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9

Cost and affordability of healthy diets across and within countries

Background paper for *The State of Food Security and Nutrition in the World 2020*

FAO AGRICULTURAL DEVELOPMENT ECONOMICS TECHNICAL STUDY

9

Cost and affordability of healthy diets across and within countries

Background paper for *The State of Food Security and Nutrition in the World 2020*

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Preface

This study aims to help bring affordability of healthy diets into focus for *The State of Food Security and Nutrition in the World 2020*. Policymakers around the world have long acknowledged that focusing on access to adequate calories, as reflected by the prevalence of undernourishment, is only one part of the information needed to assess food security. Beyond that perennial statistic, we need to know much more about access to healthy diets.

Food security, as defined by the Food and Agriculture Organization of the United Nations (FAO) in 1996, is "when all people, at all times, have physical and economic access to sufficient, safe, nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 1996). This definition embraces a vision of access to diverse, healthy diets. The recent global measurement of the Food Insecurity Experience Scale has broadened our understanding of the situation, by asking people directly about their experience. However, no analysis to date has focused on access to nutritious food that meets dietary needs.

This study and the metrics it provides are designed to answer the question: Can people actually access nutritious food to meet dietary needs? In other words, do their food environments provide nutrient adequate and healthy diets? More specifically, we ask: In any country, when people go to the market, can they find a diet that meets dietary recommendations? How much does it cost? Can people afford it?

Our findings highlight the high cost of healthy diets, which cost close to five times more than energy sufficient diets. Even nutrient adequate diets cost more than the international poverty line, without ensuring that recommended food group proportions are met. We find that in total, about 3 billion people can't afford the minimum cost of a healthy diet. There is a vast difference in cost between the type of diets people can afford, and the type of diets that will protect against malnutrition in all its forms and allow for a healthy and active life.

These results reveal that cost is an enormous barrier to the consumption of healthy diets. Nutrition education that encourages consumption of balanced, healthy diets, including those promoted in food-based dietary guidelines, cannot successfully lead people to consume diets that are out of reach.

Nearly 25 years after the FAO definition of food security was published, this report supports *The State of Food Security and Nutrition in the World* to include, for the first time, a metric squarely focused on access to nutritious food to meet dietary needs. Many actions are still needed to increase access to diverse, balanced diets to achieve our global shared vision of food security. This report lays bare the need to do so.

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Acronyms

AI	Adequate Intake
AMDR	Acceptable Macronutrient Distribution Range
AR	Average requirement
CBN	Cost of basic needs
CDRR	Chronic Disease Risk Reduction Intake
CoCA	Cost of Calorie Adequacy (energy sufficient diet)
CoNA	Cost of Nutrient Adequacy (nutrient adequate diet)
CoRD	Cost of Recommended Diet (healthy diet)
CoRD-FP	Cost of Recommended Diet (healthy diet) with food preferences
CPI	Consumer price index
DGLV	Dark green leafy vegetable
EAR	Estimated average requirement
EER	Estimated energy requirement
FAFH	Food away from home
FBDGs	Food-based dietary guidelines
H-AR	Harmonized average requirement
H-UL	Harmonized upper level of intake
IANDA	Indicators of Affordability of Nutritious Diets in Africa
ICP	International Comparison Program
IOM	Institute of Medicine (United States of America)
LCU	Local currency units
MAFAP	Monitoring and Analysing Food and Agricultural Policies (FAO)
MAR	Mean adequacy ratio
MIS	Market information systems
MoFA	Ministry of Food and Agriculture (Ghana)
MPLCS	Myanmar Poverty Living Conditions Survey
NPI	Nutritional Price Index
NRP	Nominal rate of protection
PPP	Purchasing power parity

RDA	Recommended dietary allowance
UL	Tolerable Upper Intake Level
UN	United Nations
VAM	Vulnerability Assessment and Mapping system (World Food Programme)
WHO	World Health Organization

Executive summary

Price and affordability are key barriers to accessing sufficient, safe, nutritious food to meet dietary needs and food preferences for an active and healthy life. In this study, we identify the least-cost items available in local markets to estimate the cost of three diet types: energy sufficient, nutrient adequate, and healthy (meeting food-based dietary guidelines). For price and availability we use the World Bank's International Comparison Program (ICP) dataset, which provides food prices in local currency units (LCU) for 680 foods and non-alcoholic beverages in 170 countries in 2017. In addition, country case studies use national food price datasets in United Republic of Tanzania, Malawi, Ethiopia, Ghana and Myanmar. In each case we match the available items with food composition data to find the least-cost sources of daily energy and nutrient adequacy, and match items to their food group for the least-cost sources of a healthy diet.

We find that the global average cost of meeting daily energy needs using the most affordable starchy staple at each time and place is USD 0.79 per day. The average cost of meeting all essential nutrient requirements using the most affordable foods is USD 2.33 per day, and the average cost of a healthy diet as defined by national food-based dietary guidelines is even higher. Using ten different definitions of a healthy diet published by United Nations (UN) Member States, the range of the cost of healthy diets globally is between USD 3.27 and USD 4.57 per day, with a point estimate based on median costs of USD 3.75.

The data reported here refer to the cost of purchasing the most affordable foods available in each country. Consideration of food preferences and the time required to obtain and prepare each food would raise daily costs, but our estimates provide a useful lower bound on the affordability of healthy diets in each country and for the world as a whole.

Our findings reveal that healthy diets *by any definition* are far more expensive than the entire international poverty line of USD 1.90, let alone the upper bound portion of the poverty line that can credibly be reserved for food of USD 1.20. The cost of healthy diets exceeds food expenditures in most countries in the Global South. These diets are unaffordable for over 57 percent of the population in sub-Saharan Africa and Southern Asia, as well as high proportions of people in South-eastern Asia (> 45 percent), Melanesia (> 40 percent) and Latin America (> 20 percent).

In all, we estimate that 3 billion people globally lack sufficient income to purchase the *least-cost* form of healthy diets recommended by national governments. The majority of these reside in Southern Asia (1.3 billion) and sub-Saharan Africa (829 million), with high numbers also in South-eastern Asia (326 million) and Eastern Asia (230 million). Our findings show that 186 million people, mostly concentrated in Africa (149 million), cannot afford the cheapest form of daily energy in their country, and 1.5 billion people cannot afford diets with adequate levels of all essential nutrients. These numbers are comparable to the estimated 812–822 million people counted by the FAO prevalence of undernourishment indicator, and the approximately 2 billion people who experience moderate or severe food insecurity as measured by the FAO Food Insecurity Experience Scale (FAO, IFAD, UNICEF, WFP and WHO, 2019).

Protein-rich foods including dairy, and fruits and vegetables, together make up more than 80 percent of the cost of healthy diets. Starchy staples and oils account for only 16 percent of that cost, while fruits and vegetables account for 40 percent, and dairy and other protein-rich foods combined account for 44 percent. These proportions vary somewhat by region, with dairy being notably more expensive in low-income countries.

Local prices vary significantly by region within countries, particularly for the most expensive and nutrient-rich foods such as highly perishable fruits, vegetables, and animal source foods. Country case studies in the United Republic of Tanzania and Malawi show that the cost of nutrient-rich foods is more variable subnationally and by season than calories or starchy staples. The Ethiopian case study shows that the cost of nutrient-dense food groups has risen faster over time than starchy staples and oils. And the Myanmar case study shows that the international standard method for calculating existing poverty lines is based on food baskets that are nutrient deficient and imbalanced in terms of food groups. Hence, we demonstrate the use of an alternative means of constructing a poverty line that would meet dietary needs.

The findings presented here imply that meeting international development goals for food and nutrition security would require: (a) lower prices for healthy, nutrient-rich foods including fruits and vegetables, and protein-rich foods including dairy; and (b) greater support for nutrition assistance and social safety net programmes. In addition, poverty lines may need to rise, as current international and national poverty lines are insufficient for the purchase of nutritious food to meet dietary needs. Existing food systems and assistance programmes do not enable all people to access even the least-cost versions of healthy diets which would meet dietary needs, and thereby do not fulfil longstanding aspirations for global food security.

Food-based dietary guidelines are official definitions of a healthy diet published by governments to serve their citizens. They aim to help people consume healthy diets that meet essential nutrient requirements and protect against diet-related non-communicable diseases through a diet that is balanced among food groups, and are widely used in health education and nutrition programmes throughout many countries. Our findings reveal that education and individual behaviour change would be insufficient to achieve these dietary objectives, because even the least expensive items from the required food groups are out of reach for low-income people. For people to choose healthy diets, prices of those diets need to decline, particularly from the most nutrient-rich food groups.

A variety of policy levers are needed to improve access to healthy diets. Our results show that the cost of either nutrient-adequate or healthy diets in the market is more than many people can afford; we do not account for food access via cultivation or wild harvesting. For people and places with sufficient local resources, production and harvesting of vegetables, legumes, fruits, dairy and eggs, fish and other foods can be important to provide access to nutrient adequate and healthy diets where the market does not. Agriculture and rural development should prioritize cost reductions for vegetables and fruits, and protein-rich foods including dairy. More broadly, reducing the year-round cost of acquiring sufficient quantities to meet dietary needs will require big changes in production and distribution. The public and private actions needed to lower costs will vary by location and type of food. Access to supplies from diverse sources within and between countries is also important to overcome local resource constraints and gain resilience to shocks at any one place. Finally, actions to improve storage and trade, combined with actions to improve production and distribution, can sustain a rapid shift in agriculture and food systems that bring healthy diets within reach.

1 Introduction

Price and affordability are key barriers to accessing sufficient, safe, nutritious food to meet dietary needs and food preferences for an active and healthy life. Previous literature (e.g. Drewnowski and Darmon, 2005; Chastre *et al.*, 2007; Masters *et al.*, 2018; Headey and Alderman, 2019) has shown clearly that more nutritious foods and diets cost more than basic staples and energy sufficient diets. For the poorest people, acquiring sufficient quantities of essential nutrients and nutritious food groups would consume a very large proportion of their total income, or even exceed it. In such situations, affordability imposes an insurmountable obstacle, so price and income constraints would need to be addressed before nutrition knowledge and behaviour change could be effective drivers of food choice.

1.1 Affordability of healthy diets as an aspect and indicator of food security

The longstanding, widely accepted definition of food security is "when all people, at all times, have physical and economic access to sufficient, safe, nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 1996). Economic access is measured here by affordability, defined as having enough income or other entitlement to obtain sufficient food at each time and place. Affordability of diets reflects food prices in comparison to an objective standard of income. We do not attempt to capture perceived affordability, which would encompass an individual's valuation of whether a product is worth its cost. Our results omit the time cost of acquiring and preparing food. Physical barriers can be very important for people with disabilities or other limits on access to the marketplaces where prices are measured. Likewise, social barriers may also be important where certain groups are prohibited from undertaking particular activities. All of these concerns ensure that affordability is a necessary but insufficient condition for food security, making our results a conservative lower bound on the gap between existing food systems and what would be needed to achieve global development goals.

Until now, a limitation in measuring food security has been that indicators of economic access to food have been limited to either income, or food price indexes that are defined in ways that do not clearly relate to healthy diets. This study provides new metrics for the cost and affordability of healthy diets, using newly available food price data to estimate economic access to adequate food at the population level. Economic barriers based on prices and income are not always the most important factor in food choice. Preferences, convenience and other aspects of the food environment also matter, and may be more significant factors to explain differences or changes in consumption patterns. Diet cost and affordability measure one specific dimension of food security which differs from what is measured in national food balance sheets or the prevalence of undernourishment, and also differs from what is reported in the Food Insecurity Experience Scale. The cost and affordability data reported here focus on diet quality, regarding sufficient quantities of nutritious foods for an active and healthy life. Measuring the cost and affordability of *safe* food would require other data regarding contaminant levels and associated disease burdens. We provide only one application of a metric aimed at meeting food preferences.

1.2 Affordability of diets goes beyond income and budget share

Income as such, without comparison to food prices and diet costs, has sometimes been used as a measure of food security. Other income-related metrics include budget shares that generally decline with higher income, such as the fraction of total expenditure spent on food (known as Engel's Law), and the fraction of food expenditure spent on starchy staples (known as Bennett's Law). The level of income and share of budget spent on food or starchy staples successfully capture one dimension of affordability, but does not identify how market prices for each type of food affect affordability. As shown in this study, the most affordable items needed for nutrient adequate and healthy diets differ greatly in market price around the world, ensuring that income alone cannot guarantee affordability of a nutritious or healthy diet.

This study focuses on affordability, and whether food systems bring healthy diets within reach of the poor. Which of the affordable items are actually chosen for consumption has been studied elsewhere, including by economists using demand systems to estimate the magnitude of change in household consumption or individual intake associated with changes in price or income. These demand elasticities vary greatly for different types of food and different aspects of diet quality.

Empirical evidence on how price and income affect diet quality is driven by the observation that total energy consumption (kcal/person/day) can fall sharply in famine situations, fluctuate seasonally, and vary with body size as well as physical activity levels; however, it is known to change very little in response to changes in food prices or incomes (Finaret and Masters, 2019). Behavioural responses to price and income changes typically concern diet composition, as people substitute among foods to meet their daily energy needs. The own- and cross-price elasticity of demand for any particular set of foods is a combination of substitution effects (for example, eating more potatoes when the price of rice increases) and income effects (for example, eating more preferred foods when the prices of all basic staples decrease). The income effect of price changes is particularly important for foods that occupy a large budget share among low-income people, as reducing their cost frees up resources to buy other foods.

Price elasticities of demand and substitution effects are larger within food groups than between them, and are larger for many nutrient-dense food groups than for basic staples (Green *et al.*, 2013; Cornelsen *et al.*, 2015). Many previous studies have used observed food choices to estimate demand systems, measuring a full set of own- and cross-price elasticities in response to observed changes in a given population. This work has shown that lowering prices of basic staples would have a much smaller impact on diet quality (via income effects and low cross-price elasticities) than lowering prices of nutrient-rich foods (via high own-price elasticities).

In summary, lowering food prices is not likely to affect demand for calories, but which food prices are lowered will have a large impact on consumption choices. That is, the cost of healthier foods specifically is important in understanding economic access to healthy diets.

Our focus in this study is on a) the number of people for whom healthier diets are out of reach, and b) the types of food that are most expensive, which makes healthy diets unaffordable in existing food systems around the world. Where and when prices are low enough for healthy diets to be affordable, then preferences become important and policy interventions can focus on other drivers of food choice such as nutrition knowledge, convenience and household decision-making, in addition to relative prices of food types.

1.3 Methods for measuring least-cost diets

In this study, we measure cost and affordability in terms of least-cost food baskets for three dietary standards: energy sufficient, nutrient adequate, and healthy in terms of meeting minimum quantities and proportionality among food groups.

Our estimates provide a conservative lower bound on the cost per day of meeting each dietary standard. Least-cost diets allow for substitution among locally available items, based on the most affordable combination of foods that meets each definition of diet quality. Most marketplaces offer a variety of items to meet other needs, such as taste and convenience, which consumers with higher incomes can afford to buy. Our aim is to measure the lowest cost at which a country's food systems deliver the calories and essential nutrients and food groups required for each dietary standard, so as to identify the income level required to afford that level of diet quality.

A key feature of the least-cost diets for each dietary standard is that the food items chosen may vary over time and place, drawing on locally available or seasonal items as needed to meet each dietary requirement. The least-cost energy sufficient diet substitutes among the starchy staples based only on the energy content of each food. The least-cost nutrient adequate diet recognizes substitution among alternative sources of each essential nutrient, for example allowing month-to-month variation in vitamin A sources when different fruits and vegetables are in season. For healthy diets, there is also similar substitution within each food group, as defined by dietary guidelines.

The least-cost diets used to measure affordability are based on food prices and availability in local markets, omitting information on the time cost of acquiring and preparing meals at home. Higher levels of convenience and desirability, beyond what is reflected in national dietary guidelines, would involve higher costs in money and time. By definition, the thresholds used for this study are lower bounds, describing cost and affordability for the least expensive of all available diets meeting each dietary standard. In most markets a wider range of more expensive foods are also available, offering additional attributes that some consumers are willing and able to acquire. Adding food preferences and convenience would raise the estimated costs of reaching each standard, and raise the number of people who cannot afford that level of diet quality.

In summary, our aims in this study are to quantify the cost of each diet, in absolute terms and compared to the poverty line and typical food expenditures as standards of affordability, and to quantify the number of people for whom even the cheapest nutritious or healthy diet available on local markets is out of reach. To accomplish these aims:

- Income in low- and middle-income countries is measured as total household expenditure, meaning the value of all goods and services reported to have been consumed. This includes the value of food consumed from own production, but typically excludes the value of time spent on household maintenance and childcare. In industrialized countries, income is more readily measured using reported wages, salaries and other earnings. For poverty and income distribution we use household surveys, and for a country's total income per person we use national accounts.
- Prices are measured at retail marketplaces, defined as the locations where people typically acquire their food. These locations range from open markets with multiple vendors to small neighbourhood shops and grocery stores of all sizes. Retail markets may offer thousands of distinct items at different prices that vary over time and space. To compare prices across and within countries, national statistical agencies identify representative items at widely used marketplaces, and observe their price at regular intervals. We use all prices reported by those national agencies, counting items with missing prices as not available (or equivalently, having an infinitely high price).

- Diets are defined in two ways: (1) in terms of their essential nutrients, meaning the food composition in terms of total energy from carbohydrates, protein and fats plus all known vitamins and minerals; (2) in terms of their food group classification in functional terms such as fruits and vegetables, nuts and seeds, dairy, etc. Each level of diet quality is defined in terms of different nutrient requirements or food group recommendations, as explained below.

1.4 Diet quality criteria: energy, nutrients and food groups

The cost and affordability analysis conducted for this study focuses on three levels of diet quality, defined successively in terms of energy sufficiency, nutrient adequacy, and overall balance in terms of food groups. By definition, none of these diets reflects current consumption patterns. They are benchmarks against which to compare incomes and current food expenditure, which may be inadequate for nutrition and health and in any case would be chosen based on other criteria such as cultural preferences, taste and convenience. Some ultrapoor people may consume diets that are similar to the least-cost energy sufficient diet, and preferences lead higher-income people to choose more nutritious foods, but many people consume too little of some types of food for their long-term health, while others consume more than they need.

The three types of diet referred to in this study are defined as follows:

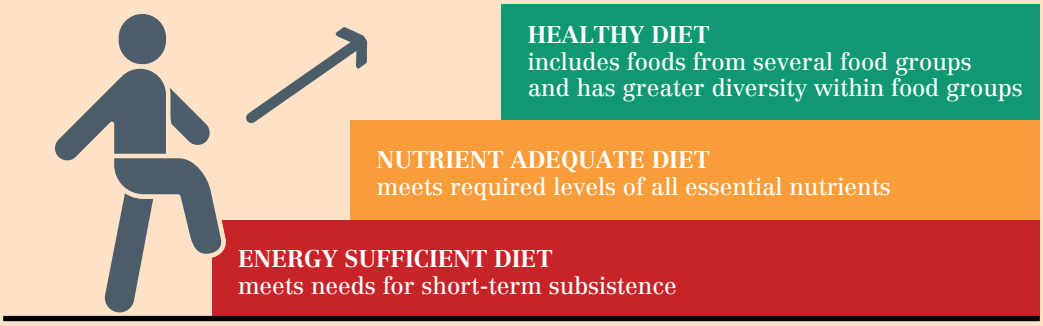
1. **"Energy sufficient" diets** provide adequate calories for energy balance at a given level of physical activity and body size, using only the least-cost starchy staple in each country. For example, such a diet could consist of only the lowest cost type of rice in that country, or only maize porridge.
2. **"Nutrient adequate" diets** provide not only adequate calories but also adequate levels of all essential nutrients – namely, carbohydrates, protein, fat, vitamins and minerals, within the upper and lower bounds needed to prevent deficiencies and avoid toxicity.
3. **"Healthy" diets** meet a set of dietary recommendations intended to provide nutrient adequacy and long-term health. There are many definitions of a "healthy" diet pattern at national, regional and global levels. In this case, we select the national food-based dietary guidelines (FBDGs) of several countries from diverse regions, in order to represent a range of dietary recommendations which have been articulated by UN Member States. Dietary patterns have been studied extensively in the nutrition epidemiology literature, relating specific foods and proportionality of different food groups to disease incidence and prevention. Nutrients alone do not explain the relationship of food to health, as there are many non-nutrient components of food, including but not limited to fibre, phytochemicals, the food matrix, and interactions between these. FBDGs focus on foods rather than nutrients, and typically concentrate on proportionality of food group intake. Furthermore, proportionality in food group intake ensures a culturally acceptable diet meeting at least a minimum standard for palatability and cultural norms, so the healthy diet is closer to actual food preferences, in terms of dietary pattern, than the energy sufficient or nutrient adequate diets.

A diet that meets calorie needs alone may be sufficient for short-term survival, but not long-term health or well-being. It does not meet the definition of food security: adequate food to meet dietary needs and food preferences for an active and healthy life. A nutrient adequate diet meets calorie and nutrient needs (defined by a specific standard for specific populations) but does not necessarily meet dietary guidelines (proportionality between food groups), and does not necessarily satisfy food preferences. Healthy diets are protective of long-term health, and FBDGs are also designed to meet general cultural food preferences. Thus, ensuring access to healthy diets meets the full UN definition of food security.

Figure 1 illustrates the conceptual foundation of our work, which is to measure how big of an increase in cost is needed to reach each level of diet quality. The height of each step in the figure is determined by global and local food systems that determine the price of locally available items needed to reach each dietary standard. Food systems differ in how steep this stairway of affordability is for each population, and in the degree of assistance provided along the way.

FIGURE 1 Three increasing levels of diet quality

THE STAIRWAY OF AFFORDABILITY, FROM SUBSTISTENCE TO HEALTH



Source: Authors' own elaboration.

1.5 Metrics for the cost of each diet

We use the following new metrics to measure the cost and affordability of the three diets:

- The Cost of Calorie Adequacy (CoCA) and Cost of Nutrient Adequacy (CoNA) are metrics of least-cost diets based on food composition and nutrient requirements. In terms of this study and the terminology we use, CoCA refers to the cost of an energy sufficient diet, and CoNA refers to the cost of a nutrient adequate diet.
- The Cost of Recommended Diet (CoRD) is a metric of a least-cost diet that meets food-based dietary guidelines, based on food group classifications. The Cost of Recommended Diet with Food Preferences (CoRD-FP) is a variant which is the cost of a diet meeting food-based dietary guidelines that accounts for local food preferences within groups. In terms of this study and the terminology we use, CoRD refers to the cost of a healthy diet, and CoRD-FP refers to the cost of a healthy diet with food preferences.
- The Nutritional Price Index (NPI) includes all foods from the country's consumer price index (CPI) but adjusts the weight on items in each food group to meet dietary guidelines, while preserving the relative quantities of items within each group. This is similar to the CoRD-FP, but expressed in price index terms.

Development of these metrics[1] was based on the observation that current food price measurements do not reflect foods or food baskets that would meet dietary needs. For many decades, food prices have been collected and reported to meet a variety of needs. For example, the FAO global food price index is designed to track the cost of the most widely traded agricultural commodities on international markets, categorized into five groups:

[1] The new metrics used to measure the cost and affordability of the three diets were created by projects led by Tufts University with funding from UKAid and the Bill & Melinda Gates Foundation.

grains, oils, meat, sugar and milk. Within countries, price reporting for agricultural market information systems (MIS) focuses on commodities of greatest interest to producers and traders, typically reporting farm-gate or wholesale prices of the most widely sold products. Rural consumer prices may be collected to guide nutrition assistance, for example through the USAID-funded Famine Early Warning System network (FEWS NET) and the World Food Programme's Vulnerability Assessment and Mapping system (VAM), and several of these sources have been combined in the FAO Global Information and Early Warning System on Food and Agriculture (GIEWS). However, these track prices for only a small number of items in each location, typically staple foods. While these systems collect copious amounts of food price data, the data has not yet been used to understand the cost of diets.

In principle, prices for the full range of foods consumed in each country are collected at nationally representative locations for each country's CPI to measure inflation and national poverty lines. Across countries, nationally representative prices for similar items are also reported every few years through the International Comparison Program (ICP) to compute national price levels, the purchasing power parity (PPP) exchange rates between currencies, and global poverty lines. Most of our analyses use prices collected for those purposes, applying nutritional criteria to compute diet costs rather than the observed expenditures used in standard price indexes.

Our metric of diet costs that most fully meets longstanding definitions of food security is the cost of a healthy diet (CoRD), because it is based on UN Member States' official characterization of dietary needs for healthy and active lives. The CoRD reflects preferences for balance between food groups, as the definition and quantities of foods in each group is included among the criteria used by national authorities in defining their dietary guidelines. Selecting the most affordable of the available items within each food group also reflects preferences within groups, but only to the extent that available items for which price is recorded in each dataset are actually purchased and consumed fairly commonly in that country. For diet costs that reflect observed preferences and other constraints on food choice, we introduce the healthy diet with food preferences (CoRD-FP) metric that reflects consumption patterns within each food group, in a given population[2] (Mahrt *et al.*, 2019). For example, in low-income countries the CoRD-FP will typically include less of all starchy staples than people actually consume (because people consume a higher share of dietary energy in starchy staples than recommended), but maintain the observed ratio among maize, rice and wheat. By definition, taking account of preferences in the CoRD-FP leads to a higher cost than the CoRD, which uses only the lowest-priced items within each group. In this study we calculate daily costs for energy sufficient (CoCA), nutrient adequate (CoNA) and healthy (CoRD) diets for all countries of the world. We also provide additional analyses and address within-country variation through thematic case studies. We cannot calculate the CoRD-FP for all countries because expenditure share weights are often not available, but we apply the method for the Myanmar case study (see footnote 1) as a demonstration of the price premium associated with maintaining observed consumption patterns of low-income households within each food group.

[2] In creating a CoRD-FP, one can select national average consumption patterns, or consumption patterns among a specific group, if sufficient household survey data are available. In the Myanmar country case study in this report, we demonstrate the use of the CoRD-FP for constructing a poverty line that would meet dietary needs, and adhere to the standard methodology in poverty line measurement by characterizing consumption patterns among the reference poor population.

2 Methods

KEY MESSAGES

- We calculate the most affordable combination of locally available items needed for an overall healthy diet at each time and place. This reveals food system performance in bringing the required mix of foods within reach of low-income people.
- For global comparisons, we use the World Bank's ICP dataset of national average prices for 2017 from 170 countries. For country studies, we use local data on spatial and temporal variation from national statistical agencies.
- We begin with the least-cost items for energy sufficient diets, then move on to the cost of nutrient adequate diets, staying within upper and lower bounds for 23 essential nutrients including acceptable macronutrient ranges. Finally, we consider the cost of a healthy diet, which delivers those nutrients through items selected from particular food groups in proportions specified by national food-based dietary guidelines or other reference diets.
- Using least-cost diets to measure food system performance brings together available data on food items' availability, price and nutrient composition at each time and place, for comparison to universal benchmarks of human needs. In combination with other kinds of data presented in *The State of Food Security and Nutrition in the World 2020*, the method described here provides actionable information to guide intervention towards global development goals.

2.1 Food price data

International Comparison Program food prices

To compare diet costs among all countries of the world we use retail prices reported by each national statistical agency through the International Comparison Program (ICP). The ICP, which is headquartered at the World Bank, works through regional bodies to obtain prices for standard items across multiple countries, for the purpose of computing PPP exchange rates. For this study we use ICP prices from 2017, the latest available round, published in May 2020. These data provide an annual average, nationally representative price in local currency units (LCU) for 680 foods and non-alcoholic beverages in 170 countries. We excluded items that were non-caloric, ingredients, condiments, baby food, and items of an unclear composition; these exclusions resulted in a final dataset of 552 items for the cost of diet analysis. Prices were converted to United States dollars at 2011 PPP exchange rates for comparison with the existing global poverty lines, because updated 2017 PPP levels were not yet available at the time of writing. The individual item prices in ICP data are used by permission and available to other researchers on request (details here: www.worldbank.org/en/programs/icp).

National sources for within-country variation in food prices

For country case studies of variation within United Republic of Tanzania, Malawi and Ethiopia, we use price data collected by national statistical agencies for their official CPI. In the United Republic of Tanzania, the dataset covers 21 regions and 71 food items between 2011 and 2015. In Malawi, the monthly prices of 55 food items were collected from 29 market locations between 2007 and 2016. In Ethiopia, the data cover 97 food items collected from 120 markets from 2002 to 2016. Food prices in Ghana are from the Ministry of Food and Agriculture's monitoring information system, which covers all ten regions in Ghana and 74 items between 2017 and 2019. Food prices in Myanmar are derived from the 2015 Myanmar Poverty Living Conditions Survey (MPLCS), a nationally representative survey of 3 648 households implemented by the Government of Myanmar and the World Bank with the purpose of monitoring socio-economic conditions. The survey collects data on 152 food items consumed in the past seven days.

2.2 Nutritional criteria for diet quality

The quantities of each food required to meet each standard of diet quality are based on nutritional criteria from sources detailed below. For energy sufficient and nutrient adequate diets, these refer to the needs of a representative adult woman, not pregnant or lactating. To calculate the estimated energy requirement (EER) of people in this reference group, we use median heights and weights (163 cm and 57 kg) of the World Health Organization (WHO) reference population at 30 years of age (Schneider and Herforth, 2020), and we assume an "active" physical activity level which is recommended by the Institute of Medicine of the United States of America for maintaining energy balance (IOM, 2006).[3] This leads to an EER of 2 329 kcal per day, which is used in all three diets (energy sufficient, nutrient adequate, healthy). For the nutrient adequate diet, requirements for other essential nutrients as detailed below are also specific to adult women; for the healthy diet, requirements for balanced intake across food groups is generally applicable to the population as a whole.

To calculate energy and nutrient requirements we use the WHO reference population's median woman of reproductive age, for two reasons. First, their requirements fall roughly at the median of the entire population distribution, in the sense that least-cost diets to meet energy and nutrient requirements for people in this reference group are approximately the median level of least costs for all sex-age groups over the entire life cycle (Bai, Herforth and Masters, forthcoming). This reference group is therefore a good representation of the population as a whole. Second, women of reproductive age are typically a nutritionally vulnerable population group, as seen in their increased risk of dietary inadequacies (due to social practices and norms that often disadvantage them in terms of access to food), which have important consequences for themselves and their children. Previous studies have also based their analyses on this reference group (Masters *et al.*, 2018; Hirvonen *et al.*, 2019).

[3] "An average of 60 minutes per day of moderately intense physical activity (e.g. brisk walking or jogging at 3–4 mph) or shorter periods of more vigorous exertion (e.g. jogging for 30 minutes at 5.5 mph), in addition to activities identified with a sedentary lifestyle, was associated with a normal BMI range and is the amount of physical activity recommended for normal-weight adults." (IOM, 2006, p. 94).

2.3 Cost of diet indicators

Cost of an energy sufficient diet

The cost of an energy sufficient diet (CoCA) is defined as the minimum cost to meet energy requirements using the least-cost available starchy staple food in each country. As detailed above, the energy requirement we use for all indicators in this study is 2 329 kcal.

