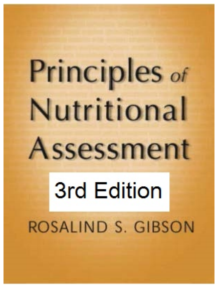

Leclercq C, Troubat N, and Gibson RS[1], Principles of Nutritional Assessment: Food Available for Consumption at National and Household Levels

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Abstract

This chapter describes how National Food Balance Sheets (FBSs) and Household Surveys allow a quantitative assessment of food available for consumption at national and household levels, respectively. Data expressed as per capita food supply for human consumption can be used to estimate per capita available intake of foods as well as energy and nutrients through matching with food composition data.

Food Balance Sheets are calculated from national food production, plus imports and food taken from stocks, with exports and food added to stocks subtracted to obtain an estimate of gross country's food supply. Both food diverted for non-human uses (e.g. animal feed, seed, non-food use) and the loss up to retail level are then subtracted from the gross country's food supply to obtain the net country's food supply (i.e. total food available for human consumption in a country at the retail level). FBSs are particularly important for low-income countries, where food consumption surveys at the household or individual-level are not performed regularly on a representative sample of the population. Unlike, household surveys, data from FBS provide no information on the distribution of the food supply within the country (in terms of geographical areas or socio-economic groups) or according to seasons.

Household food consumption is defined as the total amount of food and beverages available for consumption both within a household and/or prepared and consumed outside a household, family group, or institution. Food consumption by the household can be actually measured (i.e., in Household Food Consumption Surveys — HFCS), or assessed from food available for consumption (i.e., in Household Food and Expenditure Surveys — HCES). Harmonized methods are being developed that include a standardized food component module designed to estimate nutrient supply at the household level and apparent nutrient intake at the individual level, for widespread use in low- and middle-income economies.

Several indicators are available based on FBS and HCES data to monitor and compare poverty and food security and nutrition at the global and national levels based on the quantity of food available for consumption, e.g., prevalence of undernourishment (PoU). However, data from FBS or household surveys (HCS or HCES) provide no information on the availability of food/nutrients across the life span and the interpretation of the data in terms of dietary adequacy presents challenges and uncertainties unless complemented with individual-level dietary intake data. Increasingly, global data bases based on information synthesized from FBS, HCFS, and individual-level food consumption surveys are being used. Examples include the Global Dietary Database and the Institute for Health Metrics and Evaluation (IHME) initiative. These are capable of modeling worldwide individual intakes of foods and nutrients across the life span with the goal of improving health of the most vulnerable populations through improved diets.

2.0 Introduction

This chapter considers survey methods suitable for a quantitative assessment of food available for consumption / consumed at national and household levels. Methods suitable for measuring food consumption at the individual level are discussed in Chapter 3. Methods designed to estimate the exposure to hazardous substances, although sometimes based on household food supply, and those providing only a qualitative assessment or capturing only part of the available food supply (e.g., using Universal Product Codes — UPCs), are not considered.

The food available for human consumption by a population can be assessed through nationally representative surveys at the national level using Food balance Sheets (FBS), or alternatively at the household level using either Household Consumption Surveys (HFCS) or Household Consumption and Expenditure Surveys (HCES). The resulting data from all these surveys are expressed as per capita food supply for human consumption, and are used to estimate per capita available intake of foods, and energy and nutrients, when matched with appropriate food composition data.

The term that should be used for data derived from most of these national and household surveys is either "food supply" or "food available for consumption" rather than "food consumption". Only certain types of household surveys measure *actual* foods consumed.

Data from FBSs provide no information on the distribution of the food available for consumption within the country (in terms of geographical areas, seasonally, or demographic characteristics), unlike the data generated from household surveys. However, household surveys (HCS or HCES) do not provide information on the availability of food/nutrients across the life span. Moreover, the interpretation of the data from household surveys in terms of dietary adequacy presents challenges and uncertainties unless complemented with individual-level dietary intake data.

Contents:

Several indicators can be derived from FBS and HCES data to monitor and compare poverty and food security at the national level. These indicators can be based on the quantity of food available for consumption (e.g., prevalence of undernourishment (PoU) based on the energy supply per capita), as well as the food quality (e.g., HCES Dietary Diversity Score).

2.1 Food balance sheets

Food balance sheets are particularly important in countries where food consumption surveys at the household or individual level are not performed regularly on a representative sample of the population, as occurs for some low-income countries.

Several terms have been used to describe FBSs. These include "country's food supply", "national food accounts", "food moving into consumption", "food consumption statistics", "food disappearance data", "food available for consumption" and "consumption level estimates". Here, the term "country's food supply" is used.

Food balance sheets present a comprehensive picture of the pattern of a country's food supply during a specified reference period: the calendar year, the agricultural year or the crop year (FAO, 2021c). The sources of the food supply and its utilization are reported for each food item potentially available for human consumption, and includes primary commodities such as 'wheat, rice, fruit, vegetables, and processed commodities such as vegetable oils and butter. FBS data cannot be disaggregated to determine the distribution of a country's food supply spatially, seasonally, or by demographic characteristics.

Both official and unofficial data are used for the compilation of FBSs; National statistical offices constitute an important data source. However, data measured directly on food availability at national level may be difficult to obtain (FAO, 2021a). Instead, FBS compilers often derive estimates of food availability by making certain adjustments based on other existing data sets that measure food production or consumption. For example, two official data sources that may assist in the estimation of a country's food supply availability are Industrial Output Surveys and Household Consumption and Expenditure Surveys (HCES). See Section 2.2 for the description of HCES surveys.

The country's food supply is calculated from national food production, plus imports, plus food taken from stocks. Exports and food added to stocks are then subtracted to obtain a gross estimate of a country's food supply. The estimates of food diverted for non-human uses (e.g. animal feed, seed, non-food use) and of food loss are then subtracted from the gross country's food supply to obtain the net country's food supply, i.e. the total food available for human consumption in a country at the retail level (Figure 2.1, FAO 2021d). Data on non-commercial food production and detailed information on processed foods are not available in Food Balance Sheets.

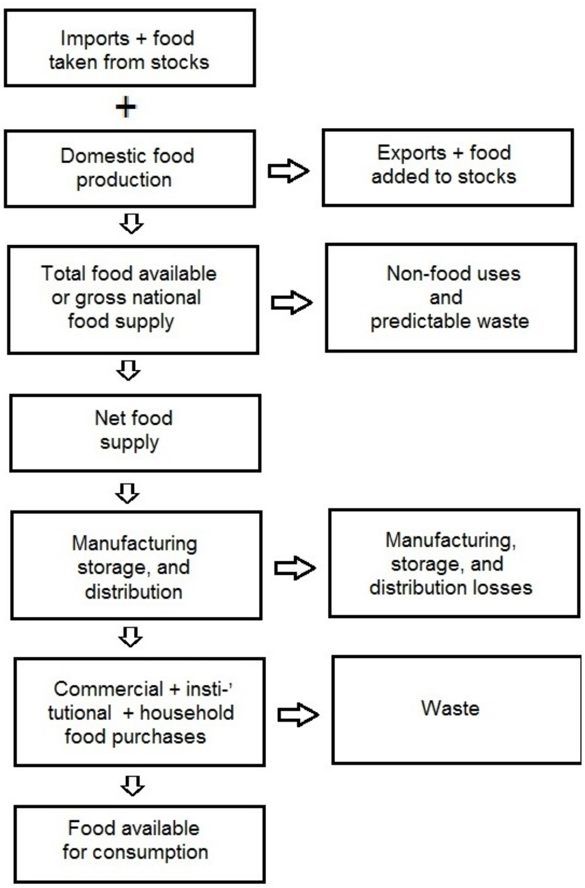


Figure 2.1. The derivation of food balance sheets. Modified from Nelson (1984).

For the purposes of the FBS, "food loss" closely aligns with "post-harvest / post-slaughter loss". It represents the quantity of food that leaves the production / supply chain at any stage, e.g., during production, processing and distribution, up to the retail level (FAO 2021a). Food loss may be considerable in countries where the agricultural products reach the consumer after travelling long distances and/or passing through several intermediaries prior to retail. In such cases, large amounts of food are lost because of damage, especially perishable foods such as fresh fruit and vegetables or processed foods with a short shelf life. Assumptions about losses may be based on expert opinion obtained in the countries. Losses or waste at the retailer, food catering, and household level are not considered in the compilation of FBS. Hence, total food supply estimates derived from the FBS are likely to be higher than average food consumed at the household level.

An example of the upper portion of an FAO food balance sheet which also shows in detail the sources of domestic supply and utilization of two of the major food groups (i.e., Cereals and Starchy roots) is shown in Table 2.1.

In some cases, information on a country's food stocks is not available. The effect of this data gap is reduced by preparing FBSs as a moving average for 3y periods for all countries. For more details, see FAO (2021f)

FAO in its online database (FAOSTAT) provides free access to FBSs for over 245 countries and territories and all the FAO regional groups, from 1961 to date (FAO, 2021c). The FBSs reported are "standardized FBSs" in which the commodity list is confined only to the quantity of the primary commodities available for consumption, with the quantity of processed commodities converted into their original primary commodity equivalent. For example, for bread, quantities are expressed in wheat equivalents comprising wheat flour and wheat-flour products. For more details on the standardization of Food Balance Sheets, see FAO (2021g).

