Optimizing the use of ADePT-Food Security Module for Nutrient Analysis

ADePT-FSM Version 3

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SUMMARY

This document describes the updates introduced in ADePT-FSM version 3 to improve its capacity for nutritional analysis by adding new indicators and refining methodologies. It also describes how to optimize the use of other indicators, produced already by ADePT-FSM version 2, for an enhanced nutritional analysis. The document is divided into four sections:

Section 1 examines considerations for processing and interpreting HCES food consumption data, and for the use of different food composition tables and databases. It also presents the results of a review of 69 food composition tables and databases on data availability for a set of micronutrients.

Section 2 discusses indicators of diet quality, such as fruit and vegetable consumption, total dietary fibre consumption, and access to a balanced diet (whose presentation in the ADePT-FSM output tables has undergone modifications compared to version 2). It also introduces a dietary diversity indicator (the Household Consumption and Expenditure Survey - Dietary Diversity Score [HCES-DDS]) to be computed in ADePT-FSM, and explains how to conduct an analysis of dietary patterns by terciles of the HCES-DDS. The section closes with a discussion about calculation and interpretation challenges of the HCES-DDS.

Section 3 reviews the rationale for the addition of zinc and folate to the suite of indicators produced by ADePT-FSM, as well as the considerations for allowing the analysis of total vitamin A to be expressed in Retinol Equivalents (in addition to Retinol Activity Equivalents). It also discusses up-to-date literature to consider for the determination of concentration of haem iron in dietary sources. Lastly, it presents a methodology for assessing the micronutrient content in foods consumed away from home (not considered in version 2 of ADePT-FSM).

Section 4 contains examples for presenting food consumption statistics by food groups, and population groups including dietary energy expressed per Adult Male Equivalents (AMEs).

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ABBREVIATIONS

ADePT-FSM	ADePT-Food Security Module
ADER	Average Dietary Energy Requirement
AME	Adult Male Equivalent
DEC	Dietary Energy Consumption
DFEs	Dietary Folate Equivalents
EAR	Estimated Average Requirements
EFSA	European Food Safety Authority
EUROSTAT	Statistical Office of the European Communities
FANTA	Food and Nutrition Technical Assistance
FCS	Food Consumption Score
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
FBS	Food Balance Sheets
FAFH	Food Consumed Away from Home
FCD	Food Composition Database
FCT	Food Composition Table
FIES	Food Insecurity Experience Scale
GWP	Gallup World Poll
HCES	Household Consumption and Expenditure Surveys
HCES-DDS	HCES-Dietary Diversity Score
HDD	Household Dietary Diversity
HDDS	Household Dietary Diversity Score
HFIAS	Household Food Insecurity Access Scale

HMD	Health and Medicine Division
IFPRI	International Food Policy Research Institute
INDDEX	International Dietary Data Expansion Project
INFOODS	International Network of Food Data Systems
IZiNCG	International Zinc Nutrition Consultative Group
LCU	Local Currency Unit
LSMS	Living Standards Measurement Study
MDD-W	Minimum Dietary Diversity for Women
MDER	Minimum Dietary Energy Requirement
NAS	National Academy of Sciences
OECD	Organisation for Economic Co-operation and Development
RAE	Retinol Activity Equivalent
RE	Retinol Equivalent
RDA	Recommended Dietary Allowance
SDGs	Sustainable Development Goals
UNICEF	United Nations Children's Fund
USDA	United States Department of Agriculture
VoH	Voices of the Hungry
WFP	World Food Programme
WHO	World Health Organization

INTRODUCTION

Sources of food consumption data

The importance of robust data about what people eat, when, and how much in order to quantify and monitor nutritional status, as well as for designing and improving food security and nutrition programs, cannot be overstated (Fiedler *et al.*, 2012).

Information on food consumption at the individual-level is normally collected through dietary intake surveys. The weighed food record method is often regarded as the most precise method for estimating food and nutrient intakes of individuals (close to a gold standard); however, it is costly both in terms of money and time, and requires highly motivated subjects with high levels of literacy. Thus, it is seldom used in large-scale epidemiological studies. In contrast, the 24-hour recall method is less expensive and burdensome, thus it is commonly used for dietary assessment in large-scale studies in Europe, the United States of America, Canada, and Australia (Biro *et al.*, 2002). These types of methodologies are not usually employed at national level in most low-income countries (Gibson and Cavalli-Sforza, 2012) mainly because of their operational costs. Therefore, countries that do not routinely conduct nationally representative individual-level food intake surveys have little option but to derive food consumption indicators using secondary data, mainly Food Balance Sheets (FBS) and household surveys.

FBS provide a national account of the food available for human consumption in a country over a reference period of usually one year. They draw from information on production, trade, and stocks of primary agricultural and fishery commodities, and from information on the various forms of utilization of those commodities to estimate the amounts of dietary energy, carbohydrates, proteins, and fats available for human consumption. However, FBS have several limitations for micronutrient analysis. First, they make no distinction between the varieties of food commodities containing different amounts of specific micronutrients (for example, different varieties of sweet potatoes provide varying amounts of vitamin A), they do not identify whether a crop is bio-fortified[1], and they usually combine all fruits and vegetables together without distinguishing those that are rich in certain micronutrients. Second, they do not distinguish between different levels of processing that could influence nutrient content; for instance, rice is expressed in milled equivalents, making it impossible to distinguish among the different milling fractions (i.e. brown rice, milled and polished), which have varying amounts of micronutrients. Third, FBS only provide estimates of food supply at the aggregate national level over one year excluding food losses or waste at the retail and household levels. Fourth, they do not capture differences in access to and acquisition of food by households during the year; thus, they cannot be used to derive statistics at subnational levels, either geographically or demographically, or to assess seasonal variations.

Because of the inherent limitations of FBS, surveys that collect data at the household level have drawn the attention of the international community (UNSG, 2015). In recent years, there has been an increasing demand for nutrition data at the level of the subnational administrative unit based on the assumption that there are wide variations in nutritional status by region (IFPRI, 2016). Food security and nutrition interventions often focus at either national or community/household levels, overlooking the importance of subnational levels such as region; however, territorial analyses can greatly enhance the effectiveness of policies aiming at food security and nutrition (OECD, 2016). The Inter-Agency and Expert Group on Sustainable Development Goals, the agency in charge of defining a monitoring framework for the 2030 Agenda for Sustainable Development, has advised that:

> Sustainable Development Goals indicators should be disaggregated where relevant by income, sex, age, race, ethnicity, migratory status, disability and geographic location, or other characteristics, in accordance with the Fundamental Principles of Official Statistics (UN ECOSOC, 2016).

[1] Bio-fortification consists on enriching staple food crops with vitamin A, zinc or iron using plant-breeding techniques. There has been an increase in the number of national and international policies and programs including bio-fortification (IFPRI, 2016).

It has been proposed that all household surveys developed to inform economic policy, such as Household Budget Surveys, Household Income Expenditure Surveys, and Living Standard Measurement Surveys be grouped under the name Household Consumption and Expenditures Surveys[2] (HCES) (Dary and Imhoff-Kunsch, 2012). HCES are often multipurpose surveys not specifically designed for food security analyses. However, they collect data on household food consumption and/or acquisition[3] as an integral part of their broader inquiry on household consumption expenditures. They customarily use national and regional representative samples with data collected throughout the year, therefore allowing for the estimation of food consumption indicators at national and subnational levels.

HCES are conducted in a large number of countries[4] every two to ten years. In the past two decades they have increasingly been used for food and nutrition analysis (Fiedler, 2013). The cost of deriving food consumption indicators from national HCES is lower than developing, implementing, and analysing national individual-level dietary intake surveys. According to Fiedler and colleagues (Fiedler *et al.*, 2013), 24-hour recall surveys with a sample size similar to HCES would cost about 75 times more than the cost of secondary analysis of HCES data. Another advantage of using HCES is their ability to allow for the comparison of food security indicators with other information on household living standards and conditions such as household income level or area of residence (urban-rural).

[2] The proposal was made by the Monitoring, Assessment, and Data working group, which is composed of volunteer members from several institutions, including the World Health Organization, United Nations Children's Emergency Fund, the Food and Agriculture Organization of the United Nations, the United States Agency for International Development, HarvestPlus/International Food Policy Research Institute, the International Micronutrient Malnutrition Prevention and Control Program/Centers for Disease Control and Prevention, the Global Alliance for Improved Nutrition, and the Micronutrient Initiative (Dary and Imhoff-Kunsch, 2012).

[3] Conforti and colleagues identified four approaches for collecting food consumption data in HCES: acquisition for consumption from all food sources; acquisition from purchases and consumption from other sources; consumption from all food sources; and both acquisition and consumption from all food sources (2015).

[4] By 2011 there were 700 surveys for 116 countries (Ravallion, 2011).

ADePT-Food Security Module

The World Bank Computational Tools Team and the Statistics Division of the Food and Agriculture Organization of the United Nations (FAO) developed the ADePT-Food Security Module (ADePT-FSM) in 2012, under the auspices of the European Union *Improved Global Governance for Hunger Reduction Program*. ADePT-FSM is a stand-alone software (freely available for downloading) that allows users to derive consistent food security statistics at national and subnational levels[5] from food acquisition and consumption data collected in HCES[6]. These statistics are presented in the form of readily available Excel tables and include: the average consumption of dietary energy, macronutrients, micronutrients and amino acids; the distribution of dietary energy consumption, and the estimated proportion of people that is likely to be undernourished in a population.

Version 2 of ADePT-FSM was launched in 2015 and included methodological refinements and computational improvements—primarily concerned with the assessment of the Prevalence of Undernourishment—as well as additional indicators and a more user-friendly interface (Wanner *et al.*, 2015).

In July 2015, the FAO Statistics Division joined the International Dietary Data Expansion (INDDEX) Project, which is implemented by Tufts University's Gerald J. and Dorothy R. Friedman School of Nutrition Science and Policy with funding from the Bill & Melinda Gates Foundation. The goal of the INDDEX Project[7] is to enable countries to increase their ability to acquire and use high-quality and timely dietary data in order to make better evidence-based decisions about agriculture, food, and nutrition policies and programs. Under the INDDEX Project, the FAO Statistics Division committed to improve version 2 of ADePT-FSM by adding new food consumption indicators, whenever appropriate, according to the type of data collected in HCES.

[5] In ADePT-FSM, the subnational levels include socio-economic, demographic, and geographical characteristics of the household, such as region and household size, and characteristics of the household head, such as gender, level of education, and occupation.

[6] ADePT-FSM is not intended for processing data collected in individual dietary surveys or FBS.

[7] INDDEX Project website URL: http://inddex.nutrition.tufts.edu/

1. PROCESSING HCES FOOD CONSUMPTION DATA

1.1 Current initiatives for improving HCES food consumption modules and metrics

Many global or national monitoring indicators such as the Gini coefficient, poverty measures, dietary energy, macronutrient and micronutrient consumption should rely on accurate and reliable measures of food expenditure and/or food consumption collected through HCES. Thus, improving the relevance, reliability, and harmonization of HCES has been on the agenda of the international community for decades.

