: promoting early childhood development. Lancet. 2017;389(10064):91–102.
05. Perez-Escamilla R. Can breastfeeding protect against childhood obesity? Washington, DC: National Academy of Medicine; 2016.
06. Victora CG HB, de Mola CL, et al. Association between breastfeeding and intelligence, educational attainment, and income at 30 years of age: a prospective birth cohort study from Brazil. Lancet Glob Health. 2015;3(4):e199–e205.
07. Pérez-Escamilla R, Segura-Pérez S, Lott M. Feeding guidelines for infants and young toddlers: a responsive parenting approach. Nutr Today. 2017;52(5):223–31.
08. Peterson AE, Perez-Escamilla R, Labbok MH, Hight V, von Hertzen H, Van Look P. Multicenter study of the lactational amenorrhea method (LAM) III: effectiveness, duration, and satisfaction with reduced client-provider contact. Contraception. 2000;62(5):22–30.
09. Stuebe AM, Rich-Edwards JW. The reset hypothesis: lactation and maternal metabolism. Am J Perinatol. 2009;26(1):81–8.
10. Carroll GJ, Buccini G, Pérez-Escamilla R. What will it cost to scale-up breastfeeding programs? A comparison of current global costing methodologies. Adv Nutr. 2018 Sep 1;9(5):572–80.
11. Rollins NC BN, Hajeebhoy N, Horton S, Lutter CK, Martines JC, PiwozEG, et al. Why invest, and what it will take to improve breastfeeding practices? Lancet. 2016; 387(10017):491–504.
12. Lutter CK, Pena-Rosas JP, Perez-Escamilla R. Maternal and child nutrition. Lancet. 2013;382(9904):1550–1.
13. WHO, UNICEF, World Bank Group. Nurturing care for early childhood development: a framework for helping children survive and thrive to transform health and human potential. Geneva: WHO; 2018.
14. Perez-Escamilla R. Breastfeeding for all in the 21st century: achieving the global Sustainable Goals. J Hum Lact. 2017;33(3):66.
15. Perez-Escamilla R, Hall Moran V. Scaling up breastfeeding programmes in a complex adaptive world. Matern Child Nutr. 2016;12(3):375–80.
16. Bradley EH, Curry LA, Taylor LA, Pallas SW, Talbert-Slagle K, Yuan C, et al. A model for scale up of family health innovations in low-income and middle-income settings: a mixed methods study. BMJ Open. 2012;2(4). pii: e000987.
17. Paina L, Peters DH. Understanding pathways for scaling up health services through the lens of complex adaptive systems. Health Policy Plan. 2012;27(5):365–73.
18. Perez-Escamilla R, Curry L, Minhas D, Taylor L, Bradley E. Scaling up of breastfeeding promotion programs in low- and middle-income countries: the "breastfeeding gear" model. Adv Nutr. 2012;3(6):790–00.
19. WHO, IBFAN. Marketing of breast-milk substitutes: national implementation of the international code. Status report. Geneva: WHO, UNICEF and IBFAN; 2016.
20. WHO. Implementation guidance: protecting, promoting and supporting breastfeeding in facilities providing maternity and newborn services – the revised Baby-friendly Hospital Initiative. Geneva: WHO; 2018.
21. Chapman DJ, Morel K, Anderson AK, Damio G, Perez-Escamilla R. Breastfeeding peer counseling: from efficacy through scale-up. J Hum Lact. 2010;26(3):314–26.
22. Lamstein S, Perez-Escamilla R, Koniz-Booher P, et al. The Community Infant and Young Child Feeding Counselling Package in Kaduna State Nigeria: a mixed methods evaluation. Final summary report. Washington, DC: SPRING/USAID; 2018.
23. Menon P, Nguyen PH, Saha KK, et al. Impacts on breastfeeding practices of at-scale strategies that combine intensive interpersonal counseling, mass media, and community mobilization: results of cluster-randomized program evaluations in Bangladesh and Viet Nam. PLOS Med. 2016;13(10):e1002159.
24. Perez-Escamilla R, Hromi-Fiedler AJ, Gubert MB, Doucet K, Meyers S, Dos Santos Buccini G. Becoming Breastfeeding Friendly Index: development and application for scaling-up breastfeeding programmes globally. Matern Child Nutr. 2018;14(3):e12596.
25. Aryeetey R, Hromi-Fiedler A, Adu-Afarwuah S, et al. Pilot testing of the Becoming Breastfeeding Friendly toolbox in Ghana. Int Breastfeed J. 2018;13:30.
26. Gonzalez de Cosio T, Ferre I, Mazariegos M, Perez-Escamilla R. Scaling up breastfeeding programs in Mexico: lessons learned from the Becoming Breastfeeding Friendly initiative. Curr Devel Nutr. 2018;2(6):nzy018.
27. Gonzalez de Cosio T. Recomendaciones para el diseño e implementación de una política nacional multisectorial de promoción, protección y apoyo de la lactancia materna en México. México: Academia Nacional de Medicina; 2016.
28. Vilar-Compte M, Teruel G, Carroll G, Buccini G, Perez-Escamilla R. Costing a maternity leave cash transfer to support breastfeeding among informally employed Mexican women. Presented at: American Society for Nutrition Meeting, 10 June 2018; Boston, MA, USA.
29. Breastfeed4Ghana [homepage]. Internet: http://breastfeed4ghana.com.gh (accessed 4 August 2018).
30. Pérez-Escamilla R, Kac G. Childhood obesity prevention: a life-course framework. Int J Obes. 2013;3(Suppl 1):S3–S5.
31. Pérez-Escamilla R, Lutter CK, Rabadan-Diehl C, Rubinstein A, Calvillo A, Corvalán C, et al. Prevention of childhood obesity and food policies in Latin America: from research to practice. Obes Rev. 2017;18 Suppl 2:28–38.
32. Segura-Pérez S, Grajeda R, Pérez-Escamilla R. Conditional cash transfer programs and the health and nutrition of Latin American children. Rev Panam Salud Publica. 2016;40(2):124–37.
33. Vilar-Compte M, Flores D, Pérez-Escamilla R. How much can Mexican primary healthcare providers learn about breastfeeding through a semi-virtual training? J Hum Lact. (provisionally accepted).

Malnutrition among Adolescents in Low- and Middle-income Countries

Rishi Caleyachetty
Unit of Academic Primary Care, Warwick Medical School, University of Warwick, Coventry, UK

Key messages

- The double burden of malnutrition has typically been described among adults and children. Its magnitude and distribution among adolescents across low- and middle-income countries (LMICs) is unknown.
- In the study under discussion, the prevalence of stunting (low height-for-age) and/or thinness (low BMI-for-age) among adolescents was about 3 in 20 adolescents. About one in four adolescents was overweight or obese. A much smaller proportion of adolescents (2%) had concurrent stunting and overweight or obesity.
- Between 38% and 59% of the variance in adolescent malnutrition was explained by macrolevel contextual factors including internal conflict, lack of democracy, GDP, food insecurity, urbanization and the year of survey.
- Context-sensitive implementation and scale-up of interventions and policies for the double burden of malnutrition are needed to achieve the Sustainable Development Goal to end malnutrition in all its forms by 2030.

> "Adolescence is a period of rapid growth, with higher nutritional demands placing adolescents at greater risk of malnutrition"

Background

Adolescence is a period of rapid growth, with higher nutritional demands placing adolescents at greater risk of malnutrition. Nutritional problems are compounded in adolescent girls by menstrual blood loss and possible pregnancies. Adolescent fertility still accounts for 11% of all births globally, with 95% of these births occurring in low- and middle-income countries (LMICs).[1]

Stunting (low height-for-age) begins *in utero* and manifests itself across infancy and affects brain and muscle growth.[2] Among adolescents, stunting is associated with impaired cognitive development and school achievement, and reduced economic productivity.[3] It is also associated with poor reproductive health outcomes in females.[4] Given that resolution of these height deficits may take several generations,[5] stunted children who are also exposed to obesogenic environments may be at greater risk of becoming overweight or obese. In fact, childhood stunting has also been reported to coexist with overweight or obesity at the individual level.[6,7] The consequences of concurrent stunting and obesity in adolescents are likely to compound health issues in adolescence and later in adulthood, particularly for females, given the heightened obstetric risk. Thinness (low BMI-for-age) in adolescence is associated with delayed maturation and poor muscle strength leading to constraints in capacity for physical work and reduced bone density later in life.[8] Obesity in adolescence has been associated with an increased risk of early onset of adult chronic diseases (type 2 diabetes, hypertension) and mortality in adult life.[9,10]

Adults and young children in countries experiencing the nutrition transition are known to be affected simultaneously by undernutrition and overnutrition.[2,11] Yet it is unknown to what extent this double burden of malnutrition affects adolescents in LMICs. Likewise unknown are the macrolevel contextual factors associated with the double burden of malnutrition. Globally, the major focus in nutrition has been on children under the age of five years and pregnant women, while adolescents have not received due attention.[12] More recently, there has been a growing interest in adolescent nutrition, particularly girls' nutrition, as a means to improve the health of women and children.[13,14]

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Urbanization is one of the most important contributors to an obesogenic environment

This article describes the double burden of malnutrition among adolescents and the macrolevel contextual factors shaping the distribution of the double burden across LMICs.

Methods

Individual-participant data from the Global School-based Student Health Survey and Health Behavior in School-aged Children surveys, conducted in 57 LMICs between 2003 and 2013 (129,276 adolescents aged 12–15 years), were used. Pooled estimates of stunting, thinness, stunting and/or thinness, overweight or obesity, and concurrent stunting and overweight or obesity were calculated with random-effects meta-analysis. Ecological linear regression models were used to examine the association between macrolevel contextual factors (internal conflict, lack of democracy, gross domestic product, food insecurity, urbanization and survey year) and stunting, thinness and overweight and obesity prevalence, respectively.

FIGURE 1: Forest plot of stunting prevalence

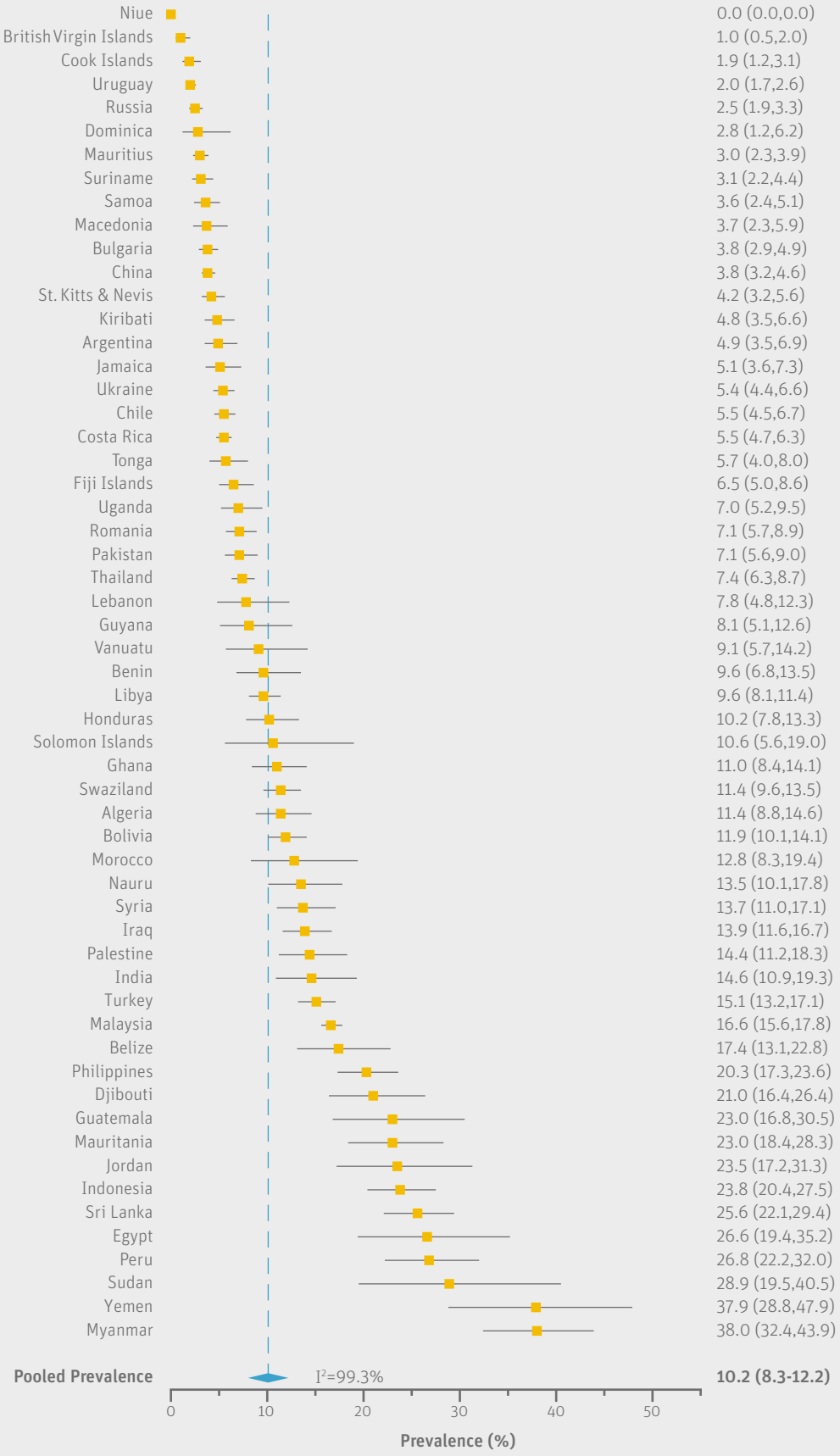


FIGURE 2: Forest plot of thinness prevalence

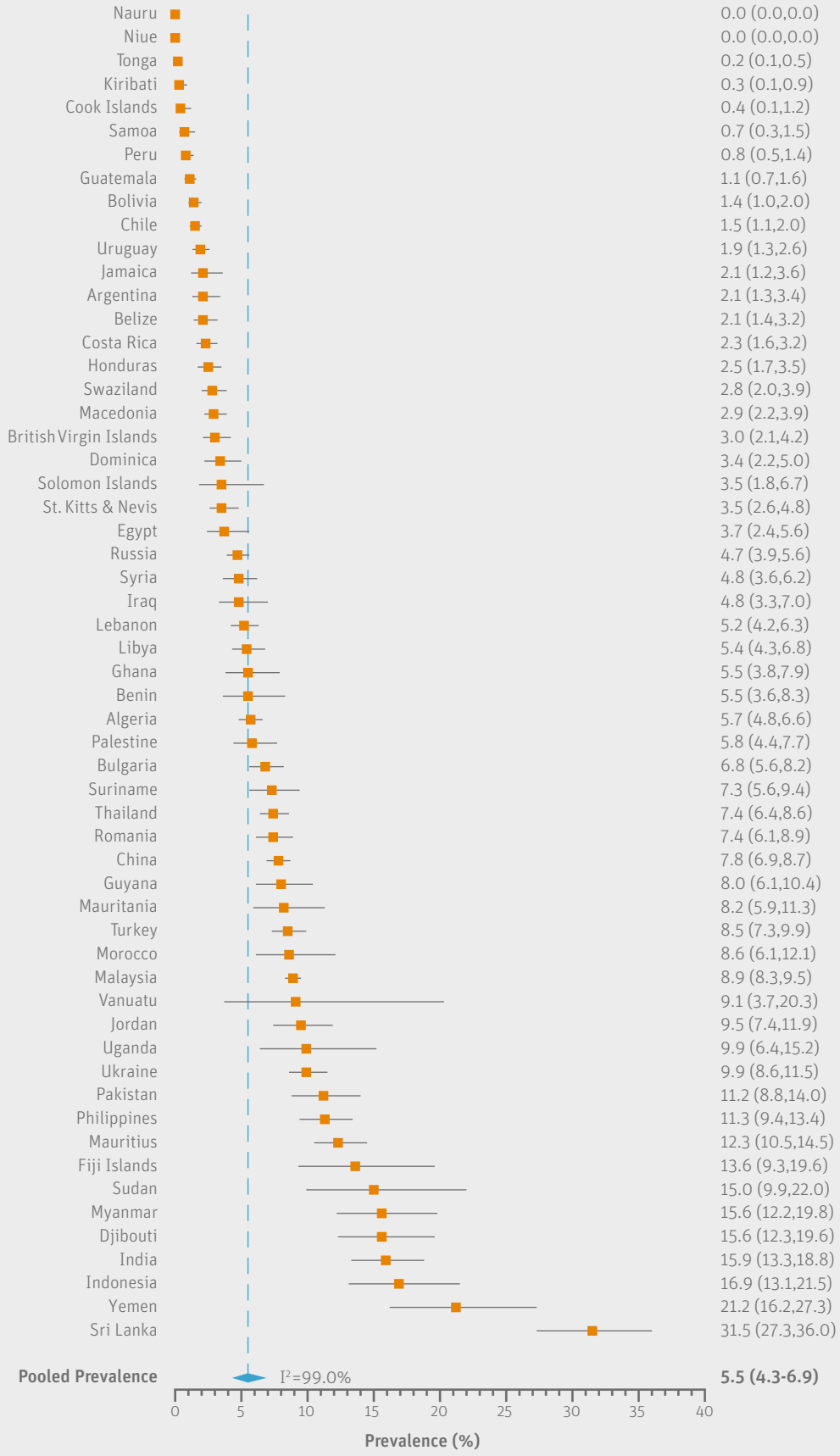


FIGURE 3: Forest plot of overweight or obesity prevalence

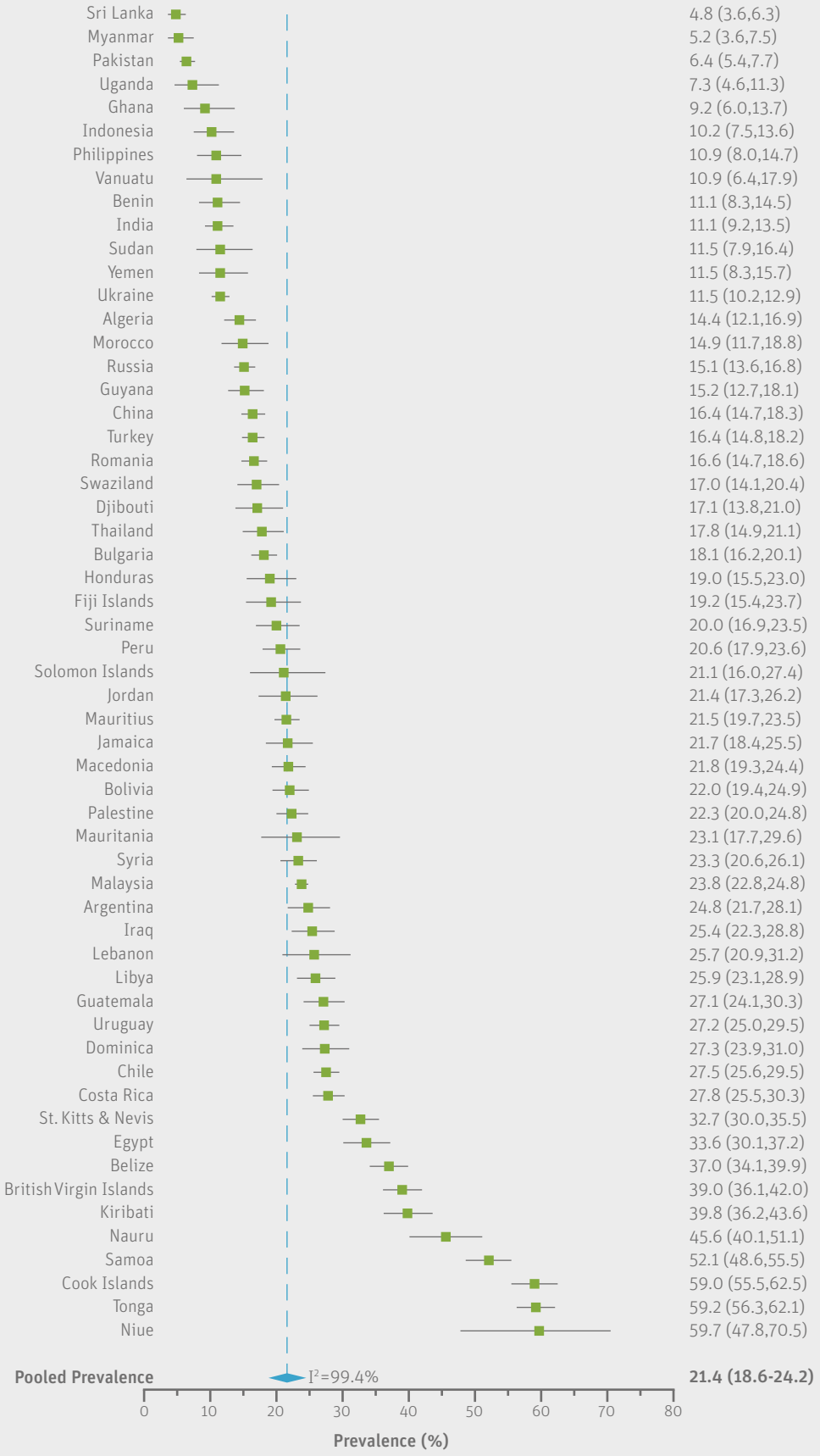


FIGURE 4: Forest plot of concurrent stunting and obesity prevalence

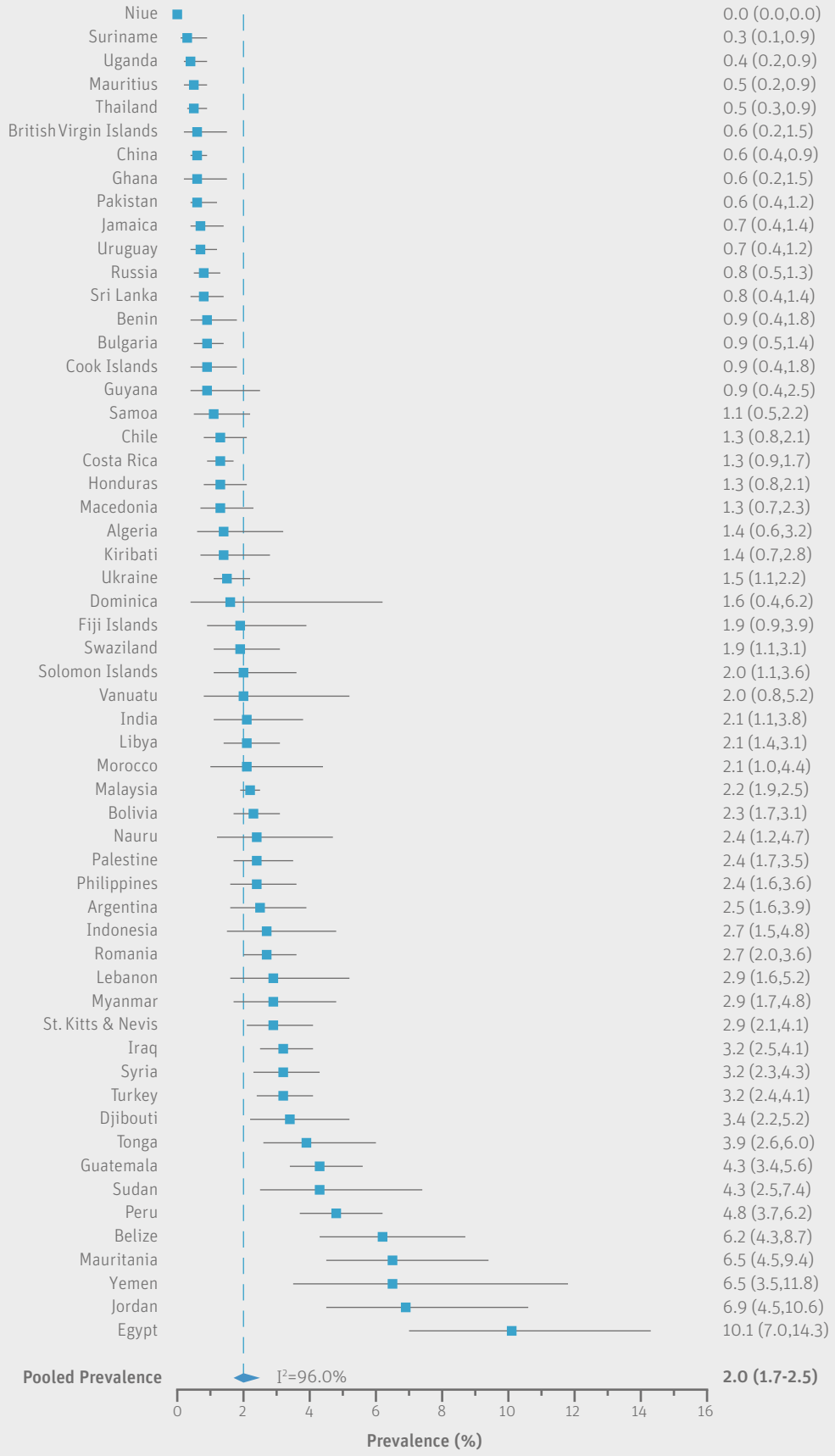
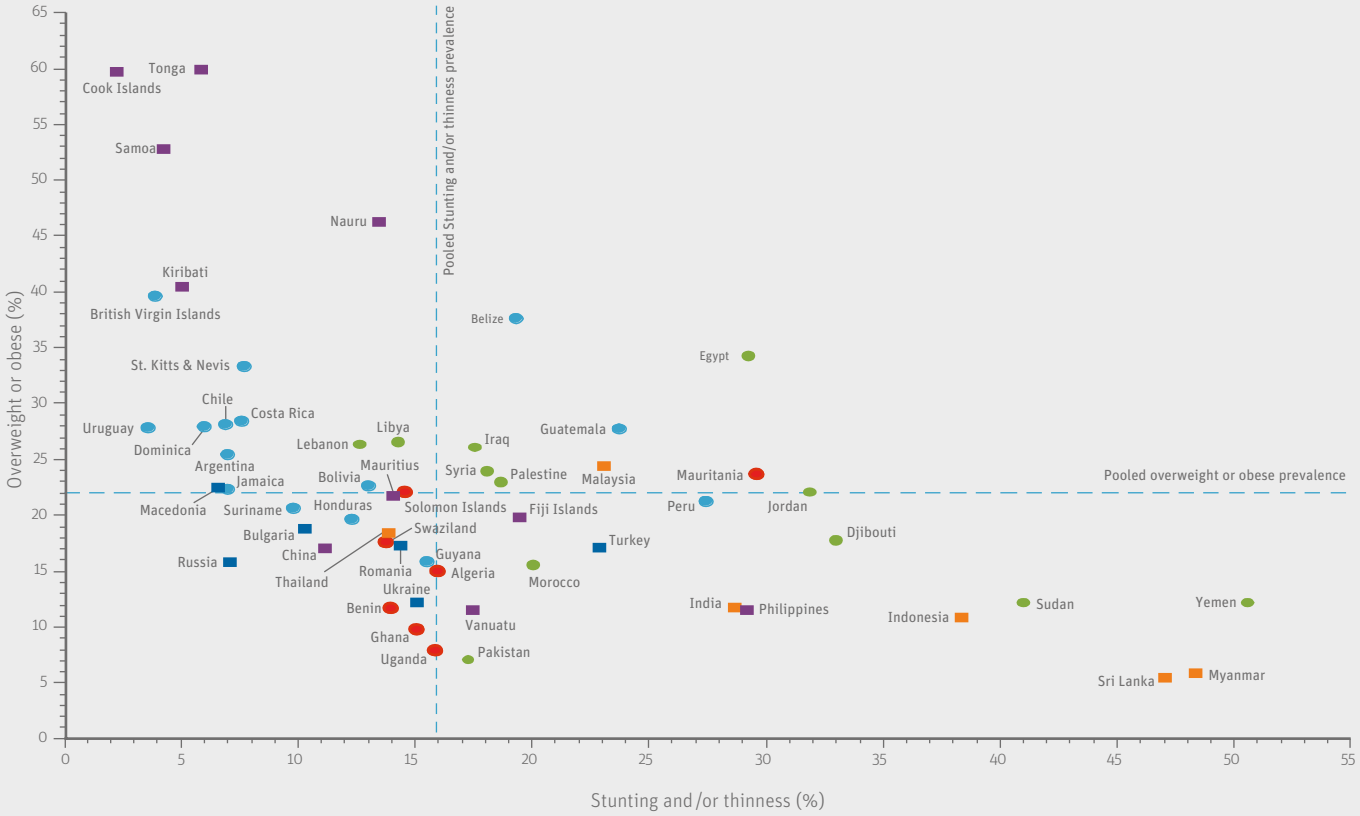


FIGURE 5: Adolescent overweight or obesity prevalence by stunting and/or thinness prevalence



Results

Stunting prevalence was 10.2% (95% CI: 8.3, 12.2) (Figure 1) and thinness prevalence was 5.5% (95% CI: 4.3, 6.9) (Figure 2). Overweight or obesity prevalence was 21.4% (95% CI: 18.6, 24.2) (Figure 3). Up to 43.4% of the variance in stunting prevalence was accounted for by recent internal conflict, lack of democracy, GDP per capita and food insecurity; 38.4% of the variance in thinness prevalence was accounted for by recent internal conflict, lack of democracy, food insecurity and survey year; and 58.7% of the variance in overweight or obesity prevalence was accounted for by recent internal conflict, GDP per capita, food insecurity, urbanization and survey year. The prevalence of concurrent stunting and overweight or obesity was 2.0% (95% CI: 1.7, 2.5) (Figure 4). Figure 5 shows adolescent overweight or obesity prevalence by stunting and/or thinness prevalence. Sixteen percent had overweight or obesity prevalence and stunting and/or thinness prevalence greater than the overall pooled prevalence estimates for overweight or obesity and stunting and/or thinness prevalence, respectively. By WHO region, per total number of LMICs, 14% in Africa, 7% in the Americas, 17% in the Eastern Mediterranean region, 33% in Europe, 0% in South-East Asia and 9% in the Western Pacific had overweight or obesity and stunting and/or thinness prevalences greater than their regional prevalence estimates for overweight or obesity and stunting and/or thinness.

Key data

Stunting prevalence was 10.2% (95% CI: 8.3, 12.2)

Thinness prevalence was 5.5% (95% CI: 4.3, 6.9).

Overweight or obesity prevalence was 21.4% (95% CI: 18.6, 24.2).

Between 38.4% and 58.7% of the variance in adolescent malnutrition was explained by macrolevel contextual factors.

The prevalence of concurrent stunting and overweight or obesity was 2.0% (1.7, 2.5).

Discussion

The prevalence of stunting and/or thinness among adolescents was 15.6%, or about three in twenty adolescents, while 21.4%,

or about one in four adolescents, was overweight or obese. A much smaller proportion of adolescents also had concurrent stunting and overweight or obesity. There were significant differences in adolescent malnutrition prevalence estimates across LMICs; 38%–59% of the variance at the population level could be explained by macrolevel contextual factors including internal conflict, lack of democracy, GDP, food insecurity, urbanization and the year of survey.

These results are not directly comparable with those of Abarca-Gómez et al.[15] because the two studies covered different age ranges (5–19 years in the Abarca-Gómez et al. study compared with 12–15 years in our study). However, both studies found thinness prevalence was highest in the South-East Asian region and overweight or obesity prevalence was highest in the Western Pacific region.

"Thinness prevalence was highest in the South-East Asian region and overweight or obesity prevalence was highest in the Western Pacific region. Concurrent stunting and overweight or obesity among adolescents in LMICs was highest in the Eastern Mediterranean region."

Concurrent stunting and overweight or obesity among adolescents in LMICs was highest in the Eastern Mediterranean region. Inadequate nutrition in the period between conception and two years can lead to reduced linear growth.[2] Given that resolution of these height deficits may take several generations,[5] stunted children also exposed to obesogenic environments may be at greater risk of becoming overweight or obese. Stunting has been reported to alter body composition and fat distribution (e.g., via greater insulin sensitivity and/or lower fat oxidation), predisposing adolescents to excess adiposity.[16]

Addressing the double burden of adolescent malnutrition in LMICs would require countries to adopt an integrated agenda (based on national or regional data) that addresses the root causes of malnutrition using a life-course approach (i.e., prior to conception and continuing up to and including adolescence).[17] At a national level, few LMICs have nutrition policies that could address both burdens at the same time, with lower-income countries tending to have policies that only address undernutrition.[18] Irrespective of what evidence-based policies and programs are offered to address both burdens of undernutrition and overnutrition among adolescents, scant attention to the macrolevel contexts can result in poor policy decisions. This issue is highlighted in a mixed method study of the South Sudan Nutrition Health and Empowerment (SSHiNE) Program.[19]

Improved food and nutrition security stems directly from government policies that integrate the food economy with a development agenda that seeks to boost economic growth while achieving a more equitable distribution of income

The SSHiNE program was a multiyear assistance program funded by the U.S. Agency for International Development Office of Food for Peace, and it included a supplementary ration provision following the 'Prevention of Malnutrition in Children Under 2 Approach.' Since independence in July 2011, the country has suffered ongoing internal conflict. While the program was initiated at a time of relative stability, political instability in the region affected households in a number of ways. Ultimately, this led to substantial obstacles to the distribution of supplementary household rations and the prevention of child malnutrition. Monthly household rations delivered via a non-emergency food assistance program were received by communities; however, the majority of households had used up these rations less than 30 days after receipt. More than one-half of children aged 12–17 months and one-third of children aged 18–23 months consumed diets consisting of fewer than four food groups in the final week of each month.[19] Notably, the strategy at the time was the most current one for preventing child malnutrition and had proved beneficial in its original evaluation in Haiti.[20]

"Addressing the double burden of adolescent malnutrition in LMICs would require countries to adopt an integrated agenda that addresses the root causes of malnutrition using a life-course approach"

Conclusion

While there is substantial variation across low- and middle-income countries in the prevalence of under- and overnutrition among adolescents, the double burden of malnutrition particularly at the population level is common in LMICs. A large proportion of the variance in adolescent malnutrition was explained by macrolevel contextual factors. Without attending to context, interventions and programs for adolescent malnutrition in LMICs may fail or underperform.

Correspondence: ***Dr Rishi Caleyachetty,***
Assistant Professor, Unit of Academic Primary Care,
Warwick Medical School, University of Warwick,
CV4 7AL, UK
Email: *R.Caleyachetty@warwick.ac.uk*

References

01. WHO. Adolescent pregnancy. Version current 1 November 2017. Internet: www.who.int/maternal_child_adolescent/topics/maternal/adolescent_pregnancy/en/
02. Black RE, Victora CG, Walker SP, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet. 2013;382(9890):427–51.
03. Grantham-McGregor S, Cheung YB, Cueto S, Glewwe P, Richter L, Strupp B. Developmental potential in the first 5 years for children in developing countries. Lancet. 2007;369(9555):60–70.
04. Dewey KG, Begum K. Long-term consequences of stunting in early life. Matern Child Nutr. 2011;7 Suppl 3:5–18.
05. Onis M, Branca F. Childhood stunting: a global perspective. Matern Child Nutr. 2016;12(S1):12–26.
06. Fernald LC, Neufeld LM. Overweight with concurrent stunting in very young children from rural Mexico: prevalence and associated factors. Eur J Clin Nutr. 2007;61 (5):623–632.
07. Popkin BM, Richards MK, Montiero CA. Stunting is associated with overweight in children of four nations that are undergoing the nutrition transition. J Nutr. 1996;126:3009–16.
08. Best C, Neufingerl N, van Geel L, van den Briel T, Osendarp S. The nutritional status of school-aged children: why should we care. Food Nutr Bull. 2010;31(3):400–17.
09. Reilly JJ, Kelly J. Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review. Int J Obes (Lond). 2011;35(7):891–8.
10. Twig G, Yaniv G, Levine H, et al. Body-mass index in 2.3 million adolescents and cardiovascular death in adulthood. N Engl J Med. 2016;374(25):2430–40.
11. Tzioumis E, Adair LS. Childhood dual burden of under- and overnutrition in low- and middle-income countries: A critical review. Food Nutr Bull. 2014;35(2):230–43.
12. Mokdad AH, Forouzanfar MH, Daoud F, et al. Global burden of diseases, injuries, and risk factors for young people's health during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2016;387(10036):2383–2401.
13. Salam RA, Hooda M, Das JK, et al. Interventions to improve adolescent nutrition: a systematic review and meta-analysis. J Adolesc Health. 2016;59(4):S29–S39.
14. Lassi ZS, Mansoor T, Salam RA, Bhutta SZ, Das JK, Bhutta ZA. Review of nutrition guidelines relevant for adolescents in low- and middle-income countries. Ann N Y Acad Sci. 2017;1393(1):51–60.
15. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128·9 million children, adolescents, and adults. Lancet. 2017 Dec 16;390(10113):2627–42.
16. Sawaya AL, Roberts S. Stunting and future risk of obesity: principal physiological mechanisms. Cad Saude Publica. 2003;19 Suppl 1:S21–8.
17. Uauy R, Garmendia ML, Corvalán C. Addressing the double burden of malnutrition with a common agenda. Nestle Nutr Inst Workshop Ser. 2014;78:39–52.
18. Sunguya BF, Ong KI, Dhakal S, et al. Strong nutrition governance is a key to addressing nutrition transition in low and middle-income countries: review of countries' nutrition policies. Nutr J. 2014;13:65.
19. Paul A, Doocy S, Tappis H, Evelyn SF. Preventing malnutrition in post-conflict, food insecure settings: a case study from South Sudan. PLOS Curr. 2014 Jul 7;6.
20. Ruel MT, Menon P, Habicht J-P, et al. Age-based preventive targeting of food assistance and behaviour change and communication for reduction of childhood undernutrition in Haiti: a cluster randomised trial. Lancet. 2008;371(9612):588–95.

Perspectives in Nutrition Science

Time to Recalibrate Nutrition Improvement Strategy?

Perspectives from Asia

Regina Moench-Pfanner
ibn360 Pte Ltd, Singapore

Klaus Kraemer
Sight and Life, Basel, Switzerland;
Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

Jeyakumar Henry
Clinical Nutrition Research Center (CNRC), A-Star, Singapore; Yong Loo Lin School of Medicine, National University of Singapore, Singapore

Key messages

- While Asia's more affluent nations are on par with, or even surpass, industrialized counterparts in other regions, a critical mass of the region's population continues to struggle with poverty and poor nutrition and health outcomes.
- Much investment and development assistance in Asia has gone towards agricultural reforms and poverty alleviation, yet there are still millions who are malnourished.
- The term 'Asians' encompasses a diversity of ethnic groups. Each group has their own distinct diet, cultural practices, genetic makeup and inherent body composition, which influence their susceptibility to overweight, obesity and diabetes.
- In view of recent insights in nutrition, science and human development, nutrition improvement thinking may need refreshing, and it could be time to overhaul the classic Conceptual Framework of Malnutrition and its more recent derivatives.

Introduction

Asia's booming tiger economies, population juggernauts and low- and middle-income countries are home to approximately 70% of the world's population. The story of nutrition in this region is as multifaceted as the region itself, defying sweeping generalizations that otherwise mask important nuances.

While Asia's more affluent nations are on par with or even surpass industrialized counterparts in other regions, however, a critical mass of the region's population – particularly that proportion living in the least developed parts of it – continues to struggle with poverty, poor nutrition and poor health outcomes. Asia has come a long way and seen successes in taming malnutrition and communicable diseases that were once problems of public health significance in many of its countries. Yet, because the region is vast and its population base massive compared to other regions, ongoing nutrition problems affect Asian populations on a scale vastly greater than in those other regions. Asia's transitional and emerging economies (India, Indonesia, Pakistan, Bangladesh) represent nearly half (45%) of the population base of the top 10 most populous countries in the world.

Among the countries of this diverse region, Bangladesh stands out as a country with a largely low- to middle-income population that has made tremendous improvements in nutrition statistics over the last few decades. Nonetheless, high rates of stunting, wasting and micronutrient deficiencies continue to keep Bangladesh and many of her low- and middle-income country peers mired in poverty and underdevelopment. To make matters worse, obesity and diet-related noncommunica-

Young boys in an Indonesian slum

Laundry slum in Mumbai, India

ble diseases (NCDs), such as type 2 diabetes, have emerged as growing problems in many of the same populations that are still fighting against undernutrition, resulting in a "double burden of malnutrition."[1–3]

According to the Asian Development Bank, much investment and development assistance over the past decades has gone towards agricultural reforms and poverty alleviation, resulting in improved agricultural production and rising household incomes. Yet, there are still millions in Asia who are malnourished and unable to afford a diet that provides for their micronutrient needs.[4–6] Have decades of investment resulted in truly robust, resilient and food-secure nations? In this article focusing specifically on Southeast Asia and South Asia, the authors reflect on the fragmented nature of nutrition in the region – a mixed reality of food affluence versus scarcity, and food quantity versus quality. Highlighting recent insights in nutrition, science and human development, the authors suggest nutrition improvement thinking may need refreshing.

Asia in a hyper-urbanizing world

Since 2014, more than half of the world's people live in urban centers versus rural areas. Southeast Asia and South Asia have been among the regions at the forefront of the modern world's thrust into this hyper-urbanization. The UN predicts up to two-thirds of the global population will be living in towns and cities by 2050, and approximately 2.25 billion of these urbanites will be in Asia and Africa. UN population projections to 2050 point to stagnation in the populations of developed regions but an increase in the total global population, driven primarily by the increasing urban population in less developed regions, while the rural share of these same populations decreases.[7]

> "Up to two-thirds of the global population will be living in towns and cities by 2050"

The good news is the number of people living in extreme poverty (i.e., less than US$1.90 per day) has dramatically fallen over the past decades in every region except Africa (where it has increased), including in Southeast Asia and South Asia.[3] The rise of urban centers in low- and middle-income countries has generally tracked with rising incomes among their populations. Nonetheless, urban poor populations living in informal settlements, nutritionally vulnerable to income and price shocks, will pose a major challenge as Asia continues to create new towns, cities, megacities and other urban agglomerations. Mounting evidence indicates that, with increasing economic growth and urbanization, gains achieved in nutrition improvement – such as child stunting reduction associated with improved access to nutrition in towns and cities – tend to slow down, while other forms of malnutrition, such as increases in overweight and obesity among adults, start to gain traction.[8]

The relatively rapid emergence of obesity and associated diet-related disorders, such as type 2 diabetes, in parts of the world where high rates of micronutrient deficiencies are still a problem, suggests that public health nutrition improvement efforts should focus not only on undernourished/underweight populations.[9,10] Populations for whom food security has historically been strained are now finding themselves awash in surplus calories resulting from increased agricultural productivity, urbanization and access to globalized food markets, including a growing share of diets reliant on processed food and beverage products.[11]

Double vs. triple burden

Some members of the health and nutrition community have called out the penetration of the processed food and beverage industry in developing markets as a leading cause of the obesity and NCD epidemics in these countries. Nonetheless, the complexity of the relationship between food and nutrition security can be missed by singling out one factor over the myriad other factors involved. Clearly, the double burden of malnutrition connotes a complex situation where food insecurity, micronutrient deficiencies, undernutrition and infectious diseases, as well as overweight, obesity and related NCDs coexist in countries, communities and households and even in the same individual.[12]

Among the ways in which low-income families cope with household-level food insecurity is by consuming low-cost, energy-dense and often nutrient-poor foods. There is strong evidence that food-insecure households trade nutritional quality and/or diversity in favor of satiety, by choosing foods that deliver more calories in order to avoid a state of absolute hunger.[13,14] With cheap but 'empty' calories made available and accessible through processed foods and beverages aimed at low-value, high-volume markets in recent decades, individuals and households historically conditioned to hoard food in times of scarcity end up overconsuming the surplus of food. The diet in many developing countries has been characterized as a 'poverty diet,' containing little fat and many refined carbohydrates, such as white rice and refined wheat products.[15] Unchecked, the increased intake of macronutrients can lead to obesity, while the low density of nutrients in the diet perpetuates the micronutrient deficiencies already present in these individuals. Is the double burden – distinguished by the dichotomy between undernutrition and 'overnutrition' – in fact a triple burden of malnutrition, characterized by the simultaneous presence of undernourishment (hunger) micronutrient deficiencies (hidden hunger), and overweight or obesity?[16] The problem with the concept of 'overnutrition' is that it could be understood to imply overweight or obese individuals are somehow also consuming excessive amounts of micronutrients, which is not necessarily the case.[9]

Many countries in Asia have progressed in addressing the food supply dimension of food security with policies and programs aimed at increasing agricultural production and food distribution; yet efforts to ensure nutritional quality and diversity of the food supply have been limited.[4] While such an approach indeed protects the region against the extremes of food-related crises, such as hunger and famine, the chronic and widespread problem of micronutrient deficiencies and their wide-ranging impacts on human health, development and economic well-being present a slow burn that hampers long-term progress.[17]

The Asian phenotype – what's the skinny?

To what extent could the triple burden emerging in Asia be intrinsic to the region because of the influence of an 'Asian phenotype'? In other words, do decades of public health advice and interventions by regional health authorities but based on standards and studies originating from Western countries need to be reconsidered as advances in genomics and precision nutrition enable more nuanced investigations? While the prevailing logic has been that differences between populations have largely been less significant than those between individuals, precision medicine based on an individualized approach is seen as an emergent new standard of care. The pharmaceutical industry has already begun replicating studies originally conducted predominantly among non-Asian populations with Asian sample populations in order to identify any major differences in drug metabolism and toxicity.[18]

> "There is currently a gap in research on Asian populations, even as mounting evidence suggests profound metabolic differences between Caucasians and Asians"

The term 'Asians' encompasses a diversity of ethnic groups, including Chinese, Indians, Malays, Japanese and Koreans. Each group has their own distinct diet, cultural practices, genetic makeup and inherent body composition, which influence their susceptibility to overweight, obesity and diabetes. However, much of the research on obesity and diabetes has been documented in Caucasian subjects. There is currently a gap in research on Asian populations, even as mounting evidence suggests profound metabolic differences between Caucasians and Asians and even further stratification within the Asian group. When exposed to the same foods, Asians have higher postprandial glycemia, lower insulin sensitivity and greater insulin resistance than their Caucasian counterparts.[19] Given the same

body mass index (BMI), Asians have higher body fat mass and therefore greater predisposition to cardiovascular diseases, even if they do not physically appear to be obese. This 'skinny fat' (or TOFI – thin on the outside but fat on the inside) conundrum among Asians makes it even more challenging to detect metabolic disorders, which could lead to poor dietary choices when consumers are unaware of their own health status. Some examples of common clinical features of the Asian phenotype include BMI, increased body fat, especially visceral fat, and a high rate of central obesity and metabolic syndrome and notably the thin-fat phenotype is already present at birth.[20,21]

Although the precise mechanism responsible for insulin resistance remains unclear, high glycemic load appears to play a role.[22] In regard to the glycemic load[a] (GL) and glycemic index[b] (GI), the Clinical Nutrition Research Center (CNRC), Singapore, has been studying how food and food ingredients can be used to reduce the GI of rice and rice-based products in order to minimize the risk of developing type 2 diabetes. In a series of novel studies, CNRC has shown how combining commonly consumed Asian foods with rice can dramatically alter the high glycemic response of rice.[23–26] Given that in Asia rice is consumed in combination with different proteins, a recent study demonstrated that consuming soybean curd with rice had the best effect on glycemic reduction of rice in comparison to chicken, egg, or fish, which are commonly consumed with rice.[27] A further study showed that the consumption of a chicken hydrolysate (soup) with rice reduced the glycemic response of rice. This study showed for the first time that the consumption of soup promotes the lowering of glycemia due to the presence of peptides and free amino acids in it.[28]

Stunting as a measure of programs – reaching too high?

Stunting results from poor nutrition during the first 1,000 days of life, from pregnancy to the child's second birthday. Stunted growth during this critical period of development is largely irreversible. Children suffering from stunting may never attain their full possible height, and their brains may never develop to their full cognitive potential. Globally, approximately 151 million children under five years of age are affected.[29] In 2017, more than half of all stunted children (83.6 million) resided in Asia, and two out of five stunted children in the world live in South Asia.[30] Leading economies such as China are also affected and, in 2017, China had 12.7 million stunted children, equivalent to the population of Tokyo and Indonesia nine million in 2016, equivalent to 1.5 times the population of Singapore.[31]

Stunting has lifelong debilitating effects: affected children drop out of school early, earn less as adults and are at increased risk of overweight/obesity and related NCDs, such as type 2 diabetes and cardiovascular diseases as adults.[32] The latter is likely related to altered body composition with increased abdominal fatness. It is striking that, in South Asia, a significant proportion of stunting results from intrauterine growth restriction (small for gestational age, or SGA) and low birthweight deliveries.[33]

> "Stunting is a dynamic process that starts *in utero*, continues into childhood and is driven by a wide range of risk factors besides nutrition"

It is also important to understand the underlying factors of stunting that make a child too short for his or her age. Stunting is a dynamic process that starts *in utero*, continues into childhood and is driven by a wide range of risk factors besides nutrition: these include the environment and sanitation, genetics, medical and physiological issues and potentially region-specific phenotypes (perhaps the reason why it is particularly high in Southeast and South Asia). This diversity of determinants driving stunting, for some of which knowledge is still nascent, confounds programmatic ambitions to reduce the phenomenon through a limited set of interventions on their own, such as education, improving sanitation and hygiene, improving diets, providing supplements and treating and preventing diarrheal infections.[34–36] We know from the literature and reviews that nutrition-specific interventions, even when scaled up 90% nationwide, can only reduce stunting by a small percentage of approximately 20% – all the other reductions need to come from nutrition-sensitive interventions that address the different causes of stunting.[37]

In light of the increasing complexity we are discovering regarding the factors underlying stunting, is there a need to consolidate our knowledge in this area and validate programs aiming

Slum in Saigon, Vietnam

A young girl in an Indian slum

to reduce stunting more conscientiously? Is it time to overhaul the classic Conceptual Framework of Malnutrition and its more recent derivatives – on the basis of which many nutrition interventions are designed, implemented and assessed – based on new knowledge, particularly regarding phenotypes as well as the role of 'omics' sciences in unraveling nutrition?[38,39] Perhaps pulling these different strands of understanding into clearer focus, to clarify the science behind stunting and other dimensions of nutritional deficit as well as well-being, may help answer the important question: in the context of limited resources and competing priorities, which interventions should we invest in for the greatest impact?

"Is it time to overhaul the classic Conceptual Framework of Malnutrition and its more recent derivatives?"

Concluding remarks

The discussion above highlights two important lines of questioning in the context of solving malnutrition problems not only in Asia but also in other regions:

Firstly, in light of increasing granularity in nutrition knowledge, specifically the notion of regional phenotypes that influence anthropometrics, metabolism and other important factors in the development of deficiencies and diseases, should more research be directed to determining the need to establish reference population standards based on these phenotypes? Given the scale of the problem of malnutrition in South and Southeast Asia, are we missing important considerations by using a yardstick that was developed to assess Western populations?

By the same token, is stunting reduction indeed the best measure of development progress in developing countries where the double burden increasingly characterizes the wider nutrition challenge? While stunting may well be useful to assess long-term nutritional and environmental distress/wellness and associated outcomes across cognitive, social, health and economic domains, what can it tell us about children and adults who are overweight or obese and/or suffering from NCDs in these same countries?

Secondly, do we have to rethink development assistance in these Asian regions in light of hyper-urbanization and rapidly changing demographics? Increasing migration from rural areas to urban centers and growing numbers of poor urban settlements, with low access to health services but high access to 'poverty diet' staples and low nutrient-dense processed foods, exacerbate micronutrient deficiencies while promoting overweight, obesity and NCDs. Clearly, the food and nutrition security challenge in Asia has shifted away from single-minded focus on agricultural intensification and poverty alleviation to more targeted, differentiated approaches that must recognize localized drivers

and obstacles to nutrition improvement. Governments and public health authorities in Asia's emerging economies should adopt and contextualize developed countries' policies and strategies based on consumer education and persuasion towards healthier diets, and partner strategically with other sectors, including the food industry, on these efforts, rather than maintain traditional top-down approaches that may have been effective with lower-educated, resource-constrained, rural populations.