Item	Pop.	Domestic Supply					Domestic Utilisation								Per Capita Supply			
		Prod.	Imp.	Stock Var.	Exp.	Total	Food	Proc.	Feed	Seed	Losses	Oth. Use	Tourist	Resid.	Total		Prot.	Fat
	(1000)	(1000 tonnes)													Kg/Yr	KCal/Day	g/Day	
Population	81,116																	
Grand Total																**3,540**	**101**	**126**
Vegetal Products																**3,002**	**65**	**92**
Animal Products																**538**	**36**	**34**
Cereals - Excl. Beer		**36,178**	**8,590**	**2,629**	**7,298**	**34,840**	**14,791**	**510**	**12,899**	**2,000**	**2,621**	**2,018**		**0**	**182**	**1,366**	**42**	**5**
Wheat and products		21,500	5,178	2,599	6,449	17,630	11,655	20	2,093	1,380	1,205	1,276		0	144	1,086	36	4
Rice and products		900	448	-88	93	1,343	1,294		1	14	33	1		0	16	98	2	0
Barley and products		7,100	460	147	9	7,404		174	5,608	520	1,065	38		0				
Maize and products		5,900	2,492	-39	694	7,737	1,643	221	4,898	47	224	704		0	20	162	4	1
Rye and products		320		15	0	305	198		39	20	48			0	2	20	1	0
Oats		250	1	0	0	251	1	95	103	15	37			0	0	0	0	0
Millet and products		5	7	0	0	11			11	0	0			0				
Sorghum and products		0		0	0	0					0			0				
Cereals, Other		203	4	-5	54	159	0		146	4	9			0	0	0	0	0
Starchy Roots		**4,801**	**305**	**1**	**285**	**4,820**	**3,801**	**0**	**259**	**264**	**486**	**10**		**0**	**47**	**91**	**2**	**0**
Cassava and products			259		0	259	0		259			0		0	0	0	0	0
Potatoes and products		4,800	46	1	285	4,560	3,800	0	0	264	486	10		0	47	91	2	0
Sweet potatoes		0	0	0		0			0		0			0				
Roots, Other		1	0	0	0	1	1		0		0			0	0	0	0	0

Table 2.1. FBS - FAOSTAT.
Abbreviations: Pop, Population; Prod, Production, Imp, Imports; Exp, Exports; Proc, Processing; Oth. Use, Other Uses; Tour, Tourists; Resid, Residual. From FAO (2022a).

The major food groups listed in the FAO FBS data are shown in Box 2.1. A list of food commodities classified into these major food groups is available from FAO (2021c) in the definition and standard section of the FBS website. As an example, the food commodity “cassava” can be found in the food group “starchy roots”. The per capita supply available for human consumption is obtained by dividing the food supply by the estimate of the partaking population in each country; it is expressed in grams per capita of individual food commodities. FAO uses mid- year official population estimates released by the United Nations Development Program (UNDP). According to the latest FAO recommendation for FBS compilers, the number of migrants and tourists must be calculated as the difference between country's outbound travellers and inbound visitors and then subtracted from the population estimate (FAO, 2021a).

Box 2.1. Major food groups listed in the FAO Food Balance Sheet data

- Cereals and products
- Oil crops
- Roots, tubers and products
- Vegetables and products
- Sugars and syrups
- Pulses
- Tree nuts
- Fruit and products
- Meat
- Eggs
- Fish and fisheries products
- Milk and cheese
- Stimulants
- Spices
- Alcoholic beverages
- Oils and fats
- Miscellaneous

Data on per capita food supplies are expressed in terms of quantity, and in terms of caloric value, referred to as the Dietary Energy Supply (DES) (kcal/capita/day). The protein and fat content of each food group and commodity calculated by applying appropriate food composition factors are also available and expressed in terms of g/capita/day) (see Table 2.1). In the future, FAO may also provide micronutrient data for each food group and commodity.

Food balance sheets are derived statistics. Hence, their accuracy is dependent on the reliability of the underlying basic statistics. The coverage and accuracy of underlying statistics vary markedly across countries. In some low-income countries, the coverage and quality of

Modified from FAO (2021c)

the statistics are uncertain — especially for food diverted for non-human food uses and for food stocks. As well, in low-income countries where subsistence agriculture is widespread, FBSs may result in an underestimate of per capita food supply because the household consumption of vegetal food products obtained through growing or gathering, and animal food products through breeding or hunting, are not considered in the FBS calculations. Further, as food systems become more sophisticated in countries, systematic errors may increase.

As a result, FAO documents caution that availability for human consumption does not equate with consumption. The quantities of food available for human consumption, as estimated in the FBS, reflect only the quantities reaching the consumer at retail level. The amount of food (and of nutrients) actually consumed may be lower than the quantity shown depending on the degree of loss and waste of edible food and nutrients in the household. These may occur during storage, in preparation and cooking, as plate-waste, and when fed to domestic animals and pets, or when thrown away. Of these sources, storage, preparation, and cooking will have a greater effect on the content of vitamins and minerals of the food commodities than on the protein and fat content. See: FAO (2021h).

Recently, FAO has changed its FBS methodology, details of which are described in the document “The New Food Balances and the utilization variables” (FAO, 2021a). The key differences between the new and old FBS include a proportional balancing mechanism, use of the 2019 UNPD population data, inclusion of a new food module, revised computations for losses, feed, and stocks, and addition of a new element on non-food for industrial use; for more details see FAO (2021b).

The release of FBS data for 2019 includes this new methodology for the FBS data for 2014-2019. The new methodology has also been applied backwards to cover 2010-2013, thereby giving consistency over time for the national per capita food supply data from 2010 to 2019. In the new methodology, food available for consumption by non-resident visitors has also been included for selected countries in which tourism has a significant impact on the food supply (e.g., Small island Developing States). Food Balance Sheet data preceding 2010 will soon be recompiled using the new methodology. FAO has developed a FBS capacity development package for countries that includes a compilation tool incorporating the new methodology. Details are given in (FAO 2022a).

2.1.1 Uses of Food Balance Sheet data

Food Balance Sheet data are easily accessible and provide coverage of per capita food supply across countries and regions using a relatively consistent methodology compared to many other sources of data on food supply.

Box 2.2. Health-related uses of food balance sheet data

- Inter-country, regional or global comparison of food groups, nutrient availability and/or dietary trends
- Within-country analysis of food availability, nutrient availability and/or dietary trends
- Comparison of FBS with other national sources of dietary data
- Modeling studies in which FBS data are used as a guide to assess whether a proposed intervention is likely to make a difference to the health and nutrition of the population. As an example, Sheehy and Sharman investigated the possibility of increasing the folate supply in the European Union by replacing normal eggs with folate-enriched eggs
- Association between FBS dietary factors and mortality or health outcomes.

From Thar et al (2020).

Hence, they are often used to analyze overall trends, historic trends, and changes at country, regional, and global levels, in relation to both Dietary Energy Supply (Figure 2.2) and Food Groups (Figure 2.3). Asia has experienced the fastest growth in DES since 2010 (i.e., 6%), whereas in contrast the lowest historical DES is apparent in Africa, where there has been a slightly decreasing trend over the last decade (Figure 2.2).

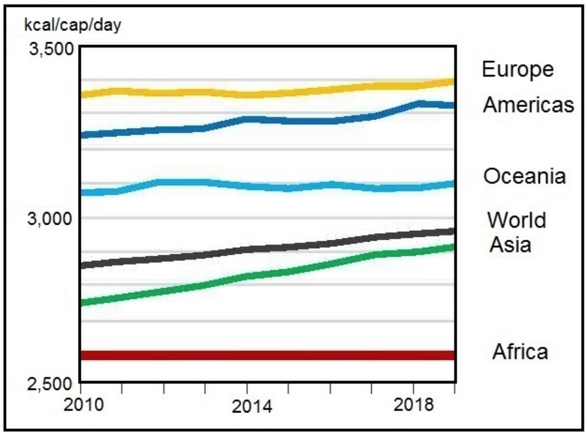


Figure 2.2 Dietary Energy Supply (DES) by region from 2010 to 2019 (kcal/cap/day). From FAO (2021d).

Food Balance Sheets can also be used to formulate agricultural policies concerned with the production, distribution, and consumption of foods.

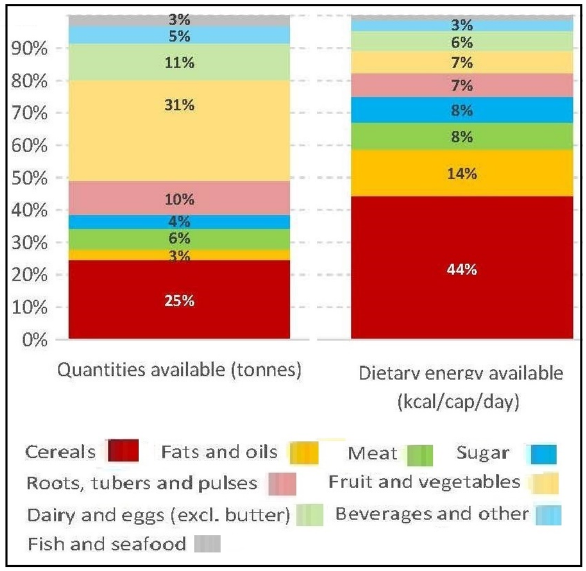


Figure 2.3. Global food availability composition in 2019 From FAO (2021d)

In relation to food groups, at the global level in 2019, cereals accounted for the highest share of the total food supply, both in quantities (in tonnes) available (25%) and dietary energy (44%), whereas although fruit and vegetables represented 31% of the total quantities available, they only accounted for 7% of the total dietary energy available due to their low kilocalorie content. In contrast, sugar, and fats and oils represented only 4% and 3% of the total quantities available but 8% and 14% respectively of the dietary energy available, as shown in Figure 2.3.

In addition, FBS data have many other uses, including correlations with other data which have a global coverage. Thar et al. (2020), have summarized several health-related uses of FBS data, as shown in Box 2.2 based on their review of 119 FBS surveys. They identified 50 studies conducted from the earliest available until 2016 that examined associations between dietary factors and mortality or health outcomes such as cancer, diabetes, or obesity. However, any interpretation in terms of causal/effect of such observed associations is highly questionable and should be discouraged. Further, given the importance of the decisions that may be taken based on FBS data, users need to have a good understanding of the strengths and weaknesses of the source of the data. See Table 2.2 and the report by Jacobs & Sumner (2002) for a thorough analysis of the appropriate uses and potential weaknesses of FBS data.

Several investigators have examined the validity of the global dietary estimates generated from FAO FBS data. For example, Gobbo et al. (2015) compared the FAO data with estimates based on nationally representative dietary data from individual-level surveys from 113 countries. Substantial overestimates were reported for most food groups including fruit, vegetables, whole grains, red and processed meat, fish and seafood, milk, and total energy, whereas beans and legumes, nuts and seeds were under-estimated based on FAO national food-supply data compared to the corressponding estimates from the national data at the individual-level. As a result, calibration equations were developed to adjust the FAO estimates to improve their validity. The authors suggest that these calibration models could be used not only to improve estimates based on FBS data of per capita food intakes at the national level but also by age and sex.

