sightandlife

WOMEN'S NUTRITION

Sight and Life

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Contents

Welcome

Can Diet Alone Deliver Good Nutrition?

Renewed interest in diet

Participating in a number of national and international nutrition gatherings in the past two years gives me the impression that the concept *'diet'* (defined by Merriam-Webster as "food and drink regularly provided or consumed, or habitual nourishment") is currently in fashion.

The 2016 Global Nutrition Report (GNR) mentions 'diet' 78 times in its 180 pages, and the 2016 Global Panel on Agriculture and Food Systems for Nutrition report 'Food systems and diets: Facing the challenges of the 21st century' mentions the word 110 times in just 16 pages! I'm inclined to think that the 2nd International Conference on Nutrition in 2014, with its Rome Declaration (19 mentions of diet/ary in six pages) and Framework for Action (13 mentions in eight pages), have stimulated renewed interest in the concept of 'diet' on the part of international organizations.

From my perspective, I believe that we must indeed aim at *food and nutrition security within the broader context of food systems*. But I do not think that a discussion that focuses on *diet* alone, or one that fails to recognize that food and nutrition security encompasses far more than just the regular consumption of food and drink, genuinely helps us address the complex challenges of malnutrition in all its forms across the world.

The GNR reiterates: "malnutrition and poor diets constitute the number-one driver of the global burden of disease." It sounds so simple – just address malnutrition and poor diets and, hey presto, the work is done. It is not that simple. There is no doubt that food systems need to become more public-health-sensitive and sustainable; but agriculture is still geared toward producing massive amounts of calories; the food industry is not sufficiently incentivized (and/or regulated) to produce nutrient-dense and safe foods; where regulations do exist, governments often lack the capacity to enforce these; and the average consumer does not have the nutrition literacy to make healthy choices in a world where fact and fiction often blend into one. And these are just a tiny fraction of the many factors that ultimately result in either good nutrition or malnutrition.

Elsewhere in this issue (pp. 135–136), we report on our new publication *Good Nutrition: Perspectives for the 21st century*, which provides in-depth perspectives on sustainable food systems and diets, food value chains, and the limits to consumerism, among many other topics that must be considered when we speak of "good nutrition." To quote Adam Drewnowski, Professor in the Center for Public Health Nutrition at the University of Washington, Seattle, WA, USA (and one of the contributors to the book): "There are limits to free choice. Consumer food choices are driven by purchasing power and socioeconomic status. Calories have become cheap; nutrients remain expensive." This summarizes the complexity of the issue, and Prof. Drewnowski's view is complemented by a quote from Tim Lang, Professor of Food Policy at City University in the United Kingdom: "The rich need to eat less, and differently, so the poor can eat more, and differently."

> "The rich need to eat less, and differently, so the poor can eat more, and differently"
>
> *Tim Lang*

There is scientific agreement that certain traditional dietary patterns, such as the Mediterranean Diet and the Nordic Diet, offer substantial health benefits, i.e., reduced risk of metabolic syndrome and non-communicable diseases such as cancer and cardiovascular disease. Furthermore, according to the Food and Agriculture Organization of the United Nations (FAO), more than 100 countries worldwide have developed food-based dietary guidelines "adapted to their nutrition situation, food availability, culinary cultures and eating habits."

While recognizing this, one should also remark that not all actually available 'diets' that people consume are anything like nutritionally adequate, and that there are many faddish so-called 'diets' – proposed by individuals lacking all credentials in nutrition science – that promise health benefits for which no scientific basis exists at all. Nevertheless, we do have evidence for the benefits of certain diets, and we do have an abundance

of dietary guidelines. The question remains, however: Do the diets that the majority of people around the world consume provide sufficient nutrient-dense and safe food for all stages of the life-course?

> "Do the diets that the majority of people eat provide sufficient nutrient-dense and safe food?"

Diet nutrient gaps – a fact

Professor Kathryn Dewey, from the Department of Nutrition at UC Davis, CA, USA, writing in a 2013 *Journal of Nutrition* article, uses an evolutionary perspective to describe the challenge of meeting the nutrient needs of older infants and young children during the complementary feeding period. According to Prof. Dewey's calculations, the Recommended Nutrient Intakes (RNIs) for iron and zinc are not met even when diverse foods – including nutrient-dense animal-source foods and breast milk – are part of the diet. Meeting nutrient requirements is even less likely when the complementary diet is based on cereals – the typical diet in most low- and middle-income countries. The World Food Programme video *Busting a Nutrition Myth* (www.youtube.com/watch?v=FrRjkpun2RU) clearly illustrates why it is so difficult to close important nutrient gaps in older infants and young children, and why appropriate fortified complementary foods, such as SUPER CEREAL *plus*, provide a formidable solution to fill the gap, when consumed as part of the complementary diet.

While optimal nutrition for older infants and young children is currently a global focus, we must not forget that women's nutrition is also critical. Thus, this edition of *Sight and Life* focuses on women's nutrition. According to Prof. Lindsay Allen from the USDA-ARS Western Human Nutrition Research Center in Davis, CA, too little attention has been paid to ensuring adequate maternal micronutrient status when breastfeeding. In her article on pp. 36–39, Prof. Allen favors the use of multiple micronutrient supplementation during lactation over the use of iron and folic acid only. She shows that micronutrients such as thiamin, riboflavin, niacin, vitamins B_{12}, A, D, and K, choline, iodine and selenium affect breast milk concentrations, while iron and folic acid do not.

The evidence is also clear that countries that have mandated the fortification of wheat flour with folic acid have experienced massive reductions in neural tube defects (NTDs). Throughout the Americas, and in many other countries where flour fortification is mandatory, this has simply become part of the diet, and the fact that it is significantly contributing to nutrient adequacy is largely forgotten. Interestingly, in Europe only Moldova and Kosovo have mandated folic acid fortification, so not surprisingly an article in the November 2016 issue of The Lancet Neurology asks, *Folic acid: time for Europe to mandate fortified flour?*

An exciting public-private partnership in Ghana, known as Affordable Nutritious Foods for Women (ANF4W), is looking at establishing a market-based solution to improve the nutritional status of women of reproductive age with fortified food products. Dr Eva Monterrosa, Senior Scientific Manager at *Sight and Life* Foundation, describes in an article on pp. 32–35 how the project aims to provide considerable amounts of the RNIs of 18 vitamins and minerals during the critical period of pregnancy and lactation when nutrient needs are elevated.

Evidence: the basis for global guidelines?

In the near future, market-based solutions providing multiple micronutrient supplements (MMS) – which demonstrably result in enhanced birth outcomes, including improvements in birth weight and reductions in both low birth weight and preterm birth – appear to be the only reasonable means of providing essential micronutrients to pregnant women. I had hoped that in this edition of *Sight and Life* we could share positive news from the long-awaited and recently released World Health Organization (WHO) antenatal care guidelines endorsing prenatal MMS. However – disappointingly – the WHO states in the document: "Multiple micronutrient supplementation is not recommended for pregnant women to improve maternal and perinatal outcomes."

This statement is made despite the overwhelming evidence in favor of MMS. The WHO continues to endorse prenatal iron/folic acid, a policy it has pursued since since 1968, although the new guidelines permit a reduction in the iron dose (30–60 mg). Why does it do this when – since the design of the UNIMAP formulation in the late 1990s – some 20 large-scale trials, the 2013 Lancet Series on Maternal and Child Nutrition, and several meta-analyses demonstrate the precise contrary? The research has corroborated an advantage of MMS over iron/folic acid on birth outcomes, though no difference on maternal anemia reduction (remembering that the UNIMAP formulation uses just half of the iron [30 mg] of iron/folic acid tablets [60 mg]).

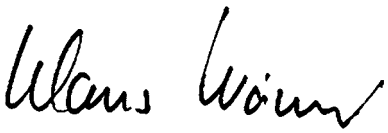
It is difficult to understand why the WHO has not followed the bulk of the evidence in updating its guidelines. In my opinion, this is a matter of public health concern. Governments must thus draw their own conclusions based on the evidence available to them, and should implement the best possible strategies – namely, multiple micronutrients and not just iron/folic acid – to supplement the diets of pregnant women. Moreover, governments should more carefully assess the underlying causes of anemia before implementing anemia-mitigating strategies. In a thought-provoking contribution in this issue of our magazine, Crystal Karakochuk, Professor at the University of British

Columbia in Vancouver, Canada, raises concerns pertaining to iron supplementation, as iron deficiency anemia appears to be less widespread, and hemoglobinopathies, such as thalassemia, more prevalent than originally thought (pp. 46–53). Iron supplementation and/or fortification in an iron-replete population provides no benefit and may even be harmful. There is more to nutrition than meets the eye!

There is little doubt in my mind that supplementation and (bio)fortification are important dietary interventions that can significantly contribute to nutrition security. Clearly they are not the answer to all the nutrition challenges we face, but they should be carefully considered as part of any public health nutrition strategy. First and foremost, we need to know the underlying causes of malnutrition (over- and/or undernutrition) and the magnitude of the (micronutrient deficiency) nutrition problem in any given local context if we are to design appropriate and effective evidence-based solutions to be delivered through public and/or private channels. In this connection, we should also challenge the type and level of evidence we require in nutrition, as Dr Lawrence Haddad, Executive Director of the Global Alliance for Nutrition (GAIN), eloquently asked in his blog of November 16, 2016, *Evidence in nutrition: have we set the bar too high?* For prenatal MMS, we have certainly reached the tipping point at which implementation should begin (see above).

Considering the magnitude of the malnutrition problem – and reading, as this edition goes to print, the article 'A new global research agenda for food' by Dr Lawrence Haddad and colleagues in the December 1, 2016 issue of Nature, which proposes "ten ways to shift the focus from feeding people to nourishing them" – I believe that we urgently need to take the evidence we have to scale, and execute the research eloquently suggested in this piece. But what we do not need is to confuse ourselves and the public by continually changing nutrition messages and terminology. Nor will our task be made easier by interference from the proponents of orthodoxies and ideologies in a 'post-truth' era.

With warm regards,

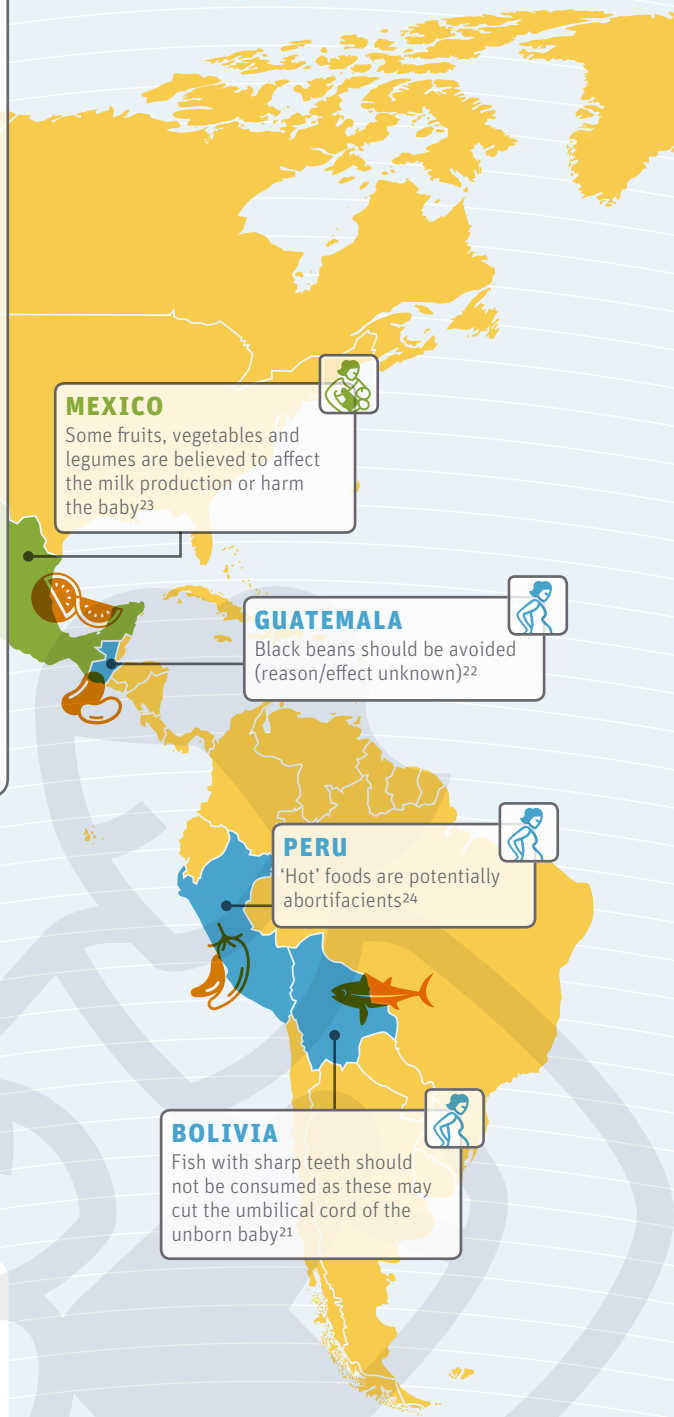


Klaus Kraemer
Managing Director, *Sight and Life* Foundation

"There is more to nutrition than meets the eye"

Food Taboos During Pregnancy and Lactation Across the World

In many countries, women have to deal with food restrictions during their pregnancy or lactation. Many of these food taboos are related to animal-source foods or fruits and vegetables. Restriction of these foods during pregnancy and lactation can be very harmful for both the mother and fetus, as essentials nutrients such as protein and vitamins are lacking in the diet[25]



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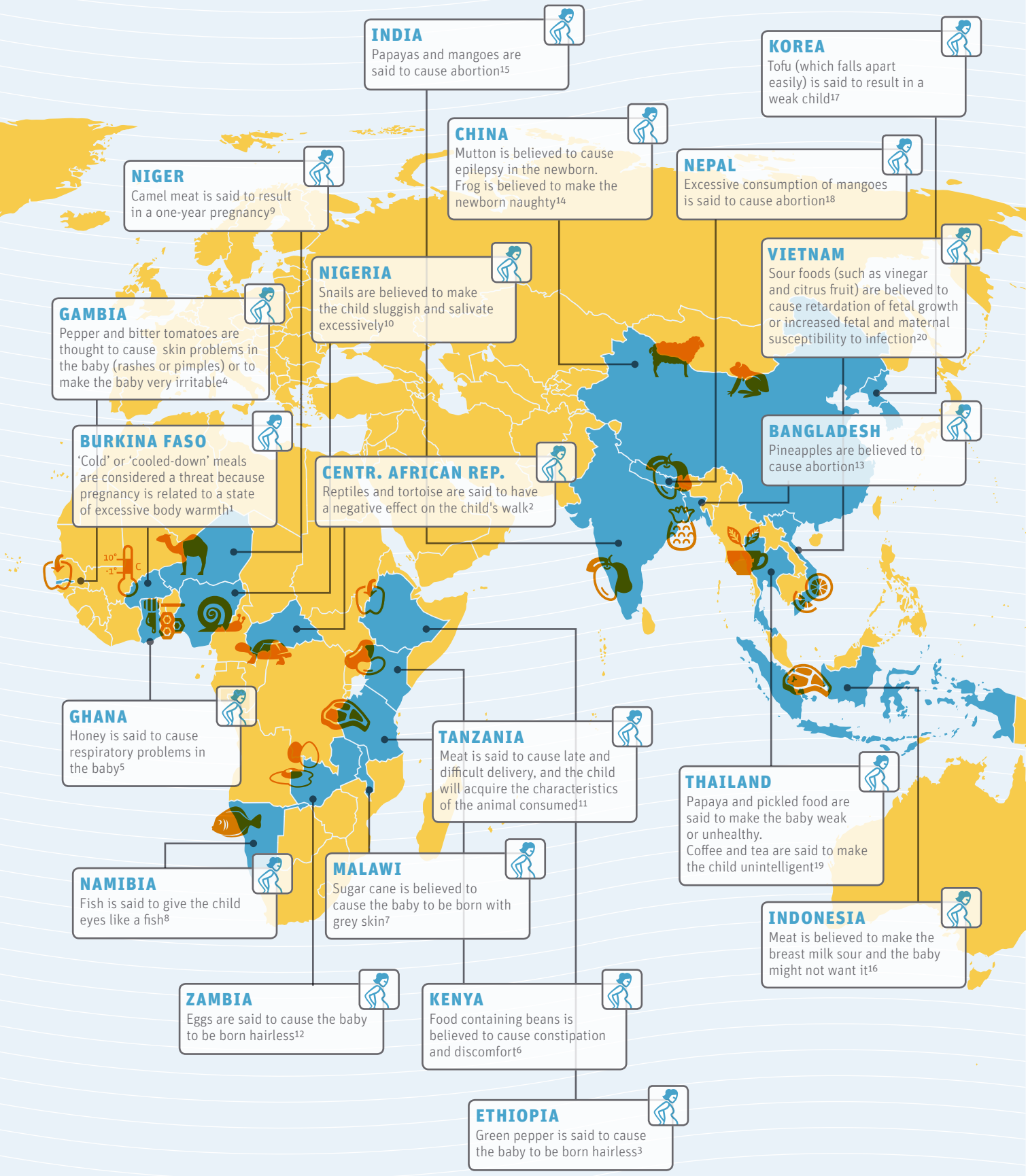

INDIA
Papayas and mangoes are said to cause abortion[15]

KOREA
Tofu (which falls apart easily) is said to result in a weak child[17]

CHINA
Mutton is believed to cause epilepsy in the newborn. Frog is believed to make the newborn naughty[14]

NEPAL
Excessive consumption of mangoes is said to cause abortion[18]

NIGER
Camel meat is said to result in a one-year pregnancy[9]

NIGERIA
Snails are believed to make the child sluggish and salivate excessively[10]

VIETNAM
Sour foods (such as vinegar and citrus fruit) are believed to cause retardation of fetal growth or increased fetal and maternal susceptibility to infection[20]

GAMBIA
Pepper and bitter tomatoes are thought to cause skin problems in the baby (rashes or pimples) or to make the baby very irritable[4]

BURKINA FASO
'Cold' or 'cooled-down' meals are considered a threat because pregnancy is related to a state of excessive body warmth[1]

CENTR. AFRICAN REP.
Reptiles and tortoise are said to have a negative effect on the child's walk[2]

BANGLADESH
Pineapples are believed to cause abortion[13]

GHANA
Honey is said to cause respiratory problems in the baby[5]

TANZANIA
Meat is said to cause late and difficult delivery, and the child will acquire the characteristics of the animal consumed[11]

THAILAND
Papaya and pickled food are said to make the baby weak or unhealthy.
Coffee and tea are said to make the child unintelligent[19]

NAMIBIA
Fish is said to give the child eyes like a fish[8]

MALAWI
Sugar cane is believed to cause the baby to be born with grey skin[7]

INDONESIA
Meat is believed to make the breast milk sour and the baby might not want it[16]

ZAMBIA
Eggs are said to cause the baby to be born hairless[12]

KENYA
Food containing beans is believed to cause constipation and discomfort[6]

ETHIOPIA
Green pepper is said to cause the baby to be born hairless[3]

Young Nutritionists Shine in Elevator Pitch Contest

At the Micronutrient Forum held in Cancun, Mexico, from October 24–28, 2016, *Sight and Life* used the elevator pitch contest format to stimulate fresh thinking about micronutrient innovation and entrepreneurship among students.

An elevator pitch is a critical part of the entrepreneurial process. The term describes an imagined scenario in which an entrepreneur accidentally meets a potential investor in an elevator and has convey his or her 'pitch' or business concept during the course of the brief ride they take together. Although drawn from the business world, this concept is increasingly relevant to young scientists, who during their careers will need to articulate their innovative scientific concepts in a manner that is concise and persuasive.

During the screening stage for the competition, graduate and post-doctoral students were invited to submit their ideas on the theme 'The Future of Micronutrient Innovation' across diverse categories in nutrition-related products, services and technologies. From the 90 submissions received from students in 18 countries, ten bold ideas were selected for presentation. The finalists were sponsored by *Sight and Life* and the Tata Trusts, who mentored them as they prepared to present their ideas to a panel of experts, in front of an audience of conference participants. The three winners – Muzi Na, a post-doctoral student; Nicholas Myers, a PhD student; and Bella Girovich, a master's student – put across their innovative concepts in true elevator pitch style at the Gala Dinner, taking just 90 seconds each.

Jury and participants at the Elevator Pitch Contest in Cancun, Mexico.

Back row, left to right: Kalpana Beesabathuni, Lead – Technology & Entrepreneurship, *Sight and Life* Foundation; Bella Girovich, Team Measure Mats, Emory University; Anna Pichler, Team Happy Water, University of San Francisco; Philip James, Team Next Generation Supplement Design, London School of Hygiene & Tropical Medicine; Shantanu Pathak, Team CareNx Innovations, Indian Institute of Technology Bombay; Nicholas Myers, Team Paper Analytical Devices, University of Notre Dame; Sabri Bromage, Team Leveraging Academic Networks for Dietary Surveys, Harvard University; Anne Williams, Team Jeevan Churri, Emory University.
Front row, left to right: Parul Christian, Senior Program Officer, Bill & Melinda Gates Foundation; Katharine Kreis, VP of International Development, PATH; Martin Short, CEO, The Power of Nutrition; Rajan Sankar, Director of Nutrition, Tata Trusts; Klaus Kraemer, Managing Director, *Sight and Life* Foundation; Jessica Ayensu, Team Nut-dieters, Kwame Nkrumah University of Science and Technology; Lini Sholihah, Team Managing Microhpon, Wageningen Research Foundation; Muzi Na, Team Empower Grandparents, University of California Davis; Siran He, Leila Larson, Elizabeth Rhodes, Team Jeevan Churri, Emory University.
Jury member (not in the picture): Rickey Yada, Dean of Land and Food Systems, The University of British Columbia.

Ten bold and creative ideas on the future of micronutrient innovation

Team name	Description of concept
Nut-dieters	Healthy snacks for adolescents in Ghana using insect protein
Microhpon	Household aquaponics for food and nutrition security in Indonesia
Empower Grandparents	Empowering grandparents in rural China, giving smart messages through mobile phones
Jeevan Churri	Bangles that can combat anemia and malaria as a wedding gift for Indian brides
Measure Mats	Rapid measurement of infant weight, length & body position
Happy Water	Bringing clean and nutritious water to people, one cup at a time
Next Generation Supplement	Targeting infant epigenetics using a novel micronutrient supplement
CareNx Innovations	Rapid point-of-care screening of micronutrient deficiencies at less than 10% the cost of traditional screening
Paper Analytical Devices	A low-cost, rapid lab-on-paper to measure iodine levels in salt and urine
Leveraging Academic Networks for Dietary Surveys	An effective, student-centered network for dietary surveys in Mongolia

FOOD for Thought

Rethinking Public Health in an Age of Pandemics

Sonia Shah
Science journalist and prizewinning author

Over the past 50 years, over 300 new infectious pathogens have either newly emerged or else re-emerged into new territory where they have never been seen before, from Ebola in West Africa and Zika in the Americas to new kinds of avian influenza and super-drug-resistant bacteria. Such pathogens often affect women disproportionately, thanks to patriarchal cultural norms, biological differences, and social inequities that heighten women's risk of exposure and of suffering more from severe diseases, compared to men. Experts are bracing themselves for a catastrophic pandemic – one that would make one billion people sick, kill 165 million, and cost the global economy trillions of dollars. The conventional wisdom is that this rising threat is primarily a biomedical problem, to be solved by scientists and clinicians. Because of the pathways that new pathogens are exploiting today, however, biomedical defenses are unlikely to be sufficient. Society-wide, multi-sectoral responses will be required.

By definition, there are no proven effective drugs and vaccines to treat and prevent never-before-seen contagions. And as critical as it is that we continue to develop new drugs and vaccines, relying on them to protect populations from novel pathogens creates an inevitable mismatch. Developing new drugs and vaccines is a linear process that takes years; meanwhile, pathogens newly introduced into susceptible populations explode exponentially. By the time a proven effective Ebola vaccine becomes available, for example, the still-lingering epidemic in West Africa will have long collapsed. Ebola will have burned through entire populations, leaving behind only the dead and the immune. The same is true of a Zika vaccine, which may take between three and 10 years to get to market – long after Zika washes over susceptible populations in the Americas and elsewhere, leaving a generation of disabled children in its wake.

But we don't have to rely solely on biomedical methods to contain new pathogens, resigning ourselves to rapidly spreading outbreaks of untreatable disease. Pathogens are microscopic and have no means of independent locomotion: it is human activity that gives them wings. If we muster the political will, the impact of those activities on public health can be both detectable and subject to our intervention.

> "It is human activity that gives pathogens wings"

Origins of new pathogens

Around 60 percent of the new pathogens that plague us today originate in the bodies of animals. They cross over into our bodies when the environmental disruption of our cities and industrial activities destroys wildlife habitat, pushing wild species into novel, intimate contact with human populations. Deforestation, for example, eradicates bat habitats, forcing bats to roost in people's farms and gardens instead of distant forests. As humans and bats draw closer together, opportunities for the microbes that live in their bodies to jump into ours grow. Epidemics of bat-derived Ebola, Marburg, and Nipah virus are one result.

Once emerged, these new pathogens have a wealth of opportunities to exploit in the global economy. The accelerating process of urbanization is one. By the year 2030, the majority of the human population will live in cities. But the teeming cities of tomorrow will not be orderly, sanitary metropolises like Washington DC and Los Angeles. They will be more like Freetown and Monrovia in West Africa, where people crowd into *ad hoc* developments with minimal infrastructure. About two billion of us will live in slums.

The influence of urbanization

Ebola and Zika are just two of the recent beneficiaries of this ongoing process of urbanization. One important reason why the 2014 Ebola epidemic was bigger than all previous Ebola out-

"Zika and Ebola affect women disproportionately"

Sonia Shah

breaks combined is that within weeks of infecting its first victim, the virus had reached three capital cities with a combined population of nearly three million. In no previous outbreak had Ebola reached any place with more than a few hundred thousand inhabitants. Zika similarly exploited modern urban growth. We have known about Zika since the mid-20th century. But until it leapt out of equatorial Africa and Asia, the virus caused few human infections – in part, because it was carried by a forest mosquito that mostly bit forest animals, not humans. It was only when Zika reached the tropical Americas – with their dramatically expanded urban areas and urban mosquitoes which exclusively bite humans – that it was able to explode.

Both Zika and Ebola are pathogens that affect women disproportionately. In West Africa, women who served as caretakers faced heightened risks of exposure to the virus, which is acquired through contact with the bodies of sick patients. Zika infection similarly exacts its heaviest toll on pregnant women and their unborn children.

"Zika and Ebola affect women disproportionately"

The influence of domestic animals

It is not just human crowds that today's pathogens can feast upon. We have also provided them with crowds of domesticated animals. We have more animals under domestication today than in the last 10,000 years of domestication until 1960 combined. A growing proportion of those animals live in the animal equivalent of slums: factory farms, in which thousands of individuals are crammed together, breathing each other's exhalations and bathed in each other's waste. Pathogens like avian influenza have exploited such animal slums. In south China, demand for cheap chicken has led to the growth of industrial farming of poultry along prime migratory routes for wild waterfowl, which are reservoirs of avian influenza viruses. Influenza-carrying waterfowl passing overhead spread influenza viruses into the crowded chicken farms below, allowing the viruses to amplify, mutate, and become more virulent. Highly virulent strains of avian influenza have been emerging with increasing frequency as a result. One such strain, ferried into the US Midwest in 2014, caused the biggest epidemic of animal disease in US history. Other strains, such as H5N1, can infect humans as well as birds.[1]

Crowding in slums and on factory farms creates additional transmission opportunities for pathogens by precipitating sanitary crises. Over two billion people around the world have no access to modern sanitation. They have long been preyed upon by pathogens that spread through the oral-fecal route. Now, in addition to the global crisis in human waste management, we are in thrall to a new crisis caused by the six billion tons of excreta produced by livestock every year. These mountains of excreta contain far more waste than can be absorbed by farmlands, so farmers simply collect it in giant unlined cesspools such as so-called "manure lagoons." When it rains, their contents spill out in to the environment, contaminating people's food and water. Because the waste of one-half of the cattle on American feedlots contains Shiga-toxin-producing *E. coli*, and cattle waste so frequently contaminates our food and water, some 70,000 Americans are infected with that pathogen every year.

The vulnerability of marginalized communities

In both poor and prosperous countries, it is often marginalized communities that are most at risk of newly marauding pathogens. Housing crises, for example, both impoverish neighborhoods and create conditions ripe for outbreaks. Neglected minority communities along the US Gulf Coast, for example, suffer repeated outbreaks of mosquito-borne disease, thanks to mosquitoes breeding in the overgrown lots of derelict homes and stagnant water collecting in piles of uncollected trash. The 2008 foreclosure crisis in Florida, which led to scores of abandoned homes where mosquitoes bred, precipitated the 2009 outbreak of dengue there. Suggestively, in the Miami neighborhood first colonized by Zika this summer, vacancy rates run five times higher than the county average.[2] In the city of Baltimore, near where this writer lives, Aedes mosquitoes are three times more abundant in poor neighborhoods compared to wealthy ones, researchers recently found, leaving impoverished, mostly minority communities especially vulnerable to Zika, West Nile virus and other pathogens.[3]

"We need to expand our concept of public health far beyond biomedicine"

The need for an expanded response to pathogens

With the US government seemingly unable to muster sufficient funds to finance its health agencies to counter Zika, calling for an expanded response to prevent contagions might seem foolhardy. But that is exactly what we need. Biomedical strategies alone take too long to contain outbreaks caused by novel pathogens and are not equipped to counter the complex social, political, and economic factors that drive them. To prevent the next pandemic, we will need to do things like restore wild habitats and protect the most vulnerable among us, from factory farmed animals to slum dwellers. The first step will be to expand our con-

cept of public health far beyond biomedicine, to include wildlife biologists, veterinarians, farmers, social scientists, engineers, anthropologists, politicians – and everyone in between as well.

This essay is adapted from *Pandemic: Tracking Contagions from Cholera to Ebola and Beyond* (New York: Sarah Crichton Books/ Farrar, Straus & Giroux, 2016) (Ed.).

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science Research-based evidence

Participatory Formative Research in Action

Community-led development of a local micronutrient powder brand in northern Nigeria

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Key messages

- Chronic malnutrition and anemia have been enduring problems in Nigeria requiring urgent attention and evidence-based interventions.
- Before introducing a Micronutrient Powder (MNP) linked with infant and young child feeding in northern Nigeria, formative research was conducted to develop a behavior change communication (BCC) strategy and to support the development of a suitable local brand that would be acceptable to community members.
- On the basis of this formative process, a national plan for MNP supplementation is being developed that aims to reach at least 11.3 million children aged 6–23 months annually by 2019.
- The information generated from this participatory research process has already guided the MNP distribution as part of the emergency nutrition response in three north-eastern states affected by the Boko Haram insurgency, which has caused the internal displacement of 2.3 million people.

Anemia in Nigeria

Chronic malnutrition is an enduring problem in Nigeria, with 32% of children under 5 years (U5) suffering from stunting,[1] which translates as over 12 million children. The situation is worse in northern than southern Nigeria, with children 0–5 years old living in the north-east four times more likely to suffer from stunting than those living in the south-east. Micronutrient

deficiencies are pernicious, not only having an acute impact at an individual level, but also stalling social progress and undermining national development.[2,3]

Anemia is problematic for young children in this setting. Eight out of 10 children U5 are reported to suffer from anemia,[4] with an estimated US$1.5 billion in gross domestic product (GDP) lost per annum due to micronutrient deficiencies.[5] One primary reason is that in Nigeria, most common complementary foods have iron levels below the minimum requirements for young children.[6]

> "Micronutrient deficiencies are pernicious, not only having an acute impact at an individual level, but also stalling social progress and undermining national development"

With 70% of the population living below the poverty line, it is unlikely that local diets, which include only small quantities of animal-source foods, can be diversified sufficiently to provide the requisite micronutrients for young children in this setting.[8] Micronutrient powder (MNP) is a novel intervention, providing a cost-effective way to deliver added vitamins and minerals to the food of young children. Informed by the empirical evidence indicating that MNP reduces anemia by 31% and iron deficiency by 51% in infants and young children aged 6–23 months,[9] the World Health Organization (WHO) recommends MNP as an intervention strategy in populations where the prevalence of anemia is 20.0% or higher.[10] The Nigerian National Guidelines on Micronutrient Deficiency Control have been updated by the Nigerian Federal Ministry of Health (FMoH) to include the use of MNP for home fortification, and to be linked with Infant & Young Child Feeding (IYCF) promotion.[4]

Before introducing an MNP linked with infant and young child feeding into the northern Nigerian context, formative research was conducted in order to develop a culturally appropriate behavior change communication (BCC) strategy. One specific aim of this research included the development of a locally branded MNP with packaging, logo, and a name specifically tailored to this population and cultural context. Achieving this aim was an important precondition for increasing the likelihood of community acceptance toward the product. This article provides an overview of the participatory research approach used in this formative work to create the local MNP brand.

FIGURE 1: Sample MNP sachet used during Phase 1 interviewing in order to solicit feedback

Methodological overview

The local MNP brand development was part of a larger formative research effort to inform the design of numerous program-related aspects of an integrated nutrition program, which broadly aims to improve infant and young child nutrition by introducing MNP as just one of several different intervention strategies. The participatory formative phase of operational research was multi-phased and iterative in nature, drawing on different methods and tools.

Information was collected using participatory methods that engaged diverse segments of the community to comprehensively inform the development of the tailored MNP brand. This work was undertaken in Kebbi and Adamawa states of northern Nigeria between January and May 2015 across five study phases. The following describes in detail the methodology used for each of the phases, as well as the key findings.

Phase 1: Exploring the local context and soliciting individual feedback

Open-ended, in-depth interviews

In-depth interviews were conducted with caregivers of children aged 6–23 months (n = 36) and community leaders (n = 18). The interviews aimed to understand larger sociocultural considerations for IYCF and MNP programming, during which a sample MNP sachet was also shown to participants (**Figure 1**). Interviewers probed for feedback on the generic MNP packaging, specifically in relation to the appropriateness of its size, color scheme, name, language, and logo. Data were collected in one of two local languages by bilingual (Hausa/Chamba and English) data collectors using digital recorders. Data were translated and transcribed concurrent to the data collection process. Using Dedoose qualitative software,[12] data were coded and analyzed, drawing on aspects of Grounded Theory.[13]

The interview findings showed that community members liked the green and white colors of the sample sachet. Many participants thought the colors represented "food" or the "colors of Nigeria," both which were positive perceptions.

> "Many participants thought the green and white of the sachet represented 'food' or the 'colors of Nigeria'"

Also common was the perception that the sample sachet was too small. "The color and the size are okay, but the packaging is very small, although I don't know how effectively it will work," said a female caregiver in Adamawa. Developing BCC messaging that directly addressed the small sachet size was one example of how this finding was then incorporated into actual programming.

Phase 2: Generating brand-related inputs through a participatory process

Community workshops with diverse community members

We used the findings from Phase 1 to develop three new sample MNP sachets (**Figures 2a–2c**). They were introduced into participatory community workshops (n = 23) in each state (**Figure 3**), serving as a platform for community members to brainstorm and vote for their favorite MNP characteristics, in terms of preferred names, slogans, color schemes and logos. With the help of health workers and village headmen, participants were purposively selected to include both men and women with young children. In Adamawa, men and women participated together, whereas in Kebbi, workshops were gender-specific due to traditional cultural rules. The 23 workshops consisted of 12–20 people each. Community leaders were excluded from participation in order to enable participants to freely express their ideas. For analysis, the numerical data were aggregated, compiled, and tallied by hand. Overall, the green/white color scheme was preferred across all workshops, with the community explaining that green and white are the basic colors of the Nigerian flag, with green representing "life," "vegetation," and "healthy feeding," while white means "purity," signifying that the powder represents "cleanliness."

Taimakon Yara ("children's helper") was the most popular MNP name generated by community members during brainstorming and voting. In Hausa, the name is concise, simple, and easy to understand. Another popular choice was Garin Tammowa ("malnutrition powder"). Tammowa is the local term for malnutrition, and so "everyone will comprehend the name and its purpose," according to participants. Two other popular names derived from the workshops included Rigakafin Tammowa ("immunization against malnutrition") and Garkuwan Jiki ("immunity booster").

FIGURE 2:
a. Mother feeding baby: sample sachet design #1
b. Mother feeding baby: sample sachet design #3
c. Baby eating alone: sample sachet design #2

The slogan Lafiyar uwar jiki ("health is wealth") was suggested across all the workshops. This phrase is a common Hausa phrase in northern Nigeria, so upon hearing it in relation to MNP, community members explained that all people would know the product is very important for children. Sinadarin mai inganci ("important food for children"), Yara manyan gobe ("children, the leaders of tomorrow") and Hodan garkuwan jiki ("immunity boosting powder") were also top slogan options.

Workshop data indicated that an image of a mother carrying a child should clearly show the child smiling because such a positive image would encourage caregivers to give their children the MNP regularly by evoking happiness. The packaging with the baby on its own (Figure 2c) was judged to be more descriptive and attractive than the other package designs. Community members explained that when a mother sees the picture of that beautiful baby, "she would like her child to look as healthy as the one in the picture."

The mother/baby white packet was the most favored because the community sees the white background color as very attractive and the picture shows the mother feeding the baby, emphasizing the link with IYCF. This mother/baby white packet image (Figure 2a) also shows "the bond that exists between mother and child," and the white background represents a bright future for the children. There was the suggestion that the outline of a map of Nigeria could be included in the logo design.

"The mother/baby white packet was the most favored because it emphasizes the link with IYCF"

Phase 3: Quantitatively confirming Phase 2 findings

Using a questionnaire to narrow down workshop findings

After the data of the Phase 2 workshops were analyzed, the top-voted names, slogans and logos across the two states were compiled into a questionnaire with a series of close-ended, multiple-choice questions for confirmation of findings. Eighty-three participants were then sampled for voting.

Taimakon Yara ("children's helper") was the community's top choice of name because if a caregiver does not take care of his or her child, then the child may not grow to be healthy and he/she will be ill all the time, according to participants. When this issue was further discussed during stakeholder engagement, it was pointed out that the term "helper" was non-specific, and therefore "children's vitamin" was proposed instead.

Lafiyar uwar jiki ("health is wealth") was another very popular slogan voted on by community members. As one person explained, "Everybody wants to be healthy because illnesses could put them on hold. Hearing 'health is wealth,' we know it is of great importance, and also children will be healthier and mothers happy." Further discussions revealed that this slogan was commonly used in rallies, however. The second most popular choice was Yara manyan gobe ("children, the leaders of tomorrow").

FIGURE 3: Community workshop during formative research in Adamawa State

The "mother feeding baby" visual was the preferred image option among participants to be placed on the MNP package.

Phase 4: Translating findings into intervention materials

Working with an artist and graphic designer on packaging development

Using the results of Phase 3, a creative brief – which is a template that an artist or graphic designer can use to develop a product – was developed for the MNP sachet design. This brief was developed from a synthesis of all data derived from the previous three steps and in consideration of global and federal guidelines, as well as in alignment with Home Fortification Technical Advisory Group (HF-TAG) recommendations.[14] Working together, an artist and a graphic designer translated the creative briefs into draft sachet designs. First, the sketch artist translated each creative brief into a series of sample sachet drawings, using his creativity to choose how best to represent the inputs generated from phases 1–3. Second, the graphic designer developed these sketches into computer graphics for printing, followed by iterative review and revision by the program staff.

Phase 5: Building consensus among key stakeholders

Engaging stakeholders to choose the final MNP packaging

After the near-final sample MNP sachet designs had been generated, a meeting was held with key stakeholders from government, UN bodies, local NGOs, and other donor organizations to build consensus around a final overall design. The meeting included a presentation of findings from the data collection. It also sought feedback from key stakeholders related to the process and outcomes of the participatory work. Specific attention was

FIGURE 4: Artwork for final local MNP package

given to choosing a finalized MNP design for introduction to the communities of northern Nigeria. An agreed-upon and approved MNP design was chosen for use during the pilot trial in Kebbi and Adamawa (Figure 4).

Conclusion: Using the formative work in the field

The local brand, named Sinadarin Bitamin Don Yara ("Children's Vitamin"), was developed on the basis of inputs resulting from this participatory and iterative research process. The findings of the formative research have also been used to design behavioral change communication strategy and program materials. A large-scale pilot to test the effectiveness of various delivery mechanisms will be carried out with the aim of identifying an effective distribution approach for high coverage and compliance while ensuring equitable reach. Based on this, a national strategy and scale-up plan will be developed with the objective of reaching at least 11.5 million children aged 6–23 months by 2019.

"A national plan is being developed that aims to reach at least 11.3 million children aged 6–23 months by 2019"

The research has already helped initiate emergency distribution of MNP in 18 internally displaced persons (IDP) camps and through 210 health facilities catering for over 2.3 million internally displaced people in three northeastern states affected by the Boko Haram Crisis.

The MNP and related messaging reached 38,000 children in the internally displaced persons (IDP) camps of those states. Currently, an expansion of the program is underway to scale up this emergency response with MNP and to reach an additional 107,000 children aged 6–23 months.

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Impact of Small-Quantity Lipid-Based Nutrient Supplements on Iodine Status

A cluster-randomized trial in young Burkinabe children

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Strategies to prevent iodine deficiency

Iodine is essential for human health, and particularly for infant and young child development, because of its key role as a structural element of thyroid hormones. Salt iodization is the most cost-effective strategy to prevent iodine deficiency, and its coverage has increased substantially in recent decades.[1] However, in countries with inadequate or unstable coverage of universal salt iodization, other supplementary iodine interventions should be considered for young children and pregnant women while efforts are made to improve the coverage of the salt iodization program.[2] These alternative intervention strategies can include iodine-fortified complementary foods or point-of-use fortificants, such as micronutrient powders (MNP) and small-quantity lipid-based nutrient supplements (SQ-LNS).

The present article summarizes a study published in the British Journal of Nutrition, which aimed to assess the impact of providing SQ-LNS on the iodine status of young Burkinabe children.[3] In Burkina Faso, salt iodization has been mandatory since 2003. The regulations require an iodine content of 50–80 ppm at time of importation and >30 ppm at retail distribution sites.[4] Thus, children in the study were also potentially exposed to iodized salt. At the time of the study, the latest national assessment dated from 2003 indicated that only 34% of households consumed iodized salt with >15 ppm iodine.

> "In countries with inadequate salt iodization, other iodine interventions should be considered"

Methods

This study was an add-on study to the iLiNS-ZINC trial, which was a partially masked, placebo-controlled, cluster-randomized intervention study conducted in 34 communities of the Dandé Health District in southwestern Burkina Faso.[5] Based on selected indicators, 25 communities were assigned to participate in the intervention cohort (IC) and 9 communities were assigned to the non-intervention cohort (NIC). Within the IC, 9-month-old children meeting the inclusion criteria received 20 g SQ-LNS daily containing different amounts of zinc from 9 to 18 months of age.[3] Two of the four intervention groups participated in the iodine assessment: **1)** SQ-LNS without zinc (LNS-ZnO) and **2)** SQ-LNS with 10 mg zinc (LNS-Zn10). Children in all of the intervention groups also received free treatment for diarrhea, malar-

A study participant with her mother receiving a weekly ration of SQ-LNS.

ia and fever, as described in more detail elsewhere.[3] Children in the NIC did not receive SQ-LNS, morbidity surveillance, or any illness treatment during the study period.

At enrollment, children were examined for eligibility to participate in the iLiNS-ZINC trial.[5] In a randomly selected subgroup of eligible children, a venous blood sample and a spot urine sample were collected at baseline and at the end of the study. Children who successfully provided a blood or urine sample at both 9 and 18 months of age were included in the present iodine analysis. Whole blood was preserved on dried blood spots, and plasma was aliquoted. Children's iodine status was assessed based on: urinary iodine (UI), whole blood thyroid-stimulating hormone (TSH) and total thyroxin (T_4), and plasma thyroglobulin (Tg) concentrations. Inadequate iodine status was defined as: UI < 100 µg/L.[6] Normal reference ranges for TSH and T_4 were 0.1–3.7 mU/L and 65–165 nmol/L, respectively. A recommended normal range for Tg assessed in dried blood spots is available only for school-age children (4–40 µg/L), but not for young children.[7] Salt samples (n=106) were collected in the households of randomly selected study participants for assessment of iodine content by iodometric titration.

Results and conclusions

A total of 3,220 children were enrolled in the iLiNS-ZINC trial, and a subset of 284 children provided blood and/or urine samples for the iodine assessment. At enrollment, children were 9.5 ± 0.3 months of age, and all children were still breastfed. Breastfeeding continued to be very common; at 18 months of age, 97% of participating children were still breastfed. In contrast, complementary feeding practices were suboptimal. At nine months of age, only 24% of children had consumed the minimum recommended number of meals during the previous 24 hours, and only 15% met the minimum food group diversity recommended by the World Health Organization.[8] Although there was some improvement by 18 months of age, complementary feeding practices remained suboptimal, with only 60% of children consuming the recommended minimum number of meals, and 27% meeting the minimum food group diversity.

The household salt samples (n=106) had a mean iodine content of 37 ppm, ranging from 5–86 ppm. Thirty-seven percent of the samples had an iodine content < 30 ppm, below the minimum level required at the retail level in Burkina Faso. Thus, the majority of households (63%) had adequately iodized salt available.

The iodine status results did not significantly differ between the intervention groups (LNS-ZnO vs. LNS-Zn10), but there were some significant differences between children in the IC versus NIC. Tg concentrations were significantly higher in the NIC at baseline compared to IC (geometric mean (95% confidence interval [CI]): 33.2 (28.8, 37.9) µg/L in NIC versus 27.5 (25.2, 29.9) µg/L in IC (p=0.005)). However, Tg concentrations were no longer significantly different between the cohorts after nine months of study intervention. Because there are no reference values for plasma Tg concentrations in young infants, differences between the cohorts was explored based on the upper and lower 2.5th percentile at 18 months, adjusted for the baseline value. Significantly more children in the NIC (n=5; 6%) had low adjusted Tg (<10.6 µg/L) compared to children in IC (n=1; 0.6%; p=0.006).

Baseline UI concentration did not differ significantly; the geometric mean (95% CI) was 220 (192, 257) µg/L in children in IC and 276 (192, 397) µg/L in children in NIC. After nine months of intervention, the UI concentration was also not significantly different, and only 4% of children in the IC and 5% in the NIC had low UI concentration (p=0.906).

There was no significant difference in TSH or T_4 concentrations between the cohorts at baseline and at endline. Only one child had elevated TSH concentration at baseline, and all children had normal TSH concentrations at the end of the study. The prevalence of low T_4 concentration was low at 9 and 18 months of age in both cohorts. However, there was a marginally significant difference in hypothyroxinemia at 18 months of age (p=0.052). Namely, fewer children (n=2; 1.6%) in the IC had abnormally low T_4 concentrations at the end of the study than in the NIC (n=5; 8.9%).

In summary, although there were some small differences in low T_4 and Tg concentrations between the IC and NIC cohorts after nine months of intervention, the vast majority of all children participating in the study had adequate iodine status and normal thyroid hormone concentrations. These results suggest that these young study participants consumed sufficient amounts of iodine either through breast milk or from iodized salt in family food.

"Study participants consumed sufficient iodine either through breast milk or from iodized salt"

The World Health Organization, the International Council for the Control of Iodine Deficiency Disorders and UNICEF recommend an intake of 90 µg iodine/day for children < 60 months of age.[9] Dietary intake was not quantitatively assessed in the study. However, considering the high frequency of continued breastfeeding reported in the study participants, children could have consumed 80–90 µg iodine per day through breast milk alone, and most were also consuming at least some complementary foods that contained iodized salt.[3] Thus, a provision of 90 µg of iodine in SQ-LNS may have been too high, and could have put some children at risk of usual intakes above the Tolerable Upper Intake Level (UL). The UL is the highest average usual iodine intake that is likely to not pose adverse health risks, and is set at 200 µg iodine per day for children 1–3 years of age.[10,11] Because there is not yet consensus on the appropriate cut-off to indicate elevated UI among young children, we are not able to judge the risk associated with the observed UI levels. However, considering that almost all children in the IC had normal thyroid hormone concentrations, the dietary iodine intakes among IC children did not seem to pose adverse health risks.

In conclusion, a reduction of SQ-LNS iodine content should be considered in settings with similarly successful salt iodization programs and high rates of continued breastfeeding. Assessment of the iodine status of the target population should be considered prior to distributing home fortification products such as SQ-LNS and MNP. Additional research on the impact of SQ-LNS on children's iodine status is needed in countries with lower or unstable coverage of the salt iodization program.

"A reduction in SQ-LNS iodine content should be considered in settings with successful salt iodization programs and high breastfeeding rates"

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James Allen Olson Memorial Lecture

Vitamin A, carotenoids, and inflammation in infancy

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Key messages

- Vitamin A and specific carotenoids are important immunomodulatory and anti-inflammatory dietary components.
- Adequate intake of vitamin A, and possibly also of carotenoids, is important for establishing normal pregnancy and resistance to infections in early life.
- Specific carotenoids promote polarization of T effector cells and macrophages toward anti-inflammatory phenotypes.
- Xanthophyll carotenoids, including lutein and astaxanthin, suppress neuroinflammation.
- Lutein inhibits the neuroinflammatory response to hypoxic ischemic brain injury in a perinatal rat model.

Dietary vitamin A and infection in early life

Dietary carotenoids and retinoids play important roles in innate and acquired immunity and in the inflammatory response during pregnancy and development. In particular, vitamin A (VA) deficiency, which affects 190 million children worldwide, increases the likelihood of early childhood mortality due to common infections.[1,2] In VA-deficient or insufficient states, the increased susceptibility to immune-mediated and inflammatory disorders is related to impaired responses to infection, impaired epithelial barrier function,[3,4] and immunological defects. In particular, responses to mucosal pathogens are impaired when VA stores are low – in part because VA metabolites promote functional maturation of innate immune cells.[3,5,6] In VA-deficient animals, T-cell and occasionally B-cell populations are reduced, and myeloid lineage cells, especially granulocytes, tend to be increased. Infections decrease VA intake as a result of infection-induced anorexia, altered VA intestinal absorption,[7] and increased urinary excretion.[8] Effects of systemic inflammation on circulating carotenoid levels, mobilization, or bioavailability have been less studied. Certainly, some carotenoid effects on immunity and inflammation are mediated by provitamin A activity. In addition, immunomodulatory and anti-inflammatory effects of specific xanthophyll carotenoids (including lutein, zeaxanthin, and astaxanthin) appear to be independent of actions on retinoid receptors (RARs, RXRs).