"Governments and public health authorities in Asia's emerging economies should adopt and adapt developed countries' policies and strategies"

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Correspondence: ***Regina Moench-Pfanner,***
ibn360 Pte Ltd, 3 Pickering Street,
#02–36 Nankin Row, Singapore 048660
Email: *regina@ibn-360.com*

Notes

a. Blood glucose levels rise and fall after an individual eats a meal containing carbohydrates. How high they rise and how long they stay high depends on the quality of the carbohydrates (GI, see below) as well as the quantity consumed. Glycemic load (or GL) combines both the quantity and quality of carbohydrates. Source: www.gisymbol.com/what-about-glycemic-load/

b. The glycemic index (GI) is a relative ranking of carbohydrate in foods according to how they affect blood glucose levels. Source: www.gisymbol.com/about-glycemic-index/

References

01. Development Initiatives. Global nutrition report 2017: nourishing the SDGs. Bristol, UK: Development Initiatives; 2017.
02. International Food Policy Research Institute. Global nutrition report 2016: from promise to impact: ending malnutrition by 2030. Washington, DC: IFPRI; 2016 (same citation for 2015 and 2014).
03. World Bank. Atlas of Sustainable Development Goals 2017: from world development indicators. Washington, DC: World Bank; 2017.
04. Asian Development Bank. Food security in Asia and the Pacific. Manila: Asian Development Bank; 2013.
05. ASEAN, UNICEF, WHO. Regional report on nutrition security in ASEAN, vol. 2. Bangkok; UNICEF; 2016.
06. Ingram J. Perspective: Look beyond production. Nature. 2017:544(7651):S17.
07. United Nations. 2018 revision of world urbanization prospects. Internet: www.un.org/development/desa/publications/2018-revision-of-world-urbanization-prospects.html (accessed 10 July 2018).
08. Global Panel. Urban diets and nutrition: trends, challenges and opportunities for policy action. Policy Brief No. 9. London, UK: Global Panel on Agriculture and Food Systems for Nutrition; 2017.
09. Laillou A, Yakes E, Le TH, Wieringa FT, Le BM, Moench-Pfanner R, et al. Intra-individual double burden of overweight and micronutrient deficiencies among Vietnamese women. PLOS ONE. 2014;9(10):e110499.
10. Garcia OP, Long KZ, Rosado J. Impact of micronutrient deficiencies on obesity. Nutr Rev. 2009;67(10):559–572.
11. Reardon T, Tschirley D, Dolislager M, Snyder J, Hu C, White S. Urbanization, diet change, and transformation of food supply chains in Asia. East Lansing, MI: Global Center for Food Systems Innovation, Michigan State University; 2014.
12. International Atomic Energy Agency. International Symposium on Understanding the Double Burden of Malnutrition for Effective Interventions. 2018. Internet: www.iaea.org/events/understanding-the-double-burden-of-malnutrition-symposium-2018 (accessed 24 August 2018).
13. Radimer KL, Olson CM, Greene JC, Campbell CC, Habicht J.-P. Understanding hunger and developing indicators to assess it in women and children. J Nutr Educ. 1992;24(1 Suppl 1):36S–44S.
14. Drewnowski A, Specter SE; Poverty and obesity: the role of energy density and energy costs. Am J Clin Nutr. 2004;79(1):6–16.
15. Pan A, Lin X, Hemler E, Hu FB. Diet and cardiovascular disease: advances and challenges in population-based studies. Cell Metab. 2018;27(3):489–496.
16. Johnston JL, Fanzo JC, Cogill B. Understanding sustainable diets: a descriptive analysis of the determinants and processes that influence diets and their impact on health, food security, and environmental sustainability. Adv Nutr. 2014;5(4):418–29.
17. Hwalla N, El Labban S, Bahn RA. Nutrition security is an integral component of food security. Front Life Sci. 2016;9(3):167–72.
18. Leow MK.-S, Characterization of the Asian phenotype – an emerging paradigm with clinicopathological and human research implications. Int J Med Sci. 2017;14(7):639–47.
19. Kataoka M, Venn BJ, Williams SM, Te Morenga LA, Heemels IM, Mann JI. Glycaemic responses to glucose and rice in people of Chinese and European ethnicity. Diabet Med. 2013;30(3):e101–7.
20. Unnikrishnan R, Anjana RM, Mohan V. Diabetes in South Asians: is the phenotype different? Diabetes. 2014:63(1):53–5.
21. Yajnik CS. Early life origins of insulin resistance and type 2 diabetes in India and other Asian countries. J Nutr. 2004;134:205–10.
22. Livesey G, Taylor R, Livesey H, Liu S. Is there a dose-response relation of dietary glycemic load to risk of type 2 diabetes?

Meta-analysis of prospective cohort studies. Am J Clin Nutr. 2013;97(3):584–96.

23. Sun L, Tan KWJ, Henry CJ. Co-ingestion of essence of chicken to moderate glycaemic response of bread. Int J Food Sci Nutr. 2015;66(8):931–35.
24. Sun L, Ranawana DV, Leow MKS, Henry CJ. Effect of chicken, fat and vegetable on glycaemia and insulinaemia to a white rice-based meal in healthy adults. Eur J Nutr. 2014;53(8):1719–26.
25. Kaur B, Ranawana V, Teh AL, Henry CJ. The impact of a low glycemic index (GI) breakfast and snack on daily blood glucose profiles and food intake in young Chinese adult males. J Clin Transl Endocrinol. 2015;2(3):92–8.
26. Kaur B, Ranawana V, Henry J. The glycemic index of rice and rice products: a review, and table of GI values. Crit Rev Food Sci Nutr. 2016;56(2):215–36.
27. Quek R, Bi X, Henry CJ. Impact of protein-rich meals on glycaemic response of rice. Br J Nutr. 2016;115(7):1194–201.
28. Soong YY, Lim Z, Sun LJ, Henry CJ. Effect of co-ingestion of amino acids with rice on glycaemic and insulinaemic response. Br J Nutr. 2015;114:1845–51.
29. WFP. 10 facts about nutrition in China. 30 June 2016. Internet: www.wfp.org/stories/10-facts-about-nutrition-china (accessed 20 August 2018).
30. World Hunger Education Service. Hunger notes. World hunger and poverty facts and statistics. 2018. Internet: www.worldhunger.org/world-hunger-and-poverty-facts-and-statistics/ (accessed 21 August 2018).
31. Worldometers.info. Singapore population. 2018. Internet: www.worldometers.info/world-population/singapore-population/ (accessed 15 August 2018).
32. Dewey KG, Begum K. Long-term consequences of stunting in early life. Matern Child Nutr. 2011;7 Suppl 3:5–18.
33. Christian P, Lee SE, Donahue Angel M, Adair LS, Arifeen SE, Ashorn P et al. Risk of childhood undernutrition related to small-for-gestational age and preterm birth in low- and middle-income countries. Int J Epidemiol. 2013;42:1340–55.
34. PATH. Underlying contributors to childhood stunting: what evidence exists on nutrition-sensitive risk factors? Seattle: PATH; 2018.
35. Hossain M, Choudhury N, Abdullah KAB, Mondal P, Jackson AA, Walson J, et al. Evidence-based approaches to childhood stunting in low and middle income countries: a systematic review. Arch Dis Child. 2017;102:903–9.
36. Perumal N, Bassani DG, Roth DE. Use and misuse of stunting as a measure of child health. J Nutr. 2018;148(3):311–5.
37. WHO. Stunted growth and development: context, causes, and consequences. Geneva: WHO; 2017.
38. Rajendhran J, Gunasekaran P. Human microbiomics. Indian J Microbiol. 2010;50(1):109–12.
39. Kato H, Takahashi S, Saito K. Omics and integrated omics for the promotion of food and nutrition science. J Tradit Complement Med. 2011;1(1):25–30.

Eat. Think. Solve.

Jessica Renzella
NCDFREE, Global; University of Oxford,
Nuffield Department of Population Health, UK

Elyse Franko-Filipasic
NCDFREE, Global

Key messages

- Malnutrition has many faces and takes many forms.
- Addressing complicated global health issues such as the double burden of malnutrition requires more people- and community-centered approaches.
- Curated discussions in relaxed settings – such as around the dinner table – can help raise awareness of problems and solutions at individual, community and national level, and can set the table for change.

Passionate young minds gather for a picnic and policy discussion in Melbourne, Australia

They say you shouldn't talk politics at the dinner table. We beg to differ.

Between the rise in 24-hour news cycles and click-bait culture, it's difficult to escape the daily onslaught of politically charged and outrageous information that is conveniently available in the palm of our hand. But despite this unprecedented increased access and subsequent attention given to 'problem' information, we seem to have ever fewer opportunities to translate our knowledge, outrage and passion into positive action. The reality is that it's easier to click on the next news story (if it doesn't automatically load) than it is to stop, think, digest, discuss, solve and act together. Our environment isn't overly conducive to actioning the change we want to see in the world.

> "Our environment isn't overly conducive to actioning the change we want to see in the world"

The dinner table (if, indeed, we are lucky enough to sit down at one each night) is perhaps one of the most nourishing political settings in our everyday lives. From the meal itself, which is a product of countless social, environmental and logistical processes, to the way we purchase, prepare and share food, and the unique opportunity for discussion and debate provided by an often relaxed and reflective environment – where better to discuss the politics of food and cook up solutions for a healthier future than over a meal?

We've inherited a messy world, and it's time we talk about it. The purpose of this article – maybe to the dismay of the reader – is not to provide a foolproof 10-step plan for a healthy future for all. Rather, it is to challenge and change the way in which we define this future and the programs and policies that will set up the world so that we can be our best, most healthful selves.

Who should be involved in creating a more nutritious future? How can we meaningfully engage people in positive change – moreover, how do people want to be engaged in positive change? What existing settings and communication channels can be harnessed by all people wanting to involve the masses in nutrition politics? Asking these questions, and involving the diverse views and voices of everyday people in the cocreation of solution generation can be unfamiliar and, frankly, quite scary. In doing so, we give up control; but we become so much more empowered and successful if our aim is to truly create appropriate, impactful and sustained positive change. After all, food is something that everyone knows and cares about because we all eat – so why not expand our definition of 'expert'?

"We become so much more empowered and successful if our aim is to truly create appropriate, impactful and sustained positive change"

Digesting our messy world

Before we can action change, we must first take stock of the problems of the present. As far as 'messy' problems go, the double burden of malnutrition is a particularly egregious one. For much of the 20th century, the message on global malnutrition was clear: malnutrition (erroneously associated exclusively with undernutrition) is a symptom of extreme poverty – a problem captured by images of starving children in somber public fundraising campaigns or aid mobilization efforts. This clear message demanded a clear solution: dedicate more funds towards nutrition programs that address stunting, wasting and other complications of undernutrition. Malnutrition, it seemed, wasn't a direct problem for developed, wealthy nations, where people were more likely to suffer from complications associated with eating too much rather than too little. That was something different altogether, and a problem that warranted wildly different solutions.

Now, firmly into the 21st century, the malnutrition message has grown murkier as the problem has expanded. Worldwide, 1.9 billion adults and 41 million children under 5 are overweight or obese. Rates of diet-related noncommunicable diseases (NCDs) are soaring, with 10% of the population in the U.S. and Western Europe[1] living with type 2 diabetes, and heart disease taking the title of 'world's biggest killer.' Despite a chronic overconsumption of calories in many countries, high rates of anemia[2] and micronutrient deficiencies in high- and low-income countries alike show that the food we consume is not fulfilling its most basic function: nourishment. All the while, improvements on undernutrition indicators have not come fast or far enough.[3] Globally, 155 million children are stunted, 52 million children are wasted and 462 million adults are underweight.[4] This contradictory, messy picture is known as the double burden of malnutrition – an increasingly pressing problem for individuals, households and countries.

"The food we consume is not fulfilling its most basic function: nourishment"

We now know that malnutrition has many faces and takes many forms, affecting one in three people globally. We have also come to learn that the pervasive, ubiquitous nature of this prob-

Setting the table for change at a Feast of Ideas in London

Diners discuss food systems over a delicious vegetarian dinner

lem shifts the malnutrition narrative away from 'us' and 'them' (based on country income classification), and requires increased collaboration, knowledge-sharing and the identification of solutions with cobenefits for over- and undernutrition; people and planet; rich and poor.

Most importantly, faced with these seemingly overwhelming tasks, we are slowly learning that traditional methods for generating solutions – most notably, the power dynamics of solution generation – must be reimagined to deliver on our bold nutrition goals outlined in the Decade of Action on Nutrition, the Sustainable Development Goals and the Noncommunicable Disease Action Plan 2013–2020. It is of course the global nature of these agenda-setting initiatives that makes them so inspiring, but also means they must take broad approaches to policy and program recommendations – something which can be particularly problematic when applied to such complicated issues as the double burden of malnutrition. Properly examining and addressing the underlying causes of nutritional shortcomings requires a more tailored approach based on individual needs, local and national budgets and capacity for change within the community. Irrespective of context, addressing the determinants of malnutrition – in all its forms – will only be achieved by championing people- and community-centered approaches.

Take a seat at the decision-making table

When it comes to food, there is a tension between our agency and the structure and choices we are offered. This juxtaposes the (incorrect) notion that individuals are solely responsible for their dietary behaviors and subsequent health outcomes. Although we disagree with this oversimplified and often stigmatizing focus on individual agency and the failure of willpower, we have taken inspiration from the idea that individuals are powerful, and if the 'menu' determines our choices, then it's time to rewrite the menu.

> "If the 'menu' determines our choices, then it's time to rewrite the menu"

NCDFREE's Feast of Ideas campaign puts power back on the plate and in the palms of individuals all over the world. The concept is simple and requires minimal resources, meaning it is highly adoptable and adaptable. Via social media, newsletters and in-person outreach events, we pose the big, messy health challenges that urgently require solutions as food for thought alongside directed questions to spark dinner-table discussion. We then ask individuals to turn a regular dinner with family and friends into a Feast of Ideas where they spend the evening eating, thinking and solving problems – together. The final step requires individuals to invite the rest of the world to their table (virtually of course) by feeding back their conversations and solutions via social media. Based on this crowdsourced information (which we collect through following the campaign hashtag – #feastofideas), NCDFREE creates a 'Menu for Change' and shares this with leading thinkers, innovators and policymakers around the world. From the comfort of their own homes and with a little help from the same technologies that often distract and click-bait us, everyone gets a seat at the decision-making table and the opportunity to contribute to positive change.

This isn't a silver-bullet solution for citizen engagement, but the results are overwhelmingly positive. In 2016, 3,000 diners in 56 countries welcomed the challenge of discussing and debating our food system, the double burden of malnutrition and noncommunicable diseases – and everyone had something to contribute. We learned that some people were upset that their government hadn't introduced taxes on unhealthy products, while others questioned where this new revenue would be allocated; many young people were actively adhering to and promoting plant-based meals/diets while others pointed out that similar approaches in different settings were not culturally appropriate and therefore required tailor-made solutions; and that people increasingly want nutrition policies and programs to include the key ingredients flavor and enjoyment, not just nutrition.

A recipe for success

Whether you're an academic, a policymaker, or a member of civil society, people should be at the center of our work, and online crowdsourcing activities are a great way to involve diverse audiences on their terms. Let's embrace rather than shy away from

meaningfully engaging people in the cocreation of health policies and programs.

To get you started, here are some tips for facilitating your own Feast of Ideas at home on any topic of your choosing:

1. **Challenge your palate.** "A table companion with alternative ideas [offers] stimulation through new materials."[5] When inviting family, friends, or colleagues to join you, embrace a diversity of opinions and experiences. A varied guest list will contribute to lively, productive discussion.
2. **Encourage curiosity.** Your guests may come to the table with different levels of knowledge and discussion skills. Ensure you facilitate and explore your guests' questions and inputs – you never know where they'll lead. Remember, when it comes to food, we can all be 'experts.'
3. **Walk the talk.** Bold, innovative discussion is best paired with a healthy, sustainable meal. Serve the change you want to inspire.
4. **Pass the plate.** Share your ideas and solutions with NCDFREE and the world through social media to ensure that everyone's voice is heard.

Yes, we are *what* we eat but we are also *how* we eat. Around the dinner table, we are one. The circular fashion in which we sit, the equal height of our chairs, the common platform off which we enjoy our meal – the table for powerful change is set. Pull up a seat and enjoy.

"We are *what* we eat but we are also *how* we eat"

References

01. WHO. Diabetes: data and statistics. Version current 17 August 2018. Internet: www.euro.who.int/en/health-topics/non-communicable-diseases/diabetes/data-and-statistics (accessed 17 August 2018).
02. WHO. Global Nutrition Targets 2025: anaemia policy brief. Geneva: WHO; 2014.
03. UNICEF. Malnutrition. Version current 17 August 2018. Internet: https://data.unicef.org/topic/nutrition/malnutrition/ (accessed 17 August 2018).
04. WHO. The double burden of malnutrition: policy brief. Geneva: WHO; 2017.
05. Kant I. Anthropology, history, and education. New York: Cambridge University Press; 2007.

Double Burden of Malnutrition at the Individual Level

The frequent co-occurrence of undernutrition and nutrition-related cardiometabolic risk

Hélène Delisle
Department of Nutrition, Faculty of Medicine, University of Montreal, Quebec, Canada

Key messages

- The phenomenon of the double burden of undernutrition and overnutrition reflects a particularly rapid nutrition transition in low-income countries, with compounded health consequences.
- The term 'dysnutrition' could be used instead of under- and overnutrition to encompass all forms of malnutrition, since for the general population and even for professionals 'malnutrition' usually means global undernutrition, while overnutrition conveys the notion of overeating, which is not always the case.
- The main phenotype of the double burden is the co-occurrence of child stunting/underweight and adult overweight/obesity, at country or household level.
- The double nutritional burden also exists at the individual level in the form of overweight/obesity combined with stunting or micronutrient deficiencies, or else, nutrition-related cardiovascular risk factors other than obesity combined with stunting or micronutrient deficiencies.
- The double nutritional burden needs to be understood and addressed through a life course continuum, and improving diet quality at all ages is crucial.

Background: main features of the double burden of malnutrition

The double burden of malnutrition is defined by the World Health Organization (WHO) as the coexistence of undernutrition along with overweight/obesity or other nutrition-related noncommunicable diseases (NCDs). 'Undernutrition' encompasses stunting, wasting or thinness, as well as specific micronutrient deficiencies. 'Overnutrition' refers primarily to overweight or obesity. Overnutrition-related conditions or cardiometabolic risk factors other than obesity include high blood pressure, hyperglycemia and diabetes and at-risk blood lipid profile. These conditions cluster as the metabolic syndrome.

The dichotomy of undernutrition- and overnutrition-related conditions is no longer relevant. Nutrition-related NCDs such as diabetes and cardiovascular disease (CVD) are rapidly rising everywhere while undernutrition is still highly prevalent, particularly in low-income countries or regions. Urbanization as a major driver of the nutrition transition is occurring most rapidly in low-income countries, and this very rapid nutrition transition is largely responsible for the double burden now observed.[1] Food system and environmental changes are undoubtedly a major culprit.

> "Urbanization as a major driver of the nutrition transition is largely responsible for the double burden now observed"

Undernutrition- and overnutrition-related conditions are not as antithetical as they may appear. There is a biological link between undernutrition *in utero* or in infancy and the risk of obesity, diabetes and hypertension later on in life, according

A busy street in Ghana

to the theory of developmental origins of chronic diseases that evolved from the Barker hypothesis.[2] The theory provides one explanation for the co-occurrence of, say, stunting and obesity within individuals. Similarly, at household level, mothers are more prone to be overweight or obese in an obesogenic environment, particularly if they themselves had stunted growth, which in turn restricts fetal growth and may result in stunting in their progeny.

Instead of speaking of the double burden of 'malnutrition,' we advocate the use of the double burden of 'dysnutrition' to encompass both undernutrition and overnutrition[3] for two main reasons:

1. For the general population, and even for professionals, 'malnutrition' usually means global undernutrition. For instance, the strategy of community management of acute malnutrition (CMAM) only refers to undernutrition; and
2. 'Overnutrition' is a misnomer, since excess intake of some macronutrients is often combined with inadequate intake of micronutrients and since nutrition-related NCD risk is not forcibly linked with overeating and obesity, while this is conveyed by the term 'overnutrition.'

The double nutritional burden is observed at country, household and individual level. The principal phenotypes that have been studied are the following:

- Overnutrition and undernutrition at country level, usually in the form of a ratio, whether considering all age groups or only obesity in adults and undernutrition in children.[4,5] Global ratios are of the order of 4, and as expected, the ratios are much lower in low-income compared to middle- or higher-income countries, ranging from 1.1 to 15.6.
- Overweight/obesity in adults and stunting or underweight in under-5 children, at household level. The combination of an overweight mother with an undernourished child (stunted or underweight) has been most studied.[6]
- Obesity and anemia at individual level in adults, primarily in women. Three components of the double burden in households and individuals of sub-Saharan Africa were examined in the light of Demographic and Health Survey (DHS) data, anemia and overweight in women and stunting in under-5 children.[1] Both types of double burden were more prevalent in urban and peri-urban areas, although the odds of maternal anemia and of child stunting were higher in rural areas.

A growing issue is now the 'triple threat' of stunting, anemia and obesity, whether at the population or individual level, as revealed in a preview of the 2018 Global Nutrition Report.[a] Perhaps with the exception of obesity combined with anemia in women, the double nutritional burden at the individual level has been little studied and is less well understood than that ob-

served at country or household level. The present paper focuses on the double nutritional burden within individuals.

"A growing issue is now the 'triple threat' of stunting, anemia and obesity"

The double burden at the individual level

Various phenotypes may be observed at the individual level, including the co-occurrence of obesity with stunting or micronutrient deficiencies and the combination of undernutrition (stunting, underweight or micronutrient deficiencies) with markers of CVD risk other than obesity.

Co-occurrence of stunting and obesity

This phenotype of the double nutritional burden has been studied particularly among children.[7] It was first reported in Latin America and in Chile, where it was observed that between 1987 and 2002, the association of child stunting with obesity increased faster than that of child tallness and obesity, reflecting the nutrition transition.[8]

Children may be at the same time stunted and overweight/obese for several reasons. Their diet may be deficient in those nutrients required for growth in height, for instance the type 2 nutrients according to Golden (e.g., protein and zinc), while providing excessive amounts of energy. Another explanation is that stunting dates back to undernutrition *in utero* or in early infancy without catch-up growth before the age of two years. It is now well established that early undernutrition increases subsequent risk of obesity, particularly abdominal obesity and NCDs.[9]

Even during childhood and not only during adolescence and adulthood, stunting was associated with higher blood pressure, as shown in Brazilian children.[10] Stunted children have proportionally more body fat and less muscle mass, possibly owing to impaired fat oxidation.[11]

Childhood undernutrition and adult 'overnutrition' are to be understood as a continuum, the former programming the latter. A review of cohort studies in low- and middle-income countries (LMICs) showed that a higher birthweight combined with higher linear growth in the first two years of life resulted in significant adult height gains and conferred some protection against NCDs.[12] Conversely, lower birthweight and poor neonatal growth are associated with lower lean body mass in adulthood.[14] This suggests that suboptimal lean body mass associated with undernutrition early in life may predispose to fat accretion, and it can explain why higher birthweight is associated with lower CVD risk.

Obesity associated with micronutrient deficiencies

Obesity alters a number of metabolic pathways, and it is therefore not surprising that it is associated with poor status in several micronutrients. Obesity and anemia are causally related, but this may not be the case for other obesity-associated micronutrients. Obesity-linked inflammation impairs iron absorption, through its stimulation of the synthesis of hepcidin, which regulates iron absorption. In Mexico, for example, based on a national nutrition survey, it was shown that obese women and children were at increased risk of iron-deficiency anemia owing to inflammation; iron intake of non-obese and obese subjects was not different.[14] The within-subject double burden of obesity and anemia exacerbates the gender inequalities, as both conditions are more highly prevalent in women than in men, as shown in North and West Africa.[15–17]

Obesity has been reportedly associated with other micronutrient deficiencies, including zinc, vitamin A and vitamin D.[7] Relative to vitamin A deficiency, obesity would lead to reduction of tissue but not circulating levels of the vitamin.[18] As regards vitamin D status, a graded and inverse relationship with body mass index (BMI) has been reported.[19] This is not unrelated to unfavorable metabolic phenotypes (insulin resistance, type 2 diabetes and CVD) that have been observed in vitamin D deficiency or suboptimal status as evidenced by low serum 25(OH) D concentrations. It has been suggested that vitamin D is sequestered in body fat compartments, leading to its reduced utilization.[19] In populations where these nutrients are in short supply, obesity may exacerbate the deficiencies.

Undernutrition and diabetes

WHO used to recognize a distinct type of diabetes associated with undernutrition, but this category no longer exists. However, reports from Ethiopia[20] and India[21] showed that undernutrition was present in a high proportion of young insulin-dependent diabetic subjects and called for reopening the case of malnutrition-related diabetes. It should also be remembered here that fetal or infancy undernutrition is associated with a higher risk of diabetes in adulthood, owing to the developmental origins of chronic disease.[2]

"The double nutritional burden may also take other forms in which undernutrition combines with nutrition-related cardiometabolic disease or risk markers, but in the absence of obesity"

Micronutrient deficiencies such as vitamin E, zinc and vitamin D have been postulated to contribute to, or be associated with, diabetes. However, whether the deficiency or suboptimal status is causally related to the disease or is only associated with it is not as yet unraveled. Supplements of vitamin E[22] and zinc[23,24] improved the metabolic control of diabetes, and zinc supplements also improved the lipid profile and blood pressure. Vitamin B_{12} deficiency has also been suspected, but there is only very limited evidence that this deficiency predisposes to diabetes or CVD.[25]

Co-occurrence of stunting and cardiometabolic risk other than obesity

Without corrupting the concept, the double nutritional burden may also take other forms in which undernutrition combines with nutrition-related cardiometabolic disease or risk markers, but in the absence of obesity. This is so for undernutrition-related diabetes. As mentioned above, even mild stunting was associated with higher blood pressure in children and adolescents of a low-income region of Brazil.[10] The stunted subjects also had higher levels of body fat than non-stunted subjects.[26] In urban Burkina Faso, our group showed that the double nutritional burden was widespread even among adults exempt from a prior diagnosis of diabetes or CVD. More than 20% of the subjects presented at least one deficiency sign and one cardiometabolic risk marker.[17] The undernutrition signs were low BMI, iron deficiency or anemia and low serum retinol; the nutrition-related CVD risk markers were those of the metabolic syndrome. Of concern, the double burden was more frequent in women than in men, and in subjects of lower rather than upper socioeconomic status.

Poor antioxidant nutrient status and CVD

Food antioxidants, which include vitamins C, D and E, as well as other phytoactive substances not considered as vitamins such as carotenoids and flavonoids, increase serum antioxidant activity and decrease oxidative stress, thereby protecting against cancer and CVD. Not all antioxidants have the status of nutrients, however, which requires that they be defined with a dietary reference intake.[27] Further research is needed to uncover the optimal intake and circulating levels of antioxidants to act against CVD and other NCDs so that they acquire the nutrient status.

Supplements of various antioxidants have been shown to reduce CVD risk. However, the positive effect of supplements does not mean that the study subjects were deficient: low status for a given micronutrient is distinct from a deficiency status. Optimal micronutrient intake, supplement dosage, or circulating levels may still be undefined.

It is puzzling that the positive effects of antioxidants are primarily observed when these are ingested in foods or beverages, in particular fruits and vegetables, while supplements have generally not proved effective.[28] Low intake of fruits and vegetables could be regarded as a deficiency state of a sort.

The association of vitamin C with CVD risk has been the subject of several studies.[29] A better vitamin C status was linked in some studies to improvements in lipid profiles, arterial stiffness and endothelial function, while other studies have not confirmed these results. However, dietary but not supplementary vitamin C was inversely related to CVD. Similarly, in the CARDIA longitudinal study, dietary and plasma vitamin C were inversely related to high blood pressure while supplemental vitamin C was not.[30]

A low Omega-3 Index (blood levels of EPA + DHA in erythrocytes) has also been found to be associated with CVD risk.[31] However, the effects of supplements and the connection of dietary omega-3 fatty acids with blood levels have been inconsistent, owing primarily to variations in bioavailability and baseline status.

Similarly, low vitamin D status was found to be associated with CVD risk and with the metabolic syndrome, but the effects of supplements were not conclusive.[32,33]

Deficiencies of vitamins involved in one-carbon metabolism and CVD

DNA methylation is the principal epigenetic mechanism through which environmental factors such as diet may impact or prevent CVD.[34] S-adenosyl methionine is the methyl donor molecule the production of which is affected by several nutrients including amino acids and vitamins, particularly folate, vitamin B_{12} and vitamin B_6. Folate and vitamin B_{12} are involved in the conversion of homocysteine to methionine. Homocysteine is also converted to cysteine and vitamin B_6 is required as coenzyme. It has therefore been speculated that a deficiency in one of these nutrients would lead to high circulating homocysteine, and affect DNA methylation and thereby CVD.[35] In vitamin B_{12} deficiency with adequate folate status, folate becomes trapped in 5-methyl tetrahydrofolate (5-MTHF) and cannot participate in further reactions. High levels of circulating homocysteine (and low folate) have been suspected of contributing to CVD and have been observed in prediabetics.[36]

The principal phenotypes of the double nutritional burden at the individual level that were described above are summarized in Table 1.

Conclusion: Implications for action

Not all individuals respond similarly to similar diets and lifestyles given the influence of genetic and epigenetic factors, as well as the microbiota. Nonetheless, diet quality is at the core of obesity and the dual burden of malnutrition,[37] and therefore improving diet quality appears crucial in all age groups. The interrelationships of dietary components with epigenetic changes and CVD risk require further research, however.

TABLE 1: Principal phenotypes of the double nutritional burden at the individual level

Undernutrition, suboptimal nutrient status	Combined with:
Undernutrition: stunting	> Obesity
	> High blood pressure
Undernutrition: stunting or underweight	> Diabetes
Iron-deficiency anemia	> Obesity
Other micronutrient deficiencies	
Low status for antioxidant nutrients	> Higher CVD risk – metabolic syndrome
Low status for vitamins involved in one-carbon metabolism	

Schoolchildren involved in the NFSI program in Cotonou, Benin

> "Diet quality is at the core of obesity and the dual burden of malnutrition, and therefore improving diet quality appears crucial in all age groups"

Much like for understanding the double nutritional burden, a life-course approach is required for appropriate action, with interventions targeting all age groups. Strategies to address the double burden, including WHO's 'double duty,' were discussed in other papers. The fact that higher birthweights and improved linear growth during the first two years of life are associated with gains in adult height (and schooling) and confer some protection against NCDs[12] supports the present focus on the first 1,000 days, from conception to the age of two years. School-age children are also a priority target group, and the Nutrition-Friendly School Initiative (NFSI) advocated by WHO as a means of preventing the double nutritional burden is also highly relevant, as we showed in capital cities of Burkina Faso and Benin, although on a small scale.[38,39]

Correspondence: ***Hélène Delisle,***
Department of Nutrition, Lilian-Stewart Building,
University of Montreal, PO Box 6128, Downtown Station,
Montreal, QC, Canada, H3C 3J7
Email: *helene.delisle@umontreal.ca*

References

01. Jones AD, Acharya Y, Galway LP. Urbanicity gradients are associated with the household and individual level double burden of malnutrition in sub-Saharan Africa. J Nutr. 2016;146(6):1257–67.
02. Barker DJP. Mothers, babies and health in later life. 2nd ed. Edinburgh: Churchill Livingstone; 1998.
03. Delisle H, Receveur O. Les « dysnutritions » dans les pays en développement [letter]. CMAJ. 2007;176(1):65.
04. Min J, Zhao Y, Slivka L, Wang Y. Double burden of diseases worldwide: coexistence of undernutrition and overnutrition-related non-communicable chronic diseases. Obes Rev. 2018;19(1):49–61.
05. Abdullah A. The double burden of undernutrition and overnutrition in developing countries: an update. Curr Obes Rep. 2015;4(3):337–49.
06. Kosaka S, Umesaki M. A systematic review of the prevalence and predictors of the double burden of malnutrition within households. Brit J Nut. 2017;117(8):1118–27.
07. Tzioumis E, Adair LS. Childhood dual burden of under- and over-nutrition in low- and middle-income countries:a critical review. Food Nutr Bull. 2014;35(2):230–43.
08. Kain J, Uauy R, Lera L, Taibo M, Albala C. Trends in height and BMI of 6-year-old children during the nutrition transition in Chile. Obesity Res. 2005;13(12):2178–86.
09. Black RE, Victora G, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income

and middle-income countries. Lancet. 2013;382(9890):427–51.
10. Clemente AP, Santos CD, Silva AA, Martins VJ, Marchesano AC, Fernandes MB, et al. Mild stunting is associated with higher blood pressure in overweight adolescents. Arq Bras Cardiol. 2012;98(1):6–12.
11. Hoffman DJ, Sawaya AL, Verreschi I, Tucker KL, Roberts SB. Why are nutritionally stunted children at increased risk of obesity? Studies of metabolic rate and fat oxidation in shantytown children from Sao Paolo, Brazil. Am J Clin Nutr. 2000;72(3):702–7.
12. Adair LS, Fall CHD, Osmond C, Stein AD, Martorell R, Zea MR, et al. Associations of linear growth and relative weight gain during early life with adult health and human capital in countries of low and middle income: findings from five cohort studies. Lancet. 2013;382(9891):525–24. Epub 2013 March 28.
13. Kulkarni B, Hills AP, Byrne NM. Nutritional influences over the life course on lean body mass of individuals in developing countries. Nutr Rev. 2014;72(3):190–204.
14. Cepeda-Lopez AC, Osendarp SJM, Melse-Boonstra A, et al. Sharply higher rates of iron deficiency in obese Mexican women and children are predicted by obesity-related inflammation rather than by differences in dietary iron intake. Am J Clin Nutr. 2011;93(5):975–83.
15. Traissac P, El Ati J, Gartner A, Ben Gharbia H, Delpeuch F. Gender inequalities in excess adiposity and anaemia combine in a large double burden of malnutrition gap detrimentaion to women in an urban area in North Africa. Pub Health Nut. 2016;19(8):1428–37.
16. Delisle H, Batal M. The double burden of malnutrition associated with poverty [letter]. Lancet 2016;387(10037):2504–5.
17. Zeba A, Delisle H, Renier G, Savadogo B, Banza B. The double burden of malnutrition and cardio-metabolic risk widens the gender and socioeconomic health gap: a study among adults in Burkina Faso (West Africa). Public Health Nutr. 2012;15(12):2210–9.
18. Trasino SE, Tang XH, Jessurun J, Gudas L. Obesity leads to tissue, but not serum vitamin A deficiency. Sci Rep. 2015;5:15893.
19. Pourshahidi LK. Vitamin D and obesity: current perspectives and future directions. Proc Nutr Soc. 2015;74(2):115–24.
20. Alemu S, Dessie A, Seid E, Bard E, Lee PT, Trimble ER, et al. Insulin-requiring diabetes in rural Ethiopia: should we reopen the case for malnutrition-related diabetes? Diabetologia. 2009;52(9):1842–5.
21. Maiti S, Khan NKM, Chattopadhyay JC. Diabetes in rural individuals of different nutritional status and the alarming situation demands focus more on its under-nutrition association. Arch Physiol Biochem. 2015;121(1):26–31.
22. Balbi ME, Tonin FS, Mendes AM, Borba HH, Wiens A, Fernandez-Llimos F, et al. Antioxidant effects of vitamins in type 2 diabetes: a meta-analysis of randomized controlled trials. Diabetol Metab Syndr. 2018;10:18.
23. Jayawardena R, Ranasinghe P, Galappatthy P. Effects of zinc supplementation on diabetes mellitus:a systematic review and meta-analysis. Diabetol Metab Syndr. 2012;4(1):13.
24. Ranasinghe P, Pigera S, Galappatthy P, Katulanda P, Constantine GR. Zinc and diabetes mellitus: understanding molecular mechanisms and clinical implications. J Pharmaceut Sci. 2015;23:44.
25. Rafnsson SB, Saravanan P, Bhopal RS, Yajnik CS. Is a low blood level of vitamin B12 a cardiovascular and diabetes risk factor? A systematic review of cohort studies. Eur J Nutr. 2011;50(2):97–106.
26. Clemente APG, Santos CD, Martins VJB, Silba AA, Albuquerque MP, Sawaya AL. Mild stunting is associated with higher body fat: study of a low-income population. J Pediatr (Rio J). 2011;87(2):138–44.
27. Morley JE. Vitamins: the good, the bad, and the ugly. J Am Med Dir Assoc. 2014;15:229–31.
28. Pellegrino D. Antioxidants and cardiovascular risk factors. Diseases. 2016;4(1):11.
29. Moser MA, Chun OK. Vitamin C and heart health: a review based on findings from epidemiologic studies. Int J Mol Sci. 2016;17(8). doi: 1328;doi:10.3390/ijms17081328.
30. Buijsse B, Jacobs DR, Steffen LM, Kromhout D, Gross MD. Plasma ascorbic acid, a priori diet quality score, and incident hypertension: a prospective cohort study. PLOS ONE. 2015;10(12):e0144920.
31. Von Schacky C. Omega-3 index and cardiovascular health. Nutrients. 2014;6(2):799–814.
32. Fry CM, Sanders TAB. Vitamin D and risk of CVD: a review of the evidence. Proc Nutr Soc. 2015;74(3):245–57.
33. Pannu PK, Zhao Y, Soares MJ, Piers LS, Ansari Z. The associations of vitamin D status and dietary calcium with the metabolic syndrome: an analysis of the Victorian Health Monitor Survey. Pub Health Nutr. 2017;20(10):1785–96.
34. Kalea AZ, Drosatos K, Buxton JL. Nutriepigenetics and cardiovascular disease. Curr Opin Clin Nutr Metab Care. 2018;21(4):252–59.
35. Glier MB, Green TJ, Devlin AM. Methyl nutrients, DNA methylation and cardiovascular disease. Mol Nutr Food Res. 2014;58(1):172–82.
36. Martí-Carvajal AJ, Solà I, Lathyris D, Dayer M. Homocysteine-lowering interventions for preventing cardiovascular events (Review). Cochrane Database of Syst Rev. 2017;8:CD006612.
37. Romieu I, Dossus L, Barquera S, Blottière HM, Franks PW, Gunter M, et al. Energy balance and obesity: what are the main drivers? Cancer Causes Control 2017;28(3):247–58.
38. Delisle H, Receveur O, Agueh V, Nishida C. Pilot-testing of the Nutrition-Friendly School Initiative in West Africa in Ouagadougou (Burkina Faso) and Cotonou (Benin). Glob Health Promot. 2013;20(1):39–49.
39. Elkhoury Edde C, Delisle H, Dabone C, Khatchab Z, Batal M. Impact of the Nutrition-Friendly School Initiative: Analysis of anthropometric and biochemical data among school-aged children in Ouagadougou. Global Health Prom. (in press).

Notes

[a] www.devex.com/organizations/food-and-agriculture-organization-of-the-united-nations-fao-44117

From *What* to *How*

The role of double-duty actions in addressing the double burden

Corinna Hawkes
Centre for Food Policy, City, University of London, UK

Key messages

- Data on, and knowledge of, the different forms of malnutrition have grown, but the resources to address them have not grown in the same proportion.
- Double-duty actions are a potentially cost-effective way of reducing the risk of both nutrient deficiencies and overweight and obesity and nutrition-related noncommunicable diseases at the same time.
- Delivering double duty requires a change of mindset from thinking about different forms of malnutrition as separate problems with separate solutions to implementing actions with the goal of improving nutritional status overall, for now and in the future.
- As a first step, all countries and stakeholders should look to where they are already allocating resources to tackle malnutrition and assess how these policies, programs and actions can work double duty.

The world has known about the double burden of malnutrition for a long time. The question now is: what do we do about it? And *how*? On the 'what,' there is no shortage of solutions to the various manifestations of malnutrition, whether it's about treating children who are underweight for their age or not growing properly, tackling micronutrient deficiency and underweight among adults, or addressing obesity and other diseases and conditions associated with eating an unhealthy diet. Globally and nationally, there is increasing recognition of the need to address the different forms. The Sustainable Development Goals call for an end of malnutrition in *all* its forms. At a national level, 84% of countries are now reported to have targets for adult overweight and obesity alongside targets for undernutrition (e.g., 58% of countries have targets for stunting).[1] More countries have developed action plans designed to address the double burden. Tanzania's National Multisectoral Nutrition Action Plan (2016–21), for example, is designed to do "double action" to "address both undernutrition and the prevention and control of the burden of diet-related noncommunicable diseases (NCDs) such as overweight and obesity."[2]

> "As the recognition of the different forms of malnutrition has grown, the financial resources available have not"

But there is a challenge here: as the recognition of the different forms of malnutrition has grown, the financial resources available have not. In the case of Tanzania, it is reported that just 40% of the program costs in the plan are funded – and the parts of the plan focusing on obesity and NCDs are not.[1] Overall, it is not at all clear *if* and *how* actions designed to address overweight and obesity are costed in national nutrition plans in double-burden countries.[3] To some extent, this is a matter of prioritization. As put by the Scaling Up Nutrition Movement, "where prioritization is present within a [nutrition] plan, implementation can be more clearly directed and the costing process is more realistic."[3] In this framing, it makes sense that a country like Ethiopia – with a 51% stunting rate in 2005 – would allocate far more to undernutrition.[4] In 2008, three of the country's top budget allocations to nutrition were nutrition in social protection (US$89.7 million), nutrition-sensitive agriculture ($43.0 million) and school nutrition (US$36.4 million).[5] In contrast, there was no budget for improving the delivery of services for nutrition-related NCDs. Likewise, it makes sense that in 2016, the largest single overseas development donor to nutrition-related NCDs was the government of Australia (US$ 8.7 million in 2016), since it largely funds programs in the Pacific Islands where the burden of obesity and diabetes is among the highest in the world.[6]

But this is where double-duty actions come in. For if history is anything to go by, Ethiopia's obesity problem will only get worse.[7] The Pacific Islands were not always, after all, plagued by

Children in Ethiopia, where tackling undernutrition is a budget priority

these conditions. While undernutrition has been around a long time, the 'nutrition transition' to obesity and nutrition-related NCDs is creeping up everywhere. We only have to look to Latin America to see how treating the 'two sides' of the double burden as separate issues allowed this to happen.

> "The 'nutrition transition' to obesity and nutrition-related NCDs is creeping up everywhere"

This struck me forcefully back in 2005 when attending the United Nations System Standing Committee on Nutrition (UN-SCN) conference on the double burden of malnutrition. The 10th Abraham Horwitz lecture that year – a lecture with the goal of mentoring young talent – was given by the now leading Chilean epidemiologist, Dr Camila Corvalán. Latin America, she said, was doing "nothing or next to nothing" to respond to the nutrition transition.[8] Moreover, she said, "programs which in the past were successful in decreasing nutritional deficiencies may unintentionally contribute to the increasing obesity rates if they are not adequately adapted." Citing evidence from an article published in 2002 by Professors Ricardo Uauy and Juliana Kain,[9] she described how the Chilean National Nursery Schools Council Program (JUNJI) established in 1971 to provide food (along with childcare) to address undernutrition, was likely culpable in overfeeding. But, she noted:

> *"Increasing food security need not imply increasing obesity. In fact, if we take a different perspective, nutrition-assistance programs can become a central and promising way to respond to the challenges associated with the nutrition transition if the energy and micronutrient content of the food is carefully determined and physical activity and healthy behaviors are encouraged. [This represents] a more cost-effective alternative than starting from zero because they already have material and human resources that ensure their functioning."*[8]

And that's exactly what double-duty actions seek to do: maximize the benefits of existing efforts and minimize the risks to simultaneously tackle both nutrient deficiencies and overweight and obesity/diet-related (DR) NCDs.[10,11] Key to the idea is to build on the human and material resources already available. If we go back to Ethiopia again, we can see how this could play out in practice: three of the country's top spending priorities – nutrition in social protection, nutrition-sensitive agriculture and school nutrition – could be tweaked to act double duty.[5] Taking the case of school nutrition, programs that supply in-school meals, snacks, or take-home rations could be designed to address all forms of malnutrition: sufficient in energy, rich in micronutrients, but mod-

Wall art from a street in Colombia

erate in fats, sugars and salt.[12,13] Yet at the moment, it is reported that school feeding programs in low- and middle-income countries rarely set standards for nutritional quality from an NCD perspective, and do little to address the growing availability of junk food sold around schools.[14,15] The fact this did not happen earlier in North America and Europe left these countries scrambling around to introduce school food standards when it was too late.

In the case of social protection, examples from Latin America indicate that adding in effective educational and behavior change components, and taking action simultaneously to make junk food less easily available and appealing, could make them doubly effective – and indeed, without this, they may present risks for obesity.[16] Agricultural development programs, too, could bring positives for the double burden, given that they can improve household and individual access to nutrient-rich foods.[17] But they would need to be tailored to this goal and the growth of unhealthy food environments tackled as part of the same package. Other obvious candidates for double duty include actions to protect and promote breastfeeding (since it brings benefits for undernutrition, obesity and NCDs) and to improve early child nutrition (since they benefit undernutrition at the time and obesity and NCDs later in life).[18]

"What these actions do is to leverage the common causes of the double burden"

What these actions do is to leverage the common causes of the double burden. That there are common causes has been known a long time, as highlighted by Dr Corvalán back in 2005. Even further back, in 1992, a paper prepared for the International Conference on Nutrition noted that improvements in nutritional problems associated with both insufficiency and excess will depend on "people having access to a variety of safe affordable foods, understanding what constitutes an appropriate diet and knowing how to best meet their nutritional needs from available resources."[19]

Double-duty actions aim to tackle the deadly combination of insufficiency overlapping with excess. For while people may suffer the disadvantage of excess, they are not necessarily getting enough micronutrients or foods known to support good health.[6] As reported in the 2018 Global Nutrition Report this year, the proportion of babies who are exclusively breastfed still only stands at 41%, while sales of infant formula are growing rapidly.[1] Fewer than one in five children (16%) aged 6 to 23 months eat a minimally acceptable diet. One-third (33%) of school-aged children do not eat any fruit daily, yet 53% consume soda every day. Adults are eating too many refined grains and sugary foods and drinks, and not enough fruits, vegetables, legumes and whole grains.

There is a lot of work to do, and the double-duty idea centers on the belief that it is more efficient to deal with the problems together. This framing does not preclude prioritization – it means simply that priority actions are designed to deliver more.

A participant in the Goroka Show, Papua New Guinea. What do we do about the double burden – and *how*?

Nor does it apply only to the combination of nutritional deficiencies with obesity and nutrition-related NCDs, but also to the overlap between any forms of malnutrition, such as wasting and stunting.[20]

"Acting double duty is not rocket science – it is common sense"

Acting double duty is not rocket science – it is common sense. Fortunately, we are beginning to see signs that this more holistic vision is being translated into planning. For example, the Action Plan to Reduce the Double Burden of Malnutrition (2015–20) in the WHO Western Pacific Region is based on the recognition that there are common conditions that could improve both aspects of the double burden.[21] But delivering change in practice will be tough, for it will require a change in the way we work: policies and practices will need to focus less on tackling a specific form of malnutrition and focus more on improving nutritional status overall, for people and populations, for now and into the future.

So, in answer to the question 'What do we do about the double burden – and how?' there is a clear first step. All countries and stakeholders should look to where they are already allocating resources to tackle malnutrition and should assess how these policies, programs and actions can work double duty. What do you have to lose?

Correspondence: ***Corinna Hawkes,***
Centre for Food Policy, City, University of London, Northampton Square, London EC1V OHB, UK
Email: *corinna.hawkes@city.ac.uk*

References

01. Development Initiatives. 2018 Global nutrition report: shining a light to spur action on nutrition. Bristol, UK: Development Initiatives; 2018.
02. United Republic of Tanzania, Prime Minister's Office. National Multisectoral Nutrition Action Plan (NMNAP) for the period July 2016–June 2021. Dar es Salaam: Government of Tanzania; 2016.
03. Scaling Up Nutrition. Planning and costing for the acceleration of actions for nutrition: experiences of countries in the Movement for Scaling Up Nutrition. Geneva: Scaling Up Nutrition; 2014.
04. Global Nutrition Report. Nutrition country profile: Ethiopia. 2017. Internet: globalnutritionreport.org/wp-content/uploads/2017/12/gnr17-Ethiopia.pdf (accessed 22 October 2018).
05. Federal Democratic Republic of Ethiopia, Ministry of Health. Tracking funding for nutrition in Ethiopia across sectors. Addis Ababa: Federal Democratic Republic of Ethiopia. 2017.
06. Parry J. Pacific islanders pay heavy price for abandoning traditional diet. Bull World Health Organ. 2010;88(7):484.
07. Mekonnen T, Tariku A, Abebe SM. Overweight/obesity among school aged children in Bahir Dar City: cross sectional study. Ital J Pediatr. 2018 Jan 23;44(1):17.
08. Corvalan C. Latin America: Avoiding the nutrition transition 'trap.' 10th Dr Abraham Horwitz Lecture. In: UNSCN (UN Standing Committee on Nutrition). Tackling the Double Burden of Malnutrition. Geneva: UNSCN; 2016: 38–45. [SCN News 32.]
09. Uauy R, Kain J. The epidemiological transition: need to incorporate obesity prevention into nutrition programs. Public Health Nutr. 2002; 5(1A):223–9.
10. IFPRI. 2015 Global nutrition report: actions and accountability to advance nutrition and sustainable development. Washington, DC: IFPRI; 2015.
11. Hawkes C, Haddad L. The challenge to nutrition researchers everywhere: identify a set of actions that reduce malnutrition in all its forms. 13 October 2015. Lancet Global Health blog. Internet: globalhealth.thelancet.com/2015/10/13/challenge-nutrition-researchers-everywhere-identify-set-actions-reduce-malnutrition-all (accessed 22 October 2018).
12. Hawkes C. Public procurement: a double duty action to address obesity and undernutrition. October 2015. Internet: www.worldobesity.org/news/wo-blog/october-2015/pp-double-duty-action-address-obesity-and-undernutrition/ (accessed 22 October 2018).
13. Hunter D, Giyose B, PoloGalante A, Tartanac F, Bundy D, Mitchell A, et al. Schools as a system to improve nutrition: a new statement for school-based food and nutrition interventions. Rome: UNSCN; 2017.
14. Aliyar R, Gelli A, Hamdani SH. A review of nutritional guidelines and menu compositions for school feeding programs in 12 countries. Front Public Health. 2015 Aug 5;3:48.
15. FAO. School feeding and possibilities for direct purchases from family farming. Santiago: FAO; 2015.
16. Fernald LCH, Gertler PJ, Hou X. Cash component of conditional cash transfer program is associated with higher body mass index and blood pressure in adults. J Nutr. 2008;138(11):2250–7.
17. Ruel MT, Quisumbing AR, Balagamwala M. Nutrition-sensitive agriculture: what have we learned so far? Glob Food Sec. 2018;17:128–53.
18. WHO. Double-duty actions for nutrition. Geneva: WHO; 2017.
19. FAO, WHO. Major issues for nutrition strategies. Papers prepared for the FAO/WHO International Conference on Nutrition (ICN), Rome, December 5–11. Geneva/Rome: WHO/FAO; 1992.
20. Khara T, Mwangome M, Ngari M, Dolan C. Children concurrently wasted and stunted: a meta-analysis of prevalence data of children 6–59 months from 84 countries. Matern Child Nutr. 2018 Apr;14(2):e12516.
21. WHO Regional Office for the Western Pacific. Action plan to reduce the double burden of malnutrition in the Western Pacific Region. Manila: WHO Regional Office for the Western Pacific; 2015.

Maximizing the Potential of Multisectoral Nutrition Policies for Double-duty Actions

Thahira Shireen Mustafa
Formerly with the Scaling Up Nutrition (SUN) Movement, Geneva, Switzerland

Key messages

- Multisectoral policy frameworks in countries remain underutilized to address the double burden of malnutrition and need to be strengthened with the implementation and scaling up of double-duty actions.
- Coordination mechanisms for nutrition have increased at the national level, but the reporting of comprehensive engagement with identified specific line ministries for coordination of nutrition activities has decreased.
- SUN Movement member countries have the advantage of leveraging the potential of existing coordination structures for nutrition that can be strengthened to deliver double-duty actions integrated across sectors, however this opportunity remains underutilized and still needs to be fully seized to address all forms of malnutrition.

BOX 1

Multisectoral nutrition planning is the application of a systematic multidisciplinary planning to produce a combination of nutrition policy or project interventions in several development sectors. When well operated and coordinated, these initiatives could be effective in reducing malnutrition by treating the problem holistically, with a unified multisectoral approach.

(IFPRI, 2011)

The breaking dawn of multisectoral nutrition planning[1] occurred in the early 1970s with the new coordinated thinking to combat malnutrition (Box 1). Although attractive and ambitious then, the concept seemed to slip through the cracks as policymakers did not realize the full potential of intersectoral initiatives.[2] Four decades later, the nutrition community has come a long way in emphasizing the need for multiple stakeholders across sectors to collaborate for designing, implementing and monitoring joint solutions to ensure improvements in nutrition. However, there remains the question of whether we have done enough to make multisectoral approaches for nutrition an incentive for sectors to recognize the agenda as their own.

In recent years there has been greater recognition of the importance of multisectoralism for nutrition and its varying benefits. The World Bank identified that multisectoral actions can maximize nutritional outcomes across other sectors by accelerating action on determinants of undernutrition, integrating nutrition considerations into programs in other sectors that may be substantially larger in scale and increasing policy coherence that may have consequences on nutrition.[3] This was further echoed by the 2013 Lancet Series on Maternal and Child Nutrition showing that nutrition-sensitive programs in agriculture, social welfare, early child development and schooling can be successful at addressing several underlying determinants of nutrition by serving as delivery platforms for nutrition-specific interventions, potentially increasing their scale, coverage and effectiveness (Box 2).[4] Recent evidence from carefully designed nutrition-sensitive agricultural programs with explicit nutrition goals and interventions shows a greater impact on household and child dietary diversity and improved consumption of animal-source foods or fruits and vegetables.[5]

Fresh and healthy foods made available, affordable and accessible in Florence, Italy

BOX 2

Nutrition-specific interventions or programs are those that address the immediate determinants of fetal and child nutrition and development – adequate food and nutrient intake, feeding, caregiving and parenting practices and low burden of infectious diseases.

Nutrition-sensitive interventions or programs are those that address the underlying determinants of fetal and child nutrition and development – food security; adequate caregiving resources at the maternal, household and community levels; and access to health services and a safe and hygienic environment – and incorporate specific nutrition goals and actions.

(Ruel and Alderman, 2013)

The Scaling Up Nutrition (SUN) Movement has played a key role in stimulating and reinforcing political interest in nutrition among leaders of governments and development partners alike. The movement has sparked consensus among the global community to embrace the multiple stakeholders' efforts of civil society, donors, United Nations agencies, and the private sector to jointly support the country-led priorities and actions to scale up nutrition. This further renewed the interest for multisectoral strategies to combat undernutrition, focusing especially on the 1,000 day window of opportunity from conception to a child's second birthday, to tackle the underlying causes of malnutrition as well as its direct manifestations.

As of August 2018, 60 countries had signed on as members of the SUN Movement committing to abide by the SUN Movement Principles of Engagement[6] that guide multiple stakeholders from different sectors as they come together to create an enabling environment, change their behaviors, mobilize resources to scale up actions and align implementation efforts to achieve results, ultimately improving the nutritional status of populations and realizing key sustainable development goals through better nutrition. The members of the movement also commit to ensure that programs in all sectors of their governments are designed to result in better nutritional outcomes through enhanced opportunities for the population to diversify their diets, improved access to safe drinking water and sanitation, improved access to health services and better consumer awareness regarding adequate nutrition and child care practices. They are further encouraged and supported to develop multisectoral national nutrition action plans, policies and strategies (hereafter referred to as 'policies').

