Essential Nutrient Requirements not Met by Diets High in Staple Foods

Results from the Fill the Nutrient Gap Analysis in selected countries

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

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

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

Key messages

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

Introduction

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

Girl cooking tortillas on a stove in Peten, Guatemala

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

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

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

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

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

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

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

Fill the Nutrient Gap

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

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

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

Methods

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

© WFP | Shehzad Noorani

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

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

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

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

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

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

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

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

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

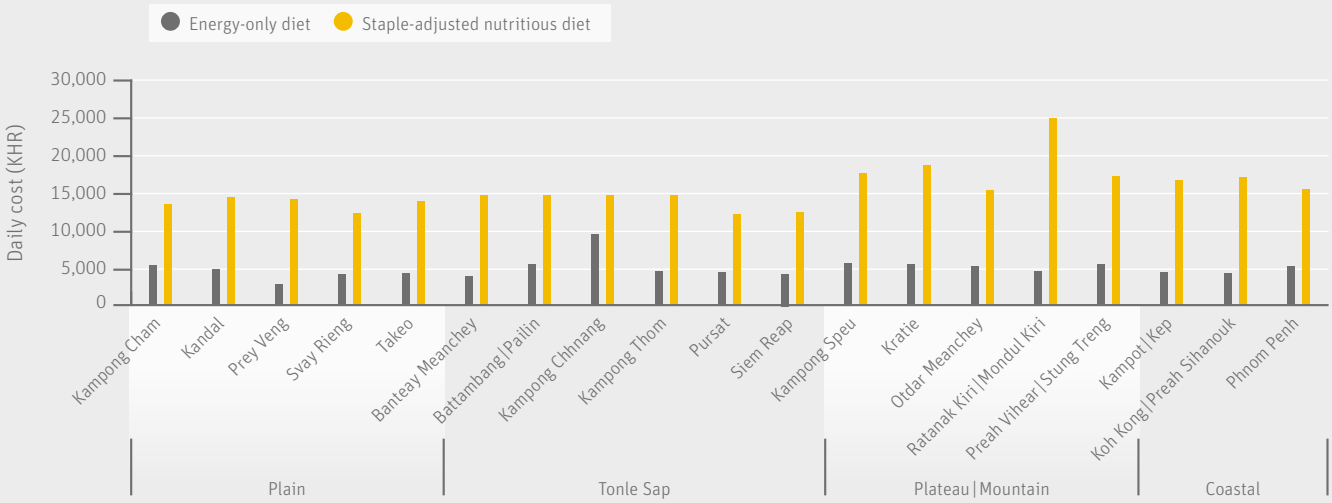
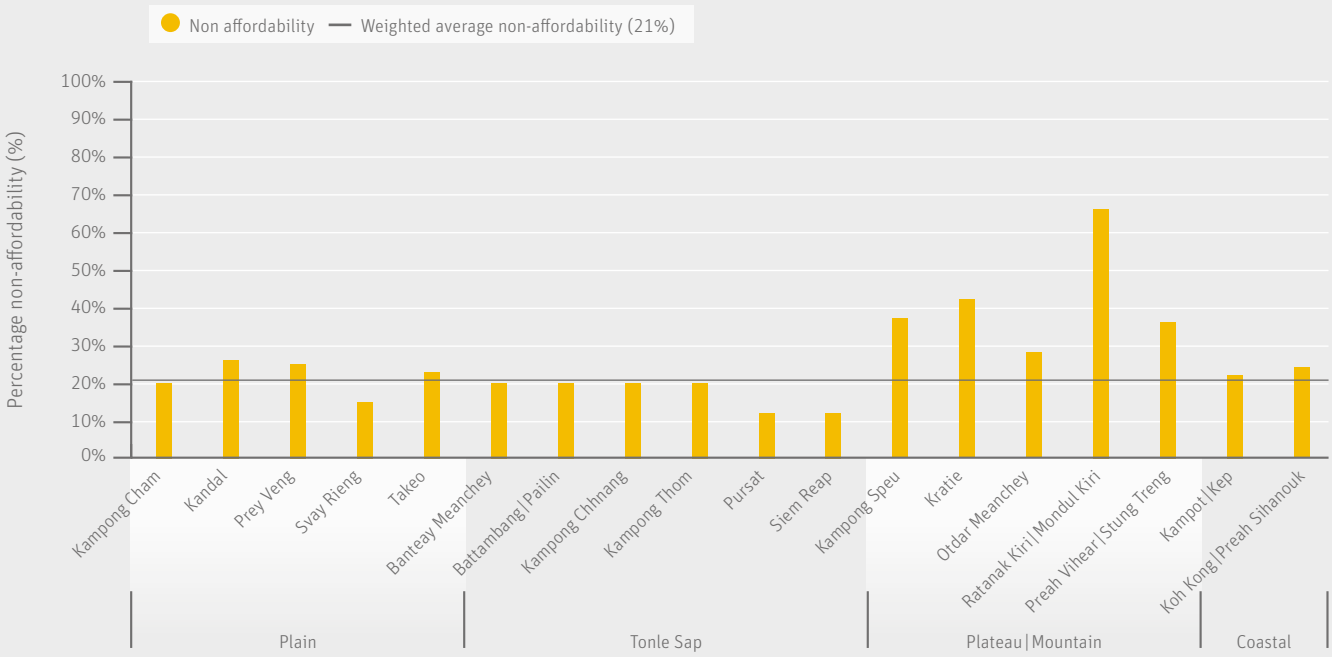