Carotenoids and inflammation in pregnancy and fetal development

The inflammatory response is tightly regulated during reproduction, embryonic and fetal development, and the postnatal transition into infancy. In humans, during implantation, uterine T helper (Th) cells are polarized to a predominant Th1 (pro-inflammatory) over Th2 (anti-inflammatory) cell effector profile and tissue pro-inflammatory cytokines (including IL-6, IL-15, IFN-γ, and TNF-α) promote placental trophoblast invasion into the maternal endometrium, myometrium, and uterine vasculature. This tissue invasion is more extensive than in other mammals, including closely related non-human primates. Placental trophoblast invasion into uterine tissue layers results in recruitment and activation of maternal immune cells. In contrast, after the uteroplacental bed is established during the first trimester, a normal pregnancy state is characterized by immune quiescence – namely, a Th2 cytokine profile and suppression of maternal immunological rejection of the "foreign" fetoplacental unit.[9] A pro-inflammatory, Th1 cytokine state is reactivated during parturition,[10] resulting in the positive feedback loop that ends with birth and placental expulsion.

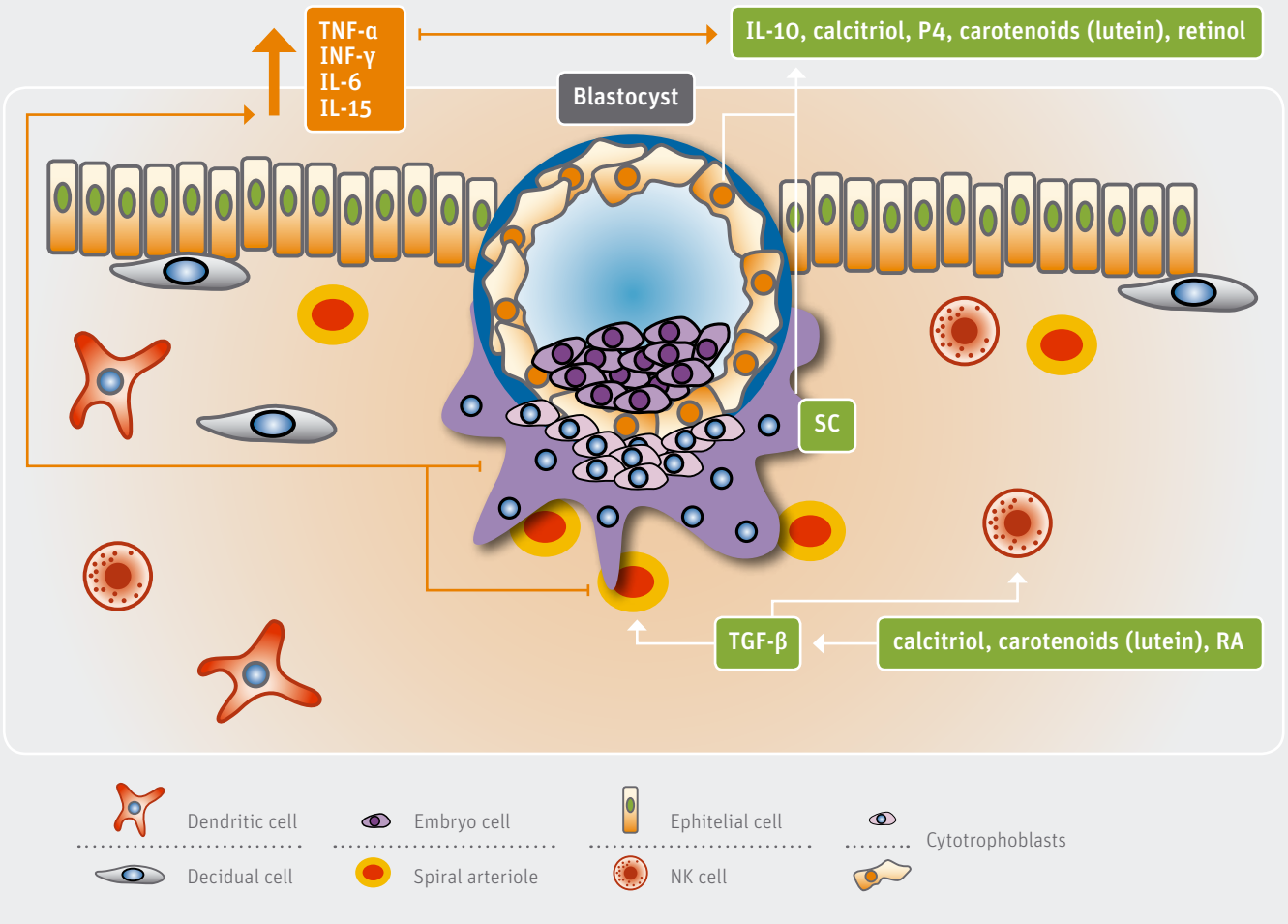
In preeclampsia, a major pro-inflammatory and pro-oxidant disorder of placentation and pregnancy, uteroplacental inflammation and pro-inflammatory Th1 cytokines persist into the second and third trimester. Retinol and certain carotenoids (e.g.,

lutein) may suppress this inflammation by antagonizing the pro-inflammatory cytokine response and by promoting TGF-β activity (Figure 1). TGF-β produced by macrophages interacts with natural killer (NK) cells, facilitating maternal tissue acceptance of trophoblasts while preventing them from killing fetal cells. In order to prevent excessive inflammation that could result in the rejection of the fetal allograft, several systemic factors including retinol and carotenoids, calcitriol, IL-10, progesterone (P4) produced by decidual cells, trophoblasts, and syncytiotrophoblasts act as anti-inflammatory factors modulating this immunosuppressive microenvironment. Retinoic acid (RA) and certain carotenoids are also known to induce TGF-β. It is intriguing that analyses of maternal carotenoid concentrations suggest inverse relationships between plasma lutein, α- and β-carotene, and lycopene with risk or severity of preeclampsia as well as another pro-inflammatory condition in pregnancy, diabetes mellitus.[11–14]

"Analyses of maternal carotenoid concentrations suggest inverse relationships between plasma lutein, α- and β-carotene, and lycopene"

Immune cell (lymphocyte) proliferative responses to mitogens are also retinoid-dependent.[15,16] In pregnant mice, supplementation with VA and β-carotene affects immune cell functions during ontogenesis.[17] In these experiments, the dams were provided with a control diet or different retinoid- and carotenoid-enriched (4,500 retinol equivalents/kg) diets beginning at conception. The VA and β-carotene supplementations variously in-

FIGURE 1: Model for specific retinoid and carotenoid action on cytokine profiles during implantation. At the fetal/ maternal interface during early pregnancy, a state of controlled inflammation promotes trophoblast invasion of the endometrium, myometrium and uterine spiral arteries. RA and certain carotenoids including lutein, α- and β-carotene, and lycopene may participate in regulating this process and subsequent onset of maternal/placental/fetal immune quiescence. Modified from[10]



creased lymphocyte numbers in early and mid-pregnancy and increased the T:B cell ratios.[17] In mice, maternal VA supplementation via intraperitoneal injections have increased serum IgM and Th2-specific IgG1 levels in the offspring.[18] Moreover during postnatal development VA regulates the Th1:Th2 switch and thereby modifies immune and inflammatory responses.[19,20]

VA, carotenoids, and inflammation in the newborn

Intermittent or sustained systemic inflammation is an important component of many diseases of newborns and infants, and importantly contributes to the pathogenesis of most disorders associated with prematurity, including chronic lung disease (also known as bronchopulmonary dysplasia [BPD]), brain damage, and neurodevelopmental disorders.[21,22] In a clinical trial among extremely low birth weight (< 1,000 g) preterm infants who have high risk for BPD, VA supplementation (5,000 IU retinyl palmitate, three times weekly for four weeks) significantly decreased the prevalence of BPD.[23] Regarding preventive and therapeutic strategies for hypoxic-ischemic brain injury in both preterm and term infants, interventions increasingly emphasize neurotoxic and neuroinflammatory cascades. A recent focus is to develop strategies for enhancing endogenous neuroprotective mechanisms. Lutein, which is selectively accumulated in retina and brain, has anti-inflammatory activity in retinal diseases and may be a promising neuroprotective agent throughout the lifespan.

> "Lutein has anti-inflammatory activity in retinal diseases and may be a promising neuroprotective agent throughout the lifespan"

Both RA[24] and lutein[25] suppress neuroinflammation mediated by astrocytes and microglia – two cell types important in acute brain injury accompanying preterm and term birth (Figure 2). In addition to lutein, several other xanthophylls, such as astaxanthin, similarly have anti-inflammatory neuroprotective effects. Known mechanisms of xanthophyll (lutein, astaxanthin) mediated neuroprotection include blocking the actions of: NF-κB signaling on microglial/astrocyte activation, neuronal inflammation, inflammatory cytokine/chemokine release, and neuronal cell death.[26]

Investigating carotenoid effects on developmental immunity in animal models has been challenging due to pronounced differences in carotenoid absorption, kinetics, and metabolism between primates (humans, macaques) and rodents. Nevertheless, we have shown as proof of principle in a perinatal rat model

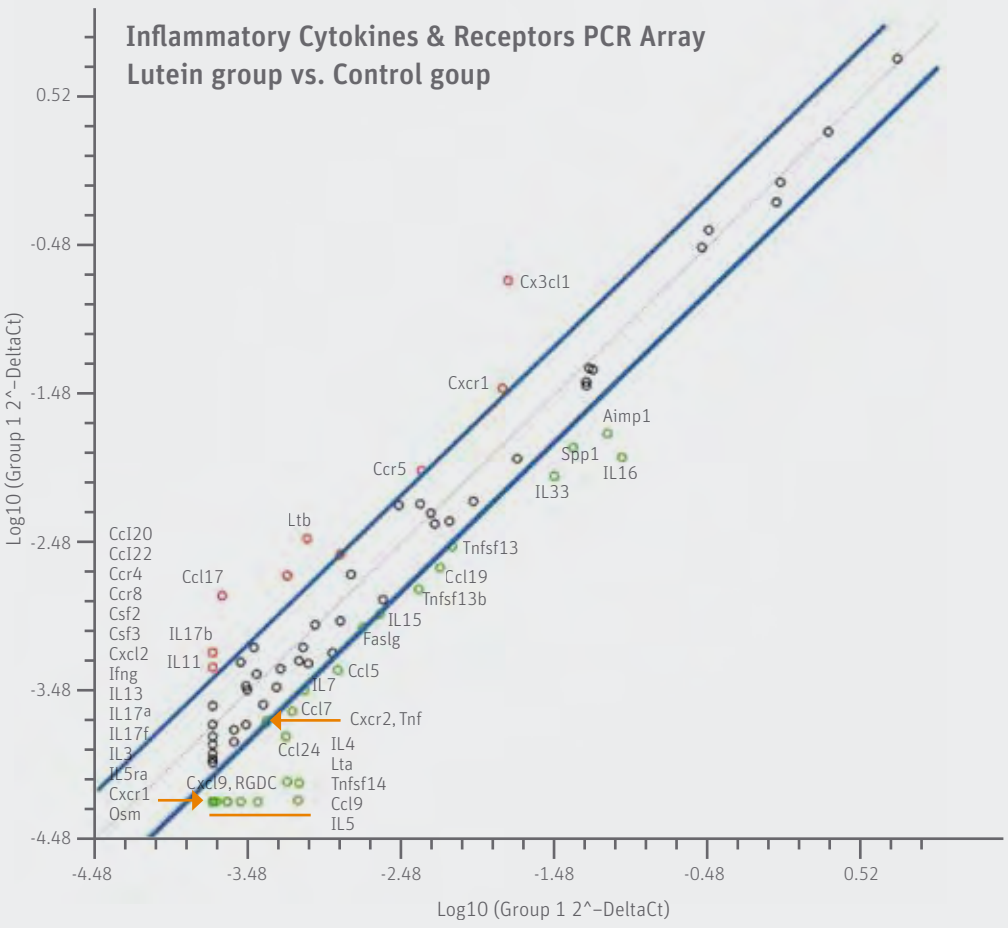
Lewis P Rubin takes the stand at the James Allen Olson Memorial Lecture

that lutein is transferred from dam to fetuses and via the milk to the pups and suppresses hypoxic ischemic neuroinflammation. In this hypoxic/ischemic (HI) brain injury model, anesthetized neonatal rat pups (day 7) undergo left carotid artery ligation (unilateral brain ischemia) followed by several hours' duration in ambient low-oxygen tension (hypoxia). Pups were sacrificed on day 10 and brain tissue analyzed by histology (hematoxylin/eosin and Nissl staining); immunohistochemistry for markers of hypoxic cell damage, apoptosis/necrosis, and neuroinflammation; gene expression profiling by RT-qPCR; protein expression and activation by western blot; and lutein accumulation by HPLC. Figure 2 illustrates the differences in inflammatory cytokine and receptor whole-brain gene expression between lutein pretreated (y-axis) and untreated (x-axis) animals. The blue lines represent greater than two-fold increased and decreased expression. Lutein upregulated several anti-inflammatory mediators including IL-11, IL-1R, CCR5, and CXCR1; lutein pretreatment decreased expression of multiple pro-inflammatory genes including TNF-α family members, interleukins, and Fas ligand.

Lutein: breast milk levels and dietary supplementation

The fetus acquires carotenoids via transplacental transfer from the mother. Hence, fetal and cord blood carotenoids levels are, in part, dependent on maternal dietary intake. In newborns and infants, breast milk is the intended complete diet. As in the case for transplacental carotenoid transfer, breast milk carotenoid levels also rely on maternal diet. Among the various carotenoids in human milk, lutein is usually predominant.[27] In term newborns, lutein supplementation suppresses measures of systemic oxidant stress.[28]

FIGURE 2: Gene expression profiling of neuroinflammatory cytokines and receptors in rat pup brain tissue after hypoxic ischemic injury, depicted by expression level and differential expression between lutein-pretreated (*y-axis*) and control (no lutein, *x-axis*). **Blue lines** represent > 2-fold differences between groups. **Red circles** indicate lutein-upregulated genes and **green circles** indicate lutein-downregulated genes. Experimental data (unpublished) from Rubin lab (TTUHSC El Paso: Sambalingam D, Gong X, Rubin LP).



> "Fetal and cord blood carotenoids levels are, in part, dependent on maternal dietary intake"

Retinopathy of prematurity (ROP), a neovascular retinopathy, appears to be a lutein-responsive disorder. ROP is the leading cause of acquired blindness in children in industrialized countries. It is characterized by systemic and localized neuroretinal inflammation.[29] In a clinical trial in preterm infants, lutein suppressed both systemic inflammation (measured by C-reactive protein, CRP) and retinopathy severity.[29] Of note, lutein supplementation (or repletion) has similar antioxidant and anti-inflammatory effects to those in ROP in adult diabetic neovascular retinopathies.[30] In experimental animal models, lutein and astaxanthin[31] suppress inflammation and improve retinal function in diabetic retinopathy. The specific effects of lutein compared to its geometric isomer zeaxanthin are currently being investigated. Unlike most foods, which contain more lutein than zeaxanthin, wolfberry (goji, *Lycium barbarum*) – an Asian fruit traditionally consumed to prevent eye diseases – is a particularly zeaxanthin-rich dietary source. In diabetic mice, wolfberry ameliorates retinopathy, suppresses inflammation, and provides retinal protection – effects that are mimicked by zeaxanthin or lutein *in vitro*.[32]

Xanthophylls as anti-inflammatory agents

Xanthophyll carotenoids exert anti-inflammatory and immunomodulatory activities by inhibiting oxidative stress responses, inflammatory mediators, and lipid peroxidation; inhibiting pro-inflammatory NF-κB and MAPK signaling; blocking advanced

glycation end-product formation; suppressing scavenger receptor expression; suppressing lymphocyte and macrophage activation;[33] and modulating T cell polarization, e.g., increasing T regulatory (Treg) and decreasing Th17 cell expansion.[5] Recent investigations point to important roles in T cell polarization for several other, presumably non-provitamin A xanthophylls. One example is fucoxanthin, found in brown algae. Fucoxanthin-mediated Treg induction and Th17 inhibition lead to suppressed inflammation and autoimmunity.[34] Recent data indicate xanthophylls are also regulators of macrophage-dependent immune responses. The dietary xanthophyll astaxanthin, which is found in pink-orange fish and crustaceans, drives IL-10 production in (anti-inflammatory) M2 macrophages. Similarly, lutein and astaxanthin both support monocyte polarization away from the 'killer' M1 macrophage phenotype to M2 macrophages (Rubin LP, unpublished data).

"Retinoids and carotenoids are important mediators of the immune system and inflammatory balance during development and early life"

Conclusions

Retinoids and carotenoids are important mediators of the immune system and inflammatory balance during development and early life. The effects of vitamin A on embryonic and fetal development, immunity, epithelial integrity, and protection from infection are well recognized. More recent evidence also highlights retinoid (e.g., retinoic acid, retinaldehyde, pro-vitamin A apocarotenoids) effects on immune cell differentiation and polarization. Carotenoids, particularly xanthophylls, also appear to play important and, perhaps, critical roles as anti-inflammatory and immunoregulatory regulators. Lutein, in particular, in experimental animal studies and clinical studies in infants, suppresses systemic inflammation and mitigates the inflammatory response to retina and brain injury. Finally, recent findings point to a wider function of various human dietary xanthophylls in differentiation and polarization of immune cells including effector T cells, macrophages, and dendritic cells.

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Special Feature

Improving the Nutritional Status of Women of Reproductive Age

The use of fortified food products in Ghana

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Key messages

- In Ghana, more than half of women of reproductive age are anemic, and estimates suggest that one in five is vitamin A deficient. Ghanaian women are therefore at risk of micronutrient deficiencies.
- Affordable Nutritious Foods for Women (ANF4W) is developing a market-based solution to micronutrient malnutrition.
- This article reports on the ANF4W project in Ghana, which aims to:
  - Develop and introduce fortified food products that are sold on the Ghanaian market
  - Promote appropriate consumption of fortified foods in addition to other healthy food options by women of reproductive age.

The challenge

Around two billion people, almost one third of the global population, receive insufficient micronutrients from their daily diet. "Hidden Hunger" refers to the insufficient intake of vitamins and minerals (also known as micronutrients). Women of reproductive age especially, including adolescent girls, pregnant and breastfeeding women, are more vulnerable to micronutrient deficiency, as they have an increased requirement for micronutrients such as iron, vitamin A, folic acid, calcium, iodine and zinc. In cases of severe iron deficiency that leads to anemia, women are at increased risk of dying during childbirth. Children with micronutrient deficiencies experience poor cognitive development and reduced learning capacity. The deaths of women and the loss of cognitive development in children have a profound and lasting impact on human capital.

In Ghana, more than half of women (57%) of reproductive age are anemic, with the higher prevalence among adolescents of 15–19 years (63%), and pregnant women (70%). Furthermore, the WHO estimates that one in five women in Ghana is vitamin A deficient, and that only 50% of mothers in the postpartum period are reached with vitamin A supplementation. According to the MICS Survey in 2011, approximately 65% of Ghanaian households do not use adequately iodized salt in meal preparation. Taken together, these data suggest that Ghanaian women are at risk of poor micronutrient intakes.

Developing a comprehensive approach to food and nutrition security is therefore one of the key future global challenges, especially as an estimated nine billion people worldwide will have to be fed by 2050.

"The deaths of women and the loss of cognitive development in children have a profound and lasting impact on human capital"

ANF4W is supporting the development of new food products that are fortified with micronutrients tailored to meet the needs of women of childbearing age

The approach of ANF4W in Ghana

Affordable Nutritious Foods for Women (ANF4W) is a development partnership with the private sector that seeks to improve the micronutrient intakes of women of reproductive age, particularly during the critical period of pregnancy and lactation. ANF4W was launched in July 2013 in Bangladesh, Ghana, Kenya and Tanzania, receiving funding from the German Federal Ministry for Economic Cooperation and Development (BMZ) through the developpp.de program and from the Bill & Melinda Gates Foundation.

In Ghana, we have received additional funding through the Children's Investment Fund Foundation (CIFF). Our private-sector partners are *Sight and Life* on behalf of DSM, and Ajinomoto. We also work with the Association of Ghana Industries. Our local public-sector partners are the National Development Planning Commission, Ghana Health Service, Food and Drugs Authority, and Ghana Standards Authority.

ANF4W is developing a market-based solution to micronutrient malnutrition. At the beginning of the project, a set of five comprehensive assessments was undertaken to help understand the supply and demand factors that would influence product concepts and the selection of local food companies. Our assessments led us to select four product concepts: instant porridge, spicy shito sauce, soy beverage, and biscuits. We are working with four local food processors that either already have unfortified versions of their products on the market or else have the capacity to develop a new, fortified product line. ANF4W has supported their business case development, premix formulation, and the modifications to their production processes necessary to facilitate fortification.

> "ANF4W is developing a market-based solution to micronutrient malnutrition"

The new food products are fortified with micronutrients tailored to meet the needs of women of childbearing age. The micronutrient premix formula includes 18 vitamins and minerals, at varying levels. The food products themselves were selected because they contain sufficient amounts of protein, which is required especially by adolescents, pregnant, and breastfeeding women. We have also placed upper limits on trans-fat, salt, sugar and total calories, in accordance with international guidelines.

In order for the consumer to distinguish between a fortified and a non-fortified product, we have supported the development of a seal to certify that the products meet voluntary fortification standards and other nutrition criteria (protein, calories, trans-fat, sugar, salt). All of these criteria must be met for a product to bear the seal. All four products will display this seal on the front of the package, as a trusted symbol of fortified foods for women. Under the chair of the National Development and Planning Commission (NDPC), government authorities have agreed on the ownership and criteria for a quality seal that certifies the products as 'healthy' and 'fortified'.

> "A seal certifies that the products meet voluntary fortification standards and other nutrition criteria"

A *seal promotion campaign* is currently being prepared to encourage women to choose fortified products. This mass-media campaign draws on the ethnographic assessment conducted at the start of the project, where women expressed a tension between eating food tailored just for them and eating from the family pot. A *branded marketing campaign* is also being prepared with the aim of creating demand for the new products, with market launch planned for February 2017 in two regions in Ghana – Brong Ahafo and Northern Region.

Local food processor

ANF4W supports the following four local food processors to develop fortified food products for women:

Soy drink

Healthilife Beverages Ltd. is the most modern Tetra Pak manufacturing plant in sub-Saharan Africa, and also one of the largest, with state-of-the art machinery to guarantee food quality and safety. The company is based in Accra, where it manufactures and distributes its beverage products.

Milk shortcake biscuit

Mass Industries Ltd. produces a wide array of biscuits products to target the middle- and lower-income segments of the market. Thanks to its parent company 'Forewin Ghana Ltd.' (a well-known Ghanaian distribution company), Mass Industries has a wide distribution network throughout the country, as well as in other countries in the West African sub-region.

Shito sauce

Samba Foods Ltd. is a wholly Ghanaian-owned indigenous food processing and preservation business based in Tema, specializ-

A young mother with her baby: Women of reproductive age, especially pregnant and breastfeeding women, are highly vulnerable to micronutrient deficiency.

ing in the condiments and seasoning market. The company was the first to commercialize the production and distribution of the local traditional pepper sauce known as *shito*.

Instant porridge

Yedent Agro Group of Companies Ltd. is a food processing company located in Sunyani. Yedent's product portfolio seeks to offer solutions that address malnutrition. Yedent produces a range of cereal-based products for children and adults containing protein, amino acids, vitamins, and minerals. Yedent sells its products in markets in Ghana and Nigeria. This would be the first instant porridge available on the Ghanaian market.

> "My dream has always been to support the fight against micronutrient deficiencies in women and children in Ghana. This partnership is a chance for my business to make my dream come true."
>
> *Ms Leticia Osafo-Addo, CEO Samba Foods*

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Perspectives in Nutrition Science

The Micronutrient Composition of Human Milk

Current knowledge and information gaps

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There is no doubt that breast milk is the optimum food for the infant; evidence continues to accumulate about its protective and development-promoting properties, especially now that analytical techniques, such as mass spectrometry, are revealing human milk constituents that support healthy gut microbiota.[1] However, surprisingly little attention has been paid to the micronutrient content of breast milk, even though it is recommended that infants should depend on it as their sole source of micronutrients for six months, and as an important source for two years or beyond.[2]

There are several reasons for this lack of scrutiny: Lactating women often receive relatively little attention from the health care system, which focuses on pregnancy but shifts postpartum to the infant and not the mother; there is little interest in questioning whether human milk is the perfect food in all situations; poor growth or micronutrient status of infants during the first six months of life tends to be attributed to factors such as the premature introduction of other fluids or foods, infections, or *in utero* deprivation; and there is considerable uncertainty about the appropriate methods for breast milk collection, including timing during a feed, time postpartum, and circadian changes in composition. The human milk matrix also poses challenges for valid laboratory analyses.

Information on nutrient concentrations in human milk is useful for several purposes. One of the most important is to set recommended nutrient intakes for breastfeeding infants and young children. For those exclusively breastfeeding during the first six months postpartum, Adequate Intake (AI) recommendations by the Institute of Medicine, for example, are based on reported average or median concentrations of each micronutrient as reported in the literature, and an estimated milk consumption of 0.78 L/day.[3] During the second six months, the intake of milk is assumed to be 0.6 L/day, and most AIs are based on the average amount of each micronutrient consumed in milk plus the average amounts provided by complementary foods. The formulation of complementary foods is often based on the need to fill the gap between requirements and estimated intakes from breast milk while the child is still breastfeeding. The additional micronutrient requirements of lactating women are also based on the estimated amounts of each nutrient they secrete in milk.

> "Information on nutrient concentrations in human milk helps set recommended nutrient intakes for breastfeeding infants and young children, as well as lactating women"

It is important to know whether the amounts of micronutrients are inadequate in the milk of women with poor micronutrient status or low intake, and to what extent this can affect infant micronutrient status and development. Maternal requirements for most micronutrients are higher in lactation than they are during pregnancy. Some 10 years ago, we defined two groups of micronutrients in the context of lactation.[4] The concentrations of Group I nutrients in milk – and subsequently the status of the infant – are affected by maternal status or intake; maternal inadequacy of these nutrients could result in infant depletion, but maternal supplementation or food fortification could increase milk levels. Based on updated information and as shown in **Table 1**, Group I nutrients include thiamin, riboflavin, niacin;

TABLE 1: Micronutrient groups during lactation[a]

Group I	Group II
Thiamin (B_1), riboflavin (B_2),	Folate
pyridoxine (B_6), cobalamin (B_{12})	Vitamin E
Vitamins A, D and K	Calcium
Choline	Iron, copper, zinc
Iodine	
Selenium	

[a]Group I micronutrients share the following characteristics in lactation: Their concentration in breast milk is affected by maternal status and/or intake so that the infant can become depleted if the status of the mother is inadequate. Supplements or fortification are likely to increase the levels in milk. Group II micronutrients in milk are relatively unaffected by maternal status or intake, and will be unaffected by maternal supplementation or fortification.

Washing red blood cells as part of the Diet-Mother-Milk-Infant (DMMI) project in Guatemala

vitamins B_{12}, A, D, and K; choline, iodine and selenium. Group II micronutrients include folate, probably vitamin E, and calcium, iron, copper and zinc. Amounts of these nutrients in milk will be independent of maternal status or intake, and increasing the mother's intake is unlikely to affect milk concentrations.

Status of current information

Our laboratory recently conducted a systematic review of micronutrients in human milk,[5] which revealed that the available data are sparse and often inadequate. Values from the literature used to estimate the AIs for infants and recommended intakes for their mothers have some major limitations. They were typically based on small numbers of milk samples collected at various times during lactation and at different times during a feed. It was not always clear whether mothers were well nourished or supplemented during pregnancy and/or lactation, and some laboratory methods of milk analysis were invalid.

> "We need guidance on the collection and measurement of micronutrients in human milk in order to improve our data on its composition"

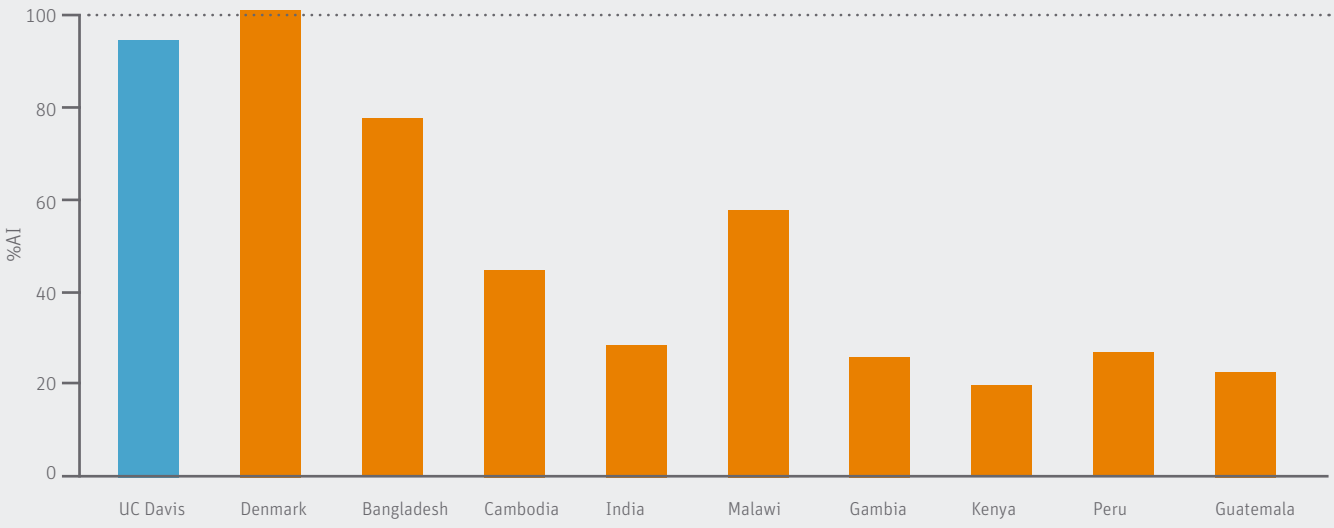
These factors typically contribute to the wide range in reported concentrations within and among studies. FAO/WHO used many of the same milk concentrations as the Institute of Medicine (e.g., for all B vitamins except niacin and folate, and for vitamins C and A) to set their Recommended Nutrient Intakes (RNI) for infants and lactating women, and the source of data for several others is unclear. A European report on infant nutrient intakes concluded that we need guidance on the collection and measurement of micronutrients in human milk in order to improve our data on its composition.

There are several likely explanations for this unsatisfactory situation. It has been very tedious and costly to analyze all the individual micronutrients in a milk sample, and this also deters investigators from conducting systematic studies of the effects of differences in sample collection methods (such as time within a feed vs. a complete breast emptying, time of day, acute effects of mothers taking a supplement, etc.) on the concentrations of all micronutrients in milk. There are large changes in micronutrient concentrations, especially from colostrum through the first 1–2 months postpartum. Not all milk analysis methods were valid. We have recently conducted a more systematic study of the effects of collection method, time of day, and acute supplementation on micronutrients in milk.[6]

As an example, our systematic review of vitamin B_{12} in breast milk found 26 relevant studies, but half were in low- or middle-income countries or in vitamin B_{12} deficient population groups.[5] Seven of the 26 studies used an invalid method of analysis, and samples were collected at very different stages of lactation. The review demonstrated substantial differences among studies in reported values, a fall in milk vitamin B_{12} from colostrum to ≈4 months postpartum, and the already established influence of maternal status on milk vitamin B_{12} concentrations.

Our own laboratory has used a recently validated method for vitamin B_{12} in milk[7] to show that concentrations in samples from India, The Gambia, Kenya, a remote region of Peru, and Guatemala are only 20–25% of the values estimated for setting the AIs (**Figure 1**). These were convenience samples, however, and

FIGURE 1: Concentrations of vitamin B_{12} in human milk samples from different countries[b]



[b] Samples are not necessarily representative of the overall population concentration in each country.

unlikely to be representative of the overall population in those countries. In Guatemalan infants aged seven months, vitamin B_{12} concentrations were lowest in those consuming breast milk and highest in those consuming some dried cow milk.[8] Some maternal and infant plasma vitamin B_{12} concentrations at 12 months postpartum were as low as those reported in clinical case studies of infant vitamin B_{12} deficiency.

Our review also indicated that low concentrations of retinol, iodine and several other B vitamins are found where mothers have poor status or low intakes of these nutrients. We recently published a mass spectrometry method for the simultaneous analysis of vitamers of thiamin, riboflavin, niacin, vitamin B_6 and pantothenic acid,[8] and compared concentrations with those used to set the AIs. While these data are provided with the caution that the samples may not be representative of the countries, at around 3–4 months postpartum we found concentrations of B vitamins to be much lower than values used to set the AIs, especially for riboflavin (10–25% of AI values in Bangladesh, Malawi, Peru, The Gambia, Philippines and Kenya), niacin (< 10% of AI values in most countries), vitamin B_6 (10–20% in The Gambia and Philippines) and thiamin (50–70% in India, Peru, The Gambia and Cambodia).

A milk sample is collected from a participant in the Diet-Mother-Milk-Infant (DMMI) project in Guatemala

The need for reference values

All we know at this time is that micronutrient concentrations in milk samples from poorer countries can be much lower than those used for setting the AIs for breastfeeding infants and lactating women by the Institute of Medicine and FAO/WHO. A big caveat, however, is that the quality and amount of data available for setting the AIs was poor, and that we don't really know how to define a concentration as 'low' or 'inadequate'. Samples obtained from women and/or infants identified with clinical or biochemical signs of deficiency are somewhat useful for this purpose[9] but suffer from many of the same usual limitations in data quality (invalid analytical methods, various collection protocols, etc.).

Moving forward, during the next few years we will be conducting a study to obtain reference values based on milk collected from well-nourished but unsupplemented women in four

Anthropometric indices are measured in one of the participating infants

countries, during the first nine months of lactation. The micronutrient status of mothers and infants will be assessed, as will milk volume. The reference values will be published as percentile curves, in a similar way to infant growth data. They can then be used to express milk concentrations of each micronutrient among and across populations, and to evaluate the need for, and effects of, maternal supplementation or food fortification.

"During the next few years we will be conducting a study to obtain reference values during the first nine months of lactation"

Summary

Based on the importance of exclusive breastfeeding and the need to optimize the quality of human milk, more attention should be directed at ensuring adequate maternal micronutrient status during lactation; it has been a relatively neglected concern. Data on milk micronutrient concentrations is currently inadequate, and while few carefully collected, representative data are available, the weight of current evidence suggests that we should pay more attention to maternal micronutrient status in lactation. The concentrations of most micronutrients in breast milk are affected by maternal status and/or intake, which implies that multiple micronutrient supplementation during pregnancy, rather than folic acid and iron supplements which have no effects on milk, as well as during lactation, may help protect milk micronutrients. However, this is as yet unproven. An additional consideration is that the poor quality of current data on milk composition probably means that our estimates of some nutrient requirements for young infants and lactating women are inaccurate. Milk micronutrient concentrations may also be a useful marker of population status, and a tool for evaluating the need for, and effectiveness of, fortification and maternal supplementation.

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Improving Nutrition in the First 1,000 Days

A social franchise model makes a (big) difference in Viet Nam

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Key messages

- The nutrition a child receives during the first 1,000 days of life can lay the groundwork for a lifetime of benefits.
- Since its inception in 2008, Alive & Thrive has tested the notion that large-scale change in infant and young child feeding (IYCF) practices over a relatively short time is possible.
- Entrenched malnutrition can't be solved with social and behavior change alone. But in many settings, social and behavior change has made a solid, sustainable difference, on a large scale.
- In Viet Nam, social franchising emerged as a strategic and effective way forward.
- Each of the four components of the program – interpersonal, mass media, advocacy, and data-based refinements along the way – reinforced the others.
- Rigorously measured and evaluated results – including a tripling of the rate of exclusive breastfeeding, improvements in child dietary diversity, and other central outcomes – prove the potential of social franchising for nutrition, when done well.

Six months of exclusive breastfeeding

When Le Huong Giang was pregnant with her first child, the 28-year-old Vietnamese tour agent saw a television advertisement that changed her life. Initially, the humor of the "talking babies" caught her attention, but it was their messages about breastfeeding that excited Giang. Thus began the first step of a journey that gave her new son access to the highest global standards for infant nutrition: six months of exclusive breastfeeding. No water, no food: nothing but breast milk.

As families around the world know, breastfeeding is not always easy. Doubts about the quality and quantity of milk supply, social pressure (often from older relatives), competing demands for a mother's time, 'latching' complications, sickness, contrary cultural dictates, and a lack of supportive health care can undermine even the most determined parents. In many settings, including Viet Nam, breast milk substitutes are inappropriately and aggressively marketed.

Giang herself faced several of these problems, and nearly gave up exclusive breastfeeding several times. But whenever the chips were down, Ms Thuy was at her side, coaching, counseling, and even getting dubious family members on board. From the nearby *Little Sun* social franchise, Ms Thuy is one of thousands of newly skilled health workers charged with fueling large-scale social and behavior change that is badly needed. Like many countries, Viet Nam suffers from high rates of child malnutrition.

> "No water, no food: nothing but breast milk"

Nutrition science meets innovation: The *Little Sun* social franchises are born, 2009

Emerging science shows that the nutrition a child receives during the first 1,000 days of life (conception through age two) can lay the groundwork for a lifetime of benefits – or harm, if the nutrition is poor. Vietnamese leaders and advocates knew that meeting basic standards of nutrition during this period saves lives, prevents illness, and fosters healthy growth, development, educational success, and even economic productivity through-

A study tour visits an infant and young child feeding support group in Quang Nam province. A group of delegates from the Lao PDR Ministry of Health were hosted by Alive & Thrive and Viet Nam's National Institute of Nutrition in August 2016, with participation from the World Bank, UNICEF, and the SUN Movement Secretariat.

out life. Breastfeeding mothers benefit from a lifelong reduced risk of cancer.

With one in four Vietnamese children stunted, and nearly one in five underweight, people across Viet Nam also felt the need for urgent action.[1] But the question remained: how could this knowledge, and this need, be translated into a feasible plan that would effect meaningful changes for hundreds of thousands, even millions of people?

The Alive & Thrive initiative was conceived to serve as a catalyst for this type of scenario. Since its inception in 2008, the initiative has tested the ambitious (and often doubted) notion that large-scale change in infant and young child feeding (IYCF) practices over a relatively short time is possible. After eight years of innovation in three very different settings (Ethiopia, Bangladesh and Viet Nam), rigorously measured improvements in child feeding practices have occurred in all intervention areas.

One key to these notable successes has been the *absence* of pre-defined solutions. Alive & Thrive supports partnerships that bring together governments, established development partners, and often non-traditional stakeholders (including sub-national groups and representatives of multiple sectors and ministries) to craft and implement contextualized nutrition solutions. Partners draw from global and domestic evidence, their own perspectives and experiences, and innovative ideas to inform strategies, build the case for policy change, and align allies and partners. They formulate a common set of clear and attainable goals to be reached through coordinated, mutually reinforcing efforts. As a result, activities take many forms throughout societies, via health and agriculture services, social support programs, churches and more. They include timed and targeted home health visits, community gatherings, radio dramas, Sunday sermons, and, in Viet Nam's case, newly minted social franchises. These co-created solutions not only increase the likelihood of success in the short term, but also foster sustainability through the commitment that ownership brings, as well as nuanced integration into existing systems.

"One key to these successes has been the *absence* of pre-defined solutions"

What's in a logo?

Clinic name: short, easy to remember and understand, reflecting the nature of the project as well as its *modus operandi*. The beaming sun symbolizes both a blooming sunflower and a smiling child in good care. The sun represents vitality; the two leaves, nurturing hands. The essence of the message is caring for a healthy, happy child and a future 'crop.'

THE LITTLE SUN
Nutrition today, health tomorrow

The work in Viet Nam began with the crafting of strategic partnerships and intensive collaboration, informed by existing data as well as new formative research, as needed. A key output was a collective decision to go with a social franchising approach – a sensible option given the context of a strong health system benefitting from recent upgrades that enabled easier access and resulted in high use at the facility level. Increasingly used in the public sector, social franchising borrows concepts that have been tried and tested in commercial settings.[2] Successful franchises build a strong brand that represents a known, reliable, consistent and desired product or service. Ideal *social* franchises create a sustainable model that efficiently produces a public good, as opposed to a profit. While the franchising model has been effectively applied to other health services, including reproductive health in Viet Nam, this application of franchising for social and behavior change related to nutrition during the first 1,000 days is a first (**Figure 1**).[3]

The relationship between franchisor and franchisee is a unique facet of this kind of effort: it ensures consistency, minimum standards, and provision of ongoing support through demand generation (often via mass media), troubleshooting, policy advocacy, and continued refinements. In this case, Alive & Thrive and the National Institute of Nutrition were the co-franchisors, and existing health facilities the franchisees.

The *Little Sun* brand was created, designed for scale, and rolled out within Viet Nam's public health system (**Figure 2**). (These distinctive and cheerful clinics were complemented by health-system-convened community support groups in remote and hard-to-reach areas.) In all cases, pregnant women, mothers, families and community leaders learn about maternal health and nutrition, breastfeeding, complementary feeding (foods and liquids introduced at six months of age), and child health. Importantly, interpersonal activities at the clinics and in the catchment areas are reinforced by high-profile mass-media campaigns and advocacy activities.[4]

From 2010 to 2014, notable results were achieved: more than 678,000 Vietnamese mothers of children received counseling and breastfeeding support from over 1,000 Little Sun franchises. (An additional two million mothers were reached by mass media.)[5] Mothers' breastfeeding knowledge, beliefs, intentions and practices increased, and the rates of exclusive breastfeeding *tripled*, from 19% to 58% in intervention areas.[6] The number of children eating a diverse diet increased by 17 percentage points.[7]

Learning from *Little Sun:* Deconstructing what worked well

Monitoring and evaluation efforts yield a steady stream of data and analysis that enable ongoing refinement of this program (and can inform similar efforts elsewhere in the world). Incorporation of a model originally developed in the private sector into a large public health system calls for revised frameworks of analysis, as opposed to private-sector considerations of simple profit or loss. In this case, evaluators created assessments using

FIGURE 1: The *Little Sun* behavior change framework

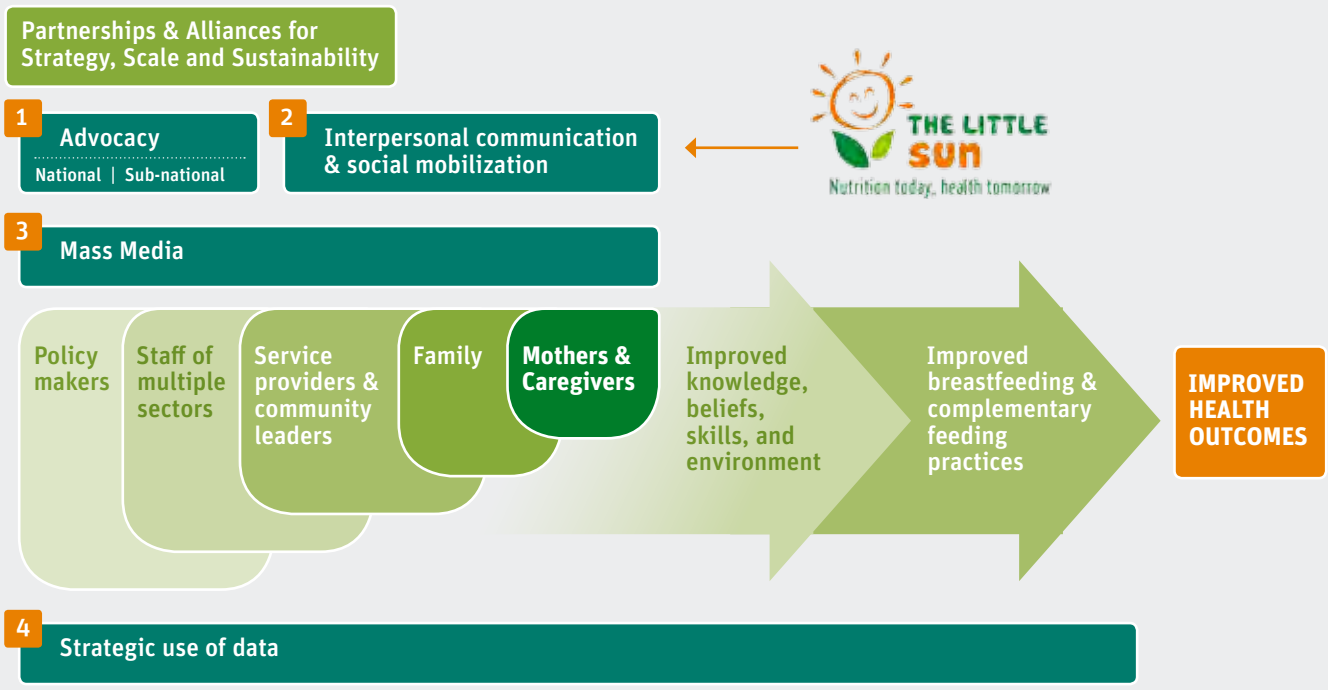
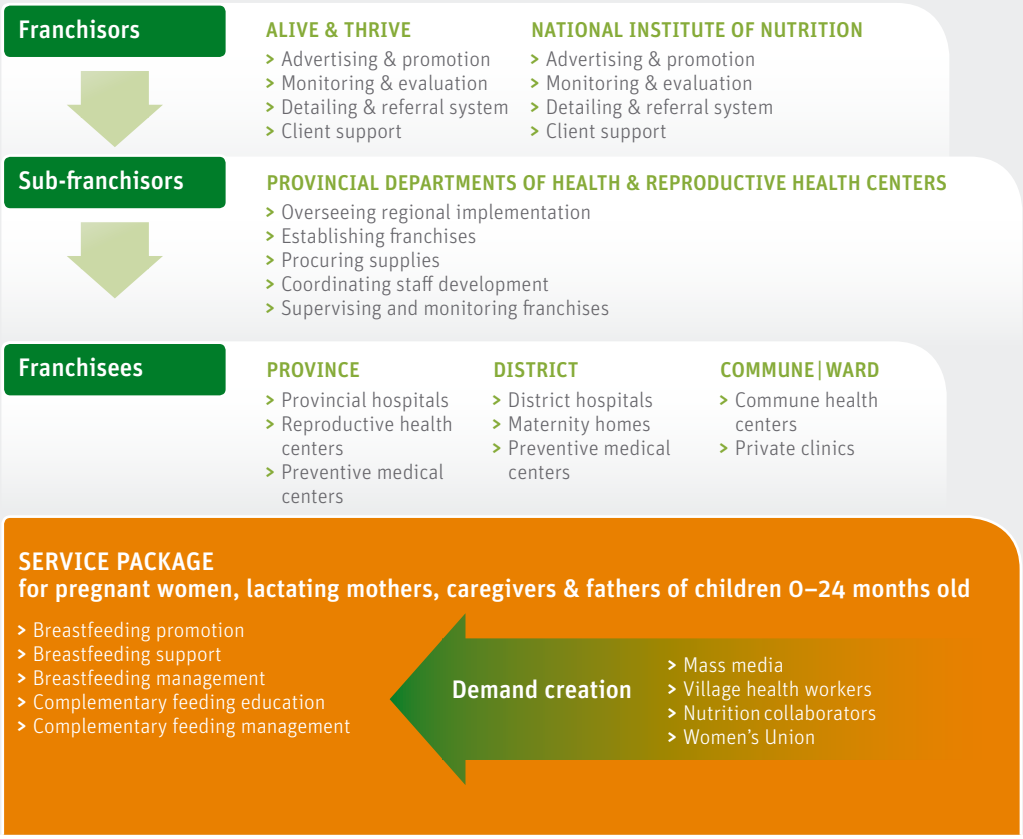


FIGURE 2: The Alive & Thrive franchise model



the public sector concepts of *quality of care*, broken into three established components of service quality: structure, process, and outcome.[8]

The *Little Sun* franchises, compared to the standard government health services, had better quality facilities, equipment and materials. While the general services and staffing were comparable, the *Little Sun* staff were better trained. *Little Sun* staff demonstrated greater knowledge in many areas, and better counseling skills, and ran counseling sessions that were of higher quality in many regards, including targeted timing, the effective practice of delivering messages exactly when applicable within the 1,000 day timeframe. Client satisfaction was high in both groups. Overall, the incorporation of social franchising elements resulted in significant improvements in nutrition counseling services, particularly with regard to structure and process.[9]

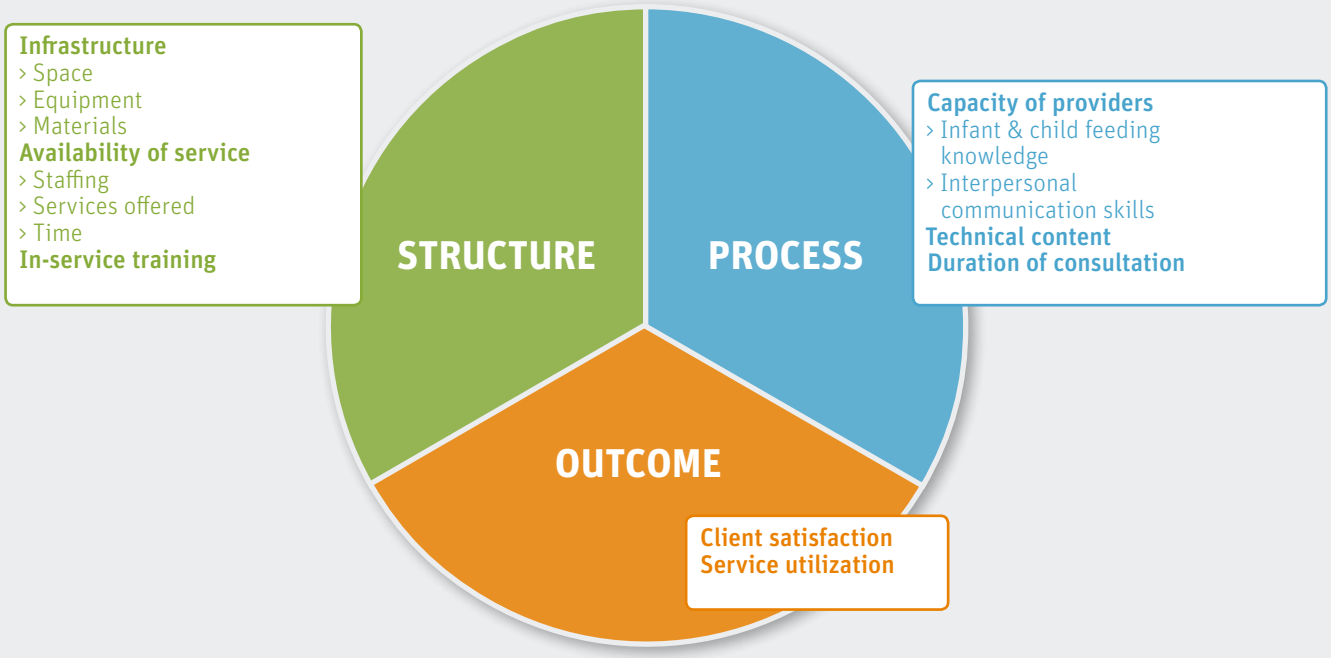
> "The incorporation of social franchising elements resulted in significant improvements in nutrition counseling services"

Low service utilization: Digging deeper

As countries such as Viet Nam transition to middle-income status, donor funding decreases, leaving health systems with the challenge of designing the most cost-efficient service models possible, including a focus on facility-based services (as opposed to community- or household-level care). Inevitably, facilities must foster a complex understanding of utilization in order to make sure their targeted clients show up – and that they realize the intended health benefits.