In May 2012, the World Health Assembly (WHA) adopted a resolution (65.6) that endorsed the Comprehensive Implementation Plan on Maternal, Infant and Young Child Nutrition, which includes six global targets for nutrition to be achieved by the

BOX 3

Global Targets 2025 to improve maternal, infant and young child nutrition

1. 40% reduction in childhood stunting
2. 50% reduction in anemia in women of reproductive age
3. 30% decrease in low birth weight
4. 0% increase in childhood overweight
5. An increase in the rate of exclusive breastfeeding in the first 6 months to at least 50%
6. A reduction in childhood wasting to less than 5%

(WHO, 2012)

year 2025 (Box 3).[7] This and other global calls to action – the Framework for Action adopted at the Second International Conference on Nutrition,[8] the 2030 Agenda for Sustainable Development,[9] and the United Nations Decade of Action on Nutrition for the period of 2016–2025[10] – have enormously contributed to the spree of comprehensive multisectoral nutrition policies that aim to address all forms of malnutrition. These include interventions addressing both the immediate and underlying causes of the problem being developed at the national level by governments to facilitate the integration of nutrition actions across sectoral ministries and development partners.

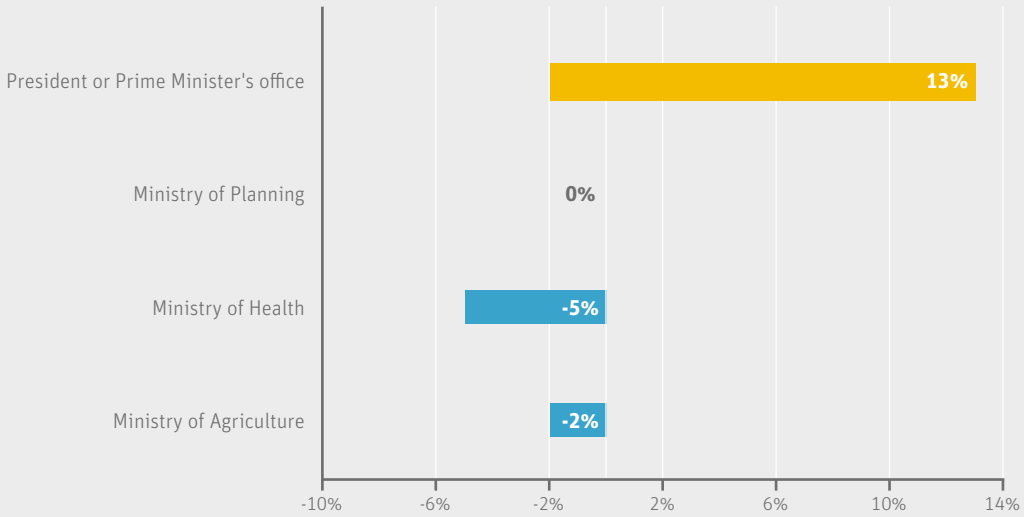
Multisectoral nutrition policies and governance: Status quo

As we are in an era where the global community is faced with the broader challenges of the double burden of malnutrition – characterized by the coexistence of undernutrition (including wasting, stunting and micronutrient deficiencies) along with overweight, obesity, or diet-related noncommunicable diseases (NCDs), it is only fitting that the policy environment is adapted to address this growing concern.

The 2nd Global Nutrition Policy Review conducted by the World Health Organization in 2016–2017 reported that 128 out of 149 countries have comprehensive nutrition policies.[11] This is promising regarding increasing understanding that tackling malnutrition in all its forms and diet-related NCDs requires cross-cutting and holistic government approaches rather than stand-alone sectoral strategies and siloed efforts. A comprehensive multisectoral nutrition policy also has the potential to attract the attention of high-level political leadership to gain ownership of the nutrition agenda, and in turn command resources for effective implementation.

In addition to comprehensive policies, strong nutrition governance in the form of relevant coordination mechanisms such as multisectoral groups or organizations that oversee, coordinate and harmonize the nutrition related activities are conducive to the scaling-up of essential nutrition actions and addressing the double burden of malnutrition. Globally, the number of countries with an established coordination mechanism for nutrition at the national level with a main objective of coordination across

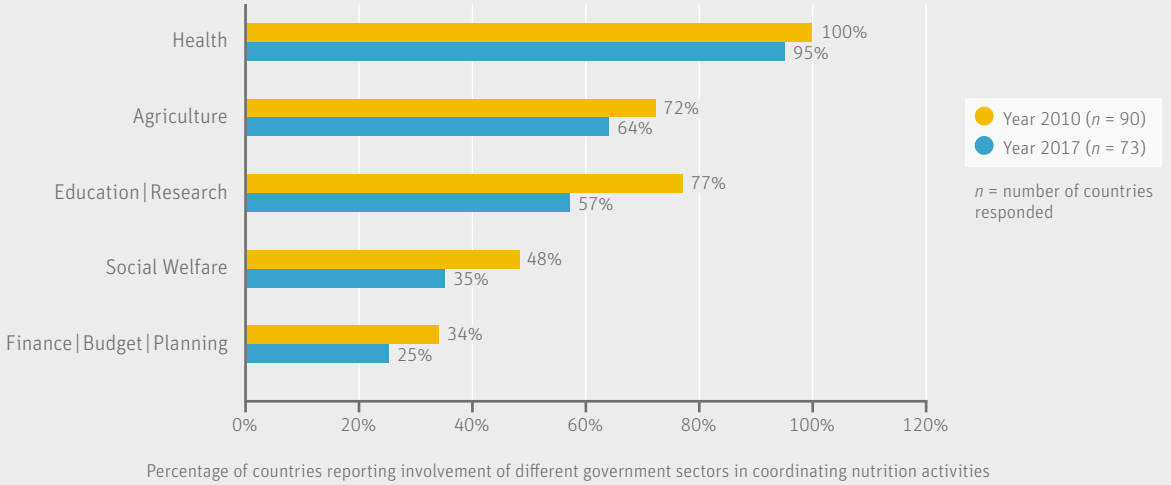
FIGURE 1: Change in coordination mechanisms established for nutrition between 2010 and 2017 (%)



The percentage indicates the difference in location of coordination mechanism for nutrition among the number of countries that responded in 2010 ($n = 90$) and 2017 ($n = 105$)

Source: Adapted from World Health Organization (2018). Global nutrition policy review 2016-2017: Country progress in creating enabling policy environments for promoting healthy diets and nutrition.

FIGURE 2: Multisectoral involvement in nutrition coordination mechanisms in countries



Source: World Health Organization (2018). Global nutrition policy review 2016-2017: Country progress in creating enabling policy environments for promoting healthy diets and nutrition; and World Health Organization (2013). Global nutrition policy review: what does it take to scale up nutrition action?

sectors has grown by 4% since 2013.[11] The strategic positioning of these mechanisms in high governmental offices, such as the president's or prime minister's office, has increased by 13% (Figure 1) and can serve as an enabler to improve the likelihood of positive policy change by building political will and creating synergy across sectors around a common goal for nutrition results rather than competition and prioritization of their own sectoral objectives.[12]

While it may only seem logical that a multisectoral policy environment will translate into a working environment that brings together the sectors for implementation, it may not be so in reality. In recent years, the number of countries reporting the involvement of multiple sectors for coordination of nutrition activities has seen a decrease. Furthermore, it should be concerning that the reported level of sectoral involvement for nutrition (meaning the comprehensive engagement with identified multiple ministries) has decreased since 2013 (Figure 2). This reported decline is a question worth pondering, and an unfortunate trend that needs to be reversed.

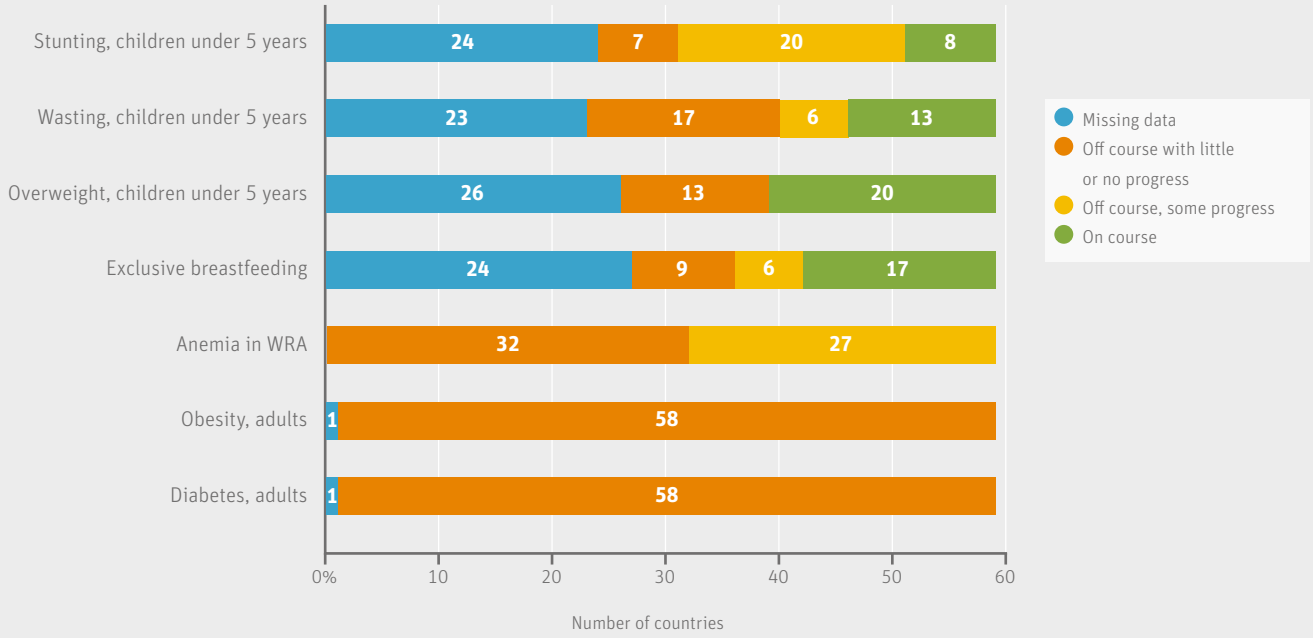
Multisectoral collaboration challenges

The importance of acting across several sectors to improve nutrition outcomes has been long emphasized; however, there is little documented evidence that demonstrates the effectiveness of multisectoral approaches. Well-recognized challenges to implementing multisectoral nutrition approaches exist at the level of individuals, organizations, and the overall system. They include: (1) the capacity constraints in aligning sectoral mandates and funding priorities with nutrition; (2) over-reliance on sectoral focal points to stimulate nutrition sensitivity and institutionalize multisectoral approaches; and (3) dysfunctional coordination structures with a lack of shared vision and commitment to country-centered strategy and ownership of the nutrition agenda.[13]

Researchers have argued that the nutrition community is required to go beyond just creating the understanding that nutrition has multisectoral causes and reinforce the role of incentives that would motivate individuals to step outside their sectors and

Women of reproductive age make use of services including anemia diagnosis and iron and folic acid supplementation in an Anganwadi center in Uttar Pradesh, India

FIGURE 3: Progress by SUN countries in meeting global nutrition targets



WRA = women of reproductive age
Source: Scaling Up Nutrition (SUN) Movement Monitoring, Evaluation, Accountability, Learning (MEAL) 2016 Baseline Report.

promote cross-sectoral collaboration.[1] It requires increased effort and resources for joint goal setting, building capacities in nutrition across sectors, strengthening ownership of nutrition, scaling up of activities and building alliances and systems to support the joint efforts.[14,15]

An in-depth experience documentation of four SUN Movement member countries (Burkina Faso, Ethiopia, Mali and Uganda) showed that multisectoral approaches often provide soft or intangible accomplishments for nutrition. This includes the improvement of the enabling environment through creation or reform of coordinating structures (e.g., national nutrition councils, multisectoral working groups, interministerial committees, etc.), and addition of multisectoral dimensions to pre-existing policies, programs and mandates[13] (e.g., involving new sectors and stakeholders to scale up and strengthen existing nutrition actions and appointing sectoral focal points to coordinate policy implementation). The achievement of tangible outcomes such as improving the nutritional status of the population requires more time and is often not as evident within the limited period of the policy cycle and can create multisectoral coordination fatigue when results are not immediate.[14]

Addressing the double burden in SUN Countries

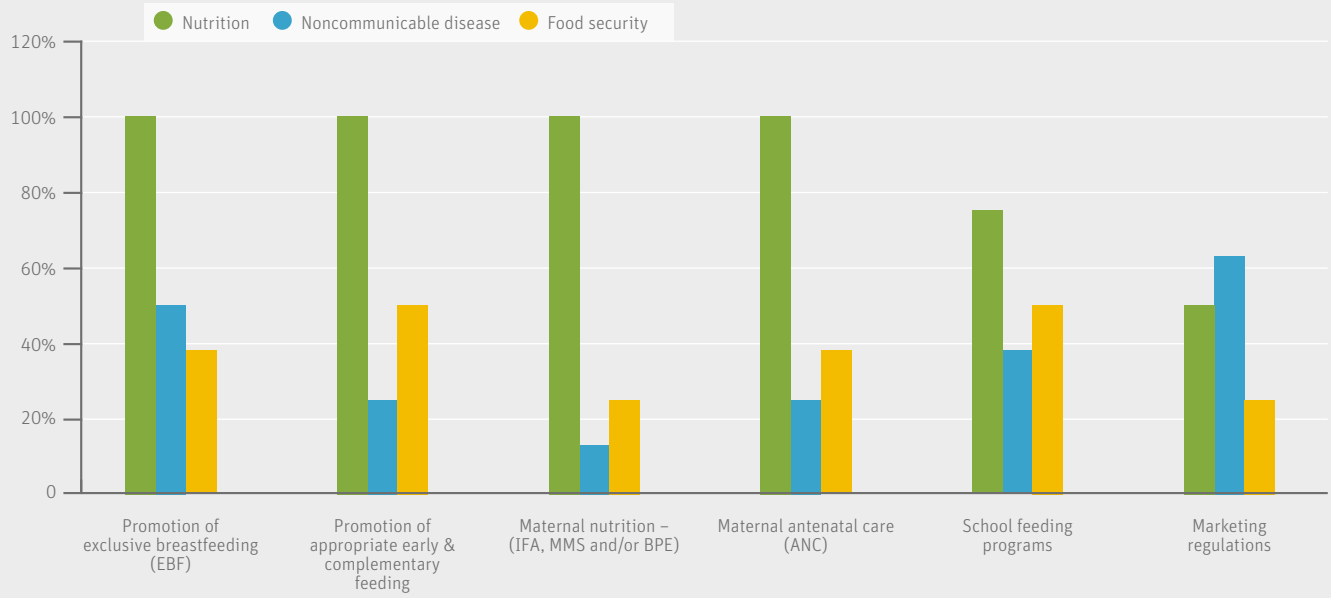
SUN Movement member countries aim to meet the WHA endorsed Global Targets to improve maternal, infant and young child nutrition by 2025, yet many SUN Countries have not yet included these goals in their national policies and strategies. In 2016, 32 of the 57 SUN Countries assessed had explicitly stated one or more of the six global nutrition targets in their national nutrition policy and strategy documents. Only 10 countries have included all the six targets.[16] Nearly 50% of the SUN countries are yet to include the diet-related NCD targets for 2025[17] (a 30% relative reduction in mean population intake of salt/sodium and halting the rise in diabetes and obesity) in their nutrition plans, national development plans and economic growth strategies.[16]

In 2016, only eight SUN Countries were reported to be on course to meet the stunting target, 13 for wasting, 20 for child overweight and 17 for exclusive breastfeeding (**Figure 3**). None of the SUN Countries are on course to reduce anemia among women of reproductive age or halt the rise in adult obesity and diabetes.

Nearly 22 SUN countries are ranked in the top 30 (out of 126 countries globally) for the presence of undernutrition in national development plans and economic growth strategies, compared to only three SUN countries ranked in the top 30 (out of 116 countries) and nearly half ranked in the bottom 30 for the presence of overnutrition in national development plans.[16]

The SUN Movement has placed a greater focus on the enabling environment for nutrition with a wide range of features that relates to broader issues of governance – including the estab-

FIGURE 4: Double-duty actions included in proportion of nutrition, noncommunicable disease and food security policies in selected SUN Movement member countries (n = 8)



* IFA = iron and folic acid, MMS = multiple micronutrient supplementation and BPE = balanced protein–energy

Source: Adapted from SPRING (2018). National Policies and Plans to Address the Dual Burden of Malnutrition: A Multi-country Policy Review.

lishment of coordination structures for nutrition with the active participation of multiple stakeholders from different sectors and the inclusion of relevant goals and targets in national policies to address all forms of malnutrition. Although 85% of the SUN Countries report having coordination structures for nutrition in the form of multistakeholder platforms,[18] currently, the enabling environment in the SUN Movement is still mostly geared towards addressing undernutrition,[16] and more efforts are required to ensure maximum coherence across sectors to tackle the double burden by facilitating cooperation both vertically and horizontally across the multiple actors and levels involved.

While the double burden of malnutrition is largely recognized by governments and nutrition stakeholders across regions, it is key to adapt the current nutrition policies and governance mechanisms to adequately respond to the rising challenges with concrete multisectoral interventions. The World Health Organization recommends the implementation of 'double-duty actions' that are not necessarily new actions but are actions that are already used to address single forms of malnutrition but with the potential to address multiple forms simultaneously (Box 4).[19]

The policy actions in eight selected countries (Cambodia, Guatemala, India, Madagascar, Nepal, Nigeria, Rwanda and Tanzania) were extensively reviewed to determine if double-duty actions were incorporated in the existing three types of policies – nutrition, NCD and food security.[20] It was observed that the double-duty actions were incorporated in nearly all nutrition and NCD policies, but rarely within food security policies (Figure 4).

BOX 4

Double-duty actions include interventions, programs and policies that have the potential to simultaneously reduce the risk or burden of both undernutrition (including wasting, stunting and micronutrient deficiency or insufficiency) and overweight, obesity, or diet-related NCDs (including type 2 diabetes, cardiovascular disease and some cancers).

(WHO, 2012)

Actions with implications for obesity and diet-related NCDs, such as marketing regulations aiming to mitigate the food marketing practices that influence children's food preferences and diet-related behaviors and outcomes, were increasingly included in NCD policies, but not as much in the nutrition policies. This emphasizes that multisectoral policies and specific sectoral policies still require better harmonization to amplify the benefits of interventions with effective utilization of resources.[20]

Double-duty actions have the potential to address the common drivers of malnutrition through shared platforms

Expectant mothers participate in a counseling session on infant and young child feeding in Vietnam

PANEL 1: Committing to double-duty actions in Vietnam

Vietnam has made great progress in combating undernutrition and achieving the Millennium Development Goal (MDG) of reducing child underweight and improvements in food security earlier than planned. In light of the new challenges facing the country, including – especially in urban areas – the rising prevalence of overweight and obesity, micronutrient deficiencies, and diet related noncommunicable diseases, the government recently launched its 2017–2020 National Plan of Action for Nutrition (NPAN) with the contributions of several line ministries and stakeholders.[21]

Vietnam has demonstrated a strong commitment to place nutrition as a high priority and to deliver for its people. This is also well reflected in the recently enacted and enforced pro-nutrition policy by including nutrition as part of the Communist Party's Resolution No. 20/NQ-TW.

Learning from the implementation challenges of the previous NPAN, a Prime Minister's Directive No: 46/CT-TTg was issued in 2017 calling upon all the ministries, sectors, and localities to coordinate effectively and strengthen multisectoral collaboration in implementing the NPAN 2017–2020. The prime minister has also requested an annual review and reporting on the results of the sectoral implementation of the activities.

The revised NPAN outlines defined roles and responsibilities of several sectors including health, planning and investment, agriculture and rural development, education and training, information and communications, industry and trade, finance, labor, and culture, and seeks cross-sectoral collaboration for the implementation of the double-duty actions to address the double burden of malnutrition.

capitalizing on existing actions across multiple sectors. The increasingly growing multisectoral policy framework in countries, however, has been underutilized for the double burden of malnutrition and needs to be strengthened with double-duty actions that allow for clear lines of sectoral responsibilities for joint actions and a win-win result for individual ministries with limited resources.

Conclusion

The SUN Movement's strategic role in working with committed governments to strengthen nutrition governance by ensuring stakeholder alignment and promoting country-owned and country-led strategies has been a recipe for success to anchor nutrition high in the political agenda. However, there is an urgency for SUN Movement member countries to translate their political commitments to address the double burden of malnutrition with a systems thinking approach to maximize the impact of double-duty actions. Systems thinking allows for multiple sectors to go beyond the policy setting and ensure coordination at every level of implementation by broadening their focus and working towards strengthening whole systems for improved nutrition outcomes.[22]

SUN Countries have increasingly been applauded for their efforts to align efforts nationally through strengthened multistakeholder platforms that include relevant line ministries – across agriculture, health, education, social welfare, women's affairs, and local government – and key partners including civil society, United Nations agencies, donors, the technical and research community, parliamentarians, media, and the private sector. Now, it is imperative that they lead the way by embracing a renewed multisectoral approach that addresses the double burden of malnutrition and advances the potential of double-duty actions. This requires breaking away from siloed thinking among sectors and enabling synergies with experience-informed and evidence-based policies and actions to deliver maximum gains for nutrition.

Disclosure statement: *The views, opinions and positions expressed in this article are the author's own and do not reflect the views of any third party, affiliated entity or organisation.*

Correspondence: ***Thahira Shireen Mustafa,***
Former Policy Advisor, Scaling Up Nutrition (SUN) Movement, Palais des Nations, Geneva 1211, Switzerland
Email: *thahirashireenmustafa@gmail.com*

References

01. Garrett J, Natalicchio M, eds. Working multi-sectorally in nutrition: principles, practices, and case studies. Washington, DC: IFPRI; 2011.
02. Field JO. Multisectoral nutrition planning: a post-mortem. Food Policy. 1987;12(1):15–28.
03. World Bank. Improving nutrition through multisectoral approaches. Washington, DC: International Bank for Reconstruction and Development; 2012.
04. Ruel MT, Alderman H. Nutrition-sensitive interventions and programs: how can they help to accelerate progress in improving maternal and child nutrition? Lancet. 2013;382:536–51.
05. Ruel MT, Quisumbing AR, Balagamwala M. Nutrition-sensitive agriculture: what have we learned so far? Glob Food Sec. 2018;7:128–53.
06. Scaling Up Nutrition (SUN) Movement. SUN Principles of Engagement. Internet: scalingupnutrition.org/about-sun/the-vision-and-principles-of-sun/ (accessed 27 May 2018).
07. WHO. Maternal, infant and young child nutrition. Geneva: WHO; 2012.
08. WHO, FAO. Framework for Action, Second International Conference on Nutrition, Rome, 19-21 November 2014. Internet: www.fao.org/3/a-mm215e.pdf (accessed 11 September 2018).
09. United Nations Sustainable Development Knowledge Platform. Sustainable Development Goals. Internet: sustainabledevelopment.un.org/?menu=1300 (accessed 27 May 2018).
10. United Nations Decade of Action on Nutrition. Seventieth session of the United Nations General Assembly, New York, 2015. Agenda item 15 (A70/L.42). Internet: www.un.org/ga/search/view_doc.asp?symbol=A/70/L.42 (accessed 27 May 2018).
11. WHO. Global nutrition policy review 2016–2017: country progress in creating enabling policy environments for promoting healthy diets and nutrition. Geneva: WHO; 2018.
12. Cullerton K, Donnet T, Lee A, Gallegos D. Playing the policy game: a review of the barriers to and enablers of nutrition policy change. Public Health Nutr. 2016;19(14):2643–53.
13. Pelletier D, Gervais S, Hafeez-ur-Rehman H, Sanou D, Tumwine J. Boundary-spanning actors in complex adaptive governance systems: the case of multisectoral nutrition. IJHPM. 2018;33(1):e293–e319.
14. Lamstein S, Pomeroy-Stevens A, Webb P, Kennedy E. Optimizing the multisectoral nutrition policy cycle. Food Nutr Bull. 2016;37(4_suppl):S107–S114.
15. Pomeroy-Stevens A, D'Agostino A, Adero N, Foehringer Merchant H, Muzoora A, Mupere E. Prioritizing and funding the Uganda nutrition action plan. Food Nutr Bull. 2016;37(4S):S124–S141.
16. Scaling Up Nutrition (SUN) Movement Monitoring, Evaluation, Accountability, Learning (MEAL). 2016 Baseline report on key indicators. 2017. Internet: docs.scalingupnutrition.org/wp-content/uploads/2017/11/MEAL-Baseline-Report_02112017.pdf (accessed 11 September 2018).
17. WHO. Global action plan for the prevention and control of non-communicable diseases 2013–2020. Geneva: WHO; 2013.
18. Scaling Up Nutrition (SUN) Movement. Annual Progress Report 2017. Internet: docs.scalingupnutrition.org/wp-content/uploads/2017/11/SUN_Main_Report_ENG_2017_WEB2.pdf (accessed 11 September 2018).
19. WHO. Double-duty actions: policy brief. Geneva: WHO; 2017.
20. Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING) Project. National policies and plans to address the dual burden of malnutrition: a multi country policy review. Arlington, VA: USAID/SPRING Project; 2018.
21. Scaling Up Nutrition (SUN) Movement. Vietnam champions the SUN Movement and leads the way for other SUN Countries. 2018. Internet: scalingupnutrition.org/news/viet-nam-champions-the-sun-movement-and-leads-the-way-for-other-sun-countries/ (accessed 11 September 2018).
22. Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING) Project. A systems thinking and action for nutrition: a working paper. Arlington, VA: USAID/SPRING Project; 2015.

BMI and Adiposity in Children

A global perspective

Christine Slater
Independent Consultant, Maryport, UK

Pernille Kaestel,
Cornelia Loechl
International Atomic Energy Agency,
Division of Human Health, Vienna, Austria

Key messages

- The WHO BMI-for-age definition of obesity underestimates the prevalence of excessive fatness in Asian and African children.
- A universal reference may not be appropriate for assessment of obesity-related disease risk in children and adolescents.
- There is a need for reference data on body composition of children and adolescents from diverse ethnic backgrounds living in low- and middle-income countries to complement the data from high-income countries.

A schoolchild eating lunch in Mauritius

Children line up for snacks in Mauritius

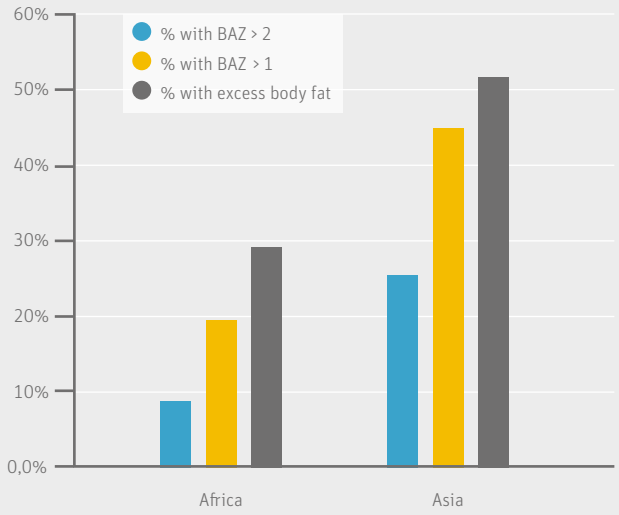
In health surveillance, body mass index (BMI)-for-age (BA) is a well-established indicator for pediatric obesity. The WHO recommends that obesity in school-age children and adolescents is defined as a BA z-score (BAZ) of >2 (equivalent to BMI 30 kg/m² at 19 years), and overweight as BAZ >1 (equivalent to BMI 25 kg/m² at 19 years).[1,2] However, obesity-related adverse health effects are related to an excess of body fat, not an excess of body weight, and there is consistent evidence that high BAZ correctly identifies individuals with highest body fatness and highest risk of co-morbidities, but fails to identify children who are excessively fat but who do not have high BAZ.[3–6] It has high specificity (low false positive rate), but low to moderate sensitivity (moderate to high false negative rate).[7] The high specificity is an advantage for clinical use, but low to moderate sensitivity is problematic for public health applications, such as obesity surveillance, since relatively large numbers of children with high body fat content will "test negative."[8] It is estimated that 25%–50% of children and adolescents defined as having a healthy BMI-for-age will also have excess body fat.[5,6] Most of the evidence comes from systematic reviews based largely on European and Western populations.[9] In many other populations, the bias associated with the use of BMI is worse, leading to more pronounced underestimates of obesity prevalence, and complicating global comparisons.[10] Asians have

TABLE 1: Characteristics of the African and Asian children

Characteristics	Africa [15]	Asia [12]
n	1,516	1,039
Age span	8–11 years	8–10 years
BAZ median (IQR)	-0.35 (-1.09–0.71)	0.64 (-0.38–2.02)
Body fat % median (IQR)	22.65 (17.43–29.60)	28.39 (21.00–36.11)

IQR: Interquartile range

FIGURE 1: Two examples from Africa[15] and Asia,[12] comparing currently recommended cut-off values for obesity and overweight by BMI-for-age z-score (BAZ) and excessive body fat percent assessed by deuterium dilution (excessive body fat defined as >25% in boys and >30% in girls)



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Lunchtime at a primary/elementary school in Mauritius

more body fat at a given BMI than Europeans, but there is also wide variation between Asian populations.[11–14] The same has been observed in a study of children from eight African countries.[15] Therefore, the widespread application of a single BMI cut-off point may not be appropriate to screen for health risks in all children.

> "The widespread application of a single BMI cut-off point may not be appropriate to screen for health risks in all children"

Most of the reference data for children's body composition comes from high-income countries.[16] Body-composition reference data for British and Indian children and adolescents are available.[17–20] There is a clear need for more data from low- and middle-income countries assessing BAZ against measures of body fatness with low bias and acceptable individual accuracy.[11,17,21] The ideal 'criterion' method for assessing body composition uses a multi-compartment model to measure total body water (TBW) by deuterium dilution, body density by air displacement plethysmography and bone mineral content by dual energy X-ray absorptiometry (DXA), but it is not practical for large epidemiological studies.[22,23] However, body fat mass estimated from TBW using a two-compartment model is feasible for large epidemiological studies, and has been used to assess body composition in large studies in Asia,[12] Latin America,[24] and Africa.[15] The International Atomic Energy Agency has published practical guidance and eLearning materials to standardize the protocols for assessing body composition by deuterium dilution,[25–27] and is compiling a database containing information on the body composition, assessed by deuterium dilution, and risk factors for obesity-related noncommunicable diseases. The database currently contains data from approximately 4,000 children and adolescents, aged 6–18 years, from Asia, Africa and Latin America.

Two large studies from Asia[12] and Africa[15] highlight that current BAZ cut-offs for obesity and overweight most likely underestimate the proportion of children with excessive body fat, which is associated with adverse health outcomes. The study populations are described in Table 1. In both studies, the age range was similar (8–11 years in the African study and 8–10 years in the Asian study), but the nutritional status of the children, as indicated by BAZ, was markedly different. The median (interquartile range) BAZ in the African children was -0.35 (-1.09 to 0.71), while that of the Asian children was 0.64 (-0.38 to 2.02). In both studies, body fat mass was assessed by deuterium dilution, and

Physical education at a primary/elementary school in Mauritius

excess adiposity was defined as >25% body fat in boys and >30% body fat in girls.[28]

Figure 1 illustrates the percentage of children that were classified as overweight (BAZ > 1), obese (BAZ > 2) and having excess body fat, and indicates that the currently recommended cut-offs may underestimate the prevalence of excessive fatness in African and Asian children, and a universal reference for obesity-related disease risk may not be applicable for all children. Further research is required on the association between adiposity and disease risk in children and adolescents from diverse ethnic backgrounds living in low- and middle-income countries to complement the data from high-income countries.

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Correspondence: ***Christine Slater,***
1 New Crown Yard, South Quay, Maryport,
Cumbria, CA15 8AB, UK

References

01. WHO. Growth reference 5–19 years. BMI-for-age (5–19 years). Internet: www.who.int/growthref/who2007_bmi_for_age/en/ (accessed 23 August 2018).
02. de Onis M, Lobstein T. Defining obesity risk status in the general childhood population: which cut-offs should we use? Int J Pediatr Obes. 2010;5(6):458–60.
03. Reilly JJ, Kelnar CJ, Alexander DW, Hacking B, McDowell ZC, Stewart ML, et al. Health consequences of obesity: systematic review. Arch Dis Child. 2003;88:748–52.
04. Okorodudu DO, Jumean MF, Montori VM, et al. Diagnostic performance of BMI to identify obesity as defined by adiposity: a systematic review and meta-analysis. Int J Obes. 2010;34:791–99.
05. Reilly JJ, Kelly J, Wilson DC. Accuracy of simple clinical and epidemiological definitions of childhood obesity: systematic review and evidence appraisal. Obes Rev. 2010;11:645–55.
06. Javed A, Jumean M, Murad MH, Okorodudu D, Kumar S, Somers VK, et al. Diagnostic performance of BMI to identify obesity as defined by body adiposity in children and adolescents: a systematic review and meta-analysis. Pediatr Obes. 2015;10:234–44.
07. Reilly JJ, Methven E, McDowell ZC, Hacking B, Alexander D, Stewart L, et al. Health consequences of obesity: systematic review and critical appraisal. Arch Dis Child. 2003;88:748–52.
08. Reilly JJ. Diagnostic accuracy of the BMI for age in paediatrics. Int J Obes. 2006;30:595–97.
09. Reilly JJ, El-Hamdouchi A, Diouf A, Monyeki A, Somda SA. Determining the worldwide prevalence of obesity. Lancet. 2018;391:1773–74.
10. Hruschka DJ, Hadley C. How much do universal anthropometric standards bias the global monitoring of obesity and undernutrition? Obes Rev. 2016;17:1030–39.

11. Deurenberg P, Deurenberg-Yap M, Guricci S. Asians are different from Caucasians and from each other in their body mass index/body fat per cent relationship. Obes Rev. 2002;3:141–6.
12. Liu A, Byrne NM, Kagawa M, Ma G, Poh BK, Ismail MN, et al. Ethnic differences in the relationship between BMI and percent body fat among Asian children from different backgrounds. Br J Nutr. 2011;106:1390–97.
13. Nightingale CM, Rudnicka AR, Owen CG, Cook DG, Whincup PH. Patterns of body size and adiposity among UK children of South Asian, black African-Caribbean and white European origin: Child Heart and Health Study in England (CHASE study). Int J Epidemiol. 2011;40:33–44.
14. Hills AP, Mokhtar N, Brownie S, Byrne NM. Childhood obesity in Asia: the value of accurate body composition methodology. Asia Pac J Clin Nutr. 2014;23(3):339–43.
15. Diouf A, Adom T, Aouidet A, El-Hamdouchi A, Joonas NI, Loechl CU, et al. Reilly JJ. Body mass index vs deuterium dilution method for establishing childhood obesity prevalence, Ghana, Kenya, Mauritius, Morocco, Namibia, Senegal, Tunisia and Republic of Tanzania. Bull World Health Org. 2018;96:(in press).
16. Wells JCK. Towards body composition reference data for infants, children and adolescents. Adv Nutr. 2014;5:3205–95.
17. Wells JCK, Williams JE, Chomtho S, Darch T, Grijalva-Eternod C, Kennedy K, et al. Body-composition reference data for simple and reference techniques and a 4-component model: a new UK reference child. Am J Clin Nutr. 2012;96:1316–26.
18. Virani N. Reference curves and cut-off values for anthropometric indices of adiposity of affluent Asian Indian children aged 3–18 years. Ann Hum Biol. 2011;38:165–74.
19. Pandit D, Chiplonkar S, Khadilkar A, Khadilkar V, Ekbote V. Body fat percentages by dual-energy X-ray absorptiometry corresponding to body mass index cutoffs for overweight and obesity in Indian children. Clin Med Pediatr. 2009;3:55–61.
20. Pandey RM, Madhavan M, Misra A, Kalaivani M, Vikram NK, Dhingra V. Centiles of anthropometric measures of adiposity for 14- to 18-year-old urban Asian Indian adolescents. Metab Syndr Relat Disord. 2009;7:133–41.
21. Hills AP, Davidsson L. Stable isotope techniques to develop and monitor nutrition interventions. Curr Nutr Food Sci. 2010;6:289–93.
22. Wells JC, Fuller NJ, Dewit O, Fewtrell MS, Elia M, Cole TJ. Four- component model of body composition in children: density and hydration of fat-free mass and comparison with simpler models. Am J Clin Nutr. 1999;69:904–12.
23. Wells JC and Fewtrell MF. Measuring body composition. Arch Dis Child. 2006;91:612–17.
24. Vasta F, Slater C, Caballero B. A 12-country assessment of body adiposity in Latin American children and its association with cardiometabolic risk factors. FASEB J. April 2014;28(1)Suppl;Abstract 1031.3.
25. International Atomic Energy Agency. Introduction to body composition assessment using the deuterium dilution technique with analysis of saliva samples by Fourier Transform Infrared Spectrometry. IAEA: Vienna, Austria; 2010. [IAEA Human Health Series No.12.]
26. International Atomic Energy Agency. Introduction to body composition assessment using the deuterium dilution technique with analysis of urine samples by isotope ratio mass spectrometry. IAEA: Vienna, Austria; 2010. [IAEA Human Health Series No.13.]
27. International Atomic Energy Agency. Assessing body composition by deuterium dilution technique. eLearning. Internet: www-naweb.iaea.org/elearning/NAHRES/Assessing_body_composition_by_deuterium_dilution_technique/story.html (accessed 23 August 2018).
28. Williams DP, Going SB, Lohman TG, Harsha DW, Srinivasan SR, Webber LS, et al. Body fatness and risk for elevated blood pressure, total cholesterol and serum lipoproteins ratios in children and adolescents. Am J Public Health. 1992;82:358–63.

Addressing Capacity Challenges

Breaking down silos in the nutrition community

Jessica Fanzo
Berman Institute of Bioethics,
School of Advanced International Studies
and Bloomberg School of Public Health,
Johns Hopkins University, Baltimore, MD, USA

Key messages

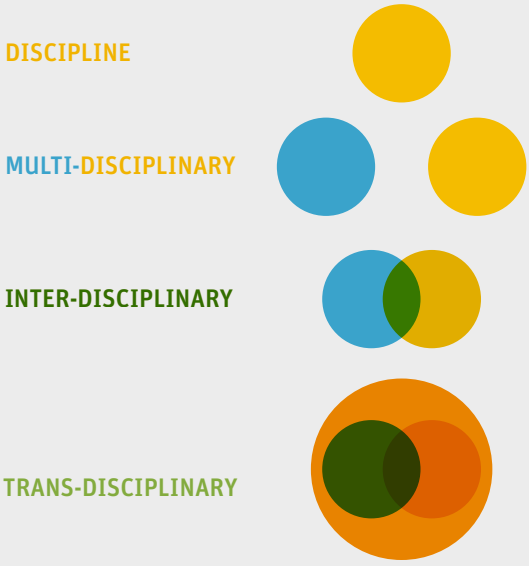
- Nutrition is a multi-temporal, multi-faceted, multi-sectoral, multi-disciplinary issue, and there are many forms of malnutrition that plague society.
- In this trans-disciplinary space, nutrition professionals need to be fluent in discussing the concepts and constructs of other disciplines.
- Four challenges need to be dealt with in the near future:
  1. We are trained to understand only our field of discipline, and those disciplines in and of themselves are complex.
  2. We are not trained to think about other sectors or even more so, other systems.
  3. We are not trained to think about how to work differently and in what timescale.
  4. The nutrition community has its own silos and divisions that rarely cross paths.
- It is essential to jointly bridge the divides within the nutrition communities in order to answer complex challenges in order to address malnutrition in all its forms.

The challenge of building capacity

Nutrition is a multi-temporal, multi-faceted, multi-sectoral, multi-disciplinary issue. While the 1991 UNICEF framework on the causes and consequences of malnutrition demonstrates just that, one is left questioning how to build capacity to address the multiplicitous nature of nutrition.[1] We also know that nutrition is complex: there are many forms of malnutrition that plague society, including undernutrition in the form of stunting and wasting, micronutrient deficiencies and overweight and obesity and diet-related noncommunicable diseases. Each of these manifestations is biologically complex, with a range of contributing factors and outcomes on health and well-being.

There have been many calls about working across disciplines and building cadres of workforce that can take on the complexity of malnutrition. In this transdisciplinary space, nutrition professionals need to be fluent in discussing the concepts and constructs of other disciplines to effectively engage with decision-makers in other sectors and seize opportunities to influence policies and programs.[2] Alas, many individuals instead train in specialized, niche areas. Why is that? First, it is just plain easier to work within a sector or a discipline. Second, inter-, multi- or trans-disciplinary working requires effort – understanding new terminologies, new ways of working, new methods, new approaches and new evidence to unpack. This way of working calls for commitment, time and resources, all of which are scarce (Figure 1).

FIGURE 1: Inter-, multi- and trans-disciplinary work



The nutrition community needs to finds new ways of understanding the challenges we all face

Malnutrition in LMICs

While every country has some type of malnutrition, low- and middle-income countries (LMICs) struggle with significant double or triple burdens of malnutrition – reeling from undernutrition, micronutrient deficiencies and overweight and obesity. There is a real dearth of nutrition capacity in LMICs, and Delisle and others have described the many factors that contribute to this scarcity of nutrition professionals, particularly in the public health sector.[3] They, too, call for building capacity and integrating nutrition tasks into other disciplines. Specifically, they call for capacity in non-health sectors such as agriculture and education, because many of the underlying causes of malnutrition are in those sectors. Even those trained in nutrition within public health need to understand more than just the biological mechanisms and causes of malnutrition and to learn soft skills on how to be leaders and facilitate working relationships.[4] Fanzo and coauthors (2015) suggested that a workforce in nutrition should look more like teams – those that are working multi- or transsectorally, that have leadership, advocacy and communication skills and can think outside the box to future challenges that will impact nutrition, such as climate change, geopolitics and demographics.[2]

"Any workforce in nutrition needs to think outside the box"

Four critical challenges to master

When we think about training across temporal, sectoral, disciplinary and faceted scales, there are four challenges that come to mind that we, the nutrition community, need to deal with in the near future. First, we are trained to understand only our field of discipline, and those disciplines in and of themselves are complex. For example, a public health epidemiologist would struggle to understand the science of a climatologist. Why? Because these specialists come from different schools of thought, learn different methodologies and indicators to measure their work and use different analyses and systems science approaches. Each discipline and subdiscipline has a nose-dive approach to their work that makes it incredibly hard for others in distinct disciplines to understand. However, these disciplines impact each other, and illustrated next is one example where these two disciplines are coming together and are important to understand. Climate scientists (and in this case, a medical doctor doing climate work) are now elucidating the impact of different climate-change scenarios on the nutritional quality of crops. Authors estimate that in high CO_2 conditions, an additional 175 million people will be zinc-deficient, and an additional 122 million people will be protein-deficient. This has significant repercussions on the advancements made in public health nutrition to address micronutrient deficiencies.[5] It is important for those working in nutrition to understand the findings stemming from their research and how that will impact the work they are doing to promote nutritious foods. **It is also important for climate**

Palm oil fruits following harvesting. The Ebola crisis had repercussions for palm oil growers in Liberia.

scientists to consider the consequences of their findings together with nutrition colleagues and to delve deeper into the causes with implications for other nutrients and crops.

Second, we are not trained to think about other sectors or even more so, other systems. Public health specialists work within health systems. Agriculturalists work within food systems. And never the twain shall cross. However, we know that they do cross, interact and feed back on each other. A blow to one system can impact another system. Ebola is one such example that comes to mind, in which a massive hit or shock to the health system had repercussions on the food system and in this case on the major cash crop – palm oil – in Liberia. The 2014 Ebola virus disease outbreak caused a significant decrease in economic activity and jobs in all of Liberia, and an especially large decline in the capital, Monrovia, due to border closures, quarantines and other restrictions that caused disorder. At the height of these restrictions, the outbreak led to disruption in the marketing of goods, including agricultural commodities. In Liberia, because of the quarantine and restricted movement, work on the palm fields halted, leading to a destruction of cash crops.[6] **Thus, there is a need for those working in nutrition to understand systems thinking and how other systems within which they do not work impact their own systems work.**

Third, we are not trained to think about how to work differently and in what timescale. In nutrition, there are divisions between those that work on humanitarian or emergency nutrition issues in shorter timescales versus those who work on longer-term nutrition development challenges. Again, these communities do not talk to each other or, what is more important, work together. Their respective indicators, surveillance systems and ways of working are completely different. The World Humanitarian Summit in Istanbul in 2016 highlighted the need to "strengthen linkages between humanitarian and development programming" because many of the humanitarian programs take place in contexts of protracted emergencies in which a short-term response is not always the best approach. The UN Office for Coordinating Humanitarian Affairs (OCHA) developed a framework that calls for joined-up analysis of acute and long-term needs, joint humanitarian and development partner planning with collective outcomes, joint leadership and coordination building on opportunities and comparative advantage, and financing modalities to support collective outcomes.[7] **It is important for these communities to come together through joint planning to help prevent and mitigate costly, devastating humanitarian situations in the next decade. This is particularly timely with climate change effects on the planet.**

Fourth, we have other divisions in the nutrition world. Those who work on undernutrition and those who work on overweight and obesity. Their respective rationales, interventions and communities are distinct. This is unfortunate because of what is now being termed 'double-duty actions.' Double-duty actions include interventions, programs and policies that have the potential to simultaneously reduce the risk or burden of both undernutrition and overweight and obesity.[8] This can be done on the one hand by retrofitting existing nutrition actions to address or improve new or other forms of malnutrition and on the other through the development of *de novo*, integrated actions aimed at the double burden of malnutrition. One example of this would be the promotion of exclusive breastfeeding to address both undernutrition and overweight and obesity in later life.[9] Not only does breastmilk provide nutritional benefits for the child in protecting against undernutrition, it can also reduce the risk for overweight and obesity later in life, as well as regulate maternal weight gain. **It is important for the nutrition communities to consider the platforms and interventions in which they carry out their work to determine if they are having double- or even triple-duty impacts.**

"It is about together bridging the divides within the nutrition communities in order to answer complex challenges that overlap and impact each other"

Thus, it is not just a question of our working trans-sectorally. It also requires us to think about the implications of our work in other systems, and what actions could serve more than one purpose. It is about delving into new communities and reading new literature and going to conferences that are unfamiliar. It is about jointly bridging the divides within the nutrition commu-

Not only does breastmilk provide nutritional benefits for the child, it can also reduce the risk for overweight and obesity later in life, as well as regulate maternal weight gain

nities in order to answer complex challenges that overlap and impact each other. It is about creating open spaces, not walls. But we need a different type of workforce for nutrition, and there have been many papers elucidating the means to get there. Ways to create this new type of workforce would be to create a consortium to link universities of the global North and global South, online training modules for middle managers and practical, hands-on experiences for frontline nutrition workers.[2,4,10]

What are the incentives to think wider and broader, and to reach across the aisle and get to know our neighbor? I can think of four reasons.

First, the work you do will have a bigger impact. Second, the work you do will be more interesting. Third, your networks grow. And last, we no longer have a choice: nutrition requires disciplines, sectors and systems engaging, collaborating and partnering in impactful ways.

Correspondence: ***Jessica Fanzo,***
Johns Hopkins University, Deering Hall 203,
1809 Ashland Avenue, Baltimore MD 21205, USA
Email: *jfanzo1@jhu.edu*

References

01. UNICEF. Conceptual framework of the causes of malnutrition. New York: UNICEF; 1991.
02. Fanzo JC, Graziose MM, Kraemer K, Gillespie S, Johnston JL, de Pee S, et al. Educating and training a workforce for nutrition in a post-2015 world. Adv Nutr. 2015 Nov 10;6(6):639–47.
03. Delisle H, Shrimpton R, Blaney S, Du Plessis L, Atwood S, Sanders D, et al. Capacity-building for a strong public health nutrition workforce in low-resource countries. Bull World Health Organ. 2017 May 1;95(5):385.
04. Shrimpton R, du Plessis LM, Delisle H, Blaney S, Atwood SJ, Sanders D, et al. Public health nutrition capacity: assuring the quality of workforce preparation for scaling up nutrition programmes. Public Health Nutr. 2016 Aug;19(11):2090–100.
05. Smith MR, Myers SS. Impact of anthropogenic CO2 emissions on global human nutrition. Nat Clim Change. 2018;8:834-9.
06. Bowles J, Hjort J, Melvin T, Werker E. Ebola, jobs and economic activity in Liberia. J Epidemiol Community Health. 2016 Mar;70(3):271–7.
07. Dolan C, Shoham J. Humanitarian-development nexus: nutrition programming and policy in Kenya. London: ENN; 2017.
08. WHO. Double-duty actions: policy brief. Geneva: WHO; 2017.
09. Rollins NC, Bhandari N, Hajeebhoy N, Horton S, Lutter CK, Martines JC, et al. Why invest, and what it will take to improve breastfeeding practices? Lancet. 2016;387(10017):491–504. doi:10.1016/S0140-6736(15)01044-2.
10. Shrimpton R, Hughes R, Recine E, Mason JB, Sanders D, Marks GC, et al. Nutrition capacity development: a practice framework. Public Health Nutr. 2014 Mar;17(3):682–8.

Equipping Chefs with the Language of the Sustainable Development Goals

Why chefs play a critical role in shifting perceptions in the fight for better nutrition

Paul Newnham
SDG2 Advocacy Hub, London, UK

Key messages

- Chefs play a critical role in changing the way we eat by moving out of silos and working across several different industries.
- The Chefs' Manifesto was written by chefs, for chefs, to engage with the Sustainable Development Goals (SDGs) and bring these directly into the kitchen.
- We must utilize the language and the cachet of chefs in order to shift the dynamic and the conversation around nutrition so that real, lasting change is enacted.

With more than two billion people suffering from micronutrient deficiencies while a further two billion are overweight or obese, the world cannot continue business as usual if we are to end all forms of malnutrition by 2030.[1] New voices must be brought into nutrition conversations that are struggling to reach their target audience.

The challenge of SDG2 and of nutrition in particular

As the prevalence of stunting, wasting and micronutrient deficiency increases, so do rates of overweight, obesity and non-communicable diseases. Never before has this phenomenon seen such high numbers, or rapidly increasing rates. **Figure 1** demonstrates this.

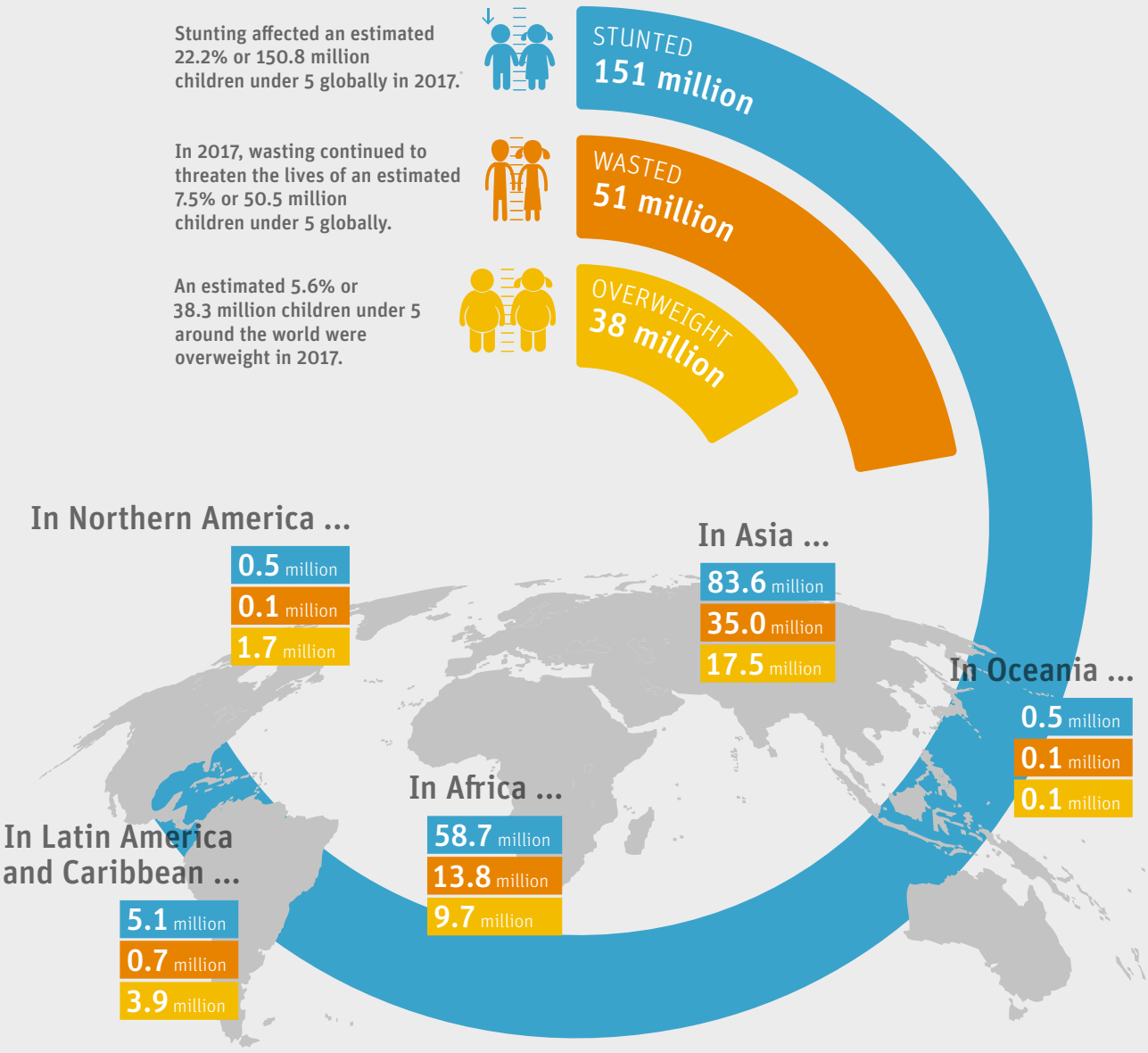
In 2016, The United Nations declared the years 2016–2025 the Decade of Action on Nutrition in an attempt to address the startling number of people affected.[2] The UN's targets are attainable, but not without significant global action and major policy changes.