Cost of a nutrient adequate diet

The cost of a nutrient adequate diet (CoNA) is defined as the lowest-cost set of items available at each time and place that would stay within the lower and upper bounds for dietary energy and all essential nutrients. Operationally, the CoNA is measured as the minimum cost to meet EER and relevant daily nutrient reference values of 23 macro- and micronutrients for a representative person in a reference population. We apply global harmonized average requirements (H-ARs), which are the levels of nutrients that meet the needs of 50 percent of the healthy population of each age and sex; harmonized upper levels of intake (H-ULs), the highest level likely to avoid risk of adverse health effects (Allen, Carriquiry and Murphy, 2019); and the Chronic Disease Risk Reduction Intake (CDRR) for sodium (National Academies, 2019; Schneider and Herforth, 2020). To calculate the CoNA, a linear program selects foods to provide nutrient content above the H-ARs and below the H-ULs and the CDRR for sodium, while specifying that the macronutrient intakes are within the Acceptable Macronutrient Distribution Range (AMDR) set by the Institute of Medicine (IOM, 2006), and meeting the energy content of exactly 2 329 kcal. These requirements are detailed in Table 1.

The CoNA is the daily cost of meeting all requirements listed in Table 1 using the most affordable combination of foods available at a given time and place. The foods in the CoNA offer the lowest-cost way to meet all known energy, macronutrient and micronutrient needs. Each AR is defined as the level of usual intake needed to avoid deficiency diseases for the median person in an otherwise healthy population. Thus, for half of that population, requirements are lower so the true CoNA would be lower; likewise, for the other half, requirements are higher so the true CoNA would be higher. For people who are less physically active, energy requirements and diet costs are lower, and for people who are more physically active, energy needs and diet costs are higher. The aim of the requirement levels listed in Table 1 is to provide the best estimate of the average cost of meeting energy, macro- and micronutrient needs within the population.

In a sensitivity analysis, we calculate the CoNA using the IOM recommended dietary allowances (RDAs), or Adequate Intakes (AIs) if the latter is not larger than the H-ARs, in order to determine the CoNA that would cover 97.5 percent of nutrient needs of the population.

TABLE 1 Nutrient reference values for a representative adult woman

	Nutrient	Unit	ARs	RDAs or AIs*	AMDR lower	AMDR upper	UL
1	Energy	kcal	2 329	2 329			
2	Protein	g	37.6	46.0	58.2	203.8	
3	Lipids	g			51.8	90.6	
4	Carbohydrates	g			262.0	378.5	
5	Calcium	mg	750	1 000			2 500
6	Iron[2]	mg	22.4, 11.2	22.4, 18			45
7	Magnesium[1]	mg	265	310			350
8	Phosphorous	mg	580	700			4 000
9	Zinc[b,3]	mg	8.9	10.2			25
10	Copper	mg	0.7	0.9			5
11	Selenium	mcg	45	55			300
12	Vitamin C[c]	mg	80	80			2 000
13	Thiamin	mg	0.9	1.1			
14	Riboflavin[c]	mg	1.3	1.3			
15	Niacin[1]	mg	11	14			35
16	Vitamin B6[c]	mg	1.3	1.3			25
17	Folate[1]	mcg	250	400			1 000
18	Vitamin B12	mcg	2.0	2.4			
19	Vitamin A[4]	mcg	490	700			3 000
20	Vitamin E	mg	12	15			300
21	Sodium	mg					2 300
22	Vitamin B5[a]	mg	4.0	5.0			
23	Choline[a]	mg	320	425			3 500
24	Manganese[a,c]	mg	2.4	2.4			11

Notes: Values shown are for a 30-year-old, non-pregnant, non-lactating woman. Average requirements (ARs) and Tolerable Upper Intake Levels (ULs) are taken from Allen, Carriquiry and Murphy (2019). *The values in this column are recommended dietary allowances (RDAs – IOM) except where noted:
a. The value is an adequate intake (AI) value.
b. The value for zinc takes the assumption of an undefined diet.
c. The same values are used for both AR and RDA because the RDA/AI is not larger than the harmonized average requirements (H-ARs).
1. The upper levels only refer to the supplement intakes, and therefore are not considered in the CoNA calculation.
2. The H-AR of iron takes the assumption of a low-absorption diet for the AR value for the CoNA, and a moderate-absorption diet for assessing nutrient content of the CoRD.
3. The H-AR of zinc takes the assumption of a semi-undefined diet for the AR value.
4. The upper level of vitamin A refers to the intake of retinol.

Source: Authors' own elaboration.

Cost of a healthy diet

The cost of a healthy diet (CoRD) is defined as the lowest-cost set of items available at each time and place that would meet requirements for each food group specified in food-based dietary guidelines (FBDGs). The CoRD can use any quantitative dietary standard, such as the dietary guidelines issued by national governments and public health agencies. Such guidelines provide expected quantities with upper and lower limits for the number of servings and size of each serving from various food groups.

To meet each guideline's requirements for dietary diversity within and across food groups, the CoRD method selects the two cheapest items for starchy staples, protein-rich foods (however defined), and fruits; the three cheapest items for vegetables (to meet minimum diversity criteria articulated by some guidelines, and sometimes necessitating subgroup inclusion, e.g. for dark green leafy vegetables [DGLVs]); and the one cheapest item for oils and dairy, respectively. This method thus selects 11–13 individual food items specific to each country to satisfy most FBDGs. This is aligned with the number of foods generally recommended in guidelines; for example, China's FBDG explicitly aim for 12 different individual foods or more in a day (Wang *et al.*, 2016). The reason we choose more than one cheapest food for most groups is indeed to meet the general "variety" requirement of FBDGs. By definition all food items in the ICP list for a country are culturally acceptable, because they are identified as having a significant level of expenditure share.

In this study, for each country, ten different definitions of a healthy diet are applied, because there is no single definitive definition of a healthy diet. The definitions we use are based on a range of FBDGs). We use several quantitative definitions from UN Member States in diverse regions in this sensitivity analysis, and take the median and range of cost in each country.

It is important to note that our purpose is to estimate the cost of healthy diets, not to recommend what people should eat in any country. In order to find the range and best estimate of what it would cost to eat a healthy diet, we apply a range of healthy diet definitions, through recent, quantifiable FBDGs in diverse regions throughout the world. We choose a range of FBDGs so that no one region would be more heavily weighted in the range and point estimate of what it costs to consume a healthy diet.

Selection and quantification of FBDGs

Over 90 countries have national FBDG, most published within the last 20 years. Each FBDG includes a variety of key messages and visual representations. A global review of FBDGs has highlighted the similarities and differences of these guidelines (Herforth *et al.*, 2019). The review found that all FBDGs discuss proportionality and include a recommendation to consume abundant fruits and vegetables, and almost all include recommendations to limit sugar, fat and salt consumption. There is less convergence among FBDGs in other areas, including whether to make dairy a separate category (as it is in 64 percent of countries), and in the guidance on red meat, fats and oils, and nuts (Herforth *et al.*, 2019). Not all guidelines are quantitative; for example, Sweden's guidelines focus on a short list of food types to eat more or less of, and Brazil's guidelines focus on consuming minimally processed foods and enjoying food. Of those guidelines that appear quantifiable, there is a range of quantifiability: some are missing critical information for one or more food groups, such as a definition of serving size.

We selected a purposive sample of FBDGs to include a set of recent, fully quantifiable FBDG from diverse regions globally. Country FBDGs were selected for having the most clearly quantifiable guidelines within each region, and for recency of publication (within the last ten years). In Asia and the Pacific, three countries were selected: one from Eastern Asia (China), one from Southern Asia (India), and one from South-eastern Asia (Viet Nam), due to

different diet patterns. In Europe, two were selected: one from Southern Europe (Malta) and one from Western Europe (Netherlands). In Latin America and the Caribbean, two countries were selected: one from Latin America (Argentina), and one from the Caribbean (Jamaica). Each FBDG was downloaded from the FAO FBDG repository (FAO, 2020b). For Viet Nam, the current FBDG is unavailable on the FAO repository and was obtained via personal communication with one of the people involved in its development (Annex 1). These ten FBDGs are not the only quantifiable FBDGs; we chose a purposive sample in order to prioritize more recent guidance, because newer guidelines are more likely to incorporate newer evidence on diet-health relationships; and in order to choose diets from a sample of countries representing the majority of the global population (Table 2). Averaging all quantifiable FBDGs would have resulted in overemphasis of guidance and diet patterns from Europe and from Latin America and the Caribbean, where most countries have national FBDG, and underemphasis of regions with few quantifiable FBDGs. Most notably, at the time of writing this study, Africa has only one country with a quantified FBDG.

TABLE 2 Regions and populations represented by each FBDG

FAO subregion	Subregion % of global population	FBDG country	Year FBDG published	Rationales for inclusion
Southern Asia	24	India	2011	Most populous country.
Eastern Asia	23	China	2016	Most recent and most populous country.
Sub-Saharan Africa	12	Benin	2015	Most recent, only quantitative choice.
Europe*	11	Netherlands, Malta	2015	Netherlands: most recent quantitative choice available at time of writing, and incorporates sustainability considerations; Malta 2015 (Southern Europe) is equally recent, included to represent a distinct (Mediterranean) diet pattern.
South-eastern Asia	9	Viet Nam	2019	Most recent and clearly quantified.
Latin America and the Caribbean	8	Argentina, Jamaica	2015	Most recent, quantitative; two chosen to represent Latin America and the Caribbean, including one Small Island Developing State.
Western Asia and Northern Africa*	6	Oman	2009	Most recent quantitative choice available at time of writing.
Northern America	5	USA	2015	Only quantitative choice, most populous country.

Notes: * Subregions below 5 percent of the global population are combined into a macroregion. Subregions with less than 1 percent of world population are not represented, including Central Asia (0.4 percent of world population), Melanesia (0.01 percent), and Australia and New Zealand (0.4 percent).

Source: Authors' own elaboration.

Across the ten national FBDGs listed in Table 2, there are broad similarities in food groupings:

- Six guidelines use exactly the same six food groupings (starchy staples, protein-rich foods including legumes/flesh/eggs, dairy, vegetables, fruits, and fats/oils); (two in Asia, one in Europe, one in Africa, one in Northern America).
- Two use the same food groupings, except that legumes are grouped with starchy staples instead of protein-rich foods (one in Asia, one in Latin America and the Caribbean).
- One (in Europe) uses the same food groupings, except that nuts are an additional food group recommended daily.
- One (in Western Asia and Northern Africa) uses the same food groupings, except that legumes and flesh/eggs are both required subgroups of the protein category.
- One (in Latin America and the Caribbean) uses the same food groupings, except that dairy and flesh/eggs are grouped together, and legumes are a separate required group.

In contrast to these national FBDGs, the EAT-Lancet reference diet (Willett *et al.*, 2019) has 12 food groups (including requirements for an exact amount of consumption of red meat, poultry, fish, eggs, legumes, and starchy roots; food groups vary within four diet patterns). In most cases the least-cost EAT-Lancet diet pattern is vegan. The EAT-Lancet diet was formulated expressly for both health and environmental impact, while most FBDGs do not yet incorporate environmental sustainability (the exception being the FBDG from Netherlands).

The groupings in these ten FBDGs represent only some of the possible ways foods can be grouped, primarily based on how foods are used culinarily. Globally, approximately half of FBDGs use six food groups; other food groupings are reviewed in Herforth *et al.*, 2019 and van't Erve *et al.*, 2017. The specifications of each FBDG are shown in Annex 1.

The ten national dietary guidelines used for this study were quantified based on the units of measurement shown in Table 3. Where recommended quantities were stated in terms of weight or volume, prices were adjusted to correct for the water added to cooked foods (for example, boiled rice or pasta) or the water removed from dehydrated foods (for example, dried fruits and powdered milk).

TABLE 3 Units of measure used for food-based dietary guidelines, by country (plus EAT-Lancet diet)

Country	Units of measure for each food group
Jamaica, Argentina, EAT-Lancet	Kilocalories
India	Grams
Viet Nam	Grams of macronutrients (carbohydrates, protein, lipids), mg of calcium
Benin, Malta, USA, China, Oman, Netherlands	Servings (variously defined)

Source: Authors' own elaboration.

The number of grams, calories or servings is typically given as a range. We take the mean of that range to calculate the cost of a healthy diet, unless servings are specified for an active female (as in India) or a specific calorie target equal to approximately 2 300 (as in the United States of America and Oman).

Dataset preparation

Each unique food in the ICP dataset was classified into food categories according to each of the ten FBDGs. Broadly, these categories included: starchy staples, protein-rich foods (flesh foods, fish, seafood, and sometimes including legumes, eggs, nuts, and dairy), dairy (sometimes including soy, small fish and crustaceans), fruits, vegetables, and fats. In addition to the above-mentioned exclusions (mixed foods/dishes, infant foods, alcoholic beverages, non-caloric items, ingredients, and foods with unclear food composition information), we excluded foods that were expressly not recommended (trans fats, processed meats) and one food for which there was no guidance regarding inclusion or recommended amount (tomato paste). We used country-specific recommended amounts of each food group, and country-specific inclusion/exclusion criteria for foods (e.g. fruit juice is included in three countries, excluded in seven). Each unique food in the ICP dataset was also matched to food composition information for edible portion, energy, protein, carbohydrates, lipids and calcium. Price per gram edible portion and price per calorie edible portion were calculated for each food item.

Food selection

The items selected for the least-cost healthy diet food basket in each country are the most affordable items that meet the requirements of each FBDG. The FBDGs from Jamaica and Argentina as well as EAT-Lancet reference diets specify quantities in calories, so the items selected are those with the lowest price per calorie. The FBDG from India is specified in terms of grams, so the items selected have the lowest price per gram. In Viet Nam, the target quantities for several food groups are based on their macronutrient composition: i.e. the requirement for starchy staples is given in terms of carbohydrates; protein-rich foods in terms of protein; fats in terms of lipids; and dairy in terms of calcium. Fruits and vegetable requirements are specified in terms of grams. The FBDGs from Benin, Malta, United States of America, China, Oman and the Netherlands describe requirements in terms of servings, using specific examples (e.g. grams of rice). Because the examples did not cover all food items in the food group, finding equivalent amounts for each food item required an additional step. First, we found the relevant macronutrient content of the quantified examples: carbohydrates for starchy staples, protein for protein-rich foods, lipids for fats, and calcium for dairy (e.g. grams of carbohydrates in 90 g of rice). Next, we calculated the mean macronutrient amount across the food examples specified. Finally, we specified the target amount of each food item as the amount containing the mean macronutrient amount relevant to each food group. Fruits and vegetable requirements are specified in terms of grams.

FBDGs require diversity, which is particularly emphasized for some food groups, generally those required in greater quantities. China's FBDG specifies that at least 12 food items should be consumed each day (Wang *et al.*, 2016). We operationalized guidance on diversity by specifying a number of food items from each food group, as shown in Table 4, and including equal amounts of each item within a food group.

Finally, to ensure isocaloric comparability across all FBDGs, the healthy diet basket as a whole was scaled to 2 329 kcal, based on the energy requirements of a 30-year old active woman, consistent with the energy sufficient and nutrient adequate diets. For FBDGs that include an allowance for discretionary foods or free sugars, these were included in the final diet but not scaled, as the language of the FBDG indicates that the amounts of these foods are a maximum not to be exceeded. For all other items, scaling preserves the proportions between foods. In some cases, as suggested in India's FBDG and also the EAT-Lancet reference diets, variation in total energy needs could be met through variation in starchy staple consumption without scaling the other food groups, but FBDGs from

the United States of America and Oman indicate proportional scaling across food groups, and other FBDGs are not explicit on how to scale to different calorie needs. Neither method (only starches, or all groups proportionally) is perfect, but we chose to scale proportionally, because distorting the proportionality of FBDGs (by scaling starches more than other food groups) is a larger problem than increasing the nutrient-rich food groups only slightly more than necessary. Proportionality is a very important aspect of FBDGs, so it is important to maintain proportionality when (as in most cases) guidelines are not explicit about how to scale calories otherwise.

◆ TABLE 4 Number of items required in healthy diet baskets, by food group

Food group	Number of items	Notes
Starchy staples	2	In USA and Oman, at least one starchy staple must be whole grain.
Legumes/ flesh/eggs	2	
Dairy	1	
Vegetables	3	In India and Benin, one vegetable is a dark green leafy vegetable (DGLV). In USA, at least one vegetable is a DGLV *or* red/orange.
Fruits	2	
Oils/fat	1	
Discretionary foods	1	Only included in Argentina, USA and EAT-Lancet diet.

Source: Authors' own elaboration.

Cost of a healthy diet extension: food preferences

A useful variant of the cost of a healthy diet (CoRD) retains the observed dietary patterns of the population and scales each food group as a whole to meet FBDGs. This healthy diet with food preferences metric (CoRD-FP) was first applied to the case of Myanmar (Mahrt *et al.*, 2019). It tracks the cost of meeting each FBDG with the recommended quantity of each food group, using products purchased by the population of interest in their observed proportions within each group. That mix of foods has a higher monetary cost than the CoRD, but reflects other influences on food choice that may include culinary practices, taste and convenience, or the time required to prepare each meal. The CoRD retains only the two least-cost items in equal quantity, whereas the CoRD-FP retains items in the observed dataset in the observed ratio to each other. For food groups such as starchy staples where observed consumption exceeds dietary guidelines, all observed items are scaled down by the same proportion, while items in other groups where observed consumption does not meet guidelines, such as fruits and vegetables, are scaled up.

In the Myanmar case, the CoRD-FP was constructed directly from household survey data, which shows how the ratio among items within each food group differs among households. In some applications, it might be appropriate to remove households in upper expenditure quintiles or non-poor households when estimating food consumption patterns.

Cost of a healthy diet extension: Nutritional Price Index

Following the logic of the CoRD-FP, the Nutritional Price Index (NPI) is designed to monitor changes in the cost of a healthy diet while capturing food preferences. It is designed to be an indicator monitored in parallel with the food CPI, which monitors changes in the cost of a typically purchased food basket, each food item weighted according to expenditure share. Using the CPI food list, we assign a predetermined weight to each food group aligned with a selected FBDG to ensure proportionality, and then use the relative CPI weight for each food item within the group to capture food preferences. Weights of discretionary foods not recommended in the FBDG (such as sugar-sweetened beverages) become zero, and weights for all vegetables typically increase, each item in proportion to its expenditure share. To weight each food group, we assign 50 percent share to fruits (20 percent) and vegetables (30 percent), and weight starches, proteins, fats and dairy by calorie share of the remainder. This is the approach to proportionality taken within the EAT-Lancet reference diet (Willett *et al.*, 2019). By definition, the NPI, like any CPI, tracks only the percentage change or difference in diet costs. To address questions of affordability, we compare the CoCA, CoNA and CoRD metrics of diet cost per person each day.

2.4 Affordability indicators

To determine affordability, diet costs need to be compared to a standard of income or expenditures. In this study, we use two standards for the global analysis:

1. Affordability indicator 1: We compare the cost of the diets to 63 percent of the international poverty line of USD 1.90 a day, which is equal to USD 1.20. We use 63 percent as the estimated proportion of expenditures on food, because it is the mean proportion of expenditures on food among the bottom consumer segment in low-income countries (calculated from the World Bank Global Consumption Database [World Bank, 2020]).
2. Affordability indicator 2: We compare the cost of the diets to typical daily food expenditures in each country. The source of national average food expenditures per capita used in affordability indicator 2 is from the ICP.
3. Affordability indicator 3: We also calculate the percent of people in each country who would not be able to afford a given diet using the World Bank PovcalNet online tool, based on the estimated 2018 income distributions across 164 countries.[4] All data from PovcalNet is in 2011 PPP. We adjust 2017 PPP costs to 2011 PPP for PovcalNet calculations, using American CPI inflation for each year between 2012 and 2017 (FRED, 2020). In the main results, we calculate this number and percent based on 63 percent of income, which is the proportion of expenditures on food by the bottom consumer segment in low-income countries (calculated from the World Bank Global Consumption Database). We apply this percentage as an estimate of the proportion of expenditures that could possibly be spent on food by the poor globally. In the main results, we show the proportion of the total population of each region, and proportion of the total population of the world, who cannot afford the diets.[5] In Annex 3, we provide the average percent who cannot afford the diets across countries, regionally and globally. In Annex 4, we show a lower-bound estimation of the number of people who cannot afford the diets, calculated assuming 100 percent of income spent on food; that is, the lower bound is the percent of people who have total daily income lower than the cost of the diet. The upper bound counts those for whom

[4] 2018 income distributions are used because those for 2017 are not available. In one country, India, we apply the 2015 income distribution, which is the most recent available.

[5] Population data are from the World Bank World Development Indicators; food expenditure data are from national accounts.

the cost of diet exceeds the mean proportion of expenditures on food, by national income level classification: food expenditures account for 15 percent, 28 percent, 42 percent, and 50 percent of expenditures on average in high-, upper-middle-, lower-middle- and low-income countries, respectively[6] (see Annex 4).

4. Affordability indicator 4: To find the number of people who cannot afford a given diet, we used affordability indicator 3 multiplied by the 2017 population in each country. We show the lower-bound estimation in the main section, and the upper-bound estimation in Annex 4. Population data are from the World Bank World Development Indicators; food expenditure data are from national accounts.

Additionally, in one of the country case studies (Ethiopia), we compare the cost of diets to rural wages. This was also done in an analysis in India by Raghunathan, Headey and Herforth, 2020.

This study uses complete data on cost of energy sufficient, nutrient adequate and healthy diets available for 170 countries. Affordability indicators 1 and 2 are available for all 170 countries; affordability indicators 3 and 4 are available for 143 countries.

A limitation of the ICP dataset is that it does not include prices on all relevant foods, many of which might be cheaper than the ones in the dataset (such as certain vegetables that are typically harvested and consumed locally, and not common across countries).

[6] The median food expenditure shares are 14 percent, 25 percent, 41 percent and 51 percent for the four income levels, which are quite close to the mean.

3 Results: Global analysis

KEY MESSAGES

- The range of the minimum cost of healthy diets globally is between USD 3.27 and USD 4.57 per day, with a point estimate of USD 3.75 as the global median among 170 countries.
- There are multiple definitions of a healthy diet; in each country we calculated the cost of ten different definitions of a healthy diet published by UN Member States, to find a range of the cost of healthy diets, and a median point estimate. In addition, we calculated the cost of the EAT-Lancet reference diet patterns in each country.
- Healthy diets *by any definition* are far more expensive than the entire international poverty line of USD 1.90, let alone the upper-bound portion of the poverty line of USD 1.20 that can credibly be reserved for food.
- The cost of healthy diets is nearly five times as expensive as the cost of energy sufficient diets.
- In all, we estimate that 3 billion people globally cannot afford the *least-cost* form of healthy diets. Moreover, 1.5 billion people cannot afford a nutrient adequate diet. The majority live in Southern Asia and sub-Saharan Africa.

The global average cost of meeting calorie needs using the most affordable starchy staple at each time and place is USD 0.79, while the average cost of meeting all nutrient needs is USD 2.33.[7] Looking across different regions, the median cost of a nutrient adequate diet is 2–5 times more expensive than that of an energy sufficient diet, and the cost of healthy diets is 1.5–2 times more expensive than the least-cost nutrient adequate diet, and 3–8 times more expensive than the least-cost energy sufficient diet (Figures 2 and 3).

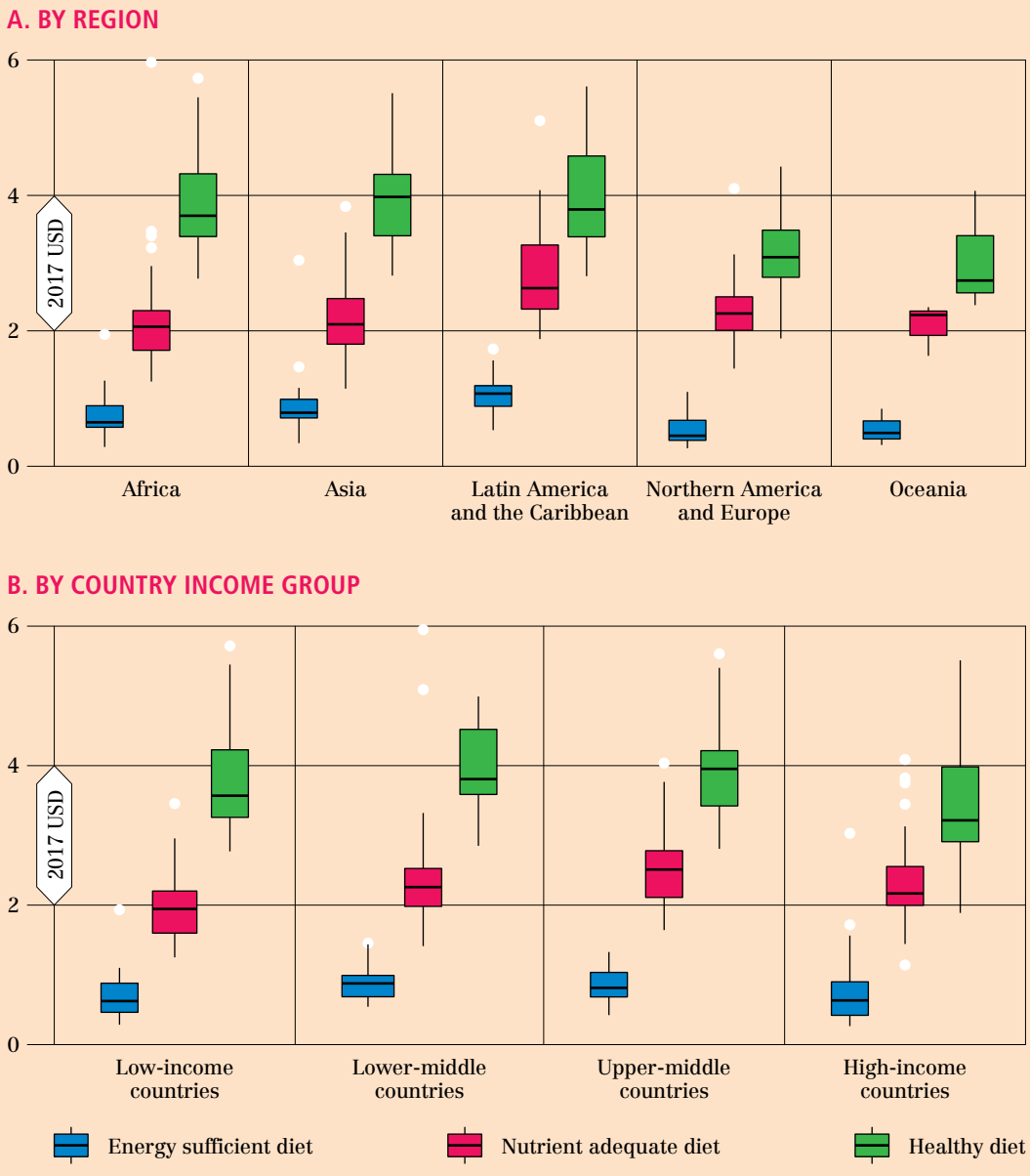
For the cost of healthy diets, over the ten different definitions of a healthy diet published by UN Member States, the range of the cost of these diets globally is between USD 3.27 and USD 4.57 per day, with a point estimate based on median costs of USD 3.75 (Figure 4). This compares to a range of between USD 3.31 and USD 3.61 for the least-cost versions of the EAT-Lancet diet, including four specific diet variants (vegan, vegetarian, pescatarian, flexitarian).[8] FBDGs are generally designed to ensure nutrient adequacy, and our findings show that the least-cost diets that meet FBDGs do satisfy 94 percent of nutrient needs on average (Annex 5). The cost of healthy diet metric allows for substitution within each food group to meet the recommended quantities for a healthy diet. Adding additional requirements would impose additional costs, for example to meet personal or culturally typical food preferences and time savings/convenience.

7 Annex 2 shows the cost of a nutrient adequate diet when using RDAs rather than H-ARs.

8 The estimate of USD 2.84 per day for the overall EAT-Lancet reference diet found in Hirvonen *et al.*, 2019 used a different dataset and some different assumptions, and is not directly comparable.

This finding shows that the cost of healthy diets *by any definition* far exceeds the entire international poverty line of USD 1.90, let alone the upper-bound portion of the poverty line of USD 1.20 that can credibly be reserved for food (Figure 5). The cost of healthy diets exceeds food expenditures in most countries in the Global South (Figure 6), and 87 percent of people in low-income countries cannot afford these diets, including over 75 percent of the population throughout sub-Saharan Africa and Southern Asia (Figure 7, Table 5). High proportions of people in South-eastern Asia (> 50 percent), Melanesia (> 40 percent) and Latin America (> 15 percent) also cannot afford these diets.[9]

FIGURE 2 The cost of energy sufficient, nutrient adequate and healthy diets by region and country income group

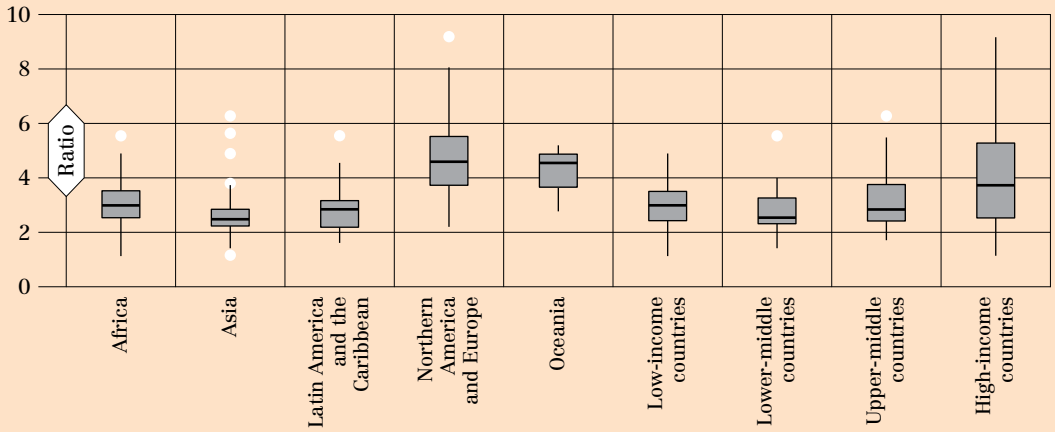


Source: Authors' own elaboration.

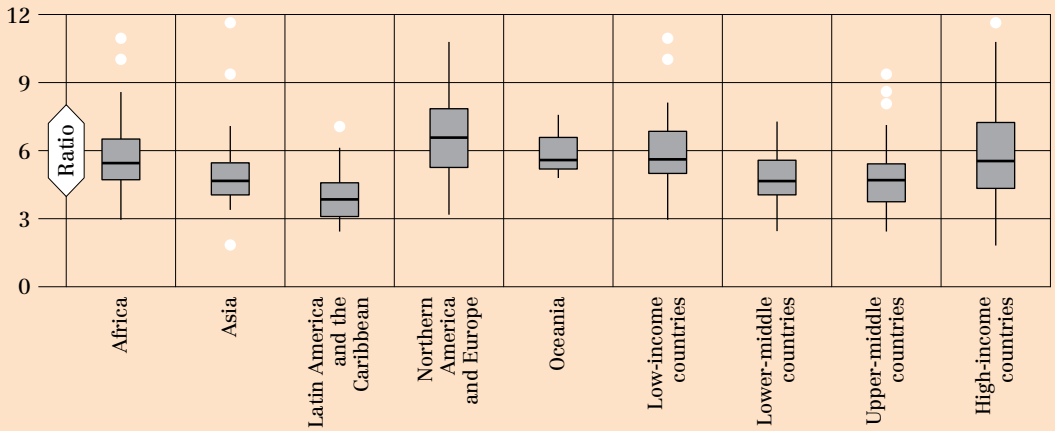
[9] Table A3.2 in Annex 3 reports the percentage of population who could not afford the three reference diets in each region and country income group, expressed as unweighted averages.