The clinics were running, and the indicators were improving. However, malnutrition rates were still high. The next challenge was to better understand supply- and demand-side factors with the goal of addressing underutilization of *Little Sun* services. Study of the full range of use patterns – ranging from one visit to completing the minimum package of services – uncovered the two most influential factors: demand-generation activities and counseling skills. The latter, which includes good interpersonal communication skills with provision of appropriate content, was already strong. On the demand side, three demand creation strategies emerged as the most influential: receiving invitation cards from health workers, viewing promotional TV spots, and seeing a promotional billboard. Further analysis indicated that the three strategies combined resulted in a multiplicative effect.

FIGURE 3: Three components of service quality: structure, process and outcome



Efforts to apply these findings resulted on ongoing increases in demand.

Ultimately, the data suggested that if all mothers could be reached by all three strategies, and could interact with health workers equipped with good counseling skills and a reasonable workload, an additional *49%* of the population could complete the entire counseling and services package.[10] Efforts to operationalize those recommendations are already bearing fruit.

Results, sustainability and replication

As indicated in **Table 1**, immediate results were large in scale and reach, as were related policy advocacy efforts. Alive & Thrive has handed over the management of the *Little Sun* franchises to the National Institute of Nutrition. Other countries seek to replicate the innovative model, including Lao PDR; Alive & Thrive has provided strategic technical assistance as part of dissemination efforts across Southeast Asia. Globally, Alive & Thrive continues to apply its framework, guidance and processes to develop contextualized solutions in a range of countries.

TABLE 1: Summary of accomplishments

Component	Achievements, 2009–2016
Little Sun	√ Franchises in 21 provinces
Social Franchise	√ 1,112 total franchises, 781 established by project and 251 replicated by the National Institute of Nutrition
achievements	√ 180,000 mothers/caretakers received infant and young child feeding counseling monthly
	√ Over four million counseling contacts
	√ Over a million mothers counseled
Complementary	√ Advertising of formula for children up to 24 months banned, including bottles and teats
policy advocacy	√ Decree issued regulating trade and usage of nutrition products for young children, including bottles and pacifiers
	√ Paid maternity leave extended to 6 months
	√ National early essential newborn care guidelines piloted in select hospitals in four provinces
	√ Decree clarifying implementation of regulations related to female employees including requirement for lactation rooms in all workplaces
	√ National early essential newborn care guidelines rolled out in all hospitals in seven provinces

In sum: Complex, contextualized, continuous learning

Entrenched malnutrition can't be solved with social and behavior change alone. But in many settings, social and behavior change has made a solid, sustainable difference, on a large scale. In Viet Nam, social franchising emerged as a strategic and effective way forward, a thoughtful hybrid fusing private-sector experience with public-sector knowledge around quality of care. Each of the four components of the program – interpersonal, mass media, advocacy, and data-based refinements along the way – reinforced the others. Rigorously measured and evaluated results – including a tripling of the rate of exclusive breastfeeding, improvements in child dietary diversity, and other central outcomes – prove the potential of social franchising for nutrition, when done well.

> "In Viet Nam, social franchising emerged as a strategic and effective way forward"

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Families and staff at the *Little Sun* Franchise at Hai Ninh Commune Health Center of Quang Binh Province in Viet Nam

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Iron Supplementation in Predominantly Iron-Replete Populations

Is there an emerging concern?

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Children outside of a health centre in Dili, Timor-Leste

The global burden and potential causes of anemia

In 2011, it was estimated that, globally, 496 million non-pregnant women of reproductive age (WRA) were anemic.[1] Defined as a hemoglobin concentration < 120 g/L in non-pregnant WRA,[2] anemia can increase the risk of adverse pregnancy outcomes,[3] impair work capacity and productivity of women,[4] and ultimately hinder social and economic development. There is a tacit assumption that approximately 50% of anemia is due to iron deficiency in low- and middle-income countries (LMIC), which has been the impetus for global WHO recommendations for blanket (untargeted) iron supplementation among women and adolescents in areas of high anemia prevalence (**Figure 1**).[5,6] However, there are many other potential causes of anemia, including infection/inflammation (e.g., environmental enteric dysfunction, EED), micronutrient deficiencies other than iron (e.g., vitamin B_{12} and folate), and genetic factors (e.g., hemoglobinopathies) (**Figure 2**).

> "It is often assumed that 50% of anemia is due to iron deficiency, which has been the impetus for global WHO recommendations for blanket iron supplementation"

Recent surveys have shown a surprisingly low prevalence of iron deficiency among non-pregnant WRA

Recent surveys in Bangladesh,[7] Cambodia,[8–10] the Democratic Republic of the Congo,[11] Nepal,[12] Rwanda,[13] Sierra Leone,[14] and Vietnam[15] have shown a surprisingly low prevalence of iron deficiency (≤ 8% based on inflammation-adjusted ferritin <12–15 µg/L) among non-pregnant WRA (**Table 1**). This is important because if iron deficiency is not a major cause of anemia, then untargeted iron supplementation is at best a waste of resources, and at worst, a potential source of harm.

Potential reasons for the low prevalence of iron deficiency among women of reproductive age

Probably many factors are contributing to high ferritin concentrations in women, although the exact cause is often difficult to ascertain. Complicating this further is the fact that many of these factors coexist and impact iron metabolism in varying ways.[16]

FIGURE 1: Global WHO recommendations for iron supplementation in non-pregnant women of reproductive age in areas of high anemia prevalence (2011 and 2016)

Left: Since 2009, the WHO has recommended intermittent IFA supplementation (60 mg elemental iron weekly for three consecutive months (followed by three months of no supplementation, after which the provision of supplements should restart) for menstruating women and adolescent girls in areas of anemia prevalence ≥ 20%. The guidelines were updated in 2011. **Right:** In 2016, WHO released *complementary* guidelines recommending daily IFA supplementation (30–60 mg elemental iron daily) for three consecutive months of the year for menstruating women and adolescent girls in areas of anemia prevalence ≥ 40%.

Infection, inflammation, and EED are all potential contributors to high ferritin concentrations. Infectious pathogens, metabolic stress and tissue damage all activate the inflammatory cascade.[17] Cytokines are released, stimulating the production of hepcidin, which functions as the main regulator of iron metabolism.[18] Hepcidin binds to and degrades ferroportin, a transport protein on the surface of the macrophage, sequestering the iron from recycled red blood cells in the macrophage and making it unavailable for erythropoiesis (thus leading to high ferritin concentrations).[19,20] Hepcidin also acts on the gut in a regulatory manner to inhibit iron absorption when hepcidin production is stimulated (as in the presence of inflammation). These are thought to be protective mechanisms to prevent pathogenic organisms from using iron in circulation.[21]

Genetic hemoglobinopathies are common in many regions of the world and can result in a decreased or defective hemoglobin production, leading to an increased risk of anemia and other serious health problems.[18,22] Sickle hemoglobin (Hb S) is a variant found in high frequencies across most of sub-Saharan Africa, the Middle East, and India.[23] These hemoglobinopathies tend to have high frequencies in tropical regions because of their conferred resistance against malaria.[23] Some hemoglobinopathies have also been shown to be associated with high ferritin concentrations.[8,24] In Cambodia, we observed that women with the hemoglobin E homozygous genotype (7%, *n*=31/450), which is a disorder caused by a mutation in the β-globin gene from both parents, was associated with 50% (95% CI: 14, 96%) higher mean ferritin concentration, as compared to women with a

FIGURE 2: Potential causes of anemia

Infection | Inflammation
- Environmental enteric dysfunction (EED)
- Malaria
- Helminth (parasites)

Iron Deficiency
- Caused by inadequate dietary iron intake, impaired absorption of iron, or increased loss of iron from the body

Micronutrient Deficiencies
- Vitamins A, B_6, B_{12}, C, riboflavin, folate, copper

Genetic Factors
- Hemoglobinopathies (Hb E, sickle cell, thalassemia)
- Glucose-6-phosphate dehydrogenase deficiency
- Mutations in the transmembrane serine protease serine 6 (*TMPRSS6*) gene (causing overproduction of hepcidin and leading to iron-refractory iron deficiency anemia)

Anemia

normal hemoglobin structure.[25] As such, the diagnostic accuracy of ferritin to estimate iron deficiency in individuals with this genotype is in question. Assessment of genetic hemoglobinopathies is a crucial factor in understanding the potential causes of anemia in a population and in designing and implementing effective anemia reduction strategies and programs.

> "Assessment of genetic hemoglobinopathies is a crucial factor in understanding the potential causes of anemia in a population"

Screening women for anemia using the HemoCue® 301+ in rural Cambodia

Naturally existing iron in groundwater may be a contributing factor to high iron stores. Elevated groundwater iron levels have been reported in Bangladesh and Cambodia.[7,26] However, the potential contribution to body iron stores largely depends on the bioavailability of the iron. Measurement of the iron bioavailability in groundwater is complicated, as both diet composition and an individual's iron status can influence bioavailability.[27] Another factor related to iron in groundwater is the utilization of point-of-use water filters, which are commonly used in households in some countries including Cambodia.[28] For example, the BioSand filter – a slow sand filter designed to remove arsenic and microbiological contamination[28] – has been shown to remove up to 98% of the iron from groundwater.[26,29] As such, the availability and use of these filter systems at the household level is an important consideration in assessing potential iron intake from groundwater. More rigorous examination of groundwater iron content, chemical form and bioavailability is warranted.

TABLE 1: Low prevalence of iron deficiency (based on inflammation-adjusted ferritin) among non-pregnant women of reproductive age in recent surveys

Country, year of publication	Surveyed population	Definition	Prevalence of iron deficiency	Reference
Bangladesh, 2012	*n*=209 women in Gaibandha district	Plasma ferritin <12 µg/L	0%	Merrill et al[7]
Cambodia, 2015	*n*=420 women 18–45 years in Prey Veng province	Serum ferritin <15 µg/L	2.1%	Karakochuk et al[8]
Cambodia, 2015	*n*=2,112 women 15–39 years in a national survey	Serum ferritin <15 µg/L	8.1%	Wieringa et al[9]
Cambodia, 2015	*n*=738 mothers 15–49 years with at least one child less than five years of age in a national survey	Serum ferritin <15 µg/L	2.6%	2014 Cambodia Demographic and Health Survey[10]
DR Congo, 2016	*n*=741 women 18–45 years in South Kivu and Kongo Centrale provinces	Serum ferritin <15 µg/L	5.4% (3.9, 7.3%)	Harvey-Leeson et al[11]
Nepal, 2016	*n*=500 mothers 15–44 years in Bhaktapur municipality	Plasma ferritin <15 µg/L	5%	Chandyo et al[12]
Rwanda, data not yet published	*n*=595 women 18–44 years in Northern and Southern provinces	Serum ferritin <15 µg/L	4.8% (3.2, 7.2%)	Angel et al[13]
Sierra Leone, 2016	*n*=871 women 15–49 years in a national survey	Plasma ferritin <15 µg/L	8.3% (6.2, 11.1%)	Wirth et al[14]
Vietnam, 2015	*n*=4,986 women planning to become pregnant in next year in Thai Nguyen province	Serum ferritin <15 µg/L	3.5%	Nguyen et al[15]

Values are proportion of women with iron deficiency (%) or iron deficiency prevalence estimates [mean (95% CI)]. Ferritin concentrations were assessed using a combined s-ELISA (with the exception of Chandyo et al (who used an electrochemiluminescence immunoassay), and were adjusted for inflammation using AGP and CRP concentrations based on Thurnham et al methods.[30]

There are a few important caveats to highlight among the studies outlined in **Table 1**. First, the Chandyo et al[12] study and the Cambodia Demographic and Health Survey[10] were conducted among *mothers* who had received iron and folic acid (IFA) supplementation during their pregnancy, which may have been a confounding factor. The findings of low iron deficiency among mothers may not be generalizable to nulliparous women, who had neither been pregnant nor received IFA. Second, all studies reported used Thurnham et al correction factors to adjust ferritin for levels of inflammation, which are based on the stages of inflammation (incubation, early and late convalescence) as assessed by the biomarkers α_1-acid glycoprotein (AGP) and C-reactive protein (CRP).[30] Recently at the Micronutrient Forum in Cancun, the Biomarkers Reflecting Inflammation and Nutritional Determinants of Anemia (BRINDA) Project proposed a new linear regression method for the correction of ferritin in the presence of inflammation.[31] Some preliminary unpublished data have shown that linear regression is a more rigorous method to comprehensively account for inflammation, as compared to the Thurnham method. This is because linear regression relies on AGP and CRP biomarkers as continuous variables, whereas the Thurnham method relies on AGP and CRP as binary variables based on arbitrary cut-offs. It has been reported that using the linear regression method (BRINDA) may result in lower corrected ferritin concentrations and thus a higher prevalence of iron deficiency. This may be of particular importance among populations with a high prevalence of inflammation. As such, the prevalence rates estimated with different inflammation-correction methods should be interpreted with some degree of caution until more evidence is established.

In many countries, numerous iron interventions are often implemented at the same time, with the shared aim of reducing, preventing, and/or treating anemia. For example, according to the National Nutrition Policy in Cambodia,[32] daily IFA (60 mg

Collecting groundwater from a well in rural Cambodia to measure iron levels

iron/day) is recommended for pregnant women for 90 days, for postpartum women for 42 days, and for women who have had a miscarriage or abortion for 42 days. Further, daily IFA (60 mg iron/twice daily [total: 120 mg/day]) is recommended for anemic women for 90 days, after which, if the anemia is not corrected, a second round of the same treatment is advised. The policy also recommends weekly IFA (60 mg iron/week) for all non-pregnant women until they become pregnant (although this program has not yet reached national scale). In addition, the policy also outlines several other strategies to increase iron intake, such as increasing dietary diversity to include more iron-rich sources of food and decreasing the consumption of iron absorption inhibitors (e.g., tea).[32] Recently, the Ministries of Planning and Health in Cambodia mandated the fortification of all fish and soy sauce with iron.[33] Another intervention in Cambodia is the Lucky Iron Fish®, an iron ingot that is placed into the household's cooking pot and slowly releases iron into cooked food.[34] In conclusion, the total iron content consumed by women in these contexts is largely unknown but expected to be high.

Emerging concerns regarding iron supplementation in children

Although there is strong evidence that iron supplementation and/or at-home fortification reduces the risk of anemia and/or iron deficiency in young children,[35–37] there have been some emerging concerns of risk of adverse outcomes with the provision of iron, specifically among children with infections such as malaria, pneumonia, tuberculosis, or diarrhea.

A trial by Soofi et al[38] in Pakistan showed that iron-containing micronutrient powders were effective at reducing iron deficiency anemia but increased the incidence of diarrhea and the risk of bloody diarrhea and respiratory illness among children six to 18 months of age. A recent Cochrane review did not find an increased risk of non-malaria infectious diseases associated with iron supplementation among children < 18 years of age, although the authors concluded with the caveat that iron supplementation was safe *"when malaria prevention or management services are provided efficiently."*[39] This poses a challenge to interpretation of the findings in this review, as there is currently a lack of well-established criteria and/or indicators used to measure the efficiency of malaria surveillance and treatment programs.

> "There have been some concerns of risk of adverse outcomes with the provision of iron, specifically among children with infections such as malaria, pneumonia, tuberculosis, or diarrhea"

A study by Zimmermann et al[40] in Cote d'Ivoire examined the effect of iron-fortified biscuit consumption on the gut microbiota profile in Ivorian children six to 14 years of age. After six months of intervention, there was a significant increase in the number of pathogenic enterobacteria, a decrease in beneficial lactobacilli bacteria, and an increase in mean fecal calprotectin concentration (a marker of intestinal inflammation) in the children receiving iron-fortified biscuits, as compared to non-fortified biscuits.[40] Iron is a growth-limiting nutrient for many pathogen-

Fish sauce and soy sauce are now fortified with iron in Cambodia

ic gut bacteria, thus it is plausible that increasing the colonic iron content of the gut could cause adverse changes to the gut microbiota profile.

At a recent symposium on *"Iron Screening and Supplementation of Iron-Replete Pregnant Women and Children"* at the National Institutes of Health (Bethesda, Maryland, USA), Zimmermann proposed potential solutions to minimize these risks associated with iron supplementation and/or at-home fortification, such as decreasing the dose of iron, the use of a more absorbable form of iron (e.g., chelated iron), or the addition of ascorbic acid or endogenous phytase (to increase iron absorption and decrease the load of colonic iron that reaches the gut), or adding a prebiotic non-digestible source of fiber (e.g., galacto-oligosaccharides, GOS) to enhance the proliferation of beneficial gut bacteria. These promising approaches require further evaluation.

The dilemma of iron supplementation in predominantly iron-replete non-pregnant women of reproductive age

There is evidence that iron supplementation reduces the risk of anemia and/or iron deficiency among menstruating women. A recent systematic review by Low et al concluded that there is evidence from ten trials (including 3,273 non-pregnant menstruating women 12–50 years) that suggests daily oral iron supplementation reduces the prevalence of anemia (relative risk [RR]: 0.39 [95% CI: 0.25, 0.60]).[41] These ten trials included all women of menstruating age (irrespective of anemia or iron status) and at varying doses and durations of iron therapy (between 4 and 12 weeks).[41] However, the authors of this review did not examine the potential risks of iron supplementation (e.g., oxidative stress, lipid peroxidation, or iron overload), as no studies included in the review measured risk-related outcomes other than the adverse gastrointestinal side effects of iron supplementation (e.g., constipation) and the studies were not of sufficient duration to investigate chronic morbidities.[41]

There are potential risks of iron supplementation in iron-replete populations (linked to iron overload), such as increased oxidative stress and reactive oxygen species,[42] which in turn have been associated with the pathogenesis of chronic conditions such as diabetes and its resulting complications (e.g., diabetic nephropathy and cardiovascular disease),[43,44] DNA damage leading to cancer,[45] and neurodegenerative diseases (e.g., Parkinson's disease).[46] It is suspected that an even higher risk from iron supplementation may exist among iron-replete individuals with inflammation and certain genetic hemoglobinopathies, as these individuals are already at risk of high iron stores.[47]

Further to the aforementioned risks described for children, the impact of adverse changes to the gut microbiota in women (especially pregnant women) are not known but could potentially impact future offspring through epigenetic mechanisms.[48] More research in this field of work is urgently needed to ascertain if risks of iron supplementation in iron-replete populations (especially among those individuals with hemoglobinopathies and inflammation) translate to adverse outcomes of biological or clinical significance.

Nutrition education session outside of a health centre in Southern Ethiopia

> "If iron deficiency is not a major cause of anemia, then national policies and programs for anemia reduction may need to be re-evaluated"

Possible solutions and future directions

- It is crucial to comprehensively assess and understand the multifactorial causes of anemia in each country-specific setting or population, and when possible, this should include a genetic (e.g., hemoglobinopathies) and biochemical assessment of indicators related to hemoglobin and iron status. This is fundamental to designing and implementing effective anemia reduction strategies and programs.
- It may be warranted to reduce the iron content in IFA supplements from 60 mg to 30 mg in regions where women of reproductive age have shown to have a low prevalence of iron deficiency and/or where anemia is probably caused by reasons other than iron deficiency. The recent 2016 WHO guidelines that recommend daily IFA supplementation for three consecutive months of the year among menstruating women and adolescent girls in areas of anemia prevalence ≥ 40%, suggest a dose between 30 mg and 60 mg elemental iron daily.[6] These guidelines were based upon the evidence

generated in a recent systematic review by Low et al.[41] Further, the UNICEF/WHO/UNU multiple micronutrient formulation for pregnant and lactating women (UNIMMAP) contains only 30 mg iron (rather than 60 mg). This dose was chosen based on the rationale that adherence would probably be improved with lower dose (due to increased adverse side effects with a higher dose), and that a lower dose of iron would have less adverse impact on zinc absorption.[49] In the recently published WHO Antenatal Care Guidelines, daily IFA (30-60 mg iron) is recommended for pregnant women, however, the guideline also provides an alternative context-specific recommendation for intermittent IFA (120 mg iron weekly) in populations with an anemia prevalence among pregnant women <20%, or when the daily IFA is not accepted due to adverse side effects. [50]

› Future studies should include outcomes that measure both the risks and benefits of iron supplementation in order to better inform policy. The potential risk-related outcomes could include indicators of oxidative stress, lipid peroxidation, DNA or cell damage, gut microbiome or metabolites related to iron overload, in addition to the adverse gastrointestinal side effects of iron supplementation (e.g., consti-pation, diarrhea, and abdominal pain).

Conclusion

The efficacy and safety of iron supplementation probably varies by population and context, and also depending on the proportion of anemia that is due to iron deficiency rather than other causes. Recent surveys showing a low prevalence of iron deficiency among non-pregnant WRA warrants further attention to the potential risks of iron supplementation in predominantly iron-replete populations.

> "Further attention to the potential risks of iron supplementation in predominantly iron-replete populations is warranted"

Presentations from the recent symposium on "Iron Screening and Supplementation of Iron-Replete Pregnant Women and Children" at the National Institutes of Health (Bethesda, MD, USA) are available online via: ***ods.od.nih.gov/Research/Iron.aspx#workshop***

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Health Economics: Making communications on maternal nutrition work

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Key messages

- For millennia, the best approach to maternal nutrition and breastfeeding has been the subject of debate – usually without involving directly affected mothers.
- The economic growth potential of maternal nutrition should be given greater emphasis in communications on the topic.
- Learning from the health communication activities of the past shows that nutrition communication can only be successful if it is dialogue-oriented and if the relevant target groups are involved.

The ancient debate on maternal nutrition

As long ago as the days of Ancient Greece and Rome, maternal nutrition and breastfeeding were the subject of controversial public debate. However, these topics were mainly discussed by wealthy and well-educated men such as Pseudo-Plutarch or Tacitus, without involving directly affected mothers at all.

Even 2,000 years ago, social and regional contexts played a crucial role in differentiating approaches to early childhood nutrition and care.[1] Historic sources state, for instance, that malnutrition due to overly short or otherwise inadequate breastfeeding results in bladder stones and anemia.[2]

Historic sources that discuss breast-milk substitutes – for instance, honey potions or diluted wine – indicate that the use of animal milk and milk substitutes was not common compared with breastfeeding and wet nursing. To avoid putting very young babies at risk, wet nurses were the subject of stringent behavioral and dietary rules. The arguments in favor of breastfeeding, however, were based not on scientific, medical or nutritional findings but rather on popular psychological rationales or the supposed laws of nature.

In our own 21st century, the debate on maternal nutrition and breastfeeding is still very much alive, but, sadly, "despite impressive scientific advances and massive economic growth … the hope of achieving significantly improved health for a greater proportion of the world's people … has become an even more distant prospect."[3]

Maternal nutritional status during and after pregnancy has a crucial influence on fetal growth and early child development and later exposure to the risk of contracting a wide variety of communicable and non-communicable diseases. Pregnant and breastfeeding women are in a particular phase of life and have very special dietary needs.

> "The hope of achieving significantly improved health for a greater proportion of the world's people has become an even more distant prospect"

Achieving goals in the fields of adherence and prevention is very often dependent on behavior change on the part of the target groups. Experience to date indicates that recommendations for healthy nutrition or dietary supplementation are often poorly implemented during and after pregnancy, either because pregnant or breastfeeding mothers have their own ideas about appropriate nutrition and dietary supplementation or else because they lack the prerequisite knowledge. The sources of advice most trusted today in matters of diet are general medical practitioners and the Internet. It is well known that effective health communication and education are very powerful tools for behavior change in matters of nutrition.[4] However, this is

A baby at the breast. The best approach to maternal nutrition and breastfeeding has been the subject of debate for millennia.

only the case if the traditional communication is replaced by a more dialogue-based approach that is tailored to the specific target group.[5]

Maternal nutrition as a global communication challenge

From a health economics point of view, improving maternal nutrition can succeed only if "countries have considerable self-interest in improving the health of their own … population."[6] However, the motivation behind these efforts is not purely philanthropic. Political and economic leaders have learned in recent years that many countries will not be able to climb out of poverty as long as a major part of their population is unable to achieve the nutritional status necessary for a healthy and productive life. For this reason, the effective communication of general nutrition concepts is of extreme relevance to the economics of healthcare. Undernutrition reduces economic growth by at least 8%. The quality of nutrition a child receives while in the womb and during its infancy has irreversible effects on its future health and development.[7]

> "The quality of nutrition a child receives while in the womb and during its infancy has irreversible effects on its future health and development"

Despite the importance of the link between early nutritional input and subsequent growth and development, the history of the Western world shows that this issue has not been at the top of the agenda of the world's political leaders – or, indeed, of the majority of pregnant and (breastfeeding) mothers, either.

Public health has always been influenced by medical and scientific arguments as well as by ethical and political considerations.[8] In the Great Britain of the 19th century, for example, the majority of today's elemental rules of infant care simply did not exist. Many poor people did not make use of midwives for the delivery of babies, and if the mother died in childbirth, the baby was allowed to die as well.[9] "Thousands of babies were born annually to mothers who were underweight and undernourished, who had contracted pelvises, who worked too hard … during the pregnancy, and who received no sound advice, either from health societies, or from any supporting network of women, about pre- and antenatal care."[10] The question is therefore whether health communication about maternal nutrition seen from an economic perspective should simply focus on the prevention of deficiencies or should rather highlight the positive biological effects of maternal nutrition on (lifetime) health. The answer is obvious: both.

Just over a decade ago, Szwajcer analyzed the nutrition-related information-seeking behaviors and motives of young Dutch women before and during pregnancy. The main information sources of the test group were the Internet and their own social environment. Pregnancy-specific nutrition information was important to the test group because such information helps protect the health of the fetus.[11] In Asia (e.g. Bangladesh), lack of (health) education, client orientation and direct communication on the part of health personnel[12] leads to a lack of knowledge about ante- and postnatal care and maternal nutrition, and the services offered are therefore not well accepted.[13] For efficient and effective nutrition programming, communication is key.

Good health communication offers economic and personal benefits

Since the 1980s, most health communication activities have focused primarily on behavior change methodologies as promoted in expert circles and leading media. The protagonists have overestimated the effectiveness of these activities, because they have focused too heavily on telling people what to do in a very sophisticated manner rather than listening to and involving the target groups themselves. Apart from a frequent disregard for the sociocultural attributes and educational background of the target groups, one chief error has been the lack of interest shown in the information tools normally used by, for example, malnourished women. Furthermore, health communication has mainly been seen as a one-way street. In the USA and Japan, for example, education, household income and other social determinants are the main drivers of different approaches to accessing health information, as well as of disparities in health status.[14] However, compared with health information supplied by healthcare providers and the Internet, levels of trust in health information provided by the mass media are not linked to socioeconomic status.[15] Empowering the poorest by informing them about health benefits should therefore involve two-way communication.

Today, a variety of much more target-group-oriented communication approaches have been developed and put into practice. According to Servaesa and Malikhaob, successful health communication should consist of behavior change communication, mass communication, advocacy communication, participatory communication, and structural and sustainable social change communication.[16] To be successful, behavior change communication has to be interpersonal. Mass communication should focus on special community media and platforms and mass media. Advocacy communication has to consist of both interpersonal communication and mass communication, while participatory communication should be based on interpersonal communication and communities. Structural and sustainable social change communication should be an amalgam of interpersonal, partici-

patory and mass communication. However, what mothers generally want from health care professionals is advice.[17]

> "What mothers generally want from health care professionals is advice"

Every patient-centered communication initiative has to be adapted to the specific situation and needs of the individual target group. Key to the success of all public health communication activities is a strategy-based approach – and this is the reason why so many health communication initiatives fail.

Conclusion

Today, the role of media- and dialogue-oriented communication in influencing health is well acknowledged. The main issue to be addressed is the communication focus in the context of maternal nutrition. Maternal nutrition communication should not be one-dimensional. To achieve a change of mindset, it has to address both the affected individual and the more general economic potential of good maternal nutrition.

To achieve a broader social acceptance of maternal nutrition campaigns and activities, health workers should therefore reconsider their approach and try to base their communication activities on two different aspects: **a)** the individual and economic outcome of efficient maternal nutrition; and **b)** a less dogmatic approach to their style of communication. The critical success factor is, however, target group orientation.

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Addressing World Poverty through Women and Girls: A feminized solution?

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The intersections between food systems and poverty

Food and nutrition have historically been deeply implicated in poverty analysis and measurement. Indeed, poverty is often defined and measured in terms of both absolute and relative incomes in macro-level international comparisons. Absolute measures, such as the "extreme poverty line," are grounded in a "basic needs" approach whereby an extreme poverty line is typically established as the income necessary to access sufficient calories to avoid death. Likewise the "poverty line" is also an absolute measure of the income/expenditure of resources needed to access not only food, but also housing and transport.

Both these measures have particular relevance to gender, given the disproportionate onus on women to provide for basic household needs – both because they are often unpaid workers and carers in the context of household livelihoods, and because in many parts of the world (especially in sub-Saharan Africa and South Asia) they are the backbone of subsistence farming and horticulture, whether in rural or urban areas.

Yet despite these inputs, women's and girls' claims to food and decent nutrition are often compromised by male bias in household consumption, which, in a number of instances – perhaps most notably in Asia – have been associated with undue mortality on the part of girl children. In addition to this, self-sacrifice on the part of women in the form of neglecting their own nutritional needs, especially when pregnant or lactating, can lead to high levels of maternal mortality, and can compound several other health problems which accrue from privations in housing, services and infrastructure. Recognizing the intersections between food systems and poverty from a gendered perspective requires acknowledging not only the hiatuses between women's production of food and its consumption, but also the manifold burdens associated with access, provision and preparation which devolve upon women and girls, and can add to their monetary privations in numerous ways, including physiologically, psychologically and socially.

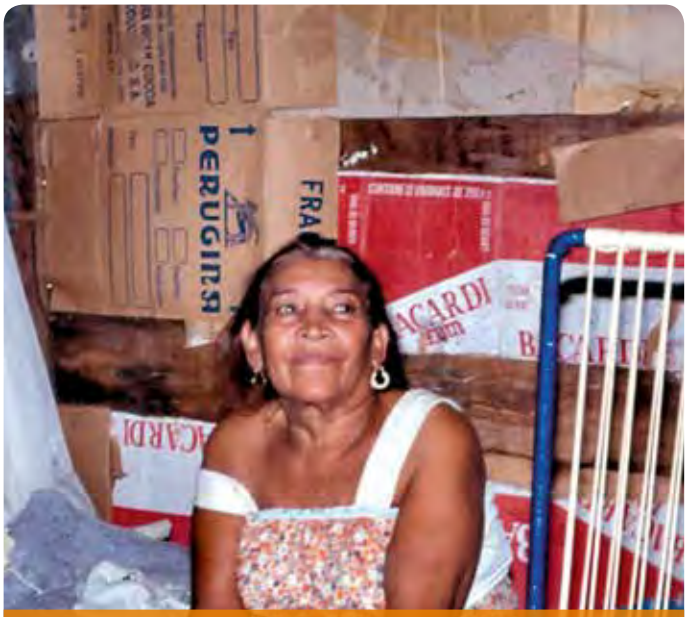
Positioning women as a pathway out of poverty

Since the "feminization of poverty" came to enjoy the status of global orthodoxy at the Fourth Women's World Conference at Beijing in 1995, women and girls have assumed an unprecedented visibility in development discourse, not only as the principal victims of economic privation, but also as frontline actors in poverty reduction.

The quest for women's empowerment and gender equality has become a vital component of contemporary anti-poverty initiatives, in which great store is set on female agency as a solution to privation in the Global South. The inclusion of, and investment in, women and girls as a pathway out of poverty is in many ways well justified. Although the "feminization of poverty" has been criticized on numerous grounds, there is widespread consensus that being female exacerbates vulnerability in many ways, and can deprive women and girls of fundamental human rights.

While not denying that men are also vulnerable, the preponderant focus on women owes not only to their comparatively greater victimization; it also rests on repeated observations that income earned by women, or under their control, is often allocated more fairly within households than by men, and is spent on the kinds of consumption which better assure familial nutrition, health and wellbeing. However, whether female-targeted poverty reduction programs provide the most appropriate route to promoting women's empowerment and/or gender equality is more contentious.

The new female focus in development policy is perhaps not accidental. An important step came in 1995 when the World Bank's flagship publication for Beijing emphasized how "[i]nvesting in women is critical for poverty reduction. It speeds economic development by raising productivity and promoting the more efficient use of resources; it produces significant social returns, improving child survival and reducing fertility, and it has considerable intergenerational pay-offs."[1] In 2007, the World Bank's business case for "investing in women" was further



Nicaraguan migrant woman in her self-built home in Cañas, north-west Costa Rica

intensified with the launch of its three-year Gender Action Plan (GAP), which was sub-titled: "Gender Equality as Smart Economics." An unfortunate consequence was to sideline "… the moral imperative of empowering women to achieve women's human rights and their full and equal rights with men."[2]

Given this history, it was arguably auspicious to see somewhat modified messaging in the Bank's *World Development Report 2012 (WDR 2012) on Gender Equality and Development*.[3] In this document, much greater space is devoted to gender equality as an intrinsic goal. By the same token, WDR 2012 is far from free of what I have called "clever conflations," whereby the repeated linking of Smart Economics and reference to women's rights implies a profound symbiosis with efficiency agendas.[4] Indeed it seems that economic utilitarianism is increasingly the major justification for promoting gender equality, yet with a version of gender equality based on some rather dubious assumptions.

These assumptions not only encompass the inclusion of women and girls as an "untapped resource"; they also trade on the idea that women and girls represent "value for money," not least because they are nominally more altruistic than men and boys, as well as more likely to be risk-averse entrepreneurs.[5,6,7,8] A further element in this assemblage is that women are "better able to incorporate compassion and humanitarianism within business practice."[9] It is little surprise, therefore, that one of the concerns raised in feminist circles relates to the instrumentalization of women to alleviate poverty, despite ostensible gestures towards "empowering" them in the process.[10,11,12,13,14,4] Such tendencies intensify a longer-observed trend for women to end up working for "development" – rather than development working for women.[15,16,17,18,19]

> "One of the concerns raised in feminist circles relates to the instrumentalization of women to alleviate poverty"

While not disputing that economic growth might be highly desirable, questions remain as to whether we should be relying on women to bear the responsibility for accomplishing such an objective.[20,21] Women end up as the duty-bearers for household poverty alleviation, with responsibility for childcare, farm work and other essential activities, while men's exclusion can effectively excuse and/or alienate them from collaboration in this struggle. On top of the immizeration and emasculation associated with male losses in the labor market, this can also play a role in exacerbating tendencies to stereotypically "disaffected male behavior" such as violence in the home and community, or drug or alcohol abuse.[22,23,24,25] None of this is good for men themselves, or for women and their children. As summarized by the United Nations Development Fund for Women (UNIFEM): "One might even argue that the economic and social reproductive realms which women are expected to tread overextend the range of roles and responsibilities of women compared to men, which does not necessarily enlarge their life choices, but may even limit them."[26] UN/UNIFEM's concerns are pertinent when weighing up some of the pros and cons of three significant female-focused strategies to deal with poverty in the Global

Recycling tin cans into cooking pots, Fajara, The Gambia

South: conditional cash transfer (CCT) programs, microfinance schemes and "investing in girls."

Intensifying women's unpaid work

CCT schemes nominally aim to "empower" women and to alleviate poverty simultaneously by channeling pecuniary handouts through women. Putting money in the hands of women signals social recognition of their conjectured financial prudence as well as altruism towards other household members, and provides official legitimation for greater female control of household income. Moreover, the fact that there have been some notable successes reveals that such programs may well provide possibilities for women to exit poverty in the medium to long term.

Nonetheless, CCTs have come in for criticism on account of their use of women as bearers of benefits to others. In placing pressure on women to intensify their unpaid maternal and community roles, while making little attempt to enjoin men in the process, this approach has entrenched a highly non-egalitarian model of the family.[27] Adult women's current needs are bypassed not only through male exclusion, but also in that they are expected to make sacrifices for future generations. Indeed, the stipulations for being a beneficiary household can thwart women's own initiatives to earn income. Paradoxically, this goes against the grain of trying to encourage greater female participation in remunerated activity, which constitutes a second string of feminized anti-poverty policy.

> "Adult women are expected to make sacrifices for future generations"

Intensifying women's remunerative activity

While CCTs capitalize on women's unpaid reproductive labor, in microfinance schemes the emphasis is more on women's "productive" work – which might, on the surface, seem more "empowering." Indeed, given women's historically limited access to formal credit,[28] micro-loans arguably create opportunities for women to embark upon and/or scale up their entrepreneurial ventures, to improve personal wellbeing and economic status, and, in the process, to challenge gender inequality. However, with group microcredit schemes frequently being "women-only" affairs, sociocultural barriers to women's entrepreneurship and empowerment tend to remain unchallenged, thereby minimizing the chances of significant gender transformation.[29] For this reason, many readings of microfinance are less than sanguine. As observed by Federici: "It is significant that loans, usually involving very small sums of money, are given mostly to women and in particular to women's groups, although in many cases it is the husbands or other men in their families who use them."[30]

Female entrepreneur with baby in tow, selling maize on the street, Kanifing, The Gambia

Over and above these concerns, the limitations of microfinance in offering a meaningful pathway out of gendered poverty are compounded by a lack of specialist guidance in enterprise growth, weak local or wider economies, and grassroots needs to divert loans to solving repeated crises of domestic consumption.[31,32,33,34,35] As highlighted by Federici: "Far from lifting themselves out of poverty by some 'virtuous' investment, [women] plunge more deeply into it, going from a small debt to a bigger one in a sequence that often ends in suicide. Even where they do not die physically, many borrowers die socially."[36]

Enabling young women to "stop poverty before it starts"?

Since the early 21st century, feminized solutions to world poverty have taken a new turn in the form of extending the remit to girls, not only as a vanguard for "turning poverty around," but also "stopping poverty before it starts."[37] For instance, the Nike Foundation makes almost uncannily precise estimations of how much the neglect of girls represents for lost economic growth, and how much might be gained by their inclusion.

The Nike Foundation was one of the earliest corporate actors to make the case for "investing in girls." It has done this via a movement called The Girl Effect, which was launched in 2008 and which involves partnerships with NGOs in developing countries, as well as with major multilateral and national agencies such as the World Bank and the UK's Department for International Development (DfID). The objective of the Girl Effect is to promote girls' "empowerment" through a variety of means, including education, vocational training, health and reproductive awareness, alternative forms of girlhood and womanhood, and sensitization to human rights. Yet while "empowering" girls

is clearly a worthy objective, it should also be borne in mind that one of the major justifications for Nike's campaign is that adolescent girls are the "world's greatest untapped solution" to eradicate poverty.[38] As articulated by the Nike Foundation's President and Chief Executive Officer, Maria Eitel: "In the world today, there are an estimated 250 million adolescent girls living in poverty. The untapped potential of these 250 million girls is the most powerful source for positive change."[39]

The "positive change" envisaged is one in which, again in line with "Smart Economics" orthodoxy, "empowered girls" will not only glean rewards themselves, but also benefit their families, communities and countries. In light of this, it is perhaps no surprise that the Girl Effect has been criticized by numerous feminist scholars on two fronts: first, on account of its suppositions about young women in developing countries as innately altruistic, and second, for the use of these "values" in maximizing the economic and societal returns from female-focused investments at the expense of promoting girls' rights.[40]

"The Girl Effect has been criticized by numerous feminist scholars"

Not only is there an issue with perpetuating bi-polar stereotypes of Global North and Global South girls, but also girls versus boys, who are largely off the radar – presumably on account of the fact that the "returns" from investing in boys are likely to be of lesser magnitude. As identified by Chant and Sweetman:[11] "[T]he issue of 'gender' as characterized in 'smart economics' messaging, and the programming emanating from it, focuses narrowly and exclusively on the agency of women and girls, and leaves men and boys out of the picture. Is this because the focus is on economic investment rather than economic, social and political change, and economic investment in men and boys is regarded as already sufficient? Or is it because the prospective "returns to development" from male investments might be less than those from their female counterparts? And if the latter is so, to what degree does this imply the perpetuation of stereotypes of male 'egoism' and 'irresponsibility' versus female 'altruism' and 'self-sacrifice'?"

Concluding comments

In the cases discussed here, the translation of assumptions anchored in traditional "feminization of poverty" thinking into the "feminization" of anti-poverty initiatives is not an unqualified success. Indeed, there is instead little convincing evidence to suggest that goals of "female empowerment" and gender equality are guaranteed by dragooning women and girls into efforts to solve world poverty.

Part of the human rights agenda is the ability to make choices, but despite the ambitious rhetoric embedded in contemporary flagship policy documents like that of UN Women (2015), could it be that women and girls are not being empowered to

"Girl Effect" campaign image

make any choices other than those which tie them ever more inextricably to serving others? As summarized by Cornwall and Edwards,[41] women's and girls' empowerment as framed by development agencies means that this is often pursued under conditions "that are not of their own choosing."[42]

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Improving Maternal and Child Nutrition Outcomes

Public-private partnerships in the food system

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Key messages

- Unsustainable food systems are both a cause and a consequence of a variety of interrelated factors.
- Fortunately, food systems are increasingly receiving the long-awaited global attention they deserve.
- A sustainable food system is "a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised."
- There are many multisectoral nutrition-specific and nutrition-sensitive interventions needed in the food system.
- Public-private partnerships (PPPs) have been at the center of many interventions in the food system aimed at making it more sustainable.
- This article explores how PPPs can increase food system sustainability and to what extent these improvements positively impact maternal and child nutrition outcomes.
- Transforming the food system will require numerous interventions at various levels ranging from local-level innovations to a reform of the global-level governance of food, health, nutrition and agriculture.

The sustainability of food systems is affected by many factors

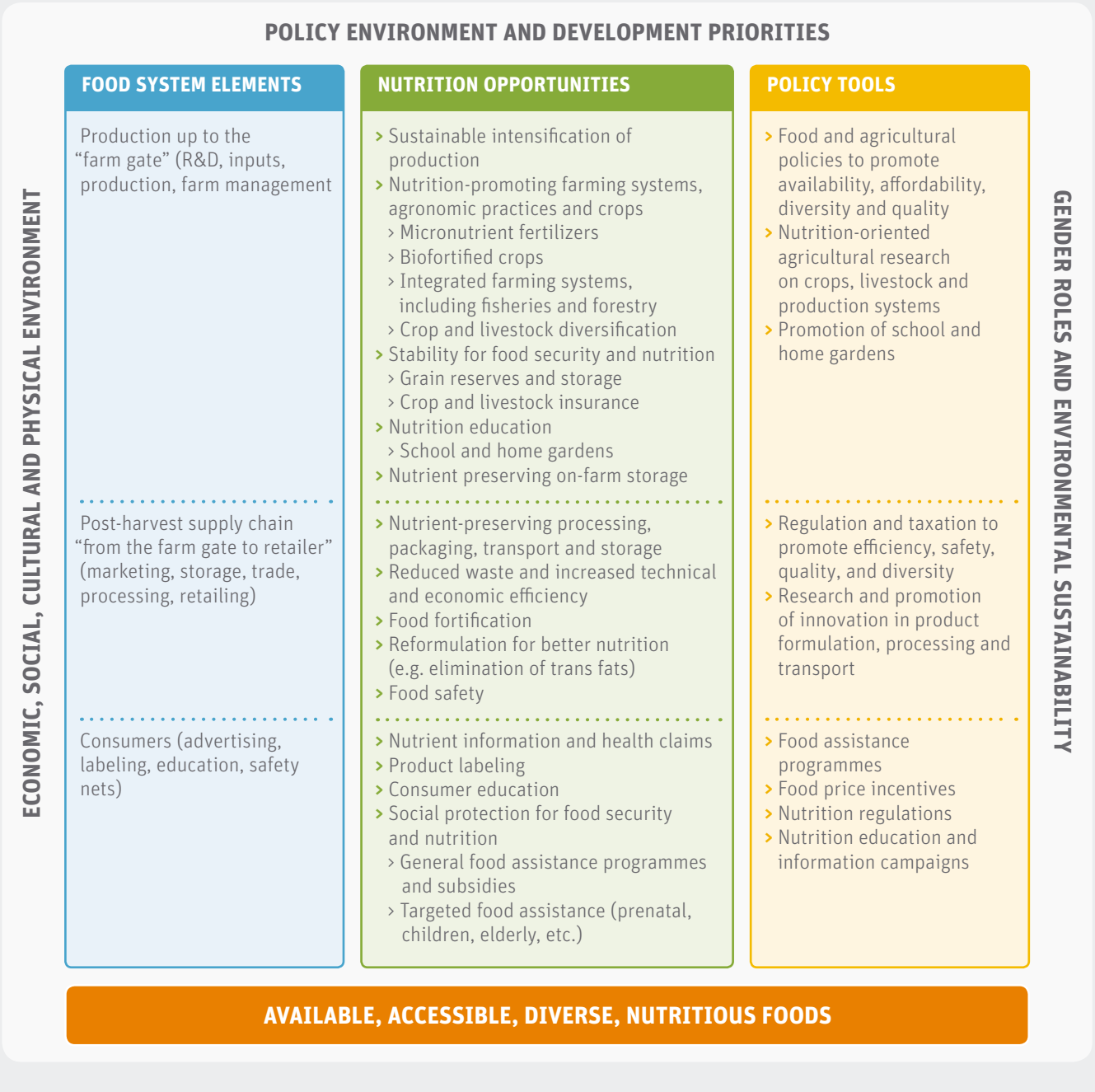
It can be argued that the current global food system is unsustainable. Unsustainable food systems are both a cause and a consequence of a variety of interrelated factors ranging from trade policies, climate change, a transition in people's diet more commonly known as the "nutrition transition," and social unrest and conflict. Although there is no doubt that a lack of democracy led to the ongoing Syrian civil war, the major drought the country faced between 2006 and 2010 reduced the availability of barley and wheat, which in turn increased food prices and resulted in a dissatisfied population protesting in the streets in March 2011.[1]

Fortunately, food systems are increasingly receiving the long-awaited global attention they deserve.[2] Laudable commitments were made at COP21[3] recognizing "the fundamental priority of safeguarding food security and ending hunger, and the particular vulnerabilities of food production systems to the adverse impacts of climate change" and setting the stage to support the transition to a climate-resilient agriculture.[4] Moreover, the Sustainable Development Goals (SDGs) adopted in September 2015 call for the world to "halve per capita global food waste at the retail and consumer level, and reduce food losses along production and supply chains by 2030."

Sustainable food systems to deliver improved nutrition outcomes

A sustainable food system is "a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised."[5] Food systems can be shaped in such a way that these positive nutrition outcomes are maximized. This requires a combination of sustainable solutions that include sound policies, improved knowledge, regulations and investments along the production-to-consumption spectrum in order to trigger behavioral changes among food producers, consumers, distributors, processors and women in particular, given their key role in channeling food system outcomes into the health and nutrition of their

FIGURE 1: Food system interventions for better nutrition[5]



children.[6] There are many multisectoral nutrition-specific and nutrition-sensitive interventions needed in the food system (Figure 1).

Public-private partnerships (PPPs)[7] have been at the center of many interventions in the food system aimed at making it more sustainable. According to the International Panel of Experts on Sustainable Food Systems, achieving sustainable food systems requires a trans-disciplinary approach whereby farmers, the food industry, consumers, and the public and private sectors' knowledge and unique understanding of food systems must be leveraged to achieve more ambitious results than they would achieve separately.[8,9] PPPs along the food supply chain can contribute to better economic, social, and environmental outcomes. Through a few case studies, this article aims to explore how PPPs can increase food system sustainability and to what extent these improvements positively impact maternal and child nutrition outcomes. The term PPP here is used in a broad sense and includes multipartner structures that bring together private entities, foundations, universities and NGOs.

The role of smallholders in sustainable agriculture

About 70% of the 1.4 billion extremely poor people of the developing world live in rural areas, meaning that in order to reach poverty reduction targets, smallholders' livelihoods must be significantly improved.[10] Furthermore, smallholders play an essential role in the attainment of global food security. As the world urgently needs to close the gap between the food currently available and the food that will be needed by 2050, overall worldwide annual crop production will have to increase by 69% vis-à-vis 2006 levels, and the production in developing countries will have to almost double.[10,11] Additionally, due to the labor-intensive nature of their farms, smallholders are major contributors to social and economic sustainability, as they create more jobs than do larger high-tech farms.[12] An increased income for producers and smallholders, and lower prices for nutritious foods, can simultaneously improve livelihoods and enhance the accessibility and availability of varied foods.

The link between female smallholders and food sustainability is even stronger. There is significant evidence suggesting that raising women's wages rather than men's is considerably more effective in enhancing children's nutrition, health and household food security.[13] A study in Cote d'Ivoire revealed that improvements in nutrition and child health brought about by a US$10 increase in women's income would require a US$110 increase in men's income.[13] Moreover, upgrades in women's status represent 11.6% of global reductions in the proportion of children who are underweight, and changes in women's secondary education enrolments account for 43% of global reductions in the proportion of children who are underweight.