Since 1989, the Statistical Office of the European Communities (EUROSTAT), in collaboration with the National Statistical Offices of the Member States of the European Union, has been working on harmonizing the Household Budget Surveys and improving the quality and comparability of statistics within the European Union (EUROSTAT, 2015). In 2015, a collaborative group was established among the Demographic and Health Surveys, the Multiple Indicator Cluster Surveys, and the Living Standards Measurement Study to increase the frequency, quality, and relevance of household survey data around the world (UNICEF, 2015).

There are many challenges that need to be considered when using HCES data to derive food consumption statistics. FAO, the International Household Survey Network (IHSN), and the World Bank (WB) assessed the reliability and relevance of food consumption data from 100 HCES from developing countries and found three major areas that needed attention. First, most HCES do not collect all the necessary information on food consumed away from home; second, seasonal variation is often not captured; and third, food consumption modules are sometimes not detailed enough and/or might not capture the most relevant food consumed by households (Smith *et al.*, 2014).

FAO and the WB are developing guidelines on best practices for food data collection in HCES. Their main recommendations for food consumption data collection relate to the reference period, the list of food items, non-standard units of measurement, acquisition vs. consumption, food partakers, seasonality, and food consumed away from home (forthcoming). Other initiatives such as the INDDEX project (Fiedler and Mwangi,

2016) have also focused on improving food consumption data collected in HCES for deriving more accurate and reliable food consumption indicators.

Terminology and interpretation of food consumption analyses

A caveat should be raised regarding the interpretation of HCES food consumption data. Food consumption indicators computed from household level data are usually labelled "apparent consumption" (Fiedler, 2013)—expressed in terms of dietary energy, macronutrients and micronutrients. These indicators are usually based on food quantities (edible amounts) available for consumption, not on actual intake, and in most cases, they refer to the raw form before preparation. An analysis using HCES could under or overestimate actual food intake as compared with an individual-level survey. The most relevant reasons for an overestimation include:

- HCES do not usually collect information on food wasted[8], given to employees, guests, relatives, or pets, used to feed livestock, used for small food businesses, or for resale;
- food quality loss or waste[9] from harvest to consumption is not considered; and
- nutrient losses during processing, cooking and preparation[10] are not considered.

On the other hand, actual intake may be underestimated because:

- HCES typically do not identify whether a crop was bio-fortified;
- HCES typically do not identify if a food item was fortified,
- HCES do not collect information on micronutrient supplement use.

[8] Food wasted refers to food appropriate for human consumption being discarded or left to spoil at consumer level – regardless of the cause (HLPE, 2014).

[9] Food quality loss or waste refers to the decrease of a quality attribute of food (nutrition, aspect, etc.), linked to the degradation of the product (HLPE, 2014).

[10] For example, processing and/or cooking at high temperatures can negatively impact the content of vitamins such as vitamin C; and the discarding of water used in cooking will lead to the loss of water soluble food components such as B vitamins, vitamin C, and certain bioactive components (FAO and INFOODS, 2012b).

1.2 Food composition data

Food composition data are sets of values of the chemical components of foods that are known or believed to be important in human nutrition. They include energy and nutrients such as water, macronutrients (e.g. protein, fat and carbohydrates), micronutrients (i.e. vitamins and minerals), and other bioactive food components (e.g. polyphenols). The data are typically presented in national or regional food composition tables[11] (FCTs) and food composition databases (FCDs).

The food consumption statistics that can be derived from food consumption data are constrained by the availability and quality of food composition data in the FCT/FCD of choice. Some of the most relevant issues related to food composition data that might affect a nutrient analysis are outlined here.

First, whilst a large number of countries have national or regional FCTs/FCDBs, quite a few contain incomplete, out-dated and/or unreliable data. Many FCTs/FCDBs are not comprehensive enough and do not include all foods that form a major part of the food supply in a country, thereby distorting nutrient intake estimations, and/or failing to include the nutrients most relevant for human health. This can be exacerbated by the fact that the analytical quality of the data on some micronutrient values may be highly variable among FCTs/FCDBs. Hence, there are cases when a given FCT/FCD might be adequate to conduct an analysis of a particular micronutrient, but not of others.

Second, there are many developing and developed countries without such tables or databases. In the absence of values, it is common practice to borrow data from other sources, such as the United States Department of Agriculture (USDA) national nutrient database or from FCTs/FCDBs from neighbouring countries. This practice may introduce a variety of errors (FAO, 2014a). The optimal practice would be for countries to develop their own FCTs/FCDBs. However, data from local FCTs/FCDBs are not necessarily free

[11] Relevant technical food composition documents prepared by the International Network of Food Data Systems (INFOODS) can be found on the FAO website on food composition. URL: http://www.fao.org/infoods/infoods/standards-guidelines/en/

from error, but using local FCTs/FCDBs makes food matching[12] easier as the nutrient profiles have been assigned to locally consumed foods.

Third, there has been an increase in the consumption of fortified foods worldwide; but fortified foods are usually not reported in FCTs/FCDBs. In countries were fortification is mandatory, these fortified foods may be included in the FCT/FCD, but may not be necessarily specified as such (FAO and INFOODS, 2012b). Failure to identify whether a commodity is fortified and/or whether the matched food item from the FCT/FCD is fortified would greatly bias a micronutrient assessment.

All these considerations could compromise a micronutrient assessment, as estimations could under or overestimate actual intake (Greenfield and Southgate, 2003). Therefore, attention must be given to the choice of the FCT(s)/FCD(s), especially if a micronutrient analysis is to be conducted. In the same vein, special care must be taken if data from different FCTs/FCDBs are combined.

Review of FCTs and FCDs from around the world

In order to determine if, and which, additional micronutrients could be added in version 3 of ADePT-FSM, a review of 68 FCT/FCDs was carried out, looking specifically at the availability of folate, iodine, and zinc values. The review also looked at the units of expression of vitamin A (in 69[13] FCTs/FCDBs) to decide whether to allow the use of values expressed in Retinol Equivalents[14]. Availability of phytate values was looked at to decide whether zinc statistics could be adjusted by bioavailability considering the phytate

[12] The COUNTRY_NCT input file includes information on the nutrient content of the food commodities listed in the survey. This information is compiled from national and regional FCTs/FCDBs. More information about how food items are matched to FCTs/FCDBs in the input files for ADePT-FSM can be found in Moltedo *et al.* (2014) and FAO and INFOODS (2012b).

[13] One of the FCTs/FCDBs only contained values of provitamin A carotenoids.

[14] In version 2 of ADePT-FSM, users could only use values of total vitamin A expressed in Retinol Activity Equivalents.

level in the diet[15] (See Appendix 1[16] for a full list of FCTs/FCDBs consulted and number of FCTs/FCDBs containing information on folate, iodine, phytate and zinc.

Appendix 2 has a full list of FCTs/FCDBs consulted for availability and definition of vitamin A values). The findings are as follows:

- Forty-two of the reviewed FCTs/FCDBs (62 percent) include information on some form of folate[17];
- Twenty (30 percent) include information on iodine;
- Five (7 percent) include information on phytate;
- Fifty-one (75 percent) include information on zinc; and
- Twenty-four (35 percent) include information on vitamin A expressed in micrograms of Retinol Equivalents (RE) and twenty-three (33 percent) express it in micrograms of Retinol Activity Equivalent (RAE); only two tables express total vitamin A in both RE and RAE.

Based on these findings, and on more detailed considerations presented in Chapter 3, it was decided to add zinc and folate to the suit of indicators produced by ADePT-FSM. It was also decided to allow for the expression of total vitamin A values in RE or RAE, based on the recognition that many FCTs/FCDBs only include values expressed in RE. Iodine was not included for analysis in ADePT-FSM, even though it is a critical micronutrient, because the best measure of intake in individuals is urinary iodine concentration, and not dietary assessment (Brantsaeter *et al.*, 2009). Further, many FCTs do not include information on the iodine content of foods, and those that do include it do so for only a few food items. Phytate was not considered in view of the paucity of data in FCTs/FCDBs.

[15] Phytate is a chelator of minerals, including iron, zinc and calcium. It acts by binding to minerals and inhibiting their absorption in the human intestine tract. Phytate has a high natural content in seeds, including cereal grains, legumes and oil seeds (IZiNGC *et al.*, 2004).

[16] The reviews in Appendices 1 and 2 only include information from FCTs/FCDBs that were available online at no cost or from hard copies available at the FAO Nutrition and Food Systems Division in Rome. Therefore, it is not a comprehensive review as there are some published FCTs/FCDBs that the authors could not have access to.

[17] Folate as food folate, folic acid, total folates or dietary folate equivalents.

It is important to note that some of the FCTs/FCDBs reviewed provide values for a rather restricted number of food items and not necessarily for all food items containing the nutrient in question, but this has not been explicitly indicated in the tables. Also, these reference lists are to be used as a reference guide, and should not be taken as a judgment on whether to use a particular FCT/FCD, or on the quality of the data contained in the FCTs/FCDBs listed. Thus, if an analyst desires to use one of the FCTs/FCDBs listed in these Appendices, it is her/his responsibility to make sure that it contains adequate information for the analysis to be conducted.

2. HCES DATASETS USED TO ILLUSTRATE NEW INDICATORS AND ANALYSES

To illustrate the new indicators, methodologies and proposals included in ADePT-FSM version 3, six national HCES from Eastern Africa, Latin America, or South-Eastern Asia conducted between 2003 and 2011 have been used. The names of the countries have been omitted because the primary purpose was not to analyse and interpret their data, but only to provide examples according to data availability for ease of illustration purposes. Therefore, countries are referred as *Country 1*, *2*, *3*, *4*, *5*, *6*, respectively. According to the World Bank country classification by income level, *Country 1*, *Country 2*, and *Country 5* are low-income economies; *Country 3* and *Country 6* are lower-middle-income economies; and *Country 4* is an upper-middle-income economy (World Bank, 2016).

Table 1 presents some of the characteristics of the food modules and the samples (number of households sampled and represented) in the six HCES datasets that are relevant for a food consumption analysis in ADePT-FSM.

Table 1 Characteristics of food modules and the samples in the six HCES datasets from *Countries 1, 2, 3, 4, 5* and *6.*

	Country 1	*Country 2*	*Country 3*	*Country 4*	*Country 5*	*Country 6*
Food module						
Module type[a]	Consumption	Consumption and acquisition	Consumption and acquisition	Consumption and acquisition	Acquisition	Consumption and acquisition
Reference period	Last 7 days	Last 7 days	Last month	Last 15 days	Last month	Last 12 months
Food data collection method	Recall with a predefined list	Recall with a predefined list	Open diary	Recall with a predefined and an open list	Open diary	Recall with a predefined list
Total number of food items	124	56	194	365	222	52
No. HHs Sampled & Represented						
National	12 266 3 070 847	7 419 5 229 645	11 970 2 938 408	18 591 6 096 385	10 421 8 060 230	9 398 22 275 698
Urban	2 232 479 342	1 698 912 132	2 384 527 796	10 871 3 951 552	7 152 2 375 882	2 649 6 796 836

	Country 1	*Country 2*	*Country 3*	*Country 4*	*Country 5*	*Country 6*
Rural	10 034 2 591 505	5 721 4 317 512	9 586 2 410 612	7 720 2 144 833	3 269 5 684 349	6 749 15 478 862
Income Quintile						
Lowest	2 259 613 919	1 488 1 045 693	2 365 587 669	4 128 1 219 009	1 232 1 611 668	2 132 4 454 682
2	2 410 614 352	1 476 1 045 854	2 371 587 561	4 150 1 219 435	1 531 1 610 484	1 964 4 456 063
3	2 462 614 151	1 483 1 045 784	2 390 587 728	3 962 1 219 180	1 887 1 612 780	1 903 4 455 306
4	2 538 614 147	1 488 1 045 725	2 406 587 680	3 623 1 218 756	2 386 1 612 803	1 803 4 456 146
Highest	2 597 614 278	1 484 1 046 588	2 438 587 769	2 728 1 220 005	3 385 1 612 495	1 596 4 453 501

No. HHs, number of households.