FIGURE 3 Premiums required to reach nutrient adequate and healthy diets, by region

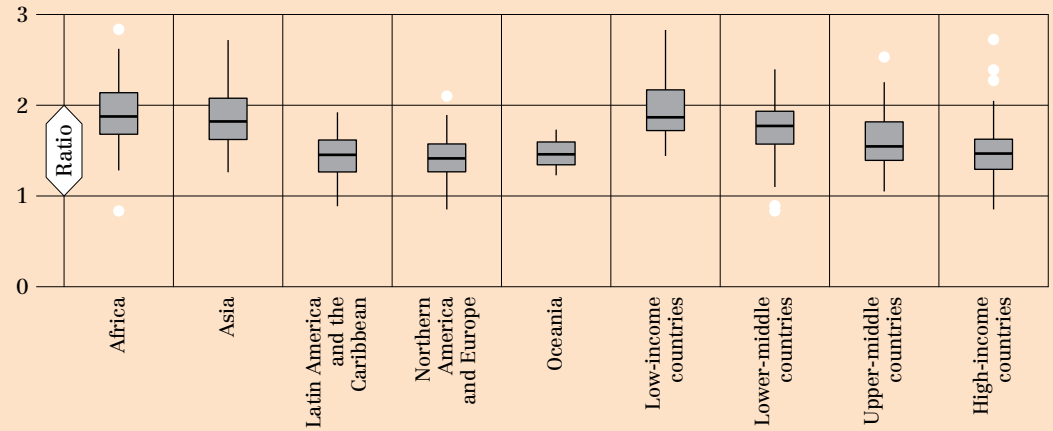
A. RATIO OF THE COST OF A NUTRIENT ADEQUATE DIET TO THE COST OF AN ENERGY SUFFICIENT DIET



B. RATIO OF THE COST OF A HEALTHY DIET TO THE COST OF AN ENERGY SUFFICIENT DIET



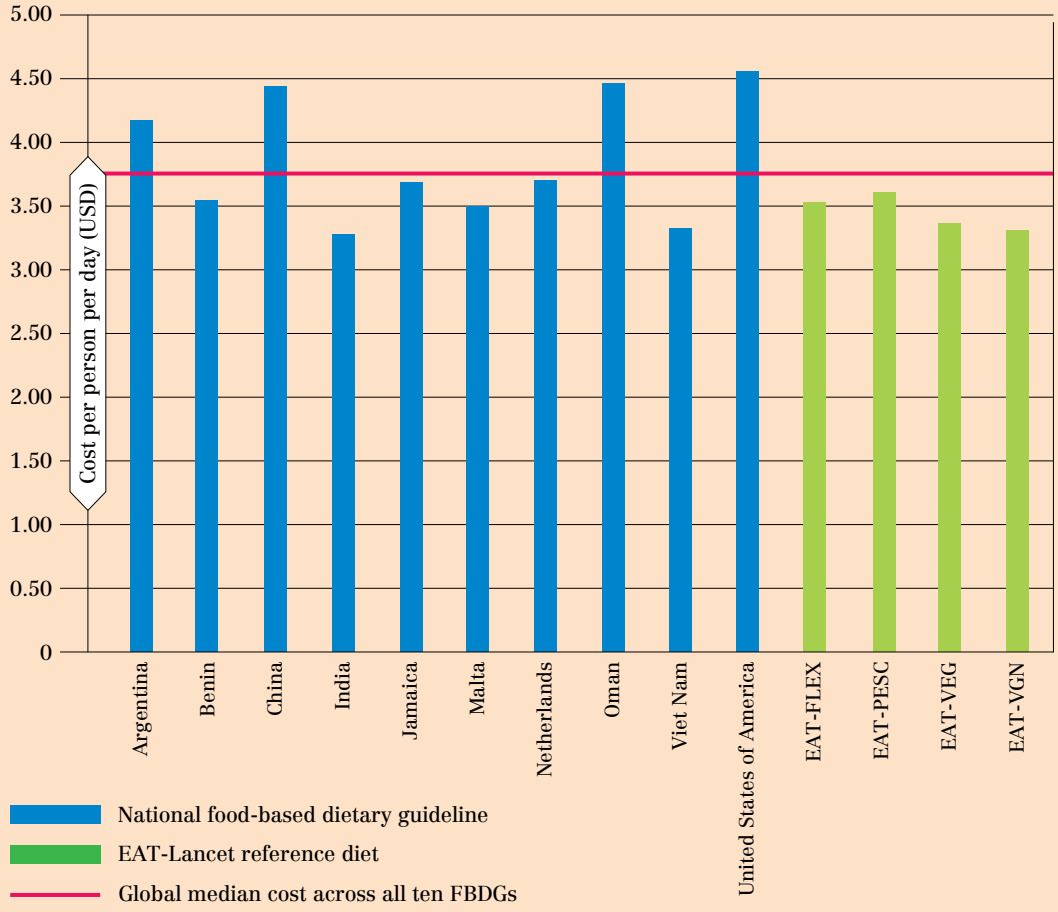
C. RATIO OF THE COST OF A HEALTHY DIET TO THE COST OF A NUTRIENT ADEQUATE DIET



Notes: Data shown are box plots for each ratio indicated, showing the median, 25th and 75 percentile, 1.5 times that interquartile range, and outlier values for the increase in cost associated with each increment of diet quality in each region and national income group.

Source: Authors' own elaboration.

FIGURE 4 Worldwide average costs of ten food-based dietary guidelines diets and four EAT-Lancet reference diets



Notes: Data shown are global means (n=170) for the least-cost set of locally available items meeting the diet quality standard shown. The horizontal line at USD 3.75 is the median of the ten national food-based dietary guidelines (FBDGs).

Source: Authors' own elaboration.

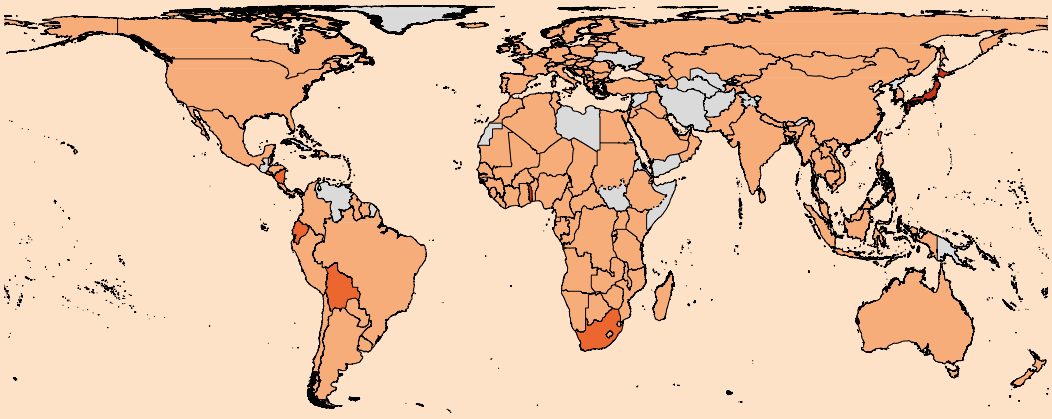
In all, we estimate that 3 billion people globally cannot afford the *least-cost* form of healthy diets (Table 6). The majority of these reside in Southern Asia (1.3 billion) and sub-Saharan Africa (829 million), with high numbers also in South-eastern Asia (326 million) and Eastern Asia (230 million).[10] Additionally, 186 million people cannot afford the cheapest form of energy sufficient diets, mostly concentrated in Africa (149 million). Last, 1.5 billion people cannot afford the cheapest form of nutrient adequate diets, almost entirely in Asia (754 million), Africa (680 million), and the Americas (72 million) (Table 6).

These numbers compare to an estimated 812–822 million people worldwide who are undernourished (using the FAO prevalence of undernourishment indicator), and approximately 2 billion people who experience moderate or severe food insecurity (FAO, IFAD, UNICEF, WFP and WHO, 2019).

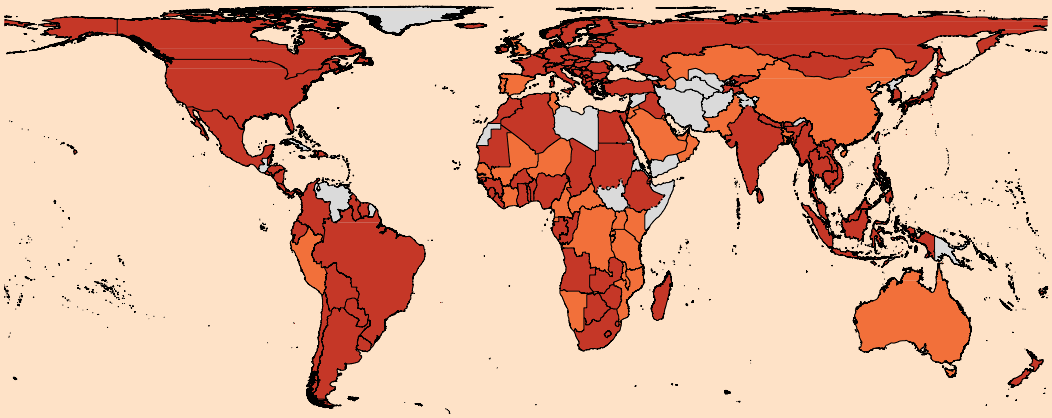
[10] Annex 3 shows upper-bound results of the number of people who cannot afford these diets.

FIGURE 5 Affordability of diets relative to the global poverty line of USD 1.90/day

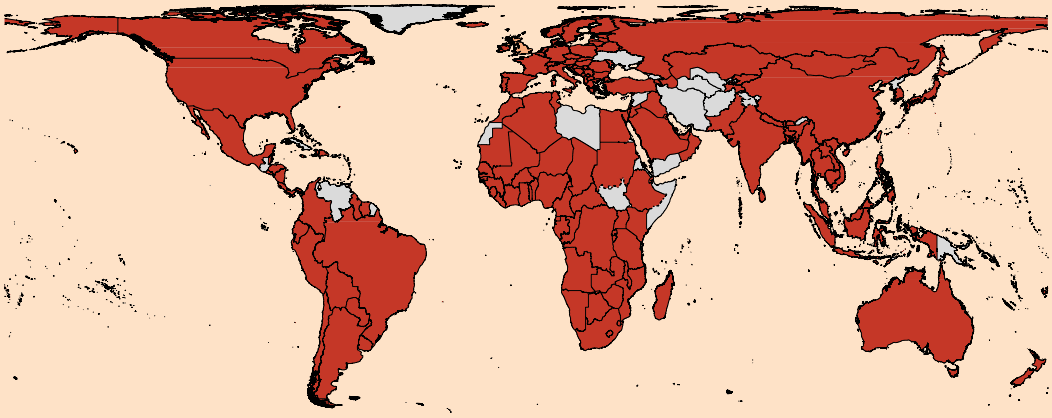
A. COST OF AN ENERGY SUFFICIENT DIET COMPARED WITH THE INTERNATIONAL POVERTY LINE



B. COST OF A NUTRIENT ADEQUATE DIET COMPARED WITH THE INTERNATIONAL POVERTY LINE



C. COST OF A HEALTHY DIET COMPARED WITH THE INTERNATIONAL POVERTY LINE

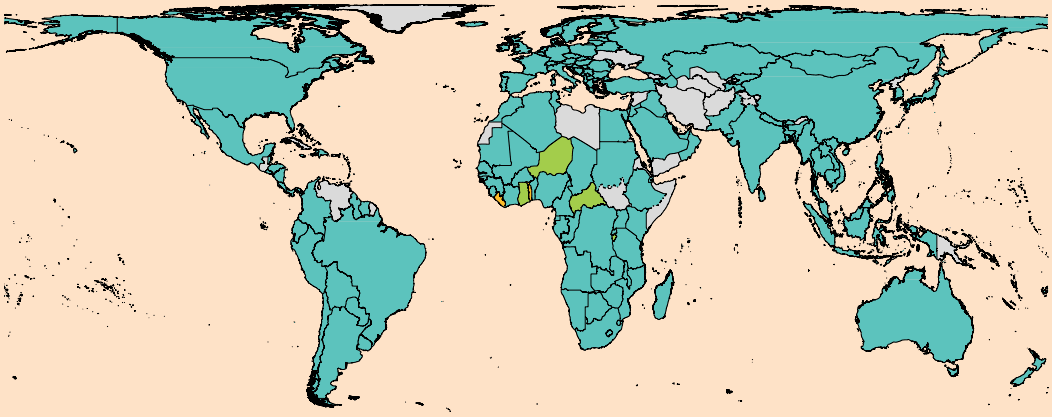


Notes: Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties. Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined. Final status of the Abyei area is not yet determined. A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

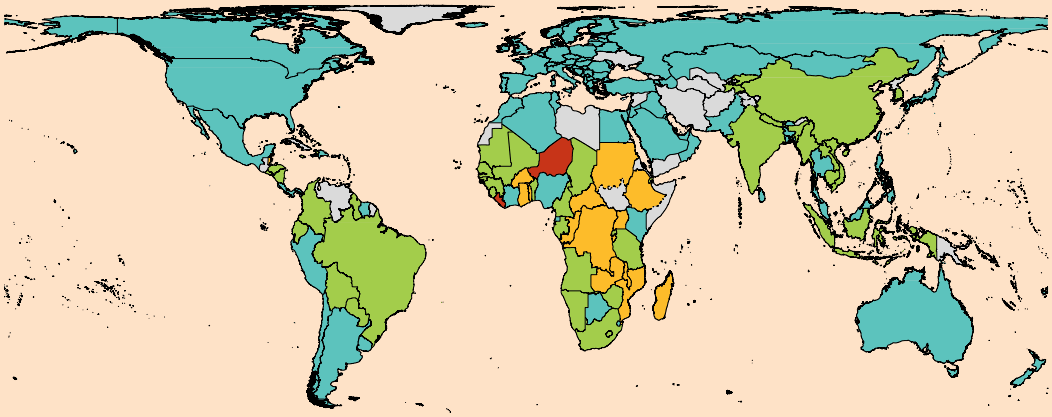
Source: Authors' own elaboration. Conforms to Map No. 4170 Rev. 19 UNITED NATIONS October 2020.

FIGURE 6 Affordability of diets relative to actual food expenditure per capita

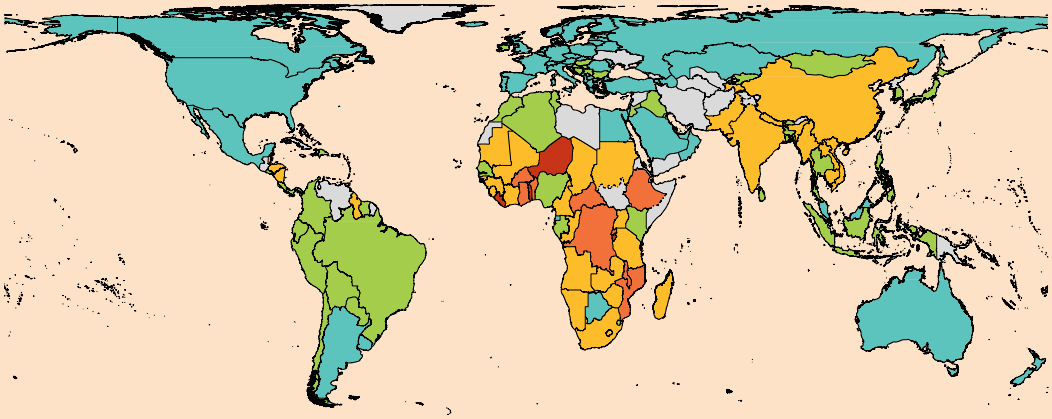
A. RATIO OF THE COST OF AN ENERGY SUFFICIENT DIET AND AVERAGE NATIONAL FOOD EXPENDITURES PER CAPITA[A]



B. RATIO OF THE COST OF A NUTRIENT ADEQUATE DIET AND AVERAGE NATIONAL FOOD EXPENDITURES PER CAPITA[A]



C. RATIO OF THE COST OF A HEALTHY DIET AND AVERAGE NATIONAL FOOD EXPENDITURES PER CAPITA

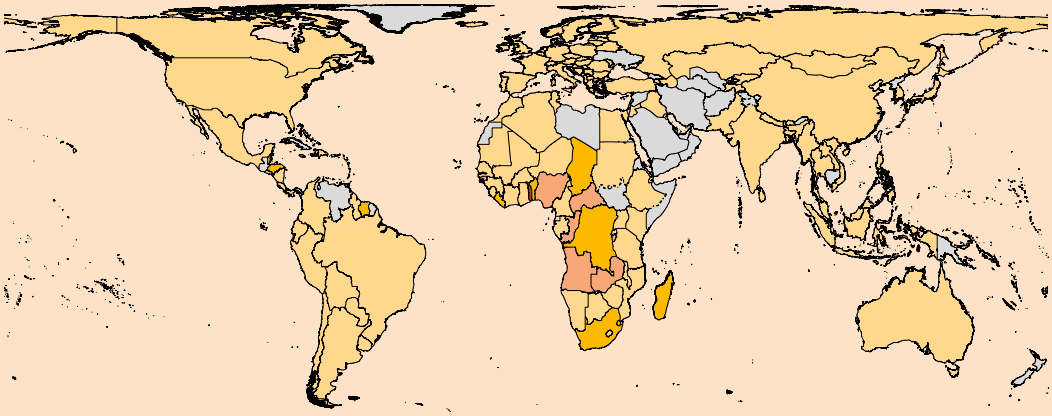


Notes: Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties. Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined. Final status of the Abyei area is not yet determined. A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

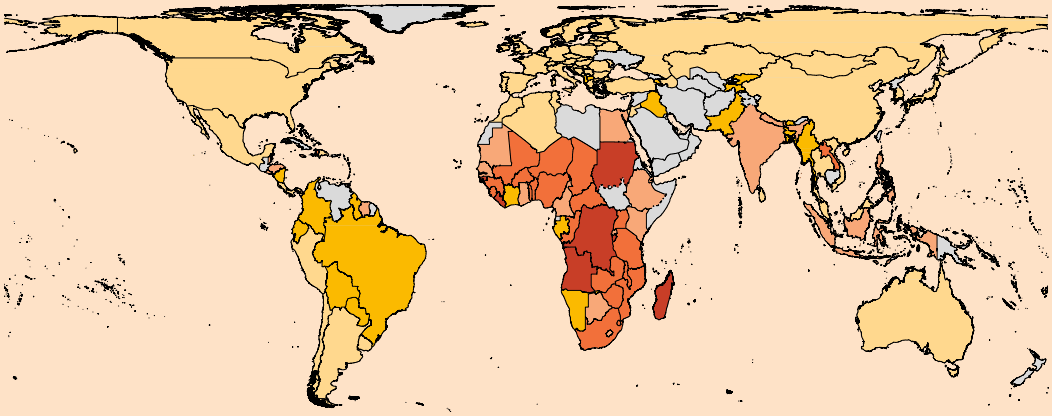
Source: Authors' own elaboration. Conforms to Map No. 4170 Rev. 19 UNITED NATIONS October 2020.

FIGURE 7 Proportion of people unable to afford each level of diet quality in 2017

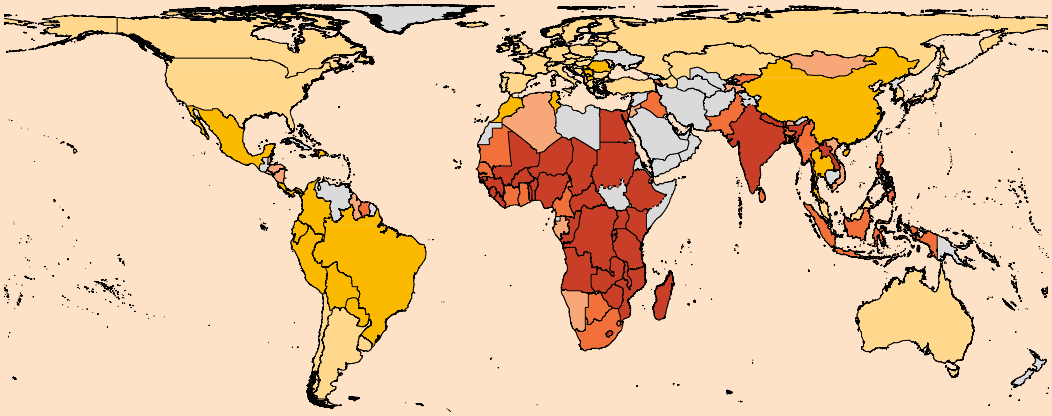
A. PERCENTAGE OF POPULATION WHO CANNOT AFFORD AN ENERGY SUFFICIENT DIET



B. PERCENTAGE OF POPULATION WHO CANNOT AFFORD A NUTRIENT ADEQUATE DIET



C. PERCENTAGE OF POPULATION WHO CANNOT AFFORD A HEALTHY DIET



Notes: Unaffordability is defined as the cost of the diet exceeding 63 percent of total expenditures, which is the proportion of food expenditure for the bottom consumer segment in low-income countries, reserving 37 percent for non-food expenditures. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties. Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined. Final status of the Abyei area is not yet determined. A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

Source: Authors' own elaboration. Conforms to Map No. 4170 Rev. 19 UNITED NATIONS October 2020.

TABLE 5 Percentage of people who cannot afford each diet, by region and country income group (population weighted average)

	Energy sufficient diet	Nutrient adequate diet	Healthy diet
Macroregion			
Africa	12.3%	56.4%	80.0%
Asia	0.5%	18.2%	46.7%
Latin America and the Caribbean	1.8%	11.7%	18.2%
Northern America and Europe	0.4%	1.0%	1.7%
Oceania	0.2%	0.8%	2.1%
Subregion			
Australia and New Zealand	0.2%	0.5%	0.7%
Central Asia	0.3%	7.4%	22.4%
Eastern Asia	0.1%	0.8%	14.7%
Eastern Europe	0.1%	1.0%	2.4%
Latin America and the Caribbean	1.8%	11.7%	18.2%
Melanesia	0.0%	9.6%	41.3%
Northern Africa	1.3%	37.3%	60.3%
Northern America	0.9%	1.4%	1.6%
Northern Europe	0.1%	0.3%	0.4%
South-eastern Asia	1.0%	23.3%	52.1%
Southern Asia	0.7%	33.4%	76.1%
Southern Europe	0.6%	1.9%	3.6%
Sub-Saharan Africa	14.9%	60.8%	84.6%
Western Asia	0.2%	4.8%	21.3%
Western Europe	0.0%	0.2%	0.2%
Country income group			
High-income countries	0.5%	1.1%	1.7%
Low-income countries	8.3%	60.9%	87.0%
Lower-middle countries	3.9%	36.3%	72.8%
Upper-middle countries	0.8%	4.3%	17.0%
World	**2.6%**	**21.6%**	**43.2%**

Notes: Data shown are the percentage of people in each region whose household income is below the total cost of the most affordable locally available items needed to meet each standard of diet quality, assuming that they can spend no more than 63 percent of their income on food. Methods and data sources are detailed in the text.

Source: Authors' own elaboration.

TABLE 6 Number of people who cannot afford each diet, by region and country income group

	Energy sufficient diet	Nutrient adequate diet	Healthy diet
Macroregion			
Africa	148.64	680.59	964.84
Asia	21.57	754.48	1933.93
Latin America and the Caribbean	10.46	66.77	104.24
Northern America and Europe	4.76	10.95	17.97
Oceania	0.06	0.21	0.55
Subregion			
Australia and New Zealand	0.06	0.12	0.18
Central Asia	0.08	2.45	7.43
Eastern Asia	1.96	13.05	230.43
Eastern Europe	0.31	2.49	5.86
Latin America and the Caribbean	10.46	66.77	104.24
Melanesia	0.00	0.08	0.36
Northern Africa	2.87	84.27	136.06
Northern America	3.34	5.05	5.96
Northern Europe	0.14	0.29	0.40
South-eastern Asia	6.29	145.40	325.53
Southern Asia	12.92	586.14	1 337.37
Southern Europe	0.95	2.81	5.40
Sub-Saharan Africa	145.76	596.32	828.78
Western Asia	0.32	7.45	33.16
Western Europe	0.03	0.31	0.36
Country income group			
High-income countries	5.99	12.12	19.22
Low-income countries	48.31	354.94	506.56
Lower-middle countries	112.24	1 041.46	2 087.45
Upper-middle countries	18.95	104.49	408.30
World	**185.49**	**1 513.01**	**3 021.53**

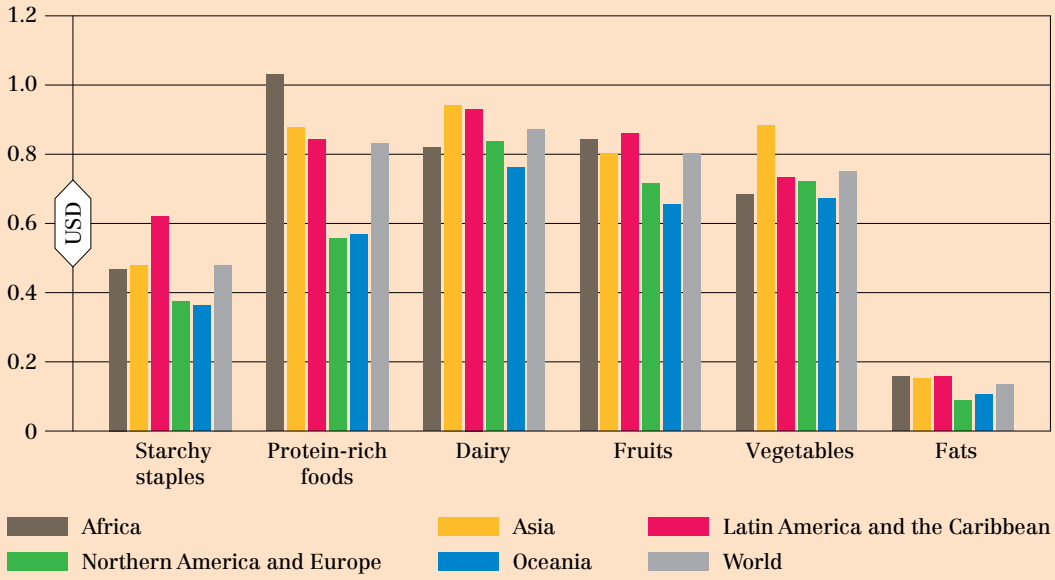
Notes: Data shown are the number of people in each region whose household income is below the total cost of the most affordable locally available items needed to meet each standard of diet quality, assuming that they can spend no more than 63 percent of their income on food. Methods and data sources are detailed in the text.

Source: Authors' own elaboration.

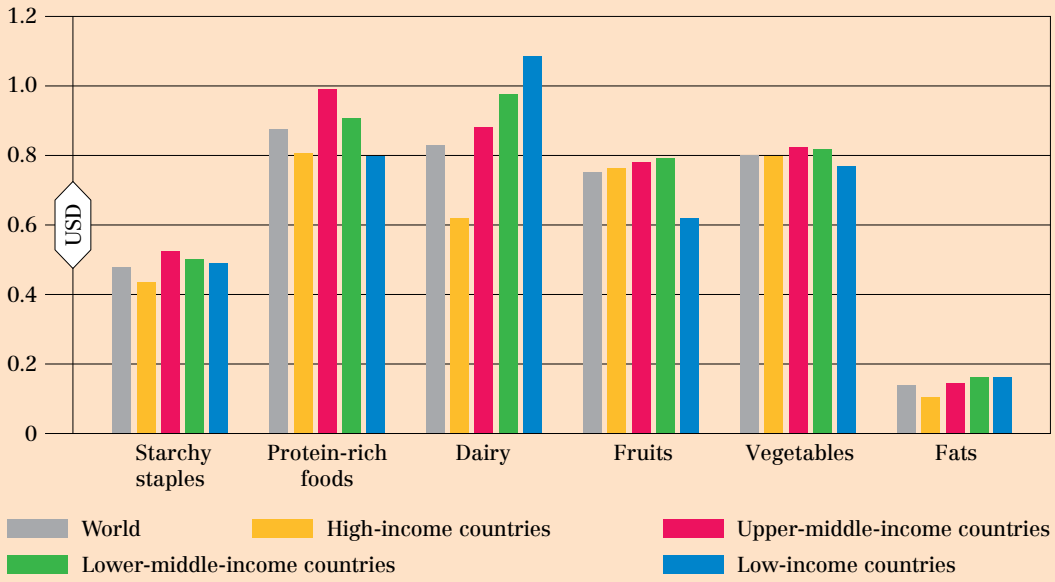
Micronutrient-rich non-staples (fruits and vegetables, dairy, and protein-rich foods) are the highest-cost food groups per day globally (Figure 8). There are regional differences, with fruits being notably more expensive in Asia, and dairy being notably more expensive in Africa and cheaper in Europe and Oceania. Starchy staples and oils account for only 16 percent of the cost of healthy diets, while fruits and vegetables account for 40 percent of the cost, with dairy and other protein-rich foods combined accounting for 44 percent (Figure 9). These proportions vary somewhat by region, with dairy being progressively more expensive in low-income countries (Figure 10).

FIGURE 8 Cost per person per day by food group, region and country income group (2017 USD)

A. BY REGION

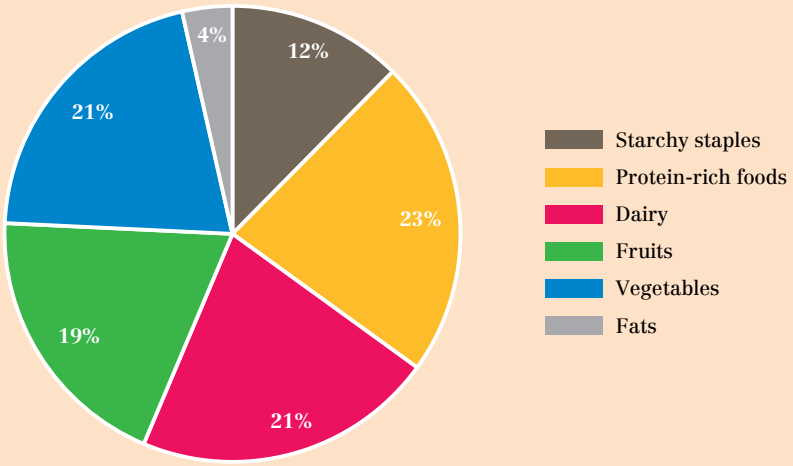


B. BY COUNTRY INCOME GROUP



Source: Authors' own elaboration.