To increase male and female smallholders' social status through the food supply chain, a competitive retail and manufacturing sector must be in place. However, integrating smallholders into domestic food value chains remains a challenge in developing countries, where smallholders face technological constraints (e.g., storage capacity, know-how, technical efficiency); structural constraints (e.g., climate, regulations, culture and traditions); and financial constraints (e.g., credits and cash-flow deficits), to name but a few.[14] These challenges are far greater for women, whose farm work is often not remunerated, and who tend to be excluded from decision-making and to have unequal access to land, markets, education, credit, extension services and inputs. In Africa, for instance, women only own 1% of the total agricultural land, they access less than 10% of agricultural credit offered to small-scale farmers, and they receive 7% of extension services. Moreover, social norms can impose even more restrictions on women's empowerment and their control over decision-making power regarding family income, which in turn hinders their ability to develop small businesses.[15]

> "Integrating smallholders into domestic food value chains remains a challenge in developing countries"

The role of PAFA in supporting producer organizations

PPPs' role in linking smallholders with high-value markets is well established (see **Table 1**). The Agricultural Value Chains Support Project (PAFA) – established in 2010 for a 6-year period and funded by the International Fund for Agricultural Development (IFAD) and the OPEC Fund for International Development – aims to sustainably improve the incomes and livelihoods of farming families from the Groundnut Basin area of Senegal by providing support for local value chains. PAFA supports five value chains: sorghum, *niébé* (cowpea), sesame, poultry and hibiscus. Small and vulnerable farmers are supported to access markets through production contracts between their farmer/producer organizations (POs) and the private sector. As part of this partnership, the POs are required to deliver a certain production quantity at a given time, which meets the criteria and quality standards specified in the contracts. Likewise, private market operators commit to buy this production in line with the modalities and prices established in advance.[16] The partnerships also set up a co-financing system for agricultural inputs (e.g., seeds and fertilizers) and equipment, which enables producers to cover their needs well in advance and to prepare for the next crop. During the first year, the PAFA funds 80% of the POs' needs, 60% in the second year, 40% in the third, and in the 5th year POs bear the full costs for inputs.[16]

Since the start of the project, producer groups supported by PAFA have seen their yields and revenues increase significantly. While PAFA's original goal was to reach 14,000 households, within a five-year timeframe, it increased the income of around 26,000 vulnerable households.[17] Seventeen cowpea POs of the Diourbel (330 ha) and Fatick (150 ha) regions had a satisfactory harvest, from which 500 rural households benefited. In the Diourbel region, harvest yields reached a net increase of 420–550 kg/ha as opposed to 200 and 157 kg/ha in the last five years.[18] The same trend was observed in the regions of Fatick and Kaffrine for the eight sesame POs. Moreover, the project provided producers with 50 storage facilities for small grain within two to three years, and the hunger gap decreased from 7 to 3 months.[19]

Data on outcomes such as decreasing malnutrition rates or changes in diet and feeding practices were not available, although subjective evidence suggests that these indirect outcomes have occurred. Nonetheless, positive outcomes in harvest yields have led to the extension of the project beyond the Louga region.[19]

TABLE 1: Public- and private-sector roles in supply chain management of high-value agricultural products[10]

Supply chain support processes	Possible roles for public-private partnership
Extension and information services	> Knowledge of specialized techniques for high value agriculture, markets (prices), rules and regulations in private and public sectors could be complementary > Public sector could subsidize costs of information about food safety standards and other market requirements for smallholders
Infrastructure development	> Manage flows between chain links quickly and efficiently; reduce distribution costs to remain competitive. This requires public (roads, ports, storage facilities) and private (processing, storage, logistics, etc.) infrastructure that could be provided through partnerships
Certification, grades, and standards	> Consistent, credible application of standards on food safety and quality specifications. Establishment of certification agencies that provide affordable services to smallholders could require public-private partnerships. Government could influence formation of standards (jointly with private sector) customized to the needs of smallholders
Coordination mechanisms	> Public sector responsibility for regulation to ensure competition and enforcement of contracts could be developed jointly with the private sector and smallholders

The role of Purchase for Progress (P4P)

Purchase for Progress (P4P) is a five-year pilot initiative initiated by the World Food Programme (WFP), the Bill & Melinda Gates Foundation and the Howard G Buffett Foundation in 2008 and managed by WFP. Within the framework of this initiative, stable demand from WFP and partners provides smallholder farmers with an incentive to invest.[20]

In 2015 in Ethiopia, WFP bought 30,000 metric tons (MT) of maize from smallholder farmers. The use of forward delivery contracts (FDCs) – enabled by a successful collaboration between the government, banks, cooperative unions (CUs), donors, and NGOs – has played a key role in making this possible. WFP contracts enabled famers' unions to access loans from the Commercial Bank of Ethiopia (this was previously restricted to exporters only), which in turn enabled the cooperatives to purchase food from their members, thereby integrating smallholder farmers into the market mainstream.[21]

The positive results of this partnership are many, ranging from enhanced leadership and management capacity for women in both Rural Saving and Credit (RUSACCO) and Primary Cooperatives (PC) to P4P's locally procured food being served in WFP school meals in 37 pilot schools in Ethiopia. Nevertheless, initial estimates of the impact of P4P in Ethiopia do not find statistically significant differences in household welfare measures (real income, asset scores, livestock holdings, and food consumption scores) between non-P4P and P4P smallholder farmers. In fact, while the intention for P4P was to impact one level of the supply chain (smallholders), P4P interventions were directed at another level of the supply chain (the farmer organizations).[22] Purchases and supply-side interventions had to 'trickle' down the supply chain from the CU to the PC to the smallholder in order to have an impact, and thus they needed to be substantial enough to influence the behaviors and outcomes for smallholders.[22]

Creating economically sustainable systems through the post-harvest supply chain

In terms of economic sustainability, for the last 20 years, French NGO GRET has been testing different approaches in Madagascar to make high-quality complementary foods readily available to the greatest number of people without their having to depend on charity aid programs. Enhancing the nutritional quality of foods

A Malagasy Hotelin-Jazakely

An *animatrice* feeding a child on her mobile round

is an important determinant of health and social sustainability in the long run, as poor nutrition leads to diseases related to being overweight, obese or undernourished, which result in increased national healthcare expenditure and loss of income.

Nutri'Zaza (**Table 2**) is a Malagasy social enterprise that was set up in 2013 with a twofold aim: first, to put in place a socially sustainable approach whereby the developed system would be scaled up and have a significant nutritional impact, and second, to create an economically sustainable system that would not eternally depend on external grants but rather cover its own costs.[23,24] Nutri'Zaza was created by GRET and other shareholders including TAF (the *Koba Aina* manufacturer), I&P and SIDI (two French investment funds), APEM (a local, Malagasy association) and GRET.[24] Nutri'Zaza sells *Koba Aina*, a local, industrially produced infant-and-young-children flour mix fortified with minerals and vitamins, and sells the product through three distribution networks. The first of these is the original distribution network of 'baby restaurants' (*Hotelin-Jazakely*) and the door-to-door mobile rounds led by so-called *'animatrices,'* in which context it is provided in the form of ready-to-eat porridge; the second is a traditional retail channel where *Koba Aina* is sold in single-serving sachets; and the third is an institutional distribution network through which the product is sold to NGOs, the United Nations and local institutions for them to distribute freely. The complementarity between these three networks ensures the profitability and sustainability of the social enterprise. Currently, the partnership benefits from a 1.2 million € subsidy from the *"Agence française de développement,"* which also provides a subsidy to GRET to support the project, and 509,000 € from its shareholders until it reaches a minimum sales volume, enabling it to cover its costs. It is expected to become financially independent in 2018.

In terms of results, Nutri'Zaza currently employs 80 people, works with 40 women, and is present in 23 cities in Madagascar. Although more than 12.5 million meals have been distributed since 2013 and about 17% of infants in baby restaurant neighborhoods are regular consumers (more than 25 meals/month), the nutritional impact of Nutri'Zaza still needs to be assessed.

Conclusion

Although there would appear to be a lot of evidence on the relevance of PPPs during the initial phases of projects (illustrated by the examples of PAFA, P4P and Nutri'Zaza), and numerous positive impacts for the beneficiaries, further investigation shows that there are very few independent rigorous assessments of the impact of private-sector engagement on improved maternal and child nutrition, and that there is therefore not enough evidence to support broad statements. Enhancing sustainability is also about measuring impact and ensuring accountability. Where the evidence base is weak, efforts must be made to investigate further. Caution is therefore necessary when assessing criticisms or commendations of PPPs in food systems, particularly when it comes to suggesting their positive impact on nutrition.[25] While the case studies are instructive and do give an overview of the range of different levels of outcomes (not enough evidence and/or enough evidence which needs further research), increasing and more relevant evidence on the indirect outcomes needs to be generated in order to establish the link between PPPs and improved maternal and child nutrition (e.g., malnutrition rates, changes in diet, and feeding practices).

Throughout the literature, there seems to be general agreement that continued collaboration across sectors is fundamentally needed. Although not explored in this article, there are several best-practice examples from which we can certainly learn. Transforming the food system will require numerous interventions at various levels ranging from local-level innovations to a reform of the global-level governance of food, health, nutrition and agriculture. Additionally, accountability needs to be pursued so as to optimize the effectiveness of PPPs and, most importantly, to investigate their impact on maternal and child nutrition.

"Enhancing sustainability is also about measuring impact"

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TABLE 2: Roles, interests and elements for success of Nutri'Zaza partners

Partner	Roles & Interests	Elements for success
TAF is a major local agrifood company created in 1945, specializing in coffee roasting, tea production and various spices of Madagascar. It is the producer of *Koba Aina*, and its sole supplier. It signed an exclusive contract with Nutri'Zaza for its distribution.	› TAF is a 20% shareholder in Nutri'Zaza and the producer of *Koba Aina*. The company ensures the quality and thus the reliability of the product. › TAF's investment in Nutri'Zaza stems primarily from a social, not financial, motivation.	**Shared goal:** The five shareholders all agreed on the social purpose of the company and agreed not to receive dividends beyond the amounts initially invested. All profits will be directly reinvested into the company, to expand and improve the *Hotely-Jazakely* network.
GRET is a French development NGO, which has been active for 40 years, from the field to the political sphere, in the fight against poverty and and inequality. It is Chairman of the Board of Nutri'Zaza.	› GRET is a 44% shareholder in Nutri'Zaza. Hotelin-Jazakelys were developed in 1994 as part of GRET's program in Madagascar (Nutrimad). They serve as the basis of Nutri'Zaza. GRET provides technical support to Nutri'Zaza (through its contract with the "Agence française de développement" it chairs the Board of Nutri'Zaza and shares experiences and lessons learned, with the aim of replicating the model and scaling it up in different contexts. › GRET's interest lies in improving the nutritional status of the population, contributing to development, and steering an innovating social entrepreneurship experience.	**Local context:** *Koba Aina* is produced from local raw material except for the vitamins and minerals; the product is in line with international quality standards that were elaborated with research partner IRD; its producer, TAF, is a local company; the product is adapted to the local context in terms of pricing, taste and format; Nutri'Zaza created jobs locally for female "*animatrices*"; the distribution network of *Hotely-Jazakely* was developed in partnership with Antananarivo University. **Key metrics:** Production of social indicators that will allow the Ethics and Social Monitoring Committee to report annually on Nutri'Zaza's social mandate (e.g. price of *Koba Aina*, number of *Hotely-Jazakely* opened, job creation and salary etc.). **Sustainability:** The social business approach was introduced to ensure the program's sustainability; Nutri'Zaza still receives funding from public sector (EUR370,000 p.a.) until full economic viability in 2018; the Nutri'Zaza White Book was developed to replicate the Nutri'Zaza experience and contribute to the debates on social entrepreneurship. **Governance:** To secure its social mandate, several safeguards were implemented, including a shareholders' agreement and binding statutes, a charter, and the creation of an ethics and surveillance committee made up of GRET's former research, policy and technical partners in Madagascar. **Added value/complementarity:** GRET has been active on the ground in Madagascar since 1994. Its close relationships with the Ministry of Health, the Malagasy Nutrition National Board and the University of Antananarivo, along with its reputation and expertise in the field, make it well placed to steer and maintain the project's social vocation. › TAF brings product quality and reliability to this partnership. › Capital from the social investors (SIDI and I&P) enables Nutri'Zaza to consolidate its economic model and to diffuse its social impact before ensuring capital gains and to deploy at larger scale. › APEM's expertise in promoting entrepreneurship specifically in a Malagasy context makes it a key partner to further sensitize Madagascar to the concept of a social enterprise and to pave the way for scale-up.
I&P (*Investisseurs & Partenaires*) aims to finance and support entrepreneurs in Africa.	› I&P is a 22% shareholder in Nutri'Zaza. It has a seat on the Board of Directors and influences strategic decision-making based on its experience.	
SIDI is a French social investor and has a long-term presence in Madagascar alongside Malagasy microfinance institutions and producer organizations.	› SIDI is a 22% shareholder in Nutri'Zaza. It also brings to the Board of Directors its experience as a social investor, and influences strategic decision-making.	
APEM is a non-profit organization that was founded in 1987 by twenty members of the Business Group in Madagascar. It aims to fight against poverty by enabling micro and small enterprises to access microfinance services.	› APEM is a 2% shareholder in Nutri'Zaza. It has a seat on the Board of Directors and influences strategic decision-making based on its experience.	

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Civil Society

An essential partner for improved nutrition

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The need for urgent measures to tackle undernutrition

Malnutrition is estimated to contribute to more than one third of child deaths globally.[1] Malnutrition can take several forms, including hunger, undernutrition, overnutrition, and micronutrient deficiencies. Chronic undernutrition in children under the age of five results in stunting, which leads to cognitive impairment, with adverse effects all the way from household to national level. In Zambia alone, 40% of children under five are stunted, while every year 42% of deaths in children under five can be attributed to undernutrition.[2] The short- and long-term economic and social implications of these statistics pose a problem requiring urgent attention.

Exploring the roles that various stakeholders can play here is important, as the best chance of success in addressing the problem is by approaching it from a multisectoral perspective that leverages the core competencies of each party. Among these, civil society organizations (CSOs) have a key role to play, especially in countries that are already resource-challenged.

The role of civil society

The role of civil society involves more than merely generating demand for nutrition. It extends to include securing political commitment to nutrition and ensuring accountability for nutrition results. Civil society therefore plays a key role in any efforts aimed at improving nutrition. It has an important task to perform in making visible the problem of malnutrition and in raising awareness of it among political players, policy-makers and implementers.

> "Civil society has to secure political commitment and ensure accountability for nutrition results"

Across a range of countries and settings, civil society organizations have helped improve the policy environment for addressing the many challenges surrounding nutrition. This has been achieved through advocacy, building consensus among other civil society actors and policy advocates, and working to shape policy solutions and recommendations for improved nutrition. At the global level, civil society has helped build support for the Scaling Up Nutrition (SUN) Movement among donor governments, while at the country level, civil society organizations have an important role to play in strengthening the political will, engaging in policy development and reform, designing and implementing programs, and monitoring progress against agreed targets.

The strategic position of CSOs, especially those based in communities affected by malnutrition, further promotes greater understanding of the causes of undernutrition. For this reason, national strategies to achieve improved nutrition require the support and involvement of CSOs, as they play a role quite different from that played by other stakeholders. First and foremost, they are there to hold government to account for its actions. Secondly, CSOs represent important segments of the population in a manner distinct from government, as they directly reflect, and respond to, the needs of a broad range of communities. Moreover, they have developed integrated solutions, as they are used to working across different sectors.

We need everyone working within the nutrition space – from governments through implementers to donors – to add their voices to the call for increased attention to the essential issue of nutrition. It is vital to do this in a coordinated manner that supports global nutrition priorities and helps improve nutrition.

> "We need everyone in the nutrition space to add their voices to the call for increased attention to nutrition"

Making the case for nutrition

While governments continue to make commitments at various national, regional, and global forums, effective follow-through is often lacking. Governments need to start walking the talk;

Chief Mwansakombe Samfya speaks during the CSO-SUN Alliance Global Day of Action

however, the onus cannot be on governments alone. It falls to all of us to ensure that governments prioritize nutrition. CSOs have an important role to play in building understanding of the importance of nutrition among citizens, so that these can demand better nutrition and hold their leaders to account for their commitments.

Experiences from Zambia

Since 2011, CSOs in Zambia have helped position the issue of maternal and child nutrition as a national priority. In 2012, the Zambia Civil Society Scaling Up Nutrition Alliance (CSO-SUN) was established, bringing together a group of diverse actors tasked with raising understanding of nutrition and of the services required to support improved nutrition. Working as a part of the Global SUN Movement, the CSO-SUN was founded on the principle that all people have the right to food and good nutrition. CSO-SUN is the first and only nutrition advocacy platform for Civil Society in Zambia. It has managed to engage 75 members of local and international NGOs and civil society groups, making it one of the most influential civil society organizations working in any arena in Zambia. This alliance has raised awareness of the impact of chronic maternal and child malnutrition on Zambia's development.

The work of the Zambia CSO-SUN has been necessitated by the fact that there has been little support from the general population, political players and policy-makers, who often have no direct experience or personal understanding of nutrition issues. The CSO-SUN has used both conventional and creative ways of raising the profile of nutrition in Zambia.[3] The means have included, but not been limited to, the following.

Overview of CSO-SUN's advocacy efforts

Working with members of parliament

CSO-SUN has found that working closely with parliamentarians has been effective in raising the profile of nutrition in Zambia. This approach has had the double benefit of making nutrition a priority in parliamentary discussions as well as helping create champions for nutrition. This partnership has seen CSO-SUN being regularly invited to make submissions and appear before various committees of the Zambian Parliament. It has also helped parliament to make better informed decisions on issues that affect nutrition. As a part of this, CSO-SUN facilitated the formation of the All-Party Parliamentary Caucus on Food and Nutrition (APPCON) – a committee of MPs dedicated to food and nutrition development – thereby prioritizing policy and financial issues through parliamentary debate.

Working with the media – The Nutrition Media Awards

Awards and public recognition have proved a sure-fire way of strengthening engagement with the media. Recognizing media professionals who have gone out of their way to advance nutrition helps ensure their continued commitment. Additionally, journalists and media broadcasters help stimulate the interest of previously oblivious media personnel. CSO-SUN has also engaged the media in efforts to create demand around the sector, through initiatives such as nutrition training workshops for media producers and editors. These workshops were an avenue to bring together representatives of national- and district-based media institutes, who received training on nutrition issues that affect the face of development in the country. The workshops have also been an opportunity for CSO-SUN to extend its awareness-

raising campaign to other provinces through the community radio stations that participate in the trainings. They have paved the way for increased coverage of nutrition through community radio stations in the provinces and also at national level.

The Vote Nutrition Campaign

CSO-SUN has taken the opportunity presented by recent elections to educate voters to choose candidates on the basis of their campaign promises. In 2014, which saw a presidential by-election, and subsequently for the full election in 2016, the CSO-SUN ran the "Vote Nutrition Campaign." In 2016, in recognition that every political party is potentially a government-in-waiting, CSO-SUN targeted political parties with messages that would secure their commitment to nutrition should they come to form a government. In making nutrition an election issue and asking all political parties to make nutrition policy pledges, CSO-SUN has a basis on which to hold the political parties to account if elected.

Making nutrition affordable through other advocacy efforts

Creating awareness of nutrition, and gaining the commitment of decision-makers, is essential for influencing policies and practices. The economic costs of not investing in nutrition are significant and have an enormous bearing on the state of food and nutrition security in the country. It is therefore a priority for civil society to influence government and other stakeholders with the aim of ensuring better-funded, effective, large-scale programs to tackle undernutrition. Targeting high-level decision-makers is key.

Encouraging nutrition champions – people with a public profile and a passion for nutrition – has proved essential in advancing the nutrition agenda in the context of the competing interests both between and within various groups of stakeholders. Nutrition advocacy champions with both political and technical backgrounds are needed at all levels to create effective political demand for better nutrition. This has been a primary goal of the CSO-SUN Alliance.

The CSO-SUN Community Sensitization Chongwe Drama Group in action

Work still to do

Despite the positive efforts of civil society to date, much remains to be done to articulate an evidence-based case for advancing the nutrition agenda. CSOs should seize every possible opportunity to document their experiences in the communities where they are working.

Civil society should also take advantage of community engagement by further accelerating efforts to combat undernutrition and at the same time to work against the current rise in overnutrition. CSOs will need funding, as they often draw their staff from these communities and work close to the ground.

Above all, civil society needs to harness the current positive momentum supporting nutrition, and must explore every means of pushing the envelope even further to drive changes in the global and local nutrition landscape. While many positive changes have occurred over the past few years, there are still many opportunities to accelerate positive change. Civil society has played an important role in gearing up action on nutrition, and this newfound focus must be sustained.

> "Civil society needs to harness the current positive momentum supporting nutrition"

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Cracking the Egg Potential During Pregnancy and Lactation

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Key messages

- This paper sets forth a nutritional rationale why eggs, and interventions to provide more eggs to at-risk pregnant and lactating women, in addition to iron and folic acid supplements, may be a sensible strategy to reduce neonatal deaths and stunting.
- Eggs provide a balanced source of energy and protein as well as essential fatty acids and a large range of vitamins, minerals, and other bioactive compounds that could likely improve nutrition during pregnancy and birth outcomes.
- Eggs have great potential to improve nutrition among vulnerable populations living in resource-poor settings. Eggs are also likely to be especially important in vegetarian populations.
- Maternal consumption of eggs during lactation can also enhance the breast milk content of certain nutrients and thus potentially contribute to child nutrition and development when children are breastfed. Nevertheless, egg consumption is relatively low among women of reproductive age.
- Chicken production and egg consumption may be a locally available and feasible option to improve maternal diets during pregnancy and lactation.

The value of a simple egg

It should not be surprising that a simple egg, which provides a chicken embryo nutritive support from conception to the time it hatches, might also be an important food to support fetal growth and development during pregnancy. Eggs have great potential to improve nutrition among vulnerable populations living in resource-poor settings.[1] They provide a nearly complete source of protein and are also an important source of essential fatty acids, choline, vitamins A and B_{12}, selenium, and other critical nutrients. At the same time, compared to other animal-source foods, they cost less and are available and valued as a food in virtually all parts of the world.

A woman's nutrition before and during pregnancy is essential to ensure optimal fetal growth and development as well as for her own health and wellbeing. The 2013 Lancet Series on Maternal and Child Nutrition provided evidence that poor maternal nutrition is the cause of more than 200,000 neonatal deaths and 20% of stunting in children less than five years of age.[2] It also identified balanced energy protein supplements and supplements of calcium and multiple micronutrients as promising interventions to reduce intrauterine growth restriction and small-for-gestational-age births.[3] In this paper, we set forth a nutritional rationale why eggs, and interventions to provide more eggs to at-risk pregnant and lactating women, in addition to iron and folic acid supplements, may be a sensible strategy to reduce neonatal deaths and stunting.

The contribution of eggs to nutrient requirements during pregnancy and lactation

Eggs provide a balanced source of energy and protein as well as essential fatty acids and a large range of vitamins, minerals, and other bioactive compounds that could likely improve nutrition

Chickens in the Cotopaxi Province, Ecuador

during pregnancy and birth outcomes. The recommended levels of nutrient intake for pregnant and lactating women, the nutrient content of a 50 g egg, and the proportion of the required intake met by consuming two 50 g eggs are presented in **Table 1**. The proportion of dietary requirements for pregnant and lactating women provided by eggs is summarized by categories in **Table 2**. During pregnancy and lactation, two 50 g eggs provide more than 25% of the nutrient requirement of riboflavin (vitamin B_2), cobalamin (vitamin B_{12}), phosphorus, selenium and choline.

Yet, egg consumption is relatively low among women of reproductive age. Round V of the Demographic and Health Surveys conducted between 2005 and 2010 collected dietary information from women of reproductive age (**Table 3**). Egg consumption the day prior to the survey ranged from 2.9% in India to 62.5% in Honduras and was lower in African countries compared to those in Latin America and the Caribbean with the exception of Haiti, where consumption was also very low.[4]

Fetal cells grow in size and number at a rapid rate, requiring a steady and increasing pool of nutrients, such as protein. Pregnant women also have their own protein needs.[5] An ideal food during pregnancy is one with a high digestible indispensable amino acid score (DIAAS).[6] Eggs, similar to other animal-source foods, are classified as one of the highest quality proteins, using the new DIAAS indicator.

While protein deposition in maternal and fetal tissues increases throughout pregnancy, most occurs during the third trimester. The current Estimated Average Requirement (EAR) and Recommended Daily Allowance (RDA) recommendation is for all stages of pregnancy and does not take into account the changing needs during its different trimesters. A recent study suggested that protein requirements are substantially higher than current recommendations at about 14%–18% of total energy.[5] When the protein intake is balanced at < 25% of energy, a reduced risk of low birth weight has been observed. However, excess protein may also be harmful. One study found that high protein diets in low-income New York City women were associated with greater risk of small-for-gestational-age infants when the protein intake was > 34% of calories.[7] Two eggs per day would provide ~70 kcal from protein, which would not put a woman in excess of 34% of her caloric intake from protein.

The nutritional value of an egg, however, goes beyond high-quality protein. It is also an important source of fatty acids, which vary in accordance with hen species and the diet they receive. Moreover, chicken feed can be enhanced with docosahexaenoic acid (DHA), which in turn enhances the content in eggs.[8] Essential fatty acids and DHA in particular are critical for early brain development.[9] Studies have shown that cholesterol, relatively high in eggs, does not increase the risk of heart dis-

TABLE 1: Recommended levels of nutrient intake (RDA or AI) for pregnant and lactating women, nutrient content of eggs, and the proportion of dietary intake provided by eggs[38,39]

Nutrients	Unit	AI/RDA Pregnancy (19–50 y)	AI/RDA Lactation (19–50 y)	Large Egg (50g)	Egg per 100g	% of pregnancy AI/RDA provided by 2 large eggs	% of lactation AI/RDA provided by 2 large eggs
Energy	kcal	–	–	72	144	–	–
Protein	g	71	71	6.28	12.56	17.7	17.7
Lipids (total)	g	ND	ND	4.76	9.51	–	–
Linoleic Acid (18:2n-6)*	g	13.0	13	0.77	1.54	11.8	11.8
α-Linolenic Acid (18:3n-3)	g	1.3	1.3	0.02	0.04	2.9	3.1
DHA (22:6n-3)	g	–	–	0.03	0.06	–	–
Vitamins							
Vitamin A, RAE	µg	770	1300	80	160	20.8	12.3
Thiamin (B_1)	mg	1.4	1.4	0.02	0.04	2.8	2.8
Riboflavin (B_2)	mg	1.4	1.6	0.23	0.46	32.6	28.5
Niacin (B_3)	mg	18	17	0.04	0.08	0.4	0.24
Pantothenic acid (B_5)*	mg	6	7	0.77	1.53	25.7	22.0
Pryridoxin (Vitamin B_6)	mg	1.9	2.0	0.09	0.17	8.9	8.5
Cobalamin (Vitamin B_{12})	µg	2.6	2.8	0.44	0.89	33.8	31.4
Folate, DFE	µg	600	500	24	47	8.0	9.6
Choline*	mg	450	550	146.9	293.8	65.3	53.4
Vitamin C (ascorbic acid)	mg	85	120	0	0	0	0
Vitamin D (D_2+D_3)	µg	15	15	1	2	13.3	13.3
Vitamin E (α-tocopherol)	mg	15	19	0.52	1.05	6.9	5.5
Vitamin K	µg	90	90	0.2	0.3	0	0
Minerals							
Calcium*	mg	1000	1000	28	56	5.6	5.6
Copper	mg	1.0	1.3	0.04	0.07	8.0	6.2
Iodine	µg	220	290	0	0	0	0
Iron	mg	27	9	0.88	1.75	6.5	19.6
Magnesium	mg	350	310	6	12	3.4	3.9
Manganese*	mg	2.0	2.6	0.01	0.03	1.4	1.1
Phosphorus	mg	700	700	99	198	28.3	28.3
Potassium*	mg	4700	5100	69	138	2.9	2.7
Selenium	µg	60	70	15.4	30.7	51.3	44.0
Sodium	mg	–	–	71	142	–	–
Zinc	mg	11	12	0.64	1.29	11.6	10.7

Adequate Intakes (AIs) are denoted with an *; otherwise values are Recommended Dietary Allowances (RDAs).

ease and stroke.[10] In fact, one study suggested that low serum cholesterol during pregnancy is associated with adverse birth outcomes.[11] Eggs are also relatively low in saturated fat, with only about 1.5 g per egg.

Eggs are an important source of choline, an important precursor of phospholipids, which are needed for cell division, growth and membrane signaling.[12,13] Inadequate intake during pregnancy has been associated with neural tube defects,[14] changes in brain structure and function in the offspring,[15] and adverse pregnancy outcomes.[16] Through its role as a methyl donor, choline may also have epigenetic effects during pregnancy.[17] Although choline is found in a number of plant-based and animal-source foods, none surpasses eggs with respect to choline per kilocalorie. More than 50% of the nutrient requirement for pregnant and lactating women is provided by two 50 g eggs (**Table 1**).

Eggs are also a good source of bioavailable vitamin A and carotenoids, vitamins E, D, and B_{12} and folate. The relative contribution of vitamin B_{12} may be particularly relevant in Latin America and the Caribbean, as deficiency continues to be a problem in most locations and population groups of those regions.[18] This may be the case among the poor in other parts of the world as well. Observational studies have shown an association between eggs and reduced risk of night blindness,[19,20] as well as xerophthalmia.[21,22] Data collected between 1995 and 2005 show that 14.3% and 18.4% of pregnant women have serum retinol <0.70 µmol/L in Africa and Asia, respectively.[2] Night blindness was reported by 9.4% of pregnant women in Africa and 7.8% of women in Asia. Vitamin A supplementation in pregnancy reduces night blindness, which is also associated with increased low birth weight and infant morbidity.[23] As shown in **Table 1**, two 50 g eggs provide 21% and 12% of the vitamin A requirement for pregnant and lactating women, respectively.

Although eggs are generally low in minerals, selenium is an important exception, with two 50g eggs providing 51% of the dietary requirement for pregnant women and 44% of the daily requirement for lactating women (**Table 1**). Selenium plays important epigenetic and antioxidant roles that may be especially important during pregnancy.[24]

The potential role of eggs to enhance concentration of key nutrients in breast milk

Maternal consumption of eggs during lactation can also enhance the breast milk content of certain nutrients and thus contribute to child nutrition and potentially development when children are breastfed. The concentration of nutrients in breast milk is most affected by a mother's intake of water-soluble vitamins. It is also influenced by her intake and stores of fat-soluble vitamins, though to a lesser extent. Micronutrients have been classified into two groups, according to the effect of maternal intake and the status of the micronutrient content of breast milk.[25] In Group 1 are those affected by maternal status including thiamin, riboflavin, vitamin B_6, vitamin B_{12}, vitamin A, iodine, and selenium. More recently, choline and vitamin D have been added to this list (Lindsay Allen, personal communication). Vitamin C also is transferred through breast milk. In Group 2 are those not affected by maternal status, including folate, vitamin D, calcium, iron, copper and zinc. During lactation, low maternal intake or stores of micronutrients in Group 1 reduces the amount in breast milk, which may negatively affect a child's development.[26] Therefore, adequate intake of Group 1 micronutrients is necessary to ensure breast-milk adequacy.

In addition to water-soluble vitamins and selenium, fatty acids in breast milk are extremely sensitive to maternal consumption and body composition, with implications for infants' neurological development.[27] The transfer of n-6 (omega-6) and n-3 (omega-3) fatty acids from the maternal diet into breast milk occurs with little interconversion of 18:2n-6 to 20:4n-6 or 18:3n-3 to DHA. There is also little evidence of regulation by the mammary gland to maintain individual fatty acids constant with varying maternal fatty acid nutrition. DHA has gained attention because of its high concentrations and roles in the brain and retina. A recent study among Chinese women showed that supplementation of DHA during pregnancy increases the concentration of polyunsaturated fatty acids in breast milk.[28]

However, a recent systematic review concluded that there have not been rigorous studies between the dietary intake of

TABLE 2: Proportion of daily nutrient requirement (RDA or AI) provided by two 50 g eggs during pregnancy and lactation

Pregnancy	Lactation
0 – < 5%	**0 – < 5%**
Niacin	Niacin
Vitamin C	Vitamin C
Vitamin K	Vitamin K
Iodine	Iodine
α-Linolenic acid	α-Linolenic acid
Vitamin B_1	Vitamin B_1
Manganese	Manganese
Magnesium	Magnesium
Potassium	Potassium
≥ 5 – < 15%	**≥ 5 – < 15%**
Vitamin B_6	Vitamin B_6
Vitamin E	Vitamin E
Folate	Folate
Linoleic acid	Calcium
Vitamin D	Copper
Zinc	Linoleic acid
Calcium	Vitamin A
Copper	Vitamin D
Iron	Zinc
≥ 15 – < 25%	**≥ 15 – < 25%**
Protein	Protein
Vitamin A	Pantothenic acid
Iron	
≥ 25%	**≥ 25%**
Riboflavin	
Pantothenic Acid	Riboflavin
Vitamin B_{12}	Vitamin B_{12}
Phosphorus	Phosphorus
Selenium	Selenium
Choline	Choline

TABLE 3: Percentage of women aged 15–49 who gave birth in the last 3 years who consumed eggs in the preceding 24 hours, DHS Surveys 2007–2010[40]

World region	Year	Eggs (%)
sub-Saharan Africa		
Ethiopia	2005	3.8
Ghana	2008	21.6
Liberia	2007	19.6
Namibia	2006–07	20.5
Nigeria	2008	17.7
Sierra Leone	2008	12.1
Uganda	2006	3.6
Zambia	2007	14.0
Zimbabwe	2006–07	11.1
South/Southeast Asia		
Cambodia	2005	19.9
India	2005–06	2.9
Indonesia	2007	n.a.
Nepal	2006	6.1
Philippines	2008	39.4
Latin America and the Caribbean		
Dominican Republic	2007	47.0
Haiti	2005–06	6.9
Honduras	2006–07	62.5

single nutrients and their presence in human milk.[29] Reasons cited by the authors include the difficulties in the collection of dietary data as well as the availability of appropriate breast-milk samples. In most studies, sample size was limited, the period of dietary recall relative to the timing of the sample obtained inconsistent, and there was a lack of control of potential confounding factors. Therefore, to understand the effect of egg consumption on the composition of breast milk, studies should have clear protocols for milk storage and analysis, definition of the time lag between the diet and milk analysis, and adjustment for other factors such as energy intakes and anthropometric characteristics.

Role of eggs in vegetarian populations

Eggs are likely to be especially important in vegetarian populations. In India, with a population of approximately 1.25 billion, nearly one-third are vegetarian. The 2005–2006 India National Family Health Survey showed that low birth weight affects nearly 20% of births and is associated with low socioeconomic status.[30] As noted in **Table 3**, egg consumption among Indian women of reproductive age is extremely low.

Cultural and economic aspects of egg consumption

In some cultures, egg consumption during pregnancy may be taboo. For example, Nepali women have cited religion as a reason for not consuming eggs.[31] In contrast, in rural Zambia, only about 5% of households believed that eggs were taboo for pregnant women, while 83% said that eggs were nutritious for pregnant women and 90% held this view for lactating women.[32] Generally, these kinds of barriers may be overcome with well-informed and carefully conducted social marketing and behavior change communication strategies.[33] For example, in a recent large-scale intervention in Bangladesh, egg consumption among children 6 to 24 months of age in the intensive intervention group increased from 18% to 48% compared to 19% to 31% among children in the non-intensive group.[34]

Economic barriers appear more important than cultural ones. Data from Demographic and Health Surveys show a high correlation between egg consumption and socioeconomic status, with consumption increasing in a dose-response manner with wealth quintile (**Table 4**).[35] In rural Zambia, 43% of households reported that cost was the primary limitation to routine egg consumption.[32] Although rural households often raise chickens, they frequently sell the eggs to purchase other essential items. For example, in Zambia, before chicken survival and productivity were improved, households would sell the eggs or chickens rather than consume them.[36] However, as a result of a technical assistance project to develop community-operated, semi-intensive egg production facilities, which resulted in higher egg yields, both producer income and community consumption of eggs improved. Homestead and/or small community chicken-and-egg production in the context of inputs to increase yield and protect children from chicken feces may simultaneously address nutrition and poverty.[1]

Eggs provide convenient solutions to problems of food preparation, storage, and transport. Eggs can be purchased in a single unit or units. Furthermore they are easy to prepare, require little fuel because of quick cooking, and can be eaten alone or mixed into a variety of dishes. Hard-boiled eggs can also be easily transported for consumption elsewhere, which is particularly important for women who farm, take care of animals, go to the market or work in other activities outside the home.

Environmental concerns

Raising chickens at home may increase exposure to chicken feces and pose risks of diarrheal infections, environmental enteric disorder and respiratory infections.[37] Particularly among young children, these illnesses are risk factors for mortality and linear growth retardation. At the same time, studies show that ownership of small animals is associated with improved nutrition. Keeping young children away from chicken feces though better poultry practices can mitigate the negative effects of chicken

TABLE 4: Percentage of women aged 15–49 who gave birth in the last 3 years who consumed eggs in the preceding 24 hours by household wealth quintile, DHS Surveys 2007–2010[41]

Country	Year	Wealth quintile	Eggs (%)
Ghana	2008	Lowest	13.8
		Second	16.4
		Middle	24.5
		Fourth	26.7
		Highest	31.8
Liberia	2007	Lowest	17.7
		Second	13.1
		Middle	14.6
		Fourth	24.1
		Highest	35.4
Madagascar	2008–09	Lowest	2.6
		Second	3.7
		Middle	4.9
		Fourth	4.8
		Highest	18.1
Nigeria	2008	Lowest	11.0
		Second	12.0
		Middle	14.3
		Fourth	23.4
		Highest	31.9
Tanzania	2010	Lowest	3.1
		Second	4.4
		Middle	5.5
		Fourth	6.8
		Highest	9.4
Zambia	2007	Lowest	9.3
		Second	10.0
		Middle	10.5
		Fourth	21.6
		Highest	23.5

feces. Interventions to improve poultry production and egg consumption among pregnant and lactating women would need to put in place reasonable control measures to reduce household exposure to chicken feces.

Summary

Chickens and eggs are ubiquitous globally and well known to be highly nutritious. While there are no rigorous studies identifying health benefits to mothers and newborns or benefits to child cognition of interventions to improve consumption during pregnancy and lactation, such interventions would appear to be attractive. Chicken production and egg consumption may be a locally available and feasible option to improve maternal diets during pregnancy and lactation.

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Essential Fatty Acid Needs During Pregnancy and Lactation

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Key messages

- The endogenous synthesis of both docosahexaenoic acid (DHA) and arachidonic acid (ARA) in early life may be insufficient, and the rate of membrane DHA incorporation depends mostly on maternal transfer and dietary supply (i.e., breastfeeding).
- DHA content in breast milk is very dependent on the mother's diet and can be very low in populations living on a primarily plant-based diet with no or limited fish intake.
- In countries with low socioeconomic status, the availability of DHA and ARA in the food supply among pregnant women, infants and young children is significantly lower than the minimum recommended intake proposed by international organizations.

Fatty acids: biological meaning and worldwide consumption

Long-chain polyunsaturated fatty acids (LC-PUFA), including docosahexaenoic acid (DHA) and arachidonic acid (ARA), are incorporated into membrane phospholipids, and their presence can influence cellular structure and function.[1] The omega-3 (n-3) LC-PUFA DHA is especially important for the brain and retina, where it rapidly accumulates during the early years of life[2] and plays an important role in the development of visual and cognitive function.[3] The omega-6 (n-6) LC-PUFA ARA is also rapidly accreted by the infant brain but, in addition, it is also widely distributed throughout other vital organs and tissues within the body. It is increasingly being recognized that both DHA and ARA are important precursors and messengers for a variety of biological processes, particularly in relation to cerebral, cardiovascular and immune functions.[4] These lipid mediators play crucial roles in the prevention or treatment of common chronic diseases that may lead to significant morbidity and mortality.[5]

There are two key components that may influence DHA and ARA status. First, there is the contribution of endogenous synthesis from the essential precursor 18-carbon n-3 and n-6 fatty acids, linoleic acid (LA) and α-linolenic acid (ALA), respectively; second, there is the contribution from preformed DHA and ARA sources in the diet.[5] Endogenous synthesis is directed through a metabolic pathway where the n-3 and n-6 fatty acids compete for a shared desaturation and elongation enzyme system. As a consequence, the balance in the intake of the essential 18-carbon n-3 and n-6 precursors can influence the levels of DHA and ARA derived from endogenous synthesis.[6] Moreover, it is now recognized that this metabolic pathway is relatively inefficient in converting n-3 and n-6 precursor fatty acids to DHA and ARA respectively, especially in early life, when organ development is at its peak.[7]

Studies have shown that the endogenous synthesis of both DHA and ARA in early life may be insufficient[8,9] and that blood and tissue concentrations decrease rapidly after birth if exogenous supplies are inadequate.[2,3,10]

In addition to substrate competition, the efficiency of the Δ5- and Δ6-desaturase steps is also dependent on the genotype of fatty acid desaturase system (FADS) 1 and FADS2, both located on chromosome 11, and which encode Δ5- and Δ6-desaturase enzymes, respectively.[6]

Concerning the supply from diet, animal-source foods, including meat, poultry, egg, milk and fish, are important sources of n-6 and n-3 fatty acids. In particular, seafood, mostly marine species, is the only food group that has a significant content of n-3 LC-PUFA (e.g., eicosapentaenoic acid [EPA] and DHA). Different populations may have different intakes of n-3 LC-PUFA based on the access to coastal areas and therefore on the type of fish species that are available for consumption.[11]

LC-PUFA may be derived from fatty fish that live in cold saltwater (like the sardines depicted here) or from algae.

Following extensive researches in Western countries, scientific interest in the beneficial effects of an optimal dietary fatty acid composition in low-income countries has recently grown, especially concerning vulnerable population groups such as pregnant women, infants and young children. Indeed, in low-income countries, the major staple foods are represented by cereals that all have a low essential fatty acid content, especially if refined.[11] On the other hand, legumes and oils thereof, such as soya bean products, in spite of high contents of anti-nutrients such as polyphenols, phytate and certain oligosaccharides, may be an important source of precursor LC-PUFA LA and ALA in population groups without access to animal-source foods.[12–15]

As a result, in many low-income countries, more than 50% of the PUFA intake comes from vegetable oil, and the most balanced ratios between LA and ALA are found in soybean oil and canola, or rapeseed oil.[11]

> "Interest in the beneficial effects of an optimal dietary fatty acid composition in low-income countries has recently grown"

Essential fatty acids in pregnancy

The accumulation of DHA in the brain takes place during the brain growth spurt in the intrauterine and neonatal period up to two years of age, and the high levels of DHA in the brain are maintained throughout life.[16] Due to the lack of *de novo* PUFA synthesis, the rate of membrane DHA incorporation in early life – in the brain as well as in other tissues – depends on direct maternal transfer, and then dietary supply (i.e., breastfeeding) and endogenous LC-PUFA production.[17] The DHA accumulation in the brain during the third trimester of pregnancy is substantially higher (in % of fatty acids [FA%]) than the overall body deposition rates, whereas brain incorporation of ARA is more in line with that which occurs in other tissues.[18] Fetal LC-PUFA accumulation occurs mainly during the last trimester, in which weight increase becomes more rapid and growth is accompanied by a deposition of fat tissue, which begins around the thirtieth week of gestation.[19]

The intrauterine PUFA supply occurs via transfer of non-esterified PUFA mainly derived from the maternal circulation across the placenta. The overall fat concentration in maternal plasma increases throughout pregnancy, and placental fat transport is driven by a concentration gradient, as the fetus has substantially lower fat concentrations, including the concentration of DHA and ARA.[18]

The n-3 fatty acids EPA and DHA help sustain pregnancy duration. In particular, for high-risk pregnant women, n-3 fatty acid intake seems to have an important effect on reducing spontaneous premature births.[20] A high ratio of n-6 to n-3 fatty acids will result in increased proinflammatory eicosanoid production (i.e., prostaglandin E_2 [PGE_2] and prostaglandin F_2 [PGF_2]). These metabolites have been associated with the initiation of labor and preterm labor. Including more EPA in the diet may lead to a reduction in the production of proinflammatory eicosanoids and increased production of prostacyclin (PGI_2), which may promote myometrial relaxation. n-3 LC-PUFA downregulate the production of prostaglandins PGE_2 and PGF_2, and may thereby inhibit the parturition process.[21,22] This results in an increased birth weight and intrauterine LC-PUFA accretion. In infants born preterm the progressive accumulation of LC-PUFA in fetal tissues is truncated at the end of pregnancy, and accumulation is also strongly limited in growth-retarded fetuses.[23]

At present, there are conflicting data regarding the impact of n-3 fatty acids on the length of gestation.[24,25] However, the amount of n-3 fatty acids derived from the recommended amount of seafood intake or daily supplementation to optimize fetal brain development may have the added benefit of reducing the risk of preterm birth in high-risk populations (i.e., women with a history of preterm birth or women with low baseline n-3 fatty acid intake).[26]

Major depressive disorder affects 10% to 20% of perinatal women. Pregnancy-related and postpartum depression have been shown to affect child attachment, cognitive development, and behavior.[26] Research by Makrides and colleagues has demonstrated that increased intake of LC-PUFA during pregnancy reduces the risk of depressive symptoms in the postpartum period.[27] Polyunsaturated fatty acids have been shown to de-

crease proinflammatory cytokine production, which is elevated in depressed patients.[28] n-3 fatty acids are transferred from the mother to the fetus during pregnancy, thereby depleting maternal stores. Because many women remain reluctant to take antidepressant medication while they are pregnant or breastfeeding, it has been postulated that increasing intake of omega-3 fatty acids from the diet and supplements could theoretically prove beneficial and protective of maternal affect.[26]

"Research has demonstrated that increased intake of LC-PUFA during pregnancy may reduce the risk of depressive symptoms in the postpartum period"

Essential fatty acids during lactation and complementary feeding period

Breast milk is the most important source of PUFA during the first two years of life, but the breast milk DHA content is very dependent on the mother's diet and can be very low in populations living on a primarily plant-based diet with no or limited fish intake.[11]

Post-natal accumulation of LC-PUFA in infant tissues is supported by maternal transfer of PUFA through breast milk, and blood levels of LC-PUFA in breastfed infants remain higher than maternal levels for some time postnatally.[29,30]

With respect to the functional effects of LC-PUFA supplementation in infancy, the most accepted developmental effect is an increased rate of visual acuity development.[31] However, little is known regarding the persistency of this effect on vision and the potential effects that this early visual deficit may have on cognitive development. Overall, meta-analyses of the randomized controlled trials that have investigated the effect of LC-PUFA supplementation on neurodevelopmental outcomes throughout the first two years of life have not shown any clear benefit of LC-PUFA addition to infant formula on development of term or preterm infants.[32–34]

The meta-analyses looking at the developmental effects of maternal n-3 LC-PUFA supplements in pregnancy and lactation have suggested some effects on neurodevelopment based on a few studies.[35,36] However, at the current stage, this does not provide any definite proof that an increase in the early DHA supply improves the mental development of infants.

Interestingly, in a small Danish trial of maternal fish oil supplementation during lactation, treatment-gender interactions were found on blood pressure at 7 years of age.[37] Blood pressure is not normally defined as cognitive outcome, but it can nevertheless be affected by the central nervous system in response to anxiety. As was the case with cognitive outcomes, boys and girls in the fish oil group were found to have comparable diastolic and mean arterial blood pressures, whereas girls had higher blood pressures than boys in the control group.[37] The intervention was also found to level out gender differences in energy intake and physical activity at 7 years of age.[37] Accordingly, these results indicate that early DHA intake could also have long-term health consequences, which might be mediated by effects in the brain and lifestyle choices.

Influence of genetic polymorphisms

The influence of FADS polymorphisms on LC-PUFA status introduces new variables to be considered in the evaluation of the effects of FADS genotype on development and health of young children. Several studies have shown that infant FADS genotype, examined by use of different individual Single Nucleotide Polymorphisms (SNPs), modifies the effect of breastfeeding on IQ-like neurodevelopmental outcomes in childhood,[38,39] while other studies did not find any significant interaction.[40,41]

In lower-income developing countries the LC-PUFA content of traditional complementary foods is low, and consequently these infants may be vulnerable to LC-PUFA deficiency, especially if they are not receiving breast milk.[11] This vulnerability may be further increased if the maternal LC-PUFA diet is insufficient, starting at the stage of transplacental transfer of LC-PUFA during pregnancy, leading to an early reduction of the LC-PUFA status of the infant at birth.[42] Moreover, maternal diet relates to the LC-PUFA content of breast milk, especially DHA, and low maternal DHA status is associated with low levels of DHA in breast milk.[43]

"In the vast majority of developing countries, the DHA and ARA intakes among pregnant women, infants and young children may be significantly lower than current recommendations"

This suggests that in the vast majority of developing countries, the DHA and ARA intakes among pregnant women, infants and young children may be significantly lower than current recommendations proposed by various international organizations (i.e., Dietary Reference Values by the European Food Safety Authority [EFSA] and the Food and Agriculture Organization of the United Nations [FAO] for the European and the global populations, respectively, which are provided in **Table 1**).[44,45] This has potential significant public health implications, and future policies on dietary DHA and ARA need to reflect the specific needs of the world's most vulnerable populations.

TABLE 1: Dietary Reference Values (DRV) for essential fatty acids (EFSA 2010, FAO 2010) [44,45]

	Infants and children		Pregnancy and lactation	
	EFSA	FAO	EFSA	FAO
ARA	No DRV	No DRV	No DRV	No DRV
DHA	AI 7–24 mo: 100 mg/day	0–6 mo: 0,1–0,18 En%	RI: 100–200 mg/day	200 mg/day
		0–6 mo: 0,1–0,18 En%		
EPA+DHA		2–4 y: 100–150 mg/day	RI: 250 mg/day	300 mg/day
		4–6 y: 150–200 mg/day		
		6–10 y: 200–250 mg/day		

AI: Adequate Intake Energy

En%: Energy %

RI: Reference Intake ranges for macronutrients. These are expressed as a proportion of daily energy intakes, to reflect intakes that are adequate for maintaining health and are associated with a low risk of chronic disease. For example, the reference intake range set for dietary fat is 20–35% of total daily energy intake.

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Protein Requirements of Pregnant and Lactating Women

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Key messages

- The protein requirement during pregnancy and lactation has been revised upward considerably.
- The safe protein intake level during the first, second and third trimesters is now 0.7, 9.6 and 31.2 g/d respectively.
- The efficiency of protein utilization during pregnancy needs to be re-examined in order to answer whether more nuanced recommendations are required.