[a] "Consumption and acquisition" refers to a survey collecting data on food acquisition from purchases and on food consumption from other sources such as own production or received in kind.

3. INDICATORS OF DIETARY QUALITY

3.1 Access to a balanced diet

FAO and the World Health Organization (WHO) provide recommendations for a balanced diet described in terms of the proportions contributed by the various energy sources in relation to the effects on the chronic non-communicable diseases (WHO, 2003). The ranges of population nutrient intake goals for energy-supplying macronutrients are expressed as a percentage of total energy:

Total fat	15-30%
Total carbohydrate	55-75%
Protein	10-15%

Using food data collected at the household level makes it impossible to assess whether individuals within the household, such as children or women, have balanced diets, due to lack of information on intra-household food distribution. However, it is possible to infer whether households classified in sub-groups have access to a potentially balanced diet (Moltedo *et al.*, 2014). The proportion of the population having access to a balanced diet can be estimated by classifying households with dietary energy consumption from the various energy sources (protein, fat and carbohydrates) being below, within, or above the recommended thresholds. If significant proportions of the population fall outside the ranges, concern could be heightened for possible adverse consequences related to chronic diseases within a household (NAS, 2006).

Following are two examples (Table 2 and Table 3) that show the proportions of the population falling within, below, or above the nutrient intake goals for energy-supplying macronutrients by income level for *Countries 2* and *5*, respectively. Results show that in *Country 2* about 50 percent of the population across all income groups does not meet any of the three recommended goals for energy-supplying macronutrients. In *Country 5*, the proportion of the population not meeting any of the three goals is higher in the lowest quintile and lower in the highest quintile (31.5 percent and 15.8 percent, respectively). In both countries adequacy increased with income level, with people in the poorest quintiles having the least access to a balanced diet.

Table 2 Proportion of the population within, below or above the ranges of population macronutrient intake goals by income quintile levels in *Country 2*.

	Income Quintile				
Percentage of the population having	Lowest	2	3	4	Highest
A balanced diet	8.0	7.4	8.9	9.7	17.5
A diet that does not meet any of the three recommended goals for energy-supplying macronutrients	47.0	53.3	54.1	50.3	42.3
Dietary energy provided by protein below the lower recommended threshold (10%)	47.6	55.2	57.5	56.4	56.2
Dietary energy provided by protein above the upper recommended threshold (15%)	11.4	7.7	6.3	6.7	7.0
Dietary energy provided by total fat below the lower recommended threshold (15%)	83.9	85.5	82.7	77.5	60.5
Dietary energy provided by total fat above the upper recommended threshold (30%)	1.5	1.2	0.9	2.0	2.9
Dietary energy provided by total carbohydrates below the lower recommended threshold (55%)	1.4	1.1	0.3	0.9	0.9
Dietary energy provided by total carbohydrates above the upper recommended threshold (75%)	75.8	80.6	79.6	74.8	61.5

Table 3 Proportion of the population within, below or above the ranges of population macronutrient intake goals by income quintile levels in *Country 5*.

	Income Quintile				
Percentage of the population having	Lowest	2	3	4	Highest
A balanced diet	17.6	21.5	27.8	31.4	34.9
A diet that does not meet any of the three recommended goals for energy-supplying macronutrients	31.5	30.8	23.1	19.5	15.8
Dietary energy provided by protein below the lower recommended threshold (10%)	39.0	43.4	40.8	42.9	41.0
Dietary energy provided by protein above the upper recommended threshold (15%)	8.7	6.6	5.4	6.0	7.1
Dietary energy provided by total fat below the lower recommended threshold (15%)	65.6	58.7	46.1	31.2	19.6
Dietary energy provided by total fat above the upper recommended threshold (30%)	3.5	3.3	6.2	10.9	19.4
Dietary energy provided by total carbohydrates below the lower recommended threshold (55%)	2.6	2.9	4.1	7.6	11.7
Dietary energy provided by total carbohydrates above the upper recommended threshold (75%)	60.2	53.3	40.7	28.1	16.1

3.2 Dietary Diversity

Overview of dietary diversity measures

A diversified diet increases the likelihood of nutrient adequacy; it is therefore important for good health and a key element of diet quality (Leroy *et al.*, 2015). In resource-constrained areas[18], low diversity diets are predominantly made up of staples such as starchy cereals, roots or tubers with relatively low nutrient density[19]. At higher levels of diversity, fruits, vegetables and nutrient-dense animal-source foods (such as meat, eggs, fish, and dairy products) are added, contributing not only essential nutrients, but also additional health benefits (Fanzo *et al.*, 2013). In fact, foods are more than carriers of nutrients. The effects of foods in the body likely reflect complex interactions among food structure, preparation methods, nutrient content, and phytochemicals (Mozaffarian and Ludwig, 2010). In low- and middle-income countries, socio-economic status has been shown to be positively associated with dietary diversity (Mayen *et al.*, 2014, Hatloy *et al.*, 2000, Savy *et al.*, 2005), with increases in income level resulting in a higher consumption of more expensive nutrient sources such as meat (Regmi, 2001), vegetables, and fruits (Pollack, 2001).

Consuming a diverse diet is a long-established and universally accepted recommendation for human health, expressed in national and international guidelines alike (FAO, 2016c). Diet diversity is also an integral part of sustainable food and agricultural systems (Webb, 2014). Therefore, having a measure for the degree of households' access to a diverse diet is valuable information for sustainable food and agriculture system approaches and can act as an indirect indication of healthy diets for disease prevention[20].

[18] An area could be resource-constrained due to scarcities related to: soil fertility, freshwater access, energy, fertilizers, climate change, governance, economic development, and urbanization (Freibauer *et al.*, 2011).

[19] Nutrient density is the vitamin or mineral content of a food or diet per unit of dietary energy. It is usually expressed by 1000 Kcal.

[20] Consuming a diversified diet does not necessarily imply a high-quality diet. A higher dietary diversity is occasionally associated with a greater consumption of energy-rich and nutrient poor

Simple dietary diversity scores (e.g. count of foods or food groups consumed over a reference period, usually 24 hours) have been developed as qualitative measures of food consumption at the individual and household levels.

Individual-level dietary diversity measures

Dietary diversity indicators derived from food intake data collected at the individual level are good proxies of nutrient adequacy and overall quality of a diet (Ruel, 2014, Leroy *et al.*, 2015). Many studies confirm a positive association between dietary diversity indicators and nutritional status (defined by anthropometric measures) in children and women. The Infant and Young Child Feeding Minimum Dietary Diversity (WHO, 2008b) and the Minimum Dietary Diversity for Women (MDD-W) (FAO and FHI 360, 2016) indicators are validated and internationally recognized measures for the assessment of micronutrient adequacy of young children aged 6-23 months, and women of reproductive age, respectively (Leroy *et al.*, 2015). ADePT-FSM does not compute individual-level dietary diversity indicators. Thus, there will be no further discussion about these here.

Household-level dietary diversity measures

Early studies based on empirical data have found a positive association between household-level food group diversity and caloric availability (Hatloy *et al.*, 2000, Hoddinott and Yohannes, 2002, Wiesmann *et al.*, 2009). Subsequent reviews assessing the existing empirical evidence confirmed this positive, although occasionally weak, association (Leroy *et al.*, 2015, Cafiero *et al.*, 2014, Ruel, 2002). Nevertheless, even though a higher score may be associated with a higher caloric consumption, no universal cut-off point has been defined to classify households with low or adequate dietary diversity based on caloric adequacy given that the reliability of the indicators has not been demonstrated and that the same score might reflect a different level of calorie adequacy in different countries/contexts (Kennedy *et al.*, 2010, Cafiero *et al.*, 2014, Lovon and Mathiassen, 2014, Leroy *et al.*, 2015, Coates, 2015). For instance, in countries

products high in saturated fat and sugar (Savy *et al.*, 2008), particularly in middle-income countries undergoing a nutrition transition.

like Bangladesh where people eat small amounts of many different types of foods and condiments, dietary diversity might be high when their caloric intake is relatively low. For that reason, a high average dietary diversity score could be associated with caloric insufficiency (still, this is the exception rather than the rule); whereas in other countries, caloric sufficiency could be achieved with a much lower dietary diversity score (Coates, 2015).

Household dietary diversity has also shown to be associated with socio-economic status and the access dimension of food security. A number of studies have found that household dietary diversity is consistently associated with household food access, as measured through the Household Food Insecurity Access Scale (HFIAS), food expenditure, and various indicators of socioeconomic status (Kennedy *et al.*, 2010, Cafiero *et al.*, 2014). In contrast to individual dietary diversity indicators, household dietary diversity indicators have not been tested for their performance in predicting micronutrient adequacy (Ruel, 2014, Leroy *et al.*, 2015).

The most frequently used indicators of household dietary diversity are the Household Dietary Diversity Score (Kennedy *et al.*, 2011), developed by the Food and Nutrition Technical Assistance (FANTA) Project and adapted by FAO for ease of data collection, and the Food Consumption Score (WFP, 2008), developed by the World Food Program (WFP). Both tools are based on diversity of food group consumption and are used for monitoring and surveillance of household economic access to food. A description of the FCS and the HDDS is presented below.

The Food Consumption Score (FCS) was developed by WFP[21] as a standard proxy for food security that could be easily computed and adapted to different contexts (WFP, 2008). It aims at reflecting both dietary quantity and quality. The FCS is calculated using the frequency of eight food groups (cereals, starchy tubers and roots; legumes and nuts; meat, fish, poultry and eggs; vegetables (including leafy greens); fruit; oils and fats; milk and dairy products; and sugar/sweets) consumed by a household

[21] In 2015, WFP developed the FCS Nutritional Quality Analysis (FCS-N), which attempts to provide nutritional information by looking at the frequency of consumption of food groups rich in protein, vitamin A and haem iron (WFP, 2015).

during the previous seven days. Food groups are assigned different subjective weights based on nutrient density[22]. The score does not capture quantities of food, but foods eaten in very small quantities are excluded. Food consumption groups are created by applying subjective standard thresholds to the FCS and calculating a prevalence (proportion of households) that belong to one of three groups: “poor” food consumption, “borderline” food consumption, and “acceptable” food consumption (WFP, 2008).