Bombarded with advice and evidence concerning healthy eating and nutritious diets, consumers are unsure what to believe and often tune out conflicting public messaging campaigns.[3] The nutrition community is struggling to have its message heard and acted upon. This nutrition echo chamber, coupled with the sector's insufficient funding commitments, threatens to derail progress towards national and global nutrition targets. It is critical, right now, that *all* actors be brought to the table. With 12 of the 17 Sustainable Development Goals (SDGs) having indicators linked to nutrition, the 2030 Agenda provides a framework for greater cross-sectoral work and the engagement of new voices in the nutrition space. At the SDG2 Advocacy Hub, we saw this as an opportunity to break out of existing silos and work in a new way that embraces fresh voices and reaches a larger audience

Chefs sharing a plant-based meal at Torsker Farm in Stockholm

FIGURE 1: Levels and trends in child malnutrition

UNICEF | WHO | World Bank Group Joint Child Malnutrition Estimates
Key findings of the 2018 edition



Source: United Nations Children's Fund (UNICEF), World Health Organization, International Bank for Reconstruction and Development/The World Bank. Levels and trends in child malnutrition: key findings of the 2018 Edition of the Joint Child Malnutrition Estimates. Geneva: World Health Organization; 2018.

with a message focused on nutritious, sustainable food for all. Chefs are one such voice, bringing new language to a conversation struggling to reach its target audience.

Bringing chefs to the table

Chefs' love for food is infectious and powerful. Chefs can convey excitement and communicate flavor. They can inspire action through their passion for ingredients and the creation of something bold and new, or subtle and delicate. They evoke memories through their dishes, connecting consumers with their five senses.

Gastrophysics, a term created by Prof. Charles Spence, is the combination of gastronomy and psychophysics – gastronomy being the knowledge and understanding of all that relates to man as he eats, and psychophysics being the branch of psychology that deals with the relations between physical stimuli and mental phenomena.[4,5]

This concept of connecting consumers with their food behaviors, attitudes to food and choice-making around food speaks to people on a basic level that everyone can understand and get excited about. Chefs can convey the message of the SDGs in ways that others have not yet mastered. It has been great to learn from chefs like Chef Jozef Youssef – the creative force behind Kitchen Theory, the gastronomy experience design lab that is home to the Gastrophysics Chef's Table, about how this sort of intentionality can be used to drive social change.

> "Chefs can convey the message of the SDGs in ways that others have not yet mastered"

Why chefs?

More and more, chefs are becoming increasingly popular, setting trends and influencing pop culture in headlines across social media platforms. One only has to turn on the television and count the numerous cookery shows to realize that people admire chefs. We like what they create. We want to try their food. What's more, chefs are trusted. This allows them to move naturally in and out of spaces that other sectors may struggle to connect with. They are present not only in our kitchens and homes via social media and television, but also in schools, neighborhood gardens, community projects and businesses. As such, they play a critical role in connecting multiple industries with a shared language of food that can educate other chefs, farmers, politicians and educators alike. With so much influence, it is little wonder that chefs globally are rallying together to stand up and fight against the ever-growing double burden facing our planet.

The Chefs' Manifesto

The Chefs' Manifesto

We have created a framework that empowers chefs to use their platforms to speak about the SDGs. The SDG2 Advocacy Hub approached chefs around the world to create their own narrative, which became embodied in the resulting Chefs' Manifesto. Breaking down the language of the SDGs, particularly with a focus on SDG 2: Zero Hunger, the Hub endeavored to educate chefs on the Global Goals and facilitate a conversation that resulted in their own Manifesto and Action Plan.

The Chefs' Manifesto is written by chefs, for chefs. It is based around eight thematic areas identified by chefs as the most important elements of the SDGs in their work:

1. Ingredients grown with respect for the earth and its oceans
2. Protection of biodiversity and improved animal welfare
3. Investment in livelihoods
4. Value natural resources and reduce waste
5. Celebration of local and seasonal food
6. A focus on plant-based ingredients
7. Education on food safety, healthy diets and nutritious cooking
8. Nutritious food that is accessible and affordable for all

The guiding principles underpinning the creation of the Manifesto are: utilize industry-relevant language; break out of traditional models of working within industry silos and start to work across sectors; and taste as an entity that evokes memory, emotion, and is a part of identity.

Through equipping chefs with the language of the Global Goals and facilitating a movement that brings the SDGs into chefs' workspaces, there is a real possibility of generating a global change towards sustainable, nutritious food for all. The aim is not to dispute the SDGs, but rather to have an unbranded movement, which can be contextualized and is culturally appropriate, to reach as many people as possible. Chefs can choose which elements to focus on, and in doing so, can educate their consumers, communities, patrons and supporters about sustainable eating and nutrition.

© Mikael Göransson

Kenya's Chef Ali Mandhry and America's Chef Mary Sue Milliken preparing a plant-based dish at Taste in Stockholm

> "Through equipping chefs with the language of the Global Goals, there is a real possibility of generating a global change towards sustainable, nutritious food for all"

Scream flavor and whisper nutrition

A chef's skillset can help to bridge this communication gap between nutrition actors and recipients. By bringing chefs into the health sector, they can shift the language from the pathologized 'nutrition' and 'healthy diets' by introducing 'taste' and 'flavor.' Consumers want to hear about food when it is presented to them as something enticing. Chefs can create a major behavioral shift in patients and consumers by changing the language of the overarching message. An obese person may not listen to a medical professional's advice to eat more fruits and vegetables but may be interested in learning how to create flavor-packed meals that make them feel good and take them on a sensory journey. Similarly, a person who is malnourished may not know how to increase their intake of iron, but could follow a meal plan that evokes their five senses and is affordable, seasonal, accessible and sustainable.

Collaboration between chefs and the health sector that utilizes chefs' food-focused language in conversations around nutrition could create real, lasting change. A meal plan created by this dynamic set of actors, for example, could fulfill specific nutritional requirements but also use chefs' language and packaging to appeal to consumers. Such a program could also be contextualized by drawing on local nutrition and food knowledge to create culturally appropriate food solutions that feed into the Global Goals.

An example of the SDGs at work through chefs

The SDG2 Advocacy Hub has worked to showcase and amplify the work of individuals or groups already engaged in the Global Goals to spread their message across sectors. Generación con Causa is one such group – a team of eight Peruvian chefs passionate about using their skills to raise awareness around hunger and nutritious diets in their communities. In 2017, working in collaboration with the Peruvian government and the World Food Programme, they created a TV series called *Cocina con Causa* (Cooking with a Cause). The series showcased cooking that is nutritious, affordable, tasty and accessible to all Peruvians. In each weekly episode, a celebrity chef highlighted a nutrition issue by living with a family and helping them to cook. The chefs also visited different regions of Peru to create or adapt tradition-

al recipes with local communities to address their nutritional needs. *Cocina con Causa* reached millions of homes in Peru, offering viewers exciting recipes that utilized locally sourced ingredients within their economic constraints that addressed key nutritional issues and were delicious.

> "*Cocina con Causa* reached millions of homes in Peru, offering exciting recipes that addressed key nutritional issues"

Similarly, chefs will also help to translate the upcoming EAT-Lancet Commission's report on Healthy Diets from Sustainable Food Systems. Set for release in early 2019, the report will detail science-based targets to achieve healthy diets for all within planetary boundaries.[6] Chefs can show us what a sustainable diet looks like on our plates. What's more, chefs can contextualize this knowledge to account for climate, nutrition, and health as well as the food preferences of each community.

Action Hubs: Chefs and the SDGs in action

To create lasting success, we need to ground solutions in geographic and cultural locations. The SDG2 Advocacy Hub will support contextualized action by empowering local chefs to work together in what we have labeled Action Hubs. These hubs will drive concrete actions locally, from within the SDG framework. It is a practical way of bringing different actors together to create localized action that can tackle the nutritional problems in each area. Action Hubs will also highlight and amplify the existing actions of chefs. In India, for example, there are chefs working with farmers to promote, produce, and harvest millet. Millet is good for the planet, and good for people: it uses less water than other grains and offers greater nutritional qualities. As part of the Chefs' Manifesto, we are promoting the wonderful work they are doing educating consumers about using millet as an alternative grain while working towards the launch of India's first Action Hub in December of 2018.

Peru's Chef Palmiro Ocampo preparing food with a local community as part of *Cocina con Causa*

Correspondence: ***Paul Newnham,***
Director, SDG2 Advocacy Hub, 10 Furnival Street, London, EC4A 1AB, UK
Email: *paul.newnham@wfp.org*

References

01. Development Initiatives. Global nutrition report 2017: nourishing the SDGs. Bristol, UK: Development Initiatives; 2017.
02. WHO. Malnutrition. Version current 16 February 2018. Internet: www.who.int/news-room/fact-sheets/detail/malnutrition (accessed 9 July 2018).
03. Royal Society for Public Health. RSPH warns of worsening public confusion over healthy diet in response to National Obesity Forum Report. Version current 23 May 2016. Internet: www.rsph.org.uk/about-us/news/rsph-warns-of-worsening-public-confusion-over-healthy-diet.html (accessed 20 July 2018).
04. Kitchen Theory. Research kitchen. Version current 15 March 2018. Internet: www.kitchen-theory.com/knowledge-base/ (accessed 19 July 2018).
05. Kitchen Theory. Defining gastrophysics. Version current 15 March 2018. Internet: www.kitchen-theory.com/defining-gastrophysics/ (accessed 19 July 2018).
06. Food Planet Health. The report. Internet: foodplanethealth.org/the-report/ (accessed 26 July 2018).

Putting Food in Food

Packaged food as an essential lever in achieving positive health, social and environmental impacts

Alison Cairns
Food Reform for Sustainability and Health (FReSH), Geneva, Switzerland

Alain Vidal
World Business Council for Sustainable Development (WBCSD), Geneva, Switzerland

Amanda Wood
EAT/Stockholm Resilience Centre, Stockholm, Sweden

Fabrice DeClerck
EAT, Montpellier, France

Amanda Harding
Convene, Paris, France

Key messages

- Packaged and processed foods are an essential lever in achieving positive health, social and environmental impacts.
- FReSH proposes a systemic approach to food system transformations whereby changes to food processing and packaging (that businesses can own and act on now) trigger improvements across the value chain.
- This systemic approach emphasizes the fact that multiple interconnected solutions exist and need to be further developed to combine both incremental and transformational changes in order to achieve healthy and sustainable foods.
- Transformation will require identifying which business practices should be phased out, repurposed, or fast-tracked into food system goals on healthy and sustainable foods that meet social needs and have a strong business case.

Transforming food systems

Food systems – all the processes involved in feeding the global population – are key to supporting good health and well-being and are a critical part of the biosphere, underpinning prosperous societies and economies.[1] Yet current food systems are not providing adequately for people or the planet. Despite progress on improving nutrition, the burden of malnutrition remains stubbornly high: 815 million individuals are hungry,[2] 2 billion are deficient in critical micronutrients,[3] and 2.1 billion adults are overweight or obese,[4] contributing to the upsurge in diet-related diseases. Beyond nutritional outcomes, food systems are also a main contributor to environmental damage. They are responsible for up to 30% of greenhouse gas emissions[5] and 70% of global freshwater use,[6,7] and they drive deforestation, biodiversity loss, land degradation and pollution.

Action is needed urgently to shift food systems from their current status as major drivers of ill health and environmental degradation to a major force for securing both environmental and human health. Achieving impact requires transformational change over a two-year timeframe to demonstrate traction. To be transformational, action will need to be broad-scale, collective and mainstreamed. Yet a business case will only advance action so far: support is needed from science, policy, the technology sector and civil society to develop solutions, implement supportive policy, develop new tech solutions and engage with consumer groups to increase trust.

> "A business case will only advance action so far: support is needed from science, policy, the technology sector and civil society as well"

Food Reform for Sustainability and Health (FReSH)

To support business action and contributions to healthy and sustainable food systems, the World Business Council for Sustainable Development (WBCSD) and EAT through FReSH (Food Reform for Sustainability and Health) have convened a series of Science to Solutions Dialogues to facilitate and accelerate dia-

logue, engagement and action between academic research, civil society and the private sector. As such the dialogue aimed to (1) share scientific thinking on healthy diets from sustainable food systems; (2) scope out the specific business solution spaces that FReSH members can support; and (3) direct new areas of relevant scientific research.

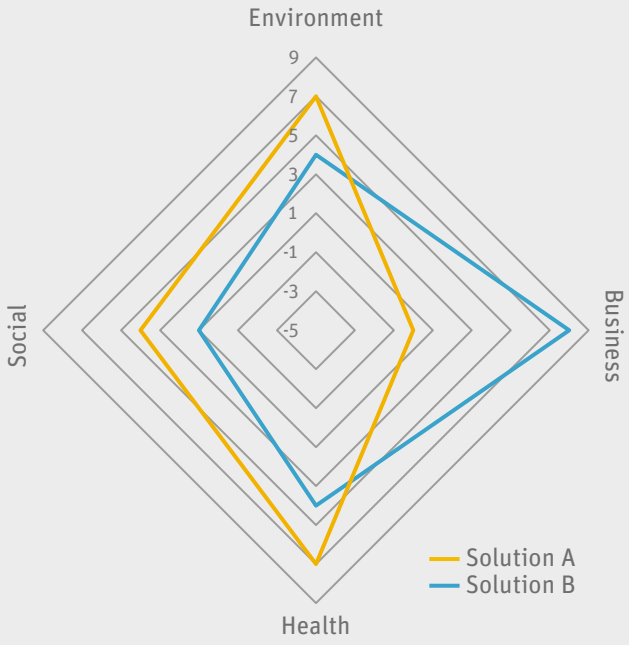
The first dialogue was held in March 2018, focusing on Putting Food in Food and identifying three challenge areas:

- How to improve the nutritional content and environmental sustainability of processed and packaged foods;
- How to bring the consumer along and unleash consumer power to embrace and drive change; and
- How to ensure that processing and packaging contribute to significant reductions of food waste and loss.

Three overarching messages emerged (Figure 1):

- Business represents a collective influence and capacity that is sufficient to set the changes required in motion;
- Business, science and society must persevere so that these actions become mainstream within the next two years – a critical timeframe to demonstrate traction; and
- The level of ambition must match the urgency for transformation.

FIGURE 1: The interrelation of environment, business, health and society



Source: FReSH, SSD1 2018.

> "Food processing is a core activity that can be used to provide affordable, safe, enjoyable and high-quality foods to all"

Providing affordable, safe, enjoyable and high-quality foods to all

So why was this necessary? Food processing is a core activity that can be used to provide affordable, safe, enjoyable and high-quality foods to all. Yet there are challenges to overcome in terms of both perception (e.g., categorical labeling of processed foods as unhealthy) and reality (e.g., generalizable low nutritional quality of many processed foods, or on the flip side, underemphasis of the contribution of food packaging to food safety and reduced food loss and waste). Greater emphasis of improved and real food quality of processed and packaged food – without neglecting taste and appeal – as well as greater emphasis on leveraging processing and packaging in order to increase the shelf life of highly perishable, highly nutritious and environmentally expensive food (e.g., high carbon, land and water footprints) are essential, if net positive health, environmental, business and social impacts are to be secured.

To test a range of business solutions, the dialogue participants engaged in a calibration exercise that simultaneously assesses candidate solution space impact on positive health *as well as* social *and* environmental *and* business impacts. They found this to be a useful exercise, but were eager to develop a more detailed semiquantitative tool to complement and test the assumptions made. For example, they noted that short-, medium- and long-term impacts would vary. In addition, the various solutions might affect different segments of the population in different ways. Participants proposed that one way to provide for this level of specificity would be to develop more precise indicators for each of the four dimensions.

Challenge areas and solution spaces

1. Improving the nutritional content and sustainability of processed food to help address over- and undernutrition

Food processing can play a pivotal role in addressing both under- and overnutrition. With a common understanding of the key challenge in mind – i.e., that solution spaces must focus on creating net positive impacts for both health and the environment – two key solutions to do this emerged during this dialogue.

First, to improve the nutritional quality of processed foods, reformulation, innovation and renovation are key tools that companies can use to optimize the healthiness of ingredients and to

Reformulation, innovation and renovation are key tools that companies can use to optimize the healthiness of ingredients and to show that taste, environment and nutrition are not mutually exclusive

show that taste and nutrition are not mutually exclusive. Second, companies can develop sourcing and procurement standards to source healthy ingredients from sustainable production systems. For maximum impact, mainstreamed procurement standards that promote high-quality (healthy + sustainable) foods based on the EAT-Lancet Commission report outcomes should combine these two solutions.

To accomplish this, we should create a consensus framework on food quality capturing contributions to reducing over- and undernutrition and supporting multiple dimensions of sustainable food production. We must also understand financial partnerships to drive change and harness sensory science, and optimize the role of technology in overcoming transparency and traceability challenges for processed food inputs along the supply chain. Finally, we should send clear signals of intent to buy healthy, sustainably produced ingredients that are socially acceptable and beneficial.

It is necessary to make these procurement standards and practices mainstream. The ambition is to have 100% adoption of such standards and to become steadfast in the pursuit of such notions.

"We should send clear signals of intent to buy healthy, sustainably produced ingredients that are socially acceptable and beneficial"

2. Bringing the consumer along

Reframing the current discourse will harness the power of individuals to embrace and drive change. It requires putting individual well-being at the core of business solutions rather than viewing consumers as reluctant followers of business trends. Any approach to influencing consumer choice should account for the four main drivers of choice (Figure 2):

1. Marketing/advertising
2. Availability (e.g., costs, supply)
3. Taste/reward
4. Habits/familiarity/cultural preferences

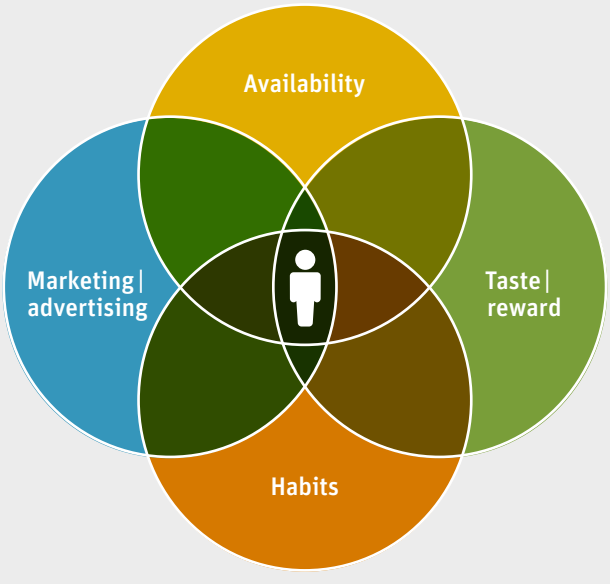
This can be done with a multifaceted consumer behavior change program that addresses these four drivers, complementing the introduction of innovative and reformulated processed foods to support health, well-being, and the environment (a solution identified in the first challenge). A holistic package of interventions targeting each driver will have a synergistic rather than additive effect. Focal areas for interventions include:

- **Marketing/advertising:** Optimize marketing and advertising to increase acceptability of healthy and sustainable food. Use innovative language to sell healthier/more sustainable foods without the healthy/sustainable label.
- **Availability:** Equivalent costs for healthy/sustainable and unhealthy/unsustainable foods could lead to equivalent acceptability.
- **Taste/reward:** Incrementally improve the health and sustainability quotient of food while preserving taste and acceptability.
- **Habit/familiarity/cultural preferences:** Use teachable moments and behavior change programs to change individuals' food habits.

Since sustained consumer behavior change programs are costly for businesses, building a convincing business case for behavior change programs is the key to selling businesses on the long-term benefits for their bottom line. Additionally, pilot interventions and scale-up strategies should recognize that one size does not fit all – one dimension of consumer choice might be more dominant in certain contexts.

Building a strong business case and piloting interventions to demonstrate multiple impacts (e.g., introducing smart foods to create demand for traditional foods and crops, encouraging towns to support communities' transition to resilient, low-carbon communities) will be central to scaling up such behavior change programs. Yet a business case will only advance actions so far; support from other actors, particularly though public policy and supportive legislation and partnerships to facilitate scale-up, will be essential to achieving mainstream support.

FIGURE 2: The four main drivers of choice



Source: FReSH, SSD1 2018.

3. Reducing food losses and waste (FLW) associated with food processing and packaging

To reduce food losses and waste associated with food processing and packaging, it is crucial to reframe the narrative from one centering on the cost of food to one emphasizing the value of food, including food that is wasted.

Four main solution spaces underscore the need for evidence to enable the development of specific solutions for this:

1. **Technologies to optimize processing and preservation** (with a particular focus on preserving fresh foods to increase their shelf life)
2. **Logistics solutions** (length of supply chain and delivery method, storage facilities)
3. **Consumer-oriented solutions** (portion size, replenishment and leftover management – technologies and apps)
4. **Mathematical modeling** (in order to limit the number of experiments that would produce FLW)

Barriers include regulatory restrictions on price agreements and purchasing agreement opacity. Consumer acceptance of processed foods is an area that requires more focus, as well as changing consumer mindsets regarding willingness to overpurchase and then waste food. There are imbalances in production versus demand, sometimes leading to overproduction, which in turn can result in food loss.

Levers include technology that producers can use to access up-to-date market information. Additionally, loans for good practice can provide incentives for producers to adopt positive production and processing methods.

To maximize impact, the FReSH platform is an ideal space to facilitate the sharing of best practices on FLW in a precompetitive space. To respond to the urgency for immediate change, businesses could adopt both incremental measures, such as shorter-term quick wins, and more systemic, longer-term solutions that might be more challenging to execute but more transformational in impact.

Reframing the current discourse will require putting individual well-being at the core of business solutions rather than viewing consumers as reluctant followers of business trends

Advancing these solutions

FReSH, WBSCD and EAT have a role in supporting the specific solutions put forth by Science to Solutions Dialogue 1: Putting Food in Food and in championing the required change on global platforms. In particular, these organizations recognize their responsibility to:

1. Create and amplify a new narrative that drives action;
2. Build the business case for action;
3. Support the development of action frameworks;
4. Curate the evidence needed to support action;
5. Normalize cross-sector collaboration; and
6. Gain support from other actors to achieve tipping points for transformation.

About FReSH

FReSH (Food Reform for Sustainability and Health) is a key WBCSD initiative aimed at food system transformation and industry change that emerged from the EAT–WBCSD partnership.

We turn the conventional 'farm to fork' approach on its head by working from 'fork to farm' to develop, implement and scale transformative solutions that are aligned with science-based targets.

This means we start with people, focusing on their consumption habits. Then we work back through the food system – from retail, packaging and distribution to how and what we grow – to determine what levers business can pull to contribute to food system reform in order to create healthy, enjoyable food for all, produced responsibly, within planetary boundaries, by 2030.

FReSH was jointly launched in January 2017 by EAT and the WBCSD and 25 founding member companies. The total membership has since grown to 36 companies thus far.

The entire outcome report can be found on the website of FReSH – we would welcome your thoughts and feedback to support food system transformation to create healthy, enjoyable food for all, produced responsibly within planetary boundaries by 2030.

Correspondence: ***Alison Cairns,***
Maison De La Paix, Chemin Eugène-Rigot, 2B,
Case Postale 2075, CH-1211, Geneva 1, Switzerland
Email: *cairns@wbcsd.org*

References

01. FAO. Food and agriculture: key to achieving the 2030 Agenda for Sustainable Development. Rome: FAO; 2016.
02. FAO, IFAD, UNICEF, WFP, WHO. The state of food security and nutrition in the world 2017. Building resilience for peace and food security. Rome: FAO; 2017.
03. WHO, FAO. Guidelines on food fortification with micronutrients. Geneva: WHO; 2006.
04. WHO. Global Health Observatory (GHO) data: overweight and obesity. Internet: www.who.int/gho/ncd/risk_factors/overweight_text/en/ (accessed 4 January 2018).
05. Vermeulen SJ, Campbell BM, Ingram JSI. Climate change and food systems. Annu Rev Environ Resour. 2012;37:195–222.
06. Foley JA, Ramankutty N, Brauman KA, et al. Solutions for a cultivated planet. Nature. 2011;478(7369):337–42.
07. Comprehensive Assessment of Water Management in Agriculture. Water for food, water for life: a comprehensive assessment of water management in agriculture. London: Earthscan; 2007.

How to Get Consumers to Choose Fruits, not Fries

Marti J. van Liere
Independent consultant, France

Valerie Curtis
London School of Hygiene and Tropical Medicine, Department of Disease Control, UK

Key messages

- Evolutionary theory explains human taste preferences for fat, sweet and salty, which is detrimental for food choices in today's omnipresence of cheap, unhealthy foods.
- Compliance with healthy eating practices requires high levels of self-control and an orientation towards the future, both being unnatural for most people.
- Private-sector marketing taps successfully into people's tendency for impulsive behavior, our need for immediate benefits and fitting into the social group and our aversion to change or choice from fear of losing what we have and know.
- Similar marketing techniques can be used to promote healthy foods and healthy eating habits.
- Healthy foods must become the easy and convenient, the desirable and affordable, the rewarding and status-enhancing choice and habit.

Introduction

Why do many consumers choose french fries over fruits? Soft drinks over plain water? Baby formula over breastfeeding? Packaged crisps over carrot sticks? How is it that the marketing and promotion of fatty, salty and sweet ultraprocessed foods is so effective – with consequences for obesity, overweight and diet-related noncommunicable diseases (NCDs)? And what can be learned from these practices to influence consumer food choices towards eating healthy foods?

> "How is it that the marketing and promotion of fatty, salty and sweet ultraprocessed foods is so effective?"

Evolution has prepared human beings to live in environments of food scarcity where survival required high levels of physical activity.[1] This gave humans their appetite for fatty, sweet foods and their capacity to accumulate fat. However, in a modern world of cheap and easily available food and energy-saving devices[1,2] this contributes to overeating. We humans have a preference for high-fat (energy-dense) and sweet foods, as this helped us to survive in a natural environment where access to food was erratic and limited.[3] This was still true until recent decades: foods were precious, meals were shared with family and sweets were a reward for good behavior from a loving mother.

Nowadays, treats are cheap – they are everywhere, every day. Modern technology has played into consumer preferences and made these desired foods cheap and easy to obtain, prepare and consume. Market competition between companies has amplified the appealing characteristics of products, leading to more sweet, fat, salty and colorful food that is more 'convenient.' Also in low-income countries, infants and young children at risk of

Why do so many consumers choose french fries over carrot sticks?

undernutrition are being fed commercially produced snacks and sugar-sweetened beverages instead of nutritious complementary foods.[4,5]

This toxic combination of human taste preferences and the omnipresence of cheap, desirable foods responding to these preferences has contributed to the obesity pandemic. Also, studies from the US and Brazil have demonstrated that the consumption of ultraprocessed foods has a negative impact on micronutrient intake.[6,7] The solution is not a simple one: behavior change is not only about the food choices that individuals make. It will be necessary to change the food environment, by ensuring that healthy foods are just as cheap, attractive and available, and by regulating the production and marketing of unhealthy foods. Efforts to influence consumer food choices towards healthy eating will not be sufficient on their own.

> "The solution is not a simple one: behavior change is not only about the food choices that individuals make"

Determinants of food choices

What consumers at the under- or overnutrition end of the spectrum want or what foods they choose is determined by numerous individual, societal and food determinants, as is illustrated in Figure 1 (adapted from Frewer, Risvik and Schifferstein).[8] Individual factors include, for instance, knowledge and awareness, emotions, self-efficacy and habits.

The ensemble of societal and food factors is also called the food environment. Food environments are defined as the collective physical, economic, policy and sociocultural surroundings, opportunities and conditions that influence people's food and beverage choices and nutritional status.[9] They include food composition, food labeling and packaging, food prices, food availability or provision in schools and other settings and trade policies affecting food availability, price and quality.[9]

In this short article, we aim to unravel the food choice determinants that are being used effectively by commercial marketing and promotion according to their influence on our eating behavior. Regardless of whether the problem is under- or overnutrition, these same insights can be used to promote healthy food choices for a diversified, balanced diet.

Self-control versus impulsive food choices

Traditionally, the public sector has focused on influencing knowledge, awareness and self-efficacy. Rational knowledge-enhancing key messages are sent to consumers about the need to consume more fruits and fewer snacks and soft drinks, and about the importance of breastfeeding babies or using iodized salt. Rational messages tap into our higher-level brains, asking us to imagine the long-term health benefits of applying self-restraint at the present time. However, it is well known that humans are temporal discounters, seeing more value in the present than in an uncertain future.[10] Health educators expect that we should apply high levels of self-control and be future-oriented – both of which are unnatural for most people.

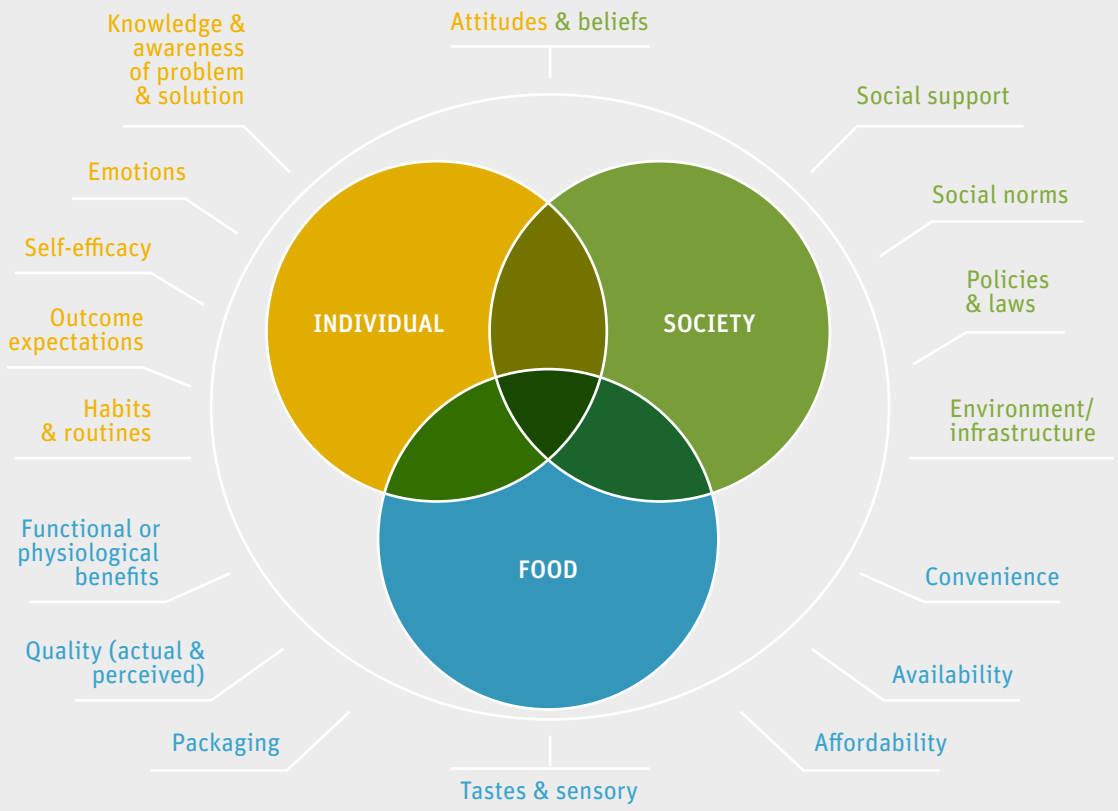
> "Health educators expect that we should apply high levels of self-control and be future-oriented – both of which are unnatural for most people"

According to Logue,[3] the difficulty of demonstrating self-control is explained by our evolutionary heritage: behavior, including eating behavior, is determined by choices between self-control or impulsive alternatives with an immediate benefit. For early sedentary agriculturists, about 10,000 years ago, life and access to food was uncertain and unpredictable, leading to impulsive decisions to take whatever food was available, whenever it was available.[3] Outcomes in the future were less valued than immediate outcomes. Though in today's world there is much less uncertainty in food supply, people are still discounting the likelihood of future negative consequences.

Whereas the public sector often relies on the assumption of self-controlled behavior, the private sector makes effective use of the human tendency for impulsive, emotionally motivated behavior. Marketers tap into emotional, underlying, or subconscious consumer motivations that deliver more immediate

A contemporary café. Commercial promotion techniques play to the fact that human beings look for the easy choice and the immediate benefit.

FIGURE 1: Determinants of food choices



Source: Modified from Frewer, Risvik and Schifferstein, 2001.

– albeit not always rational – benefits.[11] Commercial promotion techniques play to the fact that human beings are by nature lazy: they look for the easy choice and the immediate benefit, they prefer the status quo over change, and they like to conform to what others do.[11]

The attractiveness of unhealthy versus healthy foods

Modern processing technology has made foods available, affordable, easy to get and convenient. Food factors that appeal to consumers include functional attributes, food quality and safety, attractive packaging and sensory attributes. Such attributes are being used to successfully promote ultraprocessed foods using the four key principles in commercial product marketing called the 4 P's: Product, Price, Promotion and Placement.[12] Similar principles need to be applied to healthy, nutritious and less-processed foods.

Product attributes: Food companies have begun making efforts in reformulating food composition to reduce the 'baddies' in their foods (saturated fat, sugar, and salt). They can do even more to increase the 'goodies' (e.g., fibers, micronutrients), while maintaining similar taste and desirability to consumers. Attractive product packaging of the right size is another product attribute used to guide the consumer's choice for snacks and ultraprocessed foods. Less-processed foods should be offered in attractive, convenient, right-sized packages as well.

> "Less-processed foods should be offered in attractive, convenient, right-sized packages as well"

Price: In Western society, the higher price of healthier foods compared to less-healthy foods may inhibit low-income consumers to make the healthy choice.[13] At the same time, consumers in low-income countries often choose a branded, processed food product of trusted reputation over a non-branded, locally produced product.[14]

Food companies and supermarkets need to use pricing strategies to make healthier foods more affordable and accessible.

If consumers are to switch to better diets, then healthy food options must be both attractive and affordable

For instance, the 'buy-one-get-one-free' promotions for junk foods can be used to promote fruits. Subsidies on healthy foods or additional taxation of unhealthy foods may help to shift the price advantage. Also, healthy foods should be made available in single-portion sizes for a healthy snack on the go, priced at a magical price point that corresponds to that one coin or note of cash that consumers have in their pocket and use for a quick purchase.[15] Rao and his coauthors[13] suggest that an improved infrastructure and commercial framework facilitating production, transportation and marketing of healthier foods could increase the availability and reduce the prices of more healthy products.

Promotion: Nutritious foods, such as fruits, vegetables and eggs are often non-branded and are rarely the subject of a marketing campaign. Producer groups supported by public health authorities should invest in promotion campaigns of fresh healthy products, using attributes such as 'fresh,' 'natural,' 'healthy,' or 'locally produced' to promote their consumption. For healthy processed foods, attributes such as 'low in fat,' 'high in fiber,' and 'enriched with vitamins and minerals' can be used to guide consumers' choices. Promotion must follow regulations of food standards, front-of-pack labeling or health claims. Signaling approaches to inform consumers about the healthier choice will only work if the message is easy to understand and the food is also an easy choice – as simple to prepare, as affordable and as tasty as the less healthy choice.

Placement: Finally, it is not just direct promotion of the foods or their price, but also their placement (in shops, in easy eyesight, in kiosks, in schools, or in popular TV shows or internet blogs) that influences the consumer choice. Restrictions should be made on placement of unhealthy foods, banning them from school vending machines, cafeterias and checkouts. Simultaneously, incentives should be put in place for producers of healthy, nutritious foods to distribute and make their products available in these environments.

Societal support for individual healthy food choices

The attractiveness of food is not just about the features of a particular food product. Nor is it simply about where it is consumed, and in whose company. Societal norms and values around food exert a massive influence on our food choices. Early in life we are influenced by family traditions such as family Christmas or Chanukah dinners, but the way parents talk about food, cook meals and eat together also has a huge influence on the healthy eating habits that a child develops.[16]

More often people eat on the couch in front of the TV instead of the family table and youngsters hang out in fast food restaurants with their peers.

Later in life, people are influenced by their peers and role models, but also by social media and hidden product promotion in TV series or by bloggers. Celebrity chef Jamie Oliver uses

his fame to campaign for healthier food options, thus helping to change social food norms in the UK.[17]

Restrictions on promotion and placement of unhealthy foods are being put in place in various countries or municipalities, specifically when it comes to marketing to children. Though these restrictions are helpful, they only address one end of the spectrum and do not help to make healthy foods more attractive. Food companies, restaurants and supermarkets should be incentivized to market healthy foods to children, using effective techniques that are currently being used to sell unhealthy foods – for instance, using cartoon characters to promote the consumption of fruits and vegetables, quality protein and low-fat dairy snacks and water.

Applying the psychology of choice to healthy eating: Concluding remarks

The abundant availability of unhealthy foods directly appeals to humans' inborn need to accumulate fat for times of energy scarcity at a high cost. In combination with aggressive marketing techniques that appeal to our tendency for impulsive behavior, this contributes to the obesity pandemic and the increasing double burden of nutrition in developing and emerging economies.

> "Instead of appealing to rational behavior to achieve long-term goals, public health nutritionists should make use of the psychology of choice"

The same marketing techniques can be used to promote healthy foods and healthy eating habits. Instead of appealing to rational behavior to achieve long-term goals, public health nutritionists should make use of the psychology of choice. Cognitive psychologists and behavioral economists have extensively described how psychological traits influence human behavior. They have described that people do not like change (status quo bias), do not like to lose anything (loss aversion), have a strong preference for 'free' products, would rather not make a choice (default bias), prefer immediate over long-term benefits (discounting delayed events) and imitate others (social proof).[18,19]

Few companies will offer insights as to how they determine their marketing strategies. One company published its generic approach, which draws on lessons from cognitive psychology and behavioral economists.[20] Some companies work in partnership with public health organizations and apply their insights to public health campaigns.[21]

Public health authorities continuously state that food habits are hard to change, but this viewpoint is contradicted by the wholesale transformation of our diets that has occurred over the past few decades. If we want to turn the tide and encourage people towards healthier eating habits, we must learn the lessons about how the food industry changed our habits in the first place. This means more than just making (the choice for) healthy foods easy to understand. We must also:

- **Make healthy food both desirable and affordable**
  – through the use of colorful packaging, single-size portions and subsidies;
- **Reward the consumer for making healthy food choices**
  – by rendering the attendant health effect visible (e.g., reduction in number of sugar lumps, provide rewards for repeat behavior such as stickers, points, etc.);
- **Use normative and status-enhancing exemplars**
  – by having heroes, role models and key figures in society publicly exercise healthy food choices; and
- **Make healthy eating a habit**
  – by introducing healthy food consumption at key points in the day, for instance, by linking fruit consumption to breakfast or a midafternoon snack, and ensuring there are plenty of reminders to repeat the behavior over and over in order to encourage the formation of good habits.

If we can make all arrows of the food environment and individual food choices point in the same direction, we can create a food revolution that alleviates the double burden of malnutrition and improves diets across the world.

Correspondence: ***Marti J. van Liere,***
Email: *marti.j.vanliere@gmail.com*

References

01. Wells JC. The evolution of human fatness and susceptibility to obesity: an ethological approach. Biol Rev Camb Phil Soc. 2006;81(2):183–205.
02. Bellisari A. Evolutionary origins of obesity. Obes Rev. 2008;9(2):165–80.
03. Logue AW. Evolutionary theory and the psychology of eating. New York: Baruch College, City University of New York; 1998.
04. Bielemann RM, Pozza Santos L, dos Santos Costa C, Matijasevich A, Santos IS. Early feeding practices and consumption of ultra-processed foods at 6 yrs of age: findings from the 2004 Pelotas (Brazil) Birth Cohort Study. Nutrition. 2018;47:27–32.
05. Pries AM, Huffman SL, Champeny M, Adhikary I, Benjamin M, Coly AN, et al. Consumption of commercially produced snack foods and sugar-sweetened beverages during the complementary feeding period in four African and Asian urban contexts. Matern Child Nutr. 2017;13(Suppl 2):e12412.
06. Martínez Steele E, Popkin BM, Swinburn B, Monteiro CA. The share

of ultra-processed foods and the overall nutritional quality of diets in the US: evidence from a nationally representative cross-sectional study. Popul Health Metrics. 2017;15(1):6.

07. Louzada ML da C, Martins APB, Canella DS et al. Impact of ultra-processed foods on micronutrient content in the Brazilian diet. Rev Saúde Públ. 2015;49:45.
08. Frewer LJ, Risvik E, Schifferstein H. Food, people and society, a European perspective of consumers' food choices. Berlin: Springer Verlag; 2001.
09. Vandevijvere S, Swinburn B. Creating healthy food environments through global benchmarking of government nutrition policies and food industry practices. Arch Publ Health. 2014;72(1):7.
10. Cisneros PMC, Silva CLH (2017) Temporal discounting and health behavior: a review. MOJ Pub. Health 2017;6(6):00189.
11. Wilcox M. The business of choice: marketing to consumers' instincts. Upper Saddle River, NJ: Pearson Education, FT Press; 2015.
12. McCarthy EJ. Basic marketing: A managerial approach. Homewood, IL: R. D. Irwin; 1960.
13. Rao M, Afshin A, Singh G, Mozaffarian D. Do healthier foods and diet patterns cost more than less healthy options? A systematic review and meta-analysis. BMJ Open. 2013;3(12):e004277.
14. van Liere MJ, Shulman S. Creating consumer demand and driving appropriate utilisation of fortified foods. In: Mannar V, Hurrell R, eds. Food fortification in a globalized world. Elsevier; 2018:101–12.
15. MQSUN. Where business and nutrition meet: review of approaches and evidence on private sector engagement in nutrition. Washington, DC: MQSUN+ Report; in publication.
16. Weinstein, M. The surprising power of family meals. How eating together makes us smarter, stronger, healthier and happier. Hanover, NH: Steerforth Press; 2005.
17. Jamie Oliver. Campaign news. 2018. Internet: www.jamieoliver.com/campaigns (accessed 27 July 2018).
18. Kahneman D. Thinking, fast and slow. New York, NY: Farrar, Straus and Giroux; 2011.
19. Ariely D. Predictably irrational: the hidden forces that shape our decisions. New York, NY: Harper Perennial; 2010.
20. Curtis VA, Garbrah-Aidoo N, Scott B. Masters of marketing: bringing private sector skills to public health partnerships. Am J Publ Health. 2007;Apr 97(4):634–41.
21. Unilever. Expert insights into consumer behavior and Unilever's five levers of change. London: Unilever; 2011. Internet: www.unilever.com/Images/slp_5-levers-for-change_tcm244-414399_en.pdf (accessed 27 July 2018).

A Children's Rights Approach to the Double Burden of Malnutrition

Julie Teresa Mortensen
Sight and Life, Basel, Switzerland

Key messages

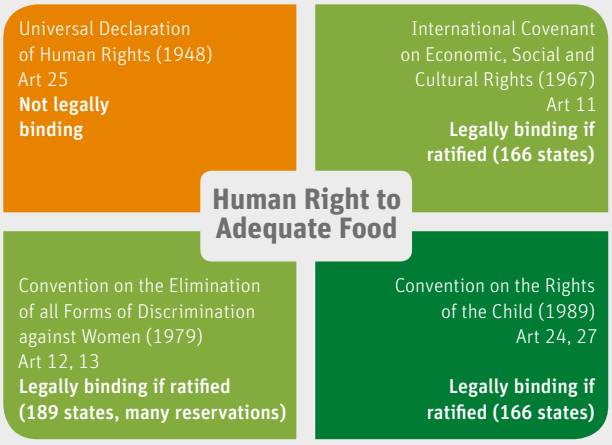
- The Human Right to Adequate Food can be found in a number of international human rights documents, the most widely accepted of which is the Convention of the Rights of the Child.
- The requirements under the Human Right to Adequate Food – to respect, to protect, to fulfill – can be linked to policy measures and global nutrition targets.
- This connection gives more weight to interventions fighting the Double Burden of Malnutrition and can play a significant role in bringing about a world free from malnutrition.

The Human Right to Adequate Food has a broad legal basis and is articulated in numerous international human rights documents (see **Figure 1**), some of which focus on a particular group of individuals in specific circumstances, such as refugees, women and children. The most widely accepted of these documents is without doubt the Convention on the Rights of the Child (CRC): not only is it legally binding, but it is also the most widely ratified international document in history (all countries have ratified it except the United States). It is a symbol that the international community can reach a consensus – after all, the protection of children is a global concern. The importance of good nutrition during the first 1,000 days (from conception to the second birthday of a child) is globally known and accepted, as interventions during this timeframe reap the greatest benefits. The double burden of malnutrition represents the presence of both undernutrition and overnutrition, leading to various health issues. As the basis for a healthy life is laid down during childhood, the rights of the child present an opportunity to attribute more importance to the problem of malnutrition, as depicted in **Figure 1** below.

> The human right to adequate food aims to create an environment in which all people can provide for themselves by producing or buying food.[1]

One of the reasons why the Human Right to Adequate Food (HRTAF) has not received the necessary attention is the misunderstanding that it obliges states to hand out free food to everybody. Because this leads to dependency or might not be feasible

FIGURE 1: Key documents articulating the Human Right to Adequate Food (HRTAF)



The HRTAF is laid down in a number of international human rights documents. Orange indicates that the document is not legally binding, while the shades of green depict the extent of ratification of the document. The CRC is the most widely ratified of these documents.

at all, some states have been reluctant to put the realization of the HRTAF on the political agenda. However, it is in fact the individual's ability to provide for him- or herself that is covered as the right to adequate food.[2]

> The right to adequate food is realized when every man, woman and child, alone or in community with others, have physical and economic access at all times to adequate food or means for its procurement. The right to adequate food shall therefore not be interpreted in a narrow or restrictive sense that equates it with a minimum package of calories, proteins and other specific nutrients. The adequacy element further entails to take cultural acceptability into account, such as perceived non-nutrient-based values attached to food.[3]

Even though human rights, and thus the human right to adequate food, can only be realized when all members of society play their part, the primary owner of human rights obligations is the respective national government. After all, the government signed human rights documents, and is therefore bound to the three requirements – to respect, to protect, to fulfill – under the human rights regime, which are also valid for children's rights.

We intend to link these requirements at the different levels of society with specific, tangible policy interventions that address both sides of the double burden of malnutrition. The WHO Double Duty policy recommendations can be used as a starting point. These are: **1)** exclusive breastfeeding in the first six months; **2)** improvement of early nutrition; **3)** improvement of maternal nutrition and ante-natal care; **4)** implementation of school food policies and programs; and **5)** the regulation of marketing activities.[4] The author is aware that there are many more policy interventions needed to solve the double burden of malnutrition globally.[5]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Beneficiaries of a household feeding program in Mirjagonj Union, Bangladesh

Obligations under the Human Right to Adequate Food (HRTAF)

Negative duty: the duty to refrain from doing something (in this case: refrain from interfering).
Positive duty: the obligation to take positive action.

The first obligation – 'to respect' – is a negative duty and falls directly on the state. Its primary obligation is to respect the freedom of each citizen to find a solution for his/her own nutritional situation and to ensure that state parties should not block existing access to adequate food, such as functioning market systems.[6] This can be construed to as the obligation of non-interference of the state itself – for example, by respecting cultural habits in relation to food choices or the role of NGOs.

The second obligation – 'to protect' – is also a negative duty. It falls on the state, but it does not target state actors. Instead it focuses on the behavior of non-state parties. This means that citizens' access to adequate food is protected by state parties from the harmful influence and interference of non-state actors, such as enterprises or individuals. The state must take positive action to protect the individual's right and hinder third parties from interfering with it, for example by designing national legislation governing maternity leave or by the promotion of breast-milk substitutes.

The third requirement – 'to fulfill' – can be further divided into two duties. The duty "to facilitate" means actively pursuing policies that ensure people's access to subsistence. Primarily, states are required to build an enabling environment consisting of economic and social systems, laws and institutions that support the individual's access to food and development. The elimination of gender-based discrimination or universal primary education can also be mentioned. Only under the second

TABLE 1: Requirements under the Human Right to Adequate Food at different levels of society.[8]

Level of Society | requirement under HRTAF	To respect	To protect	To facilitate	To fulfill
Individual | household	› Respect positive cultural habits in food, health, care › Respect individual choices	Protect individual / household from any type of exploitation and deterioration of entitlements necessary for nutrition security	› Facilitate transfer of knowledge/skills in relation to nutrition sector (capacity building) › Facilitate reducing poverty (access to social safety nets)	Provide direct support to individuals/households whose entitlements have broken down or are at risk
Community | district	Respect establishment of democratic community organizations	Protect communities and areas from economic / cultural marginalization and exploitation	Facilitate community/district situation assessment and analysis	Reduce geographic disparities in resources
National	Respect the role of NGOs in poverty alleviation and nutrition	Protect individuals through legislation (Code of Marketing for Breastmilk Substitutes; salt iodization; maternity leave, food safety), regulatory system, food safety standards	› Ensure universal primary education › Reduce gender-based constraints	› Provide basic services in health, agriculture, water, sanitation › Incorporate nutrition in surveillance system
International	Respect different ideologies (culture, religion, habits)	› Protect countries from the use of food as a political weapon › Protect civilians from unacceptable suffering in times of disaster	Facilitate international exchange and transfer of information, expertise, and experience in nutrition	› Assist victims of disasters, wars, other abuses › Monitor the progress in nutrition

part of the third obligation – the duty 'to provide' – is the state obliged to provide food or subsidies directly to individuals under specific circumstances. This latter obligation only takes effect if individuals are unable to provide food for themselves for reasons beyond their control (in the case, for instance, of natural disaster or particularly vulnerable groups). Under this requirement, the state is obliged, for example, to reduce geographic disparities in resources and to provide basic services in health and sanitation.

These three requirements can be realized at different levels of society – individual / household, regional / community, national and international level. Table 1 shows the obligations under each requirement at each societal level.[7]

In the following sections, the WHO double-duty policy recommendations[9] will be linked with the obligations under the HRTAF. As the last step, the connection between these policies and selected international nutrition targets will be shown.

Exclusive breastfeeding in the first six months

The importance of advocating for exclusive breastfeeding in the first six months has been accepted by the scientific community. This policy recommendation can be found under the **requirement to respect** at the individual/ household level, as the state is required to respect cultural habits and individual choices relating to food, health and care. On the other hand, there is also a link to the **requirement to protect** at the national level, as this obliges the state to protect the individual through legislation concerning marketing or food labeling – such as the implementation of the Code of Marketing for Breastmilk Substitutes. Furthermore, by strengthening the transfer of knowledge in relation to the nutrition sector and reducing gender-based constraints, breastfeeding behavior also falls under the **requirement to facilitate** at the individual and national level, respectively. Workplace policies enabling women to take breaks to breastfeed their children, or parental leave regulations, can

Complementary feeding at Kakuma Refugee Camp in Kenya

also have a positive impact on breastfeeding behavior. To sum up, strengthening breastfeeding has a far-reaching impact on the future health of an individual. Its relevance to the development of a child is undeniable, and it falls under several requirements of the children's right to adequate food.

Improvement of early nutrition

The necessity of healthy nutrition, not only during breastfeeding, but in general during early childhood, is the focus of the second policy recommendation. It can be categorized under the **requirement to respect** at the individual/household level, as the state is obliged to respect positive cultural values and individual choices in relation to nutrition, health and care. It further falls under the **requirement to protect** at the national level, as legislative regulations concerning the marketing and labeling of foodstuffs can have a considerable impact on nutrition decisions for young children.

Improvement of maternal nutrition and antenatal care

The role of maternal nutrition and health for the developing child is evident and is dependent on the reduction of discrimination against women. Such measures fall under the **requirement to facilitate** at the national level. The focus on the mother is further present under the **requirement to facilitate** at both the regional and national level, which require states to reduce geographic disparities (roads, infrastructure) and provide basic health services.

The first three WHO policy measures clearly focus on the importance of early nutrition for the development of the child. When designing specific policy interventions, special attention should be given to the crucial window of the first 1,000 days. Furthermore, they all show the important linkages between nutrition, children's rights and gender issues, revealing the interdependency of nutrition interventions and human rights.

Implementation of school food policies and programs

There are many examples of school food programs and policies

A Wayuu mother feeding her daughter in La Guajira, north Colombia

TABLE 2: WHO recommendations with the potential to improve rates of overweight in childhood

	SDG	WHA	WHO policies
Stunting, wasting	2.1, 2.2	1, 2	1, 2, 3, 4
Childhood mortality	3.2	4, 5, 6	1, 2, 3, 4, 5
Premature NCDs	3.4	3	5

Source: WHO, 2017

having positive effects on the nutrition status of children (World Food Programme, 2012).[10] These measures are firstly covered by the **requirement to protect** at the national level, which obliges the state to impose food standards and a regulatory system for marketing. Secondly, the **requirement to facilitate** at the national level shows an entry point for these interventions, as it states the importance of universal primary education. In case the entitlements of an individual (in this case a school child) have broken down or are at risk of breaking down, school food policies could oblige states **to provide** foods to the individual level directly.

The regulation of marketing activities

The requirement to protect focuses on the non-interference of non-state actors and calls for regulation of the private sector at the national level. This covers the last policy recommendation of the WHO double duty – the call for marketing regulation.

Connection to global development goals

It is undeniable that all 17 Sustainable Development Goals (SDGs) have linkages with nutrition. SDG 2 specifically aims to end hunger (2.1), with a specific target on stunting and wasting reduction (2.2). SDG 3 is the goal of good health, and targets 3.2 and 3.4 focus on the preventable deaths of children under five and the reduction of premature mortality from NCDs, respectively (Table 2).

Another important set of global nutrition goals are the five targets formulated by the World Health Assembly (WHA), which are to be reached by 2025: a reduction of stunting, wasting, anemia in women in reproductive age and low birth weight, an increase in exclusive breastfeeding, and no increase in childhood overweight (Table 2). Both the SDGs as well as the WHA targets focus on the double burden of malnutrition, as both undernutrition and overweight are covered.

SDG 2.1 and 2.2 and WHA targets 1 and 2 all present a reduction of stunting and wasting. One also cannot deny the impact of anemia in women, exclusive breastfeeding and low birth weight (WHA 4, 5, 6) on preventable deaths of children under five (SDG 3.2). And it is further clear that no increase in childhood overweight (WHA 3) can improve the rate of premature mortality from NCDs (SDG 3.4).