Introduction

The daily minimum protein requirement of the non-pregnant, non-lactating adult woman is based on the need to replace the daily amount of protein lost via urine and feces and to provide essential amino acids and/or other nitrogenous compounds that can be converted by human metabolism into amino acids that can be utilized by humans. The framework for determining requirements is first to determine the daily metabolic demand, which is represented by the amount of amino-nitrogen that is lost daily through urine, feces and skin on a protein-free diet. This value, based on observations across several sites across the world, has been determined to be 48 mg N/kg/day.[1]

To quantitatively replace this daily metabolic demand by dietary protein requires that we assess the body's ability to utilize dietary protein. If a unit of dietary protein were to replace a unit of metabolic demand with 100% efficiency, the daily protein requirement would simply be equal to the metabolic demand. However, dietary proteins are not fully digested and utilized once absorbed, so a utilization efficiency factor must be applied to correct for incomplete absorption and utilization. The metabolic demand used to arrive at the minimum requirement for dietary protein has been determined to be about 47%.[1] Thus, in effect, the recommended dietary protein intake for healthy individuals would need to be about twice that required to meet the metabolic demand derived from obligatory losses.

Using these terms, the minimum, or estimated average, requirement of dietary protein was determined to be 0.66 g/kg/day in the FAO/WHO/UNU report.[1] Since the protein requirement varies within and between subjects in a given population, depending on factors that affect absorption and utilization, the "safe" intake (or intake that would meet the requirement of 97.5% of the population in the distribution of requirements) of 0.87 mg/kg/day was calculated, considering the need to meet the requirements of each of the indispensable amino acids (IAA) within the metabolic demand. Protein quality, in turn, is the product of the IAA composition of the protein with respect to the pattern of IAA requirement (the amino acid score) and its ability to be digested and absorbed completely in the intestine.

To cover additional needs, such as the requirement during pregnancy and lactation, the additional amount of protein deposited (during pregnancy) or lost (through lactation) needs to be determined, as well as the efficiency of dietary protein utilization to meet this additional demand. An adequate maternal protein intake during pregnancy should include needs for protein accretion of maternal tissues during pregnancy (blood cells, lactation, uterus, placenta and extra-embryonic membranes) and the amino acids necessary to support the maintenance and healthy growth and development of the fetus.[2]

A mother in the final stage of pregnancy. Recommended protein intakes for pregnant and breastfeeding mothers have been increased considerably.

"Maternal protein intake during pregnancy should include needs for protein accretion of maternal tissues and the amino acids required to support the maintenance and healthy growth and development of the fetus."

Protein requirement during pregnancy

The revised protein requirement during pregnancy is based on a framework that takes into account the protein requirement for maintaining the weight gained by the mother during pregnancy (gestational weight gain, GWG); the protein (and its efficiency of utilization) required to support fetal deposition; and a term to account for a safe intake.[1] The maintenance requirement for the GWG for each trimester was based on the mid-trimester increase in maternal body weight and the adult maintenance value of 0.66 g/kg per day.

Protein deposition measurements were based on the measurement of the increment in total body potassium, using a whole-body counter to measure the radiation from naturally occurring body radioactive potassium (^{40}K) as pregnancy progressed. These measurements were derived from studies performed in the US,[3] where the mean GWG was 13.8 kg. With a further assumption that there is a linear relationship between GWG and protein deposition, one can deduce a protein deposition rate for different GWG; for example, with a GWG of 12 kg, mean protein deposited would be 1.6 and 6.5 g/day in the second and third trimester, respectively. It can reasonably be assumed that there is relatively negligible amount of protein deposited in the first trimester.

The question that might arise is, what is the optimal GWG that could be assumed for global use? There is no easy answer to this, since the actual data are limited to a few studies in developed countries. Thus the WHO/FAO/UNU Consultation assumed a GWG of 12 kg as desirable.[1] In addition, the efficiency of utilization of dietary protein to meet the deposition requirement was assumed to be 42%, which was lower than the earlier value of 70%,[4] based on experimental data.[1] Considering this framework, the safe protein intake required was determined to be 9.6 and 31.2 g/day of protein in the second and third trimesters (**Table 1**). These values were higher than the earlier 1985 WHO/FAO/UNU requirement value.[4]

"The need to resolve certain key questions remains"

Direct experimental evidence for the dietary protein requirement during pregnancy is also available from the use of the stable isotope-based indicator amino acid oxidation method. In a study which measured the protein requirement of healthy pregnant Canadian women at 11–20 (early) and 31–38 (late) weeks of gestation,[5] the protein requirement assessed early in gestation was 39% higher, while the late gestation figure was 73% higher in comparison to the adult Dietary Reference Intakes" (DRI) recommended Estimated Average Requirement (EAR) of 0.88 g/kg/day for protein intake during pregnancy.[6] These values converge

TABLE 1: Recommended additional protein intake during pregnancy and lactation

Pregnancy

Trimester	Weight gain (kg)	Additional protein requirement (g/day)	Additional safe intake (g/day)[a]
1	0.8	0.5	0.7
2	4.8	7.7	9.6
3	11	24.9	31.2

Lactation

Months (postpartum)	Milk intake (g/day)	Additional protein requirement (g/day)	Additional safe intake (g/day)[a]
6	897	15.5	19.4
6–12	578	10.0	12.5

Adapted from FAO/WHO/UNU, 200[71]

[a]Safe intake – calculated as the average requirement plus allowance for an assumed coefficient of variation of 12%.

directionally with those reported above,[1,3] particularly for US women. However, there is a need for confirmatory research in low- and middle-income countries (LMIC), where the GWG could be lower, even in healthy pregnancies, particularly in shorter women.

There is thus a need to resolve certain key remaining questions. First, as noted above, what is the optimal GWG for the average woman from LMIC – they may be shorter in height, with a lower GWG. Should therefore a uniform desirable GWG be applied globally? For example, the mean GWG found in a WHO collaborative study on maternal anthropometry and pregnancy outcomes was about 12 kg.[7] An assessment of GWG curves in that report showed that for countries such as India, the GWG was between 8 and 10 kg at term, for birth weights ranging from < 2500 to > 3000 g, in women whose mean height was 150 cm. However, a more recent assessment of GWG in eight countries (INTERGROWTH)[8] demonstrated that GWG in otherwise normal women who were > 153 cm tall was similar across countries, and at the fiftieth percentile was 13.69 kg at the fortieth week of pregnancy, which is similar to GWG reported above.[3] In context, the mean height of rural and urban Indian women is 152 cm,[9] and raises the question of what GWG standard should be used when evaluating quality protein needs during pregnancy and related birth outcomes; the multi-country INTERGROWTH standards might be the way forward to define what is optimal.

Second, does the conceptual framework fully capture the possible adaptations that could occur during pregnancy? For example, the efficiency of protein utilization is thought to be 42%,[1] although there is no certainty that there is no change in the efficiency of protein utilization in the "small" pregnant woman who has had a habitual suboptimal protein intake. For example, neonates recovering from severe undernutrition can use protein very efficiently, approaching an efficiency of 95–100% for absorbed protein from breast milk, after digestion. This is of course an extreme example of how the efficiency of utilization can change during recovery from acute malnutrition. However, a study on the rate of leucine (or protein) oxidation during the first and second trimester in low-BMI (body mass index) Indian women with normal protein intakes has shown that they do not have a higher efficiency of protein utilization during pregnancy.[11] It is important to emphasize that these low-BMI women also had a "normal" GWG for India, of about 10 kg, and that the birth weight of their babies was not different from normal-BMI women. Another possible adaptation is the reduction of protein oxidation through a reduction in urea synthesis rates,[12] and there could also be some recycling of urea N into the body amino-acid pool, through the involvement of the gut flora. There is limited evidence that this recycling does exist to the extent of being able to meet some 20% of the daily requirement of essential amino acids,[13] but this has not been measured during pregnancy or when there is a suboptimal protein intake. This underscores the need for research in an important area, since the term of efficiency of protein utilization is critical to the factorial calculation method.

Third, how relevant are maternal protein stores (muscle mass) in meeting some of the protein requirements of pregnancy? Detailed measurements in well-nourished women during and after pregnancy showed that there was no net accretion or loss of protein during pregnancy.[3] Nevertheless, we cannot exclude the possibility that the mother could use some of her own protein stores (to make up for a deficiency in dietary protein) during pregnancy – something that might be obscured by the weight gain due to the fetus as well as to fluid gain and fat accretion. This is an important area of investigation.

Protein requirement during lactation

The recommendations for protein requirement during lactation were determined for well-nourished women, exclusively breastfeeding for 6 months and partially breastfeeding between 6 and 24 months. Once again, the factorial method framework was used to arrive at the dietary protein requirement, assuming a secretion of 9.4 g/day of protein in milk in the first six months and 6.6 g during the following 6–24 months.[1] Although the non-protein nitrogen concentration of breast milk is high (20–27% of total milk nitrogen, mainly as urea), for the purpose of calculating requirements, the dietary protein requirement was assumed to account only for the protein component of the total nitrogen in milk. Once again, an assumption had to be made about the efficiency with which dietary protein is used for the production of milk protein. This was assumed to be 47%, which is the same value that is assumed for the efficiency of protein utilization in normal, non-pregnant, non-lactating adults. The safe protein intake that would cover the needs of 97.5% of the distribution of requirements in the population was calculated as an additional term of 1.96 SD, using a coefficient of variation of 12.5%. The additional safe protein intake required during lactation was thus determined to be 19.4 g/day in the first six months of lactation, and 12.5 g/day after six months.[1]

Moving forward

Moving forward, many questions still remain to be answered. Defining what is "normal" is one of them. The framework of the protein requirement ignores the demand that is placed by the environment, since primary measurements are often made in "clean" conditions, usually in developed countries. The metabolic demand, which forms the cornerstone of the factorial approach, should include terms for environmental and social determinants, and the stresses that women undergo during pregnancy and lactation. It is a sad reflection upon society that these additional

FIGURE 1: Shadow shield whole-body potassium counter facility at St John's Research Institute, Bangalore, India

demands should be considered "normal": ideally, they should not. Further, improvements in the state of women during pregnancy have a generational timeline.

> "The definition of what is 'normal' is yet to be agreed"

For small women in LMIC, the thought of an additional 30 g of protein/day during the third trimester might appear daunting. There is also the possibility of diminishing returns: feeding a short woman, who is likely to have a smaller GWG, with large amounts of food and protein is not without consequences, and at an extreme level, a very high protein intake has resulted in higher adverse events during pregnancy or parturition, and even in neonatal deaths.[14] Therefore, some thought has to be given to whether "one size fits all", or whether a more nuanced recommendation should be considered for the time being.

Assuming that the factorial calculations laid out above are correct, it becomes evident that there is a very high likelihood that many pregnant women in LMIC are at risk of low protein intake. It is tempting to speculate that this is the cause of the high rate of low birth weight (LBW) in many of these countries, and to jump into supplementation, but LBW is multifactorial in its cause, and some reflection is needed as to how these requirements might be evaluated and implemented. Careful and accurate measurements of protein accretion during pregnancy, particularly in LMIC and poor-resource environments, linked to accurate measurements of protein intake during pregnancy, will help answer these questions. As a first step, a state-of-the-art whole-body potassium counter has been built at St. John's Research Institute, Bangalore, India (**Figure 1**), and is currently being used to accurately measure protein accretion in Indian pregnant women who enter pregnancy in different nutritional states, before moving to interventional studies.

The goal of improving the protein quality in the nutritional intake of populations consuming predominantly cereal-based

diets should not be lost. The protein requirements detailed above are for a highly digestible, high-quality protein. Dietary selections favoring more quality, protein-rich foods, along with economics of access to such options, are important considerations that should guide the process of defining Protein Quality for Optimal Human Growth and Development.

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Closing the Nutrient Gap During Adolescent Pregnancies

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Key messages

- Twenty thousand girls a day below age 18 become pregnant in developing countries.
- Adolescence, a period of catch-up growth, involves a higher need for macro- and micronutrients in the growth process.
- Gross paucity of data exists concerning dietary practices and nutrient intakes among pregnant adolescent girls in developing countries.
- Childbearing during adolescence hampers both the post-menarcheal linear and the ponderal growth of the young girls and has adverse effects on birth outcomes.
- Strategies to identify undernourished girls, delay marriage, and prevent early and frequent pregnancies until adult height is reached are critical, alongside other multisectoral reproductive nutrition and health programs.
- Nutrition-specific and nutrition-sensitive interventions, along with access to adolescent-friendly services that adopt a lifecycle approach will help improve nutritional status.

Around the world today, 580 million adolescent girls[1] between the ages of 10 and 19 years are standing at the crossroads of childhood and adulthood, and four out of five of them reside in developing countries. These girls have the potential to grow and progress in every sector, to break the cycle of intergenerational poverty, and to advance economies. Yet they are overlooked. Adolescent girls in developing countries are more likely to be nutritionally depleted, pulled out of school, and married off early, compared with their counterparts in developed countries. They also face the reality that a leading cause of death and retarded growth for girls under 19 years is pregnancy and childbirth.

The burden of motherhood in childhood

Adolescent pregnancy is a worldwide concern, particularly as it relates to poverty and social disadvantage.[2] According to the most recent estimates for 2013, every day 20,000 girls below age 18 – nearly 19% of adolescents – become pregnant and give birth in developing countries (**Figure 1**). With 17.4 million pregnant adolescents, South Asia has the highest burden.[1] A high prevalence of child marriage as a cultural norm is one of the major reasons for teenage pregnancy.

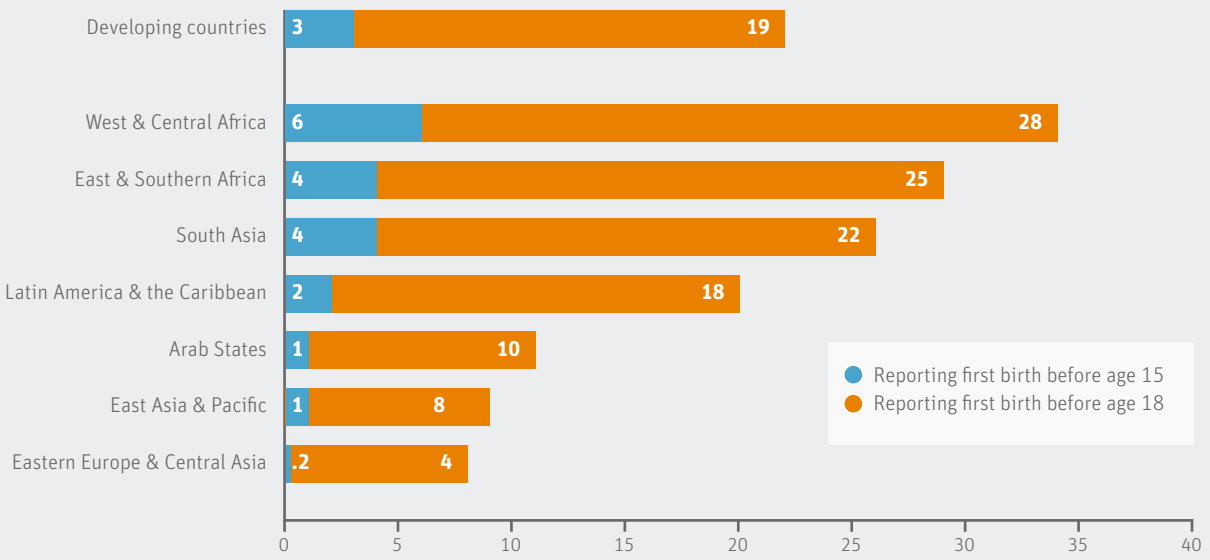
Adolescents at the peak of their growth velocity

Adolescence is the only time in life, besides the critical window of the first 1,000 days, when growth velocity increases tremendously.[3] Approximately 50% of adult body weight and 15% of final adult height are attained during adolescence.[2,4] The increment in skeletal mass, body size, and body density associated with pubescence, as well as the fact that adolescence may be an opportunity for catch-up growth, highlights the higher needs for nutrient intake, involving both macro- and micronutrients, in the growth process.

Adolescent pregnancy – a double jeopardy

Pregnancy in adolescence is a critical period, as active growth is occurring in both the young mother and the fetus. The adverse effects of adolescent pregnancy on birth outcomes, such as maternal and neonatal mortality, preterm delivery, and low birth weight, have been well established.[5,6] In many South Asian and African countries, there is evidence that chronic undernutrition can delay physical maturation and extend the adolescent growth period beyond 20 years, coinciding with the age of first pregnancy.[7]

FIGURE 1: Percentage of women between the ages of 20 and 24 reporting a birth before age 18 and before age 15[1]



Source: UNFPA, 2013. Calculations based on data for 81 countries, representing more than 83% of the population covered in these regions, using data collected between 1995 and 2011

Conventionally, it has been accepted that growth is largely completed by the time adolescents become pregnant because pregnancy occurs subsequent to menarche, when growth rate drops to a nadir.[2] However, scientific evidence from both developed[8] and developing nations[2] has demonstrated that a large proportion of pregnant adolescents were still growing in height during and following pregnancy. Importantly, a prospective cohort study in Bangladesh concluded that childbearing during adolescence may hamper both the post-menarcheal linear and ponderal growth of the young girls, which could be a potential window of opportunity for catch-up growth in an undernourished population. Early pregnancy among adolescents results into an overall loss of 0.6 to 2.7 cm in attained height in rural Bangladeshi girls, which may contribute to stunting and increased obstetric risk.[2]

> "Scientific evidence shows that a large proportion of pregnant adolescents are still growing in height during and following pregnancy"

Ideally during pregnancy, the goal is to balance partitioning of the nutrient needs between the mother and fetus, which is critical in assuring optimal fetal growth and adequate maternal nutritional status. However, adolescent girls in developing countries are already nutritionally depleted, tend to enter pregnancy with poor nutritional status, and are likely to have suboptimal dietary intake during pregnancy and lactation. This leads to poor nutritional status of adolescent mothers themselves,

Indian adolescent girls enjoying the midday meal provided in schools by the Indian Government

and a reduction in the pregnant adolescent's potential growth, possibly due to a competition between the mother and the fetus for nutrients.[2,3,8,9,10]

Research has established that preconception deficiencies of iron, folic acid, iodine, and calcium are predictors of poor pregnancy outcome.[10] Tackling undernutrition, micronutrient deficiencies and anemia during adolescence, and preventing or delaying teenage pregnancy, has shown to be effective in breaking the perpetuating, vicious intergenerational cycle of growth failure among both adolescent girls, as well as the fetus.[11]

Suboptimal nutrient intake among adolescent girls

The requirements of some nutrients are higher in adolescents than in any other age group. The Recommended Dietary Allowance (RDA)[12] for selected key nutrients shown in **Table 1** clearly highlights that the nutrient requirements tremendously increase during pregnancy in comparison to the non-pregnant girls of the same age group.

While there is a gross paucity of data available on dietary practices and nutrient intakes among pregnant adolescent girls, a recent systematic review[13] of the dietary intake of adolescent girls in low- and middle-income countries (LMIC) clearly highlighted that the energy intakes among adolescent girls are low. The findings also underscored the fact that more than 50% of the adolescent girls have intakes of all micronutrients below the recommended levels.

Cereal-based diets, with low consumption of nutrient-dense foods, characterize adolescent girls' intakes across regions. However, the consumption of energy-dense and sugary foods in urban areas is increasing among adolescent girls in LMIC, reflecting the nutrition transition among adolescents in these regions. In comparison with adult pregnant women, a lower proportion of pregnant adolescent girls in The Philippines[14] were found to be taking iron supplements, indicating limited benefit to them from public health programs. A recent study in The Lancet 2016 clearly highlighted that, across populations, the consumption of fruits and vegetables is low worldwide, which is associated with low affordability.[15] To aggravate the situation, especially in South Asia, the diet of pregnant women and adolescent girls is subject to various food taboos and cultural norms that encourage females to consume less food during pregnancy so they will give birth to smaller babies and avoid difficult labor.

Charting the way forward for closing the nutrient gap

Despite recognizing the important role played by improving the nutritional intake of adolescent girls in general, and of pregnant adolescent girls in particular, in breaking the intergenerational malnutrition cycle, a WHO review[17] clearly highlighted that few programs address adolescent nutrition in South Asia and elsewhere globally, and they are often small and experimental. They have largely been aimed at the prevention and control of anemia among adolescents, and their implementation remains patchy across countries. The promising interventions for adolescent nutrition identified by The Lancet in 2013[18] are not yet being widely implemented, and are reflected as a strategic objective in only seven out of 22 Scaling Up Nutrition (SUN) signatory countries that have plans available.[19] Unfortunately, adolescents are generally included *de facto*, as part of countries' direct nutrition interventions.

TABLE 1: Dietary Reference Intakes (DRI): Recommended Dietary Allowances of selected key nutrients during adolescence, pregnancy and lactation[12]

Nutrients		Girls		Pregnancy		Lactation	
		9–13 years	14–18 years	14–18 years	19–50 years	14–18 years	19–50 years
Macronutrients	Carbohydrates (g/d)	130	130	175 ↑	175	210	210
	Protein (g/d)	34	46	71 ↑	71	71	71
Minerals	Iron (mg/d)	8	15	27 ↑	27	10	9
	Calcium (mg/d)	1300	1300	1300	1000	1300	1000
	Iodine (µg/d)	120	150	220 ↑	220	290	290
	Zinc (mg)	8	9	12 ↑	11	13	12
Fat-soluble vitamins	Vitamin A (µg/d)	600	700	750 ↑	770	1200	1300
	Vitamin D (µg/d)	15	15	15	15	15	15
Water-soluble vitamins	Folate (µg/d)	300	400	600 ↑	600	500	500
	Vitamin C (mg/d)	45	65	80 ↑	85	115	120
	Vitamin B_{12} (µg/d)	1.8	2.4	2.6 ↑	2.6	2.8	2.8

↑ Indicates increased requirement for pregnant adolescent girls aged 14–18 years in comparison to non-pregnant adolescent girls of same age group

TABLE 2: Recommendations and actions to improve adolescents' nutrition[16]

Recommendations and actions	Who needs to take action?
Improve maternal nutrition and health	
Establish policies and strengthen interventions to ensure that pregnant and lactating adolescent mothers are adequately nourished	National policy-makers, health service providers
Introduce measures to prevent adolescent pregnancy and to encourage pregnancy spacing	National policy-makers, health service providers, education sector
Prevent and control anemia	
Promote healthy and diversified diets containing adequate amounts of bioavailable iron	National policy-makers, food and agriculture sectors, health and education sectors
Promote consumption of nutrient-dense foods, especially foods rich in iron	National policy-makers, health and education, food and agriculture sectors
Where necessary, implement supplementation strategies and consider fortification of wheat and maize flours with iron, folic acid, and other micronutrients in settings where these foods are major staples	National policy-makers, food and agriculture sectors
Prevent and treat malaria in pregnant women as part of strategies to prevent and control anemia	
Ensure universal access to, and use of, insecticide-treated nets	National policy-makers, health service providers, development partners
Provide preventive malaria treatment for pregnant women in areas with moderate to high malaria transmission	National policy-makers, health service providers
Offer a healthy diet to all populations	
Create coherence in national policies and investment plans, including trade, food, and agricultural policies, to promote a healthy diet and protect public health	Regional and national policy-makers, food and beverage industries, creative and media industries
Encourage consumer demand for healthy foods and meals	
Promote physical activity in adolescents	
Create a conducive environment that promotes physical activity to tackle sedentary lifestyle	Regional, national, and local policy-makers, urban planners, early-years education, health services
Promote optimal nutrition in adolescents with HIV/AIDS	
Provide nutrition counseling to improve health outcomes in adolescents with HIV	Health service providers, development partners

"The promising interventions for adolescent nutrition identified by The Lancet in 2013 are not yet being widely implemented"

Measures for closing the nutrient gap include both the means of improving intake and availability of the foods necessary for a healthy balanced diet, as well as improving the bioavailability and absorption of the nutrients in the food. Equally important is to raise awareness of adequate nutrient intake among adolescents. From a public health perspective, as Table 2 clearly shows, multiple sectors will need to collaborate in order to drive action forward in these recommended nutrition-specific and nutrition-sensitive areas. Additionally, linkages to policies and programs focusing on nutrition-sensitive interventions and being more sensitive to the specific needs of post-menarcheal married nulligravid and unmarried adolescents is most essential to reinforce improved dietary intake and nutrition for adolescents.

› **Strategies aiming to encourage adolescent girls, especially undernourished ones,** to delay marriage, and to prevent early and frequent pregnancies until adult height is reached are critical alongside other reproductive health and nutrition programs.

- **Targeted food-based measures,** such as dietary diversification for improved macro- and micronutrient intake coupled with micronutrient fortification of staple foods and availability of adequately iodized salt, as well as provision of food supplements to overcome the intake gap, are critical. However, these interventions face challenges related to cost, gender discrimination, and unequal intra-household food distribution, especially in resource-poor settings. Efforts to ensure that adolescent girls, especially those in food-insecure areas, have access to a balanced diet and/or fortified foods providing the necessary nutrients will help improve their nutritional status. Along with conducive, promotive government policies, the role of the private sector in producing and marketing nutrient-rich healthy foods that appeal to adolescents becomes crucial in order to improve dietary intakes.

- **Dietary supplementation with weekly iron-folic acid tablets for the prevention of anemia** in adolescent girls and women of reproductive age is recommended.[20] India provides the largest-scale example of direct nutrition interventions, targeting 108 million adolescent girls and boys under the Weekly Iron-Folic Acid Supplementation (WIFS) program, which is coupled with bi-annual deworming.[21]

- **Nutrition interventions, along with access to information and adolescent-friendly services, should focus on a lifecycle approach** – both prior to and during pregnancy, specifically targeting married and out-of-school adolescent girls. Awareness-centric programs should also involve boys and men so that they receive information about women's increased nutritional requirements during pregnancy and lactation, and may become better partners when they form families.

- **Nutrition-sensitive social protection program** interventions focusing on keeping girls in education, bank-linked cash transfer schemes to promote school enrolment, noontime meals at schools, and conditional cash transfer linked to nutrition indicators have proved effective in empowering girls and their families. This in turn has the potential to delay marriage and early pregnancies.[22,23]

  Adolescence presents an opportunity to preserve investments made in childhood and to switch trajectories. The packaging of such interventions through a skilled workforce has the potential to reach a majority of adolescents when disseminated through effective channels and platforms such as schools and universities, as well as community-based, health-based and social protection programs. Equally important are awareness and mobilization via traditional media and social media, in the workplace and at youth centers, through the support of field-based NGOs. These platforms are not mutually exclusive, and if interventions can be carried out on all these platforms as an integrated system, this may help improve the nutritional status of non-pregnant as well as pregnant adolescents.

Beneficiaries of the Weekly Iron-Folic Acid Supplementation (WIFS) program of India (showing blue-colored iron-folic acid tablets)

› **Lastly, research on energy intake and expenditure as well as nutrient intakes among pregnant adolescent girls in malnourished settings** is much needed, and would serve as a powerful tool for policy reforms aiming to improve nutritional status and delay adolescent marriage and pregnancy. This would benefit the largest generation in the world today: adolescents.

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Improving Nutrition Among Adolescent Girls

Ways to reach them

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Key messages

- Existing platforms and delivery channels that reach adolescents should be built upon to deliver nutrition-specific services and enhance their potential to have a positive impact on nutrition (also indirectly), for the benefit of the adolescent girls themselves as well as that of their future children.
- Schools offer an obvious and very good entry point, also to delay age at first pregnancy. For out-of-school adolescents, the use of other platforms should be explored, including making health system and community nutrition services more adolescent-friendly and adding a nutrition focus to adolescent- and youth-based programming.
- The food system, which largely affects what adolescents (choose to) eat, and mobile technology deserve further exploration as avenues through which to provide nutrition services and reinforce adolescent-specific nutrition and health messages.

Nine year-old Jhoti Rani eats a WFP fortified biscuit distributed in Amrita Bazaar Government Primary School in Jessore, Bangladesh, in August 2004

Making best use of available channels

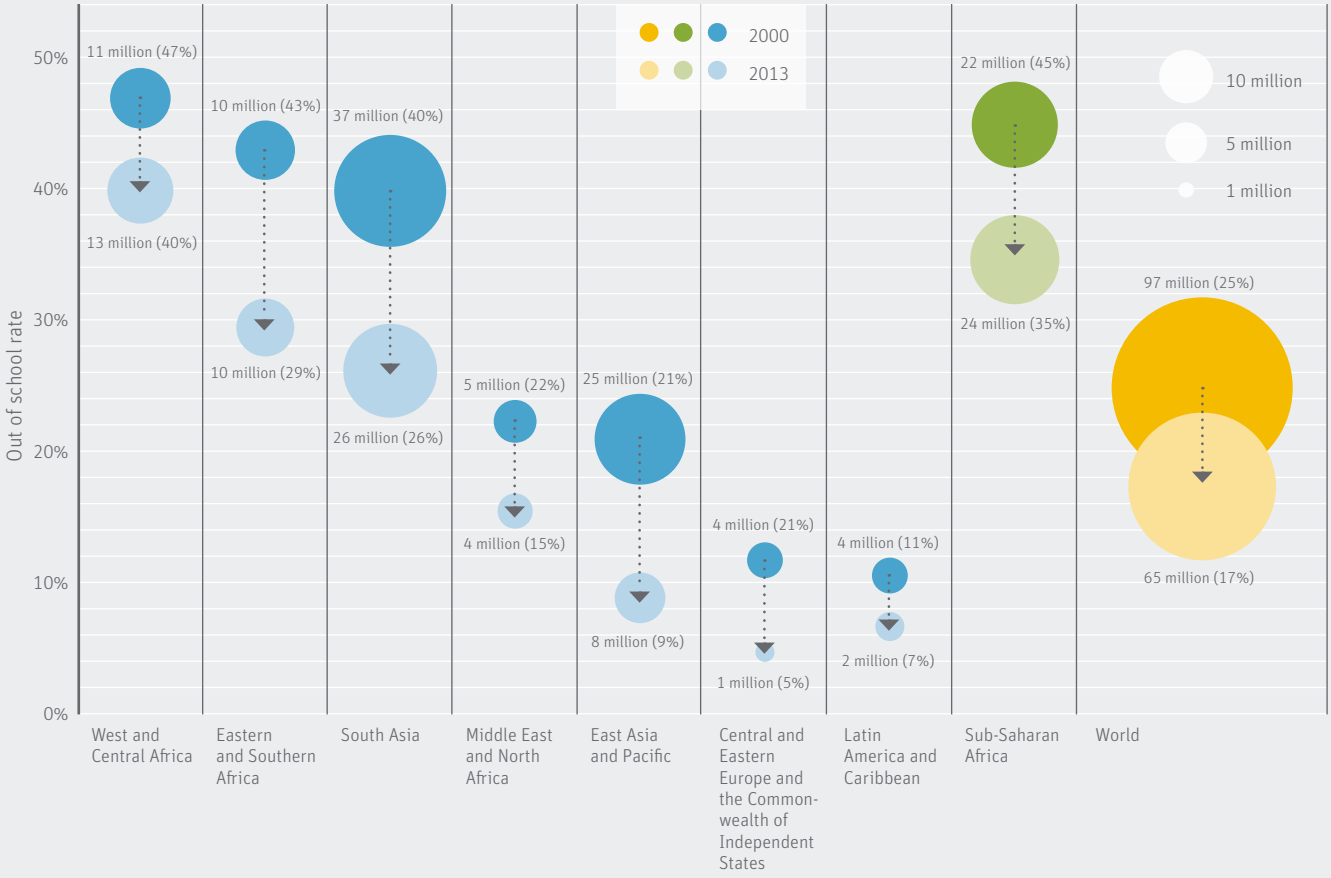
Improving the nutrition and health of adolescent girls, for their own benefit and that of their future children, requires that they be reached with specific services that directly or indirectly improve their nutritional status.

Adolescent services typically focus on sexual and reproductive health (HIV and STIs), family planning, education (formal and non-formal) and employment, as well as increasing the agency of adolescent girls to know their rights and where to seek the services they require. While these potentially nutrition-sensitive services do not specifically address nutrition, they can indirectly have a positive impact on it. Furthermore, the delivery channels that provide these services can and should be built upon to deliver nutrition-specific services too.

Delaying age at first pregnancy

Any intervention that leads to delaying age at first pregnancy, and associated age at marriage/union, until 18 years or beyond,

FIGURE 1: In sub-Saharan Africa and South Asia, more than a quarter of lower secondary-school-age children are out of school



Source: data.unicef.org/topic/education/secondary-education

allows the adolescent girl to fully develop before childbearing, which is beneficial to both her and her offspring. However, as mentioned by Mishra and Rah in their article in this issue (pp.92–97), 22% of women aged 20–24 years in developing countries had their first child before 18 years of age, including > 30% in sub-Saharan Africa and > 25% in South Asia.

> "Any intervention that leads to delaying age at first pregnancy until 18 years or beyond allows the adolescent girl to fully develop before childbearing"

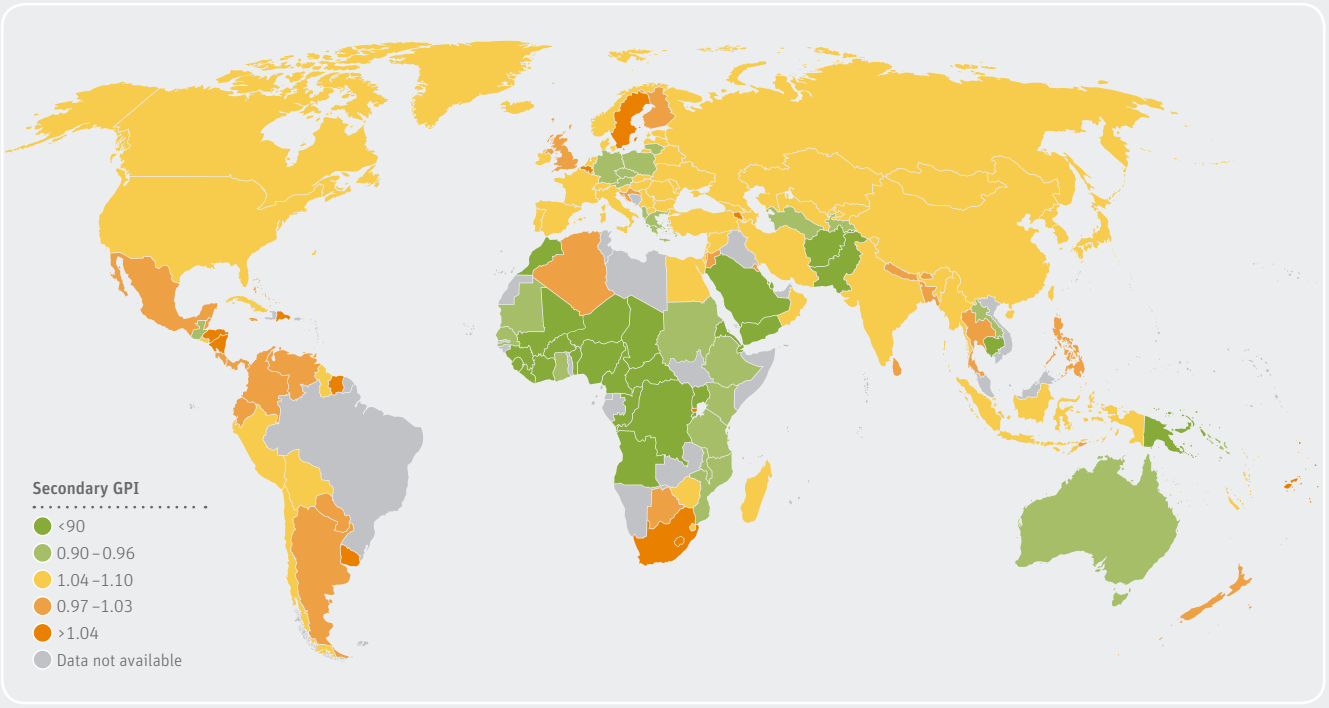
While early pregnancy may force girls to drop out of school, girls who are in school are generally less likely to become pregnant or get married. Besides efforts to keep girls in school, other interventions or situations that reduce the likelihood of girls becoming pregnant and/or delay marriage include those that help them find ways to contribute to the family financially (e.g., the availability of jobs in garment industry). In addition, it should be noted that marriage at an early age does not necessarily lead to a pregnancy or a discontinuation of education: cultural norms that support the use of family planning methods by young people, or young couples, and value continued or higher education for both girls and boys, can contribute to delayed pregnancy.

School enrolment

According to the latest UNICEF statistics, globally, 83% of lower secondary-school-age children are in (primary or secondary) school, and this is less than 70% in low-income countries.[1] In 2013, 65 million children of lower secondary school age and 55 million of primary school age were out of school.[1] Three quarters of those out of school at the lower secondary school age live in sub-Saharan Africa or South Asia.[1]

While barriers to school attendance at the secondary level are similar to those at the primary level, they present greater challenges in the former, including the cost of secondary school-

FIGURE 2: The gender gap in secondary education is widest in West and Central Africa



GPI: Gender parity index (ratio of the number of female students enrolled in secondary school to the number of male students)
Source: data.unicef.org/topic/education/secondary-education

Nutrition-specific and nutrition-sensitive interventions: Definitions

- Nutrition-specific interventions address the immediate determinants of nutrition, i.e., adequate food and nutrient intake, caring practices, and low burden of infectious disease.
- Nutrition-sensitive interventions address the underlying determinants, i.e., food security, caregiving resources, access to health services, and a safe and hygienic environment. They also incorporate specific nutrition goals and actions.[19]

ing, which tends to be higher than for primary school, the distance from the place of education, which tends to be farther and thus requires transport or lodging, and the pressure to earn an income.[1] These challenges may be more significant for girls than boys. The starkest contrast can be found in West and Central Africa, where in addition to low secondary school enrolment (40% of children of lower secondary school age are not in school, compared to 18% globally[1]), there is also high gender disparity, with 79 girls enrolled in secondary school for every hundred boys (see Figures 1 and 2).[1]

Schools as a delivery platform for nutrition-specific and nutrition-sensitive services for adolescents

Younger and older adolescents (10–14 and 15–19 years, respectively) who are in school can be reached with nutrition-specific and nutrition-sensitive interventions. Nutrition-specific interventions include those that aim to ensure adequate nutrient intake and good dietary choices and eating habits as well as those that aim to prevent disease. The following school-based nutrition-specific interventions can be distinguished:

1. **School feeding:** School feeding programs have long been implemented in low-, middle-, and high-income countries for a range of reasons: they have a demonstrable impact on increasing school attendance, alleviating hunger and improving attention among schoolchildren in areas where many come to school with an empty stomach,[2–4] and they may also be implemented to link agricultural production to consumers, and instill healthy eating habits. School feeding is implemented in almost every country

of the world, and approximately 92% of the beneficiaries are in primary school.[4]

Improving nutrition is not the primary aim of most school feeding programs, but the provision of food in a school environment offers a great opportunity, and also a moral obligation, to help address the nutritional needs of school-going children. To increase the nutritional impact of school feeding programs, improving nutritional status, in particular micronutrient status, should be included among the primary aims of school feeding activities. The use of fortified foods and/or the addition of micronutrient powders to school meals made of locally grown foods ("point-of-use fortification"), for example, are good ways to improve micronutrient intake. Furthermore, "doing no harm" in terms of overweight/obesity should also be an important consideration in school feeding, i.e., ensuring that the composition of meals and snacks is in line with food-based dietary guidelines and that it makes a good contribution to daily essential (micro- and macro-) nutrient intake. Expanding school feeding to secondary schools is also required to further extend the benefits to adolescents.

2. **Nutrition education:** Schools offer a good opportunity to instill awareness and knowledge of good dietary habits, including the consumption of a diverse and balanced diet, knowing which foods are healthy choices, understanding the importance of vitamins and minerals, and hygienic food preparation and storage practices. For example, education could be linked to (home-grown) school feeding and assessments of food options stocked by canteens and vendors in proximity to schools. This requires creativity in the adaptation, or development, of age-appropriate education materials and fitting these into the existing school curriculum.

3. **Supplementation:** Given the fact that anemia, and micronutrient deficiencies in general, are widespread, and especially so among (post-menarcheal) adolescent girls, supplementation using schools as a delivery platform is another way to try to improve the nutritional status of adolescent girls. Evidence of the impact of (weekly) supplementation, in particular of iron and folic acid, is increasing, and should be planned with a substantial awareness-raising component that is developed together with adolescents, parents, teachers and other community members, to ensure commitment and compliance from all involved.[5] The largest-scale example of weekly iron and folic acid supplementation for adolescents, which is coupled with bi-annual deworming, is from India, where both in- and out-of-school adolescents are targeted.[6]

4. **Deworming:** Where helminth infections are common, providing deworming medication to pupils through schools every 4–6 months is a relatively simple and efficacious strategy, which is implemented in a number of countries, including India and Tanzania.[6–8]

In addition to those services that are, or (in the case of school feeding) could be more nutrition-specific, schools and education benefit young people in many other ways that have the potential to positively affect nutritional status in the shorter or longer term. A higher level of parental education has, for example, been found to increase the odds of better nutritional status among their children.[9] This is probably related to higher income earning potential, more knowledge, better ability to reflect and act upon new information, and greater self-efficacy, including negotiation skills, in general.

"Schools and education benefit young people in many ways that have the potential to positively affect nutritional status"

Example of a school-based health and nutrition program for adolescent girls

India's Saloni Swasth Kishori Yojna program (SSKY; adolescent health program) in Uttar Pradesh targets 700,000 school-going adolescent girls aged 10–19 years with weekly iron and folic acid supplements, deworming, and health check-ups.[7] An additional sub-project of the SSKY intervened in the young adolescent group (aged 11–14) to promote a set of behaviors, including health-seeking, nutrition, reproductive health, and hygiene behaviors, through ten one-hour monthly sessions. In addition, 'intergenerational communication' skills were touched upon, which used role-play as a method of demonstrating how girls could initiate dialogue with their parents and other adults on topics covered by the Saloni interventions.

An evaluation of the Saloni model confirmed that the approach of focusing on early adolescence in the context of school-based structured activities provided an excellent opportunity for mentoring, supervision, and social support in this adolescent age group. The study further demonstrated that building self-efficacy for multiple health and nutrition behaviors among young adolescents is possible, as is increased

parent-child communication on culturally sensitive issues. Lastly, despite the intervention area being an impoverished district, improvements in dietary behaviors among adolescent girls were possible, and their effects could be magnified by a well-functioning SSKY commodity and supplement distribution mechanism.[7]

A training session in a Community Nutrition Center

Health system as delivery platform for nutrition services for adolescents

Although the health system represents a logical setting for adolescents to seek sexual and reproductive health services, stigma, mistreatment, and judgment by facility-based staff often constitute an important deterrent to improved care-seeking behaviors.[10] Services targeting youth and adolescents that are "acceptable and accessible to youth, conveniently located, affordable, confidential, and non-judgmental"[11] can help to break down some of these common barriers, and as such, comprise a promising approach to increasing the use of sexual and reproductive, health, and nutrition services among adolescents.

Food system possibilities for reaching adolescents with nutrition services

People's access to food and their choices from what is available are determined by the characteristics of the food system to which they are exposed and how they interact with it. For example, in rural areas of low-income countries, households, including adolescents, may largely depend on self-production, and may spend a substantial proportion of their income on staple foods when their own stocks have run out. In urban areas, people are further removed from food production and rely more on markets and shops, and a larger proportion of their food is processed.

Food processing provides opportunities to add value – for example, in the form of fortification with micronutrients, preservation and extending shelf-life, and improved food safety. Fortification of staple foods and condiments, for instance, offers an excellent opportunity for improving the micronutrient status of adolescents. On the other hand, the food industry also produces non-nutritious drinks and snacks with high sugar and/or high fat content, which have been linked to the current overweight/obesity epidemic and the increase of non-communicable diseases observed in many countries, affecting adults, adolescents, and children.

Thus, as adolescents become exposed to an increasingly complex food system, compared to what they were used to in their original situations, they should be provided with nutritious, safe and affordable options, and they should be made aware of good choices via schools and mass-media communications. In addition, interventions for improving the purchasing power of the poorest adolescents (or families) are required, as non-affordability is a key factor limiting consumption of a more diverse and adequately nutritious diet.[12,13]

Example of a food assistance program that has added an emphasis on adolescent girls and women

The primary aim of the food assistance program in Niger, Sawki, is to reduce food insecurity among vulnerable populations in the country. It is implemented by Mercy Corps, Africare, and Helen Keller International (HKI), and has a special emphasis on women and adolescent girls. Adolescents receive food rations (lentils) at "Safe Spaces" and gather there weekly for discussion groups on essential nutrition actions, family planning, and life skills.[14]

To attract and retain adolescents in the program, Safe Spaces sessions are administered by female mentors who are selected by the communities as positive role models for girls. In parallel, the program runs radio broadcasts to sensitize communities on delayed childbirth and the health and economic benefits of girls' education through influential male and female community members.[14] The use of safe spaces to discuss sensitive issues among adolescents from the community represents a promising approach and environment in which to prioritize adolescent health and nutrition.

Other platforms for reaching adolescents with nutrition services

Social Safety Net Programming, such as conditional or unconditional cash transfers, aim to reduce poverty and, consequently, its associated effects, such as low school attendance, food insecurity, poor health, and undernutrition. Social safety nets can also lead to improvement of the health or nutrition situation of adolescents in these households. They may, for example, help adolescents to remain in school – the benefits of which have been described above. While social safety nets are not implemented for their nutritional impact, they provide an attractive means of reaching vulnerable adolescents to improve reproductive and educational objectives that influence nutrition indirectly, and opportunities for adding nutrition-specific interventions can be explored.

Youth-development programs and adolescent & youth centers are designed to address a wide range of adolescent needs that are typically not delivered through other available mechanisms, such as schools or the health system. They often focus on the development of life skills, reproductive and sexual health education, employment, and psychosocial needs. Youth development programs that are designed by, and implemented in, the community in a way that engages adolescent populations, and girls in particular, have demonstrated positive impact on various sexual and reproductive health indicators. The services may be delivered at specific adolescent and youth centers, or at existing facilities such as schools or health centers.

Adolescent and youth centers that are based in the community are not only critical for reaching out-of-school adolescents, but can also offer them a 'safe zone'. In Hainsworth and colleagues' assessment of the feasibility of scale-up of such centers, a number of key characteristics were emphasized, and included "privacy and confidentiality; use of trained, nonjudgmental providers; availability of a full range of [contraceptive] methods; free or subsidized services; and adolescent involvement in design, implementation, and quality improvement of services."[15] Where feasible, the potential for delivering nutrition services through these centers should be explored.

Religious structures and groups are important actors in the majority of communities worldwide; they are closely linked with local communities and reach a wide range of people.[17] As such, religious groups and members hold great potential for communicating important issues to specific members of the community, including adolescents. One idea, which was tested in a study in Indonesia,[18] was to refer newlywed couples to the health system for weekly iron/folic acid supplements for the woman to improve her iron and folic acid status prior to a possible pregnancy.

Example of an adolescent girls' club

The Bangladesh Rural Advancement Committee (BRAC) designed and started a two-pronged Empowerment and Livelihood for Adolescents (ELA) program in Uganda in 2008 to improve both the cognitive and non-cognitive skills of adolescent girls. The program was funded by the Master Card foundation and operated through Adolescent Development Clubs, which represented a fixed meeting place within each targeted community.[16]

The Clubs were either donated by the community or the partner NGO (BRAC), and were open five afternoons per week at hours that also allowed school-going girls – aged 14–20 years – to attend. All club activities were led by a female mentor who was slightly older than the participating girls, and who provided life and vocational skills; life-skills training topics included sexual and reproductive health, pregnancy, family planning, management skills, negotiation and conflict resolution, and leadership, among others.[16] Vocational skills training comprised a series of courses on income-generating activities, promoting the establishment of self-run, small-scale enterprises such as hairdressing, tailoring, computing, agriculture, livestock rearing, and operating small trades. A randomized controlled trial of the ELA showed that the intervention was successful in delaying marriage and childbirth, and in improving HIV- and pregnancy-related knowledge, which was mirrored by reductions in risky sexual behaviors.[16]

Messaging and sensitization platforms

Technology-based platforms hold promising, largely unexplored potential for reaching adolescents with specific health and nutrition information. Experiences with mHealth and the recently launched mNutrition – where individuals register for a service that comes to them through their mobile phone provider at no cost to the recipient – should be further investigated and applied to nutrition for adolescents where feasible and/or acceptable. (**More on this topic is available at** www.gsma.com/mobilefordevelopment/wp-content/uploads/2015/04/M4D-mHealth-improved-nutrition_R1_web.pdf.)

Mass media communication can be useful for directing adolescents to available health and nutrition services in the community and to reinforce key messages that are also communicated through more interpersonal channels.

Community-based sensitization, especially that which com-

bines awareness-raising with building support networks and action within the community (such as through adolescent and youth centers and religious structures and groups) holds great potential to change community norms and beliefs on a given topic. Activities that have been documented for improving health and nutrition behavior, and that fall under community sensitization, also include community discussions, door-to-door visits, theatre, and mass media announcements through radio, television, newspapers, and billboards.

"Health services should become more adolescent-friendly"

Conclusion

The focus on adolescent girls as a target group for nutrition interventions is relatively new, and where possible, existing platforms and delivery channels should be adapted to reach them. While schools offer an obvious entry point, 65 million adolescents of lower-secondary school age are not in school, and that number is even higher among older adolescents (15–19 years). Making health services more adolescent-friendly and adding a nutrition focus to adolescent- and youth-based programming should be explored in order to reach out-of-school adolescents. Meanwhile, other platforms such as the food system, which largely affects what adolescents (choose to) eat, and mobile technology, deserve further exploration as avenues through which to provide nutrition services and reinforce adolescent-specific nutrition and health messages.

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WFP Republic of Congo Nutrition-Sensitive Urban Safety Net Program

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Key messages

- During the critical "window of opportunity" that occurs within the first 1,000 days of a child's life, investments in nutrition are crucial to ensuring proper physical growth and cognitive development.
- The monthly food vouchers for households headed by pregnant and lactating women (PLW) help to combat the intergenerational cycle of poverty linked to food insecurity and malnutrition by providing women with a source of income for food, promoting attendance at pre- and postnatal checkups, and empowering mothers with nutrition knowledge.
- The combination of nutritional supplementation and monthly food vouchers helps to meet the higher nutritional needs of people living with HIV and/or TB (PLHIV/TB) and addresses vulnerabilities that perpetuate, and are caused by, disease.

The context

While the Republic of Congo is an oil-rich, middle-income country, more than half of its population lives below the poverty line. Within this context of extreme wealth inequality, food insecurity affects 14%[1] of the population (around 600, 000 people), while 21%[2] of children under five are stunted. In addition to impeding human development and reducing opportunities for economic advancement, food insecurity and undernutrition are major contributing factors in the transmission of HIV, which affects 3.2% of the population between age 15 and 49, with urban areas being more affected. Simultaneously, poverty and food insecurity limit access to basic social services, including ante- and postnatal services and nutrition programs for People Living with HIV (PLHIV) and/or Tuberculosis (TB).