One of the main uses of FBS is to monitor global hunger and food security to provide data on national diets and their nutrient adequacy. With these, insights into the countries and regions that are most likely to be at greatest risk for low dietary supply of energy (DES)(kcal per capita) of as well as selected nutrients, can be provided. Selected indicators derived from the food component data of FBS and used to monitor global hunger, food security, and nutrient adequacy are presented in Box 2.3 . Details of some of their applications are given below.

Box 2.3. Selected global hunger, food security and nutrition indicators based on Food Balance Sheet Data

- Dietary Energy Supply (DES) (kcal/capita/day)*
- Dietary Energy Supply Adequacy (percent)* = DES/(Adequate Daily Energy Requirement)
- Prevalence of Undernourishment (PoU)
- Cost and Affordability of a Healthy Diet (CoAHD)
- Dietary energy available from cereals, roots, and tubers (kcal/capita/day), expressed as percent*
- Protein supply (g/capita/day)*
- Fat supply (g/capita/day), 3-year average
- Supply of protein of animal origin (g/capita/day)*
- Estimated prevalence of inadequate intakes of selected micronutrients at global and country-specific levels

*These indicators are present in the FAO "Suite of indicators of food security"

2.1.1a Trends in global hunger

Ideally, the assessment of global hunger (and food security) should be based on national data on food consumption at the household (see Section 2.2) or the individual level (see Chapter 3). However, only a few countries conduct such surveys on an annual basis. Therefore, FBSs have a key role in the assessment of global hunger and food insecurity, published yearly in the report "The State of Food Security and Nutrition in the World" by FAO, IFAD, UNICEF, WFP and WHO (2022). This global monitoring report identifies countries in which food insecurity is most prevalent, monitors global hunger and food security trends over time, and provides projections of future global hunger and food insecurity.

In this report, the per capita Dietary Energy Supply (DES) (Box 2.3 and Table 2.1) estimated from FBSs is used as a proxy for the average energy intake of the population. The per capita Dietary Energy Supply (DES) is available from FAOSTAT and calculated using an FAO global food composition database. The sum of the dietary energy content of the total food supply is then divided by the population size of the country and by 365 to calculate the per capita daily dietary energy supply (DES) available for human consumption (See Table 2.1 and Figure 2.2). However, DES does not yield any information on the affordability, access, or consumption of dietary energy by different population groups within a country. In addition to DES, the contribution of energy from individual food groups (Table 2.1). available for human consumption at the global level and within a country are also calculated.

Dietary Energy Supply is one of the three metrics used to estimate the prevalence of undernourishment (PoU), an indicator based on the percentage of individuals in the population who are in a condition of "under nourishment" (Table 2.2). PoU is one of the indicators of Sustainable Development Goal 2 (FAO 2021e) and is defined by FAO as the condition of an individual whose habitual food consumption is insufficient to provide, on average, the amount of dietary energy required to maintain a normal, active, and healthy life. The national PoU estimates are reported as three-year moving averages, whereas the regional and global aggregates are reported as annual estimates. PoU, however, does not provide information on which specific individuals are undernourished or on the quality or diversity of the diet. The three metrics used to estimate PoU are:

- Average dietary energy consumption (DEC). DEC is based on DES minus the incidence of caloric losses at retail distribution level
- Coefficient of Variation (CV) of energy intake. This is a measure of the levelS of inequalities in access to food consumption and hence dietary energy consumption within a population
- Average minimum dietary energy requirement (MDER) per person for the national population in each of the covered countries. This represents the minimum amount of dietary energy per person that is considered adequate to ensure they maintain a minimum weight for health.

To the CV of energy intake, data on inter-household variability from household surveys such as Household Consumption and Expenditure Surveys (HCES) are used. Higher CV values represent larger levels of dietary inequality. Use of such data in the PoU calculation is crucial because food (and consequently energy) is never equally distributed among households within a country. Hence, any comparison of per capita DES with energy requirements at the country level without considering the CV of energy intake would largely underestimate the prevalence of food insecurity at household level in many countries.

To derive the MDER, factors such as the age structure, sex, height, and activity levels of individuals within each country are applied to assess the distribution of energy requirements. Using the variation in intake and energy requirements, undernourishment can be calculated. More details of how these three metrics are used to estimate PoU are given in FAO (2022).

	Prevalence of undernourishment (percent)								
	2005	2010	2015	2016	2017	2018	2019	2020*	2021*
WORLD	**12.3**	**8.6**	**8.0**	**7.8**	**7.6**	**7.7**	**8.0**	**9.3**	**9.8**
AFRICA	**20.7**	**16.5**	**15.8**	**16.3**	**16.4**	**17.0**	**17.4**	**19.6**	**20.2**
Northern Africa	8.4	6.4	5.2	5.4	5.6	5.5	5.4	5.9	6.9
Sub-Saharan Africa	23.9	18.9	18.3	18.9	18.8	19.6	20.1	22.7	23.2
Eastern Africa	33.8	26.5	24.4	25.2	25.4	26.6	27.5	30.2	29.8
Middle Africa	34.9	26.0	26.3	27.4	26.6	27.3	28.1	30.4	32.8
Southern Africa	4.9	5.8	7.4	7.4	7.5	7.4	7.9	9.1	9.2
Western Africa	12.2	9.9	10.1	10.1	10.0	10.6	10.4	13.2	13.9
ASIA	**13.9**	**9.1**	**8.0**	**7.5**	**7.1**	**7.1**	**7.4**	**8.6**	**9.1**
Central Asia	14.0	6.0	3.8	3.5	3.2	2.9	2.6	3.1	3.1
Eastern Asia	6.8	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
South-eastern Asia	17.2	10.9	7.8	6.7	6.0	5.9	5.6	5.8	6.3
Southern Asia	20.5	15.3	14.1	13.1	12.4	12.3	13.2	15.9	16.9
Western Asia	7.8	5.9	9.6	10.4	10.2	10.3	10.0	10.1	10.0
Western Asia and Northern Africa	*8.1*	*6.1*	*7.6*	*8.1*	*8.1*	*8.1*	*7.9*	*8.2*	*8.6*
LATIN AMERICA AND THE CARIBBEAN	**9.3**	**6.6**	**5.8**	**6.7**	**6.4**	**6.6**	**6.7**	**8.0**	**8.6**
Caribbean	18.7	15.2	14.2	14.5	14.4	15.2	15.2	16.5	16.4
Latin America	8.6	6.0	5.1	6.2	5.8	6.0	6.1	7.4	8.0
Central America	8.0	7.3	7.5	8.1	7.9	7.9	7.6	8.0	8.4
South America	8.8	5.5	4.2	5.4	5.0	5.2	5.4	7.1	7.9
OCEANIA	**6.8**	**6.2**	**5.7**	**5.8**	**5.8**	**5.7**	**5.6**	**5.4**	**5.8**
NORTHERN AMERICA AND EUROPE	**<2.5**	**<2.5**	**<2.5**	**<2.5**	**<2.5**	**<2.5**	**<2.5**	**<2.5**	**<2.5**

NOTES: * Projected values based on the middle of the projected range

Table 2.2. Selected data on the prevalence of undernourishment (PoU) (as percent) from 2005-2021 for the world, Africa, Asia, Latin America and the Caribbean, Oceania, and Northern America and Europe. From FAO, IFAD, UNICEF, WFP and WHO (2022).

Note the presence of persistent regional disparities in the proportion of the population affected by hunger from 2005 to 2021 (Table 2.2), with Africa having the highest burden of undernourishment as well as the region with the largest increase in the proportion of the population affected by hunger during this time. Disparities also exist at the subregional levels: these are also summarized in the report.

FAO also provides data on the cost and affordability of a healthy diet (CAHDO). This has been shown to be strongly associated with PoU and with different forms of malnutrition, including child stunting and adult obesity. The cost of a healthy diet is defined by FAO as the minimum cost of food, using the least expensive available items in each country, that people have to pay to secure a healthy diet. The latter is based on the cost of the average quantities of each food group recommended in national Food Based Dietary Guidelines (FBDG). On average, the healthy diet meets 95% of nutrient needs.

To determine affordability of a healthy diet, the cost of a healthy diet is compared with country-specific income distributions available in the “Poverty and Inequality Platform” (PIP) of the World Bank. From these data, the percentage and number of people in each country / region who cannot afford a healthy diet are estimated. The threshold for an unaffordable healthy diet in 2020 was when its cost exceeded 63% of the income in a country. However, food prices have surged since 2020, so this threshold for unaffordability is likely to change. For more details on the derivation of CAHD and the estimates of the number of people in the world and by region and subregion, see Chapters 2 and 3 and ANNEX 3 in FAO, IFAD, UNICEF, WFP and WHO (2022).

	Cost of a healthy diet in 2020		People unable to afford a healthy diet in 2020		
	Cost (USD per person per day)	Change between 2019 and 2020 (percent)	Percent	Total number (millions)	Change between 2019 and 2020 (percent)
WORLD	**3.54**	**3.3**	**42.0**	**3074.2**	**3.8**
AFRICA	**3.46**	**2.5**	**79.9**	**1031.0**	**2.5**
Northern Africa	3.57	-0.7	57.2	136.7	-0.8
Sub-Saharan Africa	3.44	2.9	85.0	894.3	3.1
Eastern Africa	3.37	3.4	87.4	360.8	3.0
Middle Africa	3.34	2.2	85.4	152.2	3.0
Southern Africa	3.84	3.3	65.5	44.2	1.8
Western Africa	3.45	2.7	85.7	337.1	3.3
ASIA	**3.72**	**4.0**	**43.5**	**1891.4**	**4.3**
Central Asia	3.11	4.0	21.5	7.5	6.9
Eastern Asia	4.72	6.0	11.0	174.4	18.7
South-eastern Asia	4.02	4.2	53.9	347.2	4.7
Southern Asia	3.81	4.0	70.0	1331.5	2.7
Western Asia	3.22	2.9	17.8	30.9	-1.4
LATIN AMERICA AND THE CARIBBEAN	**3.89**	**3.4**	**22.5**	**131.3**	**6.5**
Caribbean	4.23	4.1	52.0	13.9	3.5
Latin America	3.56	2.5	21.0	117.3	6.9
Central America	3.47	2.1	27.8	43.1	9.8
South America	3.61	2.7	18.4	74.2	5.3
Low-income countries	3.20	2.7	88.3	454.2	3.0
Lower-middle-income countries	3.70	2.9	69.4	2230.7	2.9
Upper-middle-income countries	3.76	2.9	15.2	374.0	10.9
High-income countries	3.35	4.0	1.4	15.3	3.3
OCEANIA	**3.07**	**3.6**	**2.7**	**0.7**	**1.0**
NORTHERN AMERICA AND EUROPE	**3.19**	**3.2**	**1.9**	**19.8**	**5.4**

Table 2.3. The cost of a healthy diet is the benchmark 2017 USD cost per person per day, projected forward to 2019 and 2020 using FAOSTAT data for each country's Consumer Price Index (CPI) for food, and World Development Indicator data for purchasing power parity (PPP) exchange rate. The people unable to afford a healthy diet is expressed as the weighted percentage (%) and the total number (millions) of the population in each region and country income group who could not afford the diet in 2020. For country income groups, the 2021 World Bank income classification is used for the years 2019 and 2020. From FAO, IFAD, UNICEF, WFP and WHO (2022).