As a next step, one could also argue that these global nutrition goals can be reached, at least partly, with the WHO double-duty actions. Based on the Lancet Framework, exclusive breastfeeding, early nutrition, maternal nutrition and antenatal care and school food policies (WHO policies 1, 2, 3, 4) can all lead to improved nutrition and therefore bring about a positive impact on stunting, wasting and death rates of children under five.

TABLE 3: Overview over the links between policy recommendations, nutrition targets and the HRTAF requirements

WHO policy	HRTAF requirement	SDG	WHA
Exclusive breastfeeding	To respect (individual)	2.1 end hunger	1, 2 stunting, wasting
	To protect (national)	2.2 stunting, wasting	4, 5, 6 anemia, exclusive
	To facilitate (national)	3.2 preventable deaths < 5	breastfeeding, LBW
Early nutrition	To respect (individual)	2.1 end hunger	1, 2 stunting, wasting
	To protect (national)	2.2 stunting, wasting	4, 5, 6 anemia, exclusive
	To facilitate (national)	3.2 preventable deaths < 5	breastfeeding, LBW
Maternal nutrition, antenatal care	To facilitate (national)	2.1 end hunger	1, 2 stunting, wasting
	To fulfill (national)	2.2 stunting, wasting	4, 5, 6 anemia, exclusive
		3.2 preventable deaths < 5	breastfeeding, LBW
School food policies, programs	To protect (national)	2.1 end hunger	1, 2 stunting, wasting
	To facilitate (national)	2.2 stunting, wasting	4, 5, 6 anemia, exclusive
	To provide (individual)	3.2 preventable deaths < 5	breastfeeding, LBW
Marketing	To protect (national)	3.2 preventable deaths < 5	4, 5, 6
		3.5 premature NCDs	3 childhood obesity

Additionally, all five of the WHO recommendations have the potential to improve the rates of childhood overweight that are linked to premature mortality from NCDs (see Table 2).

Summary

In conclusion, there are several links between the two selected sets of targets for global nutrition goals – the SDGs and the nutrition targets formulated by the World Health Assembly. These can be implemented, at least to a certain extent, with the WHO double-duty policy recommendations, which would lead to a reduction of the double burden of malnutrition (underweight and overweight/obesity). And as the first part of this paper has shown, these policy recommendations can be related to the requirements under the children's right to adequate food. There are three levels influencing each other: international nutrition targets; policy recommendations; and the human rights framework, focusing especially on children's rights (see Table 3).

> "States are required to take appropriate action towards the realization of all human rights"

There is without doubt some criticism in relation to the practical applicability of the Convention of the Rights of the Child due to weak enforcement possibilities. However, states are still required to take appropriate action towards the realization of all human rights. Although this article does not present groundbreaking new evidence, it does provide new insights into how existing ideas can be connected and used as a combined force to make a stronger case for good nutrition. Connections as such should be leveraged to remind governments of their human rights obligations when discussing the implementation of nutrition policies. This framework can additionally be used to make the private sector aware of duties in relation to the protection of children. Making a stronger multisector case for children's rights is an important step to reach what might be the most important goal humanity faces today – a world free from malnutrition.

Correspondence: ***Julie Teresa Mortensen,***
Intern at Sight and Life, PO Box 2116, 4002 Basel, Switzerland
Email: *julie.m94@hotmail.com*

References

01. FAO. Right to adequate food. Rome: FAO; 2015.
02. UN Office of the High Commissioner for Human Rights (OHCHR). Fact Sheet No. 34, The Right to Adequate Food; April 2010, No. 34. Internet: www.refworld.org/docid/4ca460b02.html (accessed 16 August 2018).
03. UN Committee on Economic, Social and Cultural Rights (CESCR). General Comment No. 12: The Right to Adequate Food (Art. 11 of the Covenant). Internet: www.refworld.org/docid/4ae562c52.html (accessed 17 August 2018).
04. WHO. Double-duty actions: policy brief. Geneva: WHO; 2017.
05. Bhutta ZA, Ahmad T, Black RE, Cousens S, Dewey K, Giugliani E et al, for the Maternal and Child Undernutrition Study Group. What works? Interventions for maternal and child undernutrition and survival. Lancet. 2008;371(9610)417–40.
06. Mechlem, K. Food securtiy and the right to food in the discourse of the United Nations. European Law Journal. 2004;10(5):631–48.
07. Jonsson U. Nutrition and the United Nations Convention on the Rights of the Child. (UNICEF, Ed.) Innocenti Occasional Papers;1993:1–53.
08. Jonsson U. Nutrition and the United Nations Convention on the Rights of the Child. (UNICEF, Ed.) Innocenti Occasional Papers; 1993:1–53.
09. WHO. Double-duty actions. Policy brief. Geneva: WHO; 2017.
10. WFP. Learning from eExperience – good practices from 45 years of school feeding. Rome: WFP; 2012.

The Double Food and Environmental Pyramid

Addressing the double burden of malnutrition and achieving the SDGs

Marta Antonelli and Katarzyna Dembska
BCFN Foundation, Parma, Italy

Key messages

- The number of undernourished people in the world has risen to 821 million people, 2 billion people lack key micronutrients and 2 billion people are overweight or obese and at risk of diseases related to overconsumption.
- The agricultural sector accounts for one-third of greenhouse gas (GHG) emissions, for the largest share of freshwater withdrawals (70% on average) and for 90% of the water footprint of humanity, as well as 12% of land use.
- The food system is where the spheres of health and the environment intersect. The Double Pyramid shows that the foods with the lowest environmental impact are the same as those that are recommended for increased consumption.
- The link between nutrition and the environment is bidirectional. Eating patterns impact the environment, but the environment can also impact dietary choices.
- Food fundamentally connects people and the planet. Not only will the SDGs not be achieved if malnutrition persists, but the SDGs are also fundamental for reversing the current route of food systems, as they offer a vision of a sustainable, equitable and prosperous world where silos are broken and societal goals are pursued simultaneously.

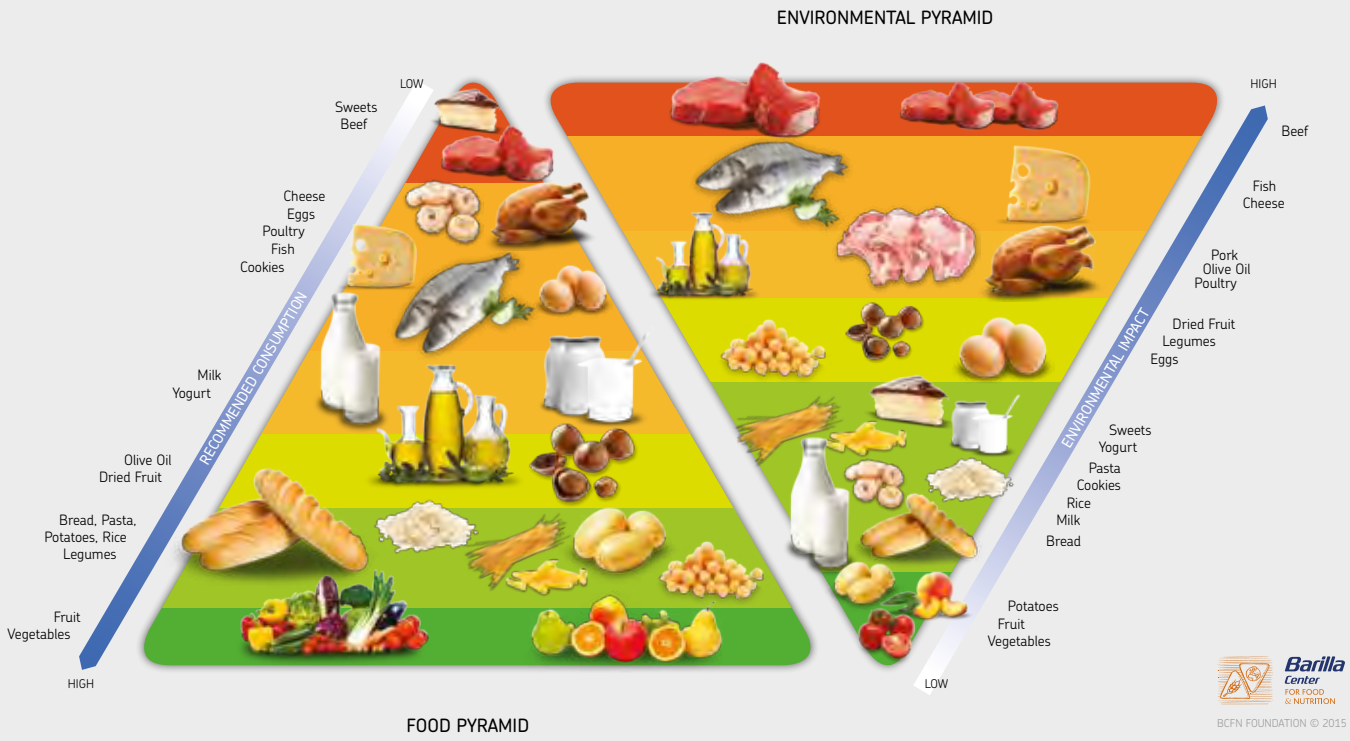
Besides being nutritionally healthy, the Mediterranean Diet has been highlighted as rich in biodiversity

Introduction: challenges of the global food system

Global food systems currently face the unprecedented challenge of feeding a growing and increasingly urbanized population, with global food production expected to increase by 70% by 2050 and nearly 100% in low-income countries to meet growing demands.[1] At present, food production is falling short of meeting nutritional requirements and guaranteeing long-term health for almost one-third of people worldwide.

The 17 Sustainable Development Goals (SDGs), adopted by the representatives of the 193 member states of the United Nations, guide the actions of various stakeholders to guarantee long-term prosperity for people and the planet. They have food systems at their very core. From ending poverty and hunger to guaranteeing health and well-being, to responding to climate change and preserving life on land and under water, to more

FIGURE 1: The Double Food and Environmental Pyramid



Source: Barilla Center for Food & Nutrition Foundation, 2015

responsible production and consumption patterns, food and sustainable diets lie at the heart of the 2030 Agenda. However, we are far from achieving these global targets.

> "Food and sustainable diets lie at the heart of the 2030 Agenda."

In 2017, the number of undernourished people rose to 821 million people, up from 804 million in 2016.[2] Globally, 151 million children under the age of five are stunted, too short for their age, and 51 million children under the age of five are wasted, too light for their height.[4] At the same time, 2 billion people lack key micronutrients[3] with iron, iodine, folate, vitamin A and zinc deficiencies being the most widespread micronutrient deficiencies (MNDs).[5] A lack of these essential vitamins and minerals often results in 'hidden hunger,' where the signs of undernutrition and hunger are less visible.[6] Low- and middle-income countries have the highest burden of MNDs; however, underestimated MNDs pose health risks in high-income economy settings as well.[5] The other side of the coin is the excess of food intake, with 2 billion people who are overweight or obese and at risk of diseases related to overconsumption. On a global scale, obesity has nearly tripled since 1975, while there has been a more than tenfold increase in the number of obese children and adolescents aged 5–19 years in the past four decades.[3,4]

> "The agricultural sector is in the spotlight, with an urgent need for change"

Against this background, the agricultural sector is in the spotlight, with an urgent need for change and calls for global action. Faced with the challenge of providing adequate and nutritious food for the world population, the sector accounts for one-third of greenhouse gas (GHG) emissions. Agricultural production is also intensive from a water and land point of view. It accounts for the largest share of freshwater withdrawals (70% on average)[7] and an astonishing 90% of the water footprint of humanity,[8] as well as 12% of land use.[1] The agricultural sector, together with forestry and other land users, is responsible for

about a quarter of human-made GHG emissions due to deforestation and agricultural emissions from livestock, soil and nutrient management.[9] The composition of diets determines the environmental impact of food. Global average dietary GHG emissions from crop and livestock production will increase by 32% between 2009 and 2050, on a per capita level, if global dietary patterns continue in line with current trends.[10]

Importantly, over the last 30 to 40 years, energy-dense foods have become cheaper, more affordable and more available, compared to fruits and vegetables. Energy-dense food cheapness has proved to be problematic and has become linked to both food waste and overconsumption.[11,12]

Sustainable and healthy diets: the Double Pyramid

The food system is where the spheres of health and the environment intersect. The need to address environmental and nutritional issues has led to a growing interest in identifying strategies aimed at promoting healthy and sustainable diets, defined as "diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations"[13] and which optimize food quality, health, environment, sociocultural values, economy and governance.[11]

The Food and Environmental Double Pyramid (DP) developed by the Barilla Center for Food & Nutrition (**Figure 1**) provides a tool for informing and educating citizens on how to eat in a healthy and sustainable way. Food items are arranged according to their contribution to a healthy diet (left pyramid) and their environmental impact (right pyramid). The food section of the DP was derived by pooling different international nutritional guidelines that can be traced back to the model known as the Mediterranean Diet, explicitly cited by FAO as an exemplary sustainable diet[12] and internationally recognized as a compass for a healthy diet, regardless of how the model is interpreted, according to different geographic locations, cultures and traditions.[14] It is widely upheld that high adherence to the Mediterranean Diet can lead to tangible health benefits, including reduced incidence of cardiovascular diseases, metabolic conditions and certain types of cancer.

"The nutritional pyramid encourages a high daily consumption of fruits and vegetables, legumes, nuts, extra virgin olive oil and cereals"

The nutritional pyramid encourages a high daily consumption of fruits and vegetables, legumes, nuts, extra virgin olive oil and cereals (50% of which are wholegrain), a moderate, weekly consumption of fish and dairy products and white meat and a low, occasional consumption of red meat and foods high in sugar content. The environmental (inverted) pyramid has been built in relation to the environmental impact of food, in terms of ecological footprint, listing the items that have a higher impact at the top and those with a lower impact at the bottom. The ecological footprint measures the assets that are required to produce the natural resources that a given population or individual consumes (e.g., plant-based food, livestock and fish products) as well as to absorb its waste.[15]

The DP clearly shows that the foods with the lowest environmental impact are the same as those that nutritionists recommend for greater consumption, while those with a higher environmental footprint are those that should be consumed in moderation.[14] Food behavior change has been recognized as significant for improving the status of the environment[16] together with improving public health.

Pathways towards better food systems

As previously stated, the link between nutrition and the environment is bidirectional. Eating patterns impact the environment, but the environment can also impact dietary choices. Besides the above-mentioned effects on human health and the environment, sustainable diets can be considered a precondition for long-term food security.[17] The environment, and especially climate and the presence of natural resources, are a precondition for the availability of food as well as the preservation of biodiversity.[18]

"One of the basic principles of nutrition is dietary diversity"

Nuts and spices can add variety and interest to a diet low in meat

Some of the key flavors in the Mediterranean Diet. It is widely upheld that high adherence to the Mediterranean Diet can lead to tangible health benefits.

Besides being nutritionally healthy, the Mediterranean Diet has been highlighted as rich in biodiversity.[6] The preservation of biodiversity can play a significant role as a strategy for fostering sustainable agricultural development and food security, as well as protecting against malnutrition.[19] The recognition of the value of biodiversity for improved nutrition is one component of the shifting paradigm in approaches to malnutrition. From a nutritional standpoint, biodiversity is intended as a variety of food and nutrients with a focus on wild and gathered species, and underutilized and underexploited food resources, leading to one of the basic principles of nutrition: dietary diversity.[19]

Past efforts to address micronutrient deficiencies have largely been based on a medical model, focused on dietary fortification and supplementation, or on increasing the micronutrient content of staple crops (biofortification). While all these approaches have their merits, agricultural biodiversity has the potential to provide a valuable complement. It has been recognized that increasing the availability and consumption of a variety of micronutrient-rich foods will not only have a positive effect on micronutrient status but also contribute to improved nutrition in general.[20] This approach goes beyond the use of specific food components, looking into including greater diversity of nutrient-dense foods. A food-based approach can effectively deliver improved nutrition, with micronutrients and other important components, such as fiber,[21] in the context of different forms of malnutrition.

Despite the evidence backing the health and environmental benefits of the Mediterranean Diet, the nutrition transition is increasingly common as more countries shift towards more Western-style diets involving increased consumption of meat, sugar, fats, and processed foods and beverages.[22,23] At the same time, the scarcity of resources, compounded by the effects of climate change, lends urgency to the call for new, innovative, and sustainable practices at the agricultural level. A number of studies have suggested that demand-side approaches may be more effective than technical agricultural mitigation options in reducing global emissions.[24] Some authors have suggested that only with a significant reduction in demand will it be possible to prevent an increase in agricultural expansion and agriculture-related GHG emissions.[25] It has been suggested that the reduction of meat consumption could be achieved through the application of economic incentives (e.g., a carbon tax), and the livestock sector should be included into a comprehensive climate mitigation policy.[26] For instance, Mexico introduced in 2014 a sugar-sweetened beverages tax of 1 peso per liter as a response to the alarming overweight and obesity trends (affecting 70% of total population), with the largest decreases in purchases of soft drinks in the poorest households.[27] These interventions need to be coupled with policy instruments focused on increasing awareness through education on healthier food and lifestyle choices, particularly for children, to effectively achieve an improvement in public health. Moreover, the externalities of agri-food systems should also be unraveled and accounted for in order to understand the true (and huge) hidden cost of food.[28] These mitigation options may be especially relevant to high-income countries, and they require sound commitment at the policy level. In low- and middle-income countries, the challenge is to overcome food insecurity and malnutrition by ensuring equitable access to a sustainable and nutritious diet.

"The SDGs are key to reversing the current direction of food systems"

Not only will the SDGs not be realized if malnutrition persists, but the SDGs themselves are key to reversing the current direction of food systems. Guaranteeing nutritious, safe, and sustainable food can result in collaborative work in the sectors of

health, education, water, land and agriculture, access to resources, women's empowerment and many other sectors. Transformative actions are needed for global diets to converge and to meet the international climate change mitigation target of 2 °C.[29] This may require recognition and agreement over internationally harmonized guidelines[30] that outline what a sustainable and nutritious diet in the 21st century should look like for both health and sustainability outcomes.

Correspondence: ***Fondazione Barilla Center for Food & Nutrition,*** *Via Madre Teresa di Calcutta, 3/a – 43121 Parma, Italy*
Email: *marta.antonelli@external.barillacfn.com; katarzyna.dembska@external.barillacfn.com*

References

01. FAO. The state of the world's land and water resources for food and agriculture (SOLAW) – managing systems at risk. Rome: FAO; 2011.
02. FAO, IFAD, UNICEF, WFP, WHO. The state of food security and nutrition in the world 2018. Building climate resilience for food security and nutrition. Rome: FAO; 2018.
03. Development Initiatives. Global nutrition report 2017: nourishing the SDGs. Bristol, UK: Development Initiatives; 2017.
04. WHO. Obesity and overweight fact sheets. 2017. Internet: www.who.int/news-room/fact-sheets/detail/obesity-and-overweight (accessed 24 July 2018).
05. Bailey RL, West Jr. KP, Black RE. The epidemiology of global micronutrient deficiencies. Ann Nutr Metab. 2015;66(Suppl 2):22–33.
06. Burchi F, Fanzo J, Frison E. The role of food and nutrition system approaches in tackling hidden hunger. Int J Environ Res Public Health. 2011 Feb;8(2):358–73.
07. FAO AQUASTAT. Water uses. 2018. Internet: www.fao.org/nr/water/aquastat/water_use/index.stm (accessed 17 August 2018).
08. Mekonnen MM, Hoekstra AY. The water footprint of humanity. PNAS. 2012 Feb;109(9): 3232–7.
09. Smith P, Bustamante M, Ahammad H, Clark H, Dong H, Elsiddig EA, et al. Agriculture, forestry and other land use (AFOLU). In: Edenhofer O, Pichs-Madruga R, Sokona Y, Farahani E, Kadner S, Seyboth K, et al., eds. Climate change 2014: mitigation of climate change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. New York, NY: Cambridge University Press; 2014:811–922.
10. Tilman D, Clark M. Global diets link environmental sustainability and human health. Nature. 2014 Nov;515:518–22.
11. Mason P, Lang T. How ecological nutrition can transform consumption and the food system. Oxon: Routledge; 2017.
12. Wiggins S, Keats S. The rising cost of a healthy diet. Changing relative prices of foods in high-income and emerging economies. London: Overseas Development Institute; 2015.
13. FAO. Sustainable diets and biodiversity. Rome: FAO; 2010.
14. Ruini LF, Ciati R, Pratesi CA, Marino M, Principato L, Vannuzzi E. Working toward healthy and sustainable diets: the "Double Pyramid Model" developed by the Barilla Center for Food and Nutrition to raise awareness about the environmental and nutritional impact of foods. Front Nutr. 2015;2:9.
15. Global Footprint Network. Ecological footprint. Internet: www.footprintnetwork.org/our-work/ecological-footprint/ (accessed 17 August 2018).
16. Poore J, Nemecek T. Reducing food's environmental impacts through producers and consumers. Science. 2018 Jun;360:987–92.
17. Berry E, Dernini S, Burlingame B, Meybeck A, Conforti P. Food security and sustainability: can one exist without the other? Public Health Nutr. 2015;18(13):2293–302.
18. Sperling L, McGuire S. Fatal gaps in seed security strategy. Food Sec. 2012;4:569–79.
19. Toledo Á, Burlingame B. Biodiversity and nutrition: a common path toward global food security and sustainable development. J Food Compost Anal. 2006;19(6–7):477–83.
20. Thompson B, Amoroso L, eds. Combating micronutrient deficiencies: food-based approaches. Rome: FAO; 2011.
21. Frison E, Cherfas J, Hodgkin T. Agricultural biodiversity is essential for a sustainable improvement in food and nutrition security, sustainability. MDPI, Open Access Journal. 2011;3(1):1–16.
22. Popkin BM. The nutrition transition and obesity in the developing world. J Nutr. 2001;131(3):871S–3S.
23. Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries, Nutr Rev. 2012;70(1):3–21.
24. Niles M, Ahuja R, Barker T, Esquivel J, Gutterman S, Heller M, et al. Climate change mitigation beyond agriculture: a review of food system opportunities and implications. Ren Agric and Food Syst. 2018 Feb;33(3):297–308.
25. Bajželj B, Richards KS, Allwood JM, Smith P, Dennis JS, Curmi E, et al. The importance of food demand management for climate mitigation. Nature Clim Change. 2014;4:924–9.
26. Ripple WJ, et al. Ruminants, climate change and climate policy. Nature Clim Change. 2013;4(1):2–5.
27. Colchero MA, Rivera-Dommarco J, Popkin BM, Ng SW. In Mexico, evidence of sustained consumer response two years after implementing a sugar-sweetened beverage tax. Health Aff (Millwood). 2017 Mar 1;36(3):564–71.
28. The Economics of Ecosystems and Biodiversity. Measuring what matters in agriculture and food systems: a synthesis of the results and recommendations of TEEB for Agriculture and Food's Scientific and Economic Foundations report. Geneva: UN Environment; 2018.
29. Wollenberg E, Richards M, Smith P, Havlík P, Obersteiner M, Tubiello FN, et al. Reducing emissions from agriculture to meet the 2C target. Global Change Biol. 2016 May;22(12):3859–64.
30. Ritchie H, Reay DS, Higgins P. The impact of global dietary guidelines on climate change. Global Environ Chang. 2018 Mar; 49:46–55.

A New Framework for Public-Private Partnership for Nutrition

Improving food and beverage industry alignment with societal needs

Peiman Milani
Sight and Life, Basel, Switzerland

Key messages

- Food systems are central to the challenges of malnutrition in its three modalities, as well as to the approaches to address them; the private sector – from multinationals to smallholder farmers – is the engine that drives food systems.
- The food and beverage (F&B) industry plays a unique role in shaping consumer access and choice, and improving its alignment with societal needs will contribute to addressing the triple burden of malnutrition.
- There are four critical areas in which F&B companies can contribute the most to nutrition outcomes: product portfolio, product labeling, marketing communications and practices and availability and affordability for low-income consumers.
- Key to improving this alignment is a systemic, locally driven approach that addresses these critical areas, encompasses all three modalities of malnutrition and includes both 'do good' and 'do no harm' actions.
- A new framework for Public-Private Partnership for Nutrition (PPP4N) offers a holistic approach to more effectively engaging the F&B industry in the journey to a world free from malnutrition.

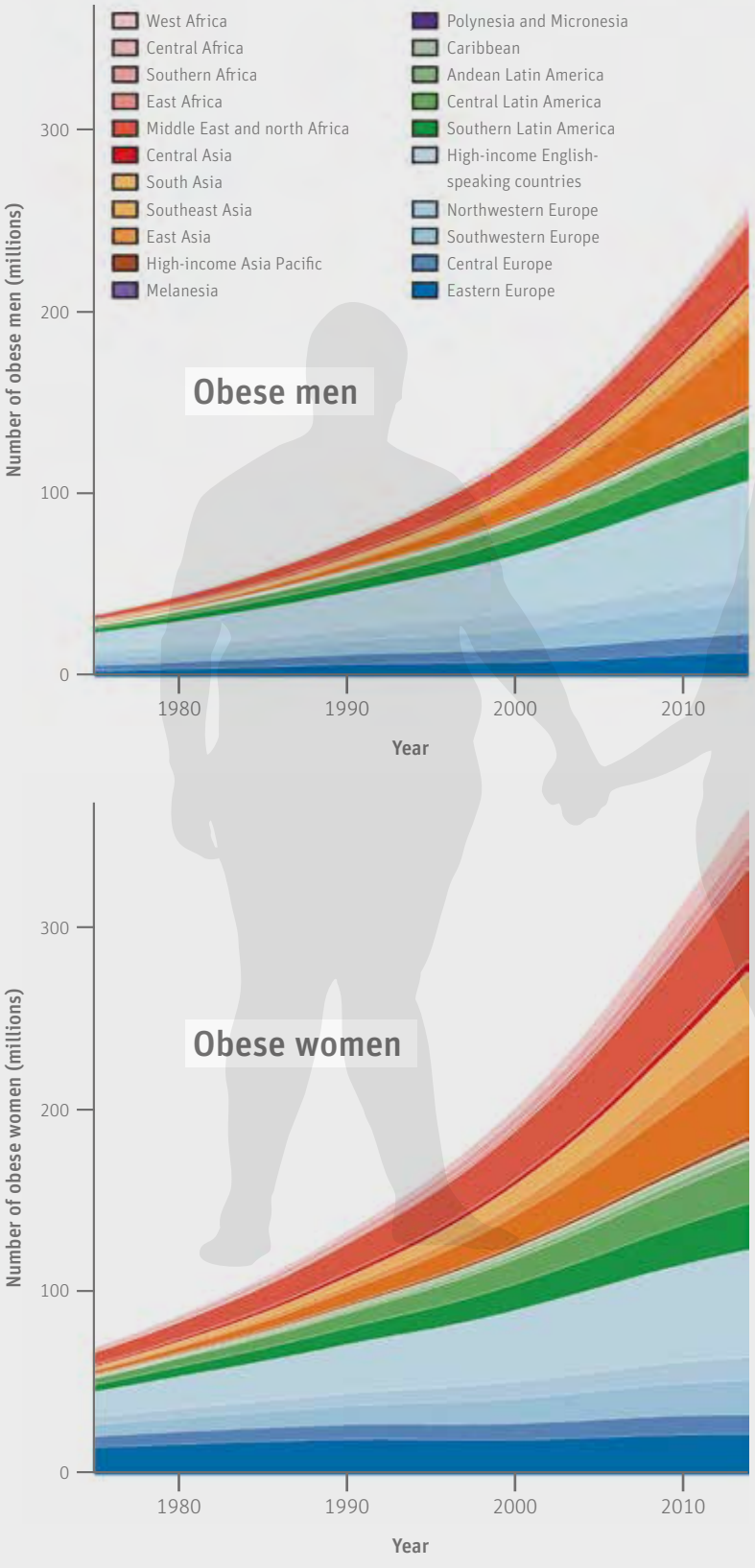
The food and beverage industry plays a unique role in shaping consumer access and choice

The challenge

Despite the progress made over the past few decades, malnutrition remains a leading global challenge and a major obstacle to achieving the Sustainable Development Goals. Eighty-eight percent of all countries face a serious burden of at least two of the three forms of malnutrition – undernutrition, micronutrient deficiencies and overweight/obesity.[1] Worldwide, stunting still affects 155 million children, and 52 million children are wasted. Two billion people are micronutrient-deficient, while another 2 billion adults and 41 million children are overweight or obese.[1] The global community is off-course to meet the agreed-upon global nutrition targets.

Central to the challenges of malnutrition in its three modalities, as well as to the approaches to address them, are food systems. Food systems – the set of processes of production, processing, marketing, distribution, purchasing and consumption of food, together with the consumer practices, resources and institutions in these processes – are major determinants of food quality and choices and consequently nutritional status and health. The

FIGURE 1: Obesity and overweight are now a global epidemic affecting 2 billion people



Worldwide obesity has nearly tripled since 1975

39% of adults worldwide are overweight or obese

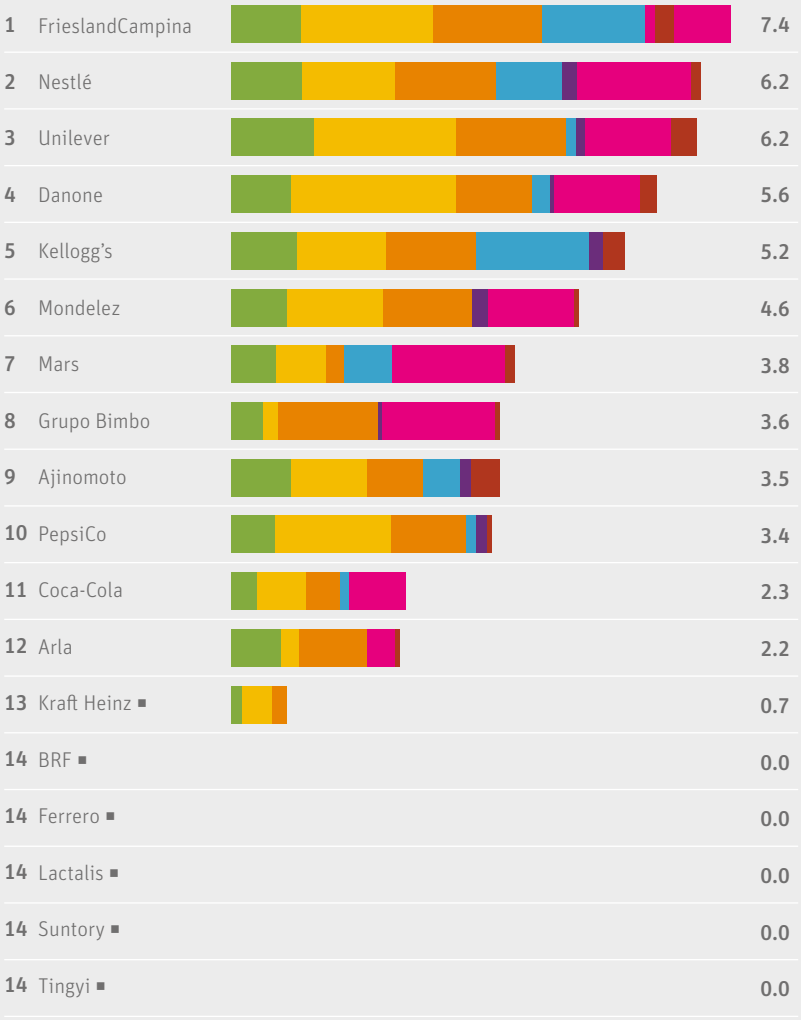
68% of global deaths are caused by noncommunicable diseases

2/3 of NCD-associated deaths occur in LMICs

US$ 2 trillion annual global cost of obesity and overweight to societies

Source: NCD Risk Factor Collaboration (NCD-RisC); WHO; World Bank; McKinsey Global Institute.

FIGURE 2: Performance of the 18 largest F&B companies on the issue of addressing undernutrition

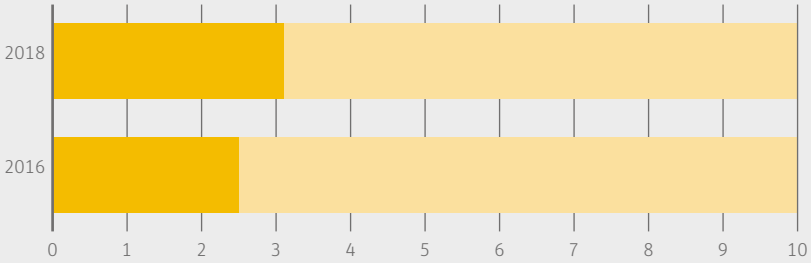


ATNI 2018 undernutrition sub-ranking

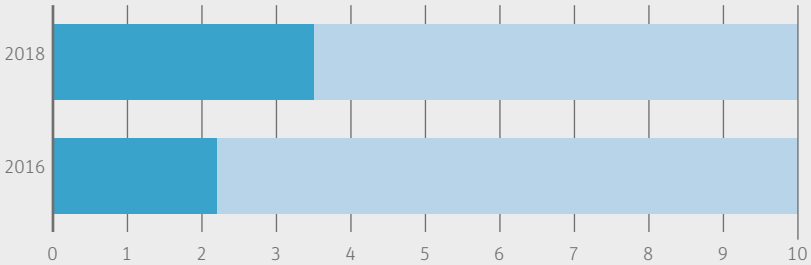
■ Did not provide information to ATNF

< 1/3 **of over 23,000 products marketed by F&B global leaders can be classified as 'healthy'**

5 out of 18 **F&B global leaders have shown commitment to BoP-targeted strategies**



ATNI average scores for 'products to fight undernutrition' in 2016 and 2018



ATNI average scores for 'accessibility and affordability of products to address undernutrition' in 2016 and 2018

Source: ATNI 2018.

FIGURE 3: Limited alignment of the F&B industry with societal needs is one of the factors contributing to the triple burden of malnutrition

private sector – from multinationals to smallholder farmers – is the engine that drives food systems, with the food and beverage (F&B) industry playing a unique and powerful role. The F&B sector has a disproportional impact on nutrition and health outcomes, as the 'nutrition transition' in low and middle-income countries (LMICs) has shown, with increased consumption of sugar, fats, refined grains and highly processed foods.[2] In LMICs, F&B industry products represent a growing share of local diets, driven by urbanization, rising incomes, maturing supply chains and increasing demand for processed foods due to their convenience and extended shelf life. Though taking place at a faster pace in cities, this transition is increasingly reaching rural areas.

The associated global obesity epidemic,[3] which has engulfed high-income countries (HICs) and LMICs alike, is costing the world an estimated US$2 trillion annually.[4] Noncommunicable diseases (NCDs) now account for 68% of all deaths worldwide,[5] with three of the four most prevalent ones – cardiovascular diseases, cancers and diabetes – being associated with diets.[6] As highlighted in the recent World Health Organization (WHO) *Saving Lives, Spending Less* report, NCDs have become an issue of equity, disproportionately affecting LMICs. Two-thirds of NCD-associated deaths occur in LMICs, which also happen to be where two-thirds of overweight or obese people live. More than 340 million children and adolescents aged 5–19 were overweight or obese in 2016. Should present trends continue, child and adolescent obesity will surpass moderate and severe underweight by 2022.[7] Some estimates put the toll imposed by obesity and associated diseases on national healthcare systems in developed countries at up to 20% of total healthcare spend.[4] The global community may well have reached a tipping point with the accumulating evidence on the global and serious nature of overweight and obesity and their major contribution to the increasing burden of NCDs and premature death. Urgent, comprehensive and systematic action is called for now to reverse this tide, as highlighted in **Figure 1**.

> "Noncommunicable diseases have become an issue of equity"

Together with consumer choices and lifestyles, the F&B sector's influence on these trends and burden is undeniable. Moreover, the industry's contribution to reducing undernutrition and micronutrient deficiencies has been insufficient, with numerous missed opportunities to help address these burdens across countries and markets. The ATNI Global Index 2018 points out that less than a third of more than 23,000 products marketed by the top F&B companies in the world can be classified as healthy.[8] Only five out of 18 surveyed F&B giants have shown commitment to marketing strategies aimed at reaching undernourished populations. **Figure 2** shows the performance of these 18 companies on the issue of addressing undernutrition. **Figure 3** shows the causal chain linking the industry's limited alignment with societal needs with malnutrition and its burden on health systems.

Levers and moves for improvement

Five key levers can be employed by society to improve the F&B sector's contribution to nutrition and health: **(1)** incentives; **(2)** a favorable enabling environment; **(3)** consumer education and

Food environments are often crowded with nutrient-poor products

demand; (4) safety net procurement; and (5) direct pressure and accountability from consumers, grassroots organizations, high-value employees and investors. Incentives through various policies can be strong inducers of positive action by private-sector actors. Tax policy, for example, can both incentivize increased availability of affordable nutritious foods and discourage production and consumption of poor-quality foods. A favorable enabling environment, primarily instituted by the public sector, can reward F&B players that contribute to public health and discourage or penalize those that do not. Consumer education and demand can pull the whole food value chain towards sustainable diets and compel companies to offer a nutritious, sustainable and ethical product portfolio. The recent clean-label movement in HICs[9] illustrates the power of consumers to catalyze major industry shifts. As institutional buyers such as national governments and multilateral agencies step in to ensure that the poorest of the poor are covered, they contribute to the viability and sustainability of nutrition-minded companies. Last but not least, the voice of society through various actors and channels can both inhibit the most egregious corporate missteps in the short term and promote long-term steering and investment in a nutrition-positive direction. An auspiciously growing trend are right-minded nudges on firms from large individual and institutional investors, including asset managers and pension funds, as highlighted by a letter from the CEO of BlackRock, the world's largest asset manager, to his fellow executives in the companies in BlackRock's portfolio.

A number of industry initiatives and public-private partnerships have made valuable contributions to improving nutrition outcomes through product reformulation, improved labeling standards, restrictions on marketing and distribution to vulnerable groups and disincentives to consumption of poor nutritional value products of such as sugar-sweetened beverages. In LMICs, these efforts have concentrated on food safety or fortification of staple foods (flour, rice, oil) and condiments with micronutrients. Some of them, including the OBAASIMA program in Ghana, have applied a demand-driven approach, with the use of a 'quality seal' logo to distinguish products meeting nutrient profile (sugar, salt, saturated fat) and fortification standards.

Today, LMICs grapple with the full spectrum of malnutrition challenges, with a persistent burden of undernutrition and micronutrient deficiencies combined with a rising tide of overweight and obesity. The aforementioned tipping point of awareness may well represent a leapfrogging opportunity for LMICs as their food systems develop and their maturing F&B industries have the chance to better align their strategy and investments with societal needs, thus avoiding the enormous burden this misalignment has imposed elsewhere. Key to this alignment is a systemic approach that applies the five key levers, encompasses all three modalities of malnutrition, includes actions that both promote the consumption of nutrient-dense foods and reduce that of poor-quality products, and addresses the critical areas in which F&B companies can make the greatest difference to nutrition outcomes: product portfolio, product labeling, marketing communications and practices and availability and affordability for low-income consumers.

The opportunity

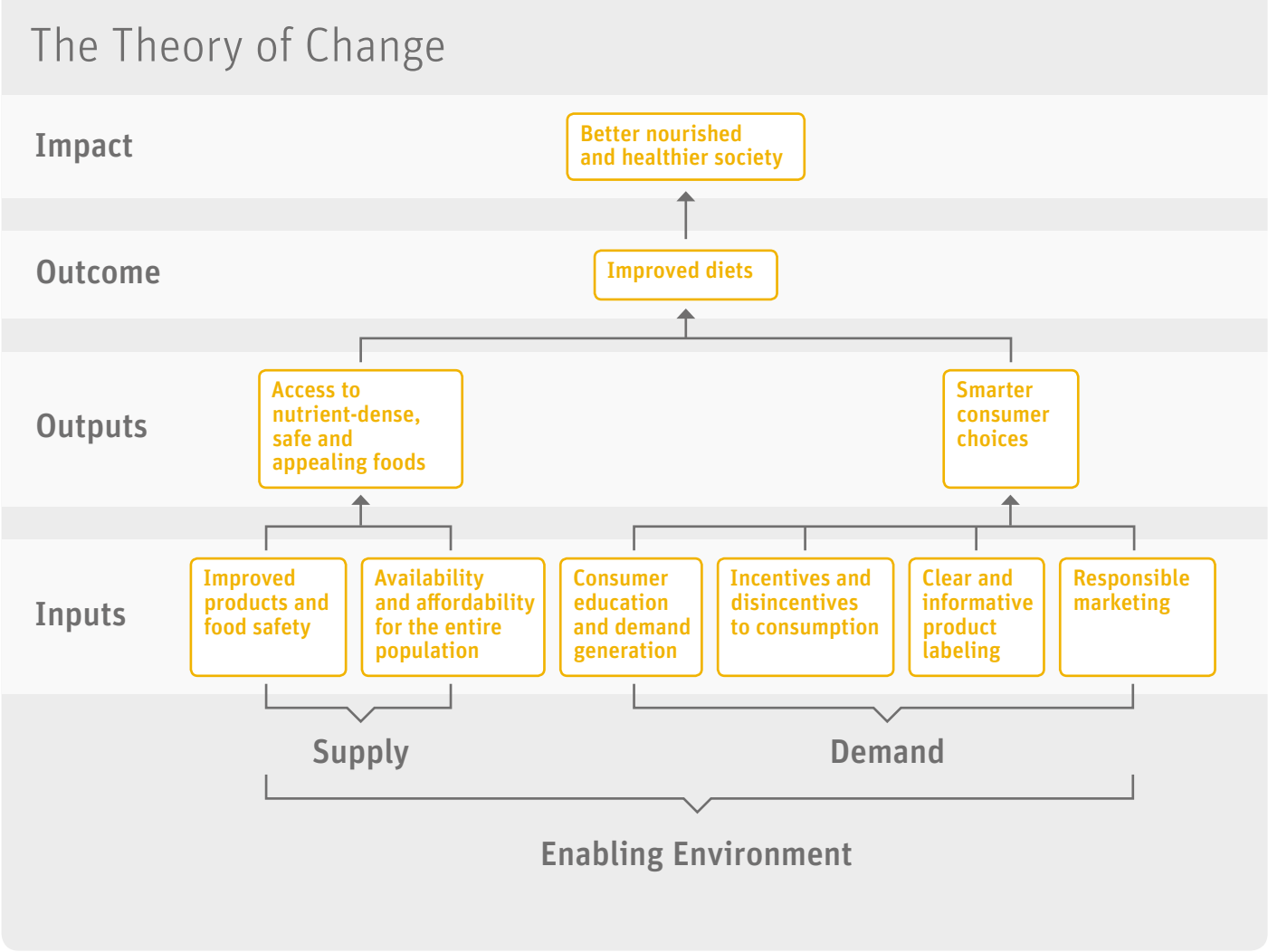
Improving alignment of the F&B industry with societal goals is an overdue imperative with substantial benefits:

- Greater availability of nutritionally improved F&B products in LMIC markets
- Greater accessibility of nutritious products to undernourished populations and the population in general
- Better informed consumers making healthier choices
- Greater transparency and accountability in the local food system
- A stronger local F&B industry that is more attractive to investors, impact-oriented or otherwise
- A better nourished and healthier society.

Figure 4 shows the simplified theory of change linking improved F&B industry alignment with societal needs to a healthier society.

This provides the motivation for a new framework for **Public-Private Partnership for Nutrition (PPP4N)**. PPP4N's design is based on the following principles:

FIGURE 4: Limited alignment of the F&B industry with societal needs is one of the factors contributing to the triple burden of malnutrition



- Build on the successes and lessons from relevant efforts so far, including initiatives to address malnutrition in all its forms and to increase transparency and accountability in the food system
- Take an 'inside-out' rather than 'outside-in' approach, flexibly engaging local players in a co-design process in which priorities and strategy are defined by local societal needs, public policies and contextual realities
- Engage all relevant agencies (health, industry, trade, agriculture, development, regulators) and capitalize on all public-sector levers (credit, taxes, procurement, subsidies, education)
- Follow an 'engage first, regulate later' approach to the F&B industry and a 'carrots and sticks, plus feed' logic – a de-risking combination of incentives and accountability with capacity building through infusions of intellectual capital (technical and management advisory support and training) and financial capital (loans, equity investment, hybrid financing) to locally operating F&B companies
- Involve the development and academic sectors, including consumer unions, and empower individual consumers through education and access to nutritious foods
- Include a transparent, publicly accountable governance system, with independent verification, monitoring and evaluation.

The scope of PPP4N is defined by the three dimensions on which it engages F&B companies:

TABLE 1: Illustrative components of a full-blown PPP4N implementation

Area	Nutrition-positive front	Nutrition-negative front
Product Portfolio	Fortification	Reduction in NCD-inducing ingredients
	New product development	Prevention of foodborne disease
	Product reformulation	
Product Labeling	Nutrition facts labeling	Removal of unsound claims
	Quality seals	
	Front-of-pack labeling	
Marketing Practices	Increased marketing of local nutritious products	Restrictions on marketing to children
	Responsible marketing across all media and channels	
	Behavior change campaigns	
Distribution	Product and pricing strategy to reach vulnerable populations	Sugar/sugary beverage taxation
	Subsidies/tax incentives for nutritious foods	Restrictions on unhealthy food distribution in schools and
	Voucher programs	other public sector channels

TABLE 2: The PPP4N framework value proposition for the various stakeholders

Stakeholder	Value proposition
Public sector	> Progress towards SDGs 2, 3, 12 (sustainable consumption and production)
	> Substantial savings on publicly funded healthcare
	> A better nourished, healthier and more productive society
F&B companies	> Increased demand for value-added, nutritious products
	> Access to intellectual and financial capital for innovation and growth
	> Greater consumer trust and brand recognition
	> Improved contribution to social good through a shared value approach
Consumers	> Awareness of and access to healthier food and beverage options
	> Enhanced education on nutrition for health
	> Improved overall nutrition, health status and life expectancy
Financial and intellectual	> Socially responsible investment opportunity in a growing industry
capital providers	> Alignment with mission and strategic goals (impact investors, venture philanthropists, intellectual capital providers)
Development partners	> Alignment with mission and strategic goals
	> Potential funding/project opportunities
	> Greater engagement with the private sector, including intellectual and financial capital providers

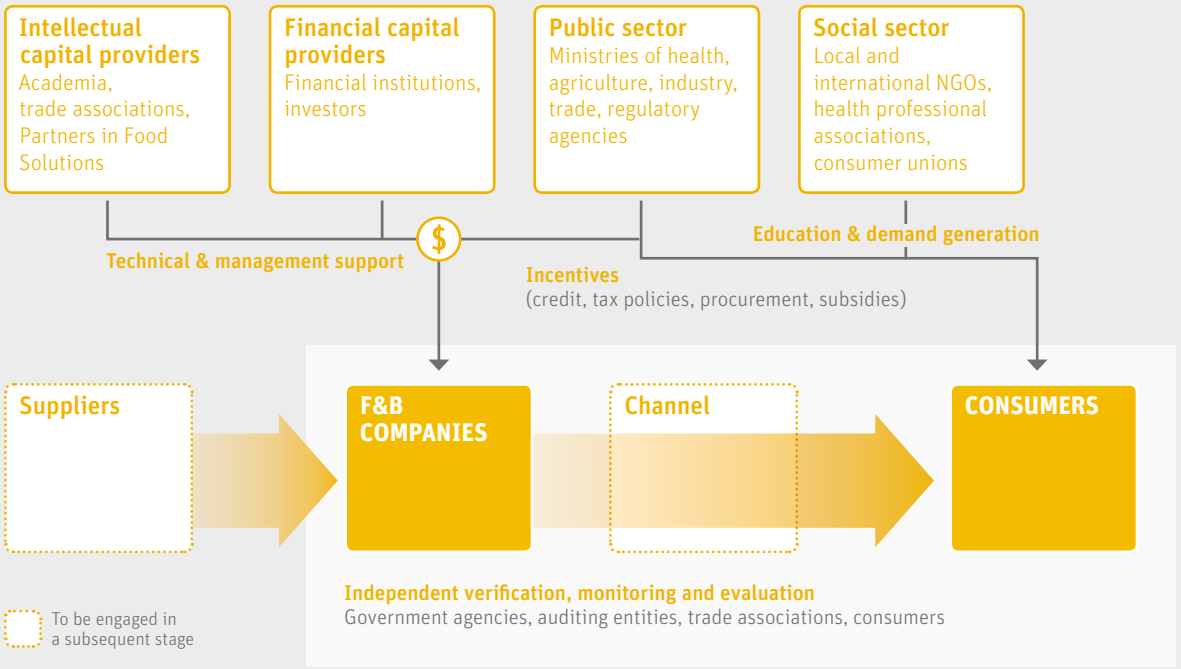
- **Three malnutrition burdens:** undernutrition, micronutrient deficiencies and overweight/obesity
- **Four core areas:** product portfolio, product labeling, marketing practices and distribution
- **Two action fronts:** *nutrition-positive* ('do good': increase consumption of or educate about nutritious foods and diets) and *nutrition-negative* ('do no harm': discourage/reduce consumption of or educate about unhealthy food products, ingredients and diets and address misinformation on nutrition).

Thus, a full-blown PPP4N implementation will address malnutrition in its three modalities, all four core areas, and actions on both the nutrition-positive and nutrition-negative fronts, as illustrated in Table 1. The value proposition for the various PPP4N stakeholders is shown in Table 2.

The approach

PPP4N is best suited for LMICs combining reasonably good governance, a maturing F&B industry and a significant burden of malnutrition. Countries with poor governance lack the capabilities to effectively implement the framework, while an

FIGURE 5: PPP4N framework implementation



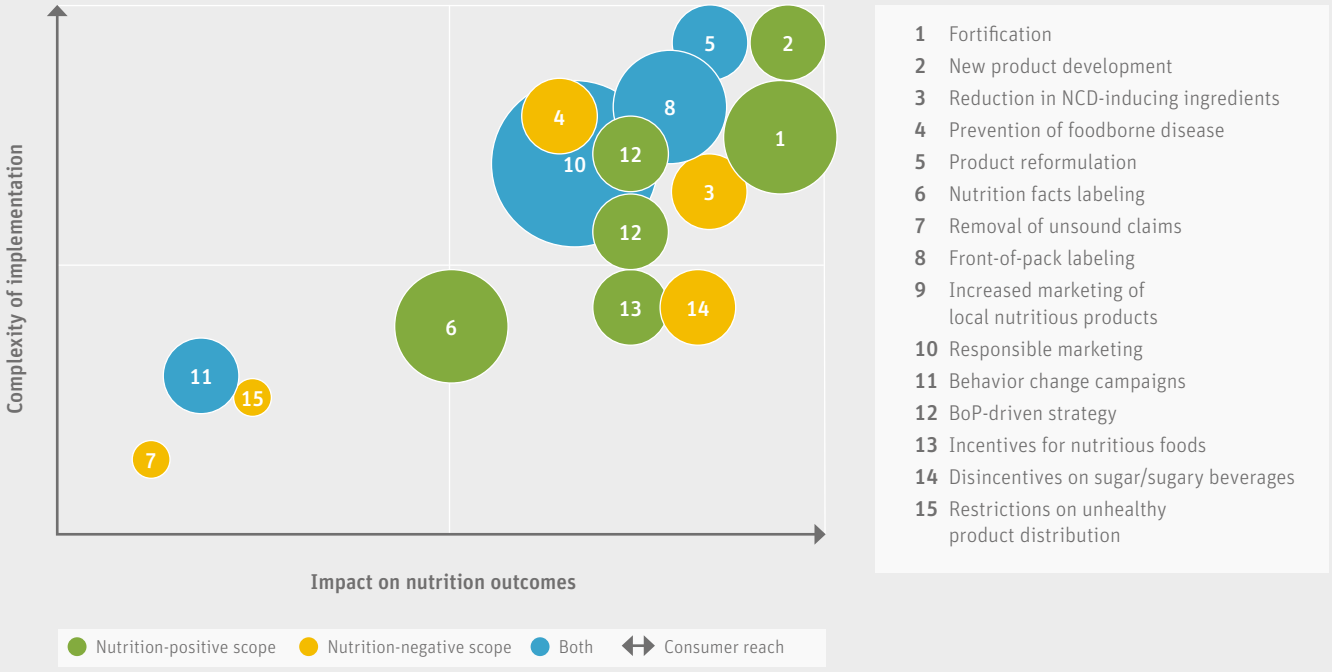
already mature industry is much more locked into portfolios and strategies driven by their capital investments over many years. Implementing PPP4N requires collaboratively engaging stakeholders from all sectors and civil society, as illustrated in Figure 5.

Making the PPP4N framework operational involves the following steps:

1. Engage the public sector at the highest relevant level possible (e.g., the country's 'Nutrition Czar'). Ensure relevant agencies, including the local regulator, are on board and ready to bring to bear incentives, consumer education and demand generation for nutritious products. Lay out the range of initiative options and co-develop the strategy based on local priorities, policies and programs (see Figure 6).
2. In the initial phase, for reasons of scale, reach and capability depth, engage multinationals and large national companies operating in the local F&B market. Bring to the table ideally between three and seven players with a relevant product portfolio to establish the scope and objectives of the PPP4N implementation. Mid-sized and small local companies are to be involved gradually at a later stage, once the PPP4N foundation has been laid.
3. Negotiate initiatives and priorities with the F&B companies into a multiyear roadmap that starts with a 12- to 18-month pilot with specific goals and targets (see Figure 7).
4. Establish clear governance, management and accountability systems for the implementation. The latter may benefit from the methods and tools developed by the Access to Nutrition Index (ATNI)[8] platform.
5. Consider developing a brand architecture that can signal alignment with public health and nutrition priorities at both the company and product category levels.
6. Implement the pilot and refine planning for each stage based on the learnings of the preceding stage.