The World Food Programme (WFP) Nutrition-Sensitive Urban Safety Net Program has been implemented since 2012 in urban (Pointe Noire and Brazzaville) and peri-urban (Sibiti and Owando) settings of Congo. The program addresses the immediate food and nutrition needs of those most vulnerable to food and nutrition insecurity and poverty, including pregnant and lactating women (PLW) and PLHIV/TB on malnutrition treatment. Implemented by the Ministry of Social Affairs, Humanitarian Action, and Solidarity, with technical and capacity-building support from WFP, the program provides electronic vouchers redeemable for food to vulnerable households. Since 2012, more than 6,123 households have benefited from health and nutrition services and food vouchers that provide access to a variety of foods from a predetermined basket.

Nutritional impact on PLHIV/TB

The combination of nutritional supplementation and monthly household vouchers is critical for meeting the specific nutritional needs of PLHIV/TB, while also addressing the associated vulnerabilities that perpetuate, and are caused by, the diseases. PLHIV/TB have higher nutritional needs and are therefore particularly vulnerable to malnutrition: supplements for PLHIV/TB help treat moderate acute malnutrition.

A WFP beneficiary and her daughter shopping for food

"Since 2012, more than 6,123 households have benefited from health and nutrition services and food vouchers"

Food insecurity and poverty limit people's ability to adhere to treatment, and poor nutrition plays a role in HIV disease progression in adults and children, thus compromising the success of treatment. WFP's provision of SUPER CEREAL – a fortified blended food supplement designed to treat and prevent acute malnutrition – ensures that people not only adhere to treatment, but are also able to access adequate nutrition in order to benefit from the treatment.

The presence of HIV and/or TB in a household not only compromises the nutritional status of those infected by the diseases but also undermines that of other family members. The cost of treatment and care for PLHIV/TB and reduced livelihood choices creates strains on limited family resources and compromises the ability to ensure adequate care and nutrition for children. The monthly household food voucher provided by WFP therefore addresses the socioeconomic limitations that prevent PLHIV/TB and their households from achieving food and nutrition security, and presents a means to develop resilience to future economic shocks. Social behavior change communication (SBCC) provided by the national nutrition services is included in the program to encourage lasting positive change in nutrition behaviors.

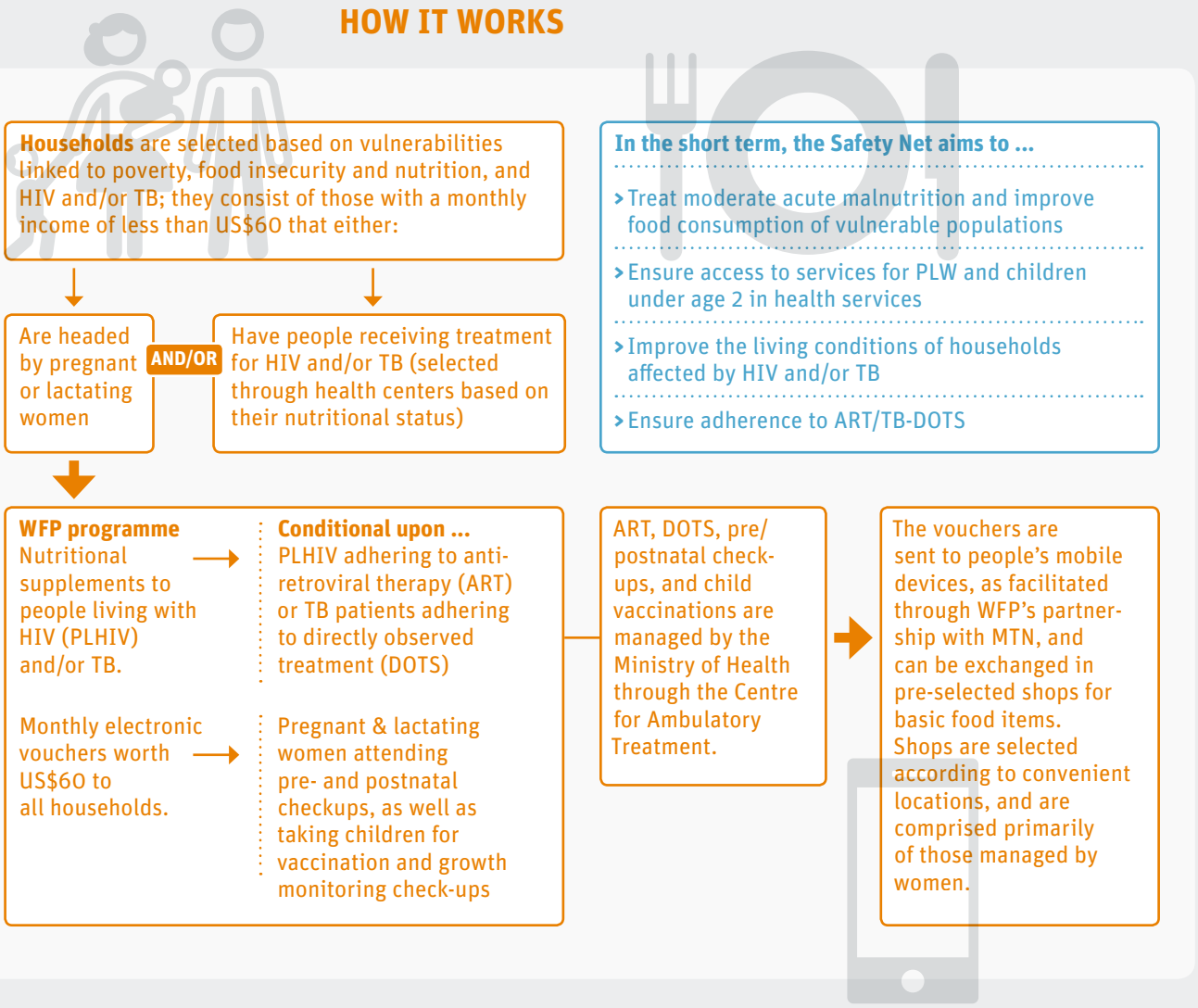
"The monthly household food voucher addresses the socioeconomic limitations that prevent PLHIV/TB and their households from achieving food and nutrition security"

The critical window of opportunity

The food voucher transfer for households headed by PLW presents a critical opportunity to combat the intergenerational causes of undernutrition and poverty. By providing a source of income for food expenditures, promoting attendance at pre- and postnatal check-ups, and enabling access to nutrition education, WFP allows mothers to increase their investments in their own nutritional improvement as well as that of their children in their first 1,000 days of life. During this critical "window of opportunity", which starts prior to birth and continues to about two years of age, investments in nutrition are crucial to preventing the largely irreversible impediments to physical growth and cognitive development as well as increased risk of non-communicable diseases in adulthood that result from malnutrition in the early stages of life. The vouchers provide the option to make purchases from a selection of nutritious foods including meat, dairy and fresh food, thereby ensuring access to essential macro- and micronutrients.

Measuring the mid-upper-arm-circumference (MUAC) of an infant

FIGURE 1: WFP's Safety Net programme



Poor nutrition in young children leads to decreased productivity in adulthood, due to both physical and mental impairment, and causes children to benefit less from education. As such, ensuring proper child nutrition in the first 1,000 days, starting with proper maternal nutrition, increases opportunities for economic advancement and the ability to break the intergenerational cycle of poverty linked to malnutrition. Improving nutrition at the household level also enables countries to enhance the effectiveness of primary education, reduce child mortality, improve maternal health, and combat HIV/AIDS, malaria, and other diseases, all of which depend crucially on nutrition.

Addressing root causes

WFP's food and nutrition assistance to vulnerable households incentivizes the use of, and access to, basic social services provided by the government. The use of conditional voucher transfers as a modality of food assistance not only reduces hunger and immediate poverty, but also promotes positive behaviors that increase resilience to food insecurity and undernutrition in the long term.

Through this nutrition-sensitive approach, the program addresses not only the immediate determinants of undernutrition (i.e., inadequate dietary intake and disease), but also targets the complex and interrelated underlying determinants, including inadequate access to food, insufficient health services, and inadequate care for children and women. WFP also provides capacity-building support to all actors (social and health staff members) involved in the project, with a view to enhance governmental capacity to gradually assume full ownership and management of the Urban Safety Net Program. To achieve this objective, WFP provides training and technical support in monitoring, data collection, and other necessary skills to the Ministry of Social Affairs, Humanitarian Action, and Solidarity.

Measuring the mid-upper-arm-circumference (MUAC) of a WFP beneficiary

> "Through this nutrition-sensitive approach, the program addresses not only the immediate determinants of undernutrition, but also targets the complex and interrelated underlying determinants"

WFP's focus on fostering strong partnerships also plays a critical role in ensuring that beneficiaries have access to the necessary support and resources as they transition out of the program, thus preventing relapses into poverty or food insecurity. WFP increasingly works with local organizations to identify income-generating activities, training programs, and microcredit opportunities through which beneficiaries who graduate from the program can continue to build their resilience and achieve economic security.

Empowering women

While the immediate objective of the vouchers is to reduce food and nutrition insecurity, the benefits of conditional vouchers extend to other realms of social development. One of the most noteworthy benefits is their impact on the status of women.

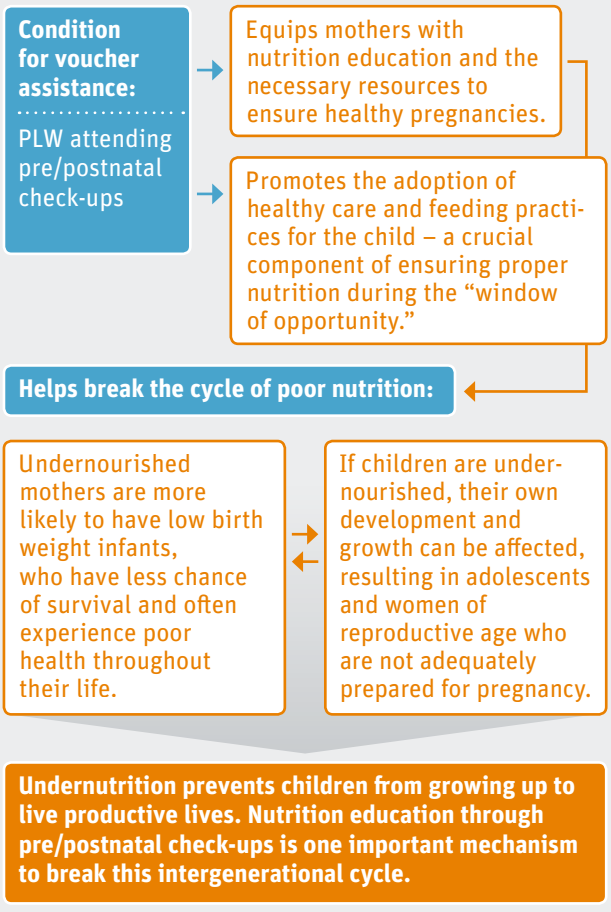
In 2015, the project assisted more than 5,200 households, of which 89% were headed by single mothers. By allowing women to cover the immediate food and nutritional needs of their households, the electronic vouchers free up other resources for women to invest in their children's, as well as their own, health and development. In 2015, 96% of children in assisted households ate three meals a day, while in non-assisted households only 23% of children consumed two meals a day.

This safety net also provides a means of independence and a source of dignity by allowing women to provide for their families without having to resort to unsustainable coping mechanisms, such as transactional sex, which could increase their vulnerability to HIV. WFP further supports the socioeconomic status of women by ensuring that the majority of the voucher shops are those managed by women. In 2015, 84% of shop-owners serving the program were women.

Reducing stigma

Both men and women living with HIV and/or TB face a unique vulnerability due to societal fears and perceptions of these diseases in Congo. Unable to engage in livelihood activities as a result of their illness, PLHIV and/or TB are often cast off as a

FIGURE 2: The intergenerational impact of conditional vouchers.



A WFP beneficiary with her purchases

burden to impoverished households. The electronic vouchers allow those with HIV and/or TB, who would otherwise have few options for earning an income, to contribute resources to their households and reduce their stigmatization. Engagement in SBCC activities allows PLHIV/TB to gain a better understanding of their own nutritional status, and also instills pride and confidence from being able to work alongside health agents to help other patients. This also allows other people to recognize the capacities of PLHIV/TB.

> "The electronic vouchers allow those with HIV and/or TB to contribute resources to their households and reduce their stigmatization"

Consistency is crucial

The foundation for ensuring that the program's food and nutrition assistance achieves lasting positive impact on households' resilience to shocks, such as poverty and disease, is consistency. As such, long-term government commitment, with technical capacity reinforcement from WFP, comprises one of the most crucial elements in achieving the primary objectives of the Urban Safety Net Program.

Due to the extreme vulnerability of the households targeted in the program, a break in, or reduction of, assistance could determine the immediate health and nutrition of household members, as well as hinder progress in socioeconomic development efforts at a national scale. This is because food and nutrition insecurity functions not only as a consequence of poverty but also as a cause of it.

Results from a joint Ministry of Health/Social Affairs and WFP Post Distribution Survey in January 2016 revealed that vouchers constituted the principal economic source for key nutritious food groups: 65% of meat, 86% of eggs, 45% of fish, 90% of dairy products. Whereas these households would have had to devote the majority of their income to food, this assistance instead allowed them to utilize their own income on health, education, and investments in income-generating activities. In 2015:

- Ninety-six per cent of assisted household members had adequate food consumption, compared with 62% of non-assisted; assisted households also consumed more foods rich in protein and micronutrients.
- The majority of non-assisted adults (98%) consumed only one meal a day, while the majority of adults receiving vouchers (74%) consumed at least three meals a day.

Lack of consistent, stable assistance could result in reduced maternal health and inadequate nutrition for children in their first 1,000 days, leading to irreversible impediments to growth and cognitive development. It could also lead to PLHIV and/or TB defaulting on ART and/or DOTS, or facing increased stigmatization, and could additionally lead to children dropping out of school as a result of inadequate resources or the need to support their families by means of income-generating activities.

WFP beneficiary ID

Personal impact

Mother-of-four Douniama Noellie knew that her HIV-positive diagnosis would not be a burden for her alone. As the sole carer and breadwinner in the household, Douniama was concerned about her ability to provide basic necessities for her family, or to protect her children from the stigma they would face as children of a parent with AIDS.

"After their father died, I was left alone to care for them," explains Douniama.

Abandoned by her family and unable to find other outlets for assistance, Douniama didn't know how she would manage to support her children, much less herself. Her situation took a turn for the better when she began receiving monthly food vouchers from WFP through the *Centre de Traitement Ambulatoire* (Walk-in Treatment Center) in Brazzaville.

"The voucher that WFP gives us to buy food in the stores doesn't cover all of our needs, but it is a big help," says Douniama. "I am thankful to WFP because if it wasn't for this support, we would have no other means of getting by."

> "If it wasn't for this support, we would have no other means of getting by"

For Douniama, the vouchers have meant the difference between barely affording food for her family to being able to pay for her children's schooling. Just as tangible as the financial impact has been the added sense of independence and dignity that came with being able to provide for her family.

FIGURE 3: Impact in numbers (based on 2013 outcomes)

HIV/TB:

- The default rate for TB treatment among patients receiving assistance through WFP was 0.78%, compared to a national default rate of 12%
- Adherence to ART was 97%, and adherence to DOTS was 98%
- The recovery rate from malnutrition was 90.66% among PLHIV and 97.32% among people with TB

Maternal and child health:

- 99% of PLW took part in postnatal checkups, compared to a national rate of 64% in urban areas
- 98% attended at least 4 prenatal visits during pregnancy, compared to a national rate of95.6% in urban areas

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Six Legs to Nutrition: A New Old Food Source

Edible insects can significantly improve maternal and child nutrition while offering socioeconomic and environmental benefits

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Key messages

- The high burden of global food insecurity and undernutrition, the increased global emphasis on sustainable food systems, and a growing demand for animal-source protein call for increasing the supply of, and access to, sustainable animal-source foods.
- Edible insects have been a part of traditional diets in many regions in Asia, Africa, and Latin America for millennia and are a highly nutritious food source, rich in macro- and micronutrients.
- Farming insects as "mini-livestock" can help address food and nutrition security challenges in many settings while also generating socioeconomic and environmental benefits, as illustrated by early results emerging in Ghana.

The challenge of scaling up food-based solutions

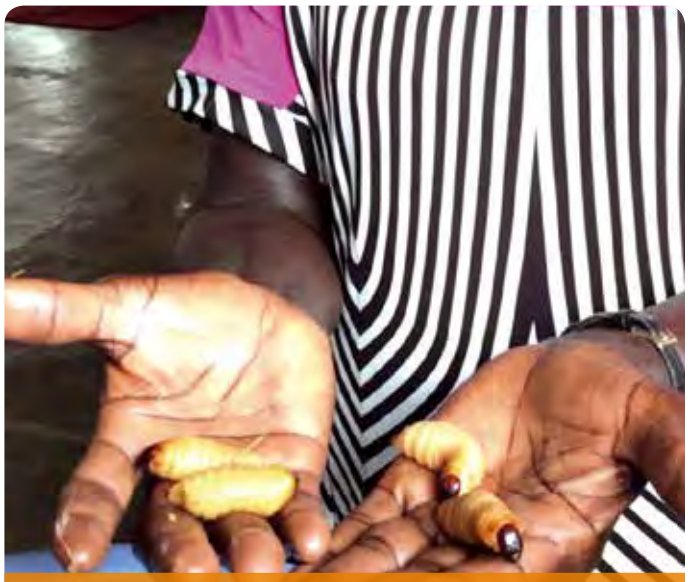
Maternal and child undernutrition is the leading underlying cause of child mortality and morbidity, and is estimated to cause 3.1 million child deaths each year.[1] The associated disease burden – which includes stunting, wasting, and micronutrient deficiencies – must be addressed with innovative and comprehensive solutions aimed specifically at pregnant and lactating women and children under two years of age. While micronutrient deficiencies have been addressed at least in part through supplementation, micronutrient powders, and food fortification, scaling up effective and sustainable food-based solutions has been a challenge.

Animal-source foods are proven sources of the nutrients required to mitigate malnutrition and promote optimal health in these vulnerable populations.[2] However, as the worldwide demand for animal protein is expected to double by 2050, a variety of innovative approaches must be identified.[3] Edible insects have emerged as a promising option to address these needs. The use of these "mini-livestock", where acceptable, could substantially enhance diet quality to meet the high nutritional needs of pregnant and lactating women – along with fast-growing infants and young children (IYC) – while also creating significant socioeconomic benefits for low-income families.

Insects as food

Entomophagy – the consumption of insects as food – has been practiced for millennia by countless cultures in regions that represent the largest burden of malnutrition in today's world. Two billion people in Asia, Africa, and Latin America consume more than 2,000 species of insects – including beetles, caterpillars, grasshoppers, and crickets – as part of their traditional diets.[3] Through the domestication and farming of these typically foraged insects, a consistent source of many essential nutrients can be provided to vulnerable populations.

According to a report from the Food and Agriculture Organization (FAO), the growing global population and increasing



Palm weevil (*Rhychophorus phoenicis*) larva, or *akokono*, an edible insect commonly found in palm trees, offers a promising platform to address maternal and child malnutrition in Ghana.

demand for protein among the middle class is leading to higher costs of animal-source proteins; food and feed insecurity; and rising environmental pressures.[3] Entomophagy offers a new platform for innovation and impact that alleviates burdens in nutrition, food security, economic development, and environmental resource management. Particularly in low-resource settings – where food insecurity and high levels of stunting, wasting, and anemia are persistent – edible insects offer a low-cost and often culturally appropriate source of macronutrients (proteins, fats and carbohydrates), vitamins, and minerals. Insect-based foods can offer complementary sources of animal protein and other nutrients to meet the growing global demand for animal-source foods.

> "Particularly in low-resource settings, edible insects offer a low-cost and often culturally appropriate source of macronutrients, vitamins and minerals"

Health impact

Insects are highly nutritious and many have high protein-to-fat ratios and low cholesterol levels.[4] They are generally rich in minerals including iron, zinc, and phosphorous, as well as many vitamins including riboflavin, pantothenic acid, biotin, folate, and vitamin A.[5,6] In a clinical study conducted in the Democratic Republic of Congo, infants fed a caterpillar-based cereal for twelve months showed higher hemoglobin concentration and lower prevalence of anemia compared with the control group.[7] This caterpillar cereal was also found to be acceptable by both mothers and infants.[8]

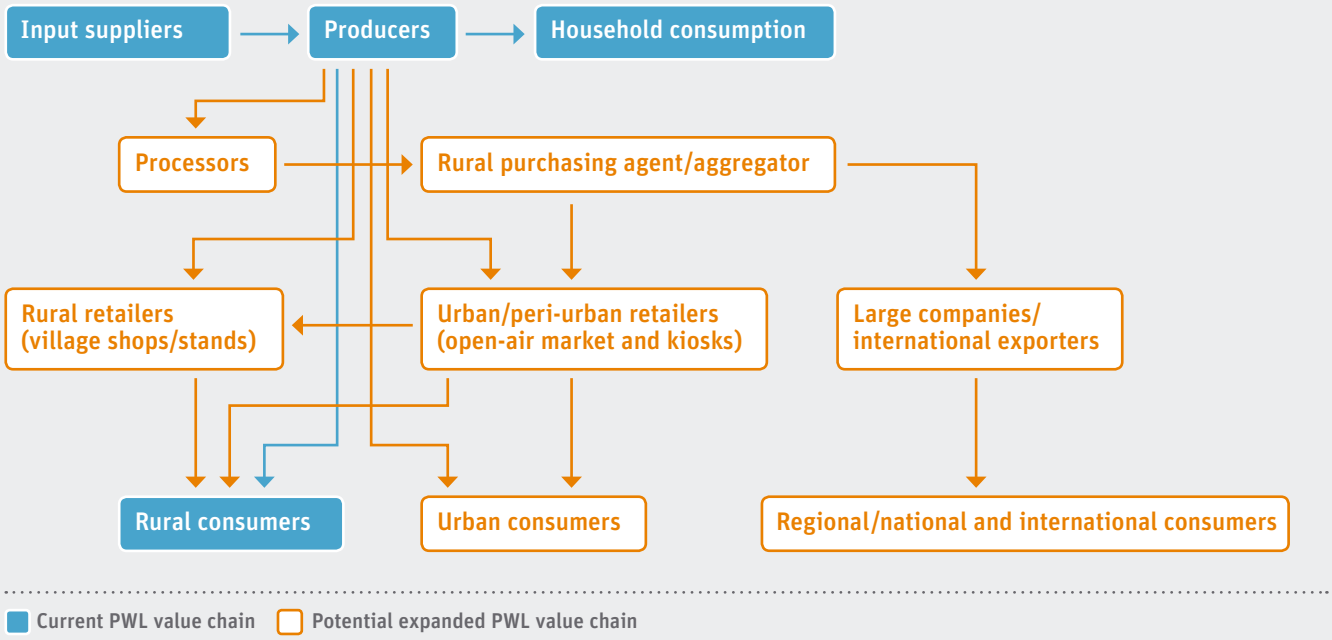
While insects are often consumed whole, they can also be processed into nutrient-rich pastes, powders, or flours. These forms are useful for integrating insects into complementary foods and fortifying local diets with additional nutrients. The combination of micro- and macronutrients found in insects can surpass food fortification by providing a whole, natural, and sustainable food source with the nutrient composition to effectively combat the burden of malnutrition. However, to effectively promote and scale up insect-based foods, higher-quality evidence on the linkage between insect consumption and the reduction of nutrient deficiencies must be generated.

Socioeconomic impact

Edible insects have traditionally been foraged from their natural environment. This practice leaves yields subject to seasonal variation and climate fluctuations. Domestication and farming practices can ensure a continuous and sustainable supply of insects, and successful experiences in Thailand, Laos, and Vietnam highlight the potential for insects as "mini-livestock."[3] Insect farming is a particularly efficient method of providing additional food for individual household consumption and food security. This economic activity can range from micro-farming for household consumption all the way to elaborate value chains that include large-scale farming, processing, and integration into existing food and feed systems to supply domestic and foreign markets.

In Ghana, *akokono* is part of traditional diets and can be prepared using multiple methods.

FIGURE 1: The *akokono* value chain is fairly simple, with linear linkages between input suppliers, producers, and consumers. There is great opportunity to improve and expand this value chain to deliver a significant nutritional and economic impact.



> "Successful experiences in Thailand, Laos, and Vietnam highlight the potential for insects as 'mini-livestock'"

The combination of low up-front investment, small spatial requirements, and physical adjacency to the household presents ample opportunity for low-income populations to engage in insect micro-farming. The short harvest cycles of many insect species can play an important role in supply smoothing and food security.[9] As with other small livestock, the proximity to the household and low physical labor and time requirements could provide significant economic opportunity for women in particular. Additionally, the small spatial requirements may also present an opportunity for urban populations to invest in micro-farming. Overall, insect farming has the potential to provide a consistent, highly nutritious food source and economic empowerment for vulnerable populations.

Environmental impact

Breeding insects requires relatively little water and land. Insects also need only small amounts of food due to their high feed-conversion rates – i.e., how much feed is needed to produce 1 kg of product.[10] Farmed insects can be fed with organic byproducts such as kitchen scraps, compost, and husks and leaves of crops such as corn and cassava.[3] Insects cultivated for animal feed purposes can also be raised on diets of food waste and other organic waste. Consequently, entomophagy could potentially jump-start new markets for agricultural byproducts that would otherwise be discarded. Furthermore, insect farming takes up little space and can be done at home. Families can thus farm insects without sacrificing their current land use: the ability to farm insects alongside produce increases the potential for dietary and economic diversity. Insect farming is therefore an efficient and sustainable venture requiring relatively few resources and producing a low environmental footprint.

Exploring opportunities in edible insects

The best opportunities to accelerate the development and scale-up of entomophagy as a new platform for innovation and impact are those combining favorable geographies and insect species. Geographies should be selected based on criteria such as scale of nutritional gaps, extent of insect consumption by different groups, economic development status, local and regional capabilities, and enabling environment. Species should be selected by matching nutrient profiles against local nutritional priorities, acceptability, and taste preferences. For any combination of geographical scope and species, a core set of activities should be carried out:

- Nutritional analysis of the species, identifying macronutrient and micronutrient profile in terms of content and bioavailability

- Research into harvester/producer/consumer behaviors related to the selected species, particularly among vulnerable groups (entailing a combination of ethnographic research and value chain analysis)
- Human studies on the efficacy, effectiveness, and safety of the species, whether in processed forms or not, to address maternal and child malnutrition
- Development or adaptation of cost-effective farming and processing technologies to enable or expand insect-based value chains, with initial focus on domestic micro-farming in rural and peri-urban areas.

Akokono in Ghana: a promising food source

Malnutrition is a pressing issue in Ghana, particularly for women and children. Almost half (42%) of women of reproductive age and two-thirds (66%) of children under five are anemic. One-fifth (19%) of Ghanaian children under five suffer from stunting and 5% suffer from wasting.[11] Eleven percent of children and 6% of women are underweight.[11]

Considering the high burden of malnutrition in Ghana, the African palm weevil (*Rhychophorus phoenicis*) larva presents a particularly compelling opportunity to improve nutrition. This species is found and consumed as food in its larval stage throughout tropical and equatorial Africa. Palm weevil larvae (PWL) are an excellent source of amino acids, fatty acids, vitamin B_{12}, and minerals such as zinc, potassium and phosphorus.[12] Particularly in Central and Southern Ghana, PWL, locally known as *akokono*, are part of traditional diets and are considered a delicacy. Currently, PWL harvesting is labor-intensive and subject to inconsistent yields, as increased pesticide use decreases availability.

The inputs required for PWL farming are relatively few, and include a bucket, a screened lid, a feed mix, and a few larvae.

During a training session, women take turns preparing *akokono*.

Although the current PWL value chain is relatively simple (see **Figure 1**), there is significant potential to improve and expand it in order to maximize the potential to deliver a substantial nutritional and economic impact in Ghana.

> "Formative research has produced promising results"

Small insects provide big opportunities

Given this opportunity for impact, PATH, Aspire Food Group, Heifer International, the University of Ghana School of Public Health, and Kintampo Health Research Center are working together in the Ashanti and Brong-Ahafo Regions of Ghana to turn this traditional food source into a new avenue for improved nutrition and prosperity among vulnerable groups. By providing starter kits to women to farm PWL at home, this initiative aims to increase consumption of animal protein, dietary diversity, and household income through market sales. Formative research has produced promising results, indicating that caregivers and stakeholders generally perceive PWL to be healthy and appropriate for both adults and children. The low supply and high demand for PWL in local markets make their farming economically attractive. By building social capital, women farmers form socially strong and economically viable community groups that promise the sustainability of PWL farming initiatives.

Conclusion

Our experiences with the PWL in Ghana highlight the potential of edible insects to improve maternal and child nutrition and empower women. The high nutritional content paired with the promising economic potential may provide the necessary conditions to alleviate the burden of malnutrition in many contexts. The nutritional, health, socioeconomic, and environmental benefits of these valuable food sources are yet to be fully tapped.

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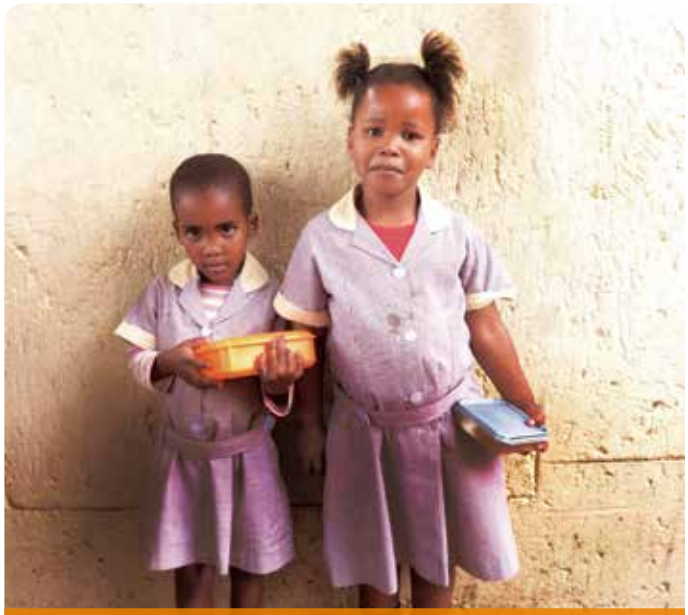
Stunting: Malnutrition or Exploitation?

Fred de Vries
Independent writer



Two girls aged seven, one showing the dramatic effects of stunting.

Childhood stunting is one of the most significant impediments to human development, globally affecting approximately 162 million children under the age of 5 years. Stunting, or being too short for one's age, is defined as a height that is more than two standard deviations below the Child Growth Standards median of the World Health Organization (WHO).[1] Factors that contribute to stunted growth and development include – but are not limited to – poor maternal health and nutrition, inadequate infant and young child feeding practices, and infection.

Klaus Kraemer, quite rightly, claims that stunting should be made a development indicator.[2]

Stunting is the face of poverty,[3] and that observation is very true, but endemic poverty also induces child labor. If the nutritional intake of a child is just above the threshold that could result in stunting, the child would normally grow to a normal height. But, if the child has to work long hours and perform calorie-consuming manual labor, then those calories and other nutrients cannot be used for growth. This will result in stunting, even though the intake of nutrients is within the accepted levels.

Thus, I would suggest that stunting is not only the result of malnutrition, but also of child exploitation. Both are indicative of poverty.

> "Stunting is not only the result of malnutrition, but also of child exploitation"

However, if children in developed countries are forced to undergo rigorous training for, say, gymnastics or soccer, growth will also be stunted. Take, for instance, female gymnasts who resemble small children but are already adults.[4] While we all can agree that these athletes probably eat meals that contain more than enough nutrients, their bodies cannot resolve where to use these nutrients. The body uses nutrients to enhance the short-term goals to the detriment of long-term growth. And even here we can see an element of exploitation.

Therefore, stunting is not only an indicator of malnutrition in children, but also of the exploitation of children. And while stunting in usually monitored in children less than five years of age, stunting as a result of exploitation should be monitored in children older than five years of age.

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Special Feature

Malnutrition and Psychosis in *Don Quixote*

Jonathan Steffen
Jonathan Steffen Limited, Cambridge, UK

The depiction of hunger in classic literature is a neglected subject. Yet it is a major theme and a key plot driver in many great works of fiction. From the cannibalism of Count Ugolino della Gherardesca in Dante's *Inferno*[1] to Oliver Twist's bewildered "Please, Sir, I want some more,"[2] the critical need for adequate nutrition has been powerfully articulated by many great writers. In the first of a new series on this subject, Jonathan Steffen examines the relationship between nutritional intake and mental health in Cervantes' *Don Quixote*.

From the appearance of the first edition of its first volume in 1605, Miguel de Cervantes Saavedra's *Don Quixote* has been considered one of the greatest and most enduringly popular works of literature ever penned.[3] It is at one and the same time an analysis of the economic and social malaises of sixteenth-century Spain, a commentary on the relationship between outmoded forms of literature and contemporary trends in writing, and a study in psychosis: Don Quixote de La Mancha is the greatest fantasist in fiction. But Cervantes' masterpiece is also a profound meditation of the relationship between food and health.

Comparison with Cervantes' English contemporary Shakespeare throws this into stark relief. While Hamlet broods memorably on the "funeral baked meats" which "coldly furnished forth the marriage tables" at his mother Gertrude's wedding to his uncle Claudius,[4] we know relatively little of what most of Shakespeare's characters ate. We do not automatically associate Romeo and Juliet, or Macbeth, or Lear, or Prospero with particular types of food, or particularly significant meals. We do make this association in respect of Don Quixote, however; and this is because the author himself makes it in the novel's opening paragraph: "Somewhere in La Mancha, in a place whose name I do not care to remember, a gentleman lived not long ago, one of those who has a lance and ancient shield on a shelf and keeps a skinny nag and a greyhound for racing. An occasional stew, beef more often than lamb, hash most nights, eggs and abstinence on Saturdays, lentils on Fridays, sometimes squab as a treat on Sundays – these consumed three-fourths of his income."[5]

From malnutrition to mental illness

In an extensive study of Don Quixote's diet,[6] Prof. Barry Ife of King's College, London, analyses the relationship between what Don Quixote consumes and his mental condition. "It seems clear that Don Quixote's diet is frugal, monotonous and unappetizing, and it is hardly surprising that with such meager fare Don Quixote is as thin as he is always portrayed. But Quixote's bad habits are not limited to diet. He also neglects his sleep: 'He spent his nights reading from dusk till dawn and his days reading from sunrise to sunset.' Here we have the classic syndrome of the single male," continues Ife: "the fatal combination of late nights and junk food. Most men go through this stage at some point in their lives, and most men grow out of it. But Don Quixote never does, and eventually he makes himself so ill that his brain dries up and he starts to lose his wits … Cervantes did not need to be a qualified doctor to recognize the symptoms of sleep deprivation and malnutrition, or to know what the combined effect would be on his hero's behavior in the novel."

> "An intelligent man is pushed into an insane fantasy"

The combined effect is to push an essentially intelligent and educated man, a kindly, thoughtful and deep-thinking person, into an insane fantasy in which he views himself as a lone redeemer whose task is to set the world to rights single-handed. Don Quixote believes that it is incumbent upon him to sally forth onto the roads of Spain as a knight errant whose selfless

Don Quixote de La Mancha, dubbed the 'Knight of the Sorrowful Countenance'

deeds will summon back the bygone age of chivalry. In a series of encounters – most famously, the one with the windmills that he mistakes for giants – Don Quixote attacks a vast range of completely innocent people and objects, believing them to be wicked knights, sorcerers and enchanters. He literally beats up the world and gets soundly beaten up in return. As his perplexed housekeeper fumes after one of his sallies: "The first time they brought him back lying across a donkey, beaten and battered. The second time he came home in an oxcart, locked in a cage and claiming he was enchanted, and the poor man was in such a state that his own mother wouldn't have recognized him: skinny, pale, his eyes sunk right into the top of his head; to bring him back to himself a little, I used more than six hundred eggs; God knows that, and so does everybody else, and my hens too, and they wouldn't let me lie."[7]

The detail of the eggs is telling. Cervantes, who struggled financially all his life, and who himself had required a full two years to recover from the wounds he sustained in the 1571 Battle of Lepanto,[8] knew all about the relationship between wealth, nutrition, and wellbeing.

Don Quixote's diet

Don Quixote's diet is indeed wretched. Prof. Ife analyses it as follows. "We might take the virtual contents of Don Quixote's virtual stomach and subject them to analysis. We know that his staple diet before the first sally consisted of five elements: *'olla'* by which we may assume is meant the classic slow-cooked stew made with beans and sausages known as *'olla podrida'*, eaten as the main midday meal; *'salpicón'* or cold meat sliced thinly with onions and vinegar for supper; *'lantejas'* or lentils on Fridays; *'duelos y quebrantos'*, probably some form of omelet, on Saturdays; and the occasional pigeon on Sundays. We may assume also that, in real life, Alonso Quijano [Don Quixote's real name] would have supplemented this diet with bread and wine, and he may possibly, but not necessarily, have also eaten some fruit and vegetables; the conventions of literary analysis, however, do not allow us to take into account what is not in the text.

"**Table 1** gives a summary analysis of the likely nutritional value of this fictional diet, together with some of the principal nutrients expressed as a percentage of the recommended daily allowance (RDA).

"Several things about this analysis require comment. Firstly, such a diet would have left Don Quixote seriously deficient in energy; his calorie intake is only about a quarter of that required by a 50-year-old male with even a sedentary lifestyle. The consequences of long-term malnourishment of this order would be wasting of the flesh and loss of muscle tone. Secondly, he is below the recommended daily amount of all nutrients, but is especially deficient in calcium (8%), vitamin C (6%) and vitamin E (10%)."[10]

The poverty of this fare is intensified by Don Quixote's deliberate neglect of his own physical needs. Viewing knight errantry

Don Quixote charges the windmills which he mistakes for giants in the novel's most famous episode. Illustration by Gustave Doré (1832–83), first published in 1868. Note that even Sancho Panza's ass Dapple protests against Don Quixote's folly.

TABLE 1: Analysis of Don Quixote's diet[9]

Nutrient	Amount	Units
Cholesterol	72.2	mg
Carbohydrates	50.0	g
Dietary fiber	16.5	g
Energy	524.8	kcal
Fat	17.3	g
Saturated fat	5.6	g
Potassium	1100.0	mg
Sodium	661.6	mg
Unsaturated fat	10.0	g

Nutrient	Amount	Units	%RDA
Calcium	67.2	mg	8
Folate	357.7	µg	89
Iron	8.0	mg	82
Magnesium	96.6	mg	28
Niacin	8.0	mg	50
Phosphorus	570.8	mg	71
Protein	42.4	g	76
Riboflavin	0.38	mg	27
Thiamin	0.68	mg	57
Vitamin A	225.8	µg	23
Vitamin B_6	0.79	mg	36
Vitamin C	3.6	mg	6

as a mystic calling, he practices a profound asceticism that subjugates the requirements of the flesh to the visions of the mind. On the road, he frequently fasts and watches all night long while his squire Sancho Panza contentedly snores besides him. Even in the midst of food, he often ignores his own need to eat. "Don Quixote gave this long discourse [on the subject of the fate of the contemporary sixteenth-century soldier] while the others were eating, and he forgot to bring a single mouthful of food to his lips, although Sancho Panza told him several times that he should eat and that later there would be time to say all he wanted to say. Those who listened to him were overwhelmed again with pity at seeing a man who apparently was intelligent and rational in all other matters could lose those faculties completely when it was a question of his accursed and bedeviled chivalry."[11]

"The poverty of this fare is intensified by Don Quixote's deliberate neglect of his own physical needs"

Sancho Panza's relationship with food

Don Quixote's 'squire', the peasant Sancho Panza, has a very different attitude to food. While Don Quixote is a country gentleman of slender means with pretensions to the aristocracy of arms, Sancho Panza represents a peasantry that was oppressed by poverty at a time when Spain was flooded with new money. As William Egginton observes: "Spain's economy in the second half of the seventeenth century was squeezing all but the wealthiest nobles, as the ceaseless war financed by silver from the New World drove prices higher and higher and made taxes more punitive, while the nobility and the Church were spared from fully sharing the burden."[12] Sancho, who has left the hardships of a peasant's existence behind him in search of gain and glory with Don Quixote, frequently laments the privations he is obliged to share with his master on the road: "I'm so poor and unlucky that all I have in my saddlebags is a little cheese, so hard you could break a giant's skull with it, and to keep it company some four dozen carob beans and the same number of hazelnuts and other kinds of nuts, thanks to the poverty of my master and the idea he has and the rule he keeps that knights errant should not live and survive on anything but dried fruits and plants of the field."[13]

Being well acquainted with hunger, Sancho takes every opportunity to feast when the occasion arises: "I'm going over to that brook with this meat pie, where I plan to eat enough for three days, because I've heard my master, Don Quixote, say that the squire of a knight errant has to eat whenever he can, and as much as he can, because they might go into the woods so deep they can't find their way out for six days, and if the man isn't full, or his saddlebags aren't well-provisioned, he might stay there, as often happens, until his flesh wrinkles and dries like a mummy's."[14]

So eager is Sancho to stuff his belly at every opportunity that a trick is practiced on him in Part II of the novel to encourage him to mend his ways. Believing that he has come into the governorship of the 'island' (*ínsula*) that Don Quixote has repeatedly promised him as a reward for his service, Sancho is made the victim of an elaborate hoax whereby a number of mouth-watering dishes are placed before him, only to be whisked away on the orders of his physician: "'I Señor, am a physician, and on this ínsula I am paid to tend to its governors, and I care for their health much more than I do my own, studying day and night, and observing the governor's constitution and temperament in order to successfully cure him if he should fall ill; and the principal thing I do is to be present at his dinners and suppers, and allow him to eat what seems appropriate to me, and to take away what I imagine will do him harm and be injurious to his stomach; and so I ordered the dish of fruit removed because it was too damp, and the other dish as well because it too hot and had a good number of spices, which increase thirst, and if one

Statue in Madrid, Spain, of Don Quixote on his horse Rocinante and Sancho Panza on his ass Dapple, with their creator Miguel de Cervantes Saavedra (1547–1605) in the background

drinks too much, one destroys and consumes the radical humor, which is to say, life.'

"'So that means that the dish of roasted partridges over there, nicely seasoned, it seems to me, won't do me any harm."

"To which the physician responded:

"'The governor will not eat them as long as I am alive.'"[15]

So traumatized is Sancho by this experience that he eventually begs to return to his old peasant status: "'Look, Señor Doctor, from now on don't bother about giving me delicate or exquisite things to eat, because that will drive my stomach out of its mind: it's used to goat, beef, bacon, dried meat, turnips, and onions, and if by some chance it's given palace dishes, it gets finicky, and sometimes even sick. What the butler can do is bring me what are called *ollas podridas*, and the more rotten they are, the better they smell, and he can pack them and fill them with anything he likes as long as it's food, and I'll thank him for it and repay him someday; but don't let anybody try to trick me, because we either are or we aren't: let's all live and eat in peace and good friendship, because when God sends the dawn, it's dawn for everybody.'"

Sanity, community and wellbeing

In a supreme stroke of irony in a book minutely attentive to the dangers of hunger on the one hand and gluttony on the other, Cervantes locates an ideal relationship with food not among his Spanish contemporaries but among a group of *Moriscos* – persons of Muslim descent living in Christian territory who had been forcibly converted to Christianity. "They stretched out on the ground, and with the grass as their tablecloth, they set out bread, salt, knives, nuts, pieces of cheese, and bare ham-bones that could not be gnawed but could still be sucked. They also set out a black food called caviar that is made of fish eggs and is a great awakener of thirst. There was no lack of olives, dried without any brine but good-tasting and flavorful. What stood out most on the field of that banquet, however, were six wineskins, for each of them took one out of his bag …

"They began to eat with great pleasure, savoring each mouthful slowly, just a little of each thing, which they picked up with the tip of a knife, and then all at once, and all at the same time, they raised their arms and the wineskins went into the air, their mouths pressed against the mouths of the wineskins and their eyes fixed on heaven, as if they were taking aim; they stayed this way for a long time, emptying the innermost contents of the skins into their stomachs, and moving their heads from one side to the other, signs that attested to the pleasure they were receiving.

"Sancho watched everything, and not one thing caused him sorrow; rather, in order to comply with a proverb that he knew very well – *When in Rome, do as the Romans do* – he asked Ricote for his wineskin and took aim along with the rest with no less pleasure than they enjoyed."[16]

> "Cervantes locates an ideal relationship with food among 'the enemy'"

The Catholic Spanish soldier Cervantes, who had been kept in slavery by Muslims in Algiers for five years,[17] presents peregrinating *Moriscos* as a model of temperance and good social organization. Their food is simple but nevertheless appetizing, and is enjoyed slowly. When they drink – adapting, it will be noted, to Christian ways by drinking alcohol – they drink together. They are at peace with themselves and each other – a peace which comes not just from the food and drink they consume but from the communal experience of sharing a meal. This observation is remarkable not just in the light of Cervantes' own experience – he had been beaten and kept in chains in Algiers, and had seen people tortured to death before his eyes[18] – but because *Don Quixote* was published in an age when all books were censored by the Spanish Inquisition. He places sanity not in his fantastic hero Don Quixote, nor in Quixote's wily peasant sidekick Sancho Panza, but in a group of 'enemy aliens' who travel in disguise

through the land from which they have been forever exiled, and which they still love with an aching passion. And he shows that sanity not just by what they say or do, but by their relationship with nutrition. Even a bone with no meat on it can be sucked. Cervantes was the inventor of the novel. He was also – as he probably very well knew himself – a nutritionist *avant la lettre*.

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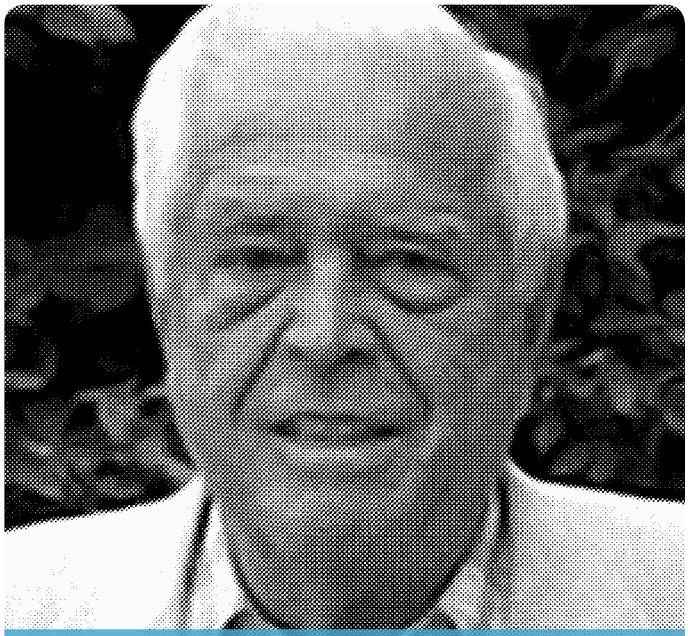
Obituaries

Professor Osman Galal (1931–2016)

Child Nutrition Researcher Professor Emeritus Osman Galal dies at 85

Kuhelika Ghosh
Features & Student Life News Editor,
UCLA Daily Bruin



Prof. Osman Galal

Osman Galal, professor emeritus in the UCLA Fielding School of Public Health, died of heart failure May 23 while traveling on an airplane to Los Angeles from Cairo. He was 85. Khalid Galal, Osman Galal's son, said his father was enthusiastic about research into childhood nutrition and spent his life trying to make sure children from underdeveloped countries were well fed.

Before being appointed to the faculty of the Department of Community Health Sciences in 1991, Galal worked in a children's hospital in Cairo, Egypt. In Cairo, he treated about 200 malnourished children per week, according to a written statement by Jody Heymann, the dean of the UCLA Fielding School of Public Health.

In 1970, Galal received the World Health Organization Postdoctoral Award, according to the statement. Galal was also a member of the WHO Expert Advisory Panel on Nutrition and worked as a UNICEF nutrition advisor in Cairo.

From 1982 to 1987, Galal served as director of the National Nutrition Institute of the Ministry of Health in Egypt, an institution focused on nutrition research.

Mona Galal, Osman Galal's daughter, said her father was motivated by his passion for his job and believed in empowering his students. She added he supported her and her brother in everything they did.

Goleen Samari, a postdoctoral research fellow at the University of Austin, who met Galal in 2008, said he was her first mentor and the reason she attended UCLA as an undergraduate.

She added he was an approachable, level-headed person who would always answer her questions about everything from research to life lessons. Samari said he would invite his students for dinner at his house at the end of every quarter.

Samari added Galal was passionate about childhood nutrition and malnutrition in the Middle East, topics she thinks are often overlooked in research. She said this inspired her to focus her own doctoral research in the Middle East, which Galal helped her with by connecting her to researchers in the region.

> "Galal was passionate about childhood nutrition and malnutrition in the Middle East"

Osman Galal spent his life trying to make sure children from underdeveloped countries were well fed.

"He did not let the sociopolitical context of the Middle East deter him from focusing on the issues that mattered," Samari said.

Khalid Galal said his father's work in the WHO and UNICEF showed that he wanted to make the world a better place for children to live in. He added his father was very generous and would go out of his way to accommodate others' wishes.

Mona Galal said though her father retired two years ago, he was still very fond of his students.

"He was the kind of person who supported everybody," Mona Galal said. "If he knew you had a dream, he would strive to help you fulfill it."

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A Day in the Life of Lucy Martinez Sullivan

Lucy Martinez Sullivan helped found the non-governmental organization 1,000 Days and serves as its Executive Director. Established in 2010, 1,000 Days works to improve nutrition for extremely vulnerable groups in some of the poorest parts of the world, but the NGO is also is aware that malnutrition constitutes a serious public health crisis in nearly every country on earth – even the United States of America. Lucy discusses her role in helping to ensure that the work of 1,000 Days supports the delivery of the nutrition-related Sustainable Development Goals.

Sight and Life (SAL): *Lucy, let's start with the term 'the first 1,000 days', from which your organization takes its name. For any of our readers who may not be familiar with the concept, could you start by explaining what it's all about?*

Lucy Martinez Sullivan (LMS): The first "1,000 days" refers to the 1,000 days from a woman's pregnancy to her child's second birthday. This 1,000-day window is a unique opportunity in a child's life, when their nutrition and early life experiences lay the foundation for the decades that are to come. We think of this in terms of three key areas.