2.1.1b Food security indicators at national level

FAO (1996) has defined "Food Security" as

> "a state in which all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life"

Five indicators present in the FAO "Suite of indicators of food security" are derived from 3y moving averages of FBS data and are shown in Box 2.3. Note that none of these indicators provide information on the affordability, accessibility, or consumption by different population groups including nutritionally vulnerable groups. For more details, see: FAO (2022). The average dietary energy supply (DES) adequacy is defined as the dietary energy supply as a percentage of the average dietary energy requirement. The latter is defined as the amount of dietary energy measured in kilocalories that is required by an individual to maintain body functions, health, and normal activity, as noted earlier. The estimates of DES adequacy consider the age structure, sex, height, and level of physical activity of different individuals in each country.

The dietary energy available from cereals, roots, and tubers (kcal / capita / day) (percent, 3y average) is an important nutritional indicator because items from these food groups are generally the least expensive. As a result, these staple foods are often a large part of the diet in low-income countries. Consequently, the nutrient density, dietary diversity, and micronutrient supply of these diets are low as described in detail in Chapter 8c.

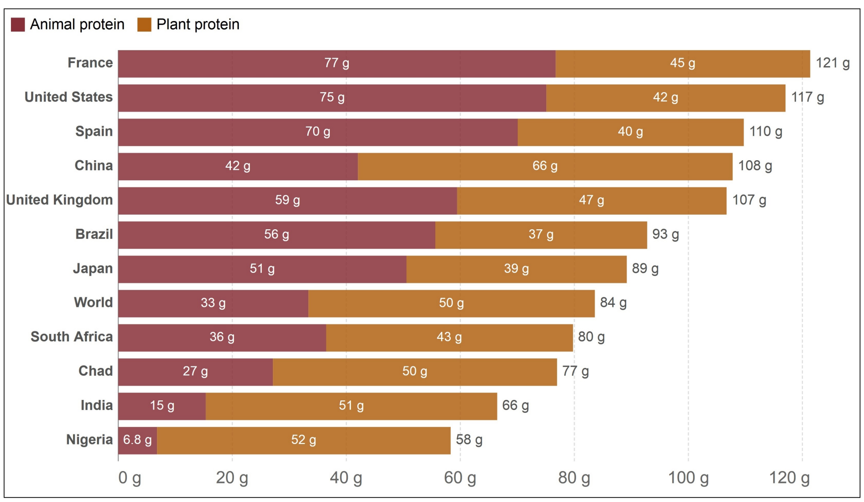


Figure 2.4. Daily protein supply from animal and plant-based foods (2020). Protein of animal origin includes protein from all meat commodities, eggs, and dairy products, and fish and seafood. Data (g / capita / d) from FAO. Map from ourworldindata.org / diet-composition. Additional information is available

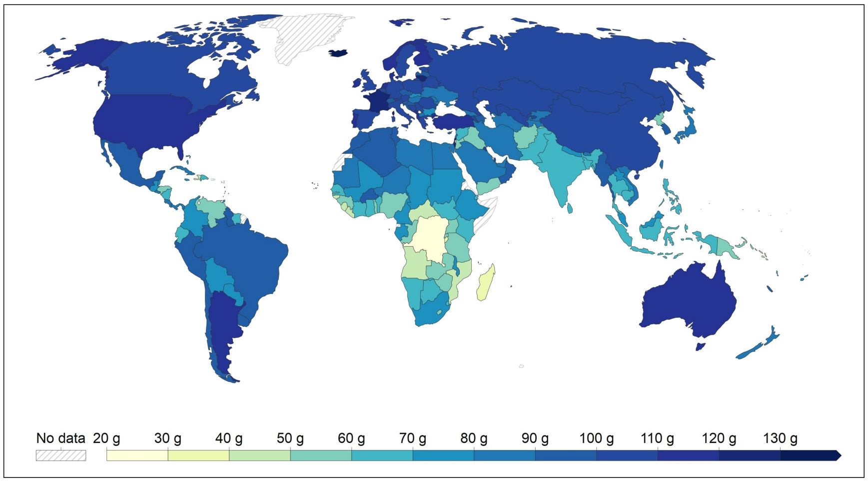
As noted earlier, average protein supply (g / capita / day, 3-year average) provides insight into the nutritional quality of the food supply at the global, regional, or national level.

The average supply of protein of animal origin (g / capita / day, 3-year average) is an additional important indicator of diet quality as animal-based proteins contains all the essential amino acids. The supply of protein from animal-based sources includes meat commodities, eggs, and dairy products, and fish and seafood, all measured in g / capita / day. Figure 2.4 present the daily protein supply from animal and plant-based foods in 2020. The data from 1961 to 2019 show that there has been an increase in the share of total protein from animal-based sources in most countries since 1961 (Roser et al., 2013).

Additional indicators of the quality of the food supply based on FBS data have been developed by INDDEX in their Data4Diets platform. They include meat consumption (expressed as total kilograms per capita at the national level), national energy available from non-staples (i.e., all food items excluding grains and tubers), and national fruit and vegetable availability in the food supply. For more details, see INDDEX Project (2018).

2.1.1c Macronutrient availability at the national level

Macronutrients include carbohydrate, protein, and fats, and are the major source of energy in the diet. Macronutrient supply per capita can be estimated by combining supply data from FBSs expressed in g/capita/day with a food composition database for all primary and processed food products, as noted earlier. A common global food composition database available in FAO (2001a) is used to estimate the FAO nutrient supply data. The source of the nutrient composition data in this global database is not cited and any differences in the nutrient composition of food items across countries is not considered.



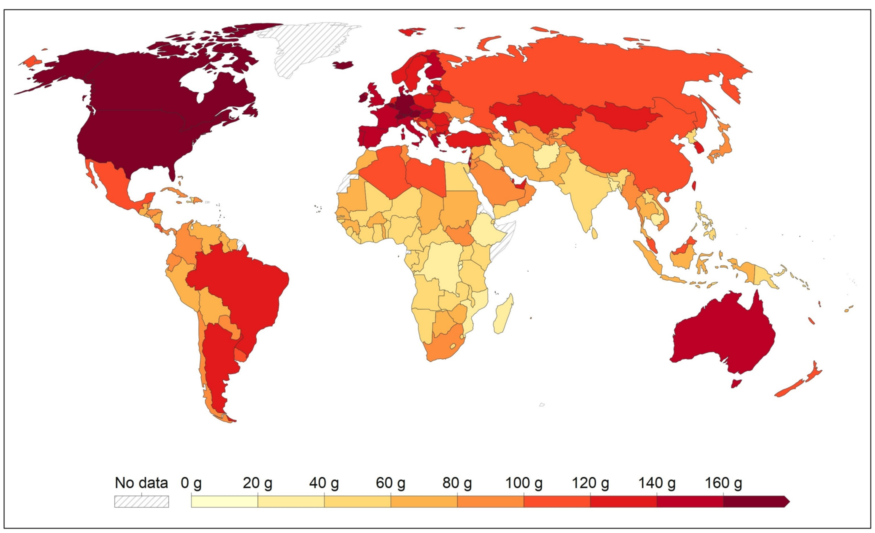
Note: Data measures the availability delivered to households but does not necessarily indicate the quantity of protein actually consumed (food may be wasted at the consumer level).

Figure 2.5. Global per capita protein supply (2020). Data from FAO. Map from ourworldindata.org/food-supply. Additional information is available

As shown in Table 2.1, the supply per capita for energy is expressed as kcal / capita / day, whereas the macronutrient supply per capita for both protein and fat are expressed as g / capita / day). Data are freely available by year and country from FAO (2021c).

Figure 2.5 presents the global per capita supply of protein and shows that in lower-income countries the per capita protein supply in 2020 is about 60-80g / capita / day, whereas in most countries across Europe, North America, and Oceania, the per capita protein supply is greater than 100g / capita / day.

The quality of the diet improves with the increased consumption of protein-rich foods. At the national level, the average protein supply provides an estimate of the protein supply per capita and thus insight into the nutritional quality of the national food supply. However, no information on the availability of protein supply in nutritionally vulnerable groups is provide by the FBS data.



Note: Data measures the fat availability delivered to households but does not necessarily indicate the quantity of fat actually consumed (food may be wasted at the consumer level).

Figure 2.6. Global per capita fat supply (2020). Data from FAO. Map from ourworldindata.org/food-supply. Additional information is available

In contrast to both energy as kcal / capita / day and protein g / capita / day, the per capita fat supply g / capita / day has increased across all regions during the period 1961 to 2014, although over the last decade, the increase has slowed in North America, Europe, and Oceania. Regional differences in supply for fat are larger than that for either energy or protein, with the average capita fat supply in North America being almost three times as large as in Africa in 2019 (Figure 2.6) (Roser et al., 2013).

Macronutrients are sometimes expressed as percentage of total energy (e.g. percentage of kilocalories from protein or fat) due to uncertainties in the data and process used to develop FBS. Values expressed in this way (i.e., as nutrient density) are said to be much less influenced by age and sex in a population. Moreover, assessment of protein supply as protein density allows the quality of the diets to be compared across countries which have differing levels of accuracy of the food supply data, and thus differing levels of under / over estimation of total nutrient per capita supply. Nevertheless, even comparison of the values for percentage of energy as well as percentage of energy from protein and fat (and any other nutrient) derived from each food group across countries can be jeopardized by a differing level of under / over estimation between food groups. In some cases, values for the ratios of polyunsaturated fatty acids to saturated fatty acids (P:S) and unsaturated fatty acids to saturated fatty acids (U:S) have also been used (Sasaki & Kesteloot, 1992) rather than per capita nutrient supply.