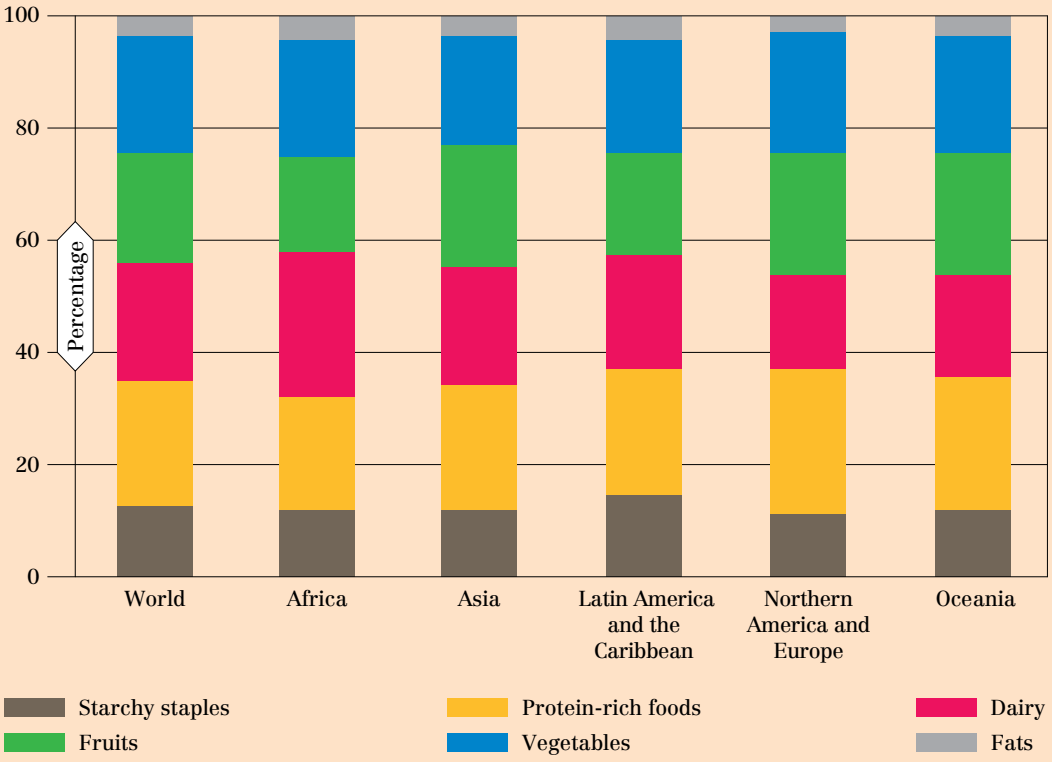
FIGURE 9 Average percentage contribution of each food group to the average global cost of a healthy diet (2017 USD)



Note: Data shown are the average over all countries (n=170).

Source: Authors' own elaboration.

FIGURE 10 Cost contribution (percentage share of total cost) of each food group in a healthy diet, by region in 2017



Note: Data shown are the average over all countries in each geographic region for the healthy diet, defined as the median cost in each country of meeting ten national food-based dietary guidelines.

Source: Authors' own elaboration.

These findings imply that (a) the cost of nutritious foods needs to go down, particularly nutrient-rich foods including fruits and vegetables, dairy, and protein-rich foods; and (b) poverty lines may need to be raised, as they are the basis for programme targets and social safety net programmes, and currently do not support the ability of humans to access even the least-cost versions of healthy diets that meet dietary needs. That is, they do not support food security.

FBDGs are state-published definitions of a healthy diet appropriate for and targeted toward its citizens, and are used as a basis for nutrition education throughout many countries. These findings indicate that nutrition education and behaviour change is not sufficient to shift population consumption toward healthy diets, particularly for the most nutritionally vulnerable, because those diets are out of reach for the majority of the world's poor. In order to enable all people to shift behaviour toward healthy diets, prices of those diets, particularly of the most nutrient-rich food groups, need to decrease.

4 Results: Country case studies

KEY MESSAGES

- National price datasets allow subnational analysis of the cost of diets. These food price datasets are collected by national statistical organizations or agriculture market information systems.
- The cost of healthy diets varies by region, as seen in the United Republic of Tanzania, and is driven by different high-cost food groups in different regions. The cost of healthy diets and nutrient adequate diets varies by season, as seen in Malawi. Food price data can also be used to examine low availability of specific food groups in specific times and places, as seen in Ghana. The Ethiopia case study shows that the cost of the most nutrient-rich non-staple food groups has gone up more rapidly than starchy staples.
- Poverty lines are typically insufficient to support the purchase of least-cost healthy diets. The standard cost of basic needs (CBN) approach to determining food poverty lines selects a food basket that meets neither nutrient needs nor dietary recommendations for healthy diets, as demonstrated in Myanmar. Instead, we demonstrate a feasible method for generating food poverty lines that would satisfy dietary guidelines, as well as taking into account typical consumption patterns of the poor.

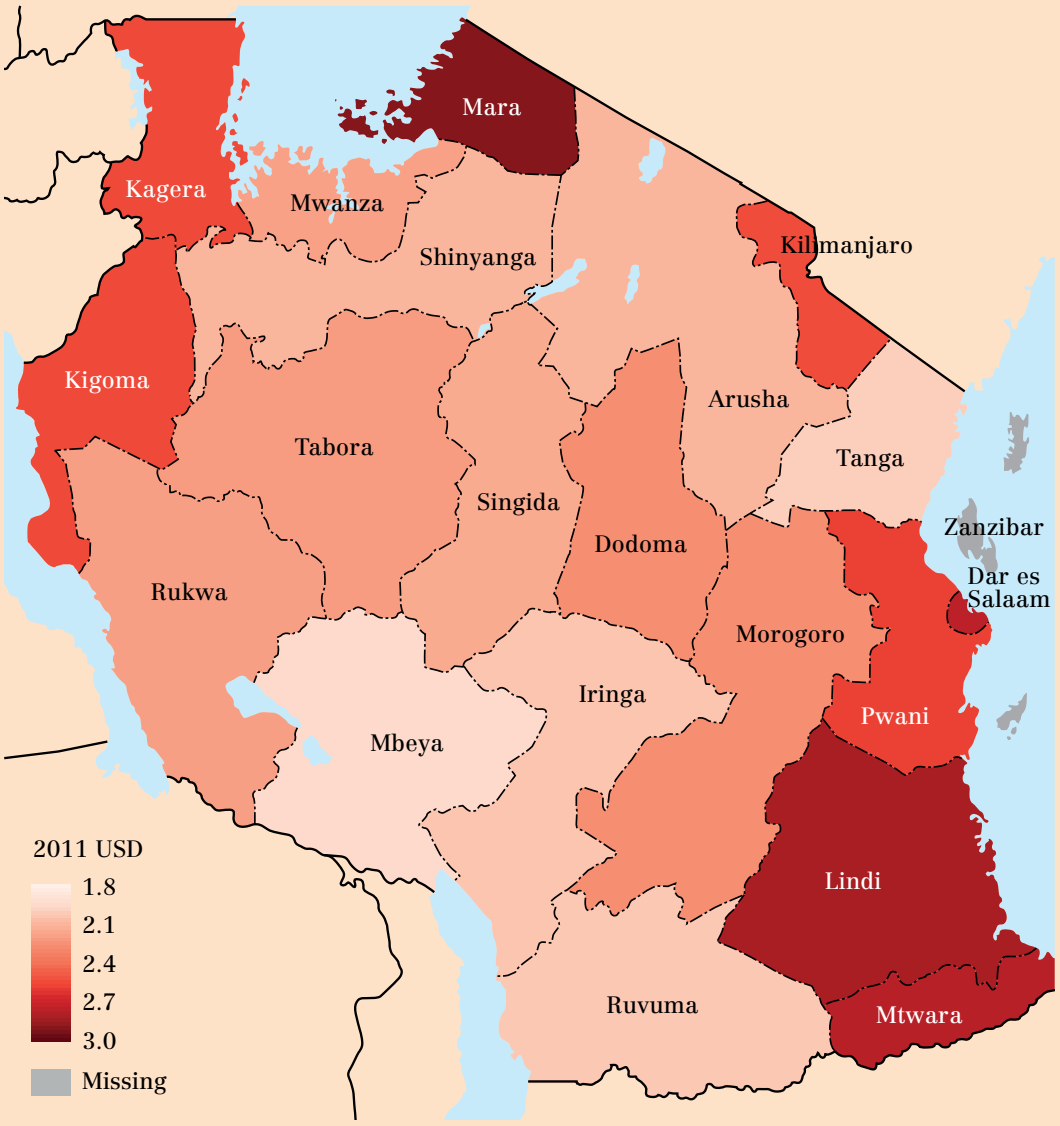
Each country case study is intended to showcase a different aspect of how national and subnational food price data shed light on the cost of the nutrient adequate diet and the healthy diet. Each country's unique circumstances reveal important aspects of how food prices relate to nutrition, showing how the cost of these diets can vary by region, by season, by life stage, and when accounting for food preferences.

4.1 United Republic of Tanzania

The Tanzanian case study focused on regional variation in the cost of food groups. To calculate the cost of a healthy diet, we used the Benin FBDG in this case, because it is the only country in Africa currently with quantifiable FBDG. The United Republic of Tanzania, Ethiopia and others are currently developing FBDGs. Those may be quantifiable and could then be used to compare with the costs shown here. The main result of our Tanzanian study is the striking regional variation in the cost of healthy diets around the country. The average cost of a healthy diet between 2011 and 2015 in the southeast coast was USD 2.83 in Lindi, USD 2.77 in Mtwara, USD 2.59 in Pwani which includes the largest city of Dar es Salaam (USD 2.75), and USD 2.54 in the east-coast region of Kilimanjaro. The average cost of a healthy diet in these regions was about 35 percent higher than the average cost in Mbeya and Iringa in the southwest, bordering Zambia and Malawi, and above the national average of USD 2.33 (Figure 11).

In the high-cost regions, vegetable prices are very high, contributing about a third of the total diet cost. In the Mara region, however, the biggest driver of cost is oils, which are 3–5 times more expensive than in most regions in the United Republic of Tanzania. In the low-cost regions, starchy staples are predominant, and nutrient-rich non-staples are much more affordable.

FIGURE 11 Average cost of a healthy diet by region in the United Republic of Tanzania, 2011–2015



Note: Data shown are the average cost of a healthy diet over all months in each region.

Source: Authors' own elaboration. Conforms to Map No. 3667 Rev. 6 UNITED NATIONS January 2006.

Looking deeper into subnational variation in the cost of food groups, Figure 12 shows variation in the cost of each food group. We see the smallest magnitude of subnational variation in fruits and protein-rich foods, and the most in vegetables and oils. Drivers such as remoteness and market access, transportation costs, and perishability may be affecting the cost patterns observed. Overall, vegetables are the most expensive in Lindi, Mtwara and Pwani regions. In these regions, the average cost of vegetables in a healthy diet is USD 0.76, which is 72 percent higher than the national average of USD 0.44.

FIGURE 12 Food group shares in the cost of a healthy diet by region in the United Republic of Tanzania, 2011–2015

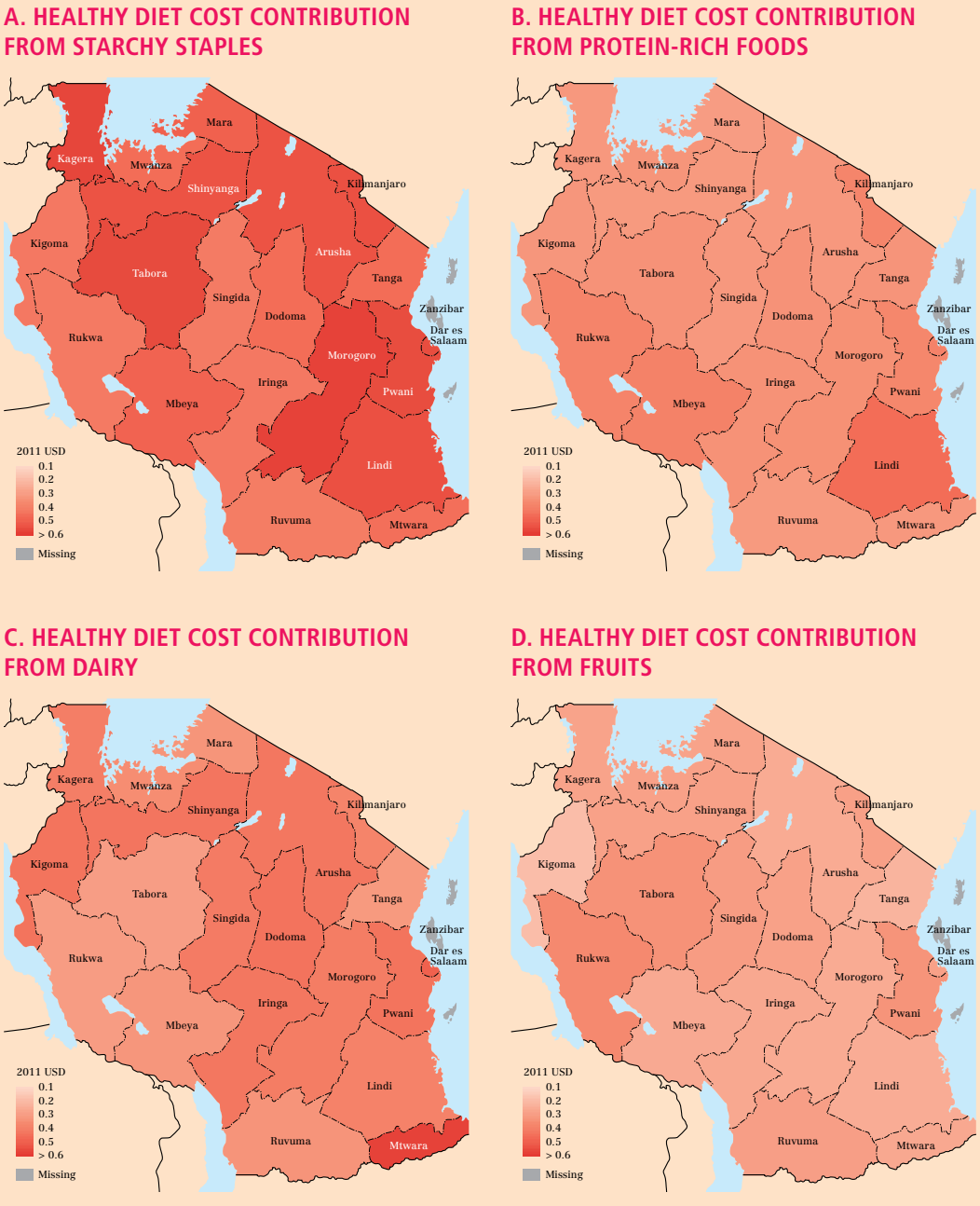
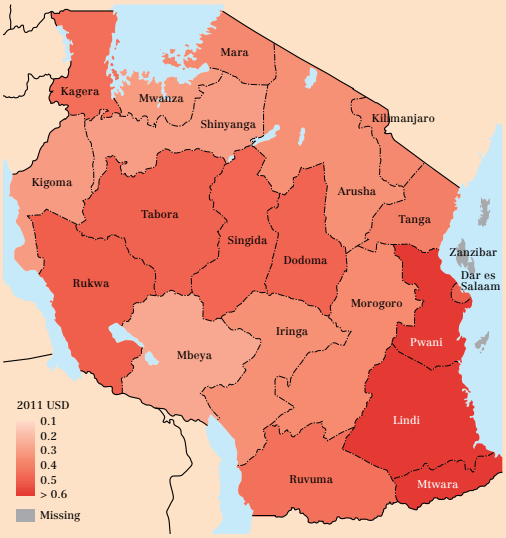
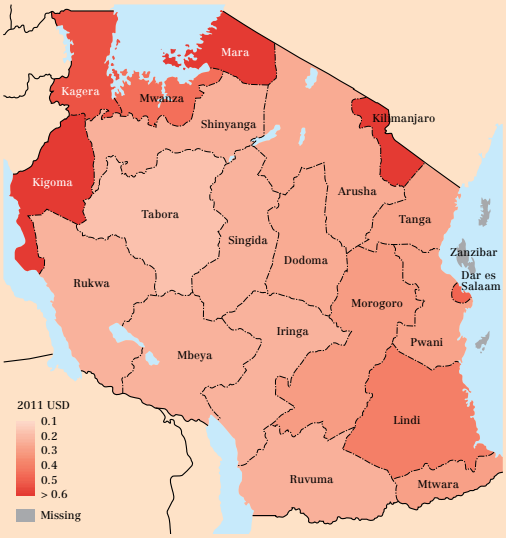


FIGURE 12 Food group shares in the cost of a healthy diet by region in the United Republic of Tanzania, 2011–2015 (cont.)

E. HEALTHY DIET COST CONTRIBUTION FROM VEGETABLES



F. HEALTHY DIET COST CONTRIBUTION FROM OILS



Note: Data shown are the average share of each food group shown in that region's cost of a healthy diet over all months in each region.

Source: Authors' own elaboration. Conforms to Map No. 3667 Rev. 6 UNITED NATIONS January 2006.

4.2 Malawi

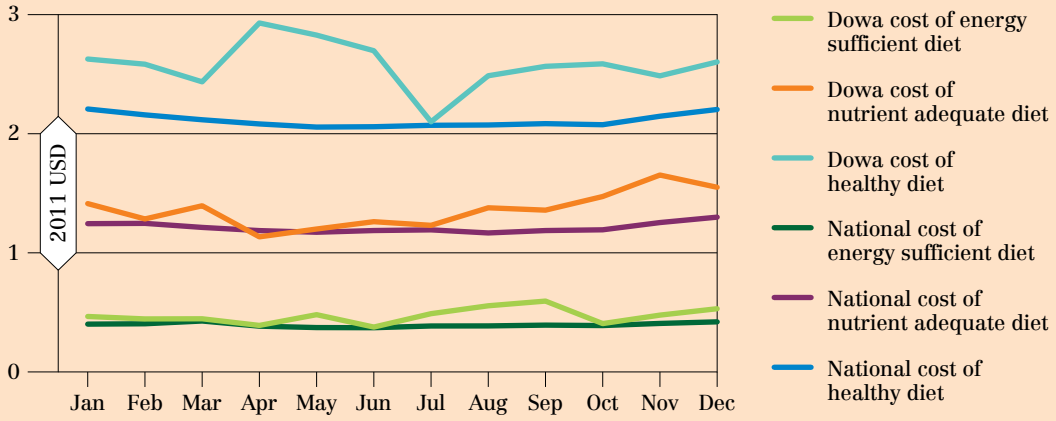
The Malawi case study focused on variation in the cost of a nutrient adequate diet in two ways: over seasons, and over life-cycle stages.

The average monthly cost of healthy diets and nutrient adequate diets show a greater seasonal gap compared to the average monthly cost of energy sufficient diets in Malawi (Figure 13). The seasonal gap refers to the highest-cost month minus the lowest-cost month. The seasonal gap for the national cost of a healthy diet is about USD 0.15 (a 7 percent rise from the lowest- to the highest-cost month), and for the cost of a nutrient adequate diet is about USD 0.13 (an 11 percent rise), compared to about USD 0.06 (a 15 percent rise) for the national cost of an energy sufficient diet. However, the seasonality of these indicators can vary significantly across different regions. For example, Dowa, to the north of the capital city of Lilongwe, is the district with the highest seasonality in cost of a healthy diet and cost of a nutrient adequate diet (Bai, Naumova and Masters, 2020). In Dowa, the seasonal gap for the cost of a healthy diet is USD 0.84 (a 32 percent rise), for the cost of a nutrient adequate diet it is more than USD 0.50 (a 38 percent rise), and for the cost of an energy sufficient diet about USD 0.20 (a 45 percent rise).

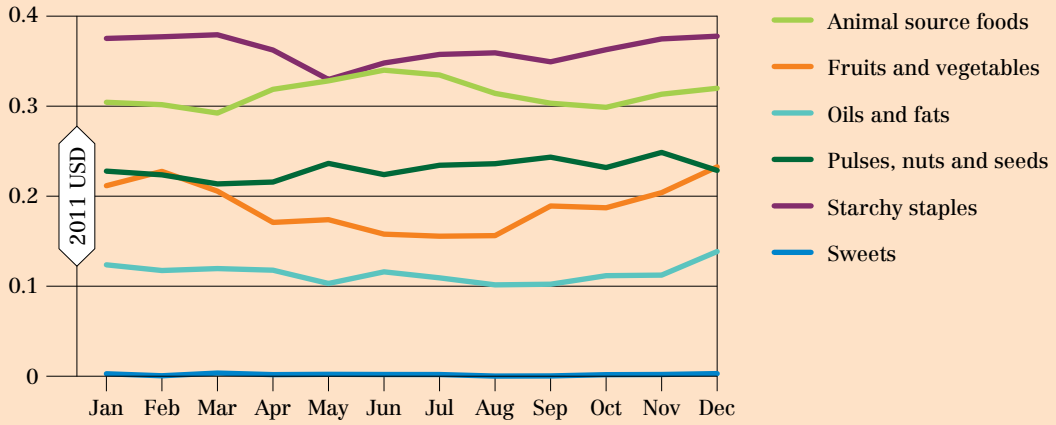
In Figure 13, panels B and C, we illustrate the average monthly cost of a nutrient adequate diet and components by different food groups. Fruits and vegetables display a greater seasonal variation compared to other food groups. The trend of monthly change for fruits and vegetables is also in line with the trend of the national costs of a healthy diet and a nutrient adequate diet. The synchronized price rises for nutrient-dense foods is the key driver of the seasonal variations of the cost of a nutrient adequate diet in several Eastern African countries (Bai, Naumova and Masters, 2020).

FIGURE 13 National and regional average diet costs per month by component in Malawi

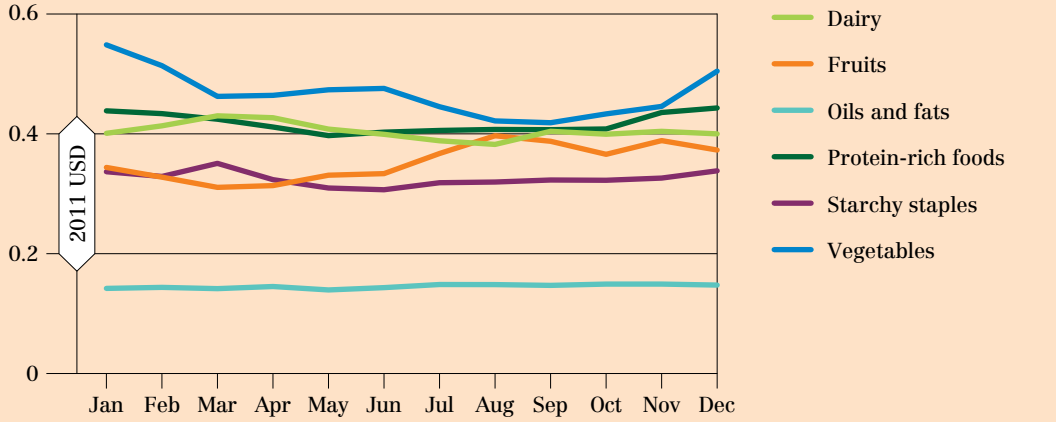
A. AVERAGE COST OF HEALTHY, NUTRIENT ADEQUATE AND ENERGY SUFFICIENT DIETS, BY MONTH



B. AVERAGE COST OF NUTRIENT ADEQUATE DIET FOOD GROUP COMPONENTS, BY MONTH



C. AVERAGE COST OF HEALTHY DIET FOOD GROUP COMPONENTS, BY MONTH



Notes: Data shown are for a representative woman aged 19–30 years, at 67 kg and 163 cm, using nutrient requirements specified by the IOM Dietary Reference Intakes (DRIs) – specifically, the estimated average requirement (EAR), Tolerable Upper Intake Level (UL), Acceptable Macronutrient Distribution Range (AMDR) and Chronic Disease Risk Reduction Intake (CDRR). All costs were converted to 2011 USD at annual average purchasing power parity (PPP) exchange rates, smoothed over months by the Denton method.

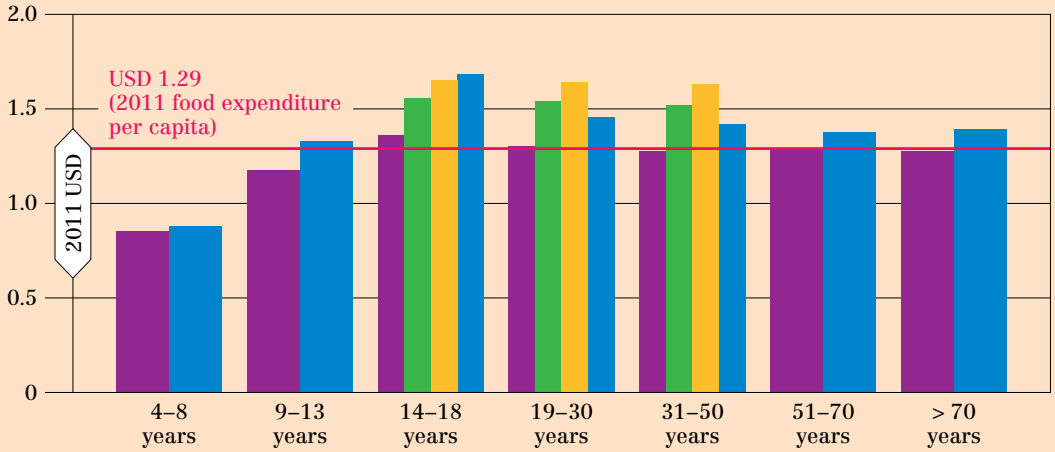
Source: Authors' own elaboration.

The cost of a nutrient adequate diet also varies across sex-age groups over the life cycle. In Malawi, as shown in Figure 14 (panel A), pregnant and lactating women and adolescent boys face the highest cost of a nutrient adequate diet. The average cost of a nutrient adequate diet of these groups is more than USD 1.5 per day, which is much higher than 70 percent of international poverty line and the food expenditure per capita per day in Malawi.

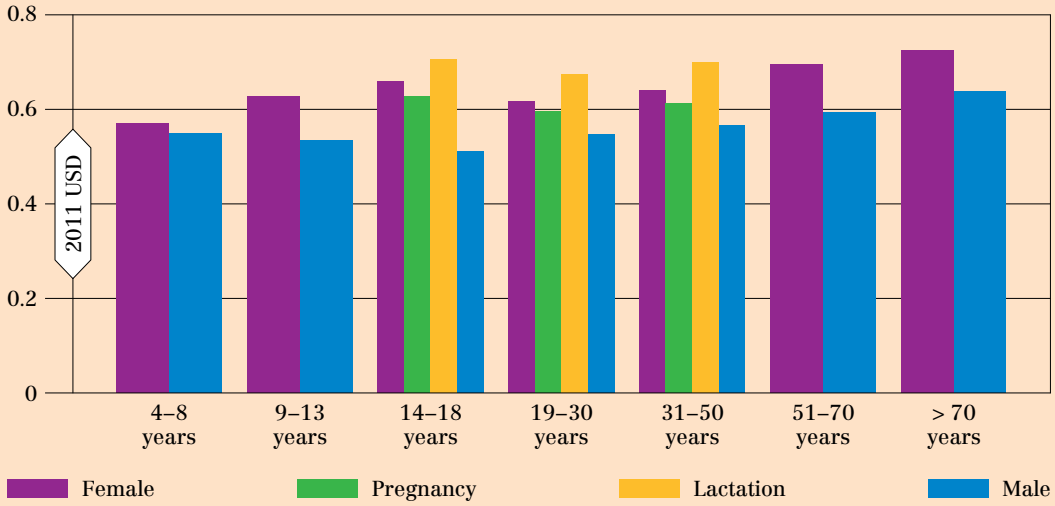
In terms of the cost per 1 000 kcal, females in general face a higher cost compared to males, due to their relatively lower required energy intake and therefore their need for more nutrient-dense foods (Figure 14, panel B). This trend is the same at a global level, showing adolescent girls and older females facing particular challenges in terms of the need for highly nutrient-dense diets (Bai, Herforth and Masters, forthcoming).

FIGURE 14 Average cost of a nutrient adequate diet by demographic group in Malawi

A. COST OF NUTRIENT ADEQUATE DIET BY DEMOGRAPHIC GROUP



B. COST OF NUTRIENT ADEQUATE DIET PER 1 000 KCAL BY DEMOGRAPHIC GROUP



Note: Data shown are for a representative person of each age, sex and reproductive status, using nutrient requirements specified by the IOM Dietary Reference Intakes (DRIs): Tolerable Upper Intake Level (UL), Acceptable Macronutrient Distribution Range (AMDR) and Chronic Disease Risk Reduction Intake (CDRR).

Source: Authors' own elaboration.

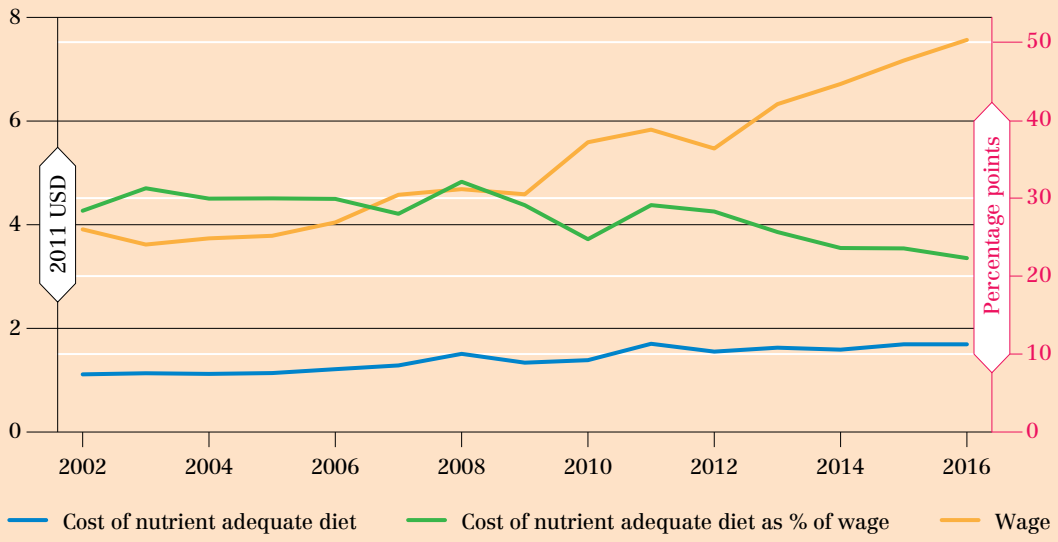
4.3 Ethiopia

In recent years, Ethiopia has had rapid economic growth at about 10 percent per year, although starting from a low base level. There have been significant road infrastructure investments in addition to an African Green Revolution focus on fertilizer and seeds for cereal grains. Yet Ethiopia has persistent high rural poverty, is dependent on food aid and safety nets, and is vulnerable to food price shocks (see for example Bachewe and Headey, 2017). These and other health challenges are reflected in the high rates of child stunting (38 percent), wasting (11 percent), micronutrient deficiencies, and underweight among women (25 percent in rural areas).