The Household Dietary Diversity Score (HDDS) is a qualitative indicator developed as a proxy measure of household economic food access. It is derived from food data collected in a household dietary diversity questionnaire. The dietary diversity questionnaire inquires about foods and beverages consumed by any member of the household during the last 24 hours. It includes foods prepared in the home and consumed inside or outside the home, and purchased or gathered outside and consumed in the home, and excludes foods purchased and consumed outside the home. The food items consumed by the households are classified into 16 groups (see Table 4) and typically re-aggregated into 12 food groups to create the HDDS[23] (Kennedy et al., 2011). The 12-food group classification combines all vegetables together, all fruits together, and organ and flesh meats together; the other food groups remain unchanged. All food groups have the same importance (relative weights equal to 1), with each group consumed providing 1 point. The HDDS is computed for each household by counting the distinct food groups consumed by the household during the previous 24 hours; it ranges from 0 to 12. For analytical purposes, the HDDS may also be ranked into terciles.

[22] The determination of the food group weights was based on an interpretation by a team of analysts of ‘nutrient density’, which is defined as “a term used to subjectively describe a food group’s quality in terms of caloric density, macro- and micro-nutrient content, and actual quantities typically eaten” (WFP, 2009; page 19, footnote 14).

[23] Two food groups capture consumption of staple cereals, roots, and tubers (mostly quantity); seven food groups capture consumption of micronutrient rich fruits, vegetables, meat, dairy products, nuts, and seeds (quality and quantity); and three food groups capture consumption of energy-rich (and largely nutrient-poor) foods (sweets, oils and fats, and condiments, and beverages) (quantity) (Leroy *et al.*, 2015).

Table 4 16-food group classification from the dietary diversity questionnaire used as a base to create the Household Dietary Diversity Score (HDDS).

Code	Food group	Examples
1	Cereals	Corn/maize, rice, wheat, sorghum, millet or any other grains or foods made from these (i.e. bread, noodles, porridge or other grain products) + insert local foods i.e. ugali, nshima, porridge or paste
2	White roots and tubers	White potatoes, white yam, white cassava, or other foods made from roots
3	Vitamin A rich vegetables and tubers	Pumpkin, carrot, squash, or sweet potato that are orange inside + other locally available vitamin A rich vegetables (i.e. red sweet pepper)
4	Dark green leafy vegetables	Dark green leafy vegetables, including wild forms + locally available vitamin A rich leaves such as amaranth, cassava leaves, kale, spinach
5	Other vegetables	Other vegetables (i.e. tomato, onion, eggplant) + other locally available vegetables
6	Vitamin A rich fruits	Ripe mango, cantaloupe, apricot (fresh or dried), ripe papaya, dried peach, and 100% fruit juice made from these + other locally available vitamin A rich fruits
7	Other fruits	Other fruits, including wild fruits and 100% fruit juice made from these
8	Organ meat	Liver, kidney, heart or other organ meats or blood-based foods
9	Flesh meats	Beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds, insects
10	Eggs	Eggs from chicken, duck, guinea fowl or any other egg
11	Fish and seafood	Fresh or dried fish or shellfish
12	Legumes, nuts and seeds	Dried beans, dried peas, lentils, nuts, seeds or foods made from these (e.g. hummus, peanut butter)
13	Milk and milk products	Milk, cheese, yogurt or other milk products
14	Oils and fats	Oil, fats or butter added to food or used for cooking
15	Sweets	Sugar, honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolates, candies, cookies and cakes
16	Spices, condiments, beverages	Spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages

Source: Kennedy *et al.* (2011)

A joint statement produced by FAO and WFP concluded that the choice between the FCS and the HDDS depends on the time and resources available for data collection and the needs of the data user (FAO and WFP, 2012). The HDDS provides a useful snapshot of the situation at population level and is an attractive choice for measuring change in situations where time and resources for data collection and analysis are limited. On the other hand, the FCS may be more appropriate for in-depth food security assessments because it has a longer reference period and incorporates frequency of consumption (FAO and WFP, 2012). The FCS and the HDDS are not interchangeable: therefore, when one of the indicators is chosen, it should be used consistently to allow tracking of trends over time and comparison across locations.

Given that only a few national HCES collect information on frequency of food items consumed, ADePT-FSM does not include the possibility of calculating the FCS. On the contrary, an indicator consisting of a simple count of food groups (like the HDDS) can be derived from most HCES.

Like all food security indicators, household dietary diversity indices cannot be considered comprehensive measures of food security on their own. However, when analysed in combination with other food security indicators, they can provide additional information on the food security status of households, and particularly on the access to a diverse diet (Cafiero *et al.*, 2014, Vaitla *et al.*, 2015, Maxwell *et al.*, 2014).

Analysis of household dietary diversity using HCES data

A review of 100 HCES examining the reliability and relevance of food data collected in household surveys concluded that most did not contain the appropriate information for deriving dietary diversity scores based on food groups (Smith *et al.*, 2014). The criterion consisted of at least 95 percent of the at-home food items falling into one and only one of the 14 food groups[24] defined for the study.

[24] The rationale provided by the authors for the choice of the 14 groups was that these were “basic food groups that represent the types of foods making up the contemporary human diet”. The food groups are: 1) cereals, roots, tubers and plantains, 2) pulses, 3) nuts and seeds, 4) vegetables, 5) fruits, 6) meat, poultry and offal, 7) fish and seafood, 8) milk and milk products, 9) eggs, 10) oils and fats, 11) sugar, jam, honey, chocolate and sweets, 12) condiments, spices and baking agents, 13) non-alcoholic beverages, and 14) alcoholic beverages.

To improve classification of food items from HCES data that cannot be categorized unambiguously into a single food group, guidelines are provided in Appendix 3[25]. Moreover, at the time this document was written, substantial efforts towards the improvement of food consumption modules in HCES were being taken as part of several international initiatives, including the INDDEX Project, and FAO's and the WB's forthcoming guidelines on best practices for food data collection in HCES. Improvement of food consumption modules will render many more HCES suitable for dietary diversity analyses.

The HCES Dietary Diversity Score (HCES-DDS)

ADePT-FSM computes a household dietary diversity indicator, called the Household Consumption and Expenditure Survey-Dietary Diversity Score (HCES-DDS), which consists of a simple unweighted count of food groups acquired/consumed by a household during the reference period of the food module. At the national and sub-national levels, the HCES-DDS is estimated as the weighted median of the households' scores.

In the construction of the HCES-DDS, the 16-food group classification shown in Table 4 is used. All food groups are assigned the same relative weight (i.e. they all contribute 1 point). Thus, the HCES-DDS ranges from 0 to 16. In the event that a food group is not represented in a national HCES (e.g. organ meat), ADePT-FSM automatically interprets it as "no consumption" and gives 0 points to all households for that particular food group. If one or more of the 16 food groups are not represented in the HCES, the analyst should consider the reasons for not having included it in the food module list—for example if that food group is not typically consumed in the country and therefore not included in the list, or if the survey has failed to capture it—and report this information together with the HCES-DDS statistics. Food consumed away from home is captured by the HCES-DDS, whenever possible, following guidelines to classify problematic food items (See Appendix 3). Food items that cannot be classified after following these guidelines are not included in the computation of the HCES-DDS.

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[25] These guidelines were adapted from the Minimum Dietary Diversity for Women – A guide to measurement (FAO and FHI 360, 2016)

The HCES-DDS uses the 16-food group classification (Table 4) from the questionnaire utilized as a base to create the HDDS. However, the HCES-DDS differs from the HDDS in three major ways: first, the survey methods are different (24-hour recall for the HDDS vs. varying instruments [e.g. open diary, recall with predefined list] for the HCES-DDS); second, the reference periods are different (24-hours for the HDDS vs. varying recall periods [e.g. 15 days, 12 months] for the HCES); and third, the number of food groups used to construct the two indicators is different (12 food groups in the HDDS vs. 16 food groups in the HCES-DDS).

Constructing the HCES-DDS on 16 food groups (instead of 12 as in the HDDS or 8 as in the FCS), was deemed more appropriate for the purposes of an analysis in ADePT-FSM because the reference period of food data collection in HCES is relatively long—usually 7 days, 15 days, a month. With longer reference periods, households may report higher numbers of food acquired or consumed; thus, using the 16-food group classification provides richer information on the diversity of household diets. Furthermore, using 16 food groups allows for a better classification of households into dietary diversity statistical quantiles.

Constructing the HCES-DDS from HCES datasets

This section presents examples for the estimation of the HCES-DDS from five datasets from *Countries 2*, *3*, *4*, *5* and *6*, *as well as* the association of HCES-DDS with income and dietary energy consumption (DEC). The purpose of these empirical tests was:

1) To examine the feasibility of constructing the HCES-DDS from datasets with different characteristics. In particular:
    a. To explore whether the 16 food groups were represented in the various food modules; and
    b. To determine the number of items that could not be classified and the proportion of households with a "zero" score.
2) To examine the association of the HCES-DDS with income and DEC, and to compare the scores of urban and rural households.

Examining the feasibility of constructing the HCES-DDS

Table 5 presents a summary of relevant features of the food consumption modules in the five datasets. From the table, it can be assessed that the food modules from *Countries 4* and *5* have the 16 food groups represented whereas the modules from *Countries 2*, *3* and *6* do not have food items representing the "organ meat" group; (ADePT-FSM interprets this as "no consumption" and gives 0 points to all households for the organ meat group). The number of food items included in the food module was largest (n=343) in *Country 3*, and smallest (n=52) in *Country 6*. Only a small number of food items (less than 5%) could not be classified into any of the 16 food groups for any given dataset using Appendix 3 as guidance. Therefore, for these five datasets, the HCES-DDS could be constructed with at least 95 percent of the food items unambiguously classified. The proportion of households with a "zero" score was nearly zero for *Countries 3*, *4*, *5* and *6*, and 1.3 percent for *Country 2*. Households with a zero score in the HCES-DDS were treated as missing data in the subsequent analyses.

Table 5 Characteristics of food consumption modules as they refer to the construction of the HCES-DDS, in five HCES datasets from *Countries 2, 3, 4, 5* and *6.*

	Country 2	Country 3	Country 4	Country 5	Country 6
Type of food module	Consumption and acquisition	Consumption and acquisition	Consumption and acquisition	Acquisition	Consumption and acquisition
Reference period of the food module	Last 7 days	Last month	Last 15 days	Last month	Last 12 months
Food data collection method	Recall with a predefined food list	Open diary	Recall with a predefined and an open list	Open diary	Recall with a predefined food list
Number of food items in the food module or collected	56	194	365	222	52
Number of food items that cannot be classified using the 16-food groups	2	7	17	8	2

	Country 2	Country 3	Country 4	Country 5	Country 6
Proportion (%) of food items that could be classified	96	96	95	96	96
Non-represented food groups	Organ meat	Organ meat	None	None	Organ meat
Proportion of households with a "zero" score (%)	1.3	0	0.2	0	0.2

Examining the association of the HCES-DDS with income and dietary energy consumption

Tables 6 through 10 present, for each country, the median HCES-DDS, the average dietary energy consumption (DEC) derived from the food items that were unambiguously classified into the 16 food groups, and the DEC derived from all food items. All statistics are expressed by income quintile, urban-rural location, and nationwide. Household weights (i.e. the expansion factor divided by the probability of a household to be sampled) were used to infer the HCES-DDS. Population weights (i.e. household weights multiplied by the household size) were used to infer the DEC.