The first is brain development. Babies are literally built from nutrition. Nutrition is the fuel that drives the incredible brain development that occurs from even the very early stages of a woman's pregnancy. Many people may take for granted the role that nutrition plays in shaping cognitive development during this phase of life, but it is absolutely essential, and its adequacy or inadequacy will dictate whether an individual will thrive or suffer irreversible damage – damage that will lead to problems at school and in the workplace later in life.

The second is health. Many of the diseases we have to deal with can be traced back to the quality of nutrition a person receives during their first 1,000 days, including type 2 diabetes, heart disease, and obesity.

Finally, the first 1,000 days matter for equality of opportunity. Good nutrition during this period will allow individuals – and, by extension, their families, their societies and their countries – to reach their full potential as they grow. The World Bank and other institutions have done great work recently quantifying the economic impact of good or bad nutrition during the first 1,000 days. Its influence on economic productivity is enormous. The same goes for healthcare spending.

So the job of my organization is to make the case for investing in good nutrition in the first 1,000 days of every child on the planet.

"Babies are literally built from nutrition"

SAL: *How did you come to co-found 1,000 Days, Lucy, and what were the challenges involved in setting it up?*

LMS: As I'm sure many of your readers are aware, Hillary Rodham Clinton – who was US Secretary of State at the time – was very moved by the findings about stunting published in 2008 in the seminal Lancet series on maternal and child undernutrition. The conclusions of this publication were underscored by a number of subsequent studies, and Hillary Clinton decided to partner with the Irish Government, which has a strong commitment to eradicate hunger worldwide, to shine an international spotlight on the importance of good nutrition during the first 1,000 days of life.

We were set up as part of that initiative, which was a call to action, and the initial plan was for the project to operate for just 1,000 days – hence the name. Our efforts generated a great deal of interest, especially around how best to bring proven nutritional solutions to scale, and our work was lent additional impetus by the launch of the six global nutrition targets in 2012 – the first time that such targets had ever been formulated. We

"Our clear focus remains making sure that the world doesn't forget about the importance of nutrition and the needs of mothers and babies during the first 1,000 days of life."

Melinda Gates, co-chair of the Bill & Melinda Gates Foundation, speaks at the 1,000 Days event 'Investing in Nutrition: A Golden Opportunity' on Capitol Hill, watched by Lucy Sullivan.

saw this as a great opportunity to rally partners in the nutrition community to action, which in turn encouraged us to broaden the scope of our activities beyond our initial focus on maternal and child malnutrition in low- and middle-income countries.

We became increasingly aware that malnutrition has no borders, and that the problem of inadequate nutrition during the first 1,000 days of life affects almost every country in the world – even our native USA. And so our perspective became more holistic, and our portfolio of activities expanded to include "our own back yard" here in America. We set out to identify partners to help us in our work, and we now in fact collaborate with over 80 different organizations. In our search, we especially wanted to identify a US organization that focused strongly on maternal and child nutrition during the first 1,000 days of life. We ascertained that there are many great organizations in the nutrition space in the USA, but none working specifically on nutrition in the first 1,000 days. And so we decided to become that organization ourselves, using our energies not just to draw attention to this issue but also to try to positively influence policies at national level.

"Malnutrition has no borders"

SAL: *What is the essence of your role as Executive Director of 1,000 Days?*

LMS: My task is to build a movement. This begins within the organization itself, and involves forming and leading a team of dedicated, passionate people who are all committed to creating a world in which every child, irrespective of where he or she is born, receives adequate and appropriate nutrition during the first 1,000 days its life. We are a "small but mighty" team of ten people based in Washington, DC. We lead and support coalitions in the nutrition space, help craft advocacy messages and tools, and try to ensure that the topic of the first 1,000 days receives proper attention.

A lot of our work involves partnering with the US Government and Administration to ensure that they understand the importance of good nutrition and that they keep funding critical, life-saving programs. We try to achieve a great deal with our small and dedicated team, but our real strength comes from our partners, of whom we have many around the world, especially in the NGO community. We support them in their advocacy efforts, and help them make the case for investments in the first 1,000 days – with policy documents, infographics and other materials that communicate the key arguments in accessible and compelling terms. As the head of the organization, I get out to talk with many audiences about this, and I really enjoy that aspect of my job.

SAL: *Do you have a typical working day? Could you tell us something about your working life, and what you most enjoy about it? Are there things that you would like to change about it?*

LMS: I have two little ones at home, a daughter who is almost four and another who is two and a half, and so my day starts early and is very focused on young child nutrition! I answer emails or participate in conference calls with our partners overseas while still at home, and then go to the office, where I work with my colleagues to fuel the growing sense of urgency around the issue of the first 1,000 days. I'll have meetings with representatives of the US Government, or one of the NGOs with which we partner, and I'll often speak at events. I spoke to a group of students last week and a group of clinicians the week before that – the scope is always very varied. It's really important to understand the first 1,000 days as a universal issue, and to articulate the key arguments in terms which are of relevance to everyone, wherever they may be in the world. We need to make a case that can be understood by a policy-maker in Indiana here in the US just as easily as by a policy-maker in India.

A lot of our partners are based on the west coast of the USA, which is three hours behind Washington, DC, and so speaking with them as well can make for a very long working day. But we're all very passionate about the issue of the first 1,000 days, and that's the fuel that keeps us going.

Of course I have to juggle my speaking and traveling commitments with the job of running the organization on a day-to-day basis.

I'm not a scientist by training, but I'm really interested in the science of nutrition, as I realized very forcibly when working on our recent First 1,000 Days: Nourishing America's Future report. Nutrition is fundamental to health and growth, and it seems that every day we learn something new about the relationship between nutrition and development – the influence of

a mother's diet on the health of her baby, for instance, or the importance of breast milk, which is much more than a source of nutrition itself. It's also a vaccine, with remarkable immunological properties. I'm also very interested in the operation of food systems, whether local or global, and the way they influence people's nutritional status.

> "We're all very passionate about this issue, and that's the fuel that keeps us going"

SAL: *Is there anything you would change if you could?*

LMS: I'd like to see more resources dedicated to the first 1,000 days. A mere 1% of development budgets is spent on the kind of high-impact nutrition interventions we support, and which we know can be so effective. Only 2% of individual country budgets are allocated to this cause. And this despite the fact that 45% of child deaths are attributable to malnutrition. All those deaths are preventable. I'm all the more aware of this because I have young children myself, and the barriers between my professional life and my personal life as a mother are very porous. When I see my daughters enjoying something like a carrousel – and they absolutely love carrousels at the moment! – I can't help but think of all the children in the world who are denied such experiences because they are living in poverty, or in dangerous parts of the world, and because they are malnourished.

SAL: *Do you have a particular hero who has inspired you in your career?*

LMS: I don't think I have an individual hero as such, but the people who have inspired me to take on this role are the millions of mothers around the world who struggle to feed themselves and their children adequately. When I took up my present role, I was shocked at the disparity between investments in the prevention of HIV/AIDS, or malaria, and the investments made in the prevention of malnutrition. At the outset, this was very much an intellectual passion fueled by my sense of justice, but as soon as I had my first child, it became a very personal passion. I just imagine what it must be like to be a mother who doesn't have access to adequate food and healthcare for her children.

Another source of inspiration are the various people for whom I have worked in my previous roles, who were always prepared to give me a chance to take on new responsibilities, even

'The First 1,000 Days: Nourishing America's Future' – a first-of-its kind report on the nutritional health of America's mothers, infants and toddlers – is launched on Capitol Hill. **From left to right:** Hugh C Welsh, President and General Counsel of DSM North America; Barbara Bush, Co-Founder of Global Health Corps; Kimberly Seals Allers, Director of the First Food Friendly Community Initiative; and Lucy Sullivan.

Lucy Sullivan delivers over 200,000 petition signatures for paid family leave to Rosa DeLauro, US Representative for Connecticut's 3rd congressional district. Members of the 1,000 Days and National Partnership for Women and Families teams took to Capitol Hill to deliver the signatures to US policymakers. **Far left:** Lucy Sullivan. **Far right:** Rosa DeLauro, the US Representative for Connecticut's 3rd congressional district.

if I wasn't the classic 'fit' for this or that job. The trust placed in me has given me a lot of confidence. I'm very grateful for it, and I'd like to be the same kind of boss myself, and inspire others to achieve their full potential.

SAL: *Unusually for someone in your position, you have a background in management consultancy, as well as in marketing and brand management. How has this experience helped you in your work for 1,000 Days?*

LMS: I think my experience as a management consultant has taught me to think very analytically, which really helps me when I'm trying to build the case for why governments and private-sector donors should invest in the first 1,000 days of life: "This is the current state of affairs, this is the cost of a high-impact intervention, and these are the positive social and economic consequences of making that intervention." Being able to spell out these arguments in detail puts us at a great advantage. As regards the marketing experience, it's also been extremely helpful. I used to sell color cosmetics for L'Oréal. A new type of lipstick may not be considered an essential item by everyone, and so you have to make a very persuasive case for investing in it. Why this product and not that? It's a line of argument I can still apply in my work today. We may be dealing with a much more serious subject-matter, but within the framework of 1,000 days advocacy we have to construct arguments that appeal to the heart as well as the mind. We have to communicate a sense of joy and possibility, however bleak the situation might sometimes seem.

SAL: *A related question, Lucy. Your academic qualifications are in Business Administration and Political Science rather than Nutrition, Biochemistry or Public Health. In what ways does your academic training influence your current work?*

LMS: Obviously we're not in the business of making a profit here at 1,000 Days, but I still try to apply best business practice to the way we operate. We have to be rigorous about what we do and always ask ourselves how any given activity is going to impact the bottom line – even though in our case the 'bottom line' is not a financial one.

SAL: *1,000 Days was established with the support of the US Government, the Government of Ireland, the Bill & Melinda Gates Foundation and several non-profit organizations. What, in your view, is the secret of successful collaboration between government and NGOs in the nutrition space?*

LMS: The most important thing is to obtain clarity as to what everyone is trying to achieve. In the case of 1,000 Days, we worked hard to get a lot of different groups of people to coalesce around a single idea and instill that idea with urgency. The creation of the initial 1,000 Days Partnership was driven by the US State Department, in collaboration with InterAction, an association of non-governmental organizations that included GAIN (the Global Alliance for Improved Nutrition). Crucially, there was excellent communication between the various actors from the start. It's very pleasing to see that nowadays governments like those of Nepal and the Philippines are taking up the concept of the first 1,000 days and creating their own campaigns around the topic.

When I was brought in, my role was to develop a clear sense of direction for the organization. We've grown since then, but our clear focus remains making sure that the world doesn't forget about the importance of nutrition and the needs of mothers and babies during the first 1,000 days of life. I didn't come in with preformed ideas: I really listened to everyone, conscious of the fact that I'm not a nutritionist by training. Together, we have forged a really strong common sense of purpose. I've learned an enormous amount, and I have many mentors in my job!

SAL: *In what ways is the work of 1,000 Days supporting the achievement of the Sustainable Development Goals?*

LMS: We did a lot of behind-the-scenes work to help ensure that nutrition was given appropriate prominence in the SDGs – something that had not been the case with the Millennium Development Goals, unfortunately. I think I speak for many of our partners when I say that I really value the clarity of the SDGs: we have an absolutely clear notion of what we need to achieve by 2030, which is to end malnutrition in all its forms. That's a historic milestone, and we're all working together to attain it and end the terrible scourge of malnutrition, which has plagued humanity for as long as we know.

> "We're an advocacy organization, and so we want to create advocates the world over"

SAL: *What advice would you give to readers wanting to actively support the first 1,000 Days initiative?*

LMS: Helping with our work of education and advocacy is the most valuable thing your readers could do. If you work in the health sector, for instance, you shouldn't imagine that all of your colleagues will know or understand the concept of the first 1,000 days. So "telling the good news" about it is very important. Also very important is to try to find out how much your own government is investing in nutrition during the first 1,000 days of life, wherever you may live and work. If you're aware of the current level of investment, you can argue much more persuasively for more, and for the adoption of programs that we know to be effective in tackling the problem of malnutrition in the first 1,000 days. We're an advocacy organization, and so we want to create advocates the world over.

SAL: *Thank you, Lucy, and the best of luck with your future endeavors.*

LMS: Thank you.

Lucy Martinez Sullivan *was interviewed by Jonathan Steffen.*

Congress Reports

18th International Society for Research in Human Milk & Lactation (ISRHML 2016)

Sicelosethu S Siro
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Dr Gretel Finch explaining her poster during the poster session.

Approximately 160 academics and professionals from all over the world attended ISRHML 2016, some involved directly in the field of human milk and lactation and others indirectly. The conference was held at the Spier Hotel in Stellenbosch, Cape Town, South Africa.

Thursday morning began with registration, followed by workshops. Two workshops ran in parallel in the morning, with two more in the afternoon. In the evening, we had a wonderful welcome session. We all participated in an activity where we were grouped according to our continents of birth and had the opportunity to network with fellow researchers from these continents. We then had to "migrate" and interact with researchers from other continents. This was quite an interesting activity: I met a number of people, found out what they were doing, and also learned about breastfeeding issues within their countries.

Dinner was then served, after which we had fun with a Xhosa traditional group. We did some drum beating and bum whacking. We made a beautiful melody as a group, while the leader of the traditional group conducted the "choir." I realized that as long as we are in agreement as a group, we can achieve great things, even if we all come from different backgrounds and may not know each other well.

> "I realized that as long as we are in agreement as a group, we can achieve great things"

We had our opening session on Friday morning and were warmly welcomed to Stellenbosch by Prof. Marietjie de Villiers, Vice Dean of Education at the Faculty of Medicine and Health Sciences of Stellenbosch University. Lars Bode – the ISRHML President-Elect from the University of California, San Diego, United States – gave the opening remarks. Lars mentioned how this conference was designed to provide opportunities for trainees to interact with experts in the field of human milk and lactation. A number of activities had been put in place to help trainees network with the experts. This included a "Meet the Experts Breakfast" that was held on the Saturday morning.

After the opening remarks, we went straight into the oral sessions. These went on right through the conference and were divided into seven scientific sessions involving 32 presenters.

Preparation for the drumming session during the Welcome Function

The sessions

Session 1: "Breastfeeding in the context of HIV," chaired by Louise Kuhn (Columbia University, New York, United States) and drawing on the input of five speakers.

Session 2: "Breast milk and pathogen protection," chaired by Evette van Niekerk (Stellenbosch University, South Africa). This session involved four speakers.

Session 3: Chaired by Rukhsana Haider (Bangladesh), with three presenters discussing "Breastfeeding programs in the middle-income and developing countries."

Session 4: Chaired by Michelle McGuire (Washington State University, Washington, United States), entitled "Obesity, diabetes and milk secretion." This session had five presentations.

Session 5: With four presentations, this session was entitled "Minerals in milk: developmental biology and requirements in infants and their mothers," and was chaired by Anne Prentice.

Session 6: Chaired by Peggy Neville (University of Colorado, United States), this session focused on "Epithelial barrier in mammary gland and intestines." The session was covered by five presenters.

Session 7: This session had five speakers and focused on "Breastfeeding, infant growth, body composition, and later obesity." The session was chaired by Kim F Michaelsen (University of Copenhagen, Denmark).

What I learned

I attended the session on "Essentials of basic research in human milk and lactation" chaired by Peggy Neville (University of Colorado, United States) and the workshop on "Analysis of Big Data" chaired by Darryl Hadsell (Baylor College of Medicine, Texas, United States). I took away the following insights from these workshops:

- The importance of establishing a hypothesis. Research should be hypothesis-driven, not results-driven. It is important to work on one hypothesis before moving on to the next, rather than working on multiple hypotheses simultaneously. When formulating a hypothesis, first define what you don't know rather than what you do know.
- The greatest advantage in the use of animal models in research is that one gets to control the trial environment, and this enables one to make observations without the influence of confounders.
- Analysis of Big Data on economics in the Neonatal Intensive Care Unit shows that breastfeeding not only reduces morbidities in very low birth weight infants but also reduces the cost of hospitalization.

From the oral presentations, I took away the following key learnings:

- Research has proved that giving ARV prophylaxis to either the mother or the infant can facilitate 12 months of breastfeeding for the infant with a reduced risk of infection with HIV. Prophylaxis during pregnancy from 14 weeks and right through lactation will suppress viral load and hence reduce HIV transmission to the infant. Giving prophylaxis to the mother may be a challenge; it should be given to the infant instead.
- The role of both the mass media and social media in promoting breastfeeding was highlighted. For example, in Vietnam it was realized that one of the hindrances to exclusive breastfeeding was a belief that there is a need to "wash down" after a meal. Hence, babies were made to drink water after eating. To address this issue, an advertisement was created for national TV. Exclusive breastfeeding rates tripled. This was not only a result of the use of mass media, however. It was also the consequence of the provision of timely and good-quality education on breastfeeding, engaging policy-makers in policy crafting and implementation and the use of quantitative and qualitative data to inform intervention programs.
- In animal models, it was shown that adiposity before and during pregnancy leads to developmental mishaps, which include impairment of the lactation capacity of the females, delayed onset of lactogenesis, and physical challenges related to nursing position.

On Friday, we were able to meet local trainees. We had an opportunity to discuss our role in promoting and protecting breastfeeding by focusing on the characteristics of the "Big Five" – the lion, buffalo, rhino, elephant and leopard. One of the conclusions we drew is to be aggressive in our approach to protecting breastfeeding, just as some of these animals are when it comes to protecting their young.

"From the 'Big Five' African animals we learned to be aggressive in our approach to protecting breastfeeding"

Coffee breaks and lunchtime each day provided time for networking and interacting. People gathered in groups to discuss various issues. It was a time to learn from one another and to share information, a time to make new acquaintances.

There were social activities that lightened the mood, providing a contrast to the "serious" sessions of the day. Friday evening was devoted to grape stomping with bare feet, and on Saturday evening a gala dinner was held at an exclusive restaurant on the Cavalli Estate. A free Sunday afternoon gave people time to explore the beauty of Cape Town. Various tours were available – to the streets of Cape Town, Table Mountain, and Robben Island.

There were two poster presentation sessions on the evenings of the Friday and the Saturday. I had the privilege of presenting my poster entitled "Breast milk intake, energy, and fat content of breast milk: A 4-day test-weighing study in exclusively breastfed South African infants and their mothers."

I greatly appreciate the support given me by *Sight and Life*, which enabled me to attend this conference: it was such a great opportunity for me as an upcoming researcher in the field of human milk and lactation. I had the chance to garner information directly from experts in the field as well as from fellow trainees. I learned a lot and gained some valuable new insights into how I can address the challenges I face as I carry out my research.

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Landmark Global Nutrition Study Launched

Good Nutrition: Perspectives for the 21st century

The launch of Good Nutrition: Perspectives for the 21st century at CFS 43 in Rome, October 21, 2016. **From left to right:** Prof. Eileen Kennedy, Prof. Jess Fanzo, Prof. Hilal Elver, Dr Hinrich Thölken, Lauren Landis, John B Cordaro, Dr Klaus Kraemer and Jonathan Steffen.

Jonathan Steffen
Jonathan Steffen Limited, Cambridge, UK

A landmark publication in the field of nutrition science and policy-making, *Good Nutrition: Perspectives for the 21st century* was launched at a side event during the 43rd Session of the United Nations Committee on World Food Security (CFS 43) on October 21, 2016. The venue for the launch was the headquarters of the Food and Agriculture Organization (FAO) of the United Nations in Rome, Italy.

The objective of this event was to encourage dialogue among CFS stakeholders involved in food security and nutrition at global, regional and national levels. The well-attended session was introduced by Dr Lawrence Haddad (Executive Director GAIN) and facilitated by Prof. Eileen Kennedy (Professor of Nutrition and former Dean of the Friedman School of Nutrition Science and Policy at Tufts University, and Member of the Steering Committee of the High-Level Panel of Experts on Food Security and Nutrition of the CFS). Members of the Editorial Board who oversaw the book's development were joined by Prof. Hilal Elver (UN Special Rapporteur on the Right to Food), Dr Hinrich Thölken (German Ambassador to the Rome-based UN Agencies) and Lauren Landis (Director of the Nutrition Division of the UN World Food Programme) to discuss the objectives, approach and content of the book.

Understanding the complexity of nutrition

Good Nutrition: Perspectives for the 21st century is a work of advocacy whose prime objective is not only to call readers to action, but also to outline what action needs to be taken to address the global nutritional challenges of our age. As Dr Lawrence Haddad observed in his introduction to the book launch, "We all face challenges, but complexity is never far away." The intrinsic complexity of nutrition was a key theme of the event, for *Good Nutrition* fully acknowledges this fact while at the same time striving to deliver accessible analyses and practical solutions based on robust scientific evidence.

> "A brilliantly clear communication vehicle"

Dr Haddad went on to observe that the elimination of hunger by 2030, as foreseen in the UN Sustainable Development Goals, is possible, but only if we accelerate nutrition while simultaneously slowing the spread of obesity. Despite the fact that poor nutrition reduces the health and wealth of nations, Dr Haddad sees malnutrition in all its forms as an "opportunity." Increasing domestic spend on nutrition from its current very low level of 1% of total government budgets and forging new and influential alliances beyond the world of nutrition itself are essential to drive positive change, however. In this context, *Good Nutrition: Perspectives for the 21st century*, is, in the words of Dr Haddad, "A brilliantly clear communication vehicle."

Prof. Manfred Eggersdorfer (Head of DSM Nutrition Science & Advocacy and Professor of Healthy Ageing at the University of

Groningen) next took the floor to introduce the structure and key content of the new publication, which was created specifically to support the post-2015 global development agenda. Placing the book firmly within the context of the UN Committee of Food Security's current drive to strengthen its role in nutrition, Prof. Eggersdorfer explained how *Good Nutrition* is designed to reach the agenda of policy-makers, donors, academics, private-sector organizations and civil society, as well as of organizations dedicated to the nutrition space, with the aim of achieving tangible outcomes and impact.

One world

Pointing out that we all live in one world, even though the nutrition challenges of the developing and the developed worlds may differ greatly, Prof. Eggersdorfer expressed his hope that *Good Nutrition* will provide a key source of reference for CFS stakeholders seeking to learn more about nutrition from global experts, each of whom examines different aspects of the challenge of malnutrition or different components of the solutions within the book's pages. One of the five sections of the new publication is dedicated to sustainable food systems, and a special chapter puts the Sustainable Development Goals into practice, which is of particular relevance to the CFS in light of the upcoming High-Level Panel of Experts (HLPE) Report on Food Systems and Nutrition.

> "The book's 25 chapters have been developed by no fewer than 50 world-leading experts in their respective fields"

Like its predecessor volume, *The Road to Good Nutrition: A global perspective* – which was published by Karger in 2013 and which won a 2014 British Medical Association book award for the best publication in the category Public Health – *Good Nutrition: Perspectives for the 21st century* century takes a broad-ranging view of its subject. The book's 25 chapters have been developed by no fewer than 50 world-leading experts in their respective fields and overseen by an Editorial Board comprising, alongside Prof. Eggersdorfer himself, Dr Klaus Kraemer (Managing Director of *Sight and Life* Foundation, and Adjunct Associate Professor in the Department of International Health of Johns Hopkins Bloomberg School of Public Health, Baltimore, MA, USA); John B Cordaro (Global Food Security, Nutrition and Safety Consultant, Mars, Incorporated); Prof. Jessica Fanzo (Bloomberg Distinguished Associate Professor of Global Food and Agriculture Policy and Ethics at the Berman Institute of Bioethics and the Nitze School of Advanced International Studies at the Johns Hopkins University, Baltimore, MA, USA, and Director of the Global Food Ethics and Policy Program); Prof. Mike Gibney (Emeritus Professor of Food and Health at University College Dublin, Institute of Food and Health); Prof. Eileen Kennedy; Prof. Alain B Labrique (Director, Johns Hopkins University Global mHealth Initiative & Associate Professor Department of International Health/ Epidemiology (jt) Johns Hopkins Bloomberg School of Public Health Baltimore, MA, USA; Department of Community-Public Health, Johns Hopkins School of Nursing (jt); Division of Health Sciences Informatics, Johns Hopkins School of Medicine); and Technical Editor Jonathan Steffen (Jonathan Steffen Limited, Cambridge, UK).

Transforming the nutritional landscape

During the panel discussion, Prof. Hilal Elver expressed her hope that the book would be used as a reference work for academic nutrition courses, pointing out that many of the topics covered are not yet being taught in universities. The richly illustrated book, which contains 79 figures and 19 tables, along with a glossary of key definitions and an introduction by Prof. Elver herself, is structured in five sections. It opens with a consideration of the major forces shaping our global food system, then moves on to discuss the relationship between nutrition, health and economic status. Next it explores the prerequisites for sustainable food systems, before presenting a number of innovative, science-led solutions to the challenge of providing good nutrition for everyone. Finally, *Good Nutrition* concludes with an extended discussion of what needs to be done in order to transform our global nutritional landscape for the better.

The panel discussion triggered a lively Q&A session that covered topics including the increasing importance of a systems approach to nutrition, the need for powerful alliances beyond the nutrition space, the promise of new technologies, the global importance of food safety as well as food security, and the drive to have access to adequate nutrition recognized as a human right.

Good Nutrition: Perspectives for the 21st century *(381 pp) is available from Karger Publishers. The PDF version may be downloaded from* ***www.karger.com/Book/Home/273171.***

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Good Nutrition

Perspectives for the 21st Century

Good Nutrition: Perspectives for the 21st Century is a work of advocacy, whose prime objective is to not only call readers to action, but to outline what actions need to be taken and how this should be done, to achieve tangible outcomes and impact. Globally recognized experts present their insights in a clear and accessible way. This book represents a "one-stop information source" and paves the way for future science-led publications dedicated to the pivotal topic of good nutrition.

"This insightful and timely book rightly argues that addressing malnutrition is crucial to achieving sustainable development."

KOFI ANNAN | CHAIR OF THE KOFI ANNAN FOUNDATION, FORMER SECRETARY-GENERAL OF THE UNITED NATIONS (1997-2006)

"Nutrition is a complex subject, affected by many intertwining factors. ***Good Nutrition: Perspectives for the 21st Century*** *pulls it all together in one easy-to-follow volume."*

ANNA LARTEY | PRESIDENT OF THE INTERNATIONAL UNION OF NUTRITIONAL SCIENCES AND DIRECTOR OF NUTRITION AT THE UNITED NATIONS FOOD AND AGRICULTURE ORGANIZATION (FAO)

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KARGER

2016 CARIG Conference Convenes in San Diego

Noel W Solomons
Center for Studies of Sensory Impairment, Aging and Metabolism, CeSSIAM in Guatemala

The Hilton Bayfront Hotel was the venue for the 2016 CARIG Conference, held on March 31, 2016, in association with the Experimental Biology meetings in San Diego, CA, USA. The overall conference theme was 'Carotenoids and Retinoids during Inflammation.' As usual, the proceedings began with the annual James Allen Olson *Perspectives in Carotenoids* Memorial Lecture; this year the lectureship went to Prof. Lewis P Rubin, MD of the El Paso Children's Hospital – Texas Tech University Health Sciences Center, El Paso, TX, USA. Prof. Rubin spoke on the topic of 'Vitamin A, Carotenoids and Inflammation in Infancy'. The full talk appears on p. 25–30 of this issue.

"Inflammation reduces the carriage of vitamin A in the circulation and distorts the interpretation of serum retinol"

This was followed by four presentations, each exploring specific facets of the mutual and bidirectional relationship between inflammation and infectious states and carotenoid status. Following the Olson Memorial Lecture, Prof. Sherry Tanumihardjo of the University of Wisconsin-Madison, Madison, WI, USA spoke on the keys to unlocking assessment of vitamin A status during inflammation. Inflammation causes changes in circulating acute-phase-response proteins. Some of these rise during inflammation – such as complement reactive protein, α_1-antitrypsin, and α_1-glycoprotein (positive acute-phase response) – whereas others – such as albumin, transferrin, retinol binding protein (RBP) and transthyretin (TTR) – decline in the circulation (negative acute-phase proteins). Important is that the latter two, RBP and TTR, are part of a complex that transports retinol in the blood. So inflammation reduces the carriage of vitamin A in the circulation and distorts the interpretation of serum retinol. Prof. Tanumihardjo pointed out that the modified retinol dose response test (one that involves dosing a subject with a vitamin A anolog, didehydroretinol) may be of special usefulness. In a state of true vitamin A depletion in the liver, stores of RBP have been accumulated above normal reserve levels. A spike release of vitamin A, detectable by monitoring the marker analog in the blood, provides a diagnostic approach to the nutrient's status, which is not distorted by inflammation or infection.

The second discourse in this series was given by Dr Torsten Bohn of the Luxembourg Institute of Health, Strassen, Luxembourg, who focused on anti-inflammatory aspects of carotenoids. Dr Bohn's discussion revolved around natural food sources of substances with anti-inflammatory activity. Under discussion were sources of polyphenols, such as plums and cabbages, and those yellow, orange and red fruits and vegetables that are known to be dietary sources of carotenoids. The leverage point seems to be the regulation of nuclear factor kappa-light-chain-enhancer of activated B cells (NF-κB), with its suppression leading to anti-inflammatory outcomes. Citing *in vitro* experiments from his own laboratory, Dr Bohn asserted that carotenoids are more potent agents than polyphenolics because they have better transport characteristics in accessing the intracellular sites of NF-κB action. It is the polar cleavage products (apocarotenals) that are most important as NF-κB suppressors.

"Infections are known to deplete the body's vitamin A stores"

Next, Dr Charles Stephensen of the Western Human Nutrition Research Center, University of California, at Davis, CA, USA discussed carotenoid and retinol metabolism during infection and inflammation. Dr Stephensen focused on overt infection or on models of the activated acute reaction outlined a bidirectional relationship. He reiterated the theme of Dr Tanumihardjo – namely, that biomarkers of vitamin A status are distorted by inflammation, with circulating concentrations of retinol declining rapidly and profoundly. This is ascribed to redistribution from the bloodstream into central organs such as the liver. Infections are known to deplete the body's vitamin A stores. Diarrheal episodes predispose the body to poor absorption of non-breast-milk sources of vitamin A, while the vitamin A in maternal milk

Prof. Catharine Ross (left) and Prof. Sherry Tanumihardjo at the lectern during the 2016 CARIG conference in San Diego, CA, USA

remains well absorbed. Moreover, in inflammatory diarrhea and acute respiratory infections, vitamin A is excreted through the urinary tract due to the uncoupling of retinol from the RBP-TTR complex, which ordinarily serves to protect vitamin A from renal filtration.

The final contribution to the conference was by Prof. Catharine Ross of Pennsylvania State University, PA, USA, who was assigned the topic of acute inflammation effects on retinoid metabolism. Dr Ross conceded that inflammation can be a successful adaptive response in acute injury or invasion of an organism, but documented how the acute-phase response alters retinol transport, its cellular metabolism and the processes of immune function, dependent on the vitamin inducing inflammation. With injections of lipopolysaccharide (LPS) – a potent inflammatory agent – into rodents, the transcription leading to RBP synthesis is suppressed. LPS also downregulates the intestinal cleavage enzyme (BCO1), which releases active vitamin A from dietary provitamin A carotenoids. This impairs uptake of new vitamin A. The expression of retinoic acid-4-hydrolase (CYB26A1) is reduced by LPS. In terms of immune function, vitamin A status is important to the toll-like receptor (TLR) family of pattern-recognition receptors. Many aspects of immune defense are downregulated and suppressed in vitamin A deficiency, such as the containment and clearance of *Citrobacter freundii* in mice, who become asymptomatic carriers of the pathogen due to deficiency-induced Th17 B-cell dysfunction. Dr Ross's presentation, however, alluded to both acute and chronic inflammation, the latter of which occurs when the inflammation is unresolved and becomes chronic; this too is problematic. An interesting observation made by Dr Ross was that an amyloid response can only be mobilized in vitamin A sufficiency, such that vitamin A deficiency would be protective against amyloid accumulation.

The conference was followed in the evening by the VARIG-CARIG reception, in which three first-place prizes were awarded for excellence in graduate student and post-doctoral fellow research on carotenoids and vitamin A. The winners were Stephanie Mondloch of the University of Wisconsin-Madison, Madison, WI, USA; Emily Mohn of Tufts University, Boston, MA, USA; and Joshua Smith of the University of Illinois, Champaign, IL, USA.

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Positioning Women's Nutrition at the Center of Sustainable Development

Micronutrient Forum 2016

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The Micronutrient Forum

About: The Micronutrient Forum serves as a global catalyst and convener for sharing expertise, insights and experience relevant to micronutrients in all aspects of health promotion and disease prevention, with special emphasis on integration with relevant sectors. Its primary objective is to foster dialogue among the research, policy, clinical, program and private sector communities to facilitate the translation of evidence for policy and program planning, and to inform research needs and priorities based on evidence gaps in order to support programs.

Vision: A world in which all people have access to essential micronutrients at levels needed to promote health and prevent disease.

The 4th Micronutrient Forum Global Conference took place from October 24 to 28, 2016, in Cancun, Mexico. This was preceded by two days of sponsored symposia. The Forum has grown since it was first held in 2007 in Turkey, the East-West nexus, where *Hidden Hunger* gained visibility on the global stage. Since then, the micronutrient message has been heard from East Asia (2009, China), Africa (2014, Ethiopia), and now North America. In two years, the Micronutrient Forum Global Conference will return to Asia.

Delegates from academia, governments, funding bodies, NGOs, program implementers, and the private sector gathered each day from 8:30 am to 7:00 pm, building dialogue and sharing their experiences and opinions across four tracks: **1)** Measuring and interpreting information on micronutrient status; **2)** Effects of micronutrient interventions on indicators and functional outcomes; **3)** Scaling up micronutrient interventions in vulnerable populations – bridging the gaps between evidence and implementations; and **4)** Transforming the enabling environment to forge a future for micronutrients – what will it take?

Mainstreaming women's nutrition for sustainable development

This year's theme focused on the most important foundation of health, food and nutrition – women. Women and girls are simultaneously the key providers and recipients of food and care in almost every society. Addressing their challenges and needs, and empowering them, is both a rights-based and cost-effective strategy to improve the wellbeing and sustainable development of families, communities and countries.

"Women hold up half the sky"

It was in the 1960s that child health was placed on the global health agenda. However, the health and nutritional status of women were not the main focus, or even a priority, at the time: mothers were regarded only as a means of improving child health. It wasn't until the late 1980s that the focus shifted toward preventing maternal mortality, with the "safe motherhood initiative." The UN then placed maternal health high on its agenda by incorporating it as the 5th Millennium Development

A speaker at the 4th Micronutrient Forum Global Conference, which focused on the key role of women and girls as both the recipients and the facilitators of better nutrition.

Goal (MDG). With this came a more holistic vision of women's health, although it was still very fragmented, with unproductive competition over which issues to prioritize.

Women have different needs compared to men, based on biological and social factors including gender rights and socioeconomic status, which puts women at a disadvantage in many societies. Hence a lifestyle approach to women's health should be adopted. Women's health directly impacts on the health of the next generation. When a mother dies, her children are ten times more likely to die by the age of ten.

Health systems are largely unresponsive to the needs of women, despite the fact that women are the majority within the health workforce. Women should not be viewed simply as bearers of health problems, but also as key to providing solutions.

It should go without saying that women throughout the world who are better nourished are more capable of caring for their families. For this to be achieved, the following should be considered:

1. Value women: provision of preventative/curative interventions;
2. Gender-responsive policies (e.g., maternity/paternity leave)
3. Compensate women: unpaid contributions;
4. Include women in data collection and analysis: sex-disaggregated status; and
5. Be accountable to women: accountability framework.

Thus a combination of gender equality and health is crucial for achieving and maintaining sustainability. Research findings presented at the Micronutrient Forum explicitly showed that focusing on women certainly delivers results, but that this should be complemented by a recognition of the contribution that can also be made by men. In fact, the Micronutrient Forum implicitly emphasized that nutrition, health and development must be a shared human and "non-gendered" endeavor. The health of women must be guaranteed, if current and future generations are to be healthy and reach their full potential. The first 1,000 days is indeed critical, but so too are the days before pregnancy.

The health and functional outcomes of women are sensitive to nutrition, including maternal health and survival, weight gain in pregnancy, birth outcomes, and postnatal growth and cognition. Proven prenatal interventions include food supplementation with a variety of products, although the energy and protein content can vary. The sharing of these food supplements with other members of the family as well as their substitution for less nutritious products is a problem. In combination with a range of additional factors, this has led to the failure of many pregnancy interventions. After a decade of research, there is still no clear recommendation for micronutrient supplementation, despite strong evidence of its benefit, such as the positive effect of calcium on reducing the risk of preeclampsia and hypertensive disorders. Such a recommendation is necessary considering that, in many developing countries, the nutritional status of women as they enter pregnancy is suboptimal.

Adolescent girls, in particular, are at increased risk of adverse birth outcomes, given that nutrition during that period is particularly important. Early (ages 10–14 years) and late adolescence (ages 15–18 years) provide a second window of opportunity to improve health, and therefore warrant more research attention. Integrative approaches such as the consideration of maternal infections and family planning are of utmost importance to women's health, and will eventually confer nutritional benefits.

Zooming out … From cell to society

A key message at the conference was the need for research across the whole cell-to-society spectrum, gathering all cellular/molecular, clinical, community, implementation and policy-level inputs, integrating the results into an effective policy and service delivery package, and finally making intradisciplinary dialogue possible between scientists and practitioners working in this field. Effective knowledge translation and transfer is key to the optimal functioning of the continuum. The same concept is applicable to our educational and training systems. We can only be as successful as the weakest link in the chain.

Interfacing between disciplines

Micronutrient malnutrition is a socioeconomic issue with biological outcomes. In its manifestations, all the social determinants of health and nutrition come into play. A woman with

A speaker panel at the 4th Micronutrient Forum

iron-deficiency anemia may need literacy and new knowledge (behavior change), access to affordable and sustainable markets, and economic support or empowerment to diversify and enrich her diet and that of her family. Many of these may fall outside of the reach of medical and health personnel. Multiple disciplines need to come together and work with one another to bring lasting solutions.

This year's Micronutrient Forum was a unique demonstration of the need for an interdisciplinary and multisector approach. It showcased how researchers and intervention projects had built and implemented crosscutting teams, dialogues and action plans with their nonmedical counterparts from industry, technology, economics, agriculture and trade, management, culture and media.

The 4th Forum: The 4th dimension for action

For many years, the triple-A approach (Assessment–Analysis–Action–re-Assessment) has been promoted in the nutrition discipline, and its research and action. This has resulted in a move away from common descriptive epidemiological studies (dominant in developing-world research, where micronutrient challenges are more prevalent) to developing and implementing practical interventional models. However, it seems, there was still a missing element – inspired, capacitated and connected nutrition professionals! The European Nutrition Leadership Program (ENLP), established in the early 1990s, started to address the leadership capacity development need. Excitingly, this training has now spread across the continents. Today we have regional leadership trainings almost everywhere. The Micronutrient Forum provided the opportunity to bring together alumni from different nutrition leadership programs to share their experiences, learn from each other, and look to the future and the establishment of a global network of empowered and inter-connected nutrition leaders.

Micronutrient nutrition: A dietitian's perspective

As a practicing dietitian, I was thrilled to have the opportunity, thanks to a grant from the *Sight and Life* Foundation, to join other nutrition family members at the 2016 Micronutrient Forum. Sadly, I didn't meet many dietitians. Nutrition scientists and program implementers seem more "collective" in their teams and actions. Our medical teams, instead, are composed of a diverse range of (para-) medical practitioners: a medical doctor, a nurse, a psychologist, but never more than one nutritionist and dietitian. One dietitian seems enough! Attending the Forum raised a few questions in my mind. How can we effectively communicate with medical teams with regard to micronutrient malnutrition? How can we link the mass interventions made by community nutrition and dietetics professionals to thousands of single interventions made sporadically by dietitians in their clinics and private offices? These are conversations I need to pick up on.

Zooming in … Track 4: Transforming the enabling environment to forge a future for micronutrients. What will it take?

This track included an enlightening plenary session, chaired by the new SUN Movement Coordinator (Gerda Verburg) with the new Executive Director of GAIN (Dr Lawrence Haddad) and with panelists from the African Nutrition Leadership Programme, the Micronutrient Initiative (MI), Access to Nutrition Foundation, The Power of Nutrition, and Tufts University. The discussion was vibrant and thought-provoking.

According to Dr Haddad, the current state of the enabling environment for micronutrient interventions is very weak. There is a low level of awareness, a low demand for solutions, and little support for solution implementation. There is some data on the distribution and depth of the hidden hunger problem, mainly from sub-Saharan Africa and South Asia. It is known that women's diets are largely monotonous, and according to the Global Nutrition Report (GNR), the minimum dietary diversity in infants aged six to 23 months for 60 countries is only 28%. Acting on the message "consume five fruits and vegetables a day" can cost up to 52% of household income in countries such as India, Pakistan, Bangladesh and Zimbabwe. It is simply not feasible to purchase five fruits and vegetables while living on $2 a day. The world signed up to halve anemia rates in women by 2025, but at the current rates of progress this will only be achieved by 2084. There are also disturbing data gaps. Government spending on micronutrient interventions, which is needed for accountability, is generally unknown; the WHO micronutrients database is still under construction; the FAO database only covers nine countries; and the Tufts University dietary database is not publicly available.

It is clear that there needs to be stronger advocacy in many, if not all, areas. It is clear that "micronutrients" are not as high on the agenda as they should be, and are in fact facing a downward trend. Thus it is important to make micronutrient malnutrition (hidden hunger) newsworthy.

What needs to change?

- There needs to be stronger and smarter advocacy, with a focus on quality over quantity. Low diet quality is a massive risk factor for global burden of disease.
- Data and statistics only go so far: emotion is needed to shape preference and demand.
- Researchers need to speak the same language as journalists and decision-makers.
- Could celebrity chefs help with communication? They may be able to penetrate the consciousness of the population.
- We have largely been focusing on improving technical capacity, but we need also to focus on functional capacity by way of developing leadership skills within the nutrition community. We have been talking about this, but not yet investing in it.
- Building partnerships is important. For example, if you are not good at fund-raising, then partner with a dynamic fund-raiser.
- We need to work together with the business community and make use of its capabilities, such as innovative research and distribution.
- There is a lot of mistrust of the business world due to bad practices and the exploitation of vulnerable groups; however, there are also good practices. There is not enough data about what businesses are doing. There should be a monitoring tool to assess what they are doing, then we can open the door for better dialogue.
- You will not get any change in behavior by not engaging with the private sector or isolating yourself from it.
- Scientists can be powerful advocates. They should inform top levels of government by creating opportunities to meet the people who matter, and should get across the message that nutrition is an excellent investment.
- Nutrition needs to be approached from an economic perspective. Low-skilled jobs are becoming automated: people need to reach their full cognitive potential to function in this changing world.

> "There is a problem with communication when the index of acronyms in a research paper is longer than the research itself. Our research needs to be able to talk to people outside of our environment."

Clear identification of the role of the many vital stakeholders

To create an enabling environment for the effective implementation of micronutrient interventions, it is crucial to define the different roles of various actors. The role of civil society in food fortification programs is to serve as a "catalyst" – to be an advocate providing support to the different stakeholders and hold them accountable. The private sector's role is to be more "open" to the idea of contributing to public-private partnerships that are targeted at solving micronutrient problems. Technical assistance is also important and serves to identify innovative ways for capacity-building and problem-solving. Technical ca-

pacity is also essential for providing leadership to develop or improve appropriate curricula for universities. The role of the donor community must be to respond to the needs and help address the gaps in human development for a targeted country. The donor community should ensure that micronutrient interventions are owned locally, with the funding only providing a start-up or initiation of the interventions. Accountability and timely monitoring and evaluation should also be facilitated by the donor community.

Are we speaking the right language to turn evidence into policy and programs?

A panel comprised of a young scientist, a former minister of public health, a UN colleague and a representative of civil society, and which also included active audience participation, delved into this critically important topic. After all, to be a champion of nutrition, it is important to speak the same language as the decision-makers.

Most people in government are not technical, so malnutrition needs to be explained to them. Political commitment is critical, so our language needs to be adjusted when speaking to different groups and in different situations: the message must be contextualized and relevant. Yes, politicians have to make decisions based on evidence, and that evidence has to be strong enough and has to be communicated effectively, but at the end of the day, "Yes I'm convinced" only means "Yes" when the budget is allocated!

In reality, the biggest drivers of policy are economics and political pressure from civil society. Nutrition information needs to be packaged and sold to the press so that it generates mounting public pressure that will force governments to take action. Therefore we need to spend as much time communicating results – to a variety of policy-makers – as we do collecting data.

Having the data is a great start, as in order to do relevant research, we need to know what the problems are. There needs to be a harmonization of data. At the moment, everyone wants to do their own survey, and we spend a lot of time collecting data and then don't seem to turn it into programs and interventions that make a difference. There needs to be a louder voice from the scientific community.

Many scientists feel like they do not have the communication skills to talk to politicians about nutrition. Scientists are taught to think critically but not necessarily how to communicate that critical thought outside of scientific circles. However, if academics do not talk to politicians, then others with their own agendas will. Scientists should be encouraged to find ways to transfer and translate their research findings to policy-makers. Media communication for academia should be considered within the context of student training, and knowledge brokers are needed for effective communication with decision-makers.

Transformational leadership – not a position but a distinct form of capacity-building

Three categories of current capacity needs include:

1. Empowering and enabling multisectoral nutrition systems, including coordinating nutrition bodies (this provides the framework for interventions to take place)
2. Program staff (including researchers, evaluators and policy designers), and
3. Frontline staff such as community health workers (possibly the most crucial group, as they provide the capacity to deliver interventions at the household level).

A clear distinction should be made between management and leadership. Management helps an organization to perform its specific role, such as delivering products or services, ensuring quality, and overseeing the budget and timeframe. Leadership takes the organization into the future by creating aligned commitment, identifying opportunities, and taking advantage of these. It requires vision and shared values, and there is a need to empower others in order for change to take place.

Transformational leadership includes a strong sense of purpose that goes beyond self-interest; strong moral and ethical values that demonstrate commitment and trustworthiness; the self-confidence and courage to confront tough issues, which creates the ability to build teams; the ability to create motivating climates and the willingness to learn; being in tune with reality; the ability to deal with ambiguity; establishing a common vision and common goals among diverse stakeholders; emotional intelligence, self-awareness and communication skills; and the ability to manage resistance to change and to influence the direction of change.

> "The quality of the leadership sets the ceiling – an organization cannot grow beyond the size of its leader"

Take-home messages from the leadership discussion included that there must be a paradigm shift in the way nutritionists are trained and taught about leadership, which should also highlight the importance of partnerships, teamwork, and taking knowledge directly into the community. The value of multisectoral collaboration was also emphasized, including the need to break out of empires, let go of egos and work together as one, sharing a common vision, as opposed to acting as competitors. There was also a call to action from team leaders to value and support their team members by finding out what is needed for them to carry out their work more effectively. Finally, as leadership involves working with people with different backgrounds

A rural medical health center in Cancun, Mexico

and perspectives, it is vital to be able to build effective relationships with various stakeholders. This approach to leadership training is what needs to be scaled up, and should possibly be incorporated into academic curricula. Transformational leadership must be considered as the lubricant to make the process run smoothly and accelerate change.

Has the arrival of the SDGs changed financing for nutrition?

Klaus Kraemer, Managing Director of the *Sight and Life* Foundation, who chaired this session, stressed that nutrition lies at the heart of the SDGs. In order to achieve the nutrition-specific SDGs, including the internationally agreed targets on stunting, there needs to be not only an increase in evidence-informed, nutrition-specific interventions (e.g., breastfeeding, supplementation and treatment of severe acute malnutrition) but also an increase in coverage to more than 90% in the highest-burden countries. Yet to date, overseas assistance for nutrition-specific interventions is less than 1%. To achieve scale-up will require significantly more investment. But what must this investment be, and how should it be secured?

It is generally known that nutrition does not receive sufficient global funding to reach its set targets. According to the Global Nutrition Report, the nutrition budget needs to be approximately $3 billion (US) per year over the next 10 years. To achieve just four of the World Health Assembly targets would require funding of $10 billion.

> "The only way to fully know whether any action will be taken versus whether it will remain on paper is if it appears in the budget!"

Rule number one in fund-raising: "If you don't know what you're asking for, you will have a hard time getting it." Rule number two: "Don't just ask for a number – ask for a number to do things." It is important for nutritionists to be clear and specific about what they hope to achieve and what it will cost, as opposed to simply asking for a figure when requesting funding.

The total development assistance budget fluctuates at around $150 billion, and nutrition receives around 1% of that. It is clear that the case for how crucial nutrition is to achieving the SDGs has not been made. Currently, the nutrition community is completely off-target for achieving the SDG 2 of ending hunger, achieving food security and improved nutrition and promoting sustainable agriculture. Although having the funds is a major part of the solution, from a political perspective, funding is only obtained when the correct logic is applied to acquire it. When thinking about ending global hunger, there are three simple questions to be asked:

Kesso van Zutphen (left) and Ghazal Avand at the *Sight and Life* Foundation booth at the Micronutrient Forum in Cancun

1. What are the needs?
2. What are the policies?
3. What are the resources available in each country?

With this in mind, efforts should be targeted toward a best-case scenario of a country with a high need, strong policies and low resources – this is the scenario that will achieve the most positive results. By contrast, a worse-case scenario would be low needs, weak policies and high resources. Country data on needs, policies and resources can be mapped in order to determine where the maximum benefit from a nutrition intervention would be achieved.

The impact of major economic, demographic, technological and developmental shifts has reshaped priorities and created the need for more innovative ideas/solutions to achieve sustainable health and development gains. In addition, there is an urgent requirement for not only multisector collaboration, but also for global partnerships. Given the close interlinkages between human and planetary health – as exemplified by the climate-change-induced food and nutrition security shocks seen in the developing world – high-income countries need to be held more accountable for their actions. Nowhere is this accountability more important than in the agricultural sector. This should involve working backwards from environmental degradation towards the desired outcomes.

With regard to moving the needle on nutrition and the development and implementation of innovative interventions, micronutrient deficiencies need to be examined within the context of changes in development. There is a particular need to introduce new tools and technologies for tracking nutritional indicators. The current pace limits the ability to utilize data to make a substantial case that more funding is needed for nutrition interventions, simply because it is difficult to say whether or not existing programs are having an impact. So it extends far beyond simply collecting data and involves using this nutrition intelligence for a purpose. Nutritionists would benefit from adapting the way we think about achieving nutrition goals and the way we engage with the food system in general. This would involve improving relationships with the controllers of the food system – the private sector – which has generally been problematic for nutritionists. The next generation of young nutritionists must realize this and will have to develop better communication across sectors, while engaging in problem-solving and creating better, more innovative, business models.