FIGURE 2: Percentage of households that could not afford the staple-adjusted nutritious diet against the weighted average of 21%. Phnom Penh was excluded as expenditure data was not available for this region.[22]



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

Findings

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

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

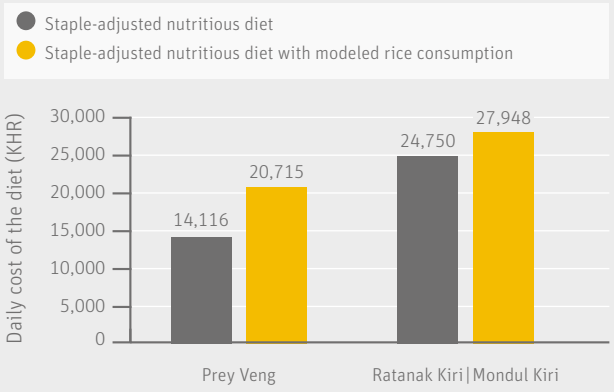


Figure 2 shows that when the cost of the staple-adjusted nutritious diet is compared to current food expenditure, an average of 21% of households would not be able to afford to purchase this diet. Non-affordability would range from 12% in rural Pursat and rural Svay Rieng to 66% in rural Ratanak Kiri/Mondul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

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

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

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

Discussion

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

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

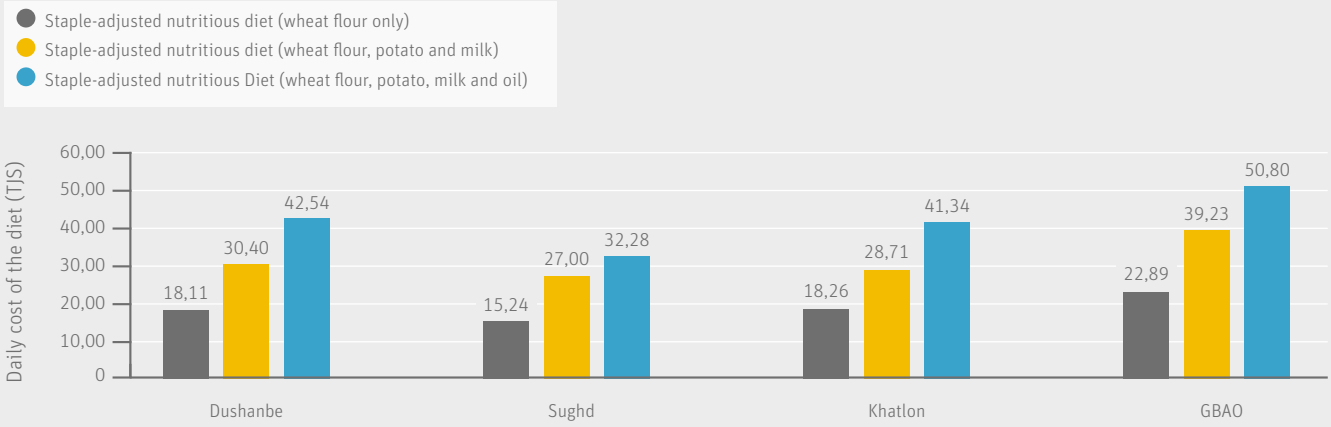
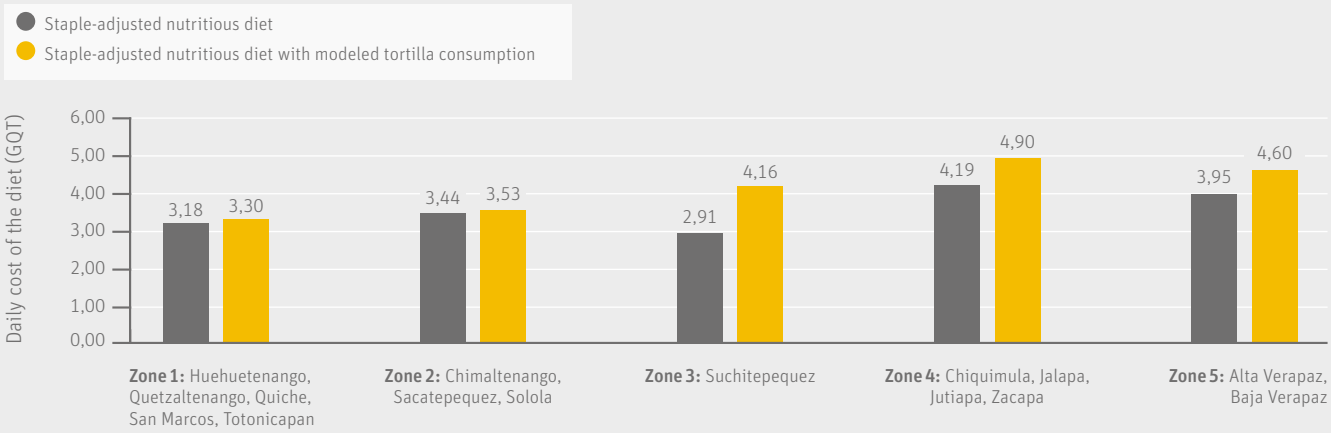


FIGURE 5: Daily cost in Guatemalan quetzal (GQT) of the staple-adjusted nutritious diet with and without the modeled tortilla consumption for a child aged 12–23 months, for five geographical zones of Guatemala[24]



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

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

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

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

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

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

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

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

Acknowledgements

The authors would like to thank the Council for Agricultural and Rural Development in Cambodia, the Ministry of Health and Social Protection Tajikistan and the Secretaría de Seguridad Alimentaria y Nutricional in Guatemala, Neil Mirochnick, Hanneke Vandyke, Francesca Erdelmann, Yav Long, Jonathan Rivers, Natalie West, Lina Badawy, Shamsiya Miralibekova, Andrea Berardo, Janne Utkilen, Heejin Kim, Zoirjon Sharipov, Mariko Kawabata, Paolo Mattei, Heather Kelahan, Katie Nelson, Jessica Fanzo, Glenn Denning, Maritza Oliva, Irma Chavarria, Melvin Alvarez, Eunice Lopez, Mario Touchette and Philippe-Serge Degernier for facilitating the Fill the Nutrient Gap analysis in Cambodia, Tajikistan and Guatemala, and for their technical guidance.

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

References

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

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

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

Notes on the text

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