Results show that, overall, HCES-DDS and DEC increase with income level. However, the interpretation of findings comparing households in rural-urban areas must be done with care. Households in urban locations have higher HCES-DDS in all countries. However, in this case, a higher score is not necessarily associated with a higher DEC from items counting towards the score. In *Country 2* (Table 6) and *Country 3* (Table 7), households in urban areas have a higher HCES-DDS than households in rural areas, yet the corresponding mean DEC (excluding food items that could not be classified into any of the 16 food groups) is lower. This difference is mainly due to a higher number of food items consumed away from home that therefore could not be classified into any of the 16 food groups and were not counted towards the HCES-DDS by urban households. When including all food items in the computation of the DEC, urban households have a higher DEC than rural ones in *Country 2* (but not in *Country 3*). This reflects the challenge of classifying some food items and the impact of food consumed away from home in total dietary energy consumption, especially in urban households. For this reason, the association of the HCES-DDS with household per capita dietary energy consumption should be interpreted with caution, on a case-by-case basis.

Moreover, it should be noted that the HCES-DDS cannot be used for global monitoring or comparison between countries due to differences in food modules, nor can it be used for screening individual households. The HCES-DDS can be used for trend analysis within a country as long as the different survey cycles allow for the construction of the 16 food groups. If the food module changes across survey cycles the analyst should assess and note how the change might affect the computation of the HCES-DDS and the conclusions.

Table 6 HCES-DDS, daily per capita dietary energy consumption (DEC) from food items counting toward the computation of the HCES-DDS, and DEC from all food items in *Country 2* by income quintile, urban-rural location, and nationwide.

Domain	HCES-DDS	DEC (Kcal/capita/day) from food items counting towards the HCES-DDS	DEC (Kcal/capita/day) from all food items
National	8	1 939	2 068
Urban	9	1 804	2 179
Rural	8	1 964	2 047
Income Quintile			
Lowest	6	1 311	1 329
2	8	1 786	1 820
3	9	2 132	2 201
4	9	2 363	2 490
Highest	10	2 351	2 860

Table 7 HCES-DDS, daily per capita dietary energy consumption (DEC) from food items counting toward the computation of the HCES-DDS, and DEC from all food items in *Country 3* by income quintile, urban-rural location, and nationwide.

Domain	HCES-DDS	DEC (Kcal/capita/day) from food items counting towards the HCES-DDS	DEC (Kcal/capita/day) from all food items
National	12	1 800	1 869
Urban	13	1 678	1 794
Rural	11	1 789	1 886
Income Quintile			
Lowest	11	1 484	1 516
2	11	1 705	1 750
3	12	1 831	1 893
4	12	1 903	1 981
Highest	12	2 227	2 374

Table 8 HCES-DDS, daily per capita dietary energy consumption (DEC) from food items counting toward the computation of the HCES-DDS, and DEC from all food items in *Country 4* by income quintile, urban-rural location, and nationwide.

Domain	HCES-DDS	DEC (Kcal/capita/day) from food items counting towards the HCES-DDS	DEC (Kcal/capita/day) from all food items
National	14	1 953	2 078
Urban	14	2 017	2 162
Rural	12	1 836	1 921
Income Quintile			
Lowest	12	1 489	1 505
2	13	1 934	1 970
3	14	2 067	2 143
4	14	2 209	2 354
Highest	14	2 265	2 712

Table 9 HCES-DDS, daily per capita dietary energy consumption (DEC) from food items counting toward the computation of the HCES-DDS, and DEC from all food items in *Country 5* by income quintile, urban-rural location, and nationwide.

Domain	HCES-DDS	DEC (Kcal/capita/day) from food items counting towards the HCES-DDS	DEC (Kcal/capita/day) from all food items
National	12	2 046	2 084
Urban	13	2 115	2 196
Rural	11	2 023	2 046
Income Quintile			
Lowest	10	1 411	1 421
2	11	1 853	1 868
3	12	2 106	2 135
4	12	2 454	2 496
Highest	13	2 957	3 091

Table 10 HCES-DDS, daily per capita dietary energy consumption (DEC) from food items counting toward the computation of the HCES-DDS, and DEC from all food items in *Country 6* by income quintile, urban-rural location, and nationwide.

Domain	HCES-DDS	DEC (Kcal/capita/day) from food items counting towards the HCES-DDS	DEC (Kcal/capita/day) from all food items
National	11	1 890	2 462
Urban	11	1 730	2 531
Rural	10	1 958	2 433
Income Quintile			
Lowest	10	1 848	2 129
2	10	1 898	2 313
3	11	1 896	2 440
4	11	1 916	2 637
Highest	11	1 901	2 898

Analysing dietary diversity patterns by HCES-DDS tercile

In addition to creating and using dietary diversity scores, it is also important to know which food groups are predominantly consumed/acquired by households with the lowest dietary diversity, as well as which foods are added by those with a higher dietary diversity (Kennedy *et al.*, 2011). Classifying households by quantile of the HCES-DDS (e.g. terciles) can therefore be useful to investigate consumption of different food groups by levels of dietary diversity. This type of analysis attempts to capture differences within a population group that remain undetected using the HCES-DDS alone.

In ADePT-FSM, categorization of households by dietary diversity terciles is defined at the national level independently of the subnational population group of analysis. This means when households are grouped by various population subcategories (such as urban-rural location), they maintain their HCES-DDS tercile classification defined at the national level. This procedure is analogous to how ADePT-FSM categorizes households by income quintile; the difference is that the HCES-DDS is a discrete variable while income is continuous. Appendix 4 shows examples of how households are classified into terciles of dietary diversity. It is important to remark that households with a "zero" score are treated as missing data in the computation of the HCES-DDS, and therefore not considered in the tercile classification.

ADePT-FSM computes the HCES-DDS and automatically classifies household into terciles of diet diversity based on the scores. The software creates a table showing the percentage of individuals living in households consuming items from the different food groups in urban and rural areas by HCES-DDS tercile. Analysts can use this information to create additional tables and graphs, such as Table 12[26], which shows the food groups consumed by at least 45 percent of individuals living in households in each dietary diversity tercile by area of residence (i.e. the list may not include all the food groups consumed by households in the specific dietary diversity tercile).

It is acknowledged that this approach to presenting dietary patterns treats each food group in a binary way, whereas a proper dietary pattern analysis should reflect combinations of foods and food groups. It would be desirable, for instance, to show the most common combinations of food groups consumed by households in the different terciles. However, due to the complexity of programming this type of analysis in ADePT-FSM, this function is not included. Analysts interested in more sophisticated statistical analyses should utilize software other than ADePT-FSM such as SPSS, STATA, SAS or R.

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[26] N.B. This table is not produced by ADePT-FSM.

One way to illustrate dietary patterns is using HCES-DDS terciles as presented in Table 11 for *Country 2*. It is important to note that the ranges of the score in each tercile depend on the reported consumption of the population. In the case of *Country 2*, the percentiles 33.33 and 66.66 correspond to the scores 6 and 10, respectively. Thus, the lowest dietary diversity tercile is composed of the scores 1 to 6, the medium tercile of the scores 7 to 9, and the highest tercile of scores equal or higher than 10.

Table 11 shows the proportion of individuals living in households classified by HCES-DDS tercile and by urban and rural areas, consuming items from the different food groups by. The main findings are as follows:

Individuals in households in the lowest dietary diversity tercile (≤ 6 food groups)

- More than 50 percent of individuals live in rural households that report consumption of “cereals”, “white roots and tubers”, “other vegetables”, and “legumes, nuts, and seeds”.
- In urban areas, more than 45 percent of individuals live in households that report consumption of “legumes, nuts, and seeds”, “other vegetables”, “cereals” and “spices, condiments, and beverages”.
- The consumption of animal-source products was reported only by a very small proportion of households in both urban and rural areas.

Individuals in households in the medium dietary diversity tercile (≥ 7 and ≤ 9 food groups)

- The dietary patterns of urban and rural households in the medium dietary diversity tercile are similar. More than 50 percent of individuals live in households which reported consuming a variety of plant-source products such as “cereals”, “white roots and tubers”, “other vegetables”, “legumes, nuts and seeds”, “oils and fats”, and “sweets” and “spices, condiments, and beverages”.
- About 40 percent of individuals live in urban or rural households which reported a consumption of “flesh meat” and “fish and seafood”.

Individuals in households in the highest dietary diversity tercile (≥ 10 food groups)

- At least 50 percent of individuals live households reporting a consumption of more than 12 food groups, including a variety of animal-source products such as "flesh meat", "fish and seafood" and "milk and milk products".

Overall, only a small proportion of individuals across any of the dietary diversity terciles live in households reporting consumption of "green leafy vegetables", "eggs" and "milk and milk products" categories.

Table 11 Percentage of individuals living in households consuming food groups (based on the 16 food groups used for the HCES-DDS) by HCES-DDS tercile and urban-rural location in *Country 2*.

Food group	HCES-DDS Tercile	Urban	Rural
Cereals	Lowest	50	64
	Mid	93	83
	Highest	99	94
White roots and tubers	Lowest	33	61
	Mid	72	82
	Highest	96	95
Vitamin A rich vegetables and tubers	Lowest	14	34
	Mid	41	56
	Highest	67	75
Dark green leafy vegetables	Lowest	7	21
	Mid	15	33
	Highest	35	52
Other vegetables	Lowest	46	69
	Mid	95	94
	Highest	100	99
Vitamin A rich fruits	Lowest	5	5
	Mid	16	13
	Highest	50	40
Other fruits	Lowest	11	10
	Mid	17	26
	Highest	62	65
Organ meat	Lowest	N/A	N/A
	Mid	N/A	N/A
	Highest	N/A	N/A
Flesh meat	Lowest	6	11
	Mid	43	39
	Highest	82	76
Eggs	Lowest	5	2
	Mid	5	5
	Highest	40	27
Fish and seafood	Lowest	14	17
	Mid	44	40

Food group	HCES-DDS Tercile	Urban	Rural
	Highest	71	57
Legumes, nuts and seeds	Lowest	47	76
	Mid	92	89
	Highest	94	97
Milk and milk products	Lowest	7	8
	Mid	24	25
	Highest	71	66
Oils and fats	Lowest	27	27
	Mid	82	67
	Highest	95	91
Sweets	Lowest	27	17
	Mid	88	66
	Highest	98	93
Spices, condiments, beverages	Lowest	69	41
	Mid	90	83
	Highest	100	97

N/A: The “organ meat” food group is not available in the *Country 2* HCES food list.

Table 12 Food groups apparently consumed by more than 45 percent of individuals in the different HCES-DDS terciles by urban and rural area in *Country 2*.