2.1.1d Micronutrient availability at national level

Efforts have been made by several investigators to use FBS for the assessment of the adequacy of micronutrient supply at the global level, in different regions of the world, and in individual countries. To accomplish this aim, FBS have been matched not only to energy, protein, and fat, but also to a full range of micronutrients. However, because the FAO FBS do not include data on the micronutrient supply per capita at the present time, investigators have compiled their own data on the micronutrient composition of the food commodities listed in the FAO FBS using data from food composition tables.

As noted earlier, FAO FBS provide only national-level estimates per capita. This precludes the assessment of per capita micronutrient supply that takes into account age and sex and the differing micronutrient needs of the national population. However, by applying data from estimates on the age and sex distributions of the national population in each country, the theoretical population mean requirement for each micronutrient at the national level can be estimated. From this, the percentage of the population at risk of inadequacy has been calculated, defined as the proportion of the population with micronutrient intakes below the theoretical average micronutrient requirement of the population. The population distribution of intakes for each micronutrient is inferred based on the assumed mean per capita micronutrient intake and coefficients of variation (CV) for each micronutrient (taken from the literature). The latter takes into account inter-individual variation in micronutrient intakes arising from the inequities which affect access and availability of certain foods. This approach of assessing risk of inadequacy is related to the Estimated Average Requirement (EAR) cut-point method and described in Chapter 8b for a population.

Several investigators have employed this approach to estimate risk of micronutrient inadequacy based on FBS data. Wuehler et al. (2005) were the first investigators to compare the adequacy of the food supply to meet the theoretical population mean requirement for zinc, based on FBS for 176 countries.

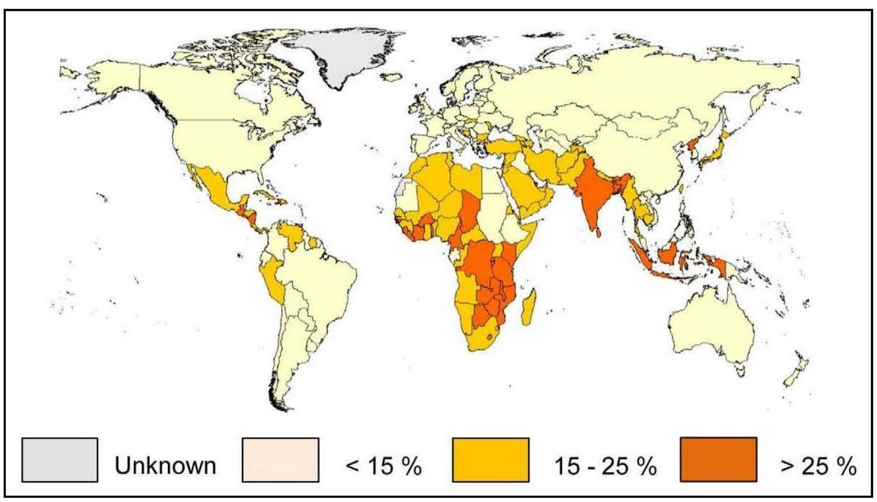


Figure 2.7. Estimated country-specific prevalence of inadequate zinc intake. Data are based on the composite nutrient composition database, IZINCG physiological requirements, the Miller Equation to estimate zinc absorption and an assumed 25% inter-individual variation in zinc intake. Data are for the 2005 time frame (2003-2007). Redrawn from Wessells & Brown (2012).

In this analysis, estimates of the absorbable zinc content of the national food supplies were derived from a global food composition database compiled by the investigators, with zinc absorption predicted using a model developed by the International Zinc Nutrition Consultative Group (IZiNCG). In this study, the investigators compared the absorbable zinc content of the food supply with the population theoretical mean *physiological* requirement to estimate the percentage of the population at risk of inadequate zinc intake. This earlier analysis was revised by Wessells & Brown in 2012. Figure 2.7 shows the estimated country-specific prevalence of inadequate zinc intake generated from this revised analysis. A companion article highlights the major sources of uncertainty in the analysis (Wessells et al., 2012). They also compared their estimated prevalence of dietary zinc inadequacy with the national prevalence of stunting in children less than 5y in 138 low- and middle-income countries (Figure 2.8).

In later publications, this same approach has been applied to assess the per capita availability of several other micronutrients in regions (e.g., Africa) (Joy et al., 2014) and South Asia (Mark et al., 2016), as well as in specific countries

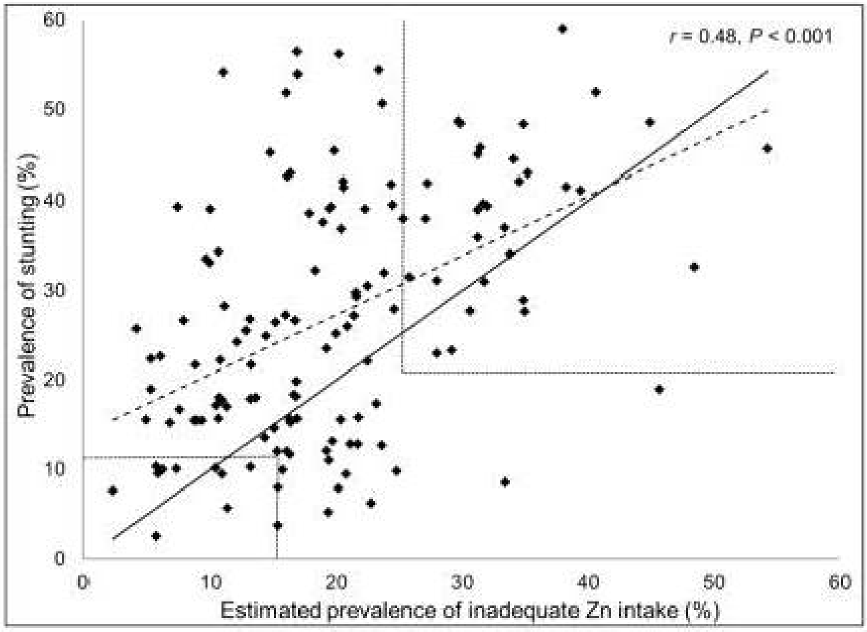


Figure 2.8 Relationship between the estimated prevalence of inadequate zinc intake and the prevalence of childhood stunting. Stunting data (low height-for-age) are for children less than 5y in138 low- and middle-income countries. The solid line represents the line of identity (intercept=0, slope=1). The dashed line represents the best-fit regression line. Dotted lines demarcate countries with a high risk of inadequate zinc intake and where the prevalence of stunting is > 20%. From Wessells & Brown (2012).

(Broadly et al., 2012; Arsenault et al., 2015; Watts et al., 2016). For example, in a study by Arsenault and co-workers FBS data from three countries (Bangladesh, Senegal, and Cameroon) were used to assess the per capita availability for eight micronutrients (vitamin A, vitamin C, vitamin B_6, riboflavin, niacin, folate, calcium and zinc). Although a common food composition database was compiled and used for all three countries, additional country-specific adjustments were made in this study to take into consideration the in-country processing of staple foods, which lead to differences in the nutrient composition of ingested foods (e.g. percentage of refined wheat at country level). Two indicators of adequacy were assessed in this study:

1. Per capita nutrient supply expressed as a percentage of the theoretical mean population-adjusted nutrient requirements for each country;
2. Percentage of the population that had an adequate usual intake, based on the assumed inter-person variability in micronutrient intakes obtained from the literature.

Each nutrient gap in the food supply was also calculated as the difference between the current amount in the food supply minus the amount of the nutrient needed to achieve 80% prevalence of adequate intakes. In this study, linear optimization modeling was also used to determine the optimal mix of crops to fill the micronutrient gaps identified in each county and thus increase their micronutrient adequacy. Table 2.4 shows the optimal set of crops required to address the micronutrient gaps identified in Senegal while minimizing land requirements.

Crops	Servings[b]	Grams	Vit. A (µg RAE)	Vit. C (mg)	Ribofl. (mg)	Folate (µg)	Calcium (mg)	Zinc (mg)	% crop land
Barley	0.50	23	0	0	0.07	4	8	0.6	1.8
Broccoli	0.50	39	30	25	0.05	42	16	0.2	1.0
Cabbage	0.50	38	2	14	0.01	11	18	0.1	0.4
Carrots	0.40	18	157	1	0.01	3	6	<0.1	0.3
Groundnuts	0.50	14	0	0	0.02	27	10	0.5	3.8
Okra	0.50	40	6	7	0.02	18	31	0.2	0.8
Pumpkin	0.25	31	90	1	0.02	3	5	0.1	0.4
Spinach	0.25	23	118	2	0.05	33	31	0.2	0.6
Total	3.40	226	403	50	0.25	141	123	1.8	9.0
%adequate intakes	—	—	81	%95	%85	%84	<1%	%80	—

Table 2.4 Optimal set of crops to address micronutrient gaps in Senegal while minimizing land requirements[a]
[a] The amounts are additional amounts needed to achieve target levels of all nutrients so that the food supply provides sufficient amounts of nutrients (except calcium) for at

In an effort to overcome some of the limitations of FBS data, notably their lack of information on both individual foods that are important in diets and actual intakes by age or sex, Smith et al. (2016) have constructed a new model: the Global Expanded Nutrient Supply (GENuS) model to estimate per capita supply for 23 individual nutrients across 225 food groups for 34 age-sex groups in 152 countries. They also provide trends in national level data over50 years (1961-2011).

To achieve these objectives, the GENuS model combines FBS data with some ancillary data from individual and household surveys at country level. This approach yields food supply estimates which consider both the edible weight of each food commodity and level of food

least 80% prevalence of adequate intakes in the population
[b] Serving sizes are in edible form, i.e., all vegetables are cooked, grains are dry but nutrients adjusted for cooking losses. Data from Arsenault et al. (2015).

fortification in 225 food groups. In each country an ad-hoc food composition database was compiled based on six national and regional food composition tables in which nutrient losses during the processing of cereals to flour were considered. Age and sex-specific supplies of foods and nutrients across 26 age groups were calculated for each country. The distribution of nutrient per capita supply by age and sex was derived through a probabilistic method (Monte Carlo simulations). Finally, to assess validity, a comparison of the GENuS estimates of nutrient supplies against USDA estimates was performed, which revealed very good agreement for 21 of 23 nutrients. For a discussion of the limitations of the data used in the GENuS model, see Smith et al. (2016).