This case study used food price and wage data to display the overall cost of all foods needed for nutrient adequacy, as well as the subsistence cost of an energy sufficient diet, and their affordability relative to daily wages for unskilled workers.

The study shows that the cost of a nutrient adequate diet has increased over time by an annual rate of 3 percent, but not as much as wage increases at an annual rate of about 5 percent. Therefore, the affordability of nutrient adequate diets has improved due to wage increases rather than improvements in the cost of food. The cost of a nutrient adequate diet as a percentage of wages decreased from 32 percent in 2008 to 22 percent in 2016 (Figure 15).

FIGURE 15 Cost of a nutrient adequate diet and wages in Ethiopia, 2002–2016

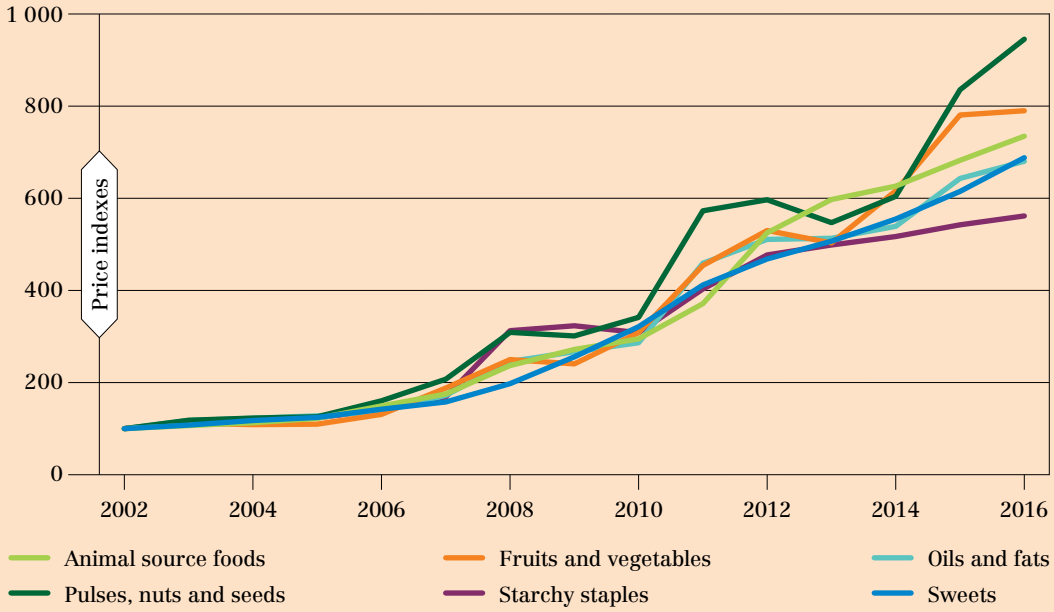


Note: Data shown are the average national level for cost of nutrient adequate diet and wages on the left axis, and cost of nutrient adequate diet as a percentage of daily wages on the right axis.

Source: Bachewe *et al.*, 2019.

Price changes in different food groups reveal that nutrient-rich foods are the main contributors to the rise in costs of a nutrient adequate diet and healthy diet over time. The average nominal prices in LCU of all food groups increased between 2002 and 2016 in Ethiopia. Prices of pulses and fruits and vegetables increased by about 9.4 and 7.9 times, while the price of starchy staples showed the lowest growth of 5.6 times over the same period (Figure 16). Looking at the real cost of different food groups considering inflation, starchy staples have become cheaper while nutrient-rich food groups have become more expensive over time (Bachewe and Headey, 2019).

FIGURE 16 Price indexes by food group in Ethiopia, 2002–2016



Note: Data shown are the simple average of prices (local currency units [LCU]/kg) of all items in each food group, indexed to January 2002=100.

Source: Authors' elaboration and Bachewe *et al.*, 2019.

While wage increases are positive for real affordability of diets, the increasing cost of healthy diets and nutrient-rich food groups is a concern, because those food groups have the highest elasticities of demand, so consumers are less likely to turn wage gains into nutrient-rich food purchases. Policy attention is needed not just on the traditional Green Revolution crops, but on horticultural crops, legumes, and animal source foods to reduce their prices.

Researchers at the FAO Regional Office for Asia and the Pacific have also found that the cost of fruits and vegetables has gone up over time more than the cost of other food groups in South-eastern Asia (Dawe and Lee, 2017).

Effects might differ by gender, but gender-specific wage data were unavailable. Here, we used nutrient needs for a reference female, and unskilled wage data not disaggregated by gender. In a similar analysis of the affordability of healthy diets in India, there were gender-specific dietary recommendations and gender-specific wage data. The diet was more unaffordable for women than for men, because women's wages were systematically lower; therefore the cost of a healthy diet required a higher percentage (80–90 percent) of women's wages, compared to 50–60 percent of men's wages (Raghunathan, Headey and Herforth, 2020).

4.4 Ghana

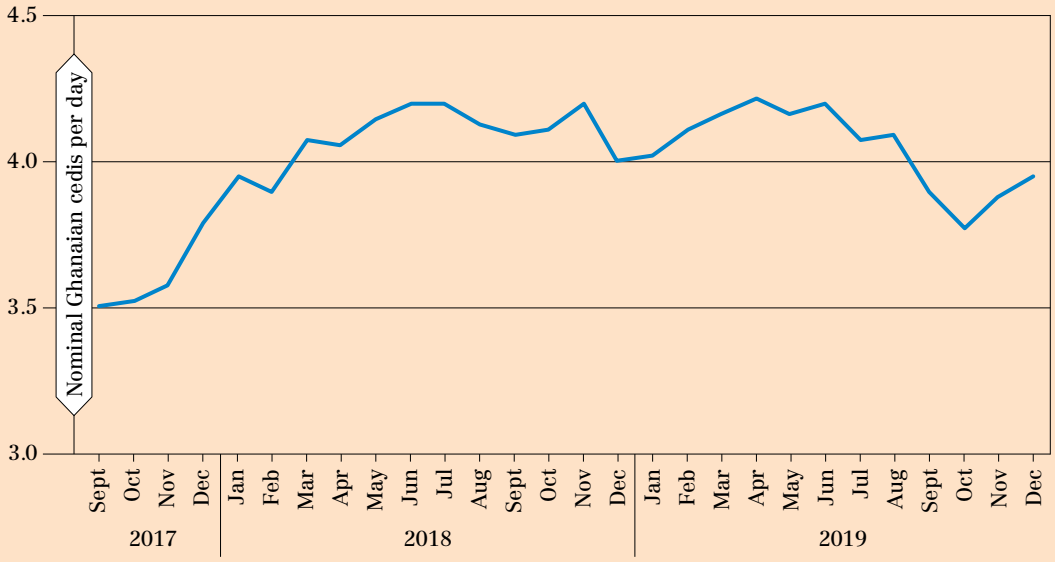
The cost of healthy diet metric was developed in consultation with food price data collectors within the governments of Ghana and the United Republic of Tanzania.[11] During this consultation led by the IANDA (Indicators of Affordability of Nutritious Diets in Africa) project at Tufts, it became clear that one important source of food price information, the Ministry of

[11] See workshop reports accessible at https://ianda.nutrition.tufts.edu/media

Food and Agriculture (MoFA) monitoring and information system (MIS), had data on many foods but insufficient food diversity to be able to calculate the cost of a diet pattern that included all recommended food groups. As a result of this discovery, MoFA requested input on foods to include in its MIS. Input on commonly consumed nutritious foods was provided by several agencies, nutrition specialists, and scholars in Ghana, in a process coordinated by IANDA. MoFA piloted this expanded list in early 2017, and then rolled out the updated food price monitoring list nationwide throughout 2017. The intent of this expanded list was to provide information about potential investments in foods where market opportunities may exist in certain areas and seasons, and to enable the tracking of the cost of healthy diet metric and its component food groups.

The cost of a healthy diet in Ghana is shown in Figure 17, computed from the new MoFA data using the expanded food list. These results show that the cost of a healthy diet rose in late 2017 into 2018, and remained relatively stable throughout most of 2018–2019, possibly with seasonal rises in May–June of both years.

FIGURE 17 Monthly cost of a healthy diet in Ghana, 2017–2019



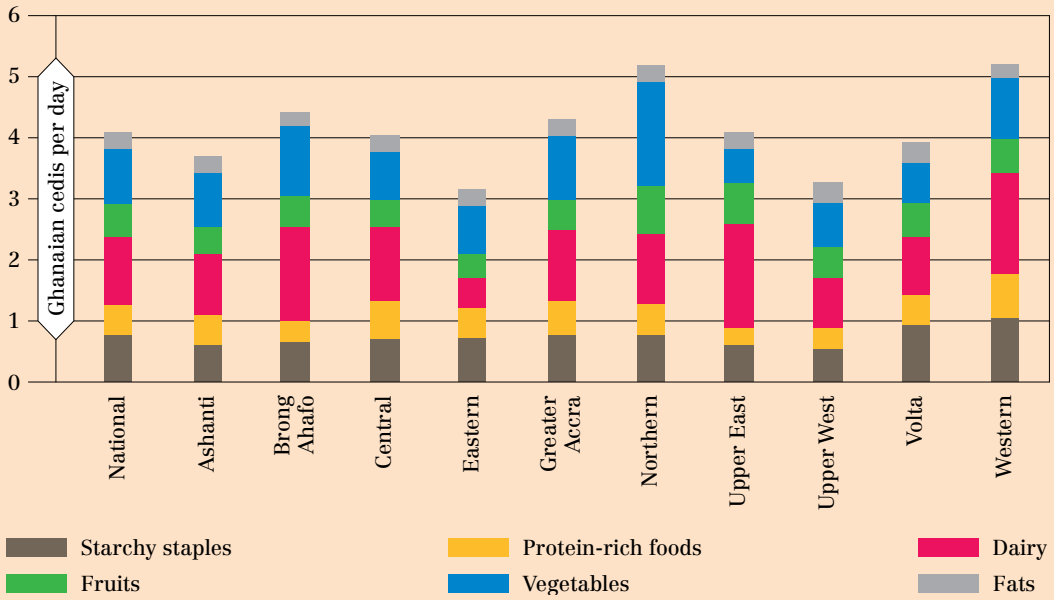
Note: Data shown use national average prices to compute the cost of a healthy diet, in nominal Ghanaian cedis per day.

Source: Authors' elaboration and the Ministry of Food and Agriculture (Ghana).

One of the main policy-relevant reasons for examining the cost of a healthy diet is to see where and when healthy diets may be out of reach, and the specific foods that are missing or expensive. Figure 18 reveals that the cost of a healthy diet is highest in the Northern and Western regions of Ghana; in the Northern region, vegetables are much more expensive than in other regions, while in the Western, Brong Ahafo and Upper East regions, dairy (including small fish and crustaceans) is more expensive. There are many time points where the cost of a healthy diet could not be computed, however, because no prices were observed for one or more food groups. The food groups most often missing were dark green leafy vegetables, dairy, oils and fruits (Figure 19). The regions where these food groups were most often unobserved were the Ashanti, Northern, and Upper West regions. It is possible that the specific markets captured in the MIS do not have oils or any dairy/small fish for sale, and that those items may be purchased from other markets. The absence of dark green leafy vegetables and fruits, however, is a concern because these would be present in the types of markets visited, if they

were available. If these items are absent from markets at certain time points, then it may not be feasible to purchase a complete recommended diet from the market at any price. The use of the cost of healthy diet metric for monitoring unavailability is an additional application to be explored in partnership with price data collectors and end users.

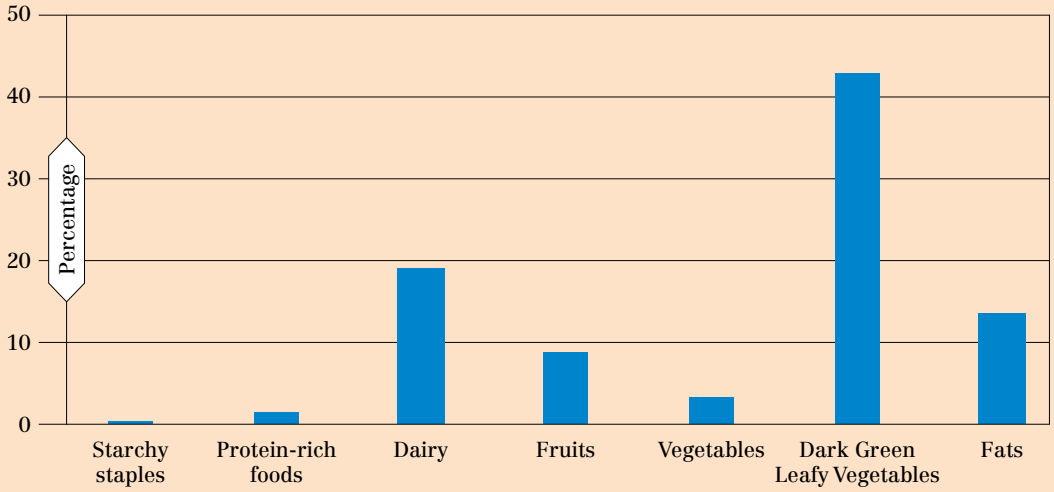
FIGURE 18 Cost of a healthy diet by food group and region in Ghana, 2018



Note: Data shown use national average prices to compute the cost of a healthy diet, in nominal Ghanaian cedis per day.

Source: Authors' elaboration and the Ministry of Food and Agriculture (Ghana).

FIGURE 19 Frequency of missing price observations for each food group in Ghana



Note: Data shown are the percent of districts with zero price observations for any item in each food group.

Source: Authors' elaboration and the Ministry of Food and Agriculture (Ghana).

4.5 Myanmar

The Myanmar country study drew upon the 2015 MPLCS household survey to gain insight into the cost of diets in Myanmar. In particular, this study expanded upon the cost of healthy diet metric's estimation of the bare minimum cost of achieving dietary recommendations with a variant that takes food preferences into account.

This case study also compared both cost of healthy diet metrics to Myanmar's official food poverty line (MoPF and World Bank, 2017a, 2107b). The country's food poverty line is derived from a basket of foods determined by food consumption quantities of poor households in the 2015 MPLCS. Unlike the nutritious foods outlined in recommended diets that form the basis of the costs of a healthy diet and of a healthy diet with food preferences, the Myanmar food poverty line basket includes all foods and non-alcoholic beverages in the 2015 MPLCS household food survey. In order to satisfy the most basic nutrition requirement, the basket is scaled to meet energy sufficiency based on the caloric needs of the Myanmar population (2 238 per capita). The food poverty line is simply the cost of acquiring the energy sufficient food basket at median household prices. To achieve consistency between the two, both healthy diet food baskets are also scaled to meet the 2 238 calorie target.[12] (For a more detailed methodology, see Annex 6.)

The healthy diet with food preferences method is analogous to the determination of food poverty lines in that within-food group costs are based on consumption quantity shares observed in the poorest households (within 10 percentage points of the poverty line) in the household survey. We take advantage of this similarity to show how nutritional needs can be taken into account in determining poverty lines and poverty estimation. Unlike current food poverty line estimation methods, the healthy diet with food preferences method additionally requires that minimum food group-level proportional criteria are met so that diets used in the estimation align with FBDG.

Myanmar does not have quantitated FBDG, and therefore guidelines from neighbouring Bangladesh provide the recommended diet used in this analysis. The Bangladesh FBDG is generally consistent with the food groupings and messages presented in a preliminary FBDG developed by the Myanmar Government (Shaheen *et al.*, 2013; MoHS, no date).

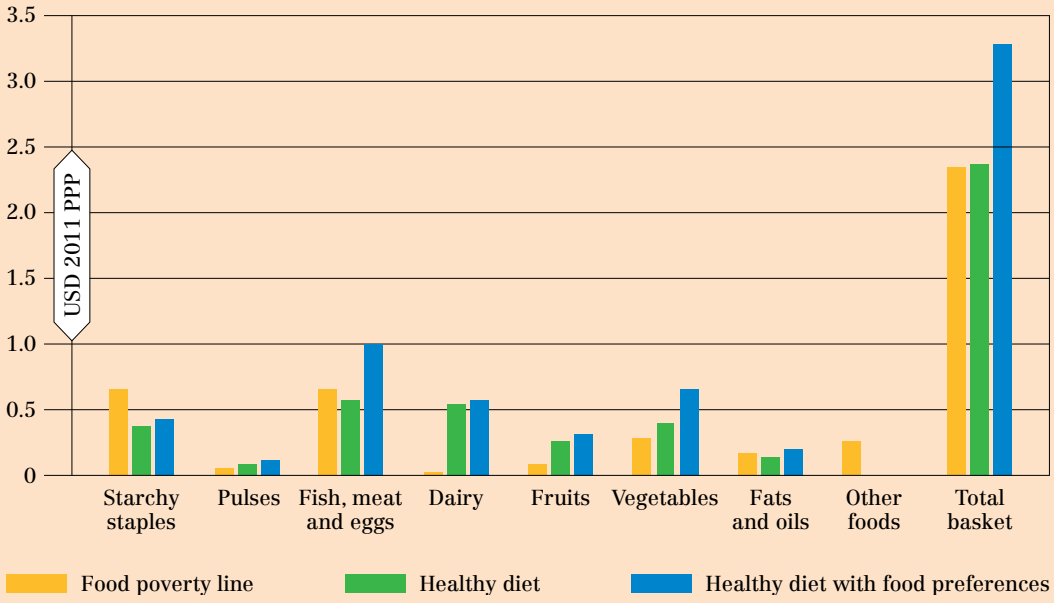
Figure 20 presents total and food group costs of the three food baskets: food poverty line, healthy diet, and healthy diet with food preferences. Differences in costs between the three are driven by two factors: basket composition and the costs of items within each food group. Basket composition is the primary factor driving differences in food group costs between the food poverty line and healthy diet with food preferences baskets, as food group costs in both baskets are based on the same actual consumption patterns. Differences between the costs of the cheapest foods and the preferred foods in each food group drive the differences in costs between the healthy diet and healthy diet with food preferences baskets. For the latter, a preference for higher-priced animal source foods is the main driver of its higher cost.

Figure 21 highlights the considerable difference in the caloric content between the food poverty line and healthy diet with food preferences baskets. Not surprisingly, nearly three-quarters (72 percent) of calories in the former are derived from starchy staples compared to just over half (53 percent) in the latter, which allocates a greater share of the diet to more nutrient-dense foods. Figure 22 illustrates cost shares of the two baskets. The cost share of starchy staples in the food poverty line basket is more than double that of the healthy diet with food preferences basket (30 percent versus 13 percent). Notable in both Figures 21 and 22 is the absence of dairy from actual consumption which stands in sharp contrast

[12] This calorie target is 91 kcal lower than the calorie target for an active 30-year-old woman used in the global analyses of this report.

to its 17 percent cost share in the healthy diet with food preferences basket. These large differences in the composition of both baskets are evident in the total costs of nearly every food group (Figure 20).

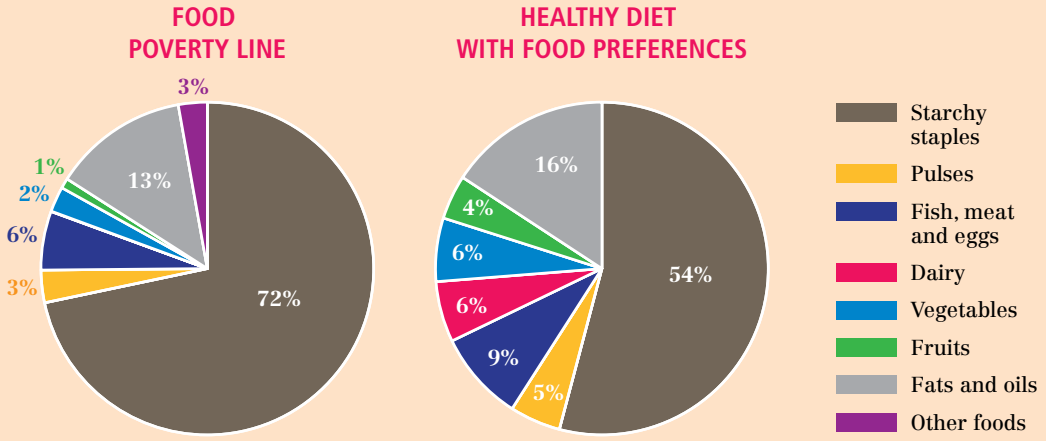
FIGURE 20 Cost of each food group for three food baskets in Myanmar



Notes: Data shown are 2011 USD purchasing power parity (PPP) per day and refer to the items in the food baskets used to compute the country's food poverty line, healthy diet and healthy diet with food preferences baskets. All diet costs exclude food away from home, and are scaled to 2 238 kcal/day.

Source: Authors' elaboration; Ministry of Planning and Finance (Myanmar) and World Bank, 2017a.

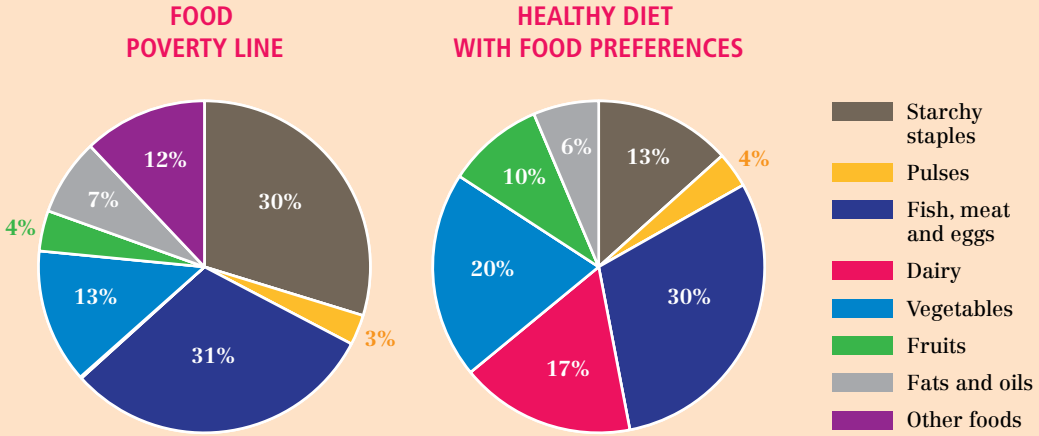
FIGURE 21 Calorie shares by food group in two Myanmar food baskets: food poverty line and healthy diet with food preferences



Note: The food poverty line basket excludes food away from home and is scaled to meet the 2 238 calorie target.

Source: Authors' elaboration; Ministry of Planning and Finance (Myanmar) and World Bank, 2017a.

FIGURE 22 Cost shares by food group in two Myanmar food baskets: food poverty line and healthy diet with food preferences

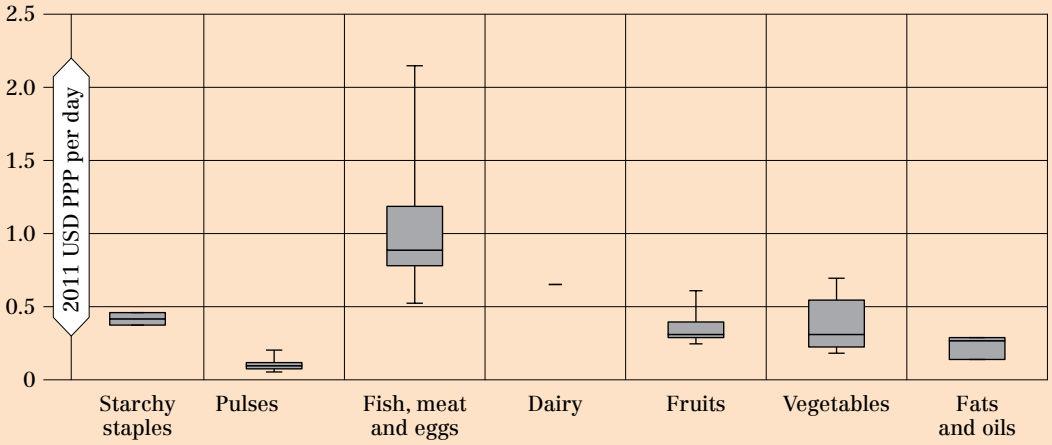


Note: The food poverty line basket excludes food away from home and is scaled to meet the 2 238 calorie target.

Source: Authors' elaboration; Ministry of Planning and Finance (Myanmar) and World Bank, 2017a.

Figure 23 highlights the other important factor driving differences in the cost of diets – the price premium of current consumption patterns compared to least-cost food selection. The cost of starchy staples, pulses, and oils varies little among the most commonly consumed food items. In contrast, the costs of animal source, protein-rich foods, and to a lesser extent vegetables, have a much wider distribution. This variation in costs is reflected in the large differences in the cost of fish/meat/eggs and vegetables between the healthy diet and healthy diet with food preferences baskets.

FIGURE 23 Costs of items in each food group in Myanmar



Note: Data shown are 2011 USD purchasing power parity (PPP) per day, as box plots for the cost of each food group in Myanmar. Box plots show the median, 25th and 75 percentile and 1.5 times that interquartile range for acquiring the recommended diet quantity in each food group. Food items are limited to those in the healthy diet with food preferences basket, using the median price of each food item observed in local markets. 2015 kyat converted to 2011 USD PPP using the World Bank's PPP conversion factor for private consumption (local currency units per international USD).

Source: Authors' own elaboration.

Table 7 provides greater detail on the costs of protein-rich foods in the healthy diet and healthy diet with food preferences baskets. The least-cost, animal source protein-rich foods are fish and eggs. Though the cost share of fish, legumes, and meat/eggs is quite similar between the two baskets, the addition of meat, particularly chicken, results in a diet cost that is nearly double that of a healthy diet (USD 1.38 PPP versus USD 0.78 PPP).

TABLE 7 Cost of protein-rich foods in two Myanmar food baskets: healthy diet and healthy diet with food preferences

Protein group food item or subgroup	Healthy diet basket		Healthy diet with food preferences basket	
	Cost per day (2011 USD PPP)	Protein group cost share (%)	Cost per day (2011 USD PPP)	Protein group cost share (%)
Fish/seafood	0.20	37	0.28	35
Legumes	0.06	13	0.08	10
Eggs	0.27	50	0.29	12
Chicken			0.80	22
Pork			0.55	14
Beef			0.77	7

Notes: Data shown are cost levels in 2015 kyat converted to 2011 USD purchasing power parity (PPP) using the World Bank's PPP conversion factor for private consumption (local currency units per international USD).

Source: Authors' own elaboration.

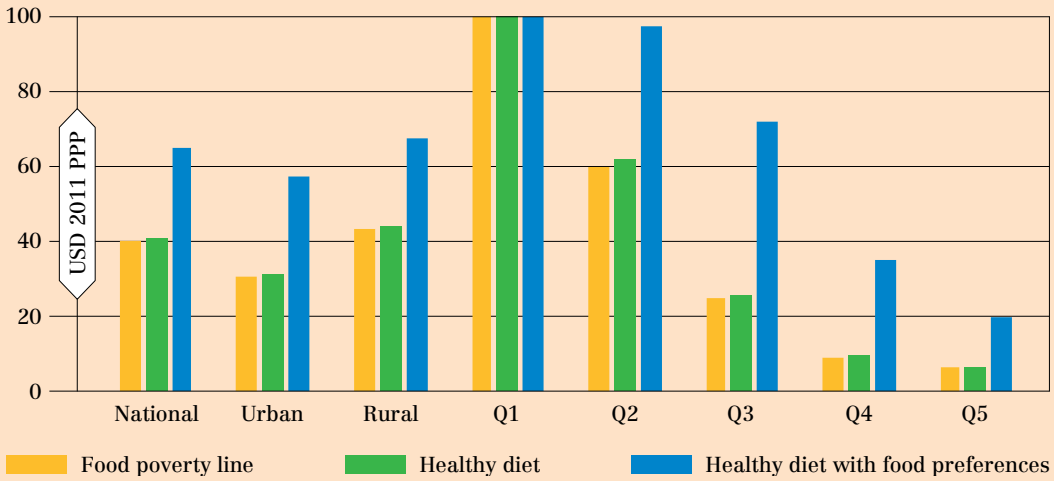
The three food baskets exceed reported household food expenditure for a large share of the population (Figure 24). Nationally, 40 percent and 41 percent of the population live in households that cannot afford the food poverty line or healthy diet basket without shifting non-food expenditure to food expenditure. Sixty-five percent cannot afford a healthy diet that aligns with food preferences. Furthermore, the majority of the population in the three lowest wealth quintiles cannot easily afford the healthy diet with food preferences basket.

In order to explore the impact of a more nutritionally complete diet that is also consistent with food group consumption patterns of poor households, we use the healthy diet with food preferences basket in place of the food poverty line basket to estimate a nutrition-sensitive poverty line. To facilitate comparison with Myanmar's official poverty rates, we calculate this poverty line as the sum of the healthy diet with food preferences poverty line and the official non-food poverty allowance. The non-food poverty allowance is an estimate of non-food expenditures by households with total consumption expenditures near the poverty line. Table 8 shows the composition of the official and healthy diet with food preferences poverty lines. Figure 25 shows the percentage of the population living in households with total expenditure below each poverty line. The healthy diet with food preferences poverty line indicates the share of the population that faces insecurity in attaining a healthy diet, and suggests that the share of the population facing such nutrition insecurity is 17 percentage points higher than the poverty rate, nationally, and 46 points higher (compared to zero) for the third wealth quintile.

Finally, we compare the nutrient composition of the baskets to the estimated average requirement (EAR) (IOM, 2006) of a 19–30 year old woman (Table 9). The costs of the healthy diet and healthy diet with food preferences baskets meet or exceed the EAR of most key nutrients, with the exception of vitamin E. In contrast, the food poverty line basket meets

approximately half of the EAR for calcium (53 percent), vitamin A (55 percent) and vitamin E (56 percent), and less than 80 percent of the EAR for vitamin C (74 percent), folate (78 percent) and vitamin B12 (71 percent). These serious micronutrient shortfalls call into question whether a calorie standard provides a sufficient nutrient standard for poverty line calculations.

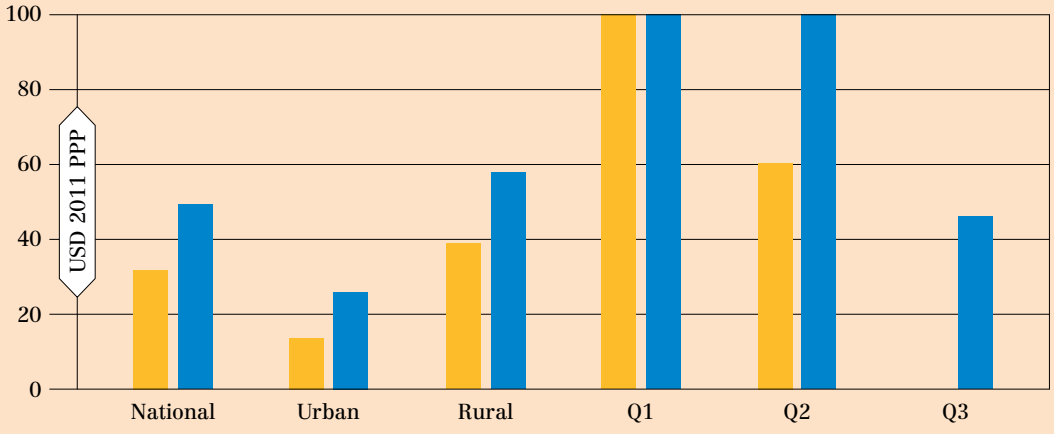
FIGURE 24 Affordability of food poverty line, healthy diet and healthy diet with food preferences baskets: % of the population living in households with food expenditure below the cost of each basket in Myanmar



Note: 2015 kyat converted to 2011 USD purchasing power parity (PPP) using the World Bank's PPP conversion factor for private consumption (local currency units per international USD). Q1 to Q5 denote wealth quintiles.