	Lowest HCES-DDS tercile (Score ≤ 6)	Medium HCES-DDS tercile (Score ≥ 7 and ≤ 9)	Highest HCES-DDS tercile (≥ 10 food groups)
Urban	1. Cereals 2. Other vegetables 3. Legumes, nuts and seeds, 4. Spices, condiments, beverages	1. Cereals 2. White roots and tubers 3. Other vegetables 4. Legumes, nuts and seeds 5. Oils and fats 6. Sweets 7. Spices, condiments, beverages	1. Cereals 2. White roots and tubers 3. Vitamin A rich vegetables and tubers 4. Other vegetables 5. Vitamin A rich fruits 6. Other fruits 7. Flesh meat 8. Fish and seafood 9. Legumes, nuts and seeds 10. Milk and milk products 11. Oils and fats 12. Sweets 13. Spices, condiments, beverages
Rural	1. Cereals 2. White roots and tubers 3. Other vegetables 4. Legumes, nuts and seeds	1. Cereals 2. White roots and tubers 3. Vitamin A rich vegetables and tubers 4. Other vegetables 5. Legumes, nuts and seeds 6. Oils and fats 7. Sweets 8. Spices, condiments, beverages	1. Cereals 2. White roots and tubers 3. Vitamin A rich vegetables and tubers 4. Dark green leafy vegetables 5. Other vegetables 6. Other fruits 7. Flesh meat 8. Fish and seafood 9. Legumes, nuts and seeds 10. Milk and milk products 11. Oils and fats 12. Sweets 13. Spices, condiments, beverages

Computation and interpretation challenges of the HCES-DDS

This section reviews some characteristics of food consumption modules in HCES that could present potential limitations; these should be considered whilst interpreting the results of the HCES-DDS.

Type of food module

Many HCES only collect data on food acquired (e.g. purchased, own-produced, received in kind), but not on food consumption. If a survey only captures food acquisition without information on initial and final stocks, the HCES-DDS would not reflect the diversity of food consumed during the reference period.

From the 100 HCES analysed by Smith *et al.* (2014), 41 percent only collected data on food acquisition. In the five datasets used for illustration purposes, four food modules (from *Countries 2, 3, 4* and *6*) captured a mix of food consumption and acquisition, and one (*Country 5*) only captured acquisition (See Table 5).

Reference period of the food module

The reference period of the food module can have an influence on the score. A longer reference period increases the probability of a higher score while a short reference period decreases the probability of being able to distinguish between true non-consumers and occasional consumers (Faber *et al.*, 2013).

In their review of 100 HCES, Smith *et al.* (2014) found that the recall period used for the at-home food data collection was less than one week in 41 percent of surveys, and one or two weeks in 29 percent of surveys. In the five datasets, the reference period varied: 7 and 15 days for *Countries 2* and *3*, respectively, 1 month for *Countries 3* and *5*, and 12 months for *Country 6* (See Table 5).

Food data collection method and non-represented food groups

In HCES, food data collection may be performed using a free recall or open diary (i.e. the interviewee has no restriction on the number and type of food items declared), or using a recall/diary with a list of predefined food items.

When using a free recall or open diary, all food items acquired and/or apparently consumed should be recorded. For example, if a food group is scored as zero, the household did not acquire and/or apparently consumed items belonging to that group during the reference period. On the other hand, when using a predefined food list, if a food group is scored as zero, it is impossible to distinguish a true no-acquisition/consumption from food acquired or consumed but not captured in the predefined food list. Consequently, when a predefined food list does not include any food representing a specific food group, all households will be scored as zero for that group. For example, the analysis of 100 HCES conducted by Smith *et al.* (2014) revealed that the food group "eggs" was not represented in four percent of the surveys.

Foods consumed in very small quantities

Estimates of the percentage of households reporting apparent consumption of a food can be misleading if amounts apparently consumed are small (Faber *et al.*, 2013). However, the HCES-DDS reflects access to a variety of food, and therefore even small quantities of a food item reflect some ability to access that item. Therefore, in ADePT-FSM there are no minimum quantities below which foods are not considered, so even small amounts of foods are counted.

Classifying food items into food groups

In general, five types of items from HCES present challenges or uncertainties in their classification to the 16 mutually exclusive food groups:

- items with broad labels such as "lunch", "snack" or "dinner" (in this case it is impossible to know the type of food consumed);
- items with labels that are not detailed enough, such as "sweet potato" (this item does not distinguish between white or orange-fleshed varieties which belong to different groups);
- items that contain multiple ingredients but that are considered a single food, such as "sweet bread" (which might contain flour, sugar, butter, nuts, dry fruits, etc.);
- items representing mixed dishes, such as "meat stew with vegetables";

- items representing two or more foods belonging to different food groups, such as "plantain and sweet banana" or "other: fruit juices, ice-cream and/or non-alcoholic beverages".

If a food item cannot be appropriately classified into one food group, it is not counted towards the HCES-DDS. Furthermore, in ADePT-FSM each food item from a HCES food list can only count towards one food group, even if the item represents several groups. These two issues can potentially bias the HCES-DDS downward. Likewise, wrongly classifying food items into food groups may bias the results of the diversity score (Cafiero *et al.,* 2014).

Appendix 3 presents an extended list (adapted from the Minimum Dietary Diversity for Women – A guide to measurement (FAO and FHI 360, 2016)) of typical classification challenges and how they could be addressed, including examples of food items that cannot be unambiguously classified into one food group. This Appendix should be used by the analyst for manually classifying food items in food groups during the construction of the (COUNTRY_NCT) input file.

Using these guidelines improved the classification of food items from the five datasets (*Countries 2, 3, 4, 5* and *6*). Only a small number of food items (≤ 5 percent) could not be classified into any of the 16 good groups for any given dataset (See Table 5). Therefore, for these five datasets, HCES-DDS could be constructed with at least 95 percent of the food items unambiguously classified into the 16 food groups.

Information to be reported in a HCES-DDS analysis

Given the aforementioned constraints, it is critical that analysts provide information on survey methodology and classification issues when presenting results of a dietary diversity analysis from HCES data. The recommended information to be reported includes:

- type of food consumption module, i.e. acquisition, consumption, or a combination of acquisition and consumption;
- reference period of the food consumption module (e.g. 7 days, 14 days);

- food data collection method (e.g. recall, diary);
- number of food items included in the food consumption module (if using a predefined food list) or reported (if using an open diary);
- number of food items that could **not** be classified;
- whether any of the 16 food groups is **not** represented in the food module (specifying which);
- any changes in the food modules since the previous survey (if there was any); and
- proportion of households with a zero score.

3.3 Fruit and vegetable consumption

Fruits and vegetables play an important role in a healthy diet. A diet rich in fruits and vegetables can help lower blood pressure, reduce risk of cardiovascular problems, and prevent some types of cancer (WHO, 2003). WHO and FAO recommend a daily consumption of at least 400[27] grams of fruits and vegetables (excluding potatoes and other starchy tubers) (WHO, 2003). Nevertheless, a low consumption of fruits and vegetables in many regions of the world, partly constrained by limited availability, is a persistent phenomenon, confirmed by the findings from food consumption surveys.

Global trends in the production and supply of fruits and vegetables indicate that availability has increased in most regions in the past decades (See Appendix 5); however, it has not been enough to reach the per capita goal. In 2000, only six out of thirteen regions[28] in Asia, Africa and Latin America had an availability of fruits and vegetables equal or greater than 400 grams per person per day (WHO, 2003). In 2011, still only seven regions had access to at least 400 grams (including non-edible parts) of fruits and vegetables available for human consumption (see Appendix 5).

FAO and WHO recommend that information on supply and consumption of fruits and vegetables be integrated into national nutrition monitoring systems (WHO, 2004).

[27] The WHO report does not clarify whether the amount includes or excludes inedible parts.

[28] Eastern Africa, Middle Africa, Northern Africa, Southern Africa, Western Africa, Central America, Caribbean, South America, Central Asia, Eastern Asia, Southern Asia, South-Eastern Asia and Western Asia.

Food Balance Sheets provide estimates of fruit and vegetable availability at the national level, while HCES data allows for the estimation of fruit and vegetable consumption by sub-groups of population or geographic classification.

Table 13 shows fruit and vegetable consumption in edible grams from HCES data for *Countries 2, 3, 4, 5* and *6*. Only in *Country 2 did* fruit and vegetable consumption surpass 400 g/capita/day for some (3) income quintiles.

Table 13 Fruit and vegetable consumption by income quintile in *Countries 2, 3, 4, 5*, and *6*.

	Fruit and vegetable consumption (edible g/capita/day)				
	Income Quintile				
	Lowest	2	3	4	Highest
Country 2	220	360	471	603	674
Country 3	123	148	163	194	258
Country 4	127	202	248	295	349
Country 5	116	173	173	205	261
Country 6	58	75	86	98	119

3.4 Total dietary fibre consumption

Dietary fibre is a heterogeneous group of components for which several definitions (Table 14) and analytical methods have been developed over the past decades, causing confusion to the users of dietary fibre data in FCTs/FCDBs (Westenbrink *et al.*, 2013). In a broad sense, dietary fibres are non-digestible carbohydrates passing to the large intestine, which are differentiated from other carbohydrates that are digested and absorbed in the human small intestine (NDA, 2010). The most recent definitions include fibres that are extracted, or in some cases, manufactured in laboratories (i.e., synthetic fibres) and added as ingredients having beneficial physiological effects in humans; these are typically called *functional fibres* (Gropper and Smith, 2013).

Table 14 Definition of dietary fibre by different institutions.

Institution and citation	Definition
EFSA (NDA (EFSA Panel on Dietetic Products, 2010)	Dietary fibre is defined as non-digestible carbohydrates plus lignin, including: • Non-starch polysaccharides: cellulose, hemicelluloses, pectins, hydrocolloids; • Resistant oligosaccharides: fructo-oligosaccharides, galacto-oligosaccharides (GOS), other resistant oligosaccharides; • Resistant starch: consisting of physically enclosed starch, some types of raw starch granules, retrograded amylose, chemically and/or physically modified starches; • Lignin associated with the dietary fibre polysaccharides.
FAO/WHO (Joint FAO/WHO Codex Alimentarius Commission, 2009)	Dietary fibre is defined as carbohydrate polymers with ≥10 monomeric units which are not hydrolysed by the endogenous enzymes in the small intestine of humans, belonging to the following categories: • Edible carbohydrate polymers naturally occurring in the food as consumed; • Carbohydrate polymers, which have been obtained from food raw material by physical, enzymatic or chemical means and which have been shown to have a physiological effect of benefit to health as demonstrated by generally accepted scientific evidence to competent authorities; and • Synthetic carbohydrate polymers which have been shown to have a physiological effect of benefit to health as demonstrated by generally accepted scientific evidence.
United States Health and Medicine Division (NAS, 2005)	Dietary fibre consists of non-digestible carbohydrates and lignin that are intrinsic and intact in plants. Functional fibre consists of isolated, non-digestible carbohydrates that have beneficial physiological effects in humans. Total fibre is the sum of dietary fibre and functional fibre.

Dietary fibre is not an essential nutrient; so, an inadequate intake does not result in biochemical or clinical symptoms of a deficiency. However, fibre has many positive physiological effects: it reduces the risk of coronary heart disease and type 2 diabetes, and improves weight maintenance (NAS, 2005, NDA, 2010). Whole grain cereals, pulses, fruits and vegetables are the main sources of dietary fibre[29]; nuts and seeds contain high concentrations but they are generally eaten in smaller amounts.