Although the supply chain feeding into F&B companies and distribution channels in the local food environment are important players, they should be engaged in a subsequent phase, once the PPP4N foundation has been established, given the complexity of successfully implementing the initial scope. An example of potential engagement of the supply chain would be sourcing of healthier or safer ingredients for product reformulations; distribution channels can play a role through

FIGURE 6: Illustrative contextual analysis of initiatives for prioritization



1 Fortification
2 New product development
3 Reduction in NCD-inducing ingredients
4 Prevention of foodborne disease
5 Product reformulation
6 Nutrition facts labeling
7 Removal of unsound claims
8 Front-of-pack labeling
9 Increased marketing of local nutritious products
10 Responsible marketing
11 Behavior change campaigns
12 BoP-driven strategy
13 Incentives for nutritious foods
14 Disincentives on sugar/sugary beverages
15 Restrictions on unhealthy product distribution

FIGURE 7: Illustrative PPP4N multiyear implementation roadmap

Lay the foundation, build capabilities, secure quick wins (18 months)

STAGE 1 – PILOT

- Fortification
- Improved product labeling
- Complementary food safety
- Consumer education
- Incentives for nutritious foods
- Nutrition-informed public sector procurement policy

Implement higher impact and more complex initiatives (18–24 months)

STAGE 2

- Product reformulation
- Prevention of foodborne disease (food safety)
- Front-of-pack labeling
- Responsible marketing
- Behavior change campaigns
- Disincentives on sugar/sugary beverages
- BoP-driven strategy

Engage mid-size companies, suppliers and channels (18–24 months)

STAGE 3

- New product development
- Prevention of foodborne disease (food safety)

choice architecture and other point-of-purchase actions, private labels and pricing and eventually food service industry participation.

"The PPP4N framework is essentially a hypothesis to be tested and refined"

Let's fasten our seat belts towards a healthier world

The PPP4N framework is essentially a hypothesis to be tested and refined, and one among a number of potential approaches to engaging the food and beverage industry for societal benefit. It draws on past and recent experiences to inspire progress towards that goal. As of September 2018, an initiative to implement the PPP4N framework in Rwanda is being considered by the government of that country, under the auspices of the National Early Childhood Development Program, the cross-agency endeavor that coordinates all nutrition actions in Rwanda. The intent is to convene a task force consisting of representatives of several agencies and the Rwanda Consumer Association to prioritize initiatives and scope out a pilot implementation as part of a multiyear roadmap. The next step will be to bring some of the largest F&B companies marketing their products in the Rwandan market to the table to agree on pilot scope and targets.

Improving alignment of the F&B sector with societal needs – the goal of the PPP4N framework – is a long, winding and overdue journey, which will ultimately benefit all individuals in all countries, as consumers, suppliers, employees, or shareholders, as well as the planet. Let's embark on this likely bumpy ride and step on the gas: a healthier, happier and more productive world awaits us and future generations.

Correspondence: ***Peiman Milani,***
Global Lead, Public-Private Partnerships, Sight and Life,
PO Box 2116, Basel, 4002, Switzerland
Email: *peiman.milani@sightandlife.org*

References

01. Development Initiatives. Global nutrition report 2017: nourishing the SDGs. Bristol, UK: Development Initiatives; 2017.
02. Hawkes C, Harris J, Gillespie S. Changing diets: urbanization and the nutrition transition. In: International Food Policy Research Institute. 2017 Global Food Policy Report. Washington, DC: IFPRI; 2017:34–41.
03. WHO. Controlling the global obesity epidemic. Internet: www.who.int/nutrition/topics/obesity/en/ (accessed 28 May 2018).
04. Dobbs R, Sawers C, Thompson F, Manyika J, Woetzel J, Child P, McKenna S, Spatharou A. Overcoming obesity: an initial economic analysis. McKinsey Global Institute; 2014.
05. WHO. Saving lives, spending less: a strategic response to noncommunicable diseases. Geneva: WHO; 2018. [WHO/NMH/NVI/18.8.]
06. World Bank. An overview of links between obesity and food systems. Implications for the Agriculture Global Practice Agenda. Washington, DC: World Bank Group; 2017.
07. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128·9 million children, adolescents, and adults. Lancet. 2017;390(10113):P2627–2642.
08. Access to Nutrition Foundation. Access to Nutrition Index. Global Index 2018. Internet: www.accesstonutrition.org/ (accessed 28 May 2018).
09. Kerry. Beyond the label: the clean food revolution. Internet: go.kerrycleanlabel.com/ (accessed 28 May 2018).

Special Feature

"You Are What Your Mother Ate"

The Dutch Hunger Winter Study

Jonathan Steffen
Jonathan Steffen Limited, Cambridge, UK

If the global nutrition community appears to agree on one thing at present, it is that the first 1,000 days of life matter. "The first 1,000 days, from conception to 2 years of age," write the authors of *The Biology of the First 1,000 Days*, "is a critical window of growth and development. Exposures to dietary, environmental, hormonal and other stressors during this period have been associated with an increased risk of health outcomes. Researchers using cell culture, animal models, and humans have identified this time as a period of rapid physiological change and plasticity with significant potential for lasting effects. As such, interventions during the first 1,000 days will have the greatest impact on outcomes, particularly in low- and middle-income countries where the need is greatest."[1]

A severely malnourished infant in the Hunger Winter, photographed on May 31, 1945

The *Hongerwinter*

Arguably no study in the history of nutrition science bears this out as clearly as the Dutch Hunger Winter Study – the most-studied famine in the literature on the long-term effects of malnutrition *in utero*.[2] Robert S. Scholte and coauthors of a discussion paper on the subject provide an excellent summary of the historical context that gave rise to the *Hongerwinter*, as it is known in Dutch:

> "In the fall of 1944, towards the end of World War II, parts of the south of the Netherlands had been liberated by Allied forces, whereas the other parts were still occupied by German forces. The London-based 'Dutch government in exile' called out a railroad strike in the occupied parts in order to support Allied military advances and in order to display its authority over the nation. As a reaction, the occupying forces initiated an embargo that prohibited food transports to the densely populated western part of the country, i.e. the provinces of North and South Holland and Utrecht. The decision by Allied Command to postpone the liberalization of the Netherlands and instead move east towards the German mainland caused a military stalemate in the western part of the Netherlands that lasted until the end of the war (European Theater) in May 1945. The effects of the food transport embargo were exacerbated by the early onset of a harsh winter, the freezing of the waterways, the generally bad state of transport infrastructure, and a naval trade blockade. As a result, the western part of the country was closed off from any imports of food, fuel, medication, etc. This caused a famine in the western part that was particularly severe in the cities (Stein et al., 1975). The situation lasted until the end of the occupation, which coincided with the end of World War II in Europe (early May 1945)."[3]

Dutch citizens tear up the sleepers from tramlines to burn as fuel

Starting in November 1944 and lasting approximately five months, this systematic attempt to starve a civilian population into submission was to claim over 20,000 lives before eventually food supplies were restored via the intervention of the Allies.[4] "At one point the population was trying to survive on only about 30 percent of the normal daily calorie intake," writes Prof. Nessa Carey in her 2012 study of the subject. "People ate grass and tulip bulbs, and burned every scrap of furniture they could get their hands on, in a desperate effort to stay alive."[5]

"At the end of the war, our hunger drove my parents to exchange the grand piano and their gold wedding rings to provide food for their children"

The account of Pieter van Marken, who was a teenager in Holland during World War II, brings the plight of the Dutch population vividly to life:

> "At the end of the war, our hunger drove my parents to exchange the grand piano and their gold wedding rings to provide food for their children … For quite a time, we had a good food reserve [in the cellar], but finally everything ran out. And the shops finally, in the winter of 1944, had nothing. No milk, no bread, eggs, fruit or vegetables or all the other grocery terms one takes for granted. There was a soup kitchen somewhere, serving a sort of horrible thin vegetable soup. Not exactly filling, but even the soup kitchen ceased to operate at the beginning of 1945. We preserved energy by lying down, mostly … I went on long bicycle rides, on food raids. *'Hongertochten'* or literally, hunger trips, they were called, to get food. You went to so-called 'friendly' or 'good' farmers to collect wheat. Other 'bad' and greedy farmers collected a fortune for their food … You would cycle for hours in the biting cold and then you stood in long queues for hours in the snow and the cold, to end up collecting perhaps only a pound of wheat. At home, this was ground into flour to make bread with, in a sort of coffee grinder-sized mill, screwed onto the window sill. We also desperately ate ground tulip bulbs; I remember you had to take out the green core, which was poisonous, but the cake which was made of ground tulip bulbs was edible in comparison to the raw grated sugar beet boiled into a kind of porridge. Awful stuff, that. It had such an awful taste."[6]

A composite picture of a daily ration of food for the Dutch populace during the Hunger Winter

Operation Manna/Chowhound

The *Hongerwinter* came to an end on May 6, 1945, one day after the capitulation of the German forces. In what the British called 'Operation Manna' and the Americans 'Operation Chowhound,' Allied planes dropped food over the Netherlands. Pieter van Marken recalls:

> "I 'helped' collect the food, and I had positioned myself on a barge in the canal – the *'Ringvaart'* – adjoining [Schipol] airfield. Others came to offload the sacks of food they had collected on the fields and runways, loaded on primitive vehicles. I helped offload the sacks into the barge. I remember the tins of butter burst open and the sacks of sugar and broken tins of bacon. Dipping my fingers into the butter and the sugar, I gorged myself on this as well as scooping and eating the bacon out of the broken tins. Everybody else did the same thing. Gorgeous. The RAF had dropped tins of hard biscuits – emergency rations – and tins of corned – 'bully' – beef. I came to love corned beef. Everything was subsequently distributed. Soon after, we also got rationing tickets to collect so-called 'Swedish bread', bread made from Swedish flour. Originally I thought that the loaves had also been dropped by air but it is only recently that I found out that the bread was made from the flour the Swedes had sent by ship. Beautiful white loaves. We also got margarine to go with it. You can't imagine what a glorious taste a slice of that white bread and margarine had. You had to stand in a long queue at the bakery shop to collect your bread rations. But you didn't mind. Thank you again, Sweden." [7]

"You can't imagine what a glorious taste a slice of that white bread and margarine had"

In his report *Starvation in Western Holland 1945*, Sir Jack Cecil Drummond – the architect of the rationing policy that had kept Great Britain from starvation during the German U-boat blockade, and who oversaw British efforts to help the Dutch population recover from the Hunger Winter – gave a precise description of the damage that had been inflicted on the populace, and of the initial remedial measures that were taken to restore them to health:

TABLE 1: Size at birth according to exposure to famine in specific trimesters among births in midwife training schools in Amsterdam and Rotterdam, 1943–1946 [9]

	Reference births 1943		Third trimester births 1 February 1945 – 30 June 1945	
	Amsterdam	Rotterdam	Amsterdam	Rotterdam
	n = 161	*n* = 163	*n* = 236	*n* = 299
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Birthweight (g)	3383 (462)	3461 (466)	3098 (442)	3148(443)
Length (cm)	50.8 (1.8)	50.6 (1.8)	49.8 (2.0)	49.9 (2.3)
Head circumference (cm)	35.5 (1.7)	35.5 (1.8)	34.5 (1.6)	34.5 (1.7)

Systematic sample of ~15 births/month at each institution in reference period, all births during famine.

Famine exposure defined as a mean ration of 1000 kcal/day over the trimester.

Dutch citizens gathered around an airdrop of vital food supplies provided by the Allies in Operation Manna/Chowhound.

"Dietary surveys indicated that on and just before liberation the average food consumed per person contained about 1,000 calories daily. Those unable to forage for themselves obtained only the bare rations, equivalent to about 500 calories. Between the second and third week after liberation, rations increased to about 2,000 calories daily for the normal consumer. Some 200,000 persons, representing about 10 per cent of the population of the cities, were found to be seriously undernourished: of these some 2,500 were admitted to hospital, while the remainder were given, as out-patients, a supplementary ration of high protein content providing 1,500 calories. In the early phase of relief about 10 per cent of those admitted to hospital died. Three types of death were observed: **(1)** sudden unexplained, early after admission to hospital; **(2)** unexpected, after the patient appeared to be recovering, a turn for the worse leading to death in about an hour; **(3)** a slow death, the patient lapsing into coma, as in any exhausting disease. In most cases bronchopneumonia was found at autopsy; some showed atrophy of the liver, heart and spleen.

All the patients complained of bodily and mental exhaustion, of dizziness, and of a tendency to collapse if they remained standing for long. Nearly always there had been periods of diarrhea. Emaciation was the most striking feature. Hunger edema occurred, but not in the majority of the patients. No definite signs of vitamin deficiency were found. The body temperature was low with a tendency to poikilothermia. All the patients were anemic, the hemoglobin usually being about 11 gm. per 100 ml. with a color index of 1; cases of marked anemia occurred, usually in seriously ill patients. Bone dystrophies were observed in some starved patients.

Treatment with protein hydrolysates was tried, but met with little success, partly because they were disagreeable to take, and provoked vomiting unless given in large volumes of fluid.

"The Dutch Hunger Winter has served as an unplanned experiment in human health"

Hydrolysates in low concentration and amounts had little effect on edema, adynamia or apathy: 2 liters of a 7.5–10 per cent hydrolysate had a moderately good effect. A pappy diet containing 80 g of protein (mainly as skimmed milk powder) and 2,000 calories was well tolerated, led to disappearance of edema but too little gain in weight. The best results were obtained with a diet of 300 g of protein (no hydrolysate) and 3, 200 calories.

Second trimester births 1 May 1945 – 30 September 1945		First trimester births 1 August 1945 – 31 December 1945		Peri-conceptional births 1 November 1945 – 31 March 1946	
Amsterdam	Rotterdam	Amsterdam	Rotterdam	Amsterdam	Rotterdam
n = 304	*n* = 275	*n* = 135	*n* = 173	*n* = 183	*n* = 268
Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
3231 (473)	3329 (485)*	3359 (448)	3495 (492)*	3408 (451)	3461 (532)
50.4 (2.2)	50.6 (2.3)	50.8 (2.1)	50.4 (2.2)	50.8 (1.9)	50.3 (2.4)**
35.0 (1.6)	35.1 (1.7)	35.4 (1.6)	35.5 (1.7)	35.3 (1.6)	35.3 (2.1)

Period of second trimester exposure overlaps with both first and third trimester exposure; period of peri-conceptional exposure overlaps with first trimester exposure. * *P* 0.05; ** *P* 0.01 by t-test.

TABLE 2: Change in z-score of selected measures of size at birth following exposure to famine during specific trimesters of pregnancy, relative to births in the same hospitals without exposure to famine in gestation. Births in midwife training schools in Amsterdam and Rotterdam, 1943–1946[10]

	Third trimester versus reference Mean (95% CI)	Second trimester versus reference Mean (95% CI)	First trimester versus reference Mean (95% CI)	Peri-conceptional versus reference Mean (95% CI)
Direct measures				
Birthweight	−0.65 (−0.78, −0.51)	−0.31 (−0.45, −0.17)	0.02 (−0.14, 0.18)	0.02 (−0.13, 0.17)
Length	−0.46 (−0.61, −0.30)	−0.13 (−0.29, 0.03)	−0.04 (−0.21, 0.13)	−0.11 (−0.27, 0.05)
Head circumference	−0.59 (−0.73, −0.46)	−0.26 (−0.39, −0.13)	−0.04 (−0.19, 0.12)	−0.13 (−0.28, 0.02)
Ratio measures				
Birthweight | length	−0.64 (−0.77, −0.50)	−0.33 (−0.47, −0.19)	0.03 (−0.12, 0.18)	0.05 (−0.09, 0.20)
Head circumference | length	−0.26 (−0.41, −0.11)	−0.16 (−0.30, −0.01)	0.00 (−0.17, 0.17)	−0.05 (−0.21, 0.10)
Head circumference | birthweight	0.54 (0.39, 0.69)	0.27 (0.12, 0.41)	−0.02 (−0.18, 0.15)	−0.05 (−0.20, 0.11)
Residual measures				
Birthweight predicted from length	−0.45 (−0.59, −0.32)	−0.30 (−0.43, −0.16)	0.05 (−0.10, 0.21)	0.13 (−0.02, 0.27)
Head circumference predicted from length	−0.43 (−0.57, −0.29)	−0.22 (−0.36, −0.08)	−0.03 (−0.19, 0.13)	−0.10 (−0.25, 0.05)
Head circumference predicted from birthweight	−0.28 (−0.42, −0.14)	−0.11 (−0.24, 0.03)	−0.06 (−0.22, 0.11)	−0.17 (−0.33, 0.02)

All measures expressed as z-scores, calculated with respect to 1943 births, using city-specific means and SDs. Residuals based on city-specific 1943 regressions. Period of second trimester exposure overlaps both first and third trimester exposure; period of peri-conceptional exposure overlaps with first trimester exposure.

> On this diet patients recovered from their depression and apathy in two days; the edema and adynamia disappeared and they got up quicker than patients who were given hydrolysates alone. The best results in infants and young children were obtained with skimmed milk powder supplemented with glucose and fruit juices."[8]

"Uniquely vulnerable"

The sufferings afflicted on Dutch citizens by a desperate and vengeful occupying power in 1945 might seem far removed from the Netherlands of today – a country that, in the words of the OECD, is "experiencing strong growth and tight labor markets, with favorable economic prospects and sound public finances."[15] Yet only on January 31, 2018, the *New York Times* ran an article with the headline: "The Famine Ended 70 Years Ago, but Dutch Genes Still Bear Scars."[16] The author, Carl Zimmer, succinctly explains why:

> "The Dutch Hunger Winter has proved unique in unexpected ways. Because it started and ended so abruptly, it has served as an unplanned experiment in human health. Pregnant women, it turns out, were uniquely vulnerable, and the children they gave birth to have been influenced by famine throughout their lives.
>
> When they became adults, they ended up a few pounds heavier than average. In middle age, they had higher levels of triglycerides and LDL cholesterol. They also experienced higher rates of such conditions as obesity, diabetes and schizophrenia."[17]

The consequences of prenatal malnutrition

Prof. Tessa Roseboom of the University of Amsterdam – herself a grandchild of a Dutchwoman who was pregnant during the *Hongerwinter*[18] – has explored the present-day health of people conceived during the period, tracing all the babies born around the same time in one hospital in Amsterdam, and investigating them from the age of 50.[19] "What we found was really quite striking," she observes. "People conceived during the famine, who were exposed to a very poor maternal diet when they had just been conceived, had double the rates of cardiovascular disease, already at the age of 50. They were more obese, they had higher cholesterol levels, higher blood pressure levels, they felt less healthy, and more of them died of cardiovascular disease." Prof. Roseboom draws the conclusion that "prenatal malnutrition does have long-term consequences. Even though the absolute amount of nutrients an embryo needs is tiny. Lots of people initially told me, 'But the fetus is the perfect parasite, it just takes whatever it needs,' but that's not true. The fetus is responsive to the environment, and the environment does have lasting consequences." The effects of famine are most significant when the fetus is exposed early in gestation. "We know that in the first trimester all of the organs are laid down. So it's not surprising

FIGURE 1: Weekly caloric rations and averages of z-scored linear measures of weight, length and head circumference at birth, for births in two institutions in the Western Netherlands, 1944–1946[11]

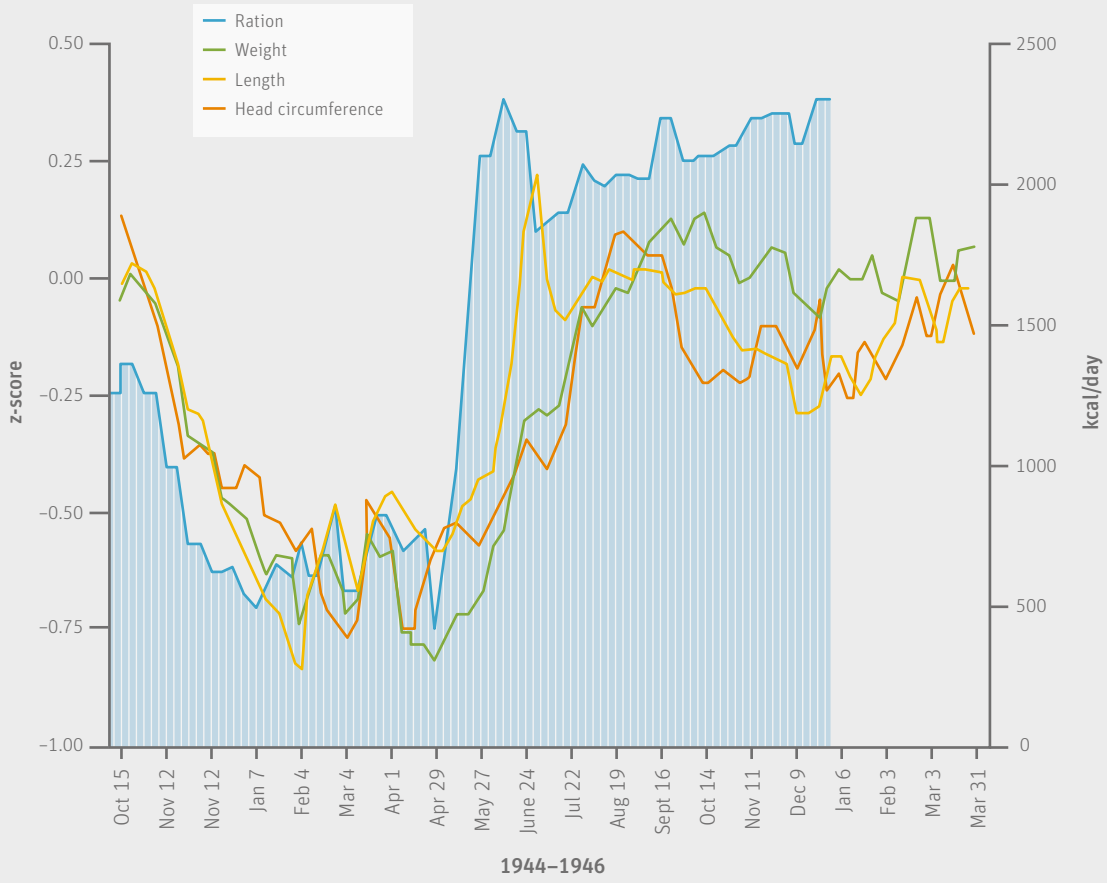
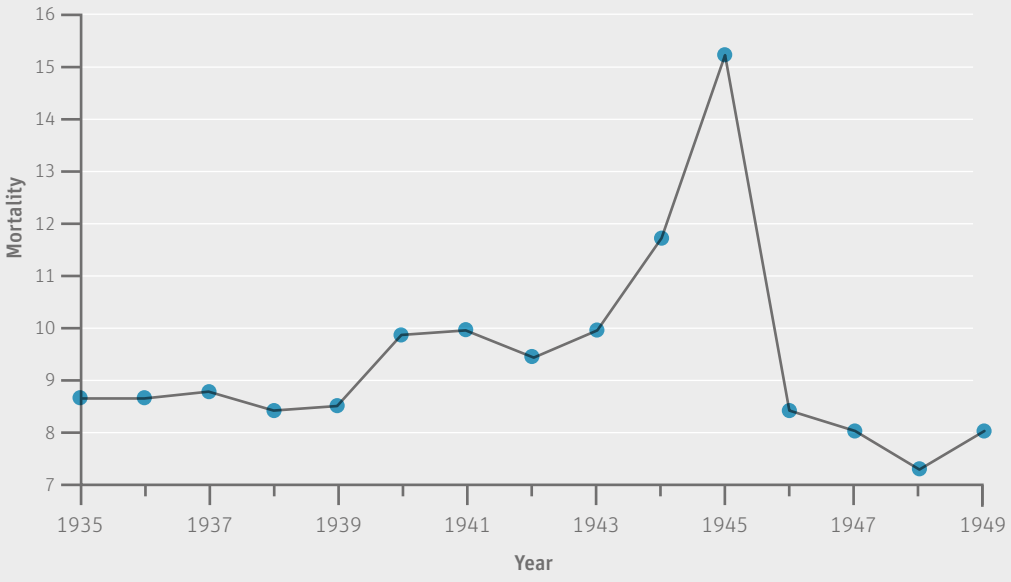


FIGURE 2: Yearly mortality per 1,000 inhabitants, the Netherlands, 1935–1949[12]



Source: Statistics Netherlands, statline.cbs.nl

FIGURE 3: Deaths within the first year of life per 1,000 live births, the Netherlands, 1940–1949[13]

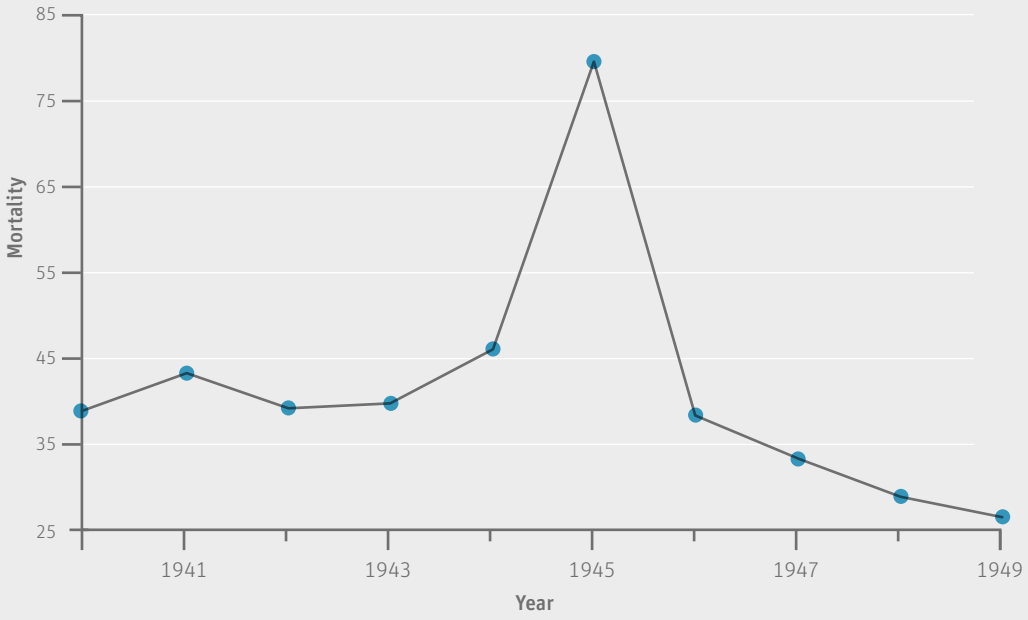
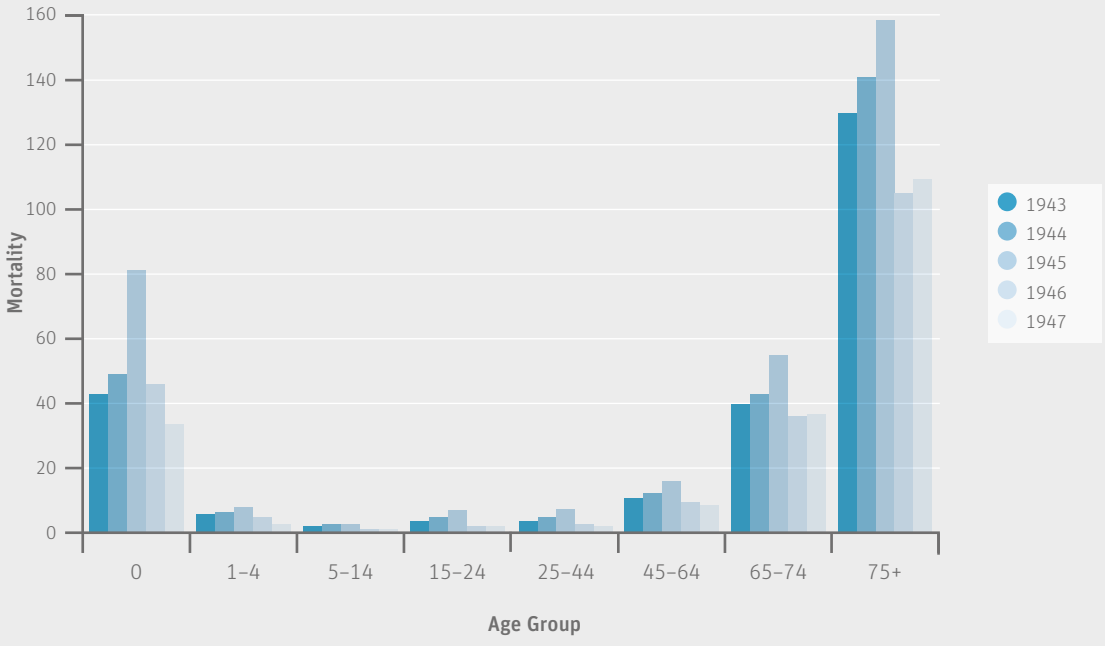


FIGURE 4: Composition of mortality by age and birth year, the Netherlands, 1943–1947[14]



Sources: Statistics Netherlands, statline.cbs.nl | Statistics Netherlands Archive

that especially exposure in early gestation had so many effects on brain, on heart, on liver, on lungs, and different organs."

It may nevertheless seem strange that the babies of the Hunger Winter did not recover fully from the nutritional insults received in the womb, despite growing up in a society that could fully provide for their nutritional needs. Prof. Nessa Carey observes: "We are all used to the idea that fetuses do most of their growing in the last few months of pregnancy. But epidemiologists were able to study these groups of babies for decades, and what they found was really surprising. The babies who were born small stayed small all their lives, with lower obesity rates than the general population. For forty or more years, those peo-

Dutch citizen and film icon Audrey Hepburn, best known for her starring role in *Breakfast at Tiffany's* and famous for her gamine looks. "The Dutch Hunger Winter ended when she was 16 years old, but the after-effects of that period, including poor physical health, stayed with her for the rest of her life." [21]

ple had access to as much food as they wanted, and yet their bodies never got over the early period of malnutrition. Why not? How did their early life experiences affect these individuals for decades? Why weren't they able to go back to normal once their environment reverted to the way it should be?" [20]

> "For forty or more years, those people had access to as much food as they wanted, and yet their bodies never got over the early period of malnutrition"

A recent epigenetic study by Elmar W. Tobi et al.[22] suggests that the Dutch Hunger Winter "silenced certain genes in unborn children – and that they've stayed quiet ever since." [23] While speculating that such as changes in DNA methylation (DNAm) – which underlie the relationship between adverse intrauterine conditions and adult metabolic health – might be responsible for the patterns they had found in the Hunger Winter cohort group, the authors' evaluation of their findings is cautious: "Our data are consistent with the hypothesis that epigenetic mechanisms mediate the influence of transient adverse environmental factors in early life on long-term metabolic health. The specific mechanism awaits elucidation." [24]

While investigations into the specific mechanism continue, adequate nutrition during the first 1,000 days of life remains a burning issue, even in parts of the globe not racked by poverty, disenfranchisement and natural and manmade disasters. Prof. Tessa Roseboom's observation that "you are what your mother ate" should perhaps serve as the nutrition community's rallying cry.

The author would like to thank Callum Cliffe for his assistance in researching this article.

Correspondence: ***Jonathan Steffen,***
Suite C, 153 St Neots Road, Hardwick,
Cambridge CB23 7QY, UK
Email: *jonathan.steffen@corporatestory.co.uk*

References

01. Karakochuk CD, Whitfield KC, Green TJ, Kraemer K. The biology of the first 1,000 days. Boca Raton, FL: CRC Press; 2018:xv.
02. Scholte RS, van den Berg GJ, Lindeboom M. Long-run effects of gestation during the Dutch Hunger Winter famine on labor market and hospitalization outcomes. J Health Econ. 2015 Jan;39:17–30.
03. Ibid.
04. Carey N. Beyond DNA: Epigenetics. Natural History. Internet: www.naturalhistorymag.com/features/142195/beyond-dna-epigenetics (accessed 25 October 2018).
05. Ibid.

06. Pieter van Marken. A teenager in Holland in WWII. More than Food. Internet: http://operationmanna.secondworldwar.nl/pietervanmarken.php (accessed 25 October 2018).
07. Ibid.
08. Burger GCE, Sandstead HR, Drummond, Sir J. Starvation in Western Holland: 1945. Lancet. 1945 Sep 1;246(6366):282–3.
09. Stein AD, Zybert PA, van de Bor M, Lumey LH. Intrauterine famine exposure and body proportions at birth: the Dutch Hunger Winter. Int J Epidemiol. 2004 Aug 1;33(4):831–6.
10. Ibid.
11. Statistics Netherlands, statline.cbs.nl. Reproduced in Scholte RS, van den Berg GJ, Lindeboom M. Long-run effects of gestation during the Dutch Hunger Winter famine on labor market and hospitalization outcomes. J Health Econ. 2015 Jan;39:17–30.
12. Ibid.
13. Ibid.
14. Ibid.
15. OECD Economic Surveys: Netherlands. 2018. Internet: www.oecd-ilibrary.org/economics/oecd-economic-surveys-netherlands-2018_eco_surveys-nld-2018-en (accessed 25 October 2018).
16. Zimmer, C. The famine ended 70 years ago, but Dutch genes still bear scars. The New York Times. 31 January 2018. Internet: www.nytimes.com/2018/01/31/science/dutch-famine-genes.html (accessed 25 October 2018).
17. Ibid.
18. Prof. Tessa Roseboom, University of Amsterdam, presenting on The Dutch Winter Hunger Study. 4 November 2014. Internet: www.youtube.com/watch?v=LeCUUCsfc2I (accessed 25 October 2018).
19. Cardwell-Smith, S. Interview with Dr Tessa Roseboom: The Dutch Hunger Winter and the importance of prenatal nutrition. 9 June 2017. Internet: www.destinationhealtheu.org/healthemory/interview-with-dr-tessa-roseboom-the-dutch-hunger-winter-and-the-importance-of-prenatal-nutrition (accessed 25 October 2018).
20. Carey N. Beyond DNA: Epigenetics. Natural History. Internet: www.naturalhistorymag.com/features/142195/beyond-dna-epigenetics (accessed 25 October 2018).
21. Ibid.
22. Tobi EW, Slieker RC, Luijk R, Dekkers KF, Stein AD 4, Xu KM, et al. DNA methylation as a mediator of the association between prenatal adversity and risk factors for metabolic disease in adulthood. Sci Adv. 2018 Jan 31;4(1):eaao4364.
23. Zimmer, C. The famine ended 70 years ago, but Dutch genes still bear scars. The New York Times. 31 January 2018. Internet: www.nytimes.com/2018/01/31/science/dutch-famine-genes.html (accessed 25 October 2018).
24. Tobi EW, Slieker RC, Luijk R, Dekkers KF, Stein AD 4, Xu KM, et al. DNA methylation as a mediator of the association between prenatal adversity and risk factors for metabolic disease in adulthood. Sci Adv. 2018 Jan 31;4(1):eaao4364.
25. Prof. Tessa Roseboom, University of Amsterdam, presenting on The Dutch Winter Hunger Study. 4 November 2014. Internet: www.youtube.com/watch?v=LeCUUCsfc2I (accessed 25 October 2018).

The Sizanani Mzanzi Marketing Mix

Promotion & Place

Kesso Gabrielle van Zutphen and Madhavika Bajoria
Sight and Life, Basel, Switzerland

What is the Marketing Mix?

Neil Borden, of Harvard Business School, used the term 'marketing mix' in 1991 to describe the set of activities comprising a firm's marketing program. He noted how firms blend elements of this 'mix' into a program and how firms competing in one and the same product category may have dramatically different 'mixes' at work. As shown in **Figure 1**, the 4 P's of Product, Price, Promotion and Place are often used to set out the marketing mix in an easy-to-recall way.[1]

FIGURE 1: The 4 P's of the marketing mix

This is part five of our ongoing Sizanani Mzanzi series focusing on lessons learned.

For part one, please refer to vol. 29(1) 2015 on *Pilot Microfranchise Program in South Africa – Empowering women while facilitating the distribution of innovative food products;*

For part two, vol. 31(1) 2017 on *Applying Consumer Research to Microfranchising in South Africa;*

Sizanani Mzanzi

Sizanani Mzanzi is a social business that was founded in 2014 by *Sight and Life* and DSM South Africa. Its objectives range from bringing affordable, nutritious foods to vulnerable South African households, to creating income-generating opportunities and building local capacity by involving low-income community members as microfranchisees.

For part three, vol. 31(2) 2017 on *Six Important Characteristics of a Successful Microfranchisee – Towards a blueprint for nutrition enterprises;*

For part four, vol. 33(1) 2018 on *Sizanani Mzanzi Marketing Mix – Product and Price.*

In this edition of the magazine, we look at the remaining two P's, Promotion and Place.

What is Promotion?

The 'Promotion' element of the marketing mix involves deciding the appropriate set of ways in which to communicate with customers to foster their awareness of the brand, the product, knowledge of its features, interest in purchasing, likelihood of trying the product and/or repeat purchasing it.

Effective marketing requires an integrated communication plan combining both:

1. Personal selling efforts
2. Non-personal selling such as advertising, sales promotion and public relations

In January 2017, Sizanani Mzanzi had noted that its products and brand were unknown in the areas in which they operated, and there was thus a need to increase awareness, visibility and confidence in these. With this aim, in 2017 BMi Research conducted consumer research to understand purchasing and consumption habits for instant porridge and juice concentrate. The results of

TABLE 1: The Sizanani Mzanzi promotion strategy

	Instant porridge	Powdered beverage
Benefits to promise	Convenient instant meal with vitamins and minerals.	Instant beverage with vitamins and minerals.
	The meal is a source of protein and high in fiber.	Simple and easy to use.
Support to promise	Healthy meal solution.	Healthy beverage option.

FIGURE 2: The two fortified products being offered by Sizanani Mzanzi

Product 1: MixMe fortified instant powdered beverage
Flavors: Orange | Pineapple
Pack size: 30 g – makes 1 L

Product 2: MixMe fortified instant maize | soy blend porridge
Flavors: Original | Vanilla
Pack size: 250 g, 750 g, 10 kg

the BMi research report confirmed the above and justified the need for extensive marketing initiatives. As a result, promotional sales activities were conducted to increase the brand and product awareness.

What are the *tasks and tools* of a promotion strategy?

A useful mnemonic in planning a communications strategy is the 6 M's model. How each of these M's were used to develop Sizanani Mzanzi's promotion strategy is described in Table 2.

"Brand is extremely important to consumers"

What is personal selling?

Brand is extremely important to consumers. At an overall level, promotion is the most important "P" to stimulate brand-switching (only to known/familiar brands), unplanned purchases, and pantry-loading. In this section, we will look at how Sizanani Mzanzi employed personal selling efforts to market the product.

Personal selling

A salesperson as a communication channel presents the advantage of permitting an interaction to take place between the firm and the potential customer rather than via merely the broadcasting of information. The salesperson can develop an understanding of the potential customer's perceptions and preferences and tailor the communication message to the situation.

TABLE 2: M's Model of Promotion for MixMe Products

1. Market:	**Geographic profile:** Suburbs and townships within Johannesburg,
To whom was the communication addressed?	extending to broader Gauteng province
	Age: 18–35-year-old consumers with a disposable income
	Roles: Working adults (young and old)
	Gender: Females, males
	Income: LSM 4–8. The Living Standards Measure or LSM is a marketing and research tool used in
	South Africa to classify standard of living and disposableincome. It segments the population
	into 10 deciles based on their relative means, with LSM 1 being the decile with the least means
	and 10 being the decile with the greatest means.
	Behavior characteristics:
	The 'Experimentalist':
	> Likes to try out new products if considered excellent value for money
	> Taste overrides importance of nutritional value
	> Likely to be swayed by promotions to try contemporary brands
	The 'Health-conscious Consumer':
	> Well informed around health and wellness
	> Reads nutritional information on packs
	> Makes informed, healthy choices on meal composition
2. Mission:	**Instant porridge**
What was the objective of the communication?	*To know:* Sizanani porridge is a convenient and fortified instant meal, anytime of the day.
	The product is a good source of protein and fiber.
	To believe: Sizanani porridge is a fortified product that will assist consumers in ensuring they
	consume a healthy meal option daily.
	To do: Consumers can buy the product from a store that stocks the products. Encourage consumers
	to have one portion (suggested serving size) of the porridge per day.
	Powdered beverage
	To know: The instant beverage is fortified and easy to use.
	To believe: It is a healthy beverage option.
	To do: Consumers can buy the product from a retail stockist.
3. Message:	**Bringing quality, affordable, nutritious products to South Africans.**
What were the specific points to be communicated?	**Instant porridge**
	Sizanani Mzanzi instant porridge contains vitamins, minerals, protein and fiber,
	making it the healthy choice.
	Powdered beverage
	The health benefits of vitamins and minerals can be found
	in the instant beverage.
4. Media:	**Promotions**
Which vehicles were used to convey the message?	The following are conducted at the promotions:
	> Informing the consumer about the product
	> Product tastings
	> Product sales
5. Money:	Sizanani uses its operational staff to do the promotional tasks. The average promotion is 6.5 hours
How much was spent on the effort?	and the approximate cost is R14,000.00 (approx. US$1,000) per day per site.
6. Measurement:	Improved sales at the retail store
How was impact assessed after the campaign?	

Microfranchising

"Microfranchising enables providers of goods and services to reach low-income segments by incentivizing or contracting local microentrepreneurs to cost-effectively take over a 'missing' function in the value chain, such as retailing, marketing and/or after-sales support. These franchisees can more easily generate a profit, which they then share with the franchisor."

Initially, Sizanani Mzanzi was operating on a microfranchising model,[2] thus the personal selling component was more significant than non-personal selling. The aim of the promotion was to create brand and product awareness among consumers. The recruitment, selection and training programs were designed to assist the microfranchising model.

What happened

- Each microfranchisee was assisted with branded promotional items to assist with sales (the items were returned upon completion of the promotion).
- Promotions were conducted in areas with a fairly good number of potential customers.
- A Sizanani Mzanzi team member would also be present at some promotional sites to document the lessons learned.

Lessons learned

- Microfranchisees find it unprofitable to do door-to-door sales. Consumers prefer to purchase products from a retail store; this is because retail stores with cheaper substitutes are easily accessible for all LSMs.
- Promotions assist in driving sales and consumer demand.

FIGURE 3: Revamped product: instant protein cereal

- Microfranchisees lack the enthusiasm to perform promotional events and sales. Shopping malls and other retail shops, which have the highest number of potential customers, tend to be too expensive or prohibit promotional events or sales of products on their premises.

Recommendations

- Brand awareness is key to the success of the product and sales. Consumers need to be informed about the health and convenience benefits of the product. Promotional activities will serve as a marketing tool for the product.
- An alternative sales channel must be considered for the brand and products to have a greater impact and reach. Consumers are confident in, and loyal to, the retail chains within South Africa.

Why did Sizanani Mzanzi shift to a non-personal promotion strategy?

As outlined above, there were several limitations to the promotion strategy within the microfranchising model for Sizanani Mzanzi. The MixMe instant porridge and powdered beverage are not doing as well because the consumer can choose from several alternative brands, which are cheaper. It is to be noted that the cheaper substitutes use low-grade micronutrients and do not have any protein, or in some cases may also be completely unfortified. The value of the Sizanani Mzanzi instant porridge and powdered beverage was not easily recognizable for the consumer.

Sizanani Mzanzi undertook a thorough rebranding exercise because of poor performance of both the microfranchisees and the products. As a result, the MixMe instant porridge and powdered beverage are being phased out and an instant cereal called **Level Up** is being launched in vanilla and original flavors (**Figure 3**). This product will be launched in Q4 of 2018.

The product is being reformulated to decrease the sodium and sugar levels and increase the fiber content of the cereal. This will enable the product to obtain the heart mark and diabetes endorsements, which will set it apart from other products in the instant cereal category. Additionally, Sizanani Mzanzi wants to be mindful of the double burden of malnutrition and to ensure that its products address not just undernutrition but also overnutrition. With this product, the target audience is preteens across all LSMs. The focus of the communication strategy is for the product to be perceived as 'cool' by the target market. Additionally, the promotion strategy here relies more heavily on non-personal selling vehicles, which include various sales promotions:

- The soft launch will be followed by a promotional giveaway, to increase appeal of the product to the target market.

TABLE 3: Strengths and weaknesses of a direct vs. indirect distribution model

	Strengths	Weaknesses
Direct distribution model	> Total control over how the product is marketed and sold	> Possibly limited market coverage
	> High-quality contact with customers	> Limited network
	> No fighting with the competition for shelf space	> High fixed costs
	> Fast feedback loop	> More time-consuming and expensive for some business owners
Indirect distribution model	> Larger coverage	> Less focused on your products
	> Reach new target segments	> Smaller margins
	> Low fixed costs	> May limit customer information
	> Expertise	> Less control

- In the stores in which the product is launched, promoters will be appointed to give out samples to customers and then try to convert the sample into a sale.
- Part of the agreement with retail outlets that are stocking the new product is to use in-store promotions to sell all the stock.

The key message to be conveyed through promotional activities is that Level Up is the *best product for the best price*.

What is Place?

In the marketing mix, the process of moving products from the producer to the intended user is called 'place,' also commonly referred to as 'marketing channels.' In other words, it is how your product is bought and where it is bought. This movement could be through a combination of intermediaries such as distributors, wholesalers and retailers, or even the internet, which itself is a marketplace.[3]

Using the right marketing channels, a company can increase sales and maintain these over a longer period.[3] In turn, this would mean a greater share of the market and increased revenues and profits. Correct placement is a vital activity that is focused on reaching the right target audience at the right time.[3] It focuses on where the business is located, where the target market is placed, how best to connect these two, how to store goods in the interim and how to eventually transport them.

There are two major decisions in channels, namely: channel design and channel management. These will both be explored in the following paragraphs.

What channel design was selected?

Channel design refers to those decisions involving the development of new marketing channels where none had existed before, or the modification of existing channels. The term 'design' implies that the marketer is consciously and actively allocating the distribution tasks to develop an efficient channel, and the term 'selection' means the actual selection of channel members.[4]

From a direct to indirect model

In the early phases of Sizanani Mzanzi back in 2015, the enterprise had a **direct distribution** channel whereby there was no independent party between the firm and its customers – the business only sold and delivered Sizanani products directly to customers using its sales agents, the so-called Sizanani Mzanzi microfranchisees. At the time, the microfranchisees would sell MixMe products from door to door, and also at creches, to their friends and family or by order (referrals or repeat customers). Selling these products from door to door was a great starting point for Sizanani Mzanzi, which needed to get a more personal feel for the market and had to be able to control the products' pricing and selling methods.

Nonetheless, this model also had numerous drawbacks: the products were heavy to carry around, and research conducted revealed that people had negative sentiments around door-to-door sales as a distribution mechanism. The biggest barriers were concerns for safety and skepticism around product quality and authenticity, since it was an unknown brand. The fact that the products were not stocked at local stores further fueled customers' skepticism of the brand. Additionally, microfranchisees lacked the resources (money and car) to cover large geographical areas to increase sales. Finally, and most importantly, there is a saturation of retail stores and supermarkets in the urban Johannesburg setting, whereby all products, across LSMs, are easily accessible at a mall, disqualifying the need for microfranchisees to knock on customers' doors.

Although direct customer contact was a critical way to gain market understanding as an input to future product development efforts, considering these growing issues, Sizanani Mzanzi investigated alternative routes to get to its customers, such as local stores and health kiosks.

FIGURE 4: The three levels of the distribution channel

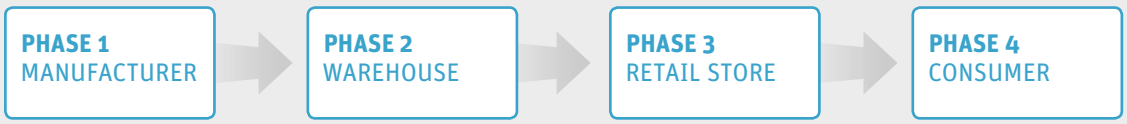
One-level channel: A one-level channel contains one selling intermediary. In consumer markets, this is usually a retailer. Here, producers sell their goods directly to large retailers, who then sell the goods to the final consumers.

Two-level channel: A two-level channel encompasses two intermediary levels – a wholesaler and a retailer. A wholesaler typically buys and stores large quantities of merchandise from various manufacturers and then breaks them down into smaller lots (bulk breaking) to supply retailers with smaller quantities. For small retailers with limited financial resources and order quantities, the use of wholesalers makes economic sense.

Three-level channel: A three-level channel, as the name implies, encompasses three intermediary levels – a wholesaler, a retailer, and a jobber (a small-scale wholesaler or middleman in the retail goods trade).

Source: Definitions and figures are taken from Singh 2011, p. 472–473.[5]

FIGURE 5: The Sizanani Mzanzi two-level channel



Phase 1 – Manufacturer: The manufacturing and packaging will be outsourced to FSSC 22000-approved facilities. The manufacturer will source all raw materials required for the product. Once the product is manufactured, it will be transported to the contract packer. A bag-in-box solution will be implemented for the packaging of the product. The contract packer will pack the product into the primary, secondary, and tertiary packaging. Once the packaging process is completed, the product is transported to the warehouse.

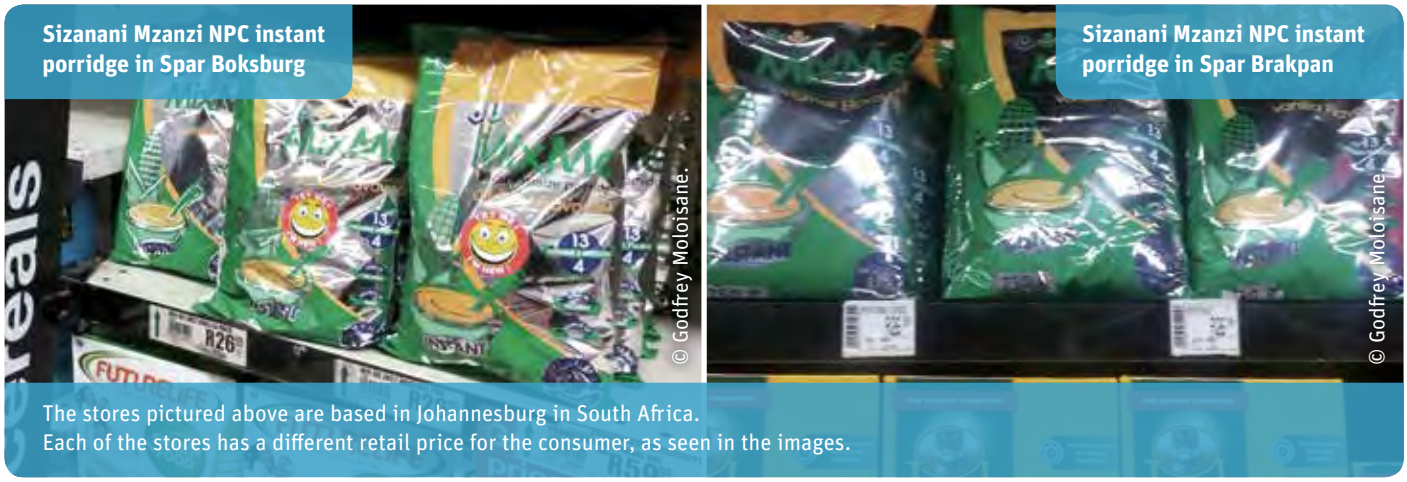
Phase 2 – Warehouse: The warehouse will store all packaged products ready for distribution. All sales orders will be distributed from the warehouse to the retail stores.

Phase 3 – Retail Store: The retail store will afford consumers the opportunity to engage with the product. Consumers will purchase the product from the retail stores.

Phase 4 – Consumer: The consumer can prepare the product and enjoy it.

"Sizanani Mzanzi has moved from a direct to an indirect distribution model"

Since early 2018, Sizanani Mzanzi has moved from a direct to an indirect distribution model whereby a retailer pays for and takes title to the enterprise's goods and is then free to sell them at whatever price and in whatever fashion it desires.[1] To keep the products affordable, pricing options will be discussed with retailers. In South Africa, retail groups usually add a 25% mark-up on products. As Sizanani Mzanzi's aim is to sell the cheapest instant protein cereal in the retail space, this will enable it to have a portion of the cereal market. To maintain the social nature of the business, Sizanani Mzanzi will utilize its profits gained from the retail sales to assist the rural development program by subsidizing products for rural communities. Additionally, the enterprise aims to commence with a feeding scheme project, where NGOs and other organizations that assist care centers for children and the elderly will be invited to apply to these feeding schemes. While companies will be able to donate cash to Sizanani, Sizanani will in turn supply instant protein cereal and beverages to these NGOs.



The stores pictured above are based in Johannesburg in South Africa. Each of the stores has a different retail price for the consumer, as seen in the images.

Channel length and breadth

Channel length and breadth are two crucial elements that characterize the channel design. Channel length refers to the levels of independent members along a distribution channel, i.e., a direct distribution channel is a short channel and an indirect distribution involves a long channel.

In the case of Sizanani Mzanzi, the large and diffuse target group of Sizanani products and the intention to increase the product basket meant that costs of account relationship could be spread over many products, justifying the transition towards an indirect (and thus longer) distribution channel. Sizanani Mzanzi approached retailers to carry the instant cereal products. It started with a few stores but has now been introduced into 20 urban retail outlets consisting of both corporate and franchised stores, of which one is the big retailer – SPAR group.

Another characteristic of the channel design is the channel breadth, which specifically determines the degree of market exposure. In other words, it refers to the number of independent members at any stage of distribution. In a narrow channel, a manufacturer or service provider sells via a few wholesalers or retailers, while in a wide channel, it sells via many. Compared to the time at which MixMe products were targeted at low LSM groups, the rebranded products throughout the 20 retail outlets approached by Sizanani Mzanzi will be targeting all LSM groups and will be selling through various retail chains. The retail chains have stores in various suburbs within South Africa across all LSM groups. Sizanani aims to discuss the store selection with retail chains. An in-store activation will support each store to create the brand and product awareness.

The aim is to have the product stocked in stores that are visited by a high number of people. It is hoped that switching to retail will generate profits which in turn will be used to subsidize the products for rural markets and for promotion purposes as explained above. At present, Sizanani Mzanzi aims for products to be distributed in the Gauteng province and is subsequently planning to expand to Western Cape and KwaZulu-Natal provinces.

Sizanani Mzanzi currently consists of a two-level channel with the process flow shown in **figure 5** for the product, from manufacturer to consumer.

It is important to note that in the light of Sizanani Mzanzi's nature as an emerging social business, it is the enterprise's aim for the products to be easily accessible to customers and thus not to have any trade barriers or increased costs on the product.