2.2. Food available for consumption at the household level

Household food consumption is defined as the total amount of food and beverages available for consumption in the household plus any foods prepared and consumed outside the household. Household surveys are of two types:

1. Household Food Consumption Surveys (HFCS). These were developed in the 1980s as an alternative to surveys at the individual level, and provide measurements of food consumption in the household.
2. Household Consumption and Expenditure Surveys (HCES). In these surveys, food available for consumption is measured.

These household surveys are widely used to inform on global food security and poverty, particularly in low- and middle-income economies. Such surveys can also be conducted in institutions such as those for institutionalized elderly. Increasingly, HCES are also being used to estimate “nutrient intakes”, despite the potential errors and imprecision that may occur using this method. In view of these challenges, the terms “nutrient supply” at the household level and “apparent nutrient intake” at the individual level are often used.

In the past, some surveys similar to HFCS or HCES were conducted in high-income countries with the objective of assessing food consumption at the household level. They were based on a record of food quantities entering the household, either purchased, received as gifts, or produced for household use, over a reference period, often seven days. They used the “food account method” (Burk & Pao, 1976; Ministry of Agriculture, Fisheries and Food, 2000), the “list-recall method” (USDA,1993), or the “food inventory method” (Turrini et al., 2001). Food consumption by individual members of the household was often recorded as an additional component of the survey. This approach led to an increased burden on the sampled households, resulting in some cases in a low response rate (USDA,1993). Such surveys are now rare and have been replaced by food consumption surveys at the individual level.

During HFCS and HCES, data on acquisition and/or expenditure and/or consumption of commodities including foods and beverages are collected. HFCS and HCES are less expensive than individual food consumption surveys and require a lower burden for participants. However, many of the technical problems and limitations of household surveys are the same as those of dietary surveys conducted at the individual level, which are discussed in detail in Chapters 4 and 5. For example, diet might be altered by the design of the survey or the recording process.

Typically, HFCS and HCES are conducted on a large nationally representative sample of households (Fiedler et al., 2012), and include the collection of information on demographic and socioeconomic characteristics of the household, thereby enabling data to be presented in terms of income level, family size, region of the country, etc. Attention must be paid to the sampling design of these surveys to ensure that a representative national sample is obtained; see details on sampling methods in Chapter 1, section 1.4.2. The sampling design should account for the influence of season, holidays, weekends, socioeconomic status, and region on food consumption patterns to ensure information on the true mean food consumption and the diverse food consumption pattern of a population is obtained.

2.2.1. Household food consumption surveys (HFCS)

Household Food Consumption Surveys measure all food and beverages consumed within a household during a specified period. They require careful supervision by the interviewer and good cooperation of the respondents. In general, these surveys are more complicated and costly to undertake than HCES and hence were often conducted infrequently. Such surveys are rarely performed today. Instead, they have been replaced by surveys of food consumption at the individual level (see Chapter 3). Two methods — weighed food records and household 24hr recalls — were used in the past to measure the household food consumption.

Weighed household food records

For this method, the food eaten by the household is recorded using weighed food records (also called food diaries). These are usually completed over at least a 1wk period, by either the householder or a fieldworker. During the survey period, the weight or volume of each food consumed at each meal is recorded, before subdivision into individual helpings (Burk & Pao, 1976). Detailed descriptions of all foods, including brand names, and their method of preparation are recorded. For composite dishes, the amount of each raw ingredient used in the recipe and the final weight of the prepared composite dish is also recorded. In some surveys the plate waste from each meal is collected and separated so that waste for individual food items can be weighed and recorded. Generally however, kitchen and plate waste, and food fed to pets, is not accounted for in this method, and instead an arbitrary wastage factor is applied.

Household 24-h recalls

In this method, the household member responsible for the food preparation is interviewed to obtain information on both household composition and household food consumption over the previous 24h period. In the first stage of the interview, information is collected on the dishes and ingredients consumed, followed by details on the quantity, focusing particularly on those foods that are important sources of energy. A technical guide for measuring household food consumption using a 24h recall was developed by Swindale & Ohri-Vachaspati (1999). This guide provides detailed instructions and sample questionnaires that can be used to collect the data, quantify the portion sizes of food consumed, and analyze the results.

2.2.2 Household Consumption and Expenditure surveys

Household Consumption and Expenditure Surveys (HCES) are typically performed within Household Expenditure Surveys (HES), i.e. economic surveys designed to inform national economic policy and usually implemented by national statistical agencies.

HCES are less costly than HFCS and are widely used in low-income settings (FAO, 2023). They are usually conducted every 3-5y and cover 7,000 to 20,000 households in a country to provide a statistically representative sample. HCES refer to a heterogeneous group of complex surveys which include Household Income Expenditure Surveys (HIES), National Household Budget Surveys (NHBS), and Living Standards Measurement Surveys (LSMS). The latter (i.e, LSMS) are multi-topic surveys which are provided with technical assistance by the World Bank's Living Standard Measurement Study (LSMS) group.

HCES were designed primarily to measure household food available for consumption in a reference period through the expenditure approach (i.e., the monetary value of the food). Over time, quantities of foods and beverages have also been collected in an effort to repurpose the surveys so they can serve other needs such as monitoring household-level food security. This has led to improvements in survey design to capture food data of a higher quality by including a more detailed food component module.

Some HCES based on the concept of acquisition, collected data on food entering the households acquired through purchases, own-production, and in-kind, on the assumption that there were no major changes in household stocks during the survey period. An important limitation of this simplified methodology is related to the fact that some foods (e.g. grains) are not perishable and can be stored. Consequently, if the survey was conducted in a period of drawing-down stocks to meet current consumption, household consumption would be underestimated. On the contrary, if the survey was conducted in a period of accumulating stocks for later consumption, household consumption would be overestimated (Smith et al., 2014). As a result, use of these simplified HCES is no longer recommended. Alternatively, a combination of acquisition and consumption data can be collected in the HCES so that both food acquired through purchases and consumed from own-production and transfer are reported.

Food consumption estimates generated from acquisition data or a combination of both acquisition and consumption data are usually referred to as “apparent consumption” or “food available for consumption” to distinguish it from actual consumption (Fiedler & Mwangi, 2016). Data collected in HCES on food available for consumption are quite often used as a proxy for the quantities eaten.

HCES vary in their complexity and respondent burden. Data may be collected through a food diary, recall, or a list, with a reference period usually ranging from seven days to one month. When a list is used, the food and food groups specified varies, and when the list is short, the aggregated food items often lack the details needed to match the food items correctly with a food composition database. Food and beverages wasted, spoiled, or fed to pets or livestock are frequently not taken into account, although in some cases, waste may be weighed or a wastage factor applied.

In general, in the past the capture of food and beverages prepared and consumed outside the home has also been poor in most HCES, although there is now a trend to improve the recording of the consumption of these items. For example, in some recent HCES a special module has been added to collect personal expenditure on snacks, meals, sweets, and drinks consumed outside the home. Adjustments are also made in some HCES for the presence of non-household members during the survey period. Ideally HCES should report all sources of food consumption, either purchased, received as gifts, or produced for household use.

Variations in the survey designs of HCES across countries and over time within countries has created many challenges. To understand the implications of these variations on the accuracy and consistency of consumption measurements, a field study was conducted in Tanzania in 2007 and 2008 in which consumption estimates in 4,000 households was measured via eight different HCES survey designs, selected to capture the most common designs used in practice (Beegle et al.,2010). The effect of variations according to survey length, use of a household diary versus recall format, and level of detail of food items listed in the HCES on over- and under-reporting was investigated, using frequently supervised personal consumption diaries as the “gold standard”.

The characteristics of the study population, notably whether they were illiterate or largely urban, was found to affect the magnitude of the underestimate of consumption using the household diary method. For the recall method, the investigators recommended the use of a full long list of food commodities to recall within a reference period of 1 or 2 weeks rather than using a shorter recall list by aggregating the number of consumption categories. In summary, over- and under-reporting appeared to depend on the specific setting and varied with traits such as the literacy of the household, the share of consumption from home production, dietary diversity, and fraction of meals eaten in the household as opposed to private food consumption in restaurants (Beegle et al.,2010).

The findings of Beegle et al. (2010) highlighted the need to improve the quality and utility of the food data components of the HCES surveys so they were more relevant to nutritionists and food security analysts, and the importance of harmonizing the HCES survey methodology. Consequently, a desk review of survey questionnaires and methods used in 100 available HCES surveys from low- and middle-income countries was conducted to identify key areas for improvement (Smith et al., 2014).

Box 2.4 Areas identified in the food data component of HCES surveys warranting further investigation

- Choice of a diary or recall survey, and the appropriate reference point
- Food consumed away from home and cooked/packaged meals
- Measuring individual versus household consumption
- Measuring food acquisition versus food consumption
- Length and specificity of survey food lists

From Zezza et al. (2017).

Five areas in the food data component of HCES surveys were selected for investigation; these are summarized in Box 2.4. For a detailed discussion of the measurement error patterns that were identified within each of these five areas, see Zezza et al. (2017). As an example, a major challenge has been the rise in the consumption of food away from home, a trend that has accompanied the nutrition transition over the last decades in both developing and developed countries. Such data may include food that is purchased (e.g., from a street stall or restaurant), and/or received in kind (e.g., provided via food assistance or a gift etc). Snacks have also become an increasingly important part of the diet and may make up a large proportion of food consumed away from home.

Food away from home can refer to food produced outside the home such as takeout meals, irrespective of whether the food is consumed outside or inside the home. Alternatively, food away from home can refer to food consumed outside regardless of the origin of the food. Examples of this scenario includes homemade meals consumed at work or school. The FAO and the World Bank 2018 have outlined a method for defining food away from home, as shown in Figure 2.9.