In ADePT-FSM, information on dietary fibre consumption is used for two main purposes: 1) to derive statistics on total dietary fibre consumption and 2) to estimate the dietary energy provided by each food item.

Statistics on total dietary fibre consumption

Most authoritative institutions suggest a population intake goal of 25 grams of dietary fibre per day. The European Food Safety Authority (EFSA) indicates that in adults there is evidence of health benefits associated with a high consumption of fibre-rich foods at dietary fibre intakes greater than 25 g per day (NDA, 2010). The United States Health and Medicine Division set an Adequate Intake for total dietary fibre of 25 g per day for women and 38 g per day for men, aged 14 to 50 years (NAS, 2005). The World Cancer Research Foundation proposed a reference value of 25 g of dietary fibre per day from natural sources (WCRF and AICR, 2007). FAO and WHO do not provide a precise population goal for total dietary fibre, but note that the recommended intake of fruits and vegetables (400 grams) and consumption of wholegrain foods is likely to provide more than 25 g per day (WHO, 2003).

Interpretation of total dietary fibre consumption statistics

It is important to note that no Estimated Average Requirements (EAR) have been determined for fibre, only population intake goals or Adequate Intakes (AI). As the United States HMD notes, the proportion of the population below the AI cannot be used as an indicator of the percentage of the population with an inadequate consumption (NAS, 2000). At best, using HCES data one can compare the mean daily per capita dietary fibre consumption with the AI, and if the mean consumption is higher than the AI, a low prevalence of inadequate fibre consumption can be expected. However, when the mean consumption is below the AI, no assumption can be made about the probability of

[29] Foods containing at least 6 g of fibre per 100 g or 3 g of fibre per 100 kcal are considered high in fibre (EU, 2006).

inadequacy of dietary fibre consumption, (with the exception of intakes being zero, in which case consumption is certainly inadequate) (NAS, 2000).

Table 15 shows total dietary fibre consumption for *Countries 2,3,4,5* and *6*. In *Countries 2* and *5*, fibre consumption was above the population intake goal of 25 g/person/day for all income quintile levels. On the contrary, in *Countries 3* and *6,* fibre consumption was well below the population intake goal for all income quintiles. As previously explained, the population goal of 25 grams is an Adequate Intake, so it can only be inferred that in *Countries 2* and *5* there might be a low prevalence of dietary fibre inadequacy. However, nothing can be inferred about the prevalence of fibre inadequacy in *Countries 3* and *6*. In *Country 4*, fibre consumption was below the recommendation in the two lowest income quintiles.

Table 15 Total dietary fibre consumption by income quintile in *Countries 2*, *3*, *4*, *5* and *6*.

	Total dietary fibre (g/capita/day)				
	Income Quintile				
	Lowest	2	3	4	Highest
Country 2	29	39	45	48	46
Country 3	8	9	10	11	14
Country 4	20	24	25	27	30
Country 5	29	35	38	40	44
Country 6	4	4	5	5	7

Using information on total dietary fibre for estimating the dietary energy provided by foods

There are different energy conversion systems used for the estimation of physiological energy, (the energy value remaining after digestion, absorption, and urinary losses) (FAO, 2003). In the construction of the COUNTRY_NCT input file, it is suggested that energy values be calculated using the Atwater extensive general factor system of coefficients (see Equation 1). In this system, the energy factor applied to fibre should be 2 kcal/g[30] (FAO, 2003).

Equation 1

$$Dietary\ energy\ (Kcal) = Protein(g) * 4 + Fats(g) * 9 + Available\ Carbohydrates\ (g) * 4 + Fibre\ (g) * 2 + Alcohol\ (g) * 7$$

In the case that the FCT/FCD of choice does not provide information on available carbohydrates, this information can be estimated subtracting grams of water, ash, protein, fat, fibre and alcohol (FAO, 2003) as shown in Equation 2:

Equation 2

$$Available\ carbohydrates = 100 - weight\ in\ grams\ [water - ash - protein - fat - fibre - alcohol]$$

However, some FCTs/FCDBs do not provide information on the content of water and/or ash, which prevents the use of Equation 2. In such cases, the amount of available carbohydrates could be estimated using Equation 3.

Equation 3

$$Available\ carbohydrates = total\ carbohydrates - fibre$$

Tagnames for fibre in FCTs/FCDBs

Standardized systems of component identification have been developed to identify food components and interchange data unambiguously, and to document data uniformly across countries. FAO promotes the use of food component identifiers (Tagnames) published by the International Network of Food Data Systems (INFOODS) (INFOODS, 2016) in FCTs/FCDBs. The Tagnames indicate the nutrient and, where relevant, which method of analysis was used to produce the data (Institute of Nutrition (Mahidol University), 2014). If the data were derived by calculation, the Tagnames indicate which formula was used for the calculation.

[30] An energy factor of 8 kJ/g (2 kcal/g) is suggested in the absence of a specific factor associated with the method of analysis.

A list of INFOODS Tagnames for fibre is presented in Table 16. In ADePT-FSM, it is recommended to use total dietary fibre, which corresponds to the INFOODS Tagname <FIBTG>. Whereas most FCTs/FCDBs include and publish total dietary fibre, some FCTs/FCDBs could show different values of dietary fibre for the same food item; this is so because different analytical methods measure different types of dietary fibre (See Table 16 and Figure 1). Total dietary fibre can also be calculated as the sum of soluble fibre <FIBSOL> and insoluble fibre <FIBINS> (See Equation 4). Failing to use the correct values of fibre could underestimate fibre consumption.

Equation 4

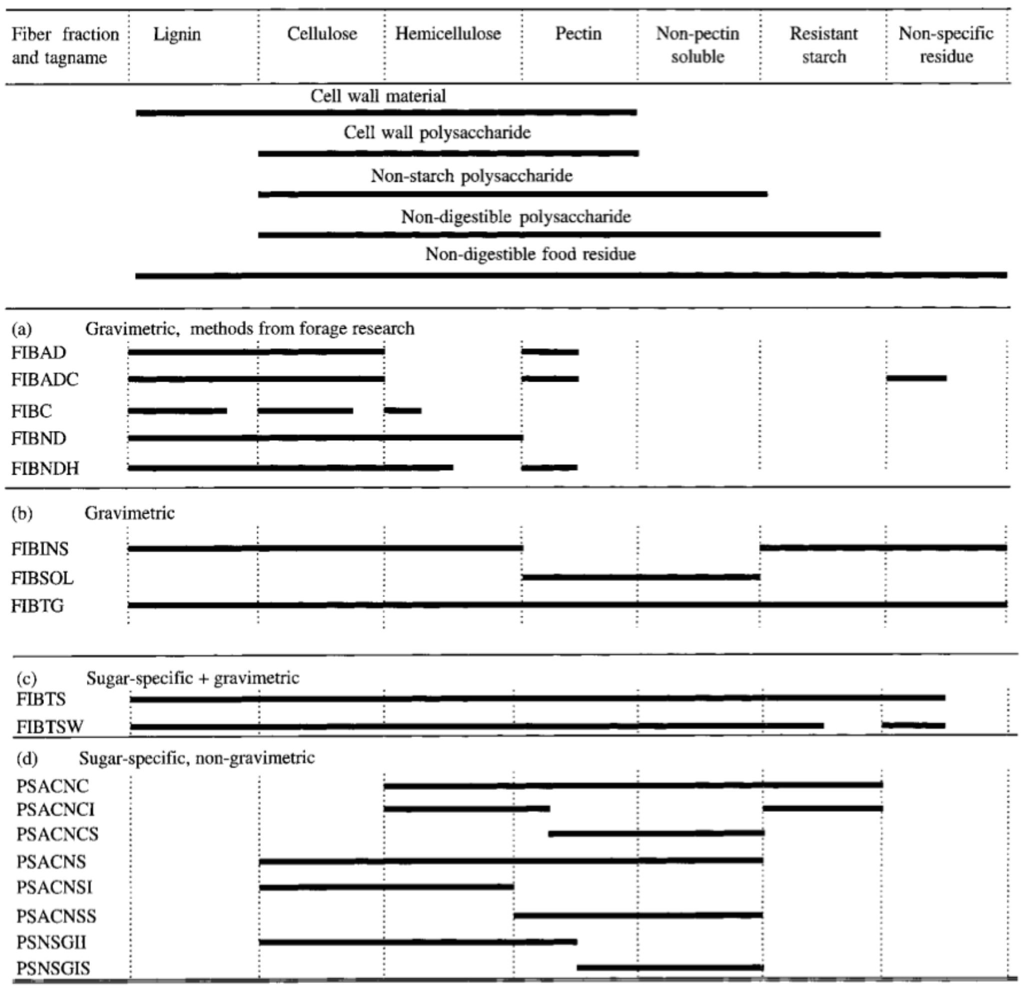
$$\text{Total dietary fibre (FIBTG)} = \sum \text{soluble fibre (FIBSOL)} + \text{insoluble fibre (FIBINS)}$$

Table 16 INFOODS Tagnames for fibre.

INFOODS Tagname	Definition
<FIBAD>	Fibre, determined by acid detergent method; includes cellulose, lignin and some hemicelluloses.
<FIBADC>	Fibre, acid detergent method; Clancy modification.
<FIBC>	Fibre, crude.
<FIBINS>	Fibre, water-insoluble; sum of insoluble components from the AOAC total dietary fibre method; includes primarily lignin, cellulose and most of the hemicellulose. Values for <FIBINS> may also be obtained by subtracting soluble fibre from total dietary fibre (i.e. by subtracting the value of <FIBSOL> from the value of <FIBTG>).
<FIBND>	Fibre, determined by neutral detergent method; includes lignin, cellulose and insoluble hemicellulose.
<FIBSOL>	Fibre, water-soluble; sum of soluble components from the AOAC total dietary fibre method; includes primarily algal polysaccharides, gums, pectins, and mucilages.
<FIBTG>	Fibre, total dietary; determined gravimetrically by the AOAC total dietary fibre method; sum of the water-soluble components and the water-insoluble components of dietary fibre; can be calculated by adding the values of <FIBSOL> and <FIBINS>; includes all non-starch polysaccharides and lignin.
<FIBTS>	Fibre, total dietary; sum of non-starch polysaccharide components and lignin; sum of the polysaccharide components of dietary fibre measured sequentially on the same sample (for example, by using the Southgate colorimetric procedure) plus lignin measured gravimetrically.
<FIBTSW>	Fibre, total dietary; Wenlock modification.

INFOODS Tagname	Definition
<FIB->	Fibre; method of determination unknown or variable; Tagname <FIB-> is used to identify fibre values which represent unknown fibre components or which were obtained by unknown methods or a mixture of methods.

Figure 1 Tagnames, definitions of dietary fibre fractions, methods for fibre analysis: approximate relationships (Monro and Burlingame, 1996).