Acknowledgements

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Correspondence: ***Kesso Gabrielle van Zutphen,***
Knowledge and Research Specialist, Sight and Life,
PO Box 2116, 4002 Basel, Switzerland
Email: *kesso.vanzutphen@sightandlife.org*

References

01. Borden NH. The concept of the Marketing Mix. In: Dolan RJ. Strategic marketing management. Boston, MA: Harvard Business School Press; 1991.
02. Feed the Future. From smallholders to shareholders: a guide to optimizing partnerships with the private sector for smallholder impact. Washington, DC: USAID; 2014.
03. Cleverism. Marketing Mix – Place in Four P's. 2014. Internet: www.cleverism.com/place-four-ps-marketing-mix/ (accessed 16 August 2018).
04. Rosenbloom B. Marketing channels: a management view. 8th ed. Mason, OH: South-Western Cengage Learning; 2013.
05. Singh, H. Retail management: a global perspective. New Delhi: S. Chand Publishing; 2009.

A Day in the Life of Arlette Eulert Checa

Star Peruvian chef **Arlette Eulert Checa** has worked alongside famous international chefs of Michelin-star restaurants, including Gaig in Barcelona, Nobu in London and D.O.M. in São Paolo. Today she runs the highly successful restaurant Matria in the Miraflores district of Lima – a city famous for the quality and also the diversity of its cuisine. As Matria celebrates its fifth anniversary, Arlette explains her philosophy of sharing what Mother Earth has to offer.

Sight and Life (SAL): *Arlette Eulert Checa, what inspired you to establish your own restaurant?*

Arlette Eulert Checa (AEC): I love food and I love cooking, and I always wanted to own a restaurant. Both my grandmothers had a great influence on me in this respect. One came from Bolivia and the other from Italy. My Bolivian grandma was a marvelous cook and specialized in big meals for special occasions. My Italian grandma, by contrast, focused on day-to-day cooking. She was extremely maternal. I lived with her, and it was from her that I learned to cook, cooking with her every day.

I studied Art at the Pontifical Catholic University of Peru here in Lima, but upon completing my studies, I decided I wanted to become a chef. And so I simply went into a restaurant and asked for a job. That was my start in the gastronomy business! I subsequently trained at Le Cordon Bleu in Lima – the largest network of culinary and hospitality schools in the world. My training took me abroad, and I was to work for some of the leading chefs in Barcelona, London and Brazil. I also learned a great deal from some of our top chefs here in Lima, where I worked at Rafael Restaurant, El Mercado and La Mar. Establishing my own restaurant in due course gave me the opportunity to offer people my own version of our native cuisine.


© Jimena Agois

Tiridato of Chilean silverside with sea urchins in a tiger milk of yellow chili peppers. *Tiridato* is a traditional dish comprising raw fish in a spicy sauce.

SAL: *What does 'Matria' mean, Arlette, and what kind of food does the restaurant serve?*

AEC: It means 'Motherland' – a cross between *madre* (mother) and *tierra* (land) in Spanish – and it refers to where our food comes from. Peru is a country of enormous diversity. With our long coastline and the Andes inland, we have a highly seasonal climate and great biodiversity. In fact, we don't have a government calendar for agricultural production because the country encompasses so many different regions and climates. My approach at Matria is therefore very seasonal, with four different menus a year, all based on Peruvian produce. I've been very fortunate: we Peruvians really love our food, and Matria has proved very successful.

SAL: *Why do you think that customers keep coming back to you?*

AEC: I think it's because of the overall experience – the space itself, the style of cooking and the variety of dishes on offer, in terms both of ingredients and of cooking techniques. I want all my customers to be happy and satisfied, and so our menu

"I love food and I love cooking, and I always wanted to own a restaurant"

Arlette Eulert Checa

Arlette at work in Matria. "You have to be always there, always involved, always improving."

includes vegetarian and vegan options, as well as gluten- and lactose-free dishes. These are important trends in Peru, and we take care to cater for them while offering an authentic Peruvian eating experience.

SAL: *What is the relationship between Matria and its suppliers?*

AEC: I know my suppliers very well – many of them I've known for years. I'm always on the look-out for new ones, of course, and sometimes suppliers I don't know will proactively approach me. Being in the capital, our sourcing isn't really local. Everything comes from different regions of Peru. The essential thing is to create a relationship of trust between supplier and restaurant.

SAL: *What makes a successful restaurant, in your opinion?*

AEC: It's a continual learning process. You have to be always there, always involved, always improving. You can always get better. I know some people think of running a restaurant as romantic, but it's also very much a business.

SAL: *You are known as a member of the Peruvian Generación con Causa ('Generation with a Cause'). What is the Generación con Causa, and what does it mean to you to be a part of it?*

AEC: *Generación con Causa* is a movement of more than 50 young chefs from Lima and the provinces whose mission is to continue consolidating the foundations of Peruvian cuisine. I am also part of the *Manifesto de Chefs* movement, a community of chefs from around the world, equipped with a set of simple actions to promote progress in addressing food problems, which looks towards a future in which chefs are socially committed and work consciously to protect the planet's resources. We are going to establish a hub here in Lima at the beginning of 2019 in alliance with the new school of gastronomy of the Catholic University of Peru, where I am a professor.

SAL: *What is the overall nutritional status of the population of Peru?*

AEC: There is a positive trend here in Lima for healthy cafeterias aimed at children, but anemia is growing in rural areas, affecting 43% of the population, while overweight and obesity are also on the rise. I said that we Peruvians love our food, but some of us still see Western diets as aspirational. All too many spend their money, if they have it, on Coca-Cola – and then throw away the plastic bottle as though it were a fruit skin. There's a great work of education to be done. We also need many more doctors in this country.

SAL: *What do you enjoy most about your work?*

AEC: Being creative. I know it's a big thing to say, but running Matria makes me feel that I'm alive. I love developing new dishes and finding new ways of reaching out to people – via pop-up gastronomy events, for example. The social dimension is very important to me. And I feel that chefs have a responsibility to give something back to society.

SAL: *If you could change one thing about your job, what would it be?*

AEC: That's a difficult question. Having a restaurant that opens only at weekends, perhaps!

Beetroot of various colors. The cuisine of Lima is famous for its quality and diversity.

Arlette puts the finishing touches to a meal. "Running Matria makes me feel that I'm alive."

SAL: *And what do you do to relax from work?*
AEC: I enjoy a glass of wine, I like going to the movies and the theater and I love reading when I'm not too tired for it. I also enjoy Pilates from time to time.

SAL: *And what is your own personal favourite food in the world?*

AEC: Pasta. Just pasta with salt and olive oil. I also love cocoa – of which we have a lot here in Peru!

SAL: *There may be readers of our magazine in Peru or other parts of the world who would like to pay a visit to Matria one day. Do you have a message for them?*

AEC: I'd say that there are so many challenges facing us today that we really just need to stop talking and take some action. There are so many ways we can bring about improvements, even if it's simply on the level of reducing the amount of food we waste in the home. We just need to get on with it.

SAL: *Arlette, many thanks for sharing your thoughts with us, and the best of luck for the next five years of Matria!*

AEC: Thank you.

***Arlette Eulert Checa** was interviewed by Jonathan Steffen.*

EAT Forum 2018

Stockholm, Sweden, June 11–12

Breda Gavin-Smith
Sight and Life, Basel, Switzerland

The stage is set for the start of EAT Forum 2018

The American anthropologist Margaret Mead once said, "Never doubt that a small group of thoughtful, concerned citizens can change the world. Indeed, it is the only thing that ever has." This quote nicely summarizes both the atmosphere and the task confronting delegates at this year's EAT Forum. The forum took place on June 11–12 in Stockholm, and was jointly hosted by EAT and the Government of Sweden. More than 600 delegates from more than 50 countries attended.

The aim of the two-day event was "to strengthen existing partnerships and forge new collaborations across a broad range of sectors and groups to compel science-led action" (EAT Forum, 2018). The conference focus areas included:

- shifting towards healthy diets;
- sustainably managing lands and oceans;
- eliminating food loss and waste;
- technology transforming the food system; and
- recipes for better yields and better nutrition.

Day One – Setting the scene

The Forum was opened by Dr Gunhild A. Stordalen, the founder and Executive Chair of EAT. Her introduction was a rallying cry for all players in the food system to come together and collaborate to enable food transformation. Challenges to real collaboration were highlighted. One challenge is a lack of common reference points, which contributes to growing polarization rather than a coming together for change. Currently, no goals examine the food system with regard to the health of both people and the planet. The EAT-Lancet Commission on Food, Planet, Health is an attempt to bring this together, and its results will be released in early 2019. The expectation is that these evidence-based global targets will support more constructive dialogue and collaboration, and will monitor transformation in the food system. In conclusion, Dr Stordalen encouraged all actors to ask difficult questions and address complexities and disagreements. We must look from "all sides of the table" if real food transformation is to become a reality.

> "We must look from 'all sides of the table' if real food transformation is to become a reality"

The Deputy Prime Minister, H. E. Isabella Lovin, followed the opening address and summarized the current situation regarding hunger, undernutrition and overnutrition. She emphasized the role of food production in global environmental degradation, with the "agricultural sector [being] the single-largest contributor to climate change, deforestation and biodiversity loss."

The State of the Union address by Prof. Johan Rockstrom from the Stockholm Resilience Center and Dr Sania Nishtar, Co-Chair for the High-level Commission on Non-communicable Diseases (NCDs) of the World Health Organization (WHO), followed. Both

A slide from one of the presentations given at the conference: Scientific targets for sustainable food systems

presented current trends with regard to health, the food system and the planet. Issues such as the double burden of malnutrition, the increasing prevalence of diabetes and the general global shifts to unhealthy diets were key themes.

The final presenter setting the scene was Christiana Figueres, convener of Mission 2020, the global campaign driving action on greenhouse gas emissions. Again, Christiana Figueres challenged the audience over the coming days to discuss how to feed a growing population in a sustainable way while keeping impacts on the environment front and center. She encouraged participants to bring others into the debate and be "stubborn optimists."

Sustainably managing land and ocean

The late morning session, day one, focused on examining how to manage land and oceans differently to support a food system that produces healthy, nutritious foods within planetary boundaries. Whether technology is the answer and whether our oceans could be the farms of the future were some of the questions posed. Speakers ranged from EAT's Science Director, Dr Fabrice DeClerck, and Jan Eliasson from the Stockholm International Peace Research Institute. An interview-style discussion with the Chair of the Farmers' Forum India, Ajay Vir Jakhar, was a real highlight. Ajay Vir Jakhar gave an impassioned plea to build capacity among farmers, supporting them as part of the solution. A change in the food system will require their trust and knowledge. It was also highlighted that two-thirds of fish comes from small-scale fisheries and that 80% of food produced in sub-Saharan Africa comes from small farms. These need to be front and center in food system planning. The need for better funding mechanisms for new initiatives and small-scale producers was also highlighted. While there are no silver-bullet solutions, new technology developments and aquaculture are starting to emerge as potential opportunities. Finally, a significant increase in protected areas from fishing, which is currently only 2% globally, is required.

"New technology developments and aquaculture are starting to emerge as potential opportunities"

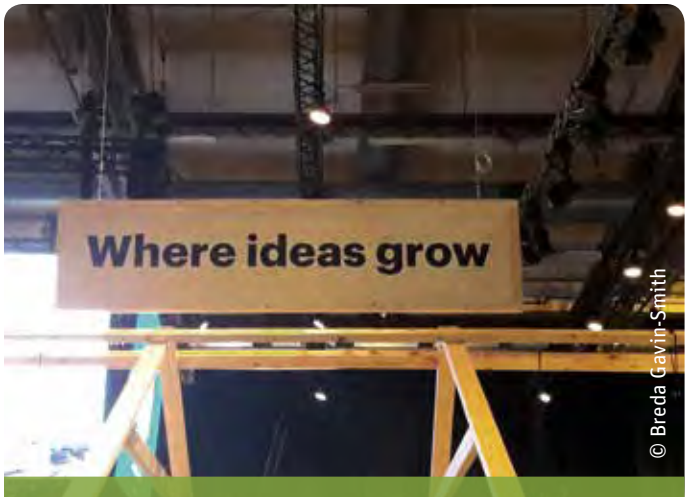
Nothing to spare: How to end food loss and waste

Prof. Jessica Fanzo from Johns Hopkins University kicked off the afternoon session with a great quote from Lauren Singer: "Our collective actions make up the state of the world." This reflects, according to Prof. Fanzo, the food waste issue, where personal change with regard to food waste is required. Forty percent of food waste in Europe and North America is lost at the hands of the consumer and retailer. In Africa and South-East Asia, 40% of food waste occurs at the food gate or during transportation. Transforming the food waste issue involves developing new technologies, changing consumer behavior, better labeling of foods, innovations across the food chain, incentives and improved measures to combat food waste in the first place.

The rest of the afternoon focused on solutions to food waste. Highlights included a personal story from the founder of Trash is for Tossers (http://trashisfortossers.com), a government regulation in France directed at retailers and the role of chefs in reducing food waste.

Day Two – Disruptive dialogues

The second day was structured in terms of a series of disruptive dialogues, enabling smaller groups to come together and discuss issues in greater depth. I attended the *Putting Food in Food* session, where a four-dimension solutions framework as a tool to access new packaged food products was presented. The four-dimensions were: environmental, social, dietary health and business case.



Gathering ideas as we enter EAT Forum 2018

A slide from one of the presentations given at the conference: The scale of the challenge. Developing a solutions-oriented dialogue will be essential for success.

Products included **(a)** a new Kellogg's 'Force of Nature' granola-type cereal with lower sugar, recyclable packaging materials and a good taste; **(b)** a good-tasting fruit smoothie (froosh) containing only fruit (the fruit fibers giving it a smoothie feel), packaged with recyclable materials; **(c)** reformulated Nesquik cereal (two versions, one to meet WHO guidelines on sugar and salt and one to meet the Chilean standards necessary to avoid the black warning labels on the front of pack); and **(d)** ModuMax, a 'taste modulator' from DSM that helps to moderate negative organoleptic characteristics in foods that have been reformulated to have lower sugar and salt. The four-dimension framework proved a useful approach when assessing products against a variety of criteria. The session also highlighted the role that incremental changes in product formulation can potentially play in improving nutritional intake as well as the significance of innovative new technology in overcoming technical challenges. It was highlighted that low- and high-income countries may require different approaches.

> "Low- and high-income countries may require different approaches"

Day two – Afternoon session

Making healthy and sustainable the new normal was the final question posed by the EAT Forum. While it is not possible to include all the details covered in the afternoon session in this report, here are some highlights.

Chilean doctor Senator Guido Girardi presented on a law he spearheaded in Chile prohibiting the advertisement of junk food during television programs and websites targeting young audiences. The law also bans the sale of such products in the country's schools, and requires companies to clearly label foods that are high in calories, salt, sugar, or saturated fat. Studies show that this law is having an effect. In fact, more than 68% of individuals in Chile have changed their eating habits, and 20% of the industry has modified its products since the law came into force.

Sam Kass, former White House Chef and Senior Policy Advisor for Nutrition in the Obama administration, made some salient points. He wisely stated it is not just about public policy, and that food is the deepest expression of our culture. When you ask someone to change, you are asking them to change themselves, and an approach that takes this reality into account is essential. He suggested we should not spend too much time on ideals and the perfect way to work. We need policies that are pragmatic, that work and that deliver easy wins.

The concluding comments from the final panel at the EAT Forum neatly sum up key challenges and next steps based on the 2018 EAT Forum's aims. Different perspectives lead to difficult conversations, but without them, transformation is not possible. A solutions-oriented dialogue that places health issues center stage is key to move forward.

Correspondence: ***Breda Gavin-Smith,***
Global Public Health Nutrition Manager,
PO Box 2116, 4002 Basel, Switzerland
Email: *breda.gavin-smith@sightandlife.org*

The Carotenoids and Retinoid Interaction Group (CARIG) Conference Meets in Boston

Noel W Solomons
Center for Studies of Sensory Impairment, Aging and Metabolism (CeSSIAM), Guatemala City, Guatemala

The Hynes Convention Center in Boston, MA, USA, was the setting for the 2018 CARIG Conference. This year's topic was "Carotenoids and Retinoids Throughout the Lifespan." The event was chaired by Dr Elizabeth Johnson of Tufts University and co-chaired by Dr Nancy Engelmann Moran of the Baylor College of Medicine's Children's Nutrition Research Center. On a sad note, the assembled acknowledged, with a moment of silent meditation, the abrupt passing earlier in 2018 of Dr Phyllis E. Bowen, a founding member of the CARIG and a staunch supporter of its development and activities.

The 17th annual James Allen Olson Memorial Perspectives on Carotenoids Lecture was delivered by Prof. Keith West, Jr., of the Center for Human Nutrition of the Bloomberg School of Public Health at Johns Hopkins University in Baltimore. His provocative and far-reaching discourse was entitled: "Vitamin A, carotenoids, health and survival by person, place and time." The overall message ranged widely and the full lecture will be published in a forthcoming issue of *Sight and Life* magazine. Suffice it to say, the conference for 2018 was enlivened and enriched by the elements of discussion brought in by Prof. West and his experiences from Nepal and Bangladesh.

Dr Corrine Hanson of the University of Nebraska Medical Center delivered a presentation entitled: "Infants: vitamin A and related compounds in maternal-infant pairs, breast milk and formula; serum retinol in women of childbearing age in the US." Although the headline word is *infant*, the first year of the lifespan, the title entails a wide-ranging swath of keywords of individuals and biomarkers. The presentation was based on analysis of venous blood from the mother and cord blood from the infant from a group of 180 maternal-infant dyads delivered at the University of NE Medical Center in Omaha, NE. The ethnic composition included 12% African-American and 15% Hispanic-American participants. Eighty-four percent were non-smokers.

The Biomarker Research Institute at the Harvard School of Public Health in Boston analyzed a wide battery of fat-soluble nutrients and compounds. In the first instance, an analysis was made of vitamin A status based on circulating retinol. With respect to the cut-off for insufficient vitamin A status of <20 µg/dL, 51% of the mothers' retinol concentrations fell into this zone, and 10% overall were deficient, with a level of <10 µg/dL. Black mothers had twice the probability of whites to have an abnormal vitamin A concentration. Of the data reported for infants, the subjects of an early-life focus, there was a significant correlation between maternal and cord-blood retinols, and 80% of infants had a retinol concentration of <10 µg/dL. It should be noted that criteria for vitamin A status in newborns have not been firmly established.

The investigators received a whole gamut of carotenoid analyses from the same paired blood specimens in the 180-dyad sample. The initial focus was on lycopene, the total circulating pigment and its *cis* and *trans* isomers. Maternal concentrations of total and *cis*-lycopene were positively associated with infant birth weight, length and head circumference after adjustment for relevant confounders. Lower maternal levels of *cis*-lycopene were associated with development of respiratory distress syndrome (RDS) and admission to the newborn intensive care unit (NICU). By contrast, higher cord blood (infant) concentrations of *trans*-lycopene were associated with RDS and NICU admission risk. Accepting a causal assumption – i.e., that total and *cis*-lycopene were responsible for the better growth and health outcomes – the reverse-causality hypothesis is that better-educated and motivated mothers, who would provide better self and infant care, would display a more diverse and balanced diet.

CARIG Symposium reception poster winners and judges. From left: Elizabeth Johnson, PhD (CARIG Chair, Tufts University, poster judge); Zhi Chai (Penn State, third place); Jelena Mustra Rakic (Tufts University, second place); Jirayu Tanprasertsuk (Tufts University, first place); Nancy Engelmann Moran, PhD (CARIG Chair-elect, Baylor College of Medicine, poster judge).

> "Having higher or lower circulating levels of carotenoids depends on dietary exposure, which in turn relies on the cultural practices and market or household availability of carotenoid-rich foods"

The Omaha–Boston research axis has reached out to rural northwest Nigeria for blood samples for similar lipid analyses. This is a population with a large and diverse consumption of edible plants; the array of carotenoid pigments in the Midwestern women is *pallid* (both literally and figuratively) as compared to their West African counterparts. Since having higher or lower circulating levels of carotenoids depends on dietary exposure, which in turn relies on the cultural practices and market or household availability of carotenoid-rich foods, variation was not unsurprising. Equally unsurprising is the fact that women consuming the typical meat- and grain-based dietary fare of the US Midwest have a less vibrant array of carotenoid compounds than women on traditional vegetable- and herb-rich repasts in rural Nigeria. That the blood mimics the dietary exposure is an accepted truism. Only supplementation or major dietary modification would move the Omaha pattern to that of Nigerian women. This line of intervention would also tend to resolve the issue of causality versus simply association in the health-related relationships.

Dr Sherry A. Tanumihardjo of the University of Wisconsin–Madison addressed the issues of childhood with a provocative flare entitled: "Children: biofortification of food and possible vitamin A toxicity." Dr Tanumihardjo has borne a singular focus on how well – or how poorly – different putative biomarkers indicate human vitamin A status, which she has shared in writing and at previous CARIG conferences. She expresses concern about circulating retinol levels being unreliable in reflecting the two poles of concern of vitamin A status: vitamin A deficiency and vitamin A excess. In this discourse, she went so far as to use the terminology of 'possible vitamin A toxicity.'

Eighty percent of total-body vitamin A is generally located as reserves in the liver. In agreement with most colleagues, Dr Tanumihardjo feels that the hepatic vitamin A content is the most faithful arbiter of nutritional status, conceding that access to this datum comes only through post-mortem exam or opportunities for liver biopsy. A concentration of >300 µg per gram of hepatic tissue is considered excessive. Less invasive marker studies such as the modified retinol dose response and stable-

isotope-labeled retinol dilution tests can provide more refined diagnoses extending from the deficient through the normal to the excessive range. Such expanse is necessary for population research, since some data cited showed that, in the USA, one can find 22% of individuals with vitamin A deficiency (VAD), whereas 4% have hepatic evidence of excessive content and fat-globule vacuoles on histological examination.

Admitting that VAD is more rampant in low-income countries, Dr Tanumihardjo warned of a downside of excessive exposure from the intervention programs arrayed against it. These include periodic supplementation and fortification of foods such as edible oils and table sugar, and the newest development: biofortification. Varieties of carrots, sweet potatoes and maize have been hybridized to augment their concentration of provitamin A carotenoids such as β- and α-carotene. Systematic feeding with these biofortified foods in Zambia resulted in orange-colored pigmentation of the palms of the hands, a condition known as carotenodermia. Known to dermatology for decades, this condition has been considered to be benign and harmless. Based on our current knowledge of molecular mechanism, carotene oxidase action in converting dietary provitamin A to retinaldehyde suppresses bioconversion at a normal (adequate) vitamin A reserve status. This was posited as a biological guarantee against hepatic excess of active retinoids. Consistent with the title of the presentation, Dr Tanumihardjo concluded with preliminary biomarker evidence for an escape from regulatory control and vitamin A excess in chronic consumers of biofortified provitamin A sources.

As an editorial comment, a field study is commencing in Guatemala, a nation with a sugar-fortification program, to examine the tissue concentrations and histology of the livers of individuals experiencing sudden death from accidents or violence; this will help clarify the relationships of exposure and adverse effect, if albeit not in the context of biofortification, but in the setting of one of the most successful public health interventions against VAD.

Dr Randy Hammond of the University of Georgia took on a process emerging into later adulthood: "The influence of the macular carotenoids on auditory and visual-motor thresholds." The term macular carotenoids refers to zeaxanthin and lutein, which are selectively deposited in the fovea (macula) of the retina and whose density is believed to represent protection of this essential structure for vision. The former compound is primarily derived from corn and named for the botanical term, *Zea mays*; notably, egg yolk and orange bell pepper are rich in zeaxanthin as well. Corn is also a leading source of dietary lutein, with important contributions from squashes, spinach and orange juice. The mechanism of action and protection has been considered a direct interaction with, and absorption of, damaging light. An internal, potentially nerve-tissue-based role for these two carotenoids in other sensory functions was the revelation of Dr Hammond's innovative thesis about these compounds being 'neural pigments' and having a role in what he termed 'neural efficiency.'

From the standpoint of feasibility and construct validity, Dr Hammond noted that xanthophilic cells, with affinity for this class of carotenoids, have been known in the brain since discovered by Craft in 2003. He reviewed findings from his groups and others regarding an association between amnesia (memory loss) and cognitive function in older individuals and the density of the macular pigments in the brain tissue itself. In this presentation, Dr Hammond brought evidence and insights for how these pigments might exert these cerebral-level effects. His focus was on the auditory system (hearing loss) and associations between consumption of the carotenoid pigments and better auditory acuity. He attributed this to their improving the neuronal efficiency to filter auditory signals of interpretive interest from background noise. However, in the presence of hearing-adverse factors, such as tobacco smoking, the improvement of audition with consumption of macular carotenoids was not demonstrated. The conclusion was that the speed and fidelity of auditory stimuli are improved with higher exposures of lutein and zeaxanthin by effects of CNS neurons.

The final presentation was from **Jirayu Tanprasertsuk** of Tufts University closing the upward tour of the lifespan with a talk entitled: "Oldest of the old: metabolomics, brain carotenoids and pathology and cognition in centenarians." The background information was the epidemiological evidence, in older individuals, that risk of cognitive deterioration was mitigated by higher vegetable consumption in some populations or by higher combined fruit and vegetable consumption in others. A legitimate hypothesis would be an effect of exposure to carotenoid pigments from the diet. B-carotene is the predominant pigment in most Western diets and in the human circulation, but lutein is the dominant carotenoid in cerebral tissue, suggesting a selective uptake of the latter.

An interesting insight comes in a potential interaction with essential fatty acids in the effects of carotenoids on human cognition. In one study reported in this presentation, the performance on four cognitive tests by elderly subjects was evaluated after oral supplementation with four treatments: **1)** placebo; **2)** lutein alone; **3)** docosahexaenoic acid (DHA); and **4)** lutein plus DHA. The only group to have superior performance on all four cognitive tests was the combined treatment.

Except with biopsy or autopsy study, the pigment density of the cerebral tissue cannot be directly quantified, but Jirayu Tanprasertsuk advanced the premise that macular-pigment optical density (MPOD) in the fovea of the eye was a faithful surrogate for the condition of the brain behind the eyes. Feeding studies comparing enhanced intakes of the macular carotenoids from

avocados and low intakes derived from potatoes and chickpeas showed a reflection in the MPOD in both Alzheimer's disease patients and more cognitively intact elders.

The speaker's own research may allow circulating levels of certain lipid biomarkers in data derived from immediate post-mortem specimens of blood and brain (frontal and temporal cortex) in 47 recently deceased participants in the Georgia Centenarian Study. After adjustments, no significant association between circulating and cerebral-tissue content was identified for retinol, total saturated fatty acid, total monounsaturated fatty acid and trans-fatty acid levels. On the other hand, strong associations were found for serum carotenoids (lutein, zeaxanthin, cryptoxanthin, β-carotene) along with tocopherols, total n-3 PUFAs and n-6/n-3 PUFA ratio.

So, the presentations on carotenoid effects on health revisit the time-honored question on the 'essentiality' of nutritional compounds that vary so widely from culture to culture and across agriculture and foraging situations of abundance and availability of sources.

> "The presentations on carotenoid effects on health revisit the time-honored question on the 'essentiality' of nutritional compounds that vary so widely from culture to culture"

Later, the CARIG reception, with its annual poster competition, was held. A jury of three senior CARIG members selected the best free-paper science among the posters in two categories: 2018 CARIG Reception Poster Competition and 2018 CARIG Emerging Leaders Poster Competition. The winners and the titles of the reports are below.

2018 CARIG Reception Poster Competition Winners

1st Place

Jirayu Tanprasertsuk, Tufts University
Brain fat-soluble nutrient pattern is related to pre-mortem cognition among non-demented centenarians

2nd Place

Jelena Mustra Rakic, Tufts University
Dietary lycopene feeding inhibits cigarette-smoke-induced COPD and lung preneoplastic lesions in ferret model

3rd Place

Zhi Chai, Pennsylvania State University
Differential expression and coexpression analyses on transcriptional profiles of lower small intestine suggest key pathways regulated by vitamin A

2018 CARIG Emerging Leaders Poster Competition Winners .

1st Place (joint)

Minkyung Bae, University of Connecticut
Hepatic stellate cells exposed to astaxanthin during activation exhibit a distinct metabotype from quiescent and activated hepatic stellate cells

1st Place (joint)

Jelena Mustra Rakic, Tufts University
Dietary lycopene feeding inhibits cigarette-smoke-induced COPD and lung preneoplastic lesions in ferret model

Next year, the CARIG conference heads for the vitamin A in oysters and the carotenoids in crabs when NUTRITION 2019 convenes in Baltimore, MD.

Correspondence: ***Noel W. Solomons,***
Executive and Scientific Director, Center for Studies of Sensory Impairment, Aging and Metabolism, CeSSIAM in Guatemala, P.O Box 02-5339, Section 3163/Guatemala, Miami, FL 33102-5339, USA
Email: *cessiam@cessiam.org.gt*

Sight and Life Elevator Pitch Contest 2018

Boston, USA, June 10

Nola Martin
Communications,
Sight and Life, Basel, Switzerland

Srujith Lingala
Manager, Technology and Entrepreneurship,
Sight and Life, Gurgaon, India

Kalpana Beesabathuni
Global Lead, Technology and Entrepreneurship,
Sight and Life, Gurgaon, India

Imagine a chance meeting with an investor in an elevator, the perfect moment to quickly share your idea in a compelling manner to a captive audience. This situation gave rise to the term 'elevator pitch' – a very popular, interactive approach whereby an entrepreneur must boil down their concept into a persuasive pitch that will spark interest from potential financiers. "I thought it was really interesting to make the pitch in five minutes: it had to be really concise and deliver an idea quickly," explains Elevator Pitch Contest finalist Anne-Julie Tessier.

Nutrition assessment

The *Sight and Life* Elevator Pitch Contest 2018 sought disruptive ideas in nutrition assessment from innovators to change the current way nutrition is measured. Whether a cutting-edge product, a service, a technology, or an application in nutrition assessment, the concept needed to improve the existing approaches in a meaningful way.

> "The concept needed to improve the existing approaches in a meaningful way"

Here at *Sight and Life*, we are striving to improve the assessment and evaluation of an individual's nutritional status. Nutritional deficiencies are major public health concerns in many low- and middle-income countries, but accurate and actionable information on their status in populations is often lacking due to the high costs and logistical challenges associated with assessing nutritional status. Accurate, user-friendly and low-cost analytical tools allowing large-scale population surveys on nutritional status are needed.

The competition

Open to young entrepreneurs, the contest drew 65 entries from 18 countries and 35 universities across diverse categories and stages. The distinguished Jury Panel brought their immense knowledge, experience and expertise in nutrition assessment to narrow the group of 65 applicants down to seven finalists. Our thanks go to all the Jury members:

Klaus Kraemer from *Sight and Life*

Simone Frey from Atlantic Food Labs

Katharine Kreis from PATH

Alain Labrique from Johns Hopkins Bloomberg School of Public Health

Parul Christian from the Bill & Melinda Gates Foundation

Karen Regan from National Institutes of Health

The seven finalists were awarded a round trip to Boston, where they presented their innovations during The American Society for Nutrition's Nutrition 2018 conference. Before the competition, each of the finalists had the opportunity to receive mentoring and feedback regarding their concept and presentation. Maryam Hashemian, an elevator pitch contest finalist, spoke highly of her experience: "It was a great opportunity for me to communicate my idea, to talk about it and to learn from other colleagues about how to improve it and how to connect with others to improve the idea."

Eleanor Shonkoff from the Picture This! team pitching her nutrition assessment innovation

"It was invigorating to watch these young entrepreneurs pitch their innovations"

It was invigorating to watch these young entrepreneurs pitch their innovations, which have the potential to change the landscape of nutrition assessment. Jury member Simone Frey describes the atmosphere during the competition: "What I find most interesting is that there are so many people with ideas, and they have seen there are problems that we can actually solve." She continues, "They've come up with great solutions. And this elevator pitch contest helps to go the next step, to bring it to the next level, to network, to bring these people together with maybe mentors, with investors, and I think that's great."

After an intense session of pitches followed by inquiries from the Jury, three contestants were awarded cash prizes.

The third-place winner is Andrea Spray, from the London School of Hygiene and Tropical Medicine, with a dietary intake innovation called INATU that measures the impact of women's time on nutrition. Spray aims to overcome the limitations of tools currently used in measuring the impact of women's time on nutrition through a method that requires neither direct observation nor self-reporting. The team proposes to equip rural mothers in Uganda with life-logging wearable cameras, GPS trackers, and mobile phones receiving automated interactive voice response (IVR) calls to assess time use and maternal and child diet.

Jury members Klaus Kraemer from *Sight and Life* and Simone Frey from Atlantic Food Labs present Anne-Julie Tessier of Keenoa with a first-place award

The second-place winner is Eleanor Shonkoff, from Tufts University, with Picture This! Shonkoff's team proposes accurate estimation of individual-level food and nutrient intake through digital imaging of food, computer vision (CV), and artificial intelligence (AI) techniques. The aim is to develop a scientifically valid method by which consumers take pictures of their food and get rapid, real-time feedback on calories and nutrients consumed. The steps involved are to use images to classify foods, construct a 3-D model, estimate boundaries and volume, and determine the food's weight and calories. The prototype algorithm draws from 3-D weight estimation techniques to determine object volume and uses machine learning algorithms to classify foods. The concept is at the prototype stage, and an early model has been built.

The winner of the 2018 Elevator Pitch Contest is Anne-Julie Tessier, from Canada's McGill University. Tessier and her team tackle the lack of tools to accurately assess food and beverage intake among individuals. Her entry, Keenoa, is an artificial intelligence–based food diary. A mobile application captures participants' eating habits to the nearest detail by enabling them to record food pictures, quantity, and the date and time of meals. This detailed information is directly linked to a clinical practitioner's/researcher's web application and is accessible in real time. The mobile and web applications developed from March 2016 to January 2018 are ready to be deployed in the field.

In addition to the three winners, *Sight and Life* selected the presentation and concept of Chikumbutso Chibwinja, an undergraduate student at Malawi's Lilongwe University, for an honorary prize. At 22 years old, Chibwinja proposed a simple technique, called Arm Distance Technique (ADT), that measures the circumference of the arm to classify a person as obese, overweight, normal, or wasted. ADT eliminates the need for equipment or technical personnel and is intuitively simple to use. Impressed with his passion for nutrition, *Sight and Life* is providing Chibwinja with an educational grant to continue supporting him in his endeavors.

"We are heading in the right direction, and this will definitely work"

This staging of the *Sight and Life* Elevator Pitch Contest brought lively competition and provided an opportunity for finalists to connect and further their ideas with a mentor. Finalist Timur Osadchiy sums it up by stating, "You have so much doubt about whether your idea is great or not. The Elevator Pitch Contest actually gave me the confidence that me and my team – we are heading in the right direction, and this will definitely work." The combination of all seven finalists brought this contest to

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Elevator Pitch Contest Finalists and Jury members with the *Sight and Life* team in Boston, USA. **From left:** Karen Regan, Julie Mortensen, Yana Manyuk, Peiman Milani, Katharine Kreis, Anne-Julie Tessier, Ethan Braun, Kesso Gabrielle van Zutphen, Maryam Hashemian, Madhavika Bajoria, Eva Monterrosa, Klaus Kraemer, Srujith Lingala, Timur Osadchiy, Andrea Spray, Nola Martin, Parul Christian, Simone Frey, Kalpana Beesabathuni and Eleanor Shonkoff.

life with their cutting-edge ideas, and we are looking forward to bright futures for all contestants:

Anne-Julie Tessier, Doctoral student,
McGill University, Canada – Keenoa

Andrea Spray, Doctoral student,
London School of Hygiene & Tropical Medicine, UK – INATU

Eleanor Shonkoff, Post-doctoral fellow,
Tufts University, USA – Picture This!

Maryam Hashemian, Post-doctoral fellow,
National Cancer Institute, USA – Salt Intake Measurement

Chikumbutso Chibwinja, Undergraduate student,
Lilongwe University, Malawi – ADT

Ethan Braun, Doctoral student,
Purdue University, USA – POWER

Timur Osadchiy, Doctoral student,
Newcastle University, UK – Intake 24

"The Elevator Pitch Contest was a great opportunity for me to communicate my idea, to talk about it, and to learn from other colleagues about how to improve it and how to connect with others to take the idea further."

Maryam Hashemian

For more information, please visit
www.elevator-pitch-contest.org

Correspondence: ***Srujith Lingala,***
Sight and Life, PO Box 2116, 4002 Basel, Switzerland
Email: *srujith.lingala@sightandlife.org*

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Field Reports

Nutrient Density as a Dimension of Dietary Quality

Part I: Theoretical considerations of the nutrient-density approach in a multicenter evaluation

Marieke Vossenaar, Noel W. Solomons
Center for Studies of Sensory Impairment, Aging and Metabolism (CeSSIAM), Guatemala City, Guatemala

Eva Monterrosa, Kesso Gabrielle van Zutphen
Sight and Life, Basel, Switzerland

Key messages

- The approach of expressing nutrient density in the description of dietary intake for individuals and populations provides an additional dimension by emphasizing the role of the background diet.
- A nutrient-density expression is a ratio, with the numerator as a value of nutrients (e.g., nutrient units, percentage of recommended intake) and the denominator as a quantifier of the diet (e.g., portion size, weight, volume, dietary energy).
- The 'critical nutrient density' is a reference value for a person or population derived from the recommended daily intake for a specific nutrient in the numerator and daily energy requirements as the denominator, typically expressed per 1000 kcal.
- When a diet is constituted with at least the critical nutrient density, one is assured that the requisite amount of a nutrient of interest will be consumed when energy needs are met.
- The nutrient-density approach is a handy tool for both planning and evaluation of diets.

Background and context

The late Prof. Doris Calloway is quoted as noting, during the process of revising the Recommended Dietary Allowances of the United States, that: *"People eat foods, not nutrients."*[1] Nevertheless, the product of the effort was a refined tabulation of the daily recommended intakes of the essential macro- and micronutrients. When planning or evaluating the adequacy of diets, the focus has remained on these two-dimensional tables of recommendations, whether they be from the Dietary Reference Intakes,[2] United Nations agencies,[3] or European Food Safety Authority[4] processes; these are limited to matching a quantity of a specific nutrient to an average or protective level of daily intake.

If we return to first principles, the fundamental origins of essential nutrients are the foods and beverages in the diet. To meet the intakes that satisfy the needs of individuals, an assortment of nutrient-rich foods or of less-nutritious foods needs to be consumed in enormous quantities. A combination of these two dietary patterns was operative in the hunter-gatherers of Paleolithic prehistory. The clan would subsist on the energy from roots, tubers and herbs during their quest for the animal of the hunt, and then gorge themselves with the abundant nutrients of the muscle and viscera of their prey. With the advent of primitive agriculture, farmers expended large quantities of energy toiling in their potato or cassava fields, or their maize and millet plots, extracting sufficient vitamins and minerals from the bulk of the tubers and grain staples ingested.

In the modern era, agriculture is increasingly mechanized, and more than half of the world's population lives in urban settings. On the one hand, this has limited the amount of food (the number of calories of daily energy) that can routinely be consumed. On the other, however, the diets are still based on carbohydrate-rich root, tuber, and cereal staples with limited availability of animal-source foods.

To meet the intakes that satisfy the needs of individuals, an assortment of nutrient-rich foods or of less-nutritious foods needs to be consumed in enormous quantities

Currently, the world is undergoing an epidemic of obesity.[5,6] The large body size, with additional weight to carry and greater muscle mass to support it, should theoretically obligate persons with obesity to consume more energy than those of normal weight. In a more constrained extent, the margin for consuming a lower-quality diet by virtue of a larger total amount is analogous to that of the primitive agriculturalist.

Nutrient density: Definition and concept

A nutrient-density expression is formed as a ratio, with a numerator and denominator. To understand the concept, it is necessary to specify the nature of the numerators and denominators that make up the expression.

The nature of the numerator: In the numerator is a quantity of a macro- or micronutrient, either in gravimetric or molar units or else as a percentage of adequate intake. This could be 40 mg of vitamin C, 2 mg of copper, or 20% of the Daily Value (DV) for sodium, for example. It can represent either the amount offered in a preparation or menu, or an amount estimated to have been consumed.

The nature of the denominator: In the denominator is a measure for a quantity of food or beverage, also as offered or consumed or, in a special application, as an amount theoretically required. The elements of the denominator can be expressed in multiple manners, including serving portion (unitary), net weight (grams), liquid volume (mL), or a quantity of dietary energy (kcal or kJ).

BOX 1: The nature of the ratio as density

The most common and familiar application of a nutrient-density expression in daily life is found on the Nutrition Facts panel on the nutritional label of commercial food products.

Nutrition Facts

Serving Size:1 serving (85.0g)
Servings:1

Amount Per Serving	
Calories 140	Calories from Fat 60
	% Daily Value*
Total Fat 6g	10%
Saturated Fat 1g	6%
Trans Fat 0g	
Cholesterol 65mg	22%
Sodium 350mg	14%
Total Carbohydrate 0g	0%
Dietary Fiber 0g	0%
Sugars 0g	
Protein 20g	

Vitamin A 4% • Calcium 20%
Iron 4% • Vitamin D 180%

*Percent Daily Values are based on a [illegible] diet.

Let us exemplify the concept with a hypothetical product offering a specified percentage of the Daily Value (DV) for calcium:

20% of the calcium DV per serving

This can also be interpreted as one getting 100% of the DV by consuming five servings in a day.

The current DV of the Food and Drug Administration is 1300 mg for calcium. This would mean that, in quantitative terms, the numerator would become 260 mg of the mineral. The density expression by serving is transformed to:

260 mg of calcium per serving

The density expression can be transformed to a weight or volume basis, as the label also describes what the manufacturer defines as a serving portion. In the case of the product of interest, a serving weighs 160 grams. This would represent 1.625 mg per gram. Since a denominator of 100 g might be most conventional and convenient, the weight-based nutrient-density expression becomes:

162.5 mg per 100 grams of product

The nutrition label also reports the calories (kcal) in a serving, such that one can base the density denominator on energy. The 100 g serving of this product provides 200 kcal. The conventional energy-based nutrient-density expression has a denominator of per 1000 kcal. The numerator would then be multiplied fivefold. Thus, the energy-related density for this product becomes:

812.5 mg per 1000 kcal

This calculation approach can be generalized for any food or beverage in a food composition database, relating the 100 g portion's content extrapolated to 1000 kcal of energy.

The concept and definition of critical nutrient density: One can expand the nutrient-density concept to a prescriptive or reference fashion by assigning the denominator energy to the individual daily energy requirement, or more commonly to the reference energy needs for a specific class of individuals, such as preschool children or adult men. The resulting expression is called the 'critical nutrient density.' The numerator is the reference daily requirement for a specific nutrient for an individual of the class. This can be the protective value, such as the Recommended Dietary Allowance (RDA) of the Dietary Reference Intakes (DRI) or the Recommended Nutrient Intake (RNI) of the UN agencies series. Alternatively, it could be the population-normative Estimated Average Requirement (EAR) value.

Nutrient density was illustrated for calcium in the previous section. The DV value of 1300 mg corresponds to the recommended dietary allowance for an adolescent boy. That would be the numerator value for the critical nutrient density for this population class. It is conventional to assume a daily energy intake of 2000 kcal, as is done for the Nutrition Facts labeling procedure in critical nutrient-density creation. A first approximation around the 1300 mg value for calcium would be 650 mg/1000 kcal. However, adolescent boys as a group have a higher daily energy expenditure, estimated at 2800 kcal/day. Expressed in conventional denominator terms, this would yield 464/1000 kcal for the more refined critical nutrient density for calcium in male adolescents at the RDA recommendation level. This age-group has an EAR for calcium of 1100 mg/day, such that the critical nutrient density based on the population distribution assumptions would be 393 mg/1000 kcal.

A brief history of nutrient-density concerns

When the ratio procedure described above is used, it represents a nutrient-density application. The approach dates back at least three decades – a period during which the estimates of both human energy requirements and specific micronutrient recommendations have been refined by ongoing research and advanced conceptual innovations.

Nutrient-density-based dietary guidelines: There have been two important international initiatives using the nutrient-density approach and the critical nutrient-density criterion. The first was undertaken in 1986 by an ad hoc committee of Latin American nutritionists convened in Caracas, Venezuela, which in the following year published a report entitled *Guías de Alimentación: Bases para su Desarrollo in América Latina* [Food Guidelines: The bases for their development in Latin America].[7] It reasoned, quite correctly, that planning and evaluation using the recommended allowances of the era was a cumbersome procedure. Based on the cultural practices of families of the region consuming the majority of their meals in congregate fashion, the dietary fare consumed in the home became the fulcrum for positive change.

There was general consensus in the 1980s that the requirements for the cofactors in the Krebs cycle chemistry for ATP generation in the mitochondrion were related to the amount of energy presented to the body. The relationships for thiamine, riboflavin and niacin were 0.4, 0.6 and 7.0 mg, respectively, per 1000 kcal. This was the model standpoint. For critical nutrient-density calculation for adults of both sexes, they assumed a daily energy requirement of 2000 kcal, with lesser amounts at

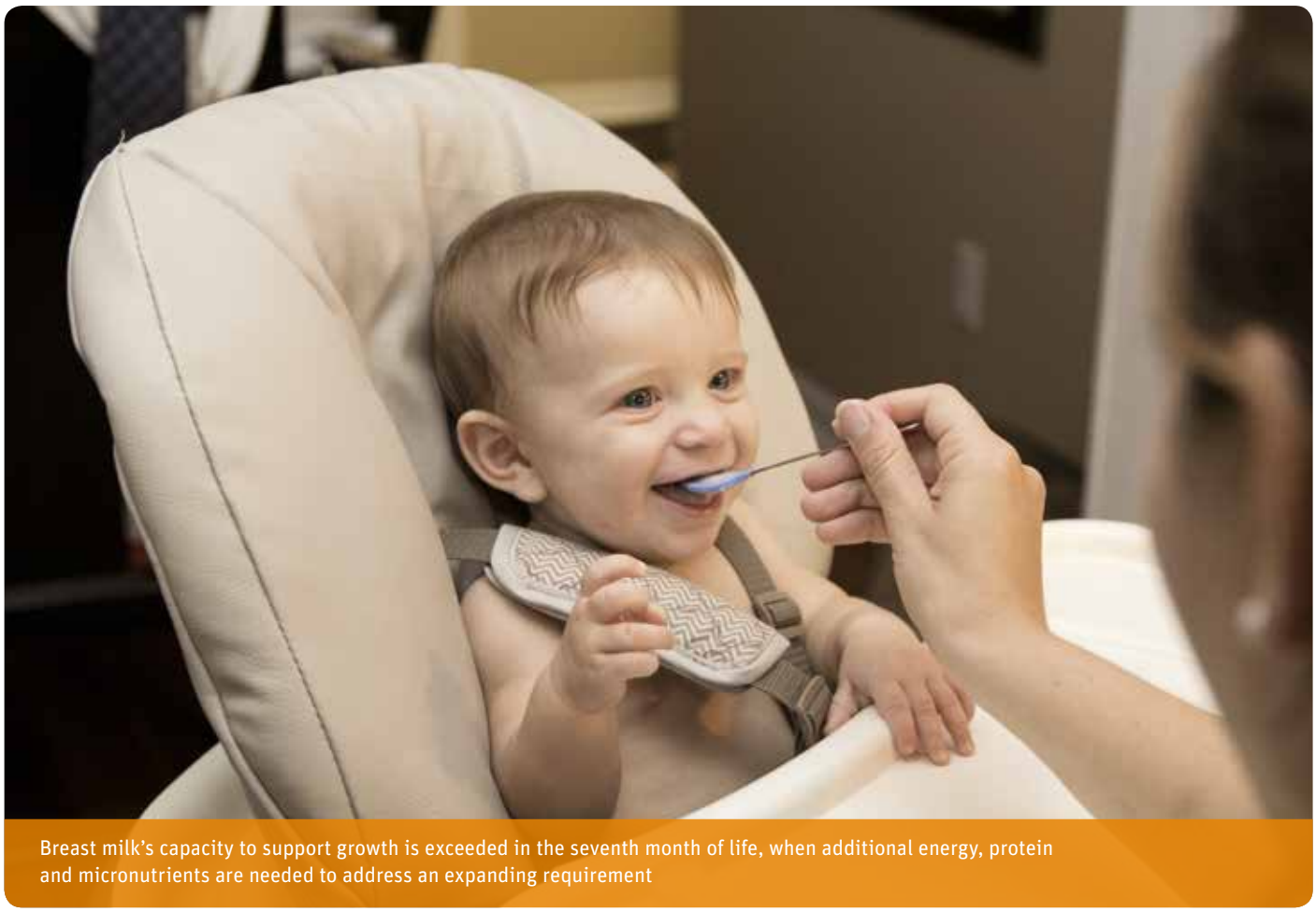
younger ages. So, this process was extended, with the assumption that a critical nutrient density could be assigned for all nutrients that cover the needs of the most sensitive individual in the family unit, and the value was expressed per 1000 kcal. The Guidelines document contains a table in which the protective (for positive essential nutrients including protein and fiber) or the non-offensive (for negative nutrients such as sodium) nutrients are outlined.[8] According to the rationale of the conveners, any family that followed all of the nutrient-density guidance in the document would assure appropriate nutrient intakes for most members. There are exceptions within the family unit: exempted from Guidelines were infants, pregnant and lactating women and the elderly of the family, as each of these groups has special circumstances or nutrient needs that do require adaptation of the diet.

The Cavendas Report[7] was widely discussed and circulated, but it never became a working guideline for any part of the Latin American region. To this date, Latin American countries have relied on the international recommendations of the UN agencies, on the US-Canada Dietary Reference Intakes, or on their own, national formulations. We feel that the conceptual approach for nutrient-density-based dietary recommendations was a visionary one with possibilities for the needs in the 21st century.

"The conceptual approach for nutrient-density-based dietary recommendations was a visionary one with possibilities for the needs in the 21st century"

Nutrient density and complementary feeding

Two decades ago, in 1998, Brown, Dewey and Allen addressed a very vexing feeding problem for young children using the nutrient-density and critical nutrient-density approaches in the WHO/UNICEF monograph *Complementary Feeding of Young Children in Developing Countries: A Review of Current Scientific Knowledge*.[9] It had a dual relationship with nutrient density. The nutrient density for the diet of an exclusively breastfed infant is effectively the cumulative nutrient concentrations in human milk. However, breast milk's capacity to support growth is exceeded in the seventh month of life, when additional energy, protein and micronutrients are needed to address an expanding requirement.



Breast milk's capacity to support growth is exceeded in the seventh month of life, when additional energy, protein and micronutrients are needed to address an expanding requirement

The fare prepared with the texture and presentation suitable for an edentulous infant, in the forms of gruels, porridges and compotes, is termed 'complementary food.' The term implies its role, to complement the nutritional delivery of human milk, which remains the most important source of food through the second semester of life. After accounting for the energy contribution of a day's intake of maternal milk, complementary food closes the calorie gap. This can be as little as 100 kcal. The simultaneous process, however, is that the vitamin and mineral delivery from breast milk also becomes insufficient for growth and nutritional reserves. With a limited denominator allowance of energy in the complementary feeding, the nutrient density of the fare emerges as a focus of concern. What Brown and colleagues[9] achieved in their monograph was a way of determining the critical nutrient density for specific nutrients in complementary feeding and what food combinations could supply the amounts needed in small volumes. Models to maximize nutrient density in complementary foods were developed for many vitamins and minerals. A general conclusion was that vitamin A, calcium, iron and zinc were 'problem nutrients,' which defied satisfaction from food combinations and required fortification to meet requirements of the mixed-fed nutrients.

"There has been a resurgence of interest in the use of the nutrient-density concept"

Contemporary applications of nutrient density

In recent years, there has been a resurgence of interest in the use of the nutrient-density concept. This is amply manifested in the concepts and applications of 'nutrient profiling' put forward by Adam Drewnowski.[10,11] Two of the present authors drew out some aspects of nutrient density in terms of the Guatemalan situation to renew its application.[12–14] Forums on nutrient density have appeared at major international nutrition meetings, such as the CeSSIAM-sponsored satellite symposium at the International Congress on Nutrition in Buenos Aires, Perspectives on Nutrient Density: Too Little and Too Much. More recently at the Nutrition 2018 meeting of the American Society of Nutrition in Boston, an evening symposium entitled "Academia and Industry Working together toward a Common Goal: Increasing Nutrient Density of the Diet" was presented with a panel from leading industries.

Correspondence: ***Dr M Vossenaar,***
Center for Studies of Sensory Impairment, Aging and Metabolism (CeSSIAM), 17 Avenida no. 16–81, Zona 11, Guatemala City 01011, Guatemala
Email: *mvossenaar@hotmail.com*

References

01. King JC. Doris Howes Calloway (1923–2001). J Nutr. 2003 Jul;133(7):2113–6.
02. Institute of Medicine. Dietary Reference Intakes: Applications in Dietary Assessment. Washington, DC: The National Academies Press; 2000.
03. FAO, WHO. Vitamin and mineral requirements in human nutrition, 2nd ed. Geneva: WHO; 2005.
04. European Food Safety Authority (EFSA). Dietary reference values for nutrients: summary report. 2017. [EFSA supporting publication 2017:e15121.] doi:10.2903/sp.efsa.2017.e15121. 2017.
05. WHO. Obesity and overweight. Geneva: WHO; 2018.
06. Caballero B. The global epidemic of obesity: an overview. Epidemiol Rev. 2007;29:1–5.
07. Bengoa JM, et al. Food guidelines: the bases for their development in Latin America. Consultation report [Guías de alimentación: bases para su desarrollo in América Latina. Informe de la Reunion]. Caracas, Venezuela: Universidad de las Naciones Unidas y Fundación Cavendes; 1988.
08. Department of Health and Human Services (HHS) and Department of Agriculture (USDA). Nutrition and your health: dietary guidelines for Americans. Washington, DC: U.S. Dept. of Agriculture; 1980.
09. WHO Programme of Nutrition. Complementary feeding of young children in developing countries: a review of current scientific knowledge. Geneva: WHO; 1998.
10. Drewnowski A. Concept of a nutritious food: toward a nutrient density score. Am J Clin Nutr. 2005;82(4):721–32.
11. Drewnowski A, Fulgoni V. Nutrient profiling of foods: creating a nutrient-rich food index. Nutr Rev. 2008;66(1):23–39.
12. Solomons NW, Vossenaar M. Nutrient density in complementary feeding of infants and toddlers. Eur J Clin Nutr. 2013;67(5):501–6.
13. M Vossenaar, Hernández L, Campos R, Solomons NW. Several 'problem nutrients' are identified in complementary feeding of Guatemalan infants with continued breastfeeding using the concept of 'critical nutrient density'. Eur J Clin Nutr. 2013;67(1):108–14.
14. Vossenaar M, Solomons NW. The concept of 'critical nutrient density' in complementary feeding: the demands on the 'family foods' for the nutrient adequacy of young Guatemalan children with continued breastfeeding. Am J Clin Nutr. 2012;95(4):859–66.