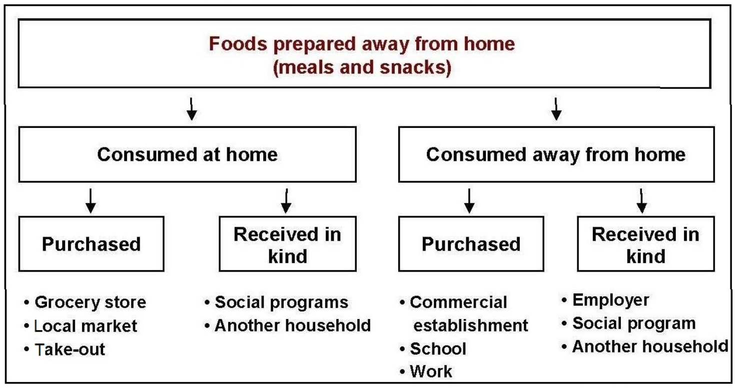


Figure 2.9 The definition of food away from home (FAFH). Redrawn from FAO and The World Bank (2018).

For nutrition and food security analysis, an additional challenge, not captured in Figure 2.9, is acquiring information on what was eaten. Such details must often be secured from other sources. Several low- and middle-income countries have developed innovative approaches to secure these details; see Annex 2 in FAO/World Bank (2018) for more details.

Table 2.5 presents data on food consumed away from home based on data collected from the 100 HCES surveys examined by Smith et al. (2014). Such data may include food that is purchased (e.g., from a street stall or restaurant) and/or received in kind (e.g., provided via food assistance or a gift etc). Snacks have also become an increasingly important part of the diet and can make up a large proportion of food consumed away from home. As shown in Table 2.5, although most of the surveys collected data on food consumed away from home, the detail with which the data were collected was very poor.

	Interview surveys (%)	Diary surveys (%)	All (%)
Whether any data collected on food consumed away from home[a]	83.3	100.0	90.0
Detail of data collection[b]			
Only one line item (e.g., “Restaurant food”)	36.0	7.9	23.9
Data collected for multiple places of consumption	14.0	35.0	23.3
Data collected on food received in-kind	46.0	65.0	54.4
Data collected on specific food items	28.0	40.0	32.9
Snacks explicitly referred to	26.0	35.1	29.9
Alcoholic beverages explicitly referred to	36.0	32.4	34.5
Data collected at the individual level	12.0	23.7	17.0
Recall period [b]			
Less than one week	60	100.0	47.8
One week	48.0	0.0	26.7
Two weeks	12.0	0.0	6.7
One month	14.0	0.0	7.8
Greater than one month	20.0	0.0	11.1

Table 2.5 Food away from home data collection.
[a] N=100 surveys. [b] Calculations are only for surveys for which any data were collected on food consumed away from home (N=90).
Data from Smith et al. (2014).

In view of the many challenges experienced in collecting the food data component of HCES surveys, and the recommendations proposed by several investigators (Carletto, Zezza & Banerjee, 2013; Smith et al., 2014; Zezza et al, 2017), guidelines to improve the quality of data collected have been developed by FAO and the World Bank (2018) and are itemized in Box 2.5.

Box 2.5 Domains and their accompanying recommendations

Recall versus diary and length of reference period

- Low-income countries are advised to adopt recall interviews and a seven-day period

Seasonality, number of visits

- Conduct one visit per household, spreading the sample over 12 months of fieldwork or
- Conduct two visits per household, when the timing of the visits is scheduled to capture seasonal variation

Acquisition versus consumption

- All surveys should collect data on all main modes of food acquisition, namely: purchases; household's own production; received in kind

- For consumption, it should be clear whether the questions concern food intended for consumption (including food waste) or food actually consumed (net of food waste).

Meal participation

- Preferably include an individual household member-based meal module.

Food away from home

- Design a separate module, based on a clear definition of food away from home, with data collection around meal events including snacks and drinks

List of food items

- Preferably adopt a standard food classification system for survey harmonisation e.g., food groups for COICOP classification list

Non-standard units of measurement

- Report on standard units and non-standard units with related conversion factors, where feasible for households

COICOP, Classification of Individual Consumption According to Purpose
From FAO and WORLD BANK (2018).

These guidelines take into consideration the best balance between accuracy and cost effectiveness. For more details on the recommendations specified for each domain and their justification, see FAO and World Bank (2018). Low- and middle-income countries are recommended to adopt these guidelines to improve the quality of the food data component collected in HCES and standardize the methodology across countries.

2.3.1 Uses of household surveys

Increasingly, HCES are being repurposed so that the data generated are not only used by economists for monitoring poverty, calculating national accounts, and as an input for consumer price indices, but also by food security analysts and nutritionists for nutrition-related analyses (Box 2.6), based on the food consumption module of the HCES surveys (Smith et al., 2014; FAO and the World Bank,2018). As noted earlier, FAO (1996) has defined “Food Security” as

> “a state in which all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life”

Box 2.6 Uses for repurposed HCES surveys

- Calculating consumer price indices
- Informing national account statistics
- Meeting private sector information needs
- Measuring poverty
- Measuring food security
- Informing the compilation of food balance sheets
- Informing food-based nutrition interventions

From Smith et al. (2014).

The World Bank has developed the most comprehensive repository of publicly available worldwide HCES data. An additional resource on HCES surveys is also available at the International Household Survey Network (HSN).

Several resources are available to derive food security and nutrition indicators as well as nutrient-based indicators based on the food module of HCES surveys. Of these, two resources itemized below provide details of their methods of construction, uses, strengths and weaknesses.

- Data4Diet platform compiled by the INDDEX project (2018) is freely available at: Data4Diet.
- ADePT-FSM Food Security Module, a standalone application, based on the research of Moltedo et al. (2018) and developed by the World Bank and FAO. This is freely available ADePT-FSM.

Readers are advised to consult these two resources. A selection of indicators designed to assess food security and nutrition are summarized in Box 2.7, whereas details of indicators designed to characterize dietary micronutrient supply are presented in Box 2.8. When compiling these indicators, the term “apparent consumption” of foods” and “nutrient supply” at the household level and “apparent nutrient intake” at the individual level rather than “intake” are used. None of these indicators permit measurement at the individual level.

Box 2.7 Selected Indicators of Food Security and Nutrition

- **Prevalence of Undernourishment** (PoU percent) is used by FAO to monitor the state of food insecurity in the world and is published routinely in the State of Food Insecurity (SOFI), an annual report by FAO, IFAD, UNICEF, WFP and WHO (2022). Data from HCES surveys provides the variability (ie., CV) in the distribution of household per capita dietary energy consumption which is the compared with the weighted average of normative capita Minimum Dietary Energy Requirement (MDER). To estimate MDER, factors such as the age structure, sex, height, and activity levels of individuals within each country are applied. Using the variation in intake (i.e. CV) and energy requirements, undernourishment can be calculated. Updated instructions related to the estimation of PoU using HCES data are available: FAO e-learning course
- **Depth of Food Deficit** (kcal/capita) represents the average per capita amount of additional energy (kcals) needed for undernourished individuals to meet the Average Dietary Energy Requirement (ADER). The Depth of Food Deficit is used to understand the degree of food insecurity in a county and compare the magnitude across countries. It does not measure dietary quality. For this estimate, the FAO probabilistc cut-point method is applied; see Moltedo et al. (2022) for more details. Details on the calculation of this indicator are available in INDDEX and Cafiero (2014) Advances in hunger measurement at: Global_Food_Security.pdf
- **Balanced Diet Indicator** is a measure of dietary quality and defined as the proportion of population with access to a balanced diet. For this, households are classified according to whether their dietary energy consumption from sources of protein, fat, and carbohydrate are below, within, or above recommended thresholds (i.e., protein, 10-15%; fat, 15-30%; total carbohydrate, 55-75%). When significant proportions of the population fall outside these thresholds, then there is a possibility of adverse consequences associated with chronic diseases within a country.
- **HCES Dietary Diversity Score (HCES HDDS)** is associated with the likelihood of nutrient adequacy. HDDS is used to assess economic access to food, to estimate food groups available for consumption by the household, or to assess how interventions designed to increase household income affect food available for consumption. Consists of a simple unweighted count of 16 food groups acquired/consumed by a household during the survey period of the food module. An estimate of the average HDDS at the national and sub-national levels can also be derived from the weighted median of household scores.
- **Household Adequacy of Fruit and Vegetable Consumption** expressed as g per capita per day, provides a measure of diet quality and an understanding of dietary patterns. It is used to identify inadequacy of fruit and vegetable consumption across countries and for subgroups based on household income, gender of head of household, geographical area etc. For this indicator, the total weight in grams of fruit and vegetables consumed by the household is divided first by the number of household members, followed by the days of survey reference period.

$$\geq 400\text{g/capita/day (i.e., 5 servings)} = \text{adequate}$$
$$< 400\text{g/capita/day} = \text{inadequate}$$

Table 2.6 presents a comparison on apparent fruit and vegetable consumption (edible g / capita / day) from HCES data by income quintile in five countries and shows that apparent fruit and vegetable consumption only surpassed 400g / capita / day for income quintiles 3, 4, and 5 for Country 2.

	Fruit and vegetable consumption (Income Quintile — edible g/capita/day)				
	1 (Lowest)	**2**	**3**	**4**	**5 (Highest)**
Country 2	220	360	471	603	674
Country 3	123	148	163	194	258

	Fruit and vegetable consumption (Income Quintile — edible g/capita/day)				
	1 (Lowest)	2	3	4	5 (Highest)
Country 4	127	202	248	295	349
Country 5	116	173	173	205	261
Country 6	58	75	86	98	119

Table 2.6 Fruit and vegetable apparent consumption by income quintiles in five countries. From ADePT-FSM software.

- **Proportion of animal protein** (as perecent of total protein). Based on acquisition and/or consumption data. Used as a proxy measure of dietary quality at the population level. Higher percentage of animal source protein likely to be associated with a higher absolute consumption of animal source foods that provide a variety of micronutrients. The latter are either less abundant or less bioavailable in plant-based food sources. Food commodities considered as animal source foods include meat, fish, eggs, milk, and cheese. Calculated as:

$$\%\text{ animal protein} = \frac{\text{Total protein from animal sources (in grams)} \times 100}{\text{Total protein (in grams) from all foods}}$$

See ADePT-FSM SOFTWARE for more details.