Source: Authors' elaboration; Ministry of Planning and Finance (Myanmar) and World Bank, 2017a.

FIGURE 25 Official poverty line headcounts compared to healthy diet with food preferences poverty line headcounts (%), by national, urban/rural and expenditure quintile in Myanmar



Note: Q1 to Q3 denote wealth quintiles.

Source: Authors' elaboration; Ministry of Planning and Finance (Myanmar) and World Bank, 2017a.

TABLE 8 Official and healthy diet with food preferences poverty lines in Myanmar

	Official poverty lines	Healthy diet with food preferences poverty lines
Food poverty line	2.34	3.27
Non-food poverty line	1.26	1.26
Total poverty line	3.60	4.53

Notes: For comparability, the official non-food poverty line is combined with the healthy diet with food preferences poverty line to estimate the total healthy diet with food preferences poverty line. 2015 kyat converted to 2011 USD purchasing power parity (PPP) using the World Bank's PPP conversion factor for private consumption (local currency units per international USD).

Source: Authors' elaboration; Ministry of Planning and Finance (Myanmar) and World Bank, 2017a.

TABLE 9 Nutrient adequacy of least-cost food baskets in Myanmar

Nutrient	EAR	Percentage of EAR		
		Food poverty line	Healthy diet	Healthy diet with food preferences
Protein (g)	38	144	163	177
Carbohydrates (g)				
Calcium (mg)	750	53	112	119
Iron (mg)	11	105	123	137
Magnesium (mg)	265	91	126	129
Phosphorus (mg)	580	139	176	185
Zinc (mg)	9	89	99	105
Copper (mg)	1	280	209	384
Selenium (mcg)	45	137	171	153
Vitamin C (mg)	80	74	153	190
Thiamin (mg)	1	87	103	122
Riboflavin (mg)	1	51	122	100
Niacin (mg)	11	112	97	128
Vitamin B6 (mg)	1	106	135	135
Folate (mcg)	250	78	169	149
Vitamin B12 (mcg)	2	71	118	154
Vitamin A (mcg)	490	55	107	116
Vitamin E (mg)	12	56	89	84

Notes: Data shown are adequacy levels by nutrient of the food baskets shown for a representative woman aged 19–30, with a 2 238 calorie diet. Light shading indicates above 90 percent, medium 80–89 percent, and dark below 80 percent.

Source: Authors' elaboration; Ministry of Planning and Finance (Myanmar) and World Bank, 2017a.

5 Global simulation of policy impacts on the cost of a nutrient adequate diet

KEY MESSAGES

- Public investment and government services can lower food prices and diet costs through innovation and market infrastructure, but governments also often cause prices to rise when they impose trade restrictions. Restricting imports protects a country's producers of a particular item, at the expense of others in that society. Trade restrictions arise most often where the burden of higher prices is spread among many dispersed consumers, while the protected group is well-organized and influential.
- Analysing price data by food group reveals that protectionism raises price the most for poultry and eggs, and vegetables. These items have economies of scale and are grown on larger farms, near cities, whose owners have more influence than other farmers, while consumers of these items are dispersed and may not know that prices are raised by trade restrictions. Protection of influential groups also raises prices for other foods, especially in middle- and high-income countries.
- The overall rise in cost of the most affordable diets was in the range of USD 35–USD 70 per year (10–20 cents/day) in middle- and high-income countries in 2011, with the same level in high-income countries in 2017, and wide variation elsewhere. This increase in diet costs could be a significant factor in diet quality, especially for low-income people in middle-income countries.
- Easier access to some imported commodities could lower consumer prices, as could reducing transport costs within countries. Using Monitoring and Analysing Food and Agricultural Policies (MAFAP) data we find impacts on total diet cost in Africa of possible domestic transport cost reductions in the range of USD 2–USD 11 per year. Greater price reductions might be possible through a combination of interventions that raise farm productivity and lower marketing costs in various ways, tailored to local needs for each type of food.

5.1 Impacts of trade policy and farm-to-market transport costs on the cost of nutrient adequate diets

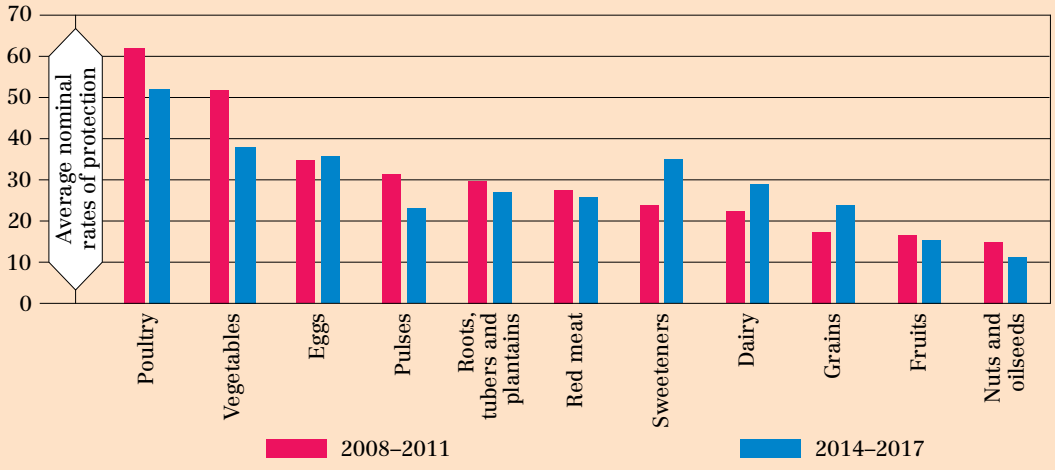
A wide range of policies can lower the cost and improve affordability of nutritious foods, including government support for research and development of new technology, public irrigation infrastructure, land development, rural transport, electrification and markets, as well as the institutions and regulations needed to maintain product standards and quality assurance. These policies offer highly cost-effective ways to help both farmers and food

consumers by raising productivity, typically lowering diet cost and improving access to nutrient adequate and healthy diets through delivery of public services tailored to each place and time (Norton, Alwang and Masters, 2014).

In this section, we focus on trade restrictions at each country's borders, as a type of agricultural policy that allows governments to help specific groups without need for public expenditure or service delivery. We describe the available data on how these restrictions change prices in low- and middle-income countries, and the effect of those price changes on diet costs. For comparison, we also show how food prices and diet costs would change if governments aimed to reduce the cost of transporting foods by investing in improved infrastructure and institutional reforms. Governments impose trade restrictions, and invest less in transport-cost reductions than consumers might want, so as to protect the influential local producers who benefit from higher prices without having to incur any fiscal cost. Some trade barriers actually raise government revenue through tariffs and the sale of quotas or licenses. The price changes that result from trade restrictions typically deliver gains that are concentrated among few members of well-organized groups that advocate for restriction, while their costs are spread among all consumers in the country so that each consumer bears a small share of the burden and is unlikely to be aware of that cost. Which sectors receive this protection depends on their relative influence in government, as detailed in Anderson (2016).

Our data on trade policies consist of percentage nominal rates of protection (NRPs), obtained by comparing a country's observed farm-gate commodity prices with the best available estimate of what that price would be if government policies did not restrict international trade. These estimates are available for 58 food commodities in 62 countries, based on prices observed in farm surveys and rural wholesale markets, as well as commodity prices observed for international trade adjusted for estimates of inland transport and handling costs, reported as farm-gate equivalent NRPs. To smooth fluctuations and match with our retail prices, we use all values observed in the four years leading up to and including each round of ICP price collection, then aggregate them into food groups and national income levels as shown in Figure 26 and Figure 27.

FIGURE 26 Worldwide average nominal rates of protection, 2008–2011 and 2014–2017

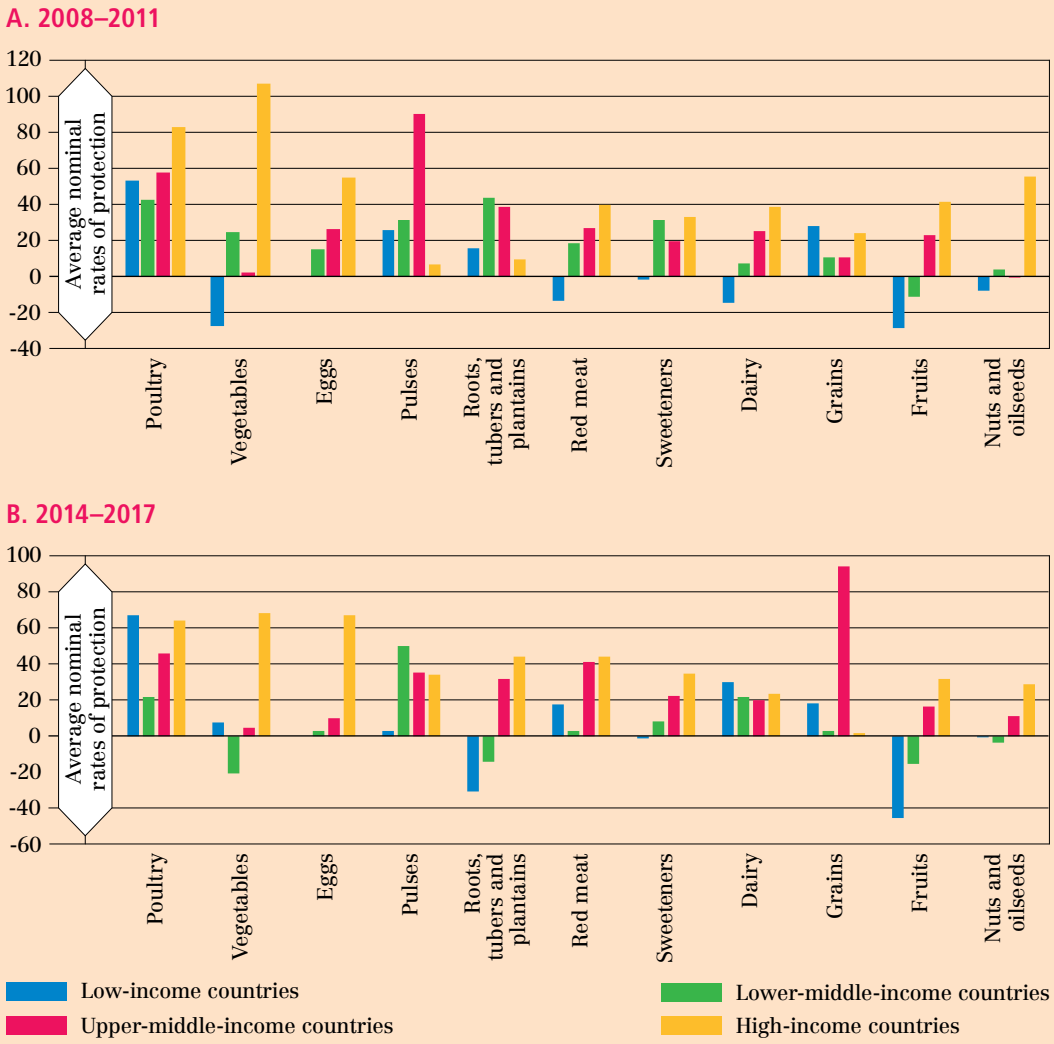


Notes: Data shown are worldwide average percentage effects of trade policy on the wholesale price of commodities from each food group computed from a total of 3 581 observations over 58 food products in 62 countries. Sources are detailed in the methodological Annex 7.

Source: Authors' own elaboration.

Figure 26 and Figure 27 are sorted by food group, in decreasing order of support for farmers producing the traded commodities in that food group. Poultry producers are the most highly protected worldwide in both time periods shown, and vegetable farmers are highly protected in high-income countries. Both groups, however, saw a decline in average protection from the 2008–2011 period to the 2014–2017 period. Most but not all categories are more protected in higher-income countries in both time periods. Pulses, often a significant contributor to least-cost diets, are less protected in the later period for all income groups except upper-middle-income countries. The average NRP is sometimes negative, which could be sustained over time only when the government restricts exports to help the country's buyers of that product. While countries in each income level observe some export restrictions on specific commodities, only for low- and lower-middle-income countries is this common enough to result in a negative average protection value at the food group level.

FIGURE 27 Average nominal rates of protection by food group and country income group



Notes: Data shown are average percentage effects of trade policy on the wholesale price of commodities from each food group in countries at each level of national income, computed from a total of 2 154 observations over 58 food products in 62 countries in 2008–2011 and from a total of 1 427 observations over 56 food products in 53 countries in 2014–2017. Sources are detailed in Annex 7.

Source: Authors' own elaboration.

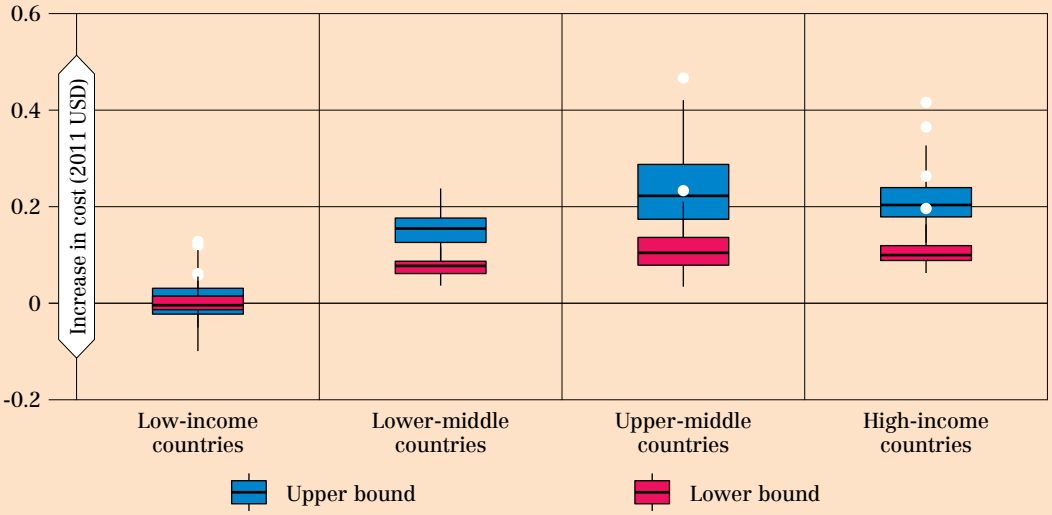
For all negative NRP observations, we check to ensure that the country is actively exporting that product or could do so competitively. When this is not the case, we classify these observations as measurement errors or temporary outliers and trim the value to zero. The criterion we apply is whether the country's FAO food balance sheet reports net exports of that product in any of the four years leading up to and including the year of observation. For these exportable foods, negative NRPs could be sustained by any policy that limits the quantity exported, whereas negative NRP observations in other settings could be sustained only through government subsidy payments for the entire quantity consumed in that country, which is implausible even in countries with large government outlays. We assume these values are caused by differences in quality, context and timing of comparisons between items whose prices are compared in the NRP.

To compute the consequences of agricultural protection for the cost and affordability of a nutrient adequate diet, first we estimate the impact of these commodity NRPs on the purchase price of retail items, taking account of variation in the wholesale product's share of each item's retail price. Our upper bound on price effects represents a scenario where farm-gate commodity prices account for one-half of retail prices paid, and our lower bound represents a scenario where that fraction is one-fourth. For each scenario we identify the quantities of items needed to meet nutrient requirements at the lowest total cost per day, and show the added expense imposed by the country's agricultural trade restrictions (see Annex 7 for detailed methodology).

Figure 28 and Figure 29 present the range of upper and lower bounds across countries in 2008–2011 and 2014–2017, showing that agricultural trade policies raise the cost of a nutrient adequate diet anywhere from 0 to 30 cents per day at the median, or roughly USD 0–USD 108 per year per person, globally. In both time periods, cost increases are highest in upper-middle-income and high-income countries. These groups see roughly the same median increase in 2008–2011. In 2014–2017, upper-middle-income countries see about 1.5 times the increase that high-income countries do, although with greater variation in effect. While lower-middle-income countries see a USD 28–USD 57 increase per annum due to trade policy in 2008–2011, this effect is much less in 2014–2017, at USD 7–USD 17. In low-income countries, the median change is approximately zero in 2008–2011, but in 2014–2017 this group sees potential cost savings of USD 15–USD 32 per person per annum, were trade restrictions to be lessened. For these countries, the food group for which agricultural protection most raises price is grains, followed by pulses, staple root vegetables, and other vegetables. In all of these categories, trade restrictions to protect farm producers lead to retail price rises that could place nutrient adequate diets out of reach for many consumers, especially the poorest.

In general, the largest plausible impact on consumer prices is twice the smallest plausible impact in percentage change terms. The actual range of impacts on consumer costs also depends on substitution among items. When an item's price increase (or decrease) is large enough, its quantity in the most affordable diet decreases (or increases) and is replaced by other items that can meet nutrient needs at a lower cost. For that reason, the actual impact of a given policy change on consumer prices at the upper bound is not always twice the lower bound, and a paradoxical reversal can occur when substitution shifts consumption from highly affected to less affected foods. In the cases of Benin, Sierra Leone, Ethiopia and Zimbabwe in 2008–2011, the change in diet cost at the upper bound is slightly smaller in absolute value than the change in diet cost at the lower bound of price transmission, because the upper bound triggers a large change away from items that are highly affected by trade policy towards items that are less affected.

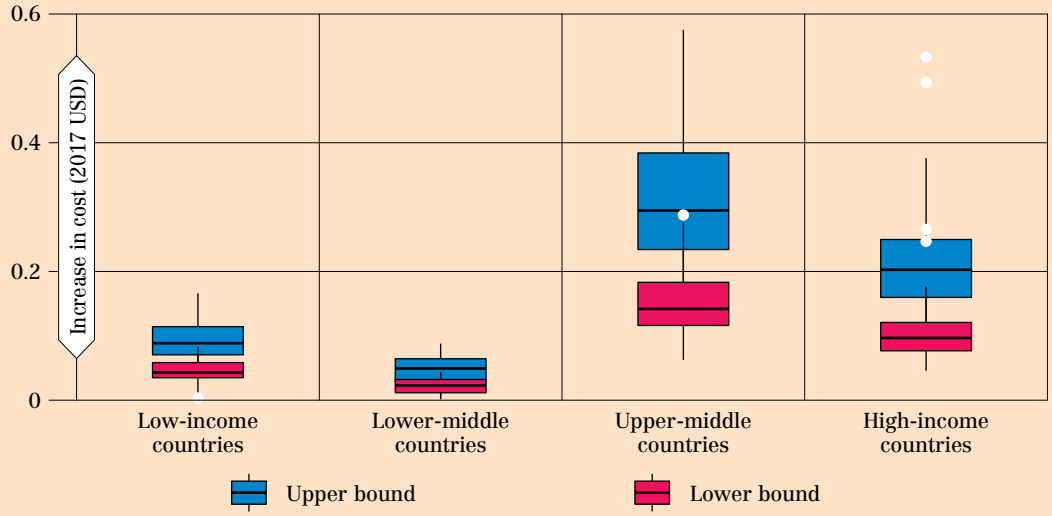
FIGURE 28 Change in cost of a nutrient adequate diet due to agricultural trade policy, 2008–2011



Notes: Data shown are median, 25th and 75th percentile range, and whiskers of 1.5 times that range for the effect of trade policy on daily retail cost of a nutrient adequate diet for an adult woman, in 2011 USD, under two scenarios: the upper bound applies to settings where wholesale costs affected by trade policy account for a large fraction of retail price, such as generic items sold in open markets; while the lower bound applies to settings where trade policy and wholesale costs are a smaller fraction of retail prices, such as supermarkets (as explained in the text and the methodological appendix). The following outliers are not shown: Japan (upper: 0.53) and Republic of Korea (upper: 0.74) in the high-income group.

Source: Authors' own elaboration.

FIGURE 29 Change in cost of a nutrient adequate diet due to agricultural trade policy, 2014–2017



Notes: Same as for Figure 28. Here, the following outliers are not shown: Bhutan (-0.2, -0.01), Mauritania (-0.01, 0), El Salvador (-0.15, -.08) and Sudan (-0.2, -0.12) in the lower-middle-income group; and Guinea (-0.07, -0.03), Comoros (-0.1, -0.08) and Chad (lower: -0.02) in the low-income group.

Source: Authors' own elaboration.

5.2 Impacts of transport cost reduction on the cost of nutrient adequate diets

This section considers the effect of within-country transport costs on the cost of nutrient adequate diets in 14 sub-Saharan African countries for which MAFAP collects agricultural commodity transport data. Estimates of potential decreases in farm-gate to wholesale transportation costs use as a reference point the country infrastructure of South Africa, the most efficient country in the region. Using the ratio of the infrastructure dimension of the World Bank's Logistics Performance Index in each country to that of South Africa, the MAFAP team calculated an adjusted transport cost for 21 commodity value chains (FAO, 2020a).

For this study, we compute an estimated transport cost reduction (*TCRij*) for each of the 21 commodities indexed *i*, in each of the 14 countries indexed *j*, in each year of observation *t*. Other models would be needed to take account of how a country's food system might adjust to changes in its farm-to-market transport costs; here we isolate only the transport cost change, holding all else constant, and apply the *TCR* for each product in each country to identify plausible changes in retail prices if farm-gate and traded product prices remained unchanged. For a price shock that can be compared directly to MAFAP's tariff-equivalent nominal rate of protection from trade policy, we express *TCRijt* as a fraction of the observed farm-gate price (*Pijt*), focusing on the cost difference between farm-to-market transport costs with reference-country infrastructure (*TiRt*) minus the observed farm-to-market transport costs (*Tijt*):

$$TCR_{ijt} = \frac{T_{iRt} - T_{ijt}}{P_{ijt}} \quad (1)$$

To apply farm-gate commodity-level shocks to retail prices, we average the shocks for ten food groups over the four years leading up to and including 2011 and 2017 – the ICP price collection years. Food groups vary in the number of countries and years for which transport cost estimates are available. Cereal grains have the most frequent transport cost data, with 128 observations across all 14 countries in each four-year period. Observations of nutrient-dense food groups such as dairy, fruits, poultry and eggs, red meat, and vegetables are relatively sparse, and often comprised of only one or two commodities from one or two countries.

As shown in Table 10, average shocks range from -0.68 percent for dairy in 2014–2017 to 6.75 percent for sweeteners in 2008–2011. In almost all cases, the shock in 2011 is greater, which would be consistent with countries in this region improving transportation infrastructure over time, so they are closer to cost levels in the reference country. Those groups for which the shock is based on only one product in one country are indicated by an asterisk.

We assume that the entirety of the transport cost reduction is passed on to the commodity price. Following the methodology of our trade policy simulation, we apply farm-gate-level food group price shocks to one quarter and one half of the retail prices, representing lower and upper bounds of impact (for details, see Annex 7). One key difference between the 2011 and 2017 simulations is the diversity of foods represented in the ICP retail data for the 14 countries studied here. In 2011, there were 259 foods in these countries compared to only 161 in 2017. This change in diversity may limit the sensitivity of the least-cost diet metric to individual country contexts.

TABLE 10 Transport cost changes used for simulation, by food group in 2008–2011 and 2014–2017

Food group	2008–2011	2014–2017
Dairy	-1.81%*	-0.68%*
Fruits	-5.98%*	-5.99%*
Grains	-5.16%	-3.12%
Nuts and oilseeds	-2.42%	-1.38%
Poultry and eggs	-3.32%*	-2.96%*
Pulses	-2.23%	-1.94%
Red meat	-3.09%	-2.49%
Roots, tubers and plantains	-6.32%	-3.03%
Sweeteners	-6.75%	-4.89%
Vegetables	-1.74%*	-2.06%*

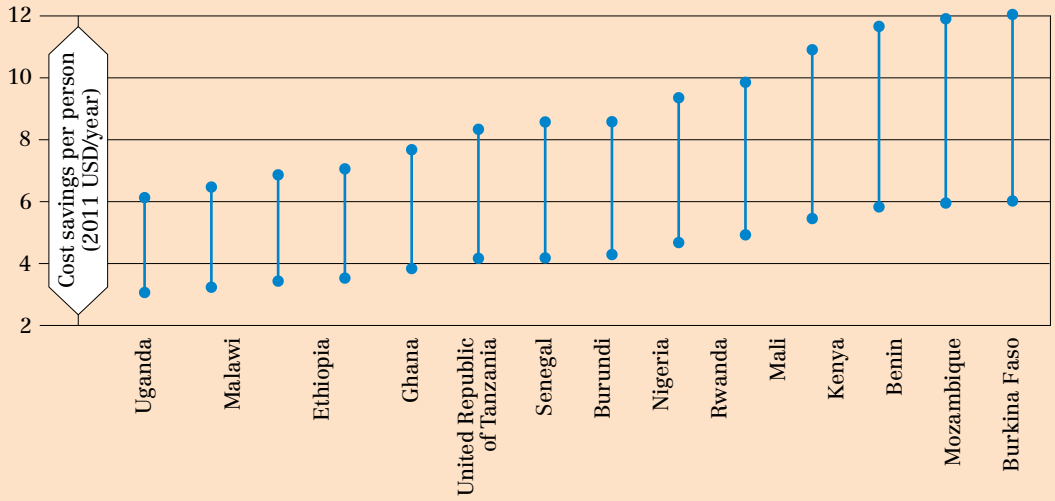
Note: Data shown are averages over all observations in each food group and time period.

Source: Authors' own elaboration.

Figure 30 and Figure 31 show the upper and lower bounds of annual cost savings for a least-cost nutrient adequate diet due to transport cost adjustment. In 2011, annual savings range from USD 2.80 to USD 11.06 per person, measured in 2011 USD at purchasing power parity (PPP). For Burkina Faso, Mozambique and Benin, the upper-bound effect is more than USD 10 per person per year, while Uganda and Malawi see relatively small savings of less than USD 6 at the upper bound. In 2011, we also see two alterations in the composition of the least-cost diet. The high transport shock adjustments for fruits and for roots, tubers and plantains make oranges a cost-efficient source of micronutrients in Burkina Faso and shift the least-cost diet in Burundi to include sweet potatoes rich in vitamin A.

In 2017, effects are more modest, ranging from USD 2.24 to USD 11.15 per person per annum, measured in 2017 USD at PPP. Potential savings amount to USD 7 per capita per year, on average, across the countries analyzed. Assuming an average household size of five members, these savings could amount on average to USD 35 per household, and up to USD 50 per household on an annual basis. Burkina Faso sees markedly higher savings compared to other countries, with savings per household amounting to USD 55 per year, while at the lower end of the effect range, Rwanda, Burundi, Malawi and Senegal all see annual cost savings of less than USD 6 per person at the upper bound. There are no changes in the composition of the least-cost diet in 2017. The lessened effect is consistent with the lower average shocks in each food group in 2017 and suggests that while infrastructure continues to improve in this region, there are still non-negligible costs of transportation inefficiency that may affect poorer consumers who struggle to access nutritious foods.

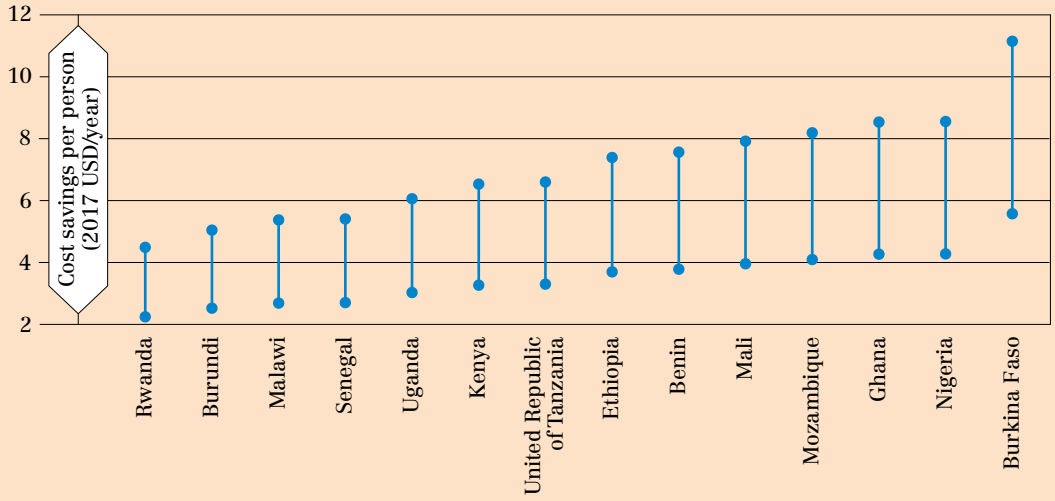
FIGURE 30 Change in cost of the nutrient adequate diet from lower transport costs, 2008–2011



Notes: Data shown are upper and lower bounds of estimated savings in annual cost of a nutrient adequate diet due to increased efficiency in transportation infrastructure, in 2011 USD. Upper bounds apply to settings where farm-gate to wholesale transportation costs account for a larger fraction of retail price, such as generic items sold in open markets, while lower bounds apply to settings where farm-gate to wholesale transportation costs are a smaller fraction of retail prices, such as supermarkets.

Source: Authors' own elaboration.

FIGURE 31 Change in cost of the nutrient adequate diet from lower transport costs, 2014–2017



Notes: Data shown are upper and lower bounds of estimated savings in annual cost of a nutrient adequate diet due to increased efficiency in transportation infrastructure, in 2017 USD. Upper bounds apply to settings where farm-gate to wholesale transportation costs account for a larger fraction of retail price, such as generic items sold in open markets, while lower bounds apply to settings where farm-gate to wholesale transportation costs are a smaller fraction of retail prices, such as supermarkets.

Source: Authors' own elaboration.

6 Applications of new food price metrics

KEY MESSAGES

- The metrics we use in this study are designed for use in current food price monitoring systems, to enable better use of food prices for understanding access to healthy diets. The metrics can be calculated and used by anyone (i.e. in government, international agencies, or research) with food price data covering a sufficient diversity of foods that constitute a healthy diet.
- The international poverty line of USD 1.90 per day is insufficient to maintain a healthy diet. This basic observation at the international level is echoed at the national level, as shown in the Myanmar case study. It calls for a re-evaluation of how food poverty lines are determined, and how they could be constructed in a way that accounts for nutritional needs.

6.1 Implications for food price monitoring

Food price data collection infrastructure

Measurement of cost and affordability in this study is made possible by the standardized collection of food prices by national governments and international agencies. Most of the price data we have used here, both through the ICP and national datasets, is collected by central statistical agencies for CPI calculations, using protocols developed for the United Nations System of National Accounts. Other price data are collected by agricultural agencies to track the prices of specific commodities, in market information systems (MIS) used to understand commercial opportunities. MIS data are collected at both retail and wholesale markets, targeting a variable and often limited number of high-volume commodities; they are not standardized across countries or uses.