While some believe that seven of the SDGs are related to nutrition, others link nutrition to 12 of the SDGs – making it an overwhelmingly global issue that affects all of us. It is estimated that addressing these goals will take up to $1.5 trillion per year, so there is a need to look beyond nutrition and beyond development. To obtain this funding may require a blended fi-

nance approach, where both public and private finance is integrated in order to achieve development goals.

At present, focusing on nutrition and agriculture in isolation to achieve development will remain insufficient until real-life traditional and modern ecosystems are created that balance nutrition, socioeconomics and health.

In our current global economic system, high-income countries import far more from low-to-middle-income countries than vice-versa, and big business is increasingly looking to start-up companies and SMEs for innovative ideas. It is therefore time to take a full one-world approach to all industrial markets as we attempt to find a way to bridge social and economic activity across countries.

The economics of demand

Marketing can be defined as the creation, management, and measurement of programs designed to influence the choices one needs people to make in order to meet specific objectives. Most marketing tends to focus on the four P's: product, price, place and promotion. Yet individual choice will finally determine actions, and therefore understanding the psychology of choice is a growing science. Brain science shows that people are a product of a long string of choices, and that our capacity for decision-making has evolved over time. Nevertheless, the way we make decisions has barely changed: 95% of our decision-making is unconscious, and 90% of the critical decisions we make are based on intuition. Overall, intuition is more influential than experience. In nutrition, we need to understand why people don't do what they are supposed to do – or, more specifically, why people don't make healthy eating choices.

Behavioral economics is an emerging science which helps us to craft ways for assisting people to make good choices through "nudge" interventions – interventions that nudge us in the right direction rather than simply telling us what is right and what is wrong. For example, it has been shown that a choice supported by peer pressure can play an important role in influencing popular behavior. Four key messages for social behavior change communication are:

1. If you want to encourage someone to do something, **MAKE IT EASY**
2. Make the example of others adopting the behavior change you require **VISIBLE TO THE PEOPLE WHOSE BEHAVIOR YOU WANT TO CHANGE**
3. Always think about how the **PROSPECT OF A LOSS** might be working against you or could work for you
4. Make your **BENEFITS FELT NOW**, not in the future

Future orientation in science and practice

Without doubt, the nutrition discipline in general, and specifically the micronutrient field, is changing, and evidence-based interventions to improve the lives of billions are growing. There has been a significant increase in developing broader stakeholder awareness of our cause. We have also widened our action umbrella and added more micronutrients (such as vitamin D and zinc) to the initial portfolio under the *Hidden Hunger* concept (vitamin A, iodine and iron). We have expanded our research and knowledge from the cellular/molecular level to the policy and implementation levels. We have developed new graduate programs to promote systemic and interdisciplinary thinking and action. We have been able to absorb and invest more assets (human, financial, technological, etc.) for the common cause of improving micronutrient nutrition. We have been able to support innovative ideas in technology to deepen our fortification, supplementation and dietary diversity strategies.

But we must not, and cannot, rest. As was clearly shown in many presentations at the Micronutrient Forum, we need to do more. More in implementation science and leadership capacity development. More basic research. More engaging with the beneficiaries – the communities we have set out to assist.

We need to keep focused on the 4 Cs: be more Committed, Comprehensive, Creative, and Collaborative in our research and practice. We need to strengthen our political, scientific and financial pillars as our three main power dimensions. We need to grow and develop leadership skills to couple with our academic and technical knowledge. We need to be resilient in our endeavors. We need to benchmark success stories, learn from our experience, and be open to harnessing different capacities and working in new and different ways. Last but not least, we need to find practical and scalable ways to mainstream women and girls for our health and development visions and plans. And we have to make sure that whatever we do is also driven by the passion to ensure sustainability.

For further information about the Micronutrient Forum, please visit *www.micronutrientforum.org*

Rice Fortification

A paradigm shift in global micronutrient deficiencies?

Rice is a staple food for three billion people, mostly living in low- and middle-income countries (LMIC) where micronutrient deficiencies (MND) are widespread. The World Food Programme (WFP), DSM and Micronutrient Initiative (MI) organized a Rice Fortification Symposium at the 2016 Micronutrient Forum in Cancun, Mexico. The objective was ambitious: to rally global partners and create a movement that will deliver a global roadmap for scaling up rice fortification.

The meeting was well attended, with key technical experts and senior managers from leading development/humanitarian, private-sector and donor entities such as WFP, FFI, MI, GAIN, UNICEF, PATH, DSM, WRIGHT GROUP and BMGF. WFP launched a short film on rice fortification with a historical perspective of staple food fortification (**available at** www.youtube.com/watch?v=iWklss9dTvo&feature=youtu.be).

The symposium constituted another important step toward aligning stakeholders in their role to scale up rice fortification globally.

As Fokko Wientjes (DSM) pointed out, staple food fortification, including the fortification of rice, is one of several interventions that support reduction of MND, and needs to be implemented within a package of nutrition-sensitive and nutrition-specific actions. The decision as to which staple food(s) should be fortified depends on various factors, such as identification of the staple foods most commonly consumed by specific vulnerable populations.

> "WFP is working on fortifying the rice that is included in its food basket, thereby fueling demand for fortified rice at the global level. While this is a complicated process that will take time, the drive is there to make it happen."
>
> *Lauren Landis, Director Nutrition Division, WFP*

A compelling case on how to trigger investments across the rice value-chain must be made through multisectoral and multistakeholder consensus, along with an assessment of cost effectiveness. Scott Montgomery, Executive Director of FFI, questioned whether the demand for, or the supply of, fortified rice should come first. He also questioned how the up-front costs to kick-start rice fortification could be covered, since the private sector requires a critical mass to invest in the production of fortified kernels and create viable commercial market opportunities. The consensus was that both "push" and "pull" strategies are necessary.

> "The policy advocacy piece is missing from the rice fortification agenda. We need to communicate with the governments' policy-makers – and establish how much the scale-up of rice fortification will cost, what they will get from it, and who's going to pay for it. The dialogue needs to be simple and not confusing."
>
> *Joel Spicer, President, Micronutrient Initiative*

The importance of fortifying humanitarian aid rice, including the rice in WFP's food basket, as well as rice distributed through social safety nets, was emphasized during the discussion. In addition, the case was made for focusing on rice fortification in West Africa, as about one third of global trade occurs between Asia and West Africa, where MND remain widespread. This rather consolidated supply chain offers additional opportunities for significant increases in volumes of fortified rice, making it possible to reach the critical mass needed to trigger the necessary private-sector investment.

Rice fortification has the potential to fill an important gap in the current food fortification landscape

Stakeholder representatives agreed that existing coordination spaces should be utilized to facilitate strong regional and global coordination. This would enable the sharing of knowledge and the learning of lessons among countries and regions.

During her closing remarks, Lauren Landis, Nutrition Director for WFP, echoed on her turn the call for global coordination, alignment on key areas, and partnerships to work for recognition of the positive public health impact of fortified rice. She pledged that WFP would take the lead in following up with partners on next steps.

Key ideas emanating from the symposium

- Rice fortification can fill an important gap in the current food fortification landscape, especially in countries where rice is a dominant staple among the population.
- A compelling case for how to trigger investment across the rice value-chain must be made, along with an assessment of cost-effectiveness. Opportunities for large-scale sustainable rice fortification include humanitarian food aid, national food-based social safety nets, and the Asia-West Africa rice trade.
- Leadership and coordination is lacking globally, and there is a need for a strong multisectoral and multistakeholder coalition to steer the scaling-up of rice fortification.
- A comprehensive action plan to scale up rice fortification is necessary in order to enable multiple partners to align and coordinate their efforts.

Nutrition Problems of Female Carpet Workers in Kathmandu

Mahendra Chalise
General Secretary / Executive Director,
Helpless Rehabilitation Society (HRS)

Bimal Poudyal
Chairperson, Helpless Rehabilitation Society (HRS)

Key messages

- Carpet factories in Nepal commonly employ women and children from various marginalized ethnic groups with very low socioeconomic status.
- Children and women working in carpet factories have numerous health problems, including micronutrient deficiency disorders.
- HRS conducted a Knowledge, Attitude and Practice (KAP) survey to understand how to combat nutrition problems among women and their children working in carpet factories.
- The introduction of Early Child Development Centers (ECDC), medical examination and nutrition education for mothers, and Healthy Baby contests has improved awareness of the importance of good nutrition.
- Despite the positive achievements to date, the activities of the Nepalese government alone may not be sufficient to reach these vulnerable people unless they are complemented by the efforts of NGOs and INGOs.

Helpless Rehabilitation Society (HRS)

Helpless Rehabilitation Society (HRS) is an NGO involved in the field of health, education and income generation activities for the benefit of underprivileged women and children. For the past 20 years, it has focused on improving the nutritional status of carpet factory workers, targeting women and children in and around the Kathmandu Valley, the most developed and populated area of Nepal.

There are about 750 carpet factories operating in the Kathmandu Valley alone. Carpet factory workers represent about 30 of the country's 75 districts. Each carpet factory employs between 100 and 800 people as carpet workers. These people come predominantly from various marginalized ethnic groups who hail from hilly and mountainous areas of the country, and have a very low socioeconomic status. Migration rates among these groups have been increasing, mainly due to political crises and poverty. They migrate to the urban areas, and especially in the capital city Kathmandu, mainly in search of employment opportunities there. The majority of these people readily obtain extremely low-paid jobs in the local carpet factories.

Malnutrition in Nepal

Malnutrition is a serious problem in Nepal, as it is in other countries of South Asia, and is a major threat to the health of infants, adolescent girls and pregnant and lactating mothers. About 80% of Nepal's people live in rural areas and depend on subsistence farming for their livelihoods. Household food security and poor nutrition are still major concerns in rural areas. Children and women working in carpet factories have numerous health problems, including micronutrient deficiency disorders. In 2011, HRS conducted a survey among the women and children of the carpet factories and found that 48% of children under five suffer from chronic malnutrition, 40% of them are underweight, and 11% are wasted. Likewise, 32% of women are malnourished, fol-

Parent counselling program organized by HRS

lowed by 39% with iron deficiency anemia, which is attributable to inadequate knowledge of nutrition, lack of extra food intake during pregnancy and lactation, and very low health-seeking behavior.

"Children and women working in carpet factories have numerous health problems, including micronutrient deficiency disorders"

The main reason for this situation is low consumption of nutritious food, including fresh fruit and vegetables. Access to such food is highly dependent on local seasonal availability, and lack of dietary intake from these sources contributes to nutritional disorders such as deficiencies in iron and vitamin A. Nutritional disorders, including iodine deficiency, are more prevalent among women employed as carpet workers. Other important influences include morbidity, poor health infrastructures, and socioeconomic factors.

Knowledge, Attitude and Practice (KAP) survey

In light of the above situation, HRS conducted a Knowledge, Attitude and Practice (KAP) survey to understand how to combat nutrition problems among women and their children working in carpet factories. The findings of the KAP, in which a total of 370 nursing mothers, pregnant women and adolescent girls participated, are as follows.

Knowledge

- Seventy-nine percent of adolescent girls, 38% of nursing mothers and only 15% of pregnant woman were correctly informed about iron-deficiency-related anemia.
- Regarding the signs and symptoms of anemia, 57% of adolescent girls, 39% of nursing mothers and 36% of pregnant women were correctly informed.
- Questioned about those most affected by anemia, 20% of adolescent girls were correctly informed, whereas among nursing mothers only 1% were correctly informed and pregnant woman did not have any knowledge about it.
- Concerning foods supporting iron absorption, 4% of adolescent girls, 7% of nursing mothers and 6% of pregnant women were correctly informed.
- In terms of iron-rich foods, 34% of adolescent girls, 34% of nursing mothers and only 24% of pregnant women were correctly informed.

Attitude

- Fifty-three percent of adolescent girls and nursing mothers and 51% of pregnant women had a positive attitude about the causes of anemia.
- Regarding where a person with anemia should turn for help, 88% of adolescent girls, 88% of nursing mothers and 77% of pregnant women had a positive attitude.
- Concerning the chances of abortion in the case of pregnant women with anemia, 47% of adolescent girls, 13% of nursing mothers and 11% of pregnant women viewed the likelihood as high.

Practice

- In practice, 12% of adolescent girls, 9% of nursing mothers and 15% of pregnant women were found to have had a nutritious meal in the morning of the day on which they were interviewed.
- Whenever they experience any symptoms of anemia, 87% of adolescent girls, 70% of nursing mothers and 56% of pregnant woman said that the head of the household suggests going to the health posts.

To combat this problem, HRS organized several meetings with the carpet factory owners, the leaders of the carpet factory union, relevant government authorities for the district, and related stakeholders in order to obtain their support. HRS then planned and implemented activities to improve the nutritional status of children and women employed as carpet workers.

A midday meal being served to children in a day care center

Major activities implemented

a) Early Child Development Center (ECDC)

Mothers working in the carpet factory do not have sufficient time to feed their children. This extends to breastfeeding. They have low economic status and do not have adequate knowledge of child care and feeding practices. This results in high child morbidity, especially as a result of malnutrition. When children's health is compromised, they become ill more frequently, which in turn hampers their mother's capacity to work. Once the mother is not working regularly, her wages drop. The reduction in her income results in the delivery of ever poorer nutrition to her children and the rest of her family.

HRS manages two Early Child Development Centers (ECDCs) at different locations, each of them taking 75 children of carpet factory workers. These children are between 2 and 6 years of age. Children aged between 2 and 3.5 years go into a play group. At 3.5–6 years, they are placed in an education group and are enrolled at the nearby schools after one year of educational rehabilitation. Each child is provided with a nutritious midday meal, improved personal hygiene, and a quarterly health check-up, including height and weight monitoring. Many more children employed in carpet factories are in need of this service, but HRS manages only 150 of these, drawing on the support made available by the Goodweave Foundation and other sources.

"Each child is provided with a nutritious midday meal, improved personal hygiene, and a quarterly health check-up"

b) Medical examination and nutrition education for mothers

Each child is examined for potential health problems, including the signs of micronutrient deficiencies, by the medical doctor every two months. A register is maintained, and the results for each child are regularly compared. At the same time, mothers are given nutrition education focusing on the care of under-fives, the selection and preparation of food, the importance of feeding vitamin A rich foods, the need for ensuring their children receive vitamin A capsules during the biannual distribution, the utilization of health care services when their children are ill, etc.

c) Healthy Baby contest

Each year, a Healthy Baby contest is organized and a winner chosen. Talks about nutrition are also given. This has created

awareness of the importance of good nutrition among the mothers themselves and also among the carpet factory owners, governmental and non-governmental organizations, and the general public.

Major outcomes achieved

a) Carpet factory owners in the program area are encouraged to support the day care centers. Because their children are taken care of and provided with nutritious food, the mothers have more time for weaving carpets. This has a beneficial effect not only on the quantity but also the quality of their output.

b) Children aged 2–6 years from various ethnic and marginalized population groups are becoming nutritionally sound, and more than 70% of them enroll in the schools each year.

c) The Healthy Baby contest has encouraged mothers to take better care of their children and feed them nutritious foods.

d) The children's caretakers are adopting preventive measures as suggested, and are improving the practice of planning and consuming nutritious foods.

e) The number of school enrollments has increased, especially for young girls.

f) The use of the existing health care facilities has changed, and the incidence of morbidity and mortality due to nutrition deficiency disorders has declined.

g) More than 80% of mothers now have good knowledge of, attitudes towards, and behavior regarding proper child care and timely enrollment of children at the school.

Individual meeting with a mother and her child

> "More than 80% of mothers now have good knowledge of proper child care"

There are high numbers of women and children working in carpet factories in Nepal, but few programs that focus specifically on the nutritional status of women and children. The activities of the Nepalese government alone may not be sufficient to reach these marginalized and vulnerable people unless they are complemented by the efforts of NGOs and iNGOs.

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Further reading

1. USAID/Nepal's Suaahara project to strengthen policies and programs that improve the health and nutritional status of women and children in Nepal. www.usaid.gov/nepal/fact-sheets/suaahara-project-good-nutrition
2. Nutrition promotion and consultancy services (NPCS) Nepal. www.npcs.org.np/about.html
3. Goodweave Foundation Annual Report. www.goodweavenepal.org/pdf/GoodWeave_AnnualReport-2014.pdf

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** and **Twitter @sightandlife.**

01

African Farmers in a Digital Age: Overcoming isolation, speeding up change, and taking success to scale

At a time when we are embracing a food systems approach to addressing the ever spiraling challenges of nutrition and breaking down silos to ensure nutrition is embedded across sectors, the task of engaging agriculture becomes increasingly important. This means not only getting closer to commercial agriculture, but also exploring how we can work with small-scale farmers who have often been bypassed in the past. African Farmers in a Digital Age is an excellent anthology, co-curated by Kofi Annan, Sir Gordon Conway, and Sam Dryden, that explores the future of African food systems and the role that digital solutions can play in overcoming the isolation of smallholder farmers and speeding up rural development. Farming is one of mankind's oldest endeavors, and digital technology is one of its newest – and now the two need to come together. By thinking in terms not just of crops or yields or prices, but rather of an integrated food system that links all players in the agricultural economy, this publication allows us to see African agricultural issues in a new light. From mobile phones to big data, from nutrition to climate change, this collection covers it all, with contributions from authors who have something powerful to say and the authority to be heard.

> "Enabling smallholder farmers to grow more food and sell it in formal markets for a fair price would change life for almost every poor person in Africa"
>
> *Kofi Annan, Secretary-General of the United Nations 1997–2006*

Making the food systems in Africa as robust as possible will have numerous benefits: it will not only address hunger and food insecurity but will also fight poverty, disease, and malnutrition in all its forms; create businesses and jobs; boost the continent's economies; and improve its trade balances. All of which we desperately need if we are to achieve the SDGs.

Take the time to enjoy and be challenged by this publication, which can be downloaded from:
www.fao.org/family-farming/detail/en/c/381860/

Did You Know?

More than 80 percent of African agricultural production comes from smallholders. The new African food system should be built around the idea that agriculture is about more than producing calories; it is about changing society. Its five components should be:

1. Valuing the smallholder farmer
2. Empowering women
3. Focusing on the quality as well as the quantity of food
4. Creating a thriving rural economy
5. Protecting the environment

02 Call for Action against Mycotoxin Contamination in Developing Countries

A Working Group of world-leading experts convened by the International Agency for Research on Cancer (IARC) recently reviewed the health effects of aflatoxins and fumonisins. The panel concluded that these mycotoxins are not only a cause of acute poisoning and cancer but also a likely contributor to the high levels of stunting in children in affected populations. The Working Group also identified effective measures to reduce mycotoxin exposure in developing countries. Their recommendations have been published in the report Mycotoxin Control in Low- and Middle-Income Countries, **available for download at** www.iarc.fr/en/publications/pdfs-online/wrk/wrk9/IARC_publicationWGR9_full.pdf (also available in French and Spanish).

The panel evaluated 15 interventions against mycotoxins, considering the strength of the evidence as well as its completeness and transferability at an individual, community, or national level. Four of the measures were adjudged ready for implementation. The intervention for which the strongest evidence of improvement to health exists, but which is also the most difficult to achieve, was to increase dietary diversity. Other strategies deemed ready for implementation included sorting of the crop; a package of post-harvest measures, including improved storage; and in Latin America for maize, optimized nixtamalization.

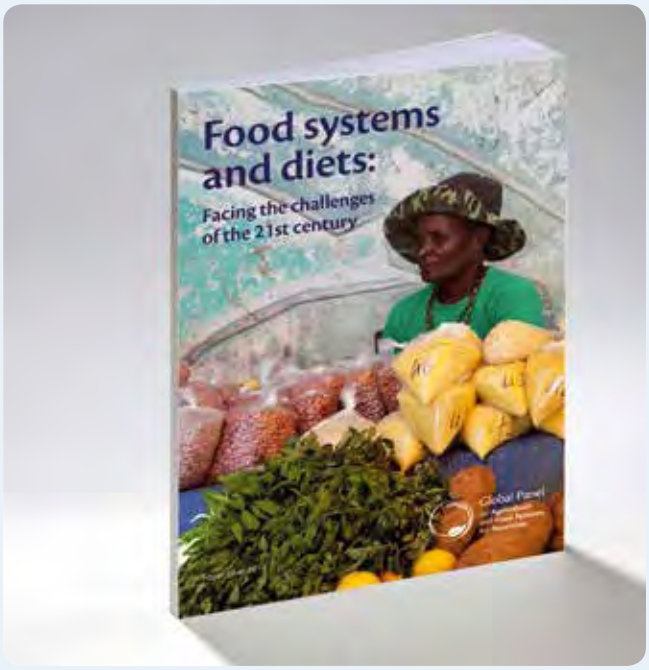
"It is time to put the existing knowledge and technology into action to control mycotoxin food contamination in low-income countries," says Dr J David Miller, Chair of the IARC Working Group.

> "It is time to put the existing knowledge and technology into action to control mycotoxin food contamination in low-income countries"

Did You Know?

- Despite a sustained investment in research over the past 60 years, aflatoxin as an agricultural problem has not diminished. Hotter summers and, in 2015–2016, an intense El Niño year, have tended to increase the geographic area affected each year.
- An estimated 500 million of the poorest people in sub-Saharan Africa, Latin America, and Asia are exposed to pervasive, biological toxins, aflatoxins and fumonisins on a daily basis simply by eating their staple diet of groundnuts, maize, and other cereals.
- Exposure occurs throughout life at levels far in excess of internationally accepted norms.

03 The Global Panel's Foresight Report Food Systems and Diets: Facing the challenges of the 21st century



Food Systems and Diets is a really important and timely report that takes a close look, using modeling and trend analysis, at the extent to which food systems are delivering healthy diets today. It assesses whether they are fit for the future, and then makes important recommendations and gives pragmatic advice for leaders at the most senior levels in countries and international organizations. Yet it is also of direct relevance to all policy-makers, decision-makers, professionals, business people, experts and researchers with interests in food systems and diets.

"Only a response on the scale and commitment used to tackle HIV/AIDS and malaria will be sufficient to address malnutrition in all its forms"

Key findings include the fact that the growing nutrition crisis requires decisive action now in order to avert profound consequences for the health of populations, health care costs and economic growth, and that current food systems are not delivering healthy diets. Unless things change, we are unlikely to reach the targets we have set. There is too much focus on food quantity rather than quality, consumers are not being helped to make healthy and affordable food choices consistent with optimal nutrition outcomes – in fact, the trend is in the opposite direction.

All the various elements that make up food systems need to be harnessed so that they nourish rather than merely feed people. This requires the public and private sector to work together, creating opportunities for interventions that decision-makers can tailor to specific country contexts.

The good news is that there are many ways in which policy-makers can reshape food systems. The report sets out ten clear priorities for action and gives detailed advice and guidance, which will be of practical and immediate use to decision-makers.

The Executive Summary is available in English, French, Portuguese and Spanish and, together with the full report, can be found at: *www.glopan.org/foresight*

Did You Know?

The last edition of the *Sight and Life* magazine was dedicated to food systems. If you missed it, you can go to our website www.sightandlife.org, click on Library and download edition 30(1)/2016. Why not also follow us on Facebook and @sightandlife on Twitter.

04 A Fair Chance for Every Child

Such a simple title, yet as stated in the foreword of this annually important publication, "Inequity imperils millions of children and threatens the future of the world." The 2016 UNICEF State of the World's Children is an uncomfortable read, but reaches to the heart of the *Sight and Life* vision – to improve the lives of the world's most vulnerable populations. The reality is that for millions of children, their futures are shaped from birth by inequities. But the report highlights how this can change – and is changing – for many, as the world makes progress in some areas and scales up cost-effective interventions that work, such as vaccines, oral rehydration salts and better nutrition. As we all recognize the need for multi-sectoral approaches if we are to find sustainable solutions to the world's most pressing problems, the report should be read from cover to cover.

> "Inequities and dangers perpetuate intergenerational cycles of disadvantage and inequality that undermine the stability of societies and even the security of nations everywhere"

It is, as always, filled with valuable information covering the key issues – health, education, poverty, useful text boxes, interesting perspectives, and tables at the end giving country, regional and global statistics.

Most important of all, it gives advice on what needs to be done – the pathways to equity. These are defined in terms of five concepts:

1. Increasing **information** about those being left behind
2. **Integrating** efforts across sectors to tackle the multiple deprivations that hold so many children back
3. **Innovating** to accelerate progress and drive change for the most excluded children and families
4. **Investing** in equity and finding new ways of financing efforts to reach the most disadvantaged children
5. **Involving** everyone, beginning with communities themselves, and with businesses, organizations and citizens around the world

This report really jolts us into always remembering to the put the children first (political commitment), not to take our eye off the ball (resource provision), and to rapidly scale up the successful implementation (collective will) of many great interventions in order to achieve the required impact.

To download the report and read case studies accompanied by evocative photo essays, please go to *www.unicef.org/sowc2016/*

Did You Know?

While methods to calculate monetary poverty provide a useful yardstick against which to measure social progress, they are limited, and do not take into account other crucial dimensions – such as lack of education, health, water or sanitation – that are extremely important for understanding how children experience poverty. Child poverty is best seen as a combination of monetary and non-monetary factors at both the household and individual levels.

05 The Cost of Malnutrition: Why policy action is urgent

The Cost of Malnutrition is the third technical briefing from the Global Panel on Agriculture and Food Systems for Nutrition. It provides compelling evidence on the economic value of reducing malnutrition with its estimated impact on the global economy of as much as US$3.5 trillion per year. This report is specifically designed for policy-makers, particularly those in ministries of economic planning and finance, who require convincing that poor nutrition impacts economic growth and is worth investing in: US$1 generates a US$16–20 return on investment.

The briefing has developed an excellent framework highlighting the pathways from malnutrition to economic loss at the individual, societal and national levels as a consequence of mortality, ill health, impaired physical growth and impaired cognitive development – none of these individual factors being mutually exclusive.

> "Although the price of addressing malnutrition can be huge, evidence shows that the cost of doing nothing is immeasurably greater"
>
> *Prof. K Srinath Reddy President of the Public Health Foundation of India and Global Panel member*

It explains that because there are numerous ways by which malnutrition can generate financial costs, there have been an increasing number of approaches used to estimate the relevant costs and losses, and the prices of various interventions. What is more, calculations of the costs of malnutrition have often isolated one or other pathway in order to simplify estimates of short- and long-term impacts on society, which makes it hard to assess packages of, or alternatives among, policy interventions.

The price of interventions, both nutrition-specific and nutrition-sensitive, is laid out in the report, but so too are the rewards. Finally, The Cost of Malnutrition makes six recommendations:

1. Governments should calculate the direct and indirect cost of malnutrition in all its forms for their own country
2. Standardized metrics must be developed to support more effective communication of findings to policy-makers
3. Viable options for policy and program interventions across the food systems must be identified and costed
4. A national Common Results Framework should be established to shape monitoring and reporting on progress
5. Rigorous data should be generated to support ongoing assessment of cost-effective actions across the food system and food environment
6. Knowledge gaps and data deficiencies on the costs and benefits should be urgently addressed

This is compulsory reading for anyone working in nutrition who has to make the argument for the value of investing.

Did You Know?

The Global Panel on Agriculture and Food Systems for Nutrition is an independent group of influential experts committed to tackling the global challenges in food and nutrition security. Their three explicit objectives are to:

1. Generate and stimulate a stronger evidence base for how changes in agriculture and food systems can improve nutrition
2. Create and promote a new understanding of the role and future potential of agriculture and food systems in improving nutrition
3. Catalyze collaboration in agricultural and food systems that will improve diets and nutrition outcomes for all.

Follow The Global Panel on Twitter @Glo_PAN or visit their website to read interesting blogs and subscribe to their newsletter: *www.glopan.org*

06 Investing in Nutrition: The foundation for development

Investing in Nutrition is a really great and user-friendly resource with excellent visuals that summarizes the analysis of the costs, impacts, and investments needed to achieve targets, and outlines how governments, donors, the private sector, foundations, and others can come together to finance nutrition actions at scale.

"More work is needed to ensure the cost-effectiveness of existing spending, address implementation bottlenecks and knowledge gaps, and strengthen delivery mechanisms for high-impact interventions"

The report has two important take home messages: the need to set priorities and the need to approach financing differently.

The time has come to prioritize where we focus investments in nutrition. The analysis undertaken suggests that priority should be given to a set of the most cost-effective interventions, all of which can be scaled up immediately. This smaller package requires an annual investment of just over US$2 billion a year above current baseline spending over the next ten years. It will save some 2.2 million lives and – together with anticipated progress in food availability and diversity, women's health and education, along with investments in water and sanitation – could result in 50 million fewer children stunted in 2025 compared to 2015.

To achieve this, however, we need a new approach to financing partnerships – an approach that requires donors, countries, innovative financing mechanisms, businesses, and even consumers themselves act in "global solidarity." National ownership and domestic financing must be maximized, and each partner will need to contribute according to its financing capacity and comparative advantage.

The briefing can be downloaded at
www.thousanddays.org/tdays-content/uploads/Investing-in-Nutrition-The-Foundation-for-Development.pdf

Did You Know?

It is estimated that country governments currently spend US$2.9 billion and donors provide just under US$1 billion annually to address stunting reduction, wasting, anemia, and exclusive breastfeeding. This means that on average, countries are spending just 1% of their health budgets on the kind of high-impact nutrition-specific programs that save lives and pay significant dividends down the road.

07 Fighting Malnutrition: A new momentum

At a time when the Sustainable Development Goals (SDGs) have been set, there has been a commitment to implement the outcomes of the International Conference on Nutrition 2 (ICN2) and the action plan of the World Health Assembly (WHA) for 2025, as well as the Non-Communicable Disease (NCD) action plan. The Decade of Action for Nutrition has been declared, and there is a collective responsibility within the UN system to engage, to act and to implement in order to support countries in delivering on their responsibility in realizing their citizens' right to nutritious food. The Strategic Plan of the UN Standing Committee on Nutrition for 2016–2020 is an important document, especially as the UN interagency work on nutrition needs to catalyze joint approaches and actions so as to achieve greater synergy and effectiveness of UN agency activities at the global and country levels. As the report states, "The UN system can and should indeed provide unified support to further advocacy for nutrition, help develop and implement robust country nutrition strategies, broker agreements and convene stakeholders, develop guidelines and analytical/monitoring tools, strengthen information systems, and leverage financial and technical assistance."

The Strategic Plan outlines four strategic objectives:

1. Maximize UN policy coherence and advocacy on nutrition
2. Support consistent and accountable delivery by the UN System
3. Explore new and emerging nutrition-related issues
4. Promote knowledge sharing across the UN System

Did You Know?

Do you know the six mandated functions of the UN Standing Committee on Nutrition (UNSCN)?

1. To provide global strategic guidance and advocacy in nutrition, to ensure engagement and investment at the highest level and to ensure progress towards nutrition security for all
2. To enhance dialogue and linkages, fostering joint nutrition action, partnerships and mutual accountability between UN agencies
3. To harmonize concepts, including methodologies and guidelines, policies and strategies in response to the nutritional needs of countries
4. To facilitate knowledge, exchange of practices, tools and needs, enhancing coherence of the global nutrition public goods agenda and identifying emerging issues
5. To communicate on global trends, progress, and results and to enhance global advocacy through networks and platforms
6. To engage in and facilitate dialogue with stakeholders across health, food security, water and sanitation and social protection constituencies for strengthening nutrition action and mainstreaming nutrition into development policies.

08

SISN 2016–20 Strategic Plan: Bringing together the 'Knowledge World' and the 'Action World'

THE SOCIETY FOR IMPLEMENTATION SCIENCE IN NUTRITION

As countries move from talk about scaling up nutrition to action, the challenge they are increasingly facing is how to scale up efficiently and effectively. This is where implementation science becomes vital, and the Society for Implementation Science in Nutrition (SISN) has now launched its 2016–20 Strategic Plan. This document forms the bedrock of SISNs operations going forward and outlines the framework and values under which the Society will deliver against its strategic goals to progress the Implementation Science for Nutrition agenda. The plan highlights five imperatives:

1. **Implementation as learning and adaptation:** Implementation must be approached as an iterative and continuous, knowledge-intensive process of learning and adaptation, on varying time scales.
2. **The implementation spectrum:** Implementation research includes a wide range of decisions, processes and capacities, together with capacity-strengthening.
3. **The implementation knowledge portfolio:** It is critical to broaden our understanding and concept of the diverse types of knowledge needed to inform and guide implementation.
4. **The implementation research capacity agenda:** It is necessary to develop, adapt, reform and/or strengthen research methods, practices and capacities to align with the distinctive needs of implementation and to mobilize the necessary human, organizational and financial resources.
5. **The institutional landscape:** It is essential to ensure that the political economy and governance dynamics at global and national (and sub-national) levels are included in implementation research agendas.

> "Nutrition research has historically focused on knowledge for 'WHAT' to implement – there now is an imperative to focus on knowledge of 'HOW' to implement."

In order to turn their words into actions and stimulate and drive change in the focus, norms and practices in organizations and systems for implementation as well as in research, the society has prioritized goals and set up a number of Working Groups. These groups are currently led by Board members with some Founding Member involvement, but SISN are inviting participation from the wider membership to support them in delivering on these goals. They are also looking to widen their membership – so if you would like to become part of this new frontier in nutrition, **visit** *www.implementnutrition.org* and connect with them on their LinkedIn page.

09 SUN Movement Strategy and Roadmap 2016–2020: From inspiration to impact

At the 2016 United Nations General Assembly, the SUN Movement launched its new Strategy and Roadmap, which will move the focus from inspiring countries to sign up and develop costed nutrition plans to driving for impact. The vision is for a world free from malnutrition in all its forms by 2030. Achieving this will be led by governments and supported by organizations and individuals and through collective action will ensure that every child, adolescent, mother and family can realize their right to food and nutrition, reach their full potential, and shape sustainable and prosperous societies. The goals are fully aligned with the WHA targets for maternal, infant, and young child nutrition by 2025, in addition to relevant targets for preventing and controlling non-communicable diseases. The Movement has developed four strategic objectives:

1. Expand and sustain an enabling political environment
2. Prioritize and institutionalize effective actions that contribute to good nutrition
3. Implement effective actions aligned with Common Results
4. Effectively use, and significantly increase, financial resources for nutrition

The SUN Movement's next phase will focus on translating momentum into results for people who suffer due to malnutrition everywhere.

A core message is to start with what exists and continuously improve – for impact. For this, countries are urged to continuously improve country planning and implementation to end malnutrition; mobilize, advocate and communicate for impact; strengthen capacity for multisectoral and multi-stakeholder collaboration at all levels; and ensure equity, equality and non-discrimination for all, with women and girls at the center of efforts.

This detailed but easy-to-read report, which also includes useful visuals and graphics, will provide you with everything you need to know about the SUN movement. Whether you want to read about the movement's the history and the roles and responsibilities of its various groups, obtain more detail on the roadmap to the strategic objectives, or learn about the tools that have been established to help track progress, inform corrective actions and share learnings, **it is certainly worth downloading from the revamped website:** *www.scalingupnutrition.org*.

Did You Know?

The SUN Movement has 10 Principles of Engagement, which guide its myriad actors in mitigating conflicts of interest, and effectively working together to end malnutrition, in all its forms.

1. Be transparent about intentions and impact
2. Be inclusive
3. Be rights-based
4. Be willing to negotiate
5. Be predictable and mutually accountable
6. Be cost-effective
7. Be continuously communicative
8. Act with integrity and in an ethical manner
9. Be mutually respectful
10. Do no harm

10

Guidelines for Iron Supplementation

The WHO Department of Nutrition for Health and Development has this year released two sets of guidelines specific to iron supplementation. One covers daily iron supplementation in infants and children living in settings where anemia is highly prevalent, and is divided into four recommendations. The first, for infants and children aged 6–23 months, is a strong recommendation based on a moderate quality of evidence which suggests a supplementation scheme of 10–12.5 mg elemental iron to be given daily for three consecutive months in a year. The second, for preschool-age children aged 24–59 months, is also a strong recommendation based on a very low quality of evidence, and the suggested supplementation scheme is 30 mg elemental iron given daily for three consecutive months in a year. The third is for school-age children aged 60 months and older, and is a strong recommendation with high quality of evidence for supplementing with 30–60 mg elemental iron daily for three consecutive months in a year. The final addresses iron supplementation in malaria-endemic areas. It is a strong recommendation, based on high-quality evidence, that the provision of iron supplementation in these infants and children should be done in conjunction with public health measures to prevent, diagnose and treat malaria.

The second guideline considers iron supplementation in menstruating adult women and adolescent girls living in settings where anemia is highly prevalent (≥ 40% anemia prevalence) as a preventive strategy for implementation at the population level. It provides a strong recommendation based on a moderate quality of evidence, for daily iron supplementation of 30–60 mg elemental iron for three consecutive months in a year.

The full documents are available at *www.who.int/nutrition/publications/micronutrients/guidelines/daily_iron_supp_children and www.who.int/nutrition/publications/micronutrients/guidelines/daily_iron_supp_womenandgirls respectively.*

Did You Know?

In 2011:

- Approximately 300 million children globally had anemia
- One in three non-pregnant women were anemic, totaling some 500 million worldwide

Other Useful Nutrition Resources

› **The 2016 Global Food Policy Report**
This is the International Food Policy Research Institute's (IFPRI) flagship report that puts into perspective major food policy issues, developments, and decisions. This year's report takes a special look at how food systems can best contribute to meeting the UN Sustainable Development Goals. **It has a great interactive on-line version.** *www.ifpri.org/publication/2016-global-food-policy-report*

› **WHO Guideline Update on HIV and Infant Feeding**
A vitally important read. The objective of this guideline is to improve the HIV-free survival of HIV-exposed infants by providing guidance on appropriate infant feeding practices and use of ARV drugs for mothers living with HIV. The guideline is intended mainly for countries with high HIV prevalence and settings in which diarrhea, pneumonia and undernutrition are common causes of infant and child mortality. **Available at** *apps.who.int/iris/bitstream/10665/246260/1/9789241549707-eng.pdf?ua=1&ua=1*

› **Stunting: The Evidence and the Required Actions to Stop Stunting in South Asia**
The Maternal and Child Nutrition (MCN) Journal has published a supplement entitled "Stop Stunting in South Asia. Improving Child Feeding, Women's Nutrition & Household Sanitation" that was funded and made open-access by UNICEF Regional Office for South Asia. It comprises six review articles, eight original articles, and six commentaries by eminent experts, and although focused on South Asia, **it is applicable globally: compulsory reading.** *onlinelibrary.wiley.com/doi/10.1111/mcn.2016.12.issue-S1/issuetoc*

› **SUN Movement Newsletter:**
Always inspirational as one reads about how the 57 SUN countries are translating their plans into actions. To subscribe, go to the bottom of the home page **of the SUN website** *scalingupnutrition.org*. Twitter handle: @SUN_Movement.

› **IDD Newsletter**
The Iodine Global Network, a non-governmental organization dedicated to sustained optimal iodine nutrition and the elimination of iodine deficiency, celebrates 30 years of existence this year and ensures that we do not forget about the importance of salt iodization in our work addressing micronutrient malnutrition. The Network's newsletter has comprehensive articles covering all aspects related to iodine, its deficiency, and prevention strategies from across the world. **To sign up, visit:** *www.ign.org*. Twitter handle: @IGN_ICCIDD.

› **The UN Standing Committee on Nutrition (UNSCN)**
The UNSCN has two publications that are well worth reading. The first is SCN News, a biannual peer-reviewed publication that features a selected topic, in addition to regular columns with updates of interest to nutrition and development practitioners. The second is SCN E-Newsletter, which contains brief nutrition news, announcements, vacancies and nutrition updates. **Subscribe at:** *www.unscn.org/en/publications/publications-mailing-lists/mailing-lists.php*. Twitter handle: @UNSCN.

› **Twitter handles and hashtags**
For those active on social media, here are twelve Twitter handles and hashtags **you might like to follow / watch:** *@sightandlife @CIFFchild @ThousandDays @gateshealth @countdown2030 @GNReport #2030Together #InvestinNutrition #hiddenhunger #foodfortification #NutritionDecade #NutritionReport*

Giving Food Fortification the Attention it Deserves

Participants of the Radcliffe Exploratory Workshop "Building Multi-Nutrient Food Fortification Policy in Emerging Democracies in the Context of Mongolia"

Standing, from left to right: Laura Rowe, President, PHC; Dr Soninkhishig, Professor of Nutrition, Mongolian University of Science and Technology; E Enkhbileg, COO, APU company; Dr Baymbatogtoh, Nutrition Officer, Mongolian Ministry of Health; Dr Klaus Kraemer, Director, *Sight and Life*; Dr Wafaie Fawzi, Professor, Harvard University; Dr Bayartulga, State Secretary, Mongolian Ministry of Food and Agriculture; Bolorsaikhan, CEO, Vitafit company; J Badamtsetseg, Trail Coordinator, MHI; RA Grace, Brigham and Women's Hospital; Janet Rich-Edwards, Director of Developmental Epidemiology at the Connors Center for Women's Health and Gender Biology, Brigham and Women's Hospital; Dr Michael Cannon, CDC; Dr Helena Pachón, Food Fortification Initiative; Dr Rebecca Lander, Instructor, University of Colorado School of Medicine; Sabri Bromage, researcher, MHI; Tsendjav Enkhjargal, Media Representative, MHI. **Seated, from left to right:** Dr Tuyatsetseg, Director of the School of Industrial Technology, Mongolian University of Science and Technology; Dr Lynnette Neufeld, Director of Monitoring, Learning and Research, GAIN; Dr Baymbasuren, Deputy Minister, Mongolian Ministry of Health; Dr Ganmaa, Assistant Professor, Harvard T.H. Chan School of Public Health; Dr Undraa, Governor of Mongolia; Dr Choijamts, ERB Chair, Mongolian Ministry of Health.

Enkhjargal Tsendjav
Media Representative, Mongolian Health Initiative (MHI)

The Radcliffe Institute for Advanced Study at Harvard University is well known for organizing seminars and workshops which bring together Harvard faculty experts and other experts from around the world to discuss pressing public policy issues and emerging ideas. To that end, former Radcliffe Institute Fellow Prof. Davaasambuu Ganmaa organized a workshop entitled 'Building Multi-Nutrient Food Fortification Policy in Emerging Democracies', which was held from October 3–5, 2016 at Harvard University, Cambridge, MA, USA.

The relevance of food fortification to Mongolia

Since 2011, the Mongolian Health Initiative NGO (MHI), founded by Dr. Ganmaa, has conducted a nationwide micronutrient survey among Mongolian adults. According to Sabri Bromage, a researcher at MHI, multiple micronutrient deficiencies are highly prevalent among both urban and rural Mongolian adults. These deficiencies could be addressed by

means of industrial fortification. The workshop aimed to identify challenges to food fortification in Mongolia, discuss how these challenges have been approached in other contexts, and develop a plan for advancing fortification policy in Mongolia.

Workshop discussion topics

Workshop delegates from Mongolia – including an MP, a state secretary, a deputy minister, and top academics – and industry leaders from around the world discussed the history and current situation of food fortification in Mongolia. Although a food fortification law was drafted in 2009 for staples, fortification never expanded beyond iodization of salt. However, the necessary consumption data and industrial infrastructure now exist to support the use of wheat flour and milk as key food vehicles for fortification. International experts made valuable observations. For example, Helena Pachón (Food Fortification Initiative) explained why mandatory fortification would be more effective than voluntary fortification, while vitamin D expert Michael Holick explained why vitamin D fortification of milk would be safe and effective.

Workshop outcomes

Following the workshop, a fortification working committee was established in the Mongolian Parliament, and the Mongolian Ministry of Food and Agriculture hosted a follow-up conference to discuss implementation. Delegates included representatives from government, industry and academia, as well as consumers. Policy-makers and industry are now aware that food fortification is a cost-effective means of tackling micronutrient deficiencies in Mongolia. Next steps will include the development of an effective monitoring system to ensure that foods are adequately fortified according to national guidelines.

A world free from malnutrition.

Sight and Life is a nutrition think tank supported by DSM

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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

The First 1,000 Days

Roger Thurow: The First 1,000 Days
Hardcover: 304 pages
Publisher: PublicAffairs (May 3, 2016)
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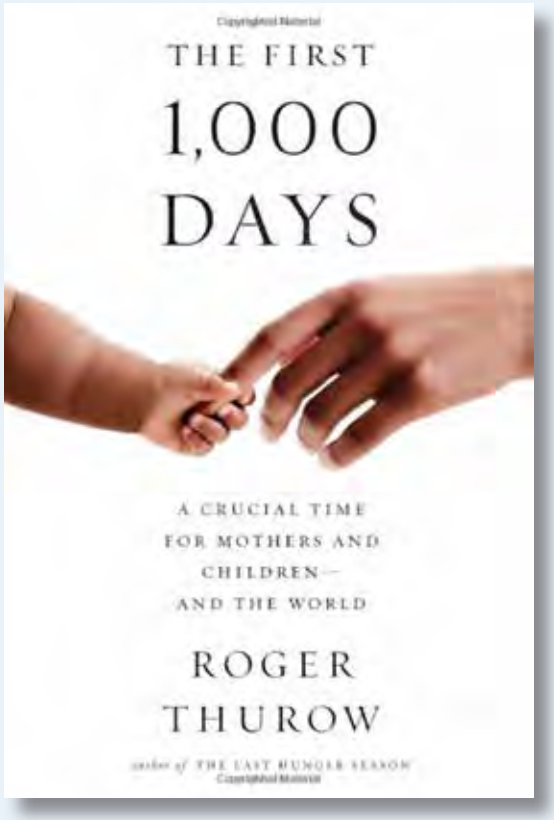
For more than half a decade, the critical importance of good nutrition during the first 1,000 days of a human being's life has been widely accepted. It is during this period, which stretches from conception to the second birthday, that the determinants of future health and wellbeing are established. So significant is this window of opportunity that it has given rise to an organization of the same name: 1,000 Days. The Executive Director of 1,000 Days, Lucy Martinez Sullivan, is in fact interviewed in the Day in the Life section of this issue of *Sight and Life*.

An excellent complement to Lucy Martinez Sullivan's reflections is Roger Thurow's new publication *The First 1,000 Days*. A Senior Fellow for Global Agriculture and Food Policy at the Chicago Council on Global Affairs, Thurow was a reporter the *Wall Street Journal* for 30 years. He is, together with Scott Kilman, the author of *Enough: Why the World's Poorest Starve in an Age of Plenty* (which won the Harry Chapin WhyHunger book award) and a recipient of the 2009 Action Against Hunger Humanitarian Award.

Not surprisingly given his background in American journalism, Thurow takes a narrative-based approach to his subject in *The First 1,000 Days*, focusing on the lives of four pregnant women from different corners of the world: Esther Okwir in rural Uganda, where the infant mortality rate is among the highest in the world; Jessica Saldana, a high school student in a violence-scarred neighborhood of Chicago; Shyamkali, the mother of four girls in a low-caste village in India; and Maria Estella, in Guatemala's western highlands, where most people are riddled with parasites and mothers can rarely afford the fresh vegetables they farm.

In the footsteps of Hemingway and Steinbeck

This approach makes Thurow's latest publication significantly different from much contemporary writing on nutrition and public health, which frequently has a policy-driven, statistics-based line of argumentation. True to the literary tradition that gave us journalist-authors such as Ernest Hemingway and John Steinbeck, Thurow commences his narrative *in medias res* and sticks closely to the experiences of his four subjects throughout. The fact that he contrasts the poverty of a depressed urban environment in his native Chicago with three settings in the developing world makes his account all the more compelling. "In the second decade of the twenty-first century," Thurow



writes, "one in every four children under the age of five is stunted – about 170 million in total, according to the World Health Organization … A child who is severely stunted is sentenced to a life of underachievement: diminished performance in school, lower productivity and wages in the workplace, more health problems throughout life, and a greater propensity for chronic illnesses such as diabetes and heart disease as an adult. And that life sentence is most often rendered by the time a child is two."

> "A child who is severely stunted is sentenced to a life of underachievement"

Readers of *Sight and Life* will be familiar with such reflections, but in Thurow's prose, they are especially powerful – direct, simple, and free of policy-speak. They are rooted in the actual experience of real women, and we see how Esther, Jessica, Shyamkali and Maria Estella all struggle with their own versions of the same problem. In a Uganda ravaged by the aftermath of the guerrilla operations of the warlord Joseph Kony, Esther dreams that her baby might one day become "a manager or president of a company, if not president of the entire country." Jessica in Chicago lives in a world in which mothers fill baby bottles with Coca-Cola or Kool-Aid because these soft beverages are cheaper than milk. In a downtrodden village in Uttar Pradesh, Shyamkali struggles with a culture that favors male children over female to the extent that the ratio of females to males in society is declining due to "female infanticide and feticide and the neglect of the wellbeing of daughters." And in the western highlands of Guatemala, Maria Estella lives in a landscape burgeoning with agricultural produce but in a subset of society that has always been condemned to malnutrition through poverty, disenfranchisement and ignorance: she and her fellow-mothers are astonished when taught how to cook a simple, nutritious potato soup.

Inspiration and heartbreak

Thurow's narrative accompanies these four women through the first 1,000 days of their children's lives, charting their progress with stories and insights that are inspiring and heartbreaking by turns. Nutrition education, breastfeeding, cookery classes, good hygiene and sanitary practices, and the consumption of nutrient-rich foods – all these measures can help, but the odds stacked against success are tragically high for the poorest of the poor.

This book details the struggle on the part of just four mothers to make the first 1,000 days work for their infant children, with the aid of people inspired by the Scaling Up Nutrition (SUN) movement, which has been pivotal in its promotion of the concept of the first 1,000 days. But 360,000 babies were born *each day* in 2011,[1] and that figure has increased since then with the constantly accelerating rise in the world's population. And as Thurow observes in his introduction, "Malnutrition has gone big, it has gone global. A stunted child in Africa is a stunted child everywhere."

The book ends on a questioning note. "As their 1,000 days came to an end, the moms in Shivgargh, Ongica, Chuicavioc, and Chicago looked upon their children and wondered how they would navigate the next years. Their dreams began in the 1,000 days but they had no end date … For as they grow, it will now be their challenge to finally break the generational cycle of malnutrition, stunting and inequality."

Essential reading for anyone who wants to know what really lies behind the disarmingly simple phrase: "the first 1,000 days."

Review by: *Jonathan Steffen*
Email: *jonathan.steffen@corporatestory.co.uk*

"The First Hundred Days" is available from PublicAffairs

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The SUN Movement
Page 45:
Alive & Thrive,
Le Huu Tho, 2013
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Claire Le Privé
Page 110:
Sophia Robele
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Nikhila Kalra
Page 116:
Sight and Life
Pages 127–130:
1,000 Days
Pages 132, 133:
Gretel Finch
Page 135:
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