Indicators designed to characterize dietary nutrient supply

Additional indicators designed to quantify, characterize, and evaluate the adequacy of household micronutrient supply across populations have also been compiled. These indicators are calculated by first multiplying the edible amounts of the food commodities listed in the food supply module of the HCES survey and said to be available for consumption (not the actual intake) for each household, with their corresponding nutrient content derived from food composition tables (FCTs) (mostly for the raw form of the food before preparation). The data generated are termed “micronutrient supply”. The nutrients included are the essential amino acids, vitamins B_1, B_2, B_6, B_{12}, and C, folate, total vitamin A (expressed as both Retinal Equivalents and Retinol Activity Equivalents), zinc, calcium, and total iron. In addition, heme iron, expressed as a percentage of total iron, can also be estimated.

Several investigators have compared the estimates of apparent nutrient intake derived from HCES data with those obtained with individual dietary assessment methods. In a systematic review of five studies, Tang et al. (2022) concluded that in general nutrient intakes were overestimated using HCES food consumption data. For some of the studies, discrepancies were large compared with the estimates from individual dietary assessment methods. For a discussion of the possible reasons for the poor agreement, see Tang et al. (2022).

Apparent micronutrient intake per capita per day and per adult-male equivalent per day as well as micronutrient density can be estimated at the national level, and disaggregated into categories when they can be used to monitor or identify target populations for policy makers. The categories that can be included depends on the household socio-economic characteristics collected in the HCES in the country and may include education, income, geography, and ruralness. Examples of these indicators disaggregated by region, urban-rural areas, and quintile of income are given in Box 2.8.

Box 2.8 Examples of indicators* based on average apparent micronutrient intake at the individual level

- **Apparent zinc intake** (mg/capita/day) at national, income quintile, and urban-rural levels. Note that the apparent zinc intake is not adjusted for bioavailability in view of the paucity of phytate data currently available in FCTs
- **Zinc density** (mg/1000kcal) at national, income quintile, and urban-rural levels. Density computed as mean of the nutrient density of the diet of the household

- **Apparent folate intake** (expressed as Dietary Folate Equivalents — µg/capita/day) at national, income quintile, and urban-rural levels
- **Dietary Folate Equivalent density** (ug/1000kcal) at national, income quintile, and urban-rural levels
- **Apparent vitamin A intake** expressed as Retinol Eqivalents (µg RE/capita/day) or Retinol Activity Equivalents (µg RAE/capita/day) at national, income quintile, and urban-rural levels
- **Retinol Activity Equivalent density** (µg RAE/1000kcal) at national, income quintile, and urban-rural levels
- **Apparent total iron intake** (mg/capita/day) at national, income quintile, and urban-rural levels
- **Apparent heme iron intake** (as percent of total iron) at national, income quintile, and urban-rural levels. Heme iron content estimated from raw and cooked meat from literature sources
- **Prevalence of Nutrient Inadequacy (PoNI)** for vitamins B_1,B_2,B_6, B_{12}, vitamin A, vitamin C, Ca, Zn. Estimates via probabilistic EAR cut-point method.

* Depending on the household characteristics collected in the HCES data, national and regional data can also be disaggregated by category of socio-economic group, education, household size, etc.

In the past, attempts to assess micronutrient adequacy from HCES survey data estimated ratios of apparent micronutrient intake per capita to the average weighted micronutrient requirement at the population level. These ratios provided a gross indication of issues with regard to meeting requirements of selected micronutrients at the population level, but provided no information on the prevalence of inadequate micronutrient intakes in the population (Moltedo et al. 2018).

Consequently, recently efforts have been made to estimate the prevalence of nutrient inadequacy (PoNI) in the population based on HCES survey data. The new method extends the FAO probabilistic cut-point method used earlier to estimate chronic dietary energy inadequacy to include micronutrients. To achieve this objective, the data generated on apparent micronutrient intake per day at the individual level must first be pre-adjusted to yield the distribution of apparent usual micronutrient intakes by removing the excess variation due to both within-person day-to-day variability and seasonal variability. After these preadjustments, the distribution of apparent usual intake levels is compared to a threshold to estimate PoNI. The threshold is based on the weighted average of the estimated average requirement (EAR) for the micronutrient under study for each sex-age group in the population.

The prevalence of inadequacy for eight micronutrients: vitamins A, B_1, B_2, B_6, B_{12}, and C, and calcium and zinc based on pre-treated household survey data versus individual level dietary data from Bangladesh has also been compared by Moltedo et al. (2022). Their estimates of inadequacy from the household survey data compared with the individual-level data in which the conventional EAR cut-point method was applied, appeared promising. Nevertheless, more research is needed to guide the use of HCES to estimate apparent nutrient intake at the individual level and prevalence of inadequacy. Detailed instructions for estimating these indictors based on nutrient analysis from FCTs and the new FAO probabilistic cut-point method, respectively, are available at:

- Upgrading ADePT-FSM for analyzing food security statistics using household consumption and expenditure survey data
- Moltedo et al. (2022)

Special attention must also be given to the choice of the food composition tables used for the micronutrient analysis. For discussion of some of the limitations of the micronutrient values in food composition tables, consult Section 1.2 in the above ADePT-FSM Version 3 Software. Note that this version of the ADePT software also permits an assessment of the micronutrient content in foods consumed away from home.

2.4 Comparison of Food Balance Sheets (FBS) and Household Consumption and Expenditure Surveys (HCES)

Both FBS and HCES are prone to measurement errors, as itemized in Table 2.6. For more details, see Thar et al. (2020) and FAO, (2001) for FBS, and Fiedler et al. (2012) and Smith et al. (2014) for HCES.

	Food Balance Sheets	Household Consumption and Expenditure Surveys
Objective	Assessment of food available for consumption at national level	Assessment of food available for consumption at the household level
Advantages	• Not expensive • Publicly available for over 245 countries & territories from 1961 • Snapshot of overall agri-food situation • Updated regularly with standardized methodology so compatible for comparison and trends of per capita food supplies in terms of quantity, caloric value, protein & fat content	• HCESs conducted regularly & publicly available • More detailed in sub-national, gender, economic strata breakdown • Fortfiable foods can be identified from percentage of HHs consuming & purchasing individual food • Report metrics that characterise food security, dietary quality, household nutrient supply, & apparent nutrient intake at individual level
Disadvantages	• Quality of FBSs limited by completeness and accuracy of in-country reports; data on country's stocks not always available • Food loss, food waste, homegrown food, & food fed to animals is under-recorded • Number of migrants & tourists not always subtracted from population estimates • Wrong matching of foods with FCTs as ambiguous details of foods listed • Nutrient supply data estimated from a common global FCT so differences in composition of foods across countries not considered • Distribution of food at sub-national level or population specific characteristics such as age, sex, SES not provided so high risk groups cannot be identified • Non-HH members during survey not always considered • No data on non-commercial food production or details of processed foods	• Relatively expensive & requires institutional capacity & trained personnel • Household food supply module not yet standardized across countries • Individual data on food purchases, food consumed from home production, food received in kind, and details of food consumed away from home not always collected • At-home food list varies (50-300 items) & not always specific leading to incorrect matching with FCTs • Seasonality of food consumption patterns not always considered • Food given to non-HH members not always reported • HCESs do not provide information on distribution of foods consumed among household members or by life-stage groups • Apparent male equivalent intake estimates limited by lack of data on physical activity, physiological state of household members

Table 2.6. Comparison of Food Balance Sheets and Household Consumption and Expenditure Surveys. From FAO (2022a).

Grünberger K. (2014) compared per capita food supply based on country-specific FBS with that of 64 HCESs from 51 low- and middle-income countries, for 16 major food groups. Overall, the results suggested that the estimated differences in the average total food supply per capita are moderate. However, underestimates for the contribution of the average consumption of cereals, eggs, fish products, pulses and vegetables are likely, whereas overshy;estimates for fruits, meat, milk, and sugar products are probable. These findings suggest that considerable uncertainty may exist in the estimates for the availability for consumption of single food groups at country and global level.

2.5 National and household surveys in the global assessment of food security and diet quality by age and sex

Where feasible, it is preferablr to use quantitative food consumption data collected at the *individual level* to assess the distribution of usual intakes of both food and nutrients in different population groups within a country. In this way, the adequacy of the nutrient intakes at the population level can be evaluated using the methods described in Chapter 8b. Such quantitative data from food consumption surveys collected at the individual level can be accessed from the FAO/WHO GIFT platform.

However, currently, quantitative national food consumption data collected at the individual level are only available for a few low- and middle-income countries. Therefore, to fill this gap, alternative global databases based on information synthesized from FBS, HCES surveys, and individual-level surveys (where possible) have been compiled. Such databases are capable of modeling worldwide individual intakes of foods and nutrients across the life-span with the goal of improving health of the most vulnerable populations through improved diets. Examples of these synthesized global databases include the Global Dietary Database (GDD) and a database developed by the Institute for Health Metrics and Evaluation (IHME) discussed briefly below.

The GDD database provides modeled data in 185 countries for 55 dietary factors including 14 foods, 7 beverages, 15 macronutrients, 19 micronutrients, and two indices of carbohydrate quality. The FoodEx2 platform is used to standardize the description and classification of foods into food groups. Modeled data are provided by country, year of primary data collection, age across the life span, sex, education level, urban or rural residence, and pregnancy/nursing status. The GDD modeled estimates can also be used to compile global patterns of healthy and unhealthy diets together with indicators such as the Healthy Eating Index and the Mediterranean Diet Score, Minimum Dietary Diversity for Women (MDDW) and for Infant and Young Child Feeding (IYCF). See Chapter 8c for more details of these indicators.

The IHME initiative database provides modeled data by country, age, sex and year of primary data collection in 204 countries for 87 indicators, including 15 :dietary indicators (9 foods and 6 nutrients). These dietary indicators are included in the Global Burden of Diseases (GBD), a worldwide observational epidemiological study that tracks the progress within and between countries of the changing health challenges. For example, Qiao et al. (2022) investigated the global burden of non-communicable diseases attributable to dietary risks from 1990-2019. They reported a high intake of sodium and low intake of whole grains and fruits were leading dietary risks for deaths and disability-adjusted life-years (DALYs) worldwide, especially in developing countries and among males. Their findings highlight the need to raise public awareness of interventions and improve dietary practices aimed to reduce the disease burden caused by suboptimal dietary intake, especially in developing countries and among males.

Data from the GBD study are also used to monitor progress in countries at the national and subnational level towards meeting the United Nations 33 health-related Sustainable Development Goals. Key research papers based on the global health estimates from the analysis of GBD data are published each year in a special issue of The Lancet.

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