How food prices are currently used

- CPI data is collected frequently (bimonthly at least) at retail markets to help countries track inflation, determine poverty lines, and measure economic activity over time.
- MIS data are collected frequently and primarily used to understand commercial opportunities. They sometimes contain data on diverse foods.
- Prices of staple foods are also used for vulnerability assessment and mapping, to monitor food price spikes and warn against potential calorie inadequacy.
- FAO or other agencies track global food prices, but these monitor only internationally traded commodities, which omits information about the many diverse foods on retail markets needed for a healthy diet.

- The ICP collects data from national governments on a standardized list of items that can be compared across countries, once every three to seven years, for the purpose of producing purchasing power parities (PPPs) and comparable price level indexes (PLIs).

Opportunities for using existing data better

Currently, food prices from all these sources are not tracked in a way that describes the price of adequate or healthy diets. However, the underlying data can be used for that purpose:

- Consumer price index (CPI) data are collected by almost all UN Member States. They aim to collect prices for a sufficient range of foods to represent national average food expenditures, typically including between 40 and 200 (and sometimes more) distinct foods and beverages which is usually enough diversity to measure the cost of nutrient adequate and healthy diets. To reliably capture the most affordable options, CPI data should include a range of fruits, vegetables, legumes, fish, eggs, dairy products and other nutrient-rich items that are locally available in markets used by low-income households. Prices for each food are typically collected monthly at multiple locations, then averaged to obtain annual or regional totals. The underlying prices for individual items are often treated as confidential but may be available to specialized researchers.
- Market information system (MIS) data are available for a limited range of countries and time periods, but in some countries can be diverse, frequent, and sufficiently high quality to be useful for calculating the cost of healthy diets. It is also sometimes possible to update MIS to include a wider range of more nutrient-dense items.
- The food price data contained in the ICP datasets have been underutilized for understanding the cost of diets; this analysis as well as Hirvonen *et al.* (2019) and Bai *et al.* (2020) reveal new insights across countries.

The metrics we use in this study are designed for use by a wide range of actors at diverse scales, from national governments and international agencies to programme implementers and academic researchers. Diet costs can be computed for people at any time and place where market prices are available for a sufficient diversity of foods. To reflect the cost of a healthy diet, a convenient rule of thumb would be to have prices for at least 60 items, including legumes, nuts and seeds, dark green leafy vegetables, other vegetables, deep orange vitamin A-rich fruits, other fruits, meat, fish, dairy, eggs and poultry as well as the most commonly consumed starchy staples. To reflect the most affordable healthy diets, price data should be collected for the lower-cost items in each food group at marketplaces that serve low-income people.

Governments and international agencies can use their food price data better to understand access to nutritious food by adopting metrics such as the cost of the healthy diet and NPI, as the Government of Ghana (Ghana Statistical Service) has announced they intend to do. Information on the cost and affordability of healthy diets, and identification of their most costly components, can then inform policies and interventions to improve food access. Interventions vary widely, and may include improving markets, on-farm own production, cash transfers, and other context-specific solutions. Projects/interventions can also use food price data in specific locations for programme design, monitoring and evaluation.

6.2 Implications for poverty estimation

It is clear from this analysis that the international poverty line of USD 1.90 per day is insufficient to allow access to a healthy diet. This basic observation at the international level is echoed at the national level, as shown in the Myanmar case study. It calls for a re-evaluation of how food poverty lines are determined, and how they could be constructed in a way that accounts for nutritional needs.

Existing food poverty lines typically use what is called a "cost of basic needs" (CBN) approach. Our analysis suggests the potential to use healthy diets instead, following the healthy diet with food preferences method that rescales poverty line food baskets to attain levels of consumption needed for a healthy diet. This is important because for many actors in governments (specifically in national statistical organizations), one of the main purposes for household food consumption, price and quantity data is to determine poverty lines. The CBN approach for poverty line calculation uses food consumption data to determine the cost of a typical diet consumed by poor households scaled to meet basic energy needs, which may be quite different from a nutritional standard.[13]

CBN poverty lines are based on the actual consumption patterns of poor or nearly poor households. This approach depends on the concept that poor households are best able to determine how to allocate their resources and as such is an approach that is decidedly not paternalistic (Ravallion, 2016).[14] In other words, the CBN approach hinges on preferences of poor households. More specifically, the food poverty line is commonly constructed from a basket of foods, including associated average quantities, consumed by poor or nearly poor households. This food basket is scaled to meet energy requirements and then evaluated at median prices, which yields the food poverty line. The total poverty line is the sum of the food poverty line and an allowance to meet essential non-food needs.

Attaining sufficient energy intake is the most fundamental purpose of food consumption, and thus the CBN poverty line provides a measure of severe deprivation. Food poverty lines reflect the dietary preferences of households striving to meet their basic food needs given limited resources. However, relatively poor households are likely to consume disproportionate quantities of low-cost per calorie staple foods such as rice (see for example, Headey and Alderman, 2019). The over-representation of staples in the food basket relative to a healthy diet is apparent in the Myanmar case study (see Figure 21). As a result, the Myanmar poverty line food basket fails to meet the nutritional standards of key micronutrients (see Table 9). Consequently, poverty lines tied only to energy requirements underestimate the cost required to access a nutrient adequate diet. Food policy in low- and middle-income countries is shifting from meeting energy needs with a focus on staple crop production to diverse diets and food systems. As policy increasingly prioritizes meeting an array of nutrient requirements essential for good health, a food poverty line designed to satisfy nutrient requirements would provide a useful additional policy tool.

The healthy diet with food preferences method has a number of features that make it a convenient choice for a food poverty line that meets nutritional needs. First, as with the poverty line food basket, the cost is calculated using consumption patterns of a reference population and is in alignment with actual dietary norms. This method is analogous to the determination of food poverty lines in that the costs within food groups are based on consumption quantity shares observed in household surveys among poor households. But unlike poverty line food basket estimation, the healthy diet with food preferences method additionally requires that minimum food group-level proportional criteria be met in order to adhere to the FBDG. Thus, the resulting poverty line is consistent with consumption patterns among poor households *within* food groups while realigning consumption *between* food groups to meet nutritional standards. This realignment of consumption patterns between food groups is an important conceptual deviation from the CBN approach which, as noted, is designed to allow for food poverty lines to meet nutritional standards without being prescriptive.

13 See Ravallion (2016) for a comprehensive discussion of CBN poverty line estimation.

14 In some cases, such as Myanmar, food baskets exclude alcohol (MoPF and World Bank, 2017b).

Second, the healthy diet with food preferences method is based on FBDG which are national policy and education tools and thus provide a relevant and policy-coherent basis for setting food poverty lines that are consistent with cultural norms as well as existing policy. Developing a methodology that results in a higher poverty rate can be politically contentious. Aligning the methodology with existing and accepted government guidelines has a clear advantage. Finally, the healthy diet with food preferences approach is straightforward and requires no more computational ability or tools to implement than the existing CBN poverty line methodology.

One challenge with this new method relates to the imposed reallocation of food consumption between food groups in accordance with FBDG, which introduces a hypothetical scenario without observable household food preferences. A reallocation from the relatively cheap staple food group to nutrient-rich yet more expensive food groups would likely be accompanied by a reallocation toward cheaper items within those food groups. For example, a poor household striving to meet FBDG might shift some consumption within an animal source protein-rich food group away from relatively expensive meats toward eggs or cheaper varieties of fish. As a result, the cost of attaining a healthy diet given food preferences is likely overestimated.

However, poverty lines tied only to energy requirements clearly underestimate the cost of attaining a diet that meets nutritional needs. Combined with the existing non-food allowance of the CBN poverty line, a healthy diet with food preferences total poverty line can be constructed and compared to total household expenditure to calculate the nutrition-sensitive poverty headcount. Used in conjunction with the traditional CBN poverty line, this poverty line provides a complementary poverty measure that considers nutritional needs. In a sense, both poverty lines taken together provide bounds rooted in household consumption patterns. The latter results in a nutrition-sensitive poverty line higher than the CBN poverty line, with a greater proportion of expenditure required for food. This suggests a higher share of the population faces insecurity in attaining a healthy diet than suggested by the poverty rate.

Others have attempted to construct nutrition-based poverty lines based on nutrient needs. Allen (2017) introduces a linear programming approach to estimating international poverty lines based on three least-cost diets that satisfy three levels of nutrient requirements. Allen argues that a food poverty line should be based on the cheapest foods, as a poverty line "represents the cost of meeting basic needs, not a level of satisfaction, and should be set accordingly" (Allen, 2017, p. 3708). This is a considerable departure from the CBN approach which strives to estimate the cost of a bundle of foods that poor households would be willing to consume. Ravallion (2016) argues that attaining adequate nutrition is not the only purpose of food consumption and that ignoring established food culture risks setting a food poverty line at an expenditure level unrelated to what poor households actually spend. Importantly, the linear programming approach ignores the proportionality needed in healthy diets, which is reflected in FBDGs that are government policy documents intended for *all* citizens. Furthermore, the least-cost nutrient-based approach results in diets that are even less proportional than the current CBN method. Nutrient-only standards do not present an equitable and dignified approach to meeting nutritional needs.

In the Myanmar case study, we have demonstrated that food baskets used to construct standard CBN poverty lines fall short in meeting both nutrient and food group proportionality standards. We argue that it is time for nutritional needs to be considered as basic needs.

7 Policy options for improving affordability of healthy diets

KEY MESSAGES

- Public funding for agricultural research and development has made grains and starchy staples relatively more abundant and cheaper relative to nutrient-rich items such as vegetables, fruits, and pulses, which have received much less public support for research and development. That imbalance is a key factor explaining the relatively high cost of nutrient adequate and healthy diets, because productivity growth driven by public services that support private-sector innovation has been the primary driver of cost reduction over time. Research and investment have not sufficiently reduced barriers to productivity and profitability of non-staple foods.
- Our results show that trade restrictions are likely to be harmful in that they raise the cost of foods needed for nutrient adequate and healthy diets.
- The cost of nutritious food should be lowered by diversification of public investment and increased market access, not by externalizing true costs by subsidizing inefficient or environmentally harmful production methods. Agricultural and trade policies should align with diet quality goals, as well as environmental, social and economic sustainability.

There is currently enough food produced for all people to meet and exceed their dietary energy needs, but even if this food were to be equally distributed it would be impossible for all people to meet dietary recommendations. For example, most countries lack adequate supplies of fruits and vegetables for all people to meet the WHO recommendations of 400 g or more of fruits and vegetables per day (Siegel *et al.*, 2014). Other micronutrient-rich food groups, such as beans, nuts, and animal source foods are also far less available and affordable than starchy staples (Herforth, 2015).

We see this reality play out on a global scale in the results of this analysis, showing that a staggering number of people cannot afford even the lowest-cost form of healthy diets. The main cause is that nutrient-dense foods are the most expensive components of the diet and make up a large share of the cost required. The purpose of the least-cost diet calculation is to establish a bottom floor: i.e. the lowest possible cost that someone would need to spend to achieve the dietary guidelines – whereas we know (and demonstrate in the Myanmar case study) that adding in food preferences only increases the cost, and thus the number of people who cannot afford the diet.

The inability of people to afford healthy diets results in food insecurity and poor diets. Poor diet quality has major impacts on malnutrition on all its forms. In relation to overweight, obesity and diet-related non-communicable disease, the consumption of ultraprocessed foods of minimal nutritional value, such as sodas, instant noodles, and packaged sweet and salty

snacks, has been rising in many countries experiencing nutrition transitions. The rise in consumption of these foods is based partly on the abundant supply and low prices of starchy staples, sugars and oils that constitute their main ingredients and make them relatively inexpensive, in addition to marketing which promotes these products as aspirational foods compared to traditional, minimally processed foods. The result is that basic starches make up too much of the diets of many people, whether in the form of monotonous, nutritionally inadequate diets or diets that promote obesity and non-communicable diseases.

Increasing access to healthy and sustainable diets will ultimately come from an interplay between supply-side and demand-side actions. Markets are a key arena where opportunities exist to affect both supply and demand of nutrition foods. A systems approach is needed to support increased supplies of vegetables, fruits, pulses, and sustainably produced animal source foods, including improvements in diversified and sustainable production, storage and transformation, and marketing.

Supply-side factors

The food environment – i.e. the kinds of food that are most available, affordable and convenient – is a major determinant of diets (Herforth and Ahmed, 2015). While consumer demand certainly influences what is produced, multiple supply-side factors do as well: for example, subsidies, standards at collection/trade points, quality of seed supply, pest resistance, transport and storage, and perishability. Supply-side policies and measures should align with diet quality goals, as well as environmental, social and economic sustainability.

Staple grains have been the focus of public investment in agriculture throughout human history, and particularly during the Green Revolution when more calories were urgently needed to avert famine. In almost all countries today, food and nutrition problems no longer call for just more calories, but for greater diversity in the food supply. Demand is increasing for diversified diets, but the supply response has been surprisingly low, partly due to risk for farmers and the other private-sector actors who supply each type of food (Pingali, 2015). Low productivity and high risk leave nutritious non-staple foods, such as fruits, vegetables and pulses, to remain out of reach for vast numbers of people.

Technological research and subsidies are needed to make more nutrient-rich, non-staple crops accessible. Growth in agricultural productivity is important and needed, but its traditional focus on agricultural commodities and export-led growth is not enough to improve nutrition or sustainability. Efforts and investments must be made in diversifying production with a focus on nutrient-dense foods such as fruits, vegetables, pulses, fish, dairy and eggs or other animal source foods. Furthermore, production methods need to be environmentally, socially and economically sustainable. It is critical to understand the ecological impact of production in choosing policies that support both human and environmental health. Integrated crop-livestock systems, including agroforestry, can help to ensure more sustainable use of natural resources (soil, water, biological diversity) as well as a supply of fuel for cooking and fodder for animals. The most sustainable solutions, considering human and environmental health as well as economics, will be context specific.

Nutrient-dense foods tend to be more perishable; therefore, improving post-harvest handling is a key area for action to improve their availability and affordability. Post-harvest measures can also improve the safety, quality and nutritional value of food. Development of pro-poor technologies and inputs can facilitate the transport, storage and safe preservation of more diverse foods, thereby reducing risk and loss which are barriers to increased production. Examples include drying of fruits, and cold chains for vegetables and dairy. Drying or freezing are processes that also protect the nutritional value of foods, while other processes such as food fortification and fermentation help improve their nutritional value.

Demand-side factors

Markets are where consumers interact with the food supply. They are a key arena for actions both in terms of promoting production (ensuring that production of nutrient-rich foods is economically viable for farmers and traders) and consumption (promotion of high-quality, nutritious, safe foods for consumers).

Nutrition-focused marketing can be a powerful tool to promote knowledge of and demand for nutritious foods. How retail outlets are organized physically and how foods are presented in the market can also significantly influence consumer choices. Geographical and sustainability indications on labels are another way that producers can leverage demand for diverse products and expand markets for traditional local foods that are sustainably produced.

There can be risks from food marketing as well, in particular with reference to children. The *Set of recommendations on the marketing of foods and non-alcoholic beverages to children* (WHO, 2010) aim to guide efforts by Member States in designing and/or strengthening policies to reduce the impact on children of marketing of highly processed foods that are high in saturated and trans fats, sugars and salt.

Nutrition education can be helpful in terms of selecting least-cost foods in order to improve access to healthy diets; often least-cost diets require substantial labour and knowledge to prepare. However, it is important to recognize that nutrition education will not result in the purchase of healthy diets among the poor until prices of those diets go down.

Removing distortions and other inefficiencies of food systems to increase affordability of healthy diets

Almost all people purchase some portion of their food, and the majority of smallholders are net buyers of food (that is, they buy more than they sell). Therefore, it is necessary to focus on what markets provide and the environments in which consumers live, in order to reach all people and reduce malnutrition in all its forms. A key area for action is linking producers to markets and improving rural infrastructure. Linking producers to markets is sometimes needed to ensure that economic opportunities are inclusive; for example, linking smallholder producers to larger markets that they have not been able to access on their own. Well-functioning market linkages can also serve to reduce food losses, for example of perishable fruits and vegetables, thereby increasing the overall supply of nutritious food. Finally, there is a need for trade policies that have co-benefits for nutrition, sustainability and equitable economic growth. Our results show that trade distortions are likely to be harmful in that they tend to raise costs of healthy diets.

8 Conclusions

Main three general takeaways from the analysis

1. Healthy diets are unaffordable for many people. The high cost of nutritious foods in places where low-income people live is a major obstacle to the achievement of global development goals.
2. Unaffordability of healthy diets is concentrated in Africa and Southern Asia. While these are known to be hot spots for malnutrition, insufficient attention has been paid to diet quality as a cause of malnutrition in all its forms. As the double burden intensifies in these regions, diet quality is becoming even more paramount.
3. Supporting nutrient adequate and healthy diets requires a combination of higher incomes and lower prices, particularly of diverse nutritious items, making a variety of healthier foods more widely available at lower cost. Where countries have national food-based dietary guidelines, there is often a lack of policy coherence on how to ensure the affordability of those diets recommended for nutrition and health. We found no definition of a healthy diet that would be globally affordable; all definitions result in similar conclusions.

Main three policy takeaways

1. Tracking the overall cost of a healthy diet highlights the disparity between dietary needs and what food systems actually produce. Food price data can be better used for nutrition, both globally and within countries:
    a. To understand where and when intervention is most needed, including which requirements are most costly and which foods can most effectively reduce the overall cost of healthy diets;
    b. To shift attention towards consumer prices and availability of all items required for healthy diets, in both rural and urban areas;
    c. To construct poverty lines that account for the cost of food in terms of meeting dietary needs, beyond only energy sufficiency.
2. Nutrition education and behaviour change will not substantially improve dietary consumption where nutrient adequate and healthy diets, even in their *cheapest* form, are unaffordable for the majority of the poor. A combination of social protection and food systems policies are needed to reduce prices and improve access to and consumption of healthy diets.
3. To make healthy diets cheaper, agricultural policies, research, and development need to shift toward a diversity of nutritious foods. Prices should not be reduced by discounting or externalizing real costs (such as reducing workers' wages, clearing forests, or intensive animal production that discounts animal welfare and water quality) or through trade protectionism. Rather, prices should be reduced through policies that support diversification and through market access that allows the flow of diverse products into markets.

Top ten take-home messages

1. People cannot live on bread alone. Food systems can and should focus on access to all elements of a healthy diet.
2. Nutrition education will not solve the problem of poor diets. Systemic changes in the food environment are also needed.
3. Healthy diets are often unaffordable for low-income people. Bringing healthy diets within reach requires higher incomes and expanded safety nets as well as lower prices for a variety of nutritious items.
4. Poverty lines need to be adjusted upward if they are meant to cover access to nutritious food that meets dietary needs. Poverty lines that are defined to include the cost of healthy diets would help align anti-poverty programmes with other global development goals, linking policies in agriculture and food security to health and human development.
5. Farm production and food markets complement each other. Homestead production of vegetables, legumes, dairy, poultry, small fish and fruits can be important forms of social protection and provide nutritious food in some settings, while markets can provide access to foods beyond what can be grown at each time and place.
6. Diversification in agriculture is needed. The innovations needed to lower diet costs differ by type of food. Moving beyond starchy staples to legumes, vegetables, fruits, nuts and seeds, as well as dairy, eggs, fish, and livestock calls for a wide range of actions including access to higher quality seeds, biotic and abiotic stress resistance (e.g. pests, drought), disease control, and management of natural resources around both crops and livestock, as well as better storage and transport, including cold chains and market infrastructure with product-specific steps to improve and maintain quality.
7. Diet costs and affordability vary significantly by region within countries, revealing geographic hotspots that are poorly served by the existing food system. The variability suggests that transport and storage networks are needed to stabilize prices and incomes over space and time, and to provide access to certain foods in places and times where they may be unavailable.
8. Protectionism in agricultural trade policy raises costs of nutrient adequate and healthy diets. It often helps influential interest groups while reducing job creation and wage growth for other people in the food sector. Reducing barriers between producers and consumers will lower diet costs while raising farm incomes.
9. Nutrient adequate and healthy diets can be achieved most affordably with small quantities of animal source foods, including dairy, eggs and small fish that complement nutrient-rich plant-based foods. It is important that efforts to reduce the cost of diets also internalize environmental costs, and therefore focus on both animal source and plant-based foods with the lowest environmental impact.
10. The highest-priority regions are Southern Asia and Africa, but poor affordability of healthy diets as well as heavy marketing of unhealthy options everywhere are driving malnutrition in all its forms all around the world.

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Annexes

Annex 1. Food-based dietary guidelines used for calculating the cost of a healthy diet

TABLE A1.1 Computing the cost of the healthy diet

FAO Region	FBDG country (or EAT-Lancet diet)	Date of FBDG	Number of groups (including subgroups)	Starchy staple	Protein-rich foods: Legumes	Protein-rich foods: Flesh/ eggs	Dairy	Vegetables	Fruits	Fat	Nuts and seeds	Discretionary/ sugars
Africa	**Benin**	2015	6	3–6 (adult woman, 3–5) servings; serving size: 185 g cooked maize paste, 220 g cooked rice, 160 g cooked pasta, 87.5 g bread, 185–200 g cassava, 60 g gari	2–3 servings; serving size: 75 g meat, 100 g fish, 80 g eggs (2), 200 g crabs (3 with shell), 100 g shrimp (including shell), 50 g dried fish, 140 g beans (cooked), 50 g soya cheese, 50 g peanut		1–2 servings; serving size: 125 g yogurt, 20 g powder, 50 g local cheese, 85 g concentrated milk (unsweetened). If milk products are not part of the diet, they can be replaced by other foods rich in calcium such as finfish, crustaceans, and dried fish	4–6 servings; serving size: 50 g leaves, 100 g other, 60 g carrots	2–3 servings; serving size: 100 g on average, or 3/4 cup juice	2–3 tablespoons, 15 g per tablespoon	(in protein-rich foods)	
Asia and the Pacific	**China**	2016	7*	250–400 g	120–200 g		300 g fluid milk equivalent	300–500 g	200–350 g	25–30 g	25–35 g nuts and tofu	
	India (moderate woman)	2011	6	9–20 (moderate woman, 11) servings; serving size: 30 g dry/uncooked (100 kcal)	2–4 (moderate woman 2.5) servings; serving size: 50 g meat/chicken/fish (100 kcal), 50 g eggs (85 kcal), 30 g dry pulses (100 kcal)		3 servings; serving size: 100 g (70 kcal)	3 servings (1 DGLV, 2 others; includes potatoes/roots and tubers); serving size: 100 g (28 kcal)	1 serving; serving size: 100 g (40 kcal)	4–8 (moderate woman, 5) servings; serving size: 5 g (45 kcal)	(none – nuts are discussed as additional in protein and fat; not clear)	

TABLE A1.1 (cont.) Computing the cost of the healthy diet

FAO Region	FBDG country (or EAT-Lancet diet)	Date of FBDG	Number of groups (including subgroups)	Starchy staple	Protein-rich foods: Legumes	Protein-rich foods: Flesh/ eggs	Dairy	Vegetables	Fruits	Fat	Nuts and seeds	Discretionary/ sugars
Asia and the Pacific	Viet Nam	2016	6	12–15 servings; each serving equivalent to 20 g of carbohydrates (examples: rice, bread, potato, sweet potato)	5–6 servings; each serving equivalent to 7 g of protein (examples: fish, meat, seafood, tofu, eggs, soybeans)		3–4 servings; each serving equivalent to 100 mg of calcium	3 servings; each serving 80 g	3 servings; each serving 80 g	5–6 servings; each serving equivalent to 5 g lipids	(in oil and fat)	
Europe	Malta	2015	6	4 servings; serving size: 40 g of breakfast cereals; 80–100 g of raw cereals, pasta and rice, preferably wholegrain or wholemeal; 80 g potatoes	Approx. 9–12 servings per week = approx. 1.5 servings per day; serving size: 115 g fish (raw), 70 legumes (raw), 21 g nuts and seeds, 1 egg, 100 g white meat (raw), 90 g red meat (raw)		2 servings; serving size: 250 ml milk, 1 tub (150 ml) yogurt, 30–40 g cheese, 45–50 g irkotta/ġbejna	3–5 servings; serving size: 80 g	2–3 servings; serving size: 80 g	1 serving; serving size: 1 tablespoon (15 ml)	(in protein-rich foods)	
Europe	Netherlands	2017	7*	4–5 servings; serving size examples: 1 brown bread sandwich, 1 serving spoon of wholegrain products or potatoes	1 serving fish/pulse/meat; serving size: 100 g meat/fish		2–3 servings; serving size 150 ml milk, 40 g cheese. Includes soy drinks	250 g	200 g	40 g	25 g	

TABLE A1.1 (cont.) Computing the cost of the healthy diet

FAO Region		Latin America and the Caribbean		Near East
FBDG country (or EAT-Lancet diet)		**Argentina**	**Jamaica**	**Oman (at 2 300 kcal level)**
Date of FBDG		2016	2015	2009
Number of groups (including subgroups)		6*	6	7
Starchy staple		4 servings; 606 kcal total + 270 kcal "optional foods" (876 kcal total)	14 servings; serving size: 70 kcal (980 kcal total)	0.95 servings whole, 3.7 refined; serving size: 28 g dry rice or pasta, or 1 cup cereal flakes
Protein-rich foods	Legumes		3 servings; serving size: 73 kcal (219 kcal total)	0.75 cup cooked lentils
	Flesh/ eggs	1 serving (224 kcal total)	5 servings; serving size: 75 kcal if meat or whole milk, 40 kcal if skim milk (total of 374 kcal if no skim consumed)	91 g; serving size: 30 g lean meat, poultry or fish, 1 egg, 15 g oz nuts or seeds
Dairy		3 servings (310 kcal total)		0.6 servings; serving size: 1 cup equivalent = 1 cup milk or yogurt, 45 g natural cheese
Vegetables		400 g	3 servings; serving size: 36 kcal (108 kcal total)	3.4 servings; serving size: 1 cup raw vegetables, 2 cup leafy salad greens, 1/2 cup chopped, cooked or canned vegetables, 1/2 cup vegetable juice
Fruits		300 g	3 servings; serving size: 40 kcal (120 kcal total)	3.95 servings; serving size: 1 cup raw fruits, 1/2 cup fruit juice, 1/2 cup chopped, cooked or canned fruits
Fat		2 servings (270 kcal total)	6 servings (including avocado and coconut); serving size: 45 kcal (270 kcal total)	66.5 g
Nuts and seeds		(in fats and seeds, also including dried fruits)	(in legumes)	(in protein-rich foods)
Discretionary/ sugars		270 kcal optional foods		

TABLE A1.1 (cont.) **Computing the cost of the healthy diet**

FAO Region	FBDG country (or EAT-Lancet diet)	Date of FBDG	Number of groups (including subgroups)	Starchy staple	Protein-rich foods: Legumes	Protein-rich foods: Flesh/ eggs	Dairy	Vegetables	Fruits	Fat	Nuts and seeds	Discretionary/ sugars
Northern America	**USA (American style at 2 300 kcal level)**	2015	6	7.5 oz-eq (half should be whole grain)		6.25 oz-eq (including meat, fish, poultry, eggs, nuts, tofu)	3 cup-eq; 1 cup milk, soymilk or yogurt = 1.5 oz cheese	3 cup-eq; 1 cup-eq = 1 cup reg-orange or other vegetables, 1 cup legumes, 2 cup DGLV, 1.5 cup potatoes	2 cup-eq; 1 cup-eq = 1 cup fresh, 1/2 cup dried, 3/4 cup 100% juice	30 g	(in protein-rich foods)	230 kcal
	USA (Mediterranean style at 2 300 kcal level)	2015	6	7.5 oz-eq (half should be whole grain)		7.25 oz-eq (including meat, fish, poultry, eggs, nuts, tofu)	2.25 cup-eq; 1 cup milk, soymilk or yogurt = 1.5 oz cheese	3 cup-eq; 1 cup-eq = 1 cup reg-orange or other vegetables, 1 cup legumes, 2 cup DGLV, 1.5 cup potatoes	2.5 cup-eq; 1 cup-eq = 1 cup fresh, 1/2 cup dried, 3/4 cup 100% juice	30 g	(in protein-rich foods)	230 kcal
	USA (Vegetarian style at 2 300 kcal level)	2015	6	8 oz-eq (half should be whole grain)	3.75 oz-eq (including eggs, legumes, tofu, nuts)		3 cup-eq; 1 cup milk, soymilk or yogurt = 1.5 oz cheese	3 cup-eq; 1 cup-eq = 1 cup reg-orange or other vegetables, 1 cup legumes, 2 cup DGLV, 1.5 cup potatoes	2 cup-eq; 1 cup-eq = 1 cup fresh, 1/2 cup dried, 3/4 cup 100% juice	30 g	(in protein-rich foods)	230 kcal

TABLE A1.1 (cont.) Computing the cost of the healthy diet

FAO Region	FBDG country (or EAT-Lancet diet)	Date of FBDG	Number of groups (including subgroups)	Starchy staple	Protein-rich foods: Legumes	Protein-rich foods: Flesh/ eggs	Dairy	Vegetables	Fruits	Fat	Nuts and seeds	Discretionary/ sugars
N/A	EAT-Lancet (flexitarian)	2019	12	2 groups: 678 kcal cereal grains + 81 kcal starchy roots	254 kcal	4 groups: 14 kcal eggs + 38 kcal fish + 28 kcal poultry + 29 kcal red meat	90 kcal	96 kcal	95 kcal	405 kcal	180 kcal	95 kcal
	EAT-Lancet (pescatarian)	2019	10	2 groups: 678 kcal cereal grains + 81 kcal starchy roots	254 kcal	2 groups: 14 kcal eggs + 76 kcal fish	90 kcal	107 kcal	103 kcal	405 kcal	180 kcal	95 kcal
	EAT-Lancet (vegetarian)	2019	9	2 groups: 678 kcal cereal grains + 81 kcal starchy roots	317 kcal	14 kcal eggs	90 kcal	114 kcal	108 kcal	405 kcal	180 kcal	95 kcal
	EAT-Lancet (vegan)	2019	7	2 groups: 678 kcal cereal grains + 81 kcal starchy roots	387 kcal			133 kcal	124 kcal	405 kcal	180 kcal	95 kcal

Notes: * Argentina: fruits and vegetables are required subgroups. China: fruits and vegetables are subgroups; dairy and nuts are required subgroups. Netherlands: nominally four groups, but "fruits and vegetables" has two required subgroups; and "protein-rich foods" has three subgroups: protein, dairy and nuts.

Source: Authors' own elaboration.