Preventing Micronutrient Deficiencies Using African Indigenous Vegetables in Kenya and Zambia

Daniel J. Hoffman
Department of Nutritional Sciences, New Jersey Institute for Food, Nutrition, and Health, Center for Childhood Nutrition Education and Research, Program in International Nutrition, New Brunswick, NJ, USA

Emily Merchant, David R. Byrnes and James E. Simon
Department of Nutritional Sciences, New Jersey Institute for Food, Nutrition, and Health, Center for Childhood Nutrition Education and Research, Program in International Nutrition, New Use Agriculture and Natural Plant Products Program, Department of Plant Biology, Rutgers University, New Brunswick, NJ, USA

Key messages

- Many countries are now facing the "double burden of malnutrition," in which a high prevalence of undernutrition coexists with an increasing prevalence of obesity.
- The double burden of malnutrition is often associated with changing dietary patterns, and interventions that once focused on providing calories must now focus on ensuring that individuals and households consume adequate micronutrients.
- African indigenous vegetables (AIVs), rich in such micronutrients and identified as limited in many populations, can meet nutritional gaps without promoting excess weight gain.
- AIVs are recognized by many communities that are at risk of undernutrition, but lack of access, availability, or cost considerations have prevented them from being consumed on a regular basis.
- While regionally consumed, AIVs are often not considered as cash crops, which has resulted in a lack of development for production and limited household consumption. Improved germplasm and production and post-harvest handling techniques, as well as culinary development and nutrition education, can improve access, availability, adoption, affordability and consumption.

The first 1,000 days

The time from conception through age 2 years, "the first 1,000 days," is vitally important to the health of a child and for optimal lifelong health.[1] However, there are millions of women and children throughout the world without access to sufficient sources of energy, protein, minerals, and vitamins. The short-term effects of poor nutrition in childhood are manifested as nutrient-specific conditions including night blindness, anemia, poor growth and development, and severe wasting. An important long-term outcome of poor nutrition is growth retardation (i.e., stunting) and it is estimated that the global prevalence of stunting decreased from 40% to 27% of children under the age of 5 years between 1990 and 2010 and is expected to reach 22% by 2020.[2]

However, while in 2015 there were 98.5 million fewer stunted children than in 1990, this decrease is partly reflected by gains in some regions, but not others, as the number of stunted children in sub-Saharan Africa has increased by 12.4 million since 1995.[3] At the same time, the prevalence of "hidden hunger," a condition in which children and adults appear to be well nour-

Children playing in Kibera, the largest slum in Nairobi, Kenya

ished or even obese, but are micronutrient-deficient, continues to increase throughout the world.[4,5] Therefore, sustainable approaches to improving micronutrient intake are needed in low- and middle-income countries.

> "Sustainable approaches to improving micronutrient intake are needed in low- and middle-income countries"

The double burden in Africa

Aside from undernutrition, the prevalence of obesity is a major public health problem in high-income and many transitional countries, and has contributed to the 'double burden of malnutrition' – the coexistence of both obesity and underweight.[1,2,6,7] Globally, it has been reported that the prevalence of obesity has doubled in the past 20 years in some African countries (e.g., Kenya, Niger, Rwanda and Uganda) and tripled in others (e.g., Zambia, Mali and Tanzania).[8,9,10] Thus, while more research needs to be done to better understand the causes and implications of the double burden, interdisciplinary approaches to improving nutrition in lower-income countries remains an important public health priority.

The case for African indigenous vegetables

African indigenous vegetables (AIVs), such as African nightshade, amaranth, hibiscus, moringa and spiderplant, are traditional foods that are grown and utilized by many African communities. They are, however, often grown as subsistence crops, and often carry the social stigma of 'famine foods.' It is well established that a healthful diet should be diverse, with a high intake of various vegetables. Yet, in most sub-Saharan African countries there is a lack of dietary diversity and variety, and AIVs can fill this nutritional gap as an important and culturally acceptable source of nutrients.

These indigenous vegetables are generally harvested from wild populations. and often require lower inputs than 'Western' vegetables, are more adapted to local conditions and environmental stress and grow well under very poor soil conditions often found in parts of sub-Saharan Africa where resource-limited smallholder farmers live and farm. Aside from the nutrient density and other health-promoting properties of AIVs,[11–14] these vegetables can be used to diversify farming enterprises and improve income opportunities that generate cash over multiple time points – as compared to agronomic crops, where farmers receive cash for their product once or twice a year. These factors can mitigate risk of crop failure due to climatic change and environmental stress, and can thus be considered as candidates to promote food security and provide local opportunities for generating income and improving health and nutrition.[11]

Preparation of soil and manure for Home Harvests

Current use of AIVs in Kenya

The availability and use of AIVs varies somewhat by country and region, but many are already known to, or consumed by, many people in sub-Saharan Africa. The stigma attached to them limits their adoption and promotion, however. It is therefore no surprise that these nutritious leafy greens have had little culinary development and systematic scientific examination compared to European vegetables. In Kenya, the traditional method of preparing AIVs is to pan-cook the vegetables with oil, tomatoes and onions, often for several hours. Aside from the culinary monotony, lengthy cooking times reduce much of the vegetable's nutritional value. Improved culinary habits can minimize monotony and promote more frequent consumption of AIVs with higher nutrient content. Thus, our team is designing and implementing a series of nutrition interventions to improve diet quality, AIV consumption and new, yet tradition-based, recipes for preparing AIVs in Kenya and Zambia.

"Home Harvests promote more frequent consumption of AIVs"

Promoting AIVs in urban settings

Recently, as one component of our broader program in Kenya and Zambia to promote cultivation and consumption of AIVs in these countries, we coordinated the training and implementation of 'Home Harvests' in Kibera, one of the largest urban slums in Nairobi, Kenya. A Home Harvest, also known as 'sac gardens,' is a garden model that provides a readily available source of vegetables to families for consumption. Residents of Kibera have access to small, informal markets, but the quality and supply are often questionable and limited. Our survey found that 53% of women reported a lack of availability of dark, leafy greens due to seasonal shortages. Moreover, the dietary diversity score of the women who participated was 3 out of 10 and 90% scored below the threshold of 5. This indicates a low dietary diversity, suggesting relative food insecurity, and is a risk factor for micronutrient deficiencies. Only 3% of the women reported eating AIVs every day, while 47% consume them one to four times a week and 38% never eat AIVs. Home Harvests promote more frequent consumption of AIVs, increasing daily intake of essential vitamins and minerals and improving dietary diversity.

In addition to household consumption, Home Harvest products can be sold to generate revenue. As income, social norms and customs influence food choice, our program was supplemented with nutrition and agricultural training conducted at the community level in partnership with Mirror of Hope, a local community group. Home Harvests are located within Kibera, reducing the need for long, daily trips to larger markets. Reducing energy required for high levels of daily activity is an important factor, as this increases the risk of undernutrition for women who may be HIV-positive or have poor access to sufficient food. The results from this pilot program will be available in 2019 when a full report of changes in income, diet, daily activity, time use and non-food expenditure will be published.

Women from Kibera planting seedlings

Instructions on maintenance of Home Harvests as provided by Naman Nyabinda

"The overall objective of our programs in Kenya and Zambia is to promote the cultivation and consumption of nutrient-dense vegetables"

Using agriculture to promote development and health

The overall objective of our programs in Kenya and Zambia is to promote the cultivation and consumption of nutrient-dense vegetables, such as AIVs, to improve dietary diversity while supporting economic development. To achieve this, we use a market-first, science-driven approach to provide significant economic benefits to smallholder farmers and expand crop diversity for family farms and communities to reduce dependency and risks associated with single commodity crops.[11] When AIVs are introduced using excellent germplasm, alongside trainings in water collection, irrigation systems, horticultural production, post-harvest and agri-business management, these plants can be exploited to achieve food and income security.

Key interventions needed along the value chain include the identification and introduction of the best available germplasm, improvement of production systems (e.g., pest management, scheduling of plantings, water management to ensure production across wet and dry seasons), post-harvest handling, nutrient-enhancing preparation methods, improved market access, and consumer awareness of the nutritional benefits of AIVs. Using participatory research and outreach-based activities to build capacity of stakeholders (e.g., farmers, suppliers, and consumers) through practical production technologies, narrowing knowledge gaps, and improving utilization can have major impacts on livelihoods and food security. In summary, the model described is scalable and replicable, and can be integrated into larger development initiatives to promote a healthful diet and economic development in lower-income countries, especially given that the use of AIVs has great potential to address many of the issues central to the first 1,000 days.

"The model described is scalable and replicable, and can be integrated into larger development initiatives"

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Correspondence: ***Daniel Hoffman,***
NJ IFNH, 61 Dudley Road, New Brunswick, NJ 08901 USA
Email: *dhoffman@sebs.rutgers.edu*

References

01. Karakochuk CD, Whitfield KC, Green TJ, Kraemer K. The biology of the first 1,000 days. Boca Raton, FL: CRC Press; 2017.
02. de Onis M, Blössner M, Borghi E. Prevalence and trends of stunting among pre-school children, 1990–2020. Pub Health Nutr. 2011;15(1):142–8.
03. Campisi S, Cherian A, Bhutta Z. World perspective on the epidemiology of stunting between 1990 and 2015. Horm Res Paediatr. 2017;88(1):70–8.
04. Cole CR. Preventing hidden hunger in children using micronutrient supplementation. J Pediatr. 2012;161(5):777–8.
05. DeClerck FA, Fanzo J, Palm C, Remans R. Ecological approaches to human nutrition. Food Nutr Bull. 2011;32(1 Suppl):S41–50.
06. Tzioumis E, Adair LS. Childhood dual burden of under- and overnutrition in low- and middle-income countries: a critical review. Food Nutr Bull. 2014;35:230–43.
07. Victora CG, Rivera JA. Optimal child growth and the double burden of malnutrition: research and programmatic implications. Am J Clin Nutr. 2014;100:1611S–2S.
08. Caleyachetty R, Thomas G, Kengne A, Echouffo-Tcheugui J, Schilsky S, Khodabocus J, et al. The double burden of malnutrition among adolescents: analysis of data from the Global School-Based Student Health and Health Behavior in School-Aged Children surveys in 57 low-and middle-income countries. Am J Clin Nutr. 2018;108(2):414–24.
09. Amugsi D, Dimbuene Z, Mberu B, Muthuri S, Ezeh A. Prevalence and time trends in overweight and obesity among urban women: an analysis of demographic and health surveys data from 24 African countries, 1991–2014. BMJ Open. 2017;7(10):e017344.
10. Mayan M, Lo S, Richter S, Dastjerdi M, Drummond J. Community-based participatory research: ameliorating conflict when community and research practices meet. Progress in Community Health Partnerships: Research, Education, and Action. 2016;10(2):259–64.
11. Weller SC, Van Wyk E, Simon JE. Sustainable production for more resilient food production systems: case study of African indigenous vegetables in Eastern Africa. International Horticultural Congress, Brisbane, Australia. Acta Horticulturae. 2015;1102:289–98.
12. Coppin J, Xu JP, Chen YP, Juliani H, Wu QL, Simon JE. Determination of flavonoids in Moringa oleifera by LC/MS. J Funct Foods. 2013;5:1892–9.
13. Juliani HR, Fonseca Y, Acquaye D, Malumo H, Malainy D, Simon JE. Nutritional assessment of Moringa (Moringa spp.) from Ghana, Senegal and Zambia. In: Juliani HR, Simon JE, Ho CT, eds. African natural plant products: discoveries and challenges in quality control. Washington, DC: American Chemical Society; 2009:469–84. [American Chemical Society Symposium Series 1021.]
14. Yang RY, Fischer S, Hanson PM, Keatinge JDH. Increasing micronutrient availability from food in sub-Saharan Africa with indigenous vegetables. In: Juliani HR, Simon JE, Ho CT, eds. African natural plant products volume II: discoveries and challenges in chemistry, health and nutrition. Washington, DC: American Chemical Society; 2013:231–54. [American Chemical Society Symposium Series 1127.]

OBAASIMA

A demand-driven approach to reduce micronutrient malnutrition in Ghana

Breda Gavin-Smith
Sight and Life, Basel, Switzerland

Daniel Amanquah
Sight and Life, Accra, Ghana

Key messages

- Around two billion people, almost one-third of the global population, receive insufficient micronutrients from the food they eat.
- Women of reproductive age, including adolescent girls and pregnant and breastfeeding women, have an increased requirement for micronutrients.
- In Ghana, despite two decades of sustained economic growth and reductions in some forms of malnutrition, progress on minimizing micronutrient deficiencies has been slow.
- The provision of healthy, nutritious, affordable food can play an important role in starting to address these deficiencies.
- OBAASIMA is a demand-driven approach that aims to increase and improve the local production of affordable, micronutrient-rich foods while ensuring products have a sound nutrition profile supporting healthy eating principles.

The OBAASIMA Seal

The challenge

Around two billion people, almost one-third of the global population, receive insufficient micronutrients from the food they eat.[1] 'Hidden hunger' or micronutrient malnutrition refers to the insufficient intake of vitamins and minerals, known as micronutrients. Malnutrition weakens the immune system and makes malnourished population groups more vulnerable to infectious diseases.

Women of reproductive age, including adolescent girls and pregnant and breastfeeding women, have an increased requirement for micronutrients. Improving the nutritional intake of adolescent, pregnant and lactating women ensures an adequate supply of nutrients during the critical window of the first 1,000 days of a child's life. The first 1,000 days, from conception to a child's second birthday, provide a unique opportunity to provide the essential nutrients for brain development, healthy growth and a strong immune system.[2] Micronutrient deficiencies negatively impact the health of the mother and the course of her pregnancy.[3]

In Ghana, despite two decades of sustained economic growth and reductions in some forms of malnutrition, progress on minimizing micronutrient deficiencies has been slow. A recent micronutrient survey conducted by the Ghana Health Service (GHS) revealed deficiencies in key micronutrients including vitamin A, iron and folate, particularly in pregnant women.[5] While micronutrient deficiencies persist, over 40% of women in Ghana are overweight or obese.[5]

OBAASIMA: An innovative solution

Women in Ghana often suffer from an insufficient intake of vitamins and minerals because of a poor and/or monotonous diet. This increases the risk of retarded fetal growth, birth defects and preterm birth for their children, and also of their own mortality.[6]

The provision of healthy, nutritious, affordable food can play an important role in starting to address these deficiencies.

> "OBAASIMA translates as 'women in all their beauty, morals and kindness'"

OBAASIMA in the Akan language translates as 'women in all their beauty, morals and kindness' and aims to increase and improve the local production of affordable, micronutrient-rich foods while ensuring products have a sound nutrition profile supporting healthy eating principles. The project was developed by Affordable Nutritious Foods for Women (ANF4W) in cooperation with the Ghana Standards Authority (GSA) and the Association of Ghana Industries (AGI). Taking ANF4W to scale resulted in the creation of OBAASIMA, an initiative working across the food chain from supply to demand. It is currently a public-private partnership that includes AGI, GSA, the German Development Cooperation (GIZ), DSM, *Sight and Life*, and the Bill & Melinda Gates Foundation.

OBAASIMA: Core principles

Three key principles are essential to the success and sustainability of OBAASIMA:

1. Provide the opportunity for business-to-business solutions with local food processors

Local food processors, especially small and medium-sized enterprises (SMEs), often have difficulties meeting basic standards of manufacturing practice, food quality and fortification standards. OBAASIMA's private-sector partners assist local food processors through training, technical advice and business development. This helps local SME food processors to start fortification, enabling them to register their food products and to develop their business. Currently, OBAASIMA supports four companies in Ghana developing supplementary fortified food products targeting women of reproductive age and is working hard to increase the number of food companies engaged.

2. Create demand for nutritious foods

A focused ethnographic study was conducted in Ghana to determine how cultural, social, physical and economic factors influence food consumption patterns and food choices of adolescents and pregnant and breastfeeding women from low-income households in Ghana. Creating a sustained demand for nutrient-dense foods for women in resource-constrained environments has a greater chance of success if the foods fit into the underlying values that inform and guide consumption decisions and choices. Instead of disseminating knowledge, creating demand for nutritious foods should address the convenience, affordability and aspirational value of nutritious foods. These areas are key to creating demand for OBAASIMA products and form a central role in marketing campaigns.

3. Regulatory environment

Quality standards for voluntarily fortified foods produced by SME food processors are usually lacking. Developing a national standard for voluntarily fortified foods for women of reproductive age has been a key part of the OBAASIMA initiative (www.obaasimaghana.com). A trademark has been developed, the OBAASIMA Seal, regulated by the Ghana Food Standards Authority. This OBAASIMA Seal is assigned to products that adhere to the minimum fortification content as well as nutrition criteria on maximum allowable content of sugar, salt, fat and trans-fat. This trademark helps to inspire healthy food choices by making products easily identifiable and recognizable.

OBAASIMA in action

Companies in Ghana, in partnership with OBAASIMA, have developed ready-to-eat, fortified, processed and packaged foods that are low in sugar, salt and fat. One innovation is the instant Tom Vita,[2] which only requires the addition of hot water for preparation. Another product currently being developed and earmarked to come on stream will be the first extruded corn-soy blend (CSB)[3] to be sold on the market by a local company. The use of extrusion technology, in addition to other treatment, will bring out an instant CSB that requires no cooking before consumption. This is a natural wholesome blended food that is highly nutritious, precooked and affordable for people of all ages.

> "All OBAASIMA products are fortified with 18 vitamins and minerals as part of a specifically designed premix"

All OBAASIMA products are fortified with 18 vitamins and minerals as part of a specifically designed premix developed with the support of DSM. Codex and WHO/UNICEF guidelines for supplementation during pregnancy have been used as a reference in ensuring appropriate levels of vitamins and minerals.[6,7] The premix added to each product can be adjusted taking into consideration the production process, while the local food producers conduct various tests to ensure safety and acceptability for the fortified product.

All products carrying the OBAASIMA Seal must adhere to a 'healthy criteria' portfolio. This is essential in ensuring that

From left: fortified ready-to-eat milk biscuit; fortified ready-to-eat vegetable sauce; fortified ready-to-eat corn-soy blend

improving micronutrient intake does not result in consuming products with higher fat, salt, or sugar levels – a double-duty action.

Conclusion

As much as fortified foods have been proven to help alleviate micronutrient deficiencies, they are not a panacea. In light of the double burden of malnutrition emerging in low and middle-income countries, projects such as OBAASIMA, and the development of a trademark seal in particular, are encouraging examples that illustrate the possibility of addressing two challenges at once (micronutrient deficiencies and the risk of overweight and obesity). Perhaps most importantly, they are the result of reflecting on an essential nutrition intervention and redesigning it in a way that it is tailored to one of the biggest challenges the world is currently facing.

Correspondence: ***Breda Gavin-Smith,***
Global Public Health Nutrition Manager,
PO Box 2116, 4002 Basel, Switzerland
Email: *breda.gavin-smith@sightandlife.org*

References

01. WHO. Preventing and controlling micronutrient deficiencies in populations affected by an emergency. 2007. Internet: www.who.int/nutrition/publications/WHO_WFP_UNICEF-statement.pdf (accessed 13 August 2018).
02. UNICEF. The first 1,000 days of life: the brain's window of opportunity. 2018. Internet: www.unicef-irc.org/article/958-the-first-1000-days-of-life-the-brains-window-of-opportunity.html (accessed 13 August 2018).
03. WHO. Multiple micronutrient supplementation during pregnancy. 2018. Internet: www.who.int/elena/titles/micronutrients_pregnancy/en/ (accessed 13 August 2018).
04. University of Ghana, GroundWork, University of Wisconsin-Madison, KEMRI-Wellcome Trust, UNICEF. Ghana Micronutrient Survey 2017. 2017. Internet: groundworkhealth.org/wp-content/uploads/2018/06/UoG-GroundWork_2017-GHANA-MICRONUTRIENT-SURVEY_Final_180607.pdf (accessed 20 July 2018).
05. Gernand, AD. Micronutrient deficiencies in pregnancy worldwide: health effects and prevention. Nat Rev Endocrinol. 2016;12(5):274–89.
06. UNICEF, WHO, UNU. Composition of a multi-micronutrient supplement to be used in pilot programmes among pregnant women in developing countries. New York, NY: UNICEF; 1999.
07. FAO, WHO. Codex Alimentarius. International food standards. 2018. Internet: www.fao.org/fao-who-codexalimentarius/codex-texts/all-standards/en/ (accessed 12 September 2018).

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Sight and Life will host an engaging session titled: "The role of demand creation in addressing the double burden of malnutrition." **Come join us at the event!**

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https://hiddenhunger.uni-hohenheim.de

What's New?

Did you know? You can now visit the *Sight and Life* website **www.sightandlife.org** on a regular basis to get the latest news about what is happening in the field of nutrition. You can also follow us on **Facebook**, **Twitter** and **Instagram @sightandlife.**

01 The State of Food Security and Nutrition in the World

The State of Food Security and Nutrition in the World (SOFI) Report is an annual flagship report jointly prepared by FAO, IFAD, UNICEF, WFP and WHO to inform on progress towards ending hunger, achieving food security and improving nutrition and to provide in-depth analysis of key challenges for achieving this goal in the context of the 2030 Agenda for Sustainable Development. The report targets a wide audience, including policymakers, international organizations, academic institutions and the general public.
This year's edition is entitled Building Climate Resilience for Food Security and Nutrition.

According to the report, new evidence continues to signal that the number of hungry people in the world is growing, reaching 821 million in 2017, or one in every nine people. Hunger has been on the rise over the past three years, reverting to levels from a decade ago. The situation is worsening in South America and most regions of Africa, while the decreasing trend in undernourishment that characterized Asia seems to be slowing down significantly.

> "The report also reveals that climate variability and climate extremes are among the key drivers behind the rise in hunger"

Analysis in the report also reveals that climate variability affecting rainfall patterns and agricultural seasons, along with climate extremes such as droughts and floods, are among the key drivers behind the rise in hunger, together with conflict and economic slowdowns.

Additionally, limited progress is also being made in addressing the multiple forms of malnutrition, ranging from child stunting to adult obesity, putting the health of hundreds of millions of people at risk.

All in all, the report calls for implementing and scaling up interventions aimed at guaranteeing access to nutritious foods and breaking the intergenerational cycle of malnutrition. Policies must pay special attention to groups that are the most vulnerable to the harmful consequences of poor food access: infants, children aged under five, school-aged children, adolescent girls and women.

At the same time, a sustainable shift must be made towards nutrition-sensitive agriculture and food systems that can provide safe and high-quality food for all. The report also calls for greater efforts to build climate resilience through policies that promote climate change adaptation and mitigation, and disaster risk reduction.

The publication can be read here:
www.fao.org/3/I9553EN/i9553en.pdf

"If we are to achieve a world without hunger and malnutrition in all its forms by 2030, it is imperative that we accelerate and scale up actions to strengthen the resilience and adaptive capacity of food systems and people's livelihoods in response to climate variability and extremes"

Heads of the FAO, IFAD, UNICEF, WFP, and WHO

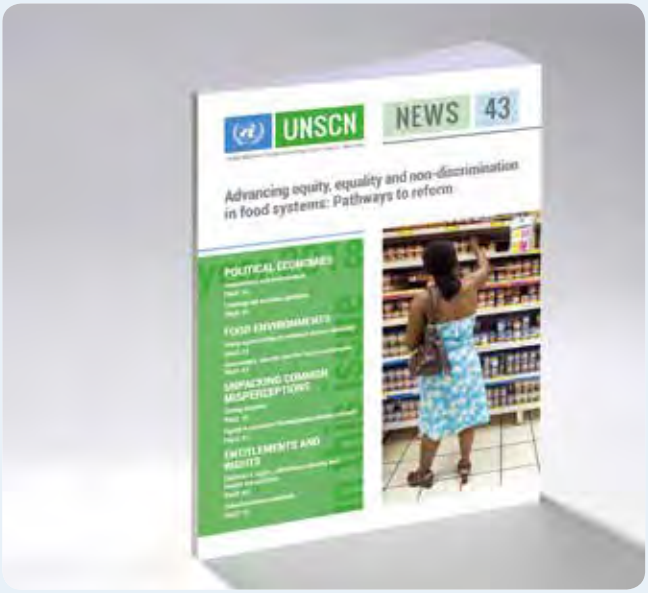
Did You Know?

- The number of undernourished people in the world has been on the rise since 2014, reaching an estimated 821 million in 2017.
- Short on time? Have a look at the key messages of the report here: **www.fao.org/3/CA1355en/CA1355en.pdf**

02

UNSCN News 43

Advancing equity, equality, and non-discrimination in food systems: Pathways to reform



The theme for this year underscores UNSCN's dedication to working to its strengths and bringing added value, as set out in the organization's strategic plan. It is universal (not limited to specific groups of countries), rights-based, focused on the UN system, intent on tackling all forms of malnutrition, determined to promote intersectoral analysis and action, and alert to global issues that are relevant at country level.

This issue of UNSCN News brings together a number of papers that address questions of equity and non-discrimination in food systems. Together, they illustrate the usefulness of such a politico-economic approach. They identify several problems: the persistence of inequalities, the continued concentration of power, and the delay in reforms. However, they also point to many solutions that lie in the hands of both politicians and social actors.

The papers in this edition examine:

- Political economies as gears to unlock healthy and sustainable food systems
- Food environments that help shape positive food choices and lifestyles

- Production methods that support the availability of nutritious diets
- Ways to improve the collection and curation of disaggregated data to shed light on inequalities
- Evolving cultural norms to effect nutritional intake at household level
- Children's rights-based approaches to promote more effective obesity- and noncommunicable disease-prevention strategies
- Solutions that take full advantage of innovation and technology to close the gender gap
- Methods for the international nutrition research to extend and deepen its treatment of equity issues
- International instruments to more systematically underpin efforts aimed at bettering nutrition

You can read the full report here:
www.unscn.org/uploads/web/news/UNSCN-News43-WEB.pdf

Did You Know?

- UNSCN News is a periodic review of developments in international nutrition compiled by UNSCN from a variety of sources of information.
- The UNSCN's resource center is a database of nutrition-related documents and materials where you can retrieve documents and/or links that have been recently issued (from 2010 onwards). You can access any of the documents in the archive section here: **www.unscn.org/archive**

03 Strengthening Nutrition Action: A resource guide for countries based on the policy recommendations of the Second International Conference on Nutrition (ICN2)

The Strengthening Nutrition Action resource guide is part of the follow-up to the Second International Conference on Nutrition (ICN2) that was held in November 2014 in Rome, Italy.

FAO and WHO have developed this resource guide to help Member States and regional and global communities to stimulate nutrition action and to consider the relevance of each of the recommended policies and actions included in the ICN2 Framework for Action. The aim is to make existing commitments more ambitious or to make additional SMART (specific, measurable, achievable, relevant and time-bound) commitments where needed. The report does so by guiding countries to translate the 60 recommended policies and actions of the voluntary ICN2 Framework for Action into more binding, concrete, country-specific commitments for action on nutrition. This process should be done according to national needs and conditions, and should be built on existing policies, strategies, programs, plans and investments in order to achieve the 10 commitments of the Rome Declaration on Nutrition.

"This resource guide is structured around 24 themes that form the ICN2 Framework for Action"

The resource guide is structured around 24 themes that form the ICN2 Framework for Action (24 thematic guidance sheets). The reader is invited to pick and choose those themes that are most relevant and applicable to his or her area of work. This document is not a 'how-to' guide for multisectoral nutrition planning; it is a tool to support countries and other stakeholders in translating the generic ICN2 Framework for Action recommendations into concrete and SMART country commitments for action.

The report is primarily intended for policy advisors supporting government decision-makers and development partners involved in food security and nutrition policy development and implementation.

You can download the report by visiting: *apps.who.int/iris/bitstream/handle/10665/274739/9789241550253-eng.pdf?ua=1*

Did You Know?

- The Second International Conference on Nutrition (ICN2) was a high-level intergovernmental meeting, held in November 2014 that focused global attention on addressing malnutrition in all its forms.
- The two main outcome documents of the conference were the Rome Declaration on Nutrition and the Framework for Action, a political commitment document and a flexible policy framework, respectively.

04 Goalkeepers Report 2018

On September 24, 2018, the Bill & Melinda Gates Foundation launched the 2018 edition of the Goalkeepers Data Report, charting progress towards the SDGs against 18 indicators. This year's report highlights ways that young people can help to transform Africa, given the use of promising approaches in health and education. The Gates Foundation also released the results of a poll of 40,000 people around the world, finding heightened levels of optimism about the future.

The Goalkeepers initiative, launched in September 2017, uses stories, data and partnerships to highlight progress towards the Goals, hold governments accountable and foster new leadership. The initiative tracks progress using the following indicators: poverty, stunting, agriculture, maternal mortality, under-five mortality, neonatal mortality, HIV, tuberculosis, malaria, neglected tropical diseases, family planning, universal health coverage, smoking, vaccines, education, gender equality, sanitation and financial services for the poor. The Gates Foundation has committed to issuing the report every year until 2030.

You can download the publication here:
www.gatesfoundation.org/goalkeepers/report?download=false

"Young people have enormous potential to drive growth. They are the activists, innovators, leaders and workers of the future"

Bill & Melinda Gates, Gates Foundation

Did You Know?

- Watch Bill and Melinda discuss their Goalkeepers report on National Geographic here: **bit.ly/2Ocb7TN**
- Gates is a key partner in the OBAASIMA project along with *Sight and Life*, DSM and GIZ. Learn more about OBAASIMA here: **bit.ly/2Db2JCP**

05 Taking Action on Childhood Obesity Report

Childhood obesity is one of the most serious global public health challenges of the 21st century, affecting every country in the world. In just 40 years, the number of school-age children and adolescents with obesity has risen more than tenfold, from 11 million to 124 million (2016 estimates). In addition, an estimated 216 million were classified as overweight but not obese in 2016.

"All countries have agreed a set of global targets for halting the increase in obesity"

In response, all countries have agreed a set of global targets for halting the increase in obesity. This includes no increase in overweight among children under five, school-age children, or adolescents by 2025 (from 2010 levels). Action to reverse the epidemic is the focus of the recommendations made by the WHO Commission on Ending Childhood Obesity and is one of the main objectives of the Decade of Action on Nutrition. The epidemic has been growing most rapidly in low- and middle-income countries, particularly in Northern and Southern Africa, the Middle East and the Pacific Islands. Although most countries are still off track to meet the 2025 targets, many are taking action, and some have achieved a leveling-off in childhood obesity rates.

In this document, WHO illustrates the progress being made, with examples of actions at national level.

Key messages:

- While most countries are still off track to meet the target, many are taking action, and some have achieved a leveling-off in childhood obesity rates
- Investing in children's health will help meet the global

health targets and substantially reduce the predicted health and economic costs of obesity.

Call to action:

1. Governments should urgently review their progress towards meeting the 2025 targets, and implement the recommendations of the Commission on Ending Childhood Obesity (ECHO):
   - Improve the environments in which children live, play and learn
   - Implement policies to support healthy food environments, for mothers, infants, and children
   - Increase policy priority to ensure safe and accessible environments for physical activity for children of all ages
   - Strengthen the measurement of food and physical activity environments and policy implementation
   - Work towards universal health coverage for all people to ensure children, adolescents, and their families have access to the obesity prevention and treatment services they need

You can access the document here:
apps.who.int/iris/bitstream/handle/10665/274792/WHO-NMH-PND-ECHO-18.1-eng.pdf?ua=1

Did You Know?

- The World Obesity Federation represents professional members of the scientific, medical, and research communities from over 50 regional and national obesity associations. Through its membership, it creates a global community of organizations dedicated to driving global efforts to reduce, prevent, and treat obesity.
- Did you miss ECHO's (Commission on Ending Child Obesity) final report (2016) calling for high-level action to address major health challenges? You can access the report by visiting: **bit.ly/2B5leIu**

06 Noncommunicable Diseases Country Profiles 2018

At the First and Second UN High-level Meetings on Noncommunicable Diseases (NCDs) in 2011 and 2014, the World Health Organization released Country Profiles highlighting the latest data on NCDs in each WHO Member State. This third set of Country Profiles provides an update on each Member State, presenting key data on NCD mortality, risk factor prevalence, national systems capacity to prevent and control NCDs, and existence of national targets based on the Global Monitoring Framework. These profiles allow Member States to track their progress towards achieving the nine global targets, to be attained by 2025.

Additionally, to address the growing burden of NCDs, WHO identified a package of 16 "best-buy" interventions that are cost-effective, affordable, feasible, and scalable in all settings. The "best buys" were first designated in 2011 and were updated in 2017 based on the latest evidence of intervention impact and costs. Implementing all 16 "best buys" in all countries between 2018 and 2025 would avoid 9.6 million premature

deaths, thus moving countries appreciably towards the NCD mortality reduction targets. The best buys for nutrition-related NCDs are described in the report (see Table 1).

For the first time, the profiles include Member State estimates of the number of lives that could be saved by 2025 by implementing the 16 WHO 'best buys.'

You can download the report by visiting:
www.who.int/nmh/publications/ncd-profiles-2018/en/

Did You Know?

- In 2016, NCDs were responsible for 41 million of the world's 57 million deaths (71%). Fifteen million of these deaths were premature (30 to 70 years).
- The burden is greatest within low- and middle- income countries, where 78% of all NCD deaths and 85% of premature deaths occurred.

TABLE 1: The best buys for nutrition-related NCDs

Risk factor/disease to be addressed	Intervention	Description
Unhealthy diet	Reformulation of food	Reduce salt intake through the reformulation of food products to contain less salt and through the setting of target levels for the amount of salt in foods and meals.
	Supportive environments	Reduce salt intake through the establishment of a supportive environment in public institutions such as hospitals, schools, workplaces and nursing homes to enable lower-sodium options to be provided.
	Education	Reduce salt intake through a behavior change communication and mass-media campaign.
	Packaging	Reduce salt intake through the implementation of front-of-pack labeling.
Physical activity	Education	Implement community-wide public education and awareness campaigns for physical activity, which includes a mass-media campaign combined with other community-based education, motivational and environmental programs aimed at supporting behavioral change regarding physical activity levels.
Cardiovascular disease and diabetes	Drug therapy and counseling	Drug therapy (including glycaemic control for diabetes mellitus and control of hypertension, using a total risk approach) and counseling for individuals who have had a heart attack or stroke and for persons with high risk (≥30%) of a fatal and non-fatal cardiovascular event in the next 10 years.

07

Building Momentum
Lessons on implementing evidence-informed nutrition policy

This report is the first in a series aimed to help policymakers overcome common barriers to implementing evidence-informed nutrition policy. The implementation of evidence-based nutrition policies is essential to tackle the growing burden caused by diet-related NCDs such as cancer, heart disease and diabetes. Policymakers face increasing barriers and challenges to introducing and implementing such policies, and this research seeks to establish ways to help policymakers overcome these barriers and challenges.

Sugar-sweetened beverage (SSB) consumption promotes weight gain and contributes to rising rates of diet-related NCDs globally. Results from rigorous monitoring and evaluation research into the effects of implemented SSB taxes are encouraging policymakers across the globe to take action.

Lessons can be drawn from governments that have successfully passed and implemented, or attempted to pass, an SSB tax. This report outlines the lessons learned from those examples on:

- what evidence is required;
- how to design the tax;
- how to run and sustain a public and political campaign in support of the tax;
- how to frame the tax;
- how best to engage with stakeholders; and
- how to counter common arguments against the tax.

This report is primarily aimed at policymakers seeking to implement SSB taxes. It is informed by a literature review, along with interviews conducted with policymakers, advocates and academics involved in SSB tax development, advocacy and implementation around the world.

The report can be downloaded here:
www.wcrf.org/sites/default/files/building-momentum.pdf

> "We have had enough of the lack of action on NCDs worldwide, and SSB taxes are an indispensable and underutilized policy tool to improve public health and tackle the global NCD epidemic"
>
> *Katie Dain, Chief Executive Officer, NCD Alliance*

Did You Know?

- Sugar-sweetened beverages (SSBs) are beverages that contain added caloric sweeteners, such as sucrose, high-fructose corn syrup and fruit juice concentrates. These include, but are not limited to, carbonates, fruit beverages, sports beverages, energy and vitamin water beverages, sweetened iced tea and lemonade.
- The following evidence table highlights the effects of implemented SSB taxes: **www.wcrf.org/sites/default/files/Building-Momentum-evidence-table-SSB-taxes.pdf**
- The Building Momentum series will cover other nutrition policies such as front-of-pack nutrition labels and the marketing of unhealthy food and drink to children.

08

Good Food is Good Business

Opportunities driving the future of affordable nutrition

'Good Food Is Good Business' was commissioned by the Bill & Melinda Gates Foundation and developed by the Institute for the Future (IFTF). It forecasts future forces that will drive private-sector business opportunities to create more affordable, accessible, appealing and nutritious foods for lower-income consumers over the next decade. The report is aimed at four stakeholder groups: national and regional food and beverage companies, multinational food and beverage companies, innovators and input suppliers to the industry.

How did the report come about?

The Bill & Melinda Gates Foundation and the Institute for the Future hosted a first-of-its-kind two-day summit in Singapore in March 2018 to kickstart fresh thinking about how our market-based food system can play a key role in improving the health of nutritionally vulnerable populations in low- and middle-income countries. The meeting brought together a small group of global thought leaders and experts to take a mid-to-long-term ambitious view, asking what innovations might lie just ahead on the horizon. Together, the group created an initial broad vision for designing products that are affordable, accessible, appealing and nutritious for lower-income consumers of the future.

Building on the concepts generated at the summit, five opportunity zones were identified for creating affordable and nutritious foods in lower-income markets. These opportunity zones describe promising new pathways for addressing old problems.

> "The report explores five zones of technological innovation that will spark an affordable nutrition revolution"

The report explores five zones of technological innovation that will spark an affordable nutrition revolution, finally making it possible for food companies to do well and drive market share – while doing good:

1. AI collaboration
2. Traditional wisdom
3. Microbiota management
4. Cellular agriculture
5. Programmable assets

Did You Know?

- Dr Klaus Kraemer from *Sight and Life* and Mr. Gurvinder Ahluwalia from Beyond Protocol and Digital Twin Labs gave a special address on the report at the 2018 World Congress of Food Science and Technology (IUFoST) in Mumbai. To join the conversation, look up the #SALPanel Twitter hashtag.
- The Institute for the Future (IFTF) identifies emerging discontinuities that will transform global society and the global marketplace. It provides organizations with insights into business strategy, design process, innovation and social dilemmas. Its research spans from health and healthcare to technology, the workplace and human identity.

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Ready-to-use Therapeutic Food and Ready-to-use Supplementary Food

New approaches in formulation and sourcing

Paul GJ Murphy
Valid Nutrition, Bantry, Co Cork, Ireland

Dear Editor,

The article published in *Sight and Life* vol. 32 (1) 2018, page 40, by Mark Manary and Meghan Callaghan-Gillespie: *Ready-to-use Therapeutic Food and Ready-to-use Supplementary Food: New approaches in formulation and sourcing,*[1] states:

"The standard formulation for RUTF has been used for over a decade and although several alternative formulations have been developed and tested by leading researchers, most of these products have not been successful in achieving comparable effectiveness to the current milk- and peanut-based formula."

This statement references an article published in *Maternal and Child Nutrition* in 2015 describing the results of a cluster-randomized controlled equivalence trial that we undertook in Zambia between June 2009 and August 2010.[2] This trial indeed shows that a non-milk-containing RUTF based on soya-maize and sorghum was not equivalent to the standard milk-peanut recipe in children aged 6–24 months. However the Manary et al. article does not mention a more recent article we published in *The American Journal of Clinical Nutrition* that reports the results of a large RCT looking at a refined version of that soya-maize-sorghum RUTF recipe that included some crystalline amino acids.[3] This article demonstrates that the new soya-maize-sorghum RUTF recipe is not inferior to the standard milk-peanut recipe in terms of recovery from SAM, mortality, or default. The paper also demonstrates that the recipe is superior to the milk-containing product for the restoration of body iron stores and the treatment of anemia.[3] Critically, the recipe will cost approximately 20% less than the current milk-peanut formula, potentially allowing for the treatment of almost 1 million more cases of SAM within existing budgets.

"In addition to the increased clinical effectiveness and reduced costs, the new recipe has other important advantages"

In addition to the increased clinical effectiveness and reduced costs, the new recipe has other important advantages.[4] The base ingredients can all be grown in developing countries, thereby facilitating manufacture in those countries and avoiding the need to import expensive milk powder. The exclusion of peanuts also reduces the risks of aflatoxin contamination, making the new recipe easier and safer to manufacture.[5] The elimina-

tion of animal-source ingredients and the use of locally grown pulses and grains also dramatically reduces the carbon footprint and increases the potential for sustainable production.[4] The new recipe also contains 10% less sugar than the standard RUTF recipe and avoids problems associated with lactose intolerance or nut allergies.[6,7,8,9]

The superior efficacy in the restoration of body iron stores and the treatment of anemia proffers the potential for a new range of plant-based RUFs to supplement pregnant and lactating women and treat or prevent moderate acute malnutrition (MAM). In conclusion, this successful trial demonstrates that a non-milk product has clinical advantages over the standard, milk-based product, at much lower cost and reduced environmental impact. We therefore believe that this represents an important breakthrough that should have been described in the original article.

Correspondence: ***Paul GJ Murphy,***
Chief Executive, Valid Nutrition, Cuibin Farm,
Derry Duff, Bantry, Co Cork, P75 PD60, Ireland
Email: *office@validnutrition.org*

References

01. Manary M, Callaghan-Gillespie M. Ready-to-Use Therapeutic Food and Ready-to-Use Supplementary Food: new approaches in formulation and sourcing. *Sight and Life*. 2018;32(1):40–5.
02. Irena AH, Bahwere P, Owino VO, Diop EI, Bachmann MO, Mbwili-Muleya C, et al. Comparison of the effectiveness of a milk-free soy-maize-sorghum-based ready-to-use therapeutic food to standard ready-to-use therapeutic food with 25% milk in nutrition management of severely acutely malnourished Zambian children: an equivalence non-blinded cluster randomised controlled trial. Matern Child Nutr. 2015;11 Suppl 4:105–19.
03. Bahwere P, Akomo P, Mwale M, Murakami H, Banda C, Kathumba S, et al. Soya, maize, and sorghum-based ready-to-use therapeutic food with amino acid is as efficacious as the standard milk and peanut paste-based formulation for the treatment of severe acute malnutrition in children: a noninferiority individually randomized controlled efficacy clinical trial in Malawi. Am J Clin Nutr. 2017;106(4):1100–12.
04. Joseph M, Alavi S, Johnson Q, Mohamedshah F, Walton S, Webb P. Improving the nutritional value of foods in the USAID food aid basket: optimisation of macro and micronutrients, food matrices, novel ingredients and food processing technologies. Report to USAID from the Food Aid Quality Review. Boston, MA: Tufts University; 2018.
05. Manary MJ. Local production and provision of ready-to-use therapeutic food (RUTF) spread for the treatment of severe childhood malnutrition. Food Nutr Bull. 2006;27(3 Suppl):S83–S89.
06. Paglia L. WHO: healthy diet to prevent chronic diseases and caries. Eur J Paediatr Dent. 2018;19(1):5.
07. Nyeko R, Kalyesubula I, Mworozi E, Bachou H. Lactose intolerance among severely malnourished children with diarrhoea admitted to the nutrition unit, Mulago hospital, Uganda. BMC Pediatr. 2010;10:31.
08. Boye JI. Food allergies in developing and emerging economies: need for comprehensive data on prevalence rates. Clin Transl Allergy. 2012;2(1):25.
09. Yang Z. Are peanut allergies a concern for using peanut-based formulated foods in developing countries? Food Nutr Bull. 2010;31(2 Suppl):S147–S153.

Response to Letter from Paul GJ Murphy

Ready-to-use Therapeutic Food and Ready-to-use Supplementary Food: New approaches in formulation and sourcing

Mark Manary
Project Peanut Butter, MO, USA

Meghan Callaghan-Gillespie
Washington University School of Medicine, MO, USA

> "Certainly the line of investigation suggested in the Malawi study holds promise"

The letter from Paul Murphy highlights an interesting study of an alternative RUTF from 2017, and we thank him for bringing this to the attention of the readers.

Our piece for *Sight and Life* magazine was meant to highlight the possibilities and pitfalls of alternative RUTFs in treating children with severe acute malnutrition (SAM) rather than to provide a comprehensive review of the topic.

We chose not to discuss the study using milk-free RUTF from Malawi in our article, because of some limitations of this work.[1] Foremost, RUTF is used for home-based therapy, treating SAM children when they are given a 1–2 ration week of food to be consumed at home.[2] This study was facility-based, a setting where children came to a treatment center daily for feeding, thus we have no direct evidence how this product would perform in the setting for which it is intended. The rates of weight gain were significantly less among those children consuming a milk-free RUTF, suggesting there may be some nutritional inferiority of the product to rebuild wasted tissues.[1] The author raises a couple of 'straw men' in the letter – lactose intolerance and peanut allergy – and asserts these problems are averted by use of milk-free alternative RUTF. These are actually not relevant clinical problems: a trial among the most vulnerable SAM children in the initial phase of treatment receiving lactose-free feeding found no less diarrhea or feeding intolerance, and an eczematous rash from RUTF allergy in our experience occurred in about 1 out 10,000 children treated. Finally, the cost considerations need to be more carefully evaluated, given the additional food safety risks of pathogen contamination from local grains which require more processing.

Certainly the line of investigation suggested in the Malawi study – using less milk and realizing lower RUTF costs – holds promise, and we look forward to learning more about this in the future.

Correspondence: ***Mark Manary,***
Project Peanut Butter, 7435 Flora Avenue,
Maplewood, MO 63243, USA
Email: manary@kids.wustl.edu

Correspondence: ***Meghan Callaghan-Gillespie,***
Washington University School of Medicine,
660 S Euclid Ave, St. Louis, MO 63110, USA
Email: mcallaghan@wustl.edu

References

01. Bahwere P, Akomo P, Mwale M, Murakami H, Banda C, Kathumba S, et al. Soya, maize, and sorghum-based ready-to-use therapeutic food with amino acid is as efficacious as the standard milk and peanut paste-based formulation for the treatment of severe acute malnutrition in children: a noninferiority individually randomized controlled efficacy clinical trial in Malawi. Am J Clin Nutr. 2017;106(4):1100–12. Epub 2017/08/18. doi: 10.3945/ajcn.117.156653. PubMed PMID: 28814393.

01. Trehan I, Manary MJ. Management of severe acute malnutrition in low-income and middle-income countries. Arch Dis Child. 2015;100(3):283–7. Epub 2014/11/26. doi: 10.1136/archdischild-2014-306026. PubMed PMID: 25421910.

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Books
Reviews & Notices

Editor's note: This section contains reviews of books, whether brand new or classic, that we hope will be of interest to our readers.

Book Review

Mapping the Pathways to a Better Food System

Nourished Planet: Sustainability in the Global Food System
Barilla Center for Food & Nutrition Foundation
Publisher: Island Press, Washington, DC, 2018
Language: English
Editor: Danielle Nierenberg
ISBN-13: 978-1610918947
ISBN-10: 1610918940

In its 2017 analysis of the relationship between food systems and nutrition, the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Security mapped out the food systems that shape today's world and simultaneously stressed the need to change these radically. "Acting to change systems is never easy," the authors of the report conceded. "Vested interests, technical challenges and human and financial resource constraints all have to be overcome. Effort and focus need to be sustained." The authors continued: "Carrying out superficial repairs to our existing food systems will no longer suffice. We need disruptive change within and across today's varied and complex food systems."[1]

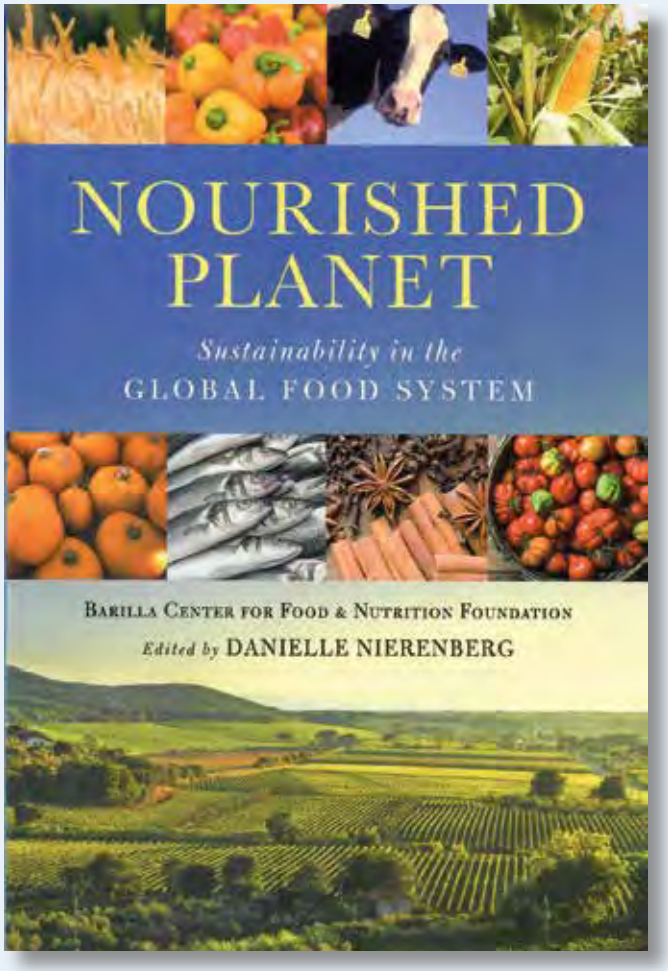
Nourished Planet makes the same argument, albeit more concisely and much more graphically.

> *"It's no exaggeration to say that today's food system*
> *is like the Titanic.*
> *Immense.*
> *Complex.*
> *A marvel of engineering.*
> *Thought to be invincible.*
> *But racing to its destruction."*[2]

"There is a lot that farmers in the Global North can learn from farmers in the Global South"

In an interview conducted in June 2018, the editor of *Nourished Planet*, Danielle Nierenberg, explains the impulse behind this thought-provoking book:

> *"Rich and poor countries face many of the same challenges – hunger and obesity are paradoxes that plague both wealthy and developing countries and climate change is impacting*



farmers all over the world. What's exciting to me is that there is a lot of information-sharing that can take place – and it's not only from the North to the South, but there is a lot of information that can be exchanged South to South as farmers engage with one another on ways to combat pests or drought or find ways to increase equality in fields and businesses. And I think there is a lot that farmers in the Global North can learn from farmers in the Global South around mitigating and adapting to climate change, including growing a diversity of crops instead of relying on monocultures."[3]

Information-sharing, engagement, equality, learning and diversity – these are the key themes that underpin this publication. Writing in the Foreword, Pavan Sukhdev and Alexander Müller state that *Nourished Planet* "represents a significant step in the right direction for enlightening policy-makers, businesses and society at large about the many dimensions of our eco-agri-food systems." Importantly, they go on to emphasize that "this book focuses on not only the problems – of hunger, obesity, climate change and poor nutrition – but also on the solutions."[4]

The book is structured in four main sections – Food for All, Food for Sustainable Growth, Food for Health and Food for Culture – each of which is accompanied by interviews with 'Voices from the New Food Movement.' This simple but highly engaging structure is mirrored by the content, which provides succinct explanations of phenomena such as land grabbing and food deserts but also offers thought-provoking reflections on topics such as 'Rethinking the Meat that We Eat' and 'Tools for Promoting Well-Being.' Clear infographics underpin the powerful arguments for change.

Asked what she perceived as the single biggest threat to worldwide food security when the book was published, Danielle Nierenberg replied: "Apathy. If we don't understand the urgency of these issues and take action now, we will continue to have nearly a billion people worldwide who go to bed hungry each night. We need farmers, businesses and governments to invest in the research and education around food and agriculture so that the next generation can live in a world free of hunger and poverty."[5]

Nourished Planet is an antidote to apathy. Anyone who is motivated to map out the pathways to a better global food system might do well to slip a copy of it in their rucksack.

Review by Jonathan Steffen
Correspondence: ***Jonathan Steffen,***
Suite C, 153 St Neots Road, Hardwick,
Cambridge CB23 7QY, UK
Email: *jonathan.steffen@corporatestory.co.uk*

References

01. HLPE. Nutrition and food systems. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Security. Rome: FAO; 2017. [HLPE Report 12.]

02. Nierenberg D (ed.), Fisher L, Frederick B, Peñuelas M. 2018. Nourished planet: sustainability in the global food system. Washington, DC: Island Press; 2018:34.

03. Nourished planet: sustainability in the global food system: Q&A with editor Danielle Nierenberg. 2018. Internet: foodtank.com/news/2018/06/nourished-planet-danielle-nierenberg/ (accessed 1 November 2018).

04. Nierenberg D (ed.), Fisher L, Frederick B, Peñuelas M. 2018. Nourished planet: sustainability in the global food system. Washington, DC: Island Press; 2018:ix–x.

05. Nourished planet: sustainability in the global food system: Q&A with editor Danielle Nierenberg. 2018. Internet: foodtank.com/news/2018/06/nourished-planet-danielle-nierenberg/ (accessed 1 November 2018).

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Sight and Life Foundation
Klaus Kraemer, Managing Director,
PO Box 2116, 4002 Basel, Switzerland
Phone: +41 (0) 61 815 8756
Fax: +41 (0) 61 815 8190
Email: info@sightandlife.org
www.sightandlife.org

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