4. MICRONUTRIENT ANALYSIS

4.1 Zinc

Zinc is a vital micronutrient in humans for protein synthesis and cell growth (WHO, 2013). Zinc deficiency is highly prevalent in low- and middle-income countries. In 2013, the WHO estimated that zinc deficiency affected about one-third of the world's population, ranging from 4 to 73 percent across sub-regions (WHO, 2013). The clinical features of severe zinc deficiency in humans include growth retardation, delayed sexual and bone maturation, skin lesions, and increased susceptibility to infections worsened by or coupled with defects in the immune system (FAO and WHO, 2004). Zinc deficiency has also been associated with reduced appetite and poor sensitivity to taste, and may thereby contribute to deficiencies of other nutrients. There are multiple causes of zinc deficiency[31], but inadequate dietary intake of absorbable zinc is likely to be the primary cause in most situations (IZiNGC *et al.*, 2004). This may result from a combination of low total dietary intake, heavy reliance on foods with low zinc content and/or diets with poorly absorbable zinc (IZiNGC *et al.*, 2004).

Zinc is found in its highest concentrations in animal source foods, particularly in the organs and/or flesh of beef, pork, poultry, fish, and shellfish, with lesser amounts in eggs and dairy products. Zinc content is relatively high in nuts, seeds, pulses (legumes), and wholegrain cereals, and is lower in tubers, refined cereals, fruits, and vegetables (IZiNGC *et al.*, 2004). Absorption of zinc depends on the overall composition of the diet (FAO and WHO, 2004) as a result of physiochemical interactions among food components. On one hand, phytate is a strong inhibitor of zinc, yet, on the other, animal protein appears to have enhancing effects, besides being high in bioavailable zinc (IZiNGC *et al.*, 2004). Diets high in unrefined cereals (grains) and pulses and low in animal source foods—characteristic of many developing countries—have a low zinc absorption level.

[31] The principal causes of zinc deficiency, in isolation or in combination, are inadequate intake, increased requirements, malabsorption, increased losses, and impaired utilization (Solomons and Cousins, 1984).

In ADePT-FSM, the statistics on zinc consumption are unadjusted by bioavailability, in view of the paucity of phytate data currently available in FCTs/FCDBs. Nonetheless, the inclusion of zinc in ADePT-FSM—even if unadjusted for bioavailability—allows having estimates of dietary zinc consumption for different population groups at a subnational level. However, these statistics should be carefully interpreted in combination with other food consumption indicators produced by ADePT-FSM that reflect the composition of a diet, such as the presence of food items with a high phytate content or items that increase zinc absorption.

Table 17 shows statistics of daily consumption of zinc (in mg per capita) for *Countries 2, 3, 4, 5* and *6* at national, income quintile and urban-rural levels. For all countries, it can be observed that the zinc consumption does not differ much between urban and rural households. However, household level income is a determining factor in accessing zinc. For instance, in *Country 5*, the amount of zinc consumed by the richest households (highest quintile) is twice the amount consumed by the poorest ones (lowest quintile).

Table 17 Zinc consumption (mg/capita/day) at national level, by urban-rural area, and by income quintile in *Countries 2, 3*, *4*, *5* and *6.*

				Income Quintile				
	National	Urban	Rural	Lowest	2	3	4	Highest
Country 2	7.7	7.8	7.7	5.5	7.0	8.3	9.0	10.0
Country 3	8.5	8.3	8.6	7.0	8.0	8.7	9.0	10.8
Country 4	9.0	9.4	8.2	6.2	8.3	9.2	10.4	12.2
Country 5	9.1	9.1	9.1	6.5	8.4	9.3	10.5	12.9
Country 6	11.5	12.1	11.2	9.6	10.6	11.3	12.4	14.0

4.2 Folate

Folate is a generic term for a water-soluble B-complex vitamin that occurs in many chemical forms (NAS, 1998). Most naturally occurring folates, commonly called *food folate*, are chemically unstable and suffer a significant loss of biochemical activity—about half to three quarters—during harvesting, storage, processing and preparation (FAO and WHO, 2004). Folic acid is almost completely stable for months or even years but occurs rarely in food; thus, a synthetic form is used in vitamin supplements and fortified food products (NAS, 1998).

Although folate is found naturally in a wide variety of foods–including fresh, dark green leafy vegetables, pulses (legumes), some fruits, dairy products, poultry and meat, eggs, seafood, and cereals (grains)– it is present in a relatively low density, (except in liver) (FAO and WHO, 2004). Some staples, such as white rice and unfortified corn, are particularly low in folate. The foods most commonly fortified with folic acid include cereal grain products, particularly wheat flour (and products made from flour such as bread), corn flour, corn meal, and rice (Crider *et al.*, 2011).

Folate deficiency occurs primarily because of insufficient intake, and in some cases by poor absorption conditions including celiac disease. Pregnant women are at high risk of folate deficiency because pregnancy substantially increases requirements, especially during periods of rapid foetal growth and during lactation; losses of folate in milk also increase the folate requirement (FAO and WHO, 2004). Folate deficiency causes megaloblastic anaemia and, in pregnant women, poses a risk of delivering preterm and low birth weight infants (WHO, 2008a). Most importantly, folate deficiency greatly increases the risk of foetal neural tube defects, with the risk increasing 10-fold as folate status goes from adequate to poor (FAO and WHO, 2004). In adults, particularly in the elderly, folate deficiency has also been associated with cognitive impairment (WHO, 2008a).

Dietary folate equivalents

The recommended folate intake is given as dietary folate equivalents (DFEs), which accounts for differences in the absorption of naturally occurring food folate and synthetic folic acid obtained from dietary supplements or fortified food (NAS, 1998).

The quantity of DFEs occurring naturally in food is equivalent to micrograms of folate, while the DFEs provided by fortified foods is equivalent to the micrograms of folate found naturally in food plus 1.7 times the micrograms of folic acid added:

Equation 5

$$Total\ DFEs = \mu g\ food\ folate + 1.7 * \mu g\ synthetic\ folic\ acid$$

It is important to note that the terms "folate" and "folic acid" are sometimes used synonymously in FCTs (FAO and INFOODS, 2012b). Furthermore, some FCTs/FCDBs provide values for DFEs. Therefore, it is of utmost importance that analysts preparing the input file (COUNTRY_NCT) carefully read the description[32] of the nutrient within the FCTs/FCDBs, especially when they are compiling information from different FCTs/FCDBs. In addition, regulations for mandatory fortification of wheat flour with folic acid are currently in place in over 50 countries, although in many cases these regulations have not been implemented (Crider *et al.*, 2011). Therefore, in countries where there is mandatory fortification of wheat flour or other products with folic acid, analysts should pay special attention to the interpretation of results.

As expected, Table 18 shows that DFEs and dietary energy increase with income in *Country 2*. However, folate density is inversely associated with income and dietary energy, suggesting that richer households' diets are less nutrient-dense.

Table 18 Dietary energy, dietary folate equivalents (DFEs) consumption, and DFE density at national level, by urban-rural areas, and by income quintile in *Country 2*.

				Income Quintile				
	National	Urban	Rural	Lowest	2	3	4	Highest
DFEs (mcg/capita/day)	513	513	513	352	469	555	607	652
Dietary energy (Kcal/capita/day)	2 068	2 179	2 047	1 329	1 820	2 201	2 490	2 860
DFE density[a] (mcg/1000 Kcal)	260	238	264	283	272	264	253	228

[a]The nutrient density values are computed as the mean of the households' nutrient densities and not as the ratio of the means of nutrient and dietary energy at the population level.

[32] Nutrient values are influenced by the analytical method used, and this is particularly true in the case of folate (Westenbrink *et al.*, 2013), with some methods rendering much higher results.

4.3 Vitamin A

Vitamin A deficiency remains prevalent in south Asia and sub-Saharan Africa (Stevens *et al.*, 2015), causing blindness and increasing the risk of death from common childhood illnesses such as diarrhoea and measles. In 2013, about one third of children between 6 and 59 months were estimated to suffer from vitamin A deficiency (UNICEF, 2016).

National and international institutions to combat vitamin A deficiency have implemented several worldwide initiatives. These initiatives include promoting exclusive breastfeeding, promoting the consumption of diversified diets, distributing vitamin A supplements, fortifying foods with vitamin A, and bio-fortifying crops with vitamin A (IFPRI, 2016, UNICEF, 2013).

Vitamin A is available in the human diet in the form of preformed vitamin A (retinol) and provitamin A carotenoids (NAS, 2006). Retinol is found in animal-source foods, such as meat (especially liver), dairy products, eggs and fish. The major source of carotenoids is plant food, primarily orange and yellow vegetables and fruits, and dark green leafy vegetables, as well as red palm oil. The most important provitamin A carotenoid is beta-carotene (β-carotene); other provitamin A carotenoids include alpha-carotene and beta-cryptoxanthin.

Given that carotenoids can be converted in the body into vitamin A, systems have been created to estimate their equivalence in retinol so that the content of vitamin A between different foods (particularly between animal- and plant-source foods) can be comparable and so that dietary vitamin A can be expressed on a common basis. The accepted equivalences have changed throughout time. The oldest system of equivalence, now obsolete, was the International Unit (IU) (FAO and WHO, 2004), in which:

Equation 6

$$1\ \text{IU} = 0.3\ \mu\text{g retinol} = 0.6\ \mu\text{g}\ \beta.\text{carotene} = 1.2\ \mu\text{g other provitamin A carotenoids}$$

Later, in 1967, FAO/WHO introduced a new system of equivalence, which expresses vitamin A in retinol equivalents (RE) (FAO and WHO, 2004):

Equation 7

$$1\ \mu g\ RE = 1\ \mu g\ retinol = \frac{1\ \mu g\ \beta.carotene}{6} = \frac{1\ \mu g\ other\ provitamin\ A\ carotenoids}{12}$$

Therefore, the conversion of retinol and provitamin A carotenoids into vitamin A expressed in RE is derived applying Equation 8:

Equation 8

$$Vitamin\ A\ in\ \mu g\ RE = \mu g\ retinol + \frac{\mu g\ \beta.carotene}{6} + \frac{\mu g\ other\ provitamin\ A\ carotenoids}{12}$$

Recent studies showed evidence of the efficiency in absorption of dietary provitamin A carotenoids is lower than what was traditionally thought (FAO and WHO, 2004). Since 2001 the United States Health and Medicine Division (HMD) recommends a new system of equivalence that expresses vitamin A in retinol activity equivalents (RAE) to reflect the reduced absorption of carotenoids (NAS, 2006). Equation 9 shows this system of equivalence:

Equation 9

$$1\ \mu g\ RAE = 1\ \mu g\ retinol = \frac{1\ \mu g\ \beta.carotene}{12} = \frac{1\ \mu g\ other\ provitamin\ A\ carotenoids}{24}$$

Therefore, the conversion of retinol and provitamin A carotenoids into vitamin A expressed in RAE is derived applying Equation 10:

Equation 10

$$Vitamin\ A\ in\ \mu g\ RAE = \mu g\ retinol + \frac{\mu g\ \beta.carotene}{12} + \frac{\mu g\ other\ provitamin\ A\ carotenoids}{24}$$

In summary, food items containing provitamin A carotenoids have a higher content of vitamin A when expressed in RE as compared to