Annex 2. Cost of the nutrient adequate diet using RDA compared to using H-AR

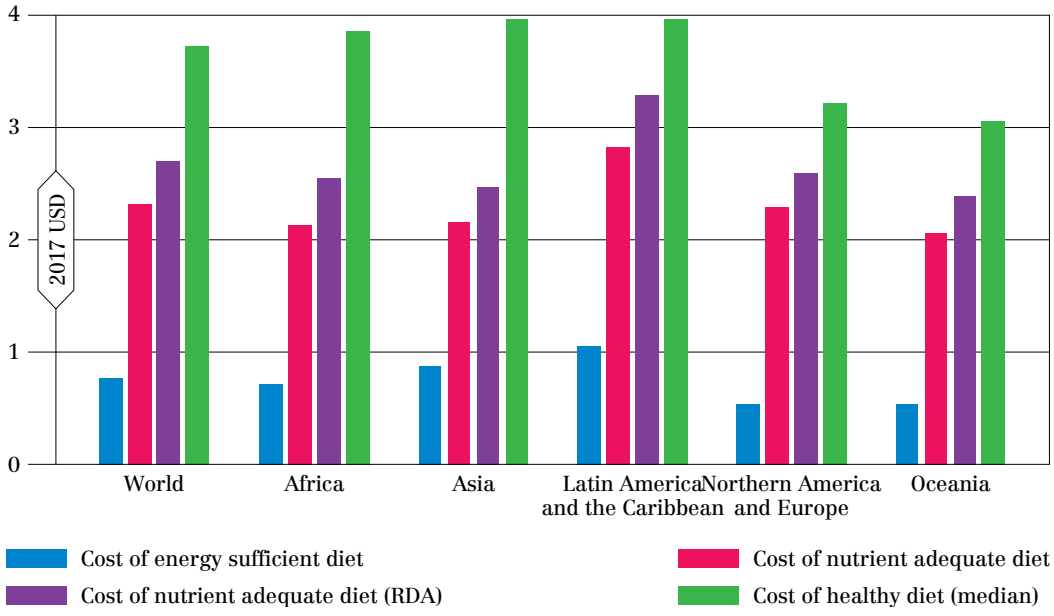
TABLE A2.1 Regional mean cost by macroregion for all cost of diet indicators (2017 international USD)

Macroregion	Energy sufficient diet	Nutrient adequate diet	Nutrient adequate diet (RDA)	Healthy diet (median)
Africa	0.73	2.15	2.56	3.87
Asia	0.88	2.18	2.48	3.97
Latin America and the Caribbean	1.06	2.83	3.30	3.98
Northern America and Europe	0.54	2.29	2.61	3.21
Oceania	0.55	2.07	2.39	3.06
World	**0.79**	**2.33**	**2.71**	**3.75**

Notes: To provide a sensitivity analysis, the Table compares the cost of the nutrient adequate diet calculated in this study using harmonized average requirements (H-ARs), harmonized upper levels of intake (H-ULs) and Acceptable Macronutrient Distribution Ranges (AMDRs) set by IOM (2006), with the cost of the nutrient adequate diet calculated using the IOM (2006) recommended dietary allowances (RDAs), or Adequate Intakes (AIs) if the latter is not larger than the H-ARs. For the methodology, see subsection 2.3.2.

Source: Authors' own elaboration.

FIGURE A2.2 Regional mean cost by macroregion for all cost of diet indicators (2017 international USD)



Source: Authors' own elaboration.

Annex 3. Average cost of each diet and national percentage of people who cannot afford each diet, by region and income level (simple average across countries)

TABLE A3.1 Average cost of each diet, by region and country income group (simple average across countries)

Regions	Energy sufficient diet	Nutrient adequate diet	Healthy diet
World	**0.79**	**2.33**	**3.75**
Africa	**0.73**	**2.15**	**3.87**
Northern Africa	0.75	2.90	4.12
Sub-Saharan Africa	0.73	2.06	3.84
Eastern Africa	0.61	1.98	3.67
Middle Africa	0.73	2.09	3.73
Southern Africa	0.86	2.29	3.99
Western Africa	0.80	2.05	4.03
Asia	**0.88**	**2.18**	**3.97**
Central Asia	0.84	2.04	3.39
Eastern Asia	1.27	2.63	4.69
South-eastern Asia	0.92	2.42	4.20
Southern Asia	0.80	2.12	4.07
Western Asia	0.74	1.87	3.58
Latin America and the Caribbean	**1.06**	**2.83**	**3.98**
Caribbean	1.12	2.89	4.21
Latin America	1.00	2.78	3.75
Central America	1.13	3.04	3.81
South America	0.91	2.61	3.71
Oceania	**0.55**	**2.07**	**3.06**
Northern America and Europe	**0.54**	**2.29**	**3.21**
Country income group			
Low-income countries	0.70	1.98	3.82
Lower-middle income countries	0.88	2.40	3.98
Upper-middle income countries	0.87	2.52	3.95
High-income countries	0.71	2.31	3.43

Notes: Data shown are the average cost (USD) per person per day of each diet. Methods and data sources are detailed in the text.

Source: Authors' own elaboration.

TABLE A3.2 Average national percentage of people who cannot afford each diet, by region and country income group (simple average across countries)

	Energy sufficient diet	Nutrient adequate diet	Healthy diet
Macroregion			
Africa	11.3%	51.0%	73.8%
Asia	0.4%	11.7%	36.6%
Latin America and the Caribbean	3.7%	18.1%	26.5%
Northern America and Europe	0.3%	1.7%	3.7%
Oceania	0.1%	5.0%	21.0%
Subregion			
Australia and New Zealand	0.2%	0.5%	0.7%
Central Asia	0.3%	11.0%	33.2%
Eastern Asia	0.3%	1.8%	15.6%
Eastern Europe	0.3%	1.7%	3.5%
Latin America and the Caribbean	3.7%	18.1%	26.5%
Melanesia	0.0%	9.6%	41.3%
Northern Africa	1.4%	29.2%	46.0%
Northern America	0.6%	1.0%	1.2%
Northern Europe	0.2%	0.4%	0.8%
South-eastern Asia	0.7%	20.7%	46.2%
Southern Asia	0.5%	17.9%	57.6%
Southern Europe	0.4%	3.8%	8.7%
Sub-Saharan Africa	12.5%	53.4%	76.9%
Western Asia	0.3%	3.8%	21.7%
Western Europe	0.1%	0.2%	0.3%
Country income group			
High-income countries	0.3%	0.9%	2.0%
Low-income countries	12.7%	61.4%	86.2%
Lower-middle countries	6.3%	33.1%	58.9%
Upper-middle countries	2.1%	11.5%	24.2%
World	**4.6%**	**23.3%**	**38.3%**

Notes: Data shown are the percentage of people in each region whose household income is below the total cost of the most affordable locally available items needed to meet each standard of diet quality, assuming that they can spend no more than 63 percent of their income on food. Average percentages are reported as in Table 8 of The State of Food Security and Nutrition in the World 2020 (FAO, IFAD, UNICEF, WFP and WHO, 2020). Methods and data sources are detailed in the text.

Source: Authors' own elaboration.

Annex 4. Lower- and upper-bound estimates of the number of people who cannot afford each diet type

The lower-bound estimate for the number of people who cannot afford each diet type is calculated assuming 100 percent of income spent on food; that is, the lower bound counts the number of people who have total daily income lower than the cost of a given diet (Table A4.1). By this calculation, 1.86 billion people would be unable to afford healthy diets.

Because people do not spend all of their income on food, our main estimate assumes 37 percent of income needs to be spent on non-food items such as housing and agriculture. However, many people need to spend more than this amount on non-food items, and would not be able to spend 63 percent of income on food, particularly in higher-income countries where food expenditures are typically lower than 30 percent and housing costs are high. Therefore, we calculate upper-bound estimates as the mean food expenditure share across countries within World Bank income groupings. The mean share of expenditure on food is 14.9 percent, 27.9 percent, 42.3 percent, and 50.2 percent for high-, upper-middle-, lower-middle- and low-income countries, respectively.[15] We define income needed as the income that would be required to afford both a healthy diet and other non-food needs, based on the cost of the healthy diet and holding the food/non-food share constant. We calculate income needed using the following formula: [Cost of the diet / food expenditure share in World Bank country income classification]. For example, if the cost of a healthy diet is USD 3 in a given low-income country, where food expenditures are on average 50 percent of total expenditures, income would need to be USD 6 to afford both the healthy diet and non-food needs. This upper-bound estimation is shown in Table A4.2. By this calculation, 4.75 billion people would not be able to afford healthy diets.

TABLE A4.1 Lower-bound estimate of the number of people (in millions) who cannot afford the cost of each diet, by region and country income group

	Energy sufficient diet	Nutrient adequate diet	Healthy diet
Macroregion			
Africa	59.62	413.55	754.34
Asia	2.81	184.05	1 050.71
Latin America and the Caribbean	4.24	31.02	49.41
Northern America and Europe	4.49	7.25	9.60
Oceania	0.06	0.13	0.24
Subregion			
Australia and New Zealand	0.06	0.12	0.12
Central Asia	0.01	0.44	2.43
Eastern Asia	1.52	3.14	53.93
Eastern Europe	0.24	1.23	2.24

[15] The median food expenditure shares are 14 percent, 25 percent, 41 percent and 51 percent for the four income levels, which are quite close to the mean.

TABLE A4.1 (cont.) Lower-bound estimate of the number of people (in millions) who cannot afford the cost of each diet, by region and country income group

	Energy sufficient diet	Nutrient adequate diet	Healthy diet
Latin America and the Caribbean	4.24	31.02	49.41
Melanesia	0.00	0.01	0.12
Northern Africa	0.42	43.70	86.44
Northern America	3.25	4.15	4.24
Northern Europe	0.12	0.20	0.24
South-eastern Asia	0.28	43.13	182.28
Southern Asia	0.98	136.13	800.23
Southern Europe	0.86	1.60	2.58
Sub-Saharan Africa	59.20	369.85	667.90
Western Asia	0.01	1.21	11.84
Western Europe	0.03	0.07	0.31
Country income group			
High-income countries	5.71	8.36	11.00
Low-income countries	17.13	207.05	403.74
Lower-middle countries	40.82	373.21	1 316.69
Upper-middle countries	7.56	47.38	132.87
World	**71.22**	**636.01**	**1 864.30**

Notes: Data shown are the number of people in each region whose household income is below the cost of the most affordable locally available items needed to meet each standard of diet quality, assuming that they can spend 100 percent of their income on food. Methods and data sources are detailed in the text.

Source: Authors' own elaboration.

TABLE A4.2 Upper-bound estimate of the number of people (in millions) who cannot afford the cost of each diet, by region and country income group

	Energy sufficient diet	Nutrient adequate diet	Healthy diet
Macroregion			
Africa	267.12	866.74	1 081.54
Asia	199.94	1 684.12	3 033.55
Latin America and the Caribbean	39.14	224.31	304.14
Northern America and Europe	10.01	67.50	154.33
Oceania	0.16	0.88	1.43
Subregion			
Australia and New Zealand	0.12	0.36	0.68
Central Asia	0.27	6.68	19.31
Eastern Asia	26.00	258.23	886.97
Eastern Europe	0.94	23.20	68.02
Latin America and the Caribbean	39.14	224.31	304.14
Melanesia	0.04	0.52	0.75
Northern Africa	10.38	134.50	182.95
Northern America	6.77	17.16	32.69
Northern Europe	0.28	2.09	4.60
South-eastern Asia	40.01	283.15	463.27
Southern Asia	124.66	1 088.04	1 583.58
Southern Europe	1.93	21.48	39.15
Sub-Saharan Africa	256.74	732.23	898.59
Western Asia	8.99	48.02	80.42
Western Europe	0.09	3.57	9.87
Country income group			
High-income countries	23.35	101.88	212.17
Low-income countries	81.88	423.79	533.76
Lower-middle countries	327.06	1 755.80	2 497.58
Upper-middle countries	84.09	562.07	1 331.47
World	**516.38**	**2 843.54**	**4 574.98**

Notes: Data shown are the number of people in each region whose household income is below the cost of the most affordable locally available items needed to meet each standard of diet quality, assuming that they can spend the national average expenditure share of their income on food (14.9 percent, 27.9 percent, 42.3 percent and 50.2 percent for high-, upper-middle-, lower-middle- and low-income countries, respectively). Methods and data sources are detailed in the text.

Source: Authors' own elaboration.

Annex 5. Nutrient adequacy of the selected diets

The healthy diet results were analysed for mean adequacy ratio (MAR) across 20 nutrients that have a lower bound. For included nutrients, please refer to Table 1.

TABLE A5.1 Percent of nutrient needs met by healthy diets (mean adequacy ratio)

	MAR_HAR		MAR_RDA	
	mean	sd	mean	sd
Macroregion				
Africa	0.93	0.03	0.88	0.04
Asia	0.94	0.04	0.89	0.06
Latin America and the Caribbean	0.94	0.04	0.89	0.06
Northern America and Europe	0.94	0.03	0.89	0.04
Oceania	0.94	0.03	0.89	0.04
Food-based dietary guidelines				
Argentina	0.91	0.04	0.84	0.05
Benin	0.93	0.03	0.89	0.04
China	0.95	0.03	0.90	0.05
India (moderate woman)	0.93	0.04	0.87	0.05
Jamaica	0.93	0.04	0.88	0.05
Malta	0.91	0.04	0.85	0.05
Netherlands	0.94	0.03	0.89	0.04
Oman (at 2 300 kcal level)	0.93	0.04	0.88	0.04
USA (American style at 2 300 kcal level)	0.96	0.03	0.92	0.04
USA (Mediterranean style at 2 300 kcal level)	0.96	0.03	0.93	0.04
USA (Vegetarian style at 2 300 kcal level)	0.97	0.02	0.93	0.03
Viet Nam	0.93	0.03	0.88	0.04
World	**0.94**	**0.04**	**0.89**	**0.05**

Source: Authors' own elaboration.

Annex 6. Methodological note on constructing a nutritious food poverty line in Myanmar

In order to construct a healthy diet (CoRD) and healthy diet with food preferences (CoRD-FP) comparable to the 2015 Myanmar food poverty line and total poverty line, we closely adhere to the methodology and the following details outlined in the World Bank's poverty estimation technical report (MoPF and World Bank, 2017b): the reference poor population (households with expenditure within 10 percentage points of the poverty line); the food poverty line calorie target (2 238 calories); the composition of the food basket; the caloric content of foods; and wastage factors.

The CoRD is designed to reflect the cost of the cheapest foods within each food group and is typically constructed using data comprising commonly available foods. The CoRD-FP reweights food consumption patterns to meet dietary guidelines and as such places greater weight on non-staple food groups. The fish/meat/eggs, fruits, and vegetable food groups tend to have a wide variety of foods with a wide distribution of prices. To reduce the influence of atypically costly and/or rarely consumed foods, we limit the CoRD and CoRD-FP food baskets to items within the top 85 percent of total food expenditure within each food group.

For consistency with the 2015 Myanmar total poverty line, the World Bank non-food allowance of 436 kyat per capita per day is added to the CoRD-FP to yield a CoRD-FP poverty line (MoPF and World Bank, 2017a). Affordability of the World Bank, CoRD and CoRD-FP food baskets is assessed by comparing spatially adjusted per capita household food expenditure to the cost of each food basket. Official poverty and CoRD-FP poverty headcounts are assessed by comparing spatially adjusted per capita household total expenditure to each poverty line.

The World Bank poverty line food basket includes prepared foods purchased for consumption at home and food away from home (FAFH). Because it is not possible to classify prepared foods and FAFH into food groups, the CoRD-FP basket must exclude these items. In order to compare the composition of the poverty line food basket to the CoRD and CoRD-FP food baskets, a new poverty line basket is constructed, which excludes FAFH and is then rescaled to hit the 2 238 calorie target.

Annex 7. Data and methods to simulate impacts of policy change on diet costs

Data sources

Agricultural market distortions are modelled using estimates of nominal rates of protection for 62 countries and 58 food products. The nominal rate of protection (NRP) is calculated using the difference between observed border price and farm-gate price, after accounting for market access costs. This difference primarily represents international trade barriers, though other policies such as price interventions or exchange rate management may also play a role (Pernechele, Balié and Ghins, 2018). Nominal rates of protection are compiled, harmonized and published by the AgIncentives Consortium with data and input from the World Bank, Agrimonitor at the Inter-American Development Bank, the Monitoring and Analysing Food and Agricultural Policies (MAFAP) unit at FAO, and the Organisation for Economic Co-operation and Development.

Retail price data is from the 2011 round of the World Bank's International Comparison Project (ICP). The NRP values used to match 2011 and 2017 ICP retail prices are drawn from the four years leading up to and including each year. We have updated the publicly available NRP data using MAFAP file data, resulting in the addition of data for 2017 and several observations for poultry meat and sesame seed in Mozambique from earlier years. Additionally, there are several significant revisions to existing publicly available NRP data for sub-Saharan African countries. The final dataset includes 3 581 total observations across all eight years, with 2 154 observations in 2008–2011 and 1 427 observations for 2014–2017. One limitation of the 2017 simulation is that the AgIncentives NRP data extends only through 2016. 2017 observations come only from the MAFAP file data, which covers 14 sub-Saharan African countries.

After compiling all available data, we impose a validity check on any negative NRP values in the dataset to retain only those values which could plausibly be sustained over time by export restrictions. We check that for each negative NRP for a given product in a given country, that country has had positive net exports of the product in that year or any one of the three years prior. Products are matched by FAO commodity list code to FAO export and import data (FAO, 2020c). In seven cases, where a product in the AgIncentives NRP dataset had no exact match in the FAO trade data, the closest match from that commodity group was chosen. In three cases where trade data was missing for a product with negative NRP values, products were matched to the corresponding HS-6 codes and UN Comtrade data was used to assess export and import levels (accessed through USDA, 2020). We assume that any negative NRPs where the country did not competitively export the product within the four years leading up to or including that year to be temporary outliers or measurement errors, and we trim these values to zero. In total, we trimmed 185 negative observations across the eight years considered in the study.

Countries and number of observations are listed in Table A7.1, which also shows 2011 and 2017 income classifications for results reported in the main text. We use World Bank country income classifications as the basis for four income groups. Income group is chosen over regional group because region classifications vary considerably in the heterogeneity of their components. Some, like Southern Asia, are relatively alike, while others, like East Asia and Pacific, are very diverse. Table A7.1 lists the 62 countries by income group and shows the total number of NRP observations for each time period for each country. Two-thirds (65.1 percent) of the data are from high-income and upper-middle-income countries. There are relatively few observations for low-income countries (13.1 percent),

pointing to the need for better data on the implications of agricultural policies in these countries. Observations are particularly sparse for nutrient-dense food groups such as fruits, vegetables, and dairy.

Items in the price dataset are matched to one of nine functional food groups listed in Table A7.2. Table A7.2 lists all of the 58 foods in the dataset by food group classification. Analysing nutrient adequacy requires the use of nutritionally functional food groups. For example, vegetables are typically grouped into leafy green vegetables, red-orange vegetables, and other vegetables based on their differing micronutrient profiles. Palm oil, vegetable oils, and leguminous crops like peanuts and soybean would be treated separately as sources of saturated fat, unsaturated fat and protein, respectively. This analysis cannot capture such levels of nuance due to the limited number of foods in the NRP dataset. We classify foods based broadly on nutritional function, with some aggregations: all vegetables are grouped together, and oil crops that may be used to produce either oil or other food items, such as groundnuts and soybean, are grouped together as nuts and oilseeds. Though there are relatively few observations of eggs compared to other food groups, we treat them as a separate food group both due to nutritional differences between eggs and poultry meat and because the value chains for these products have significant differences. For low-income countries, we do not observe any NRPs for eggs, so we instead use the average NRP for eggs in the sub-Saharan Africa region. The low-income country group has a majority of countries from this region and may have similar policies due to regional trade agreements.

TABLE A7.1 Countries by income group and number of nominal rate of protection observations, 2008–2011 and 2014–2017

	2011		2017	
	countries	**obs.**	**countries**	**obs.**
High-income countries	Australia	60	Argentina	27
	Bahamas	16	Australia	45
	Barbados	8	Bahamas	8
	Canada	60	Barbados	8
	European Union	68	Canada	45
	Iceland	24	Chile	30
	Israel	60	European Union	51
	Japan	76	Iceland	18
	Republic of Korea	40	Israel	45
	New Zealand	40	Japan	57
	Norway	36	Republic of Korea	30
	Switzerland	44	New Zealand	30
	Trinidad and Tobago	22	Norway	27
	USA	52	Panama	20
			Switzerland	33
			Trinidad and Tobago	22
Total		**606**		**565**

TABLE A7.1 (cont.) Countries by income group and number of nominal rate of protection observations, 2008–2011 and 2014–2017

	2011		2017	
	countries	obs.	countries	obs.
Lower-middle-income countries	Belize	10	Ghana	21
	Bolivia (Plurinational State of)	16	India	57
	El Salvador	28	Indonesia	24
	Ghana	24	Kenya	31
	Guatemala	52	Nigeria	8
	Guyana	14	Philippines	33
	Honduras	9	Sri Lanka	7
	India	76	Ukraine	39
	Indonesia	48	Viet Nam	24
	Nicaragua	18		
	Nigeria	16		
	Pakistan	31		
	Paraguay	26		
	Philippines	44		
	Senegal	12		
	Sri Lanka	28		
	Ukraine	52		
	Viet Nam	32		
Total		**536**		**244**
Upper-middle-income countries	Argentina	36	Belize	10
	Brazil	36	Brazil	27
	Chile	40	China	42
	China	56	Colombia	33
	Colombia	44	Costa Rica	27
	Costa Rica	36	Dominican Republic	30
	Dominican Republic	40	Ecuador	18
	Ecuador	24	Guyana	5
	Jamaica	48	Jamaica	12
	Kazakhstan	48	Kazakhstan	36
	Mexico	56	Mexico	42
	Panama	20	Russian Federation	39
	Peru	32	South Africa	42
	Russian Federation	52	Suriname	9

TABLE A7.1 (cont.) Countries by income group and number of nominal rate of protection observations, 2008–2011 and 2014–2017

	2011		2017	
	countries	obs.	countries	obs.
Upper-middle-income countries	South Africa	56	Turkey	42
	Suriname	36		
	Turkey	56		
	Uruguay	30		
Total		**746**		**414**
Low-income countries	Benin	8	Benin	10
	Burkina Faso	28	Burkina Faso	25
	Burundi	18	Burundi	18
	Ethiopia	36	Ethiopia	31
	Haiti	32	Malawi	12
	Kenya	36	Mali	25
	Malawi	11	Mozambique	21
	Mali	28	Rwanda	15
	Mozambique	18	Senegal	16
	Rwanda	15	United Republic of Tanzania	13
	United Republic of Tanzania	16	Uganda	18
	Uganda	20		
Total		**266**		**204**

Total observations across all countries 2008–2011: 2 154
Total observations across all countries 2014–2017: 1 427

Source: Authors' own elaboration.

TABLE A7.2 Summary of nominal rates of protection data by food group and product

Food group	Product	Nominal rate of protection 2008–2011				Nominal rate of protection 2014–2017			
		Obs.	Median	Min.	Max.	Obs.	Median	Min.	Max.
Dairy	Milk	160	6.1	-68.5	204.6	98	3.4	-56.0	361.7
Eggs	Eggs	110	8.2	-48.4	309.6	73	0.0	-13.3	346.2
Fruits	Bananas	56	0.0	-72.8	72.6	29	0.0	-58.8	109.7
	Grapes	26	0.0	0.0	199.5	18	0.0	0.0	140.6
	Apples	24	7.2	0.0	113.8	18	0.0	0.0	69.7
	Pineapples	20	0.0	-69.8	77.1	13	0.0	-59.8	113.7
	Oranges	19	0.0	0.0	235.5	10	0.0	0.0	287.7
	Mangoes	16	0.0	-23.6	16.4	7	0.0	-49.6	0.0
	Avocados	10	9.6	0.0	339.1	7	72.4	0.0	161.5
	Coconuts	10	-12.6	-32.5	38.0	5	-17.5	-32.3	42.4
	Grapefruit (including pomelos)	6	0.0	0.0	34.8	4	0.0	0.0	0.0
	Other melons (including cantaloupes)	4	-30.0	-37.1	-27.0	N/A	N/A		
	Pears	4	129.9	79.5	187.8	3	72.7	69.0	86.1
	Strawberries	4	15.5	6.0	24.9	3	11.7	8.1	11.8
	Tangerines, mandarins, clementines	4	88.5	31.2	117.7	3	41.8	29.6	42.9
	Papayas	2	4.2	-27.4	35.9	2	18.0	-0.5	36.5
Grains	Maize	165	0.0	-76.1	351.1	115	0.0	-67.9	189.2
	Rice	157	11.7	-54.6	258.6	107	29.8	-71.4	216.3
	Wheat	106	0.0	-43.9	95.9	76	0.0	-52.4	145.8
	Barley	63	0.0	-43.3	146.2	48	0.0	-30.1	248.1
	Sorghum	37	0.0	-85.0	156.0	27	0.0	-37.5	72.5
	Oats	28	0.0	-45.0	100.5	21	0.0	-25.2	83.7
	Rye	8	-7.5	-37.0	13.5	6	-9.6	-22.9	6.3
	Millet	4	3.4	-6.8	8.9	4	-2.5	-10.4	5.6
	Teff	4	-24.1	-50.4	-12.6	4	69.7	60.0	97.4
Nuts and oilseeds	Soybeans	57	0.0	-36.3	990.5	38	0.0	-40.4	478.7
	Groundnuts	36	0.0	-56.0	180.9	32	0.0	-47.5	108.0
	Sunflower seed	32	0.0	-43.1	19.6	24	0.0	-44.9	75.1
	Rapeseed	24	0.0	-24.2	159.2	18	0.0	-9.7	86.2
	Palm oil	18	0.0	-22.7	25.7	12	0.7	-11.5	41.8
	Cashew nuts	16	0.0	-22.6	34.6	13	-26.4	-54.2	71.2
	Sesame seed	8	3.0	-19.2	18.1	10	21.9	-33.7	118.7

TABLE A7.2 (cont.) Summary of nominal rates of protection data by food group and product

Food group	Product	Nominal rate of protection 2008–2011				Nominal rate of protection 2014–2017			
		Obs.	Median	Min.	Max.	Obs.	Median	Min.	Max.
Pulses	Beans, dry	45	27.4	-12.7	186.3	26	2.6	-46.3	330.4
	Chickpeas, dry	8	0.4	0.0	1.9	3	8.0	0.0	10.7
	Lentils, dry	8	0.0	-13.0	97.5	7	0.0	0.0	90.7
	Peas, dry	4	0.0	0.0	0.0	3	0.0	0.0	0.0
	Pulses, not elsewhere specified	4	0.0	0.0	0.0	3	0.0	0.0	0.0
Poultry	Poultry meat	152	30.2	-19.2	512.2	99	15.1	0.0	484.5
Red meat	Bovine meat	166	0.0	-48.9	152.7	101	1.5	-41.7	231.5
	Pig meat	133	16.0	0.0	293.3	82	11.8	0.0	235.3
	Sheep meat	59	0.0	0.0	69.0	44	5.3	0.0	170.3
Roots, tubers and plantains	Potatoes	51	0.1	-48.7	599.5	33	0.0	-71.8	325.8
	Cassava	35	0.0	-28.8	153.6	24	10.7	-16.5	127.4
	Yams	13	0.0	-37.0	62.5	5	0.0	-71.3	112.5
	Plantains	12	7.1	-10.6	38.2	8	28.8	0.0	54.8
	Sweet potatoes	11	36.0	0.0	137.0	4	145.8	0.0	173.4
Sweeteners	Sugar	116	12.4	-71.6	208.8	77	26.1	-61.8	147.5
	Honey	6	-16.9	-40.3	108.8	2	206.4	179.4	233.4
Vegetables	Tomatoes	37	0.0	-48.0	129.1	21	0.0	-57.8	29.6
	Onions	22	18.5	-47.3	342.3	15	5.0	-42.3	239.4
	Cabbages and other brassicas	8	126.2	27.0	314.1	6	126.5	27.0	245.2
	Chillies and peppers	8	125.2	0.0	403.9	4	183.8	-32.3	187.8
	Beans, green	4	-40.5	-65.6	-26.1	2	-54.5	-55.1	-53.8
	Cucumbers and gherkins	4	17.5	3.0	52.6	3	3.0	3.0	3.0
	Spinach	4	3.0	3.0	3.0	3	3.0	3.0	3.0
	Asparagus	2	0.0	0.0	0.0	N/A	N/A		
	Pumpkins, squash and gourds	2	42.3	-43.0	127.7	2	-25.9	-38.3	-13.6
	Vegetables: fresh, not elsewhere specified	2	223.6	136.9	310.3	2	122.7	58.7	186.6

Source: Authors' own elaboration.

Data analysis

We first collapse the NRP observations from 2008–2011 and 2014–1207 for all countries and products into a set of mean protection rate by income level for each food group. Because the NRP is measured at the farm-gate level and our price data is at the retail level, we assume 100 percent as a lower bound of markup from farm gate to retail and 300 percent as an upper markup bound. Assuming that the rate of protection applies only to the farm-gate portion of the retail price, we compute a reference price for each retail food item as follows:

$$P_r' = m\left(\frac{P_r}{1+m}\right) + \frac{P_r}{(1+\tau)(1+m)} \quad (1)$$

where:

m = assumed markup from wholesale to retail

τ = nominal rate of protection (NRP)

P_r = observed ICP retail price.

We calculate a wholesale price (Pw) based on observed retail price and assumed markup:

$$P_w = \frac{P_r}{1+m} \quad (2)$$

Assuming the additional cost due to markup remains constant as a cost of retail supply, $P_s = mP_w$, we can adjust the P_w to reflect a zero-distortion scenario as follows:

$$P_w' = \frac{P_w}{1+\tau} \quad (3)$$

then add the constant cost of retail supply to obtain an adjusted retail price, which we label a reference price:

$$P_r' = P_s + P_w' \quad (4)$$

Substituting equations 2 and 3 into equation 4, we obtain equation 1. Because we do not have an observed wholesale price, we keep the component of the price attributed to the markup from wholesale to retail (Ps) constant for the purposes of this simulation. We calculate two reference prices based on an income-group NRP imputation at 100 percent and 300 percent markup for each of the 159 and 170 countries in the ICP datasets for 2011 and 2017, respectively. Reference prices are then used to calculate a new cost of nutrient adequacy for each country.

Price and affordability are key barriers to accessing sufficient, safe, nutritious food to meet dietary needs and food preferences for an active and healthy life. In this study, the least-cost items available in local markets are identified to estimate the cost of three diet types: energy sufficient, nutrient adequate, and healthy (meeting food-based dietary guidelines). For price and availability the World Bank's International Comparison Program (ICP) dataset is used, which provides food prices in local currency units (LCU) for 680 foods and non-alcoholic beverages in 170 countries in 2017. In addition, country case studies are developed with national food price datasets in United Republic of Tanzania, Malawi, Ethiopia, Ghana and Myanmar.

The findings reveal that healthy diets by any definition are far more expensive than the entire international poverty line of USD 1.90, let alone the upper bound portion of the poverty line that can credibly be reserved for food of USD 1.20. The cost of healthy diets exceeds food expenditures in most countries in the Global South. The findings suggest that nutrition education and behaviour change alone will not substantially improve dietary consumption where nutrient adequate and healthy diets, even in their cheapest form, are unaffordable for the majority of the poor. To make healthy diets cheaper, agricultural policies, research, and development need to shift toward a diversity of nutritious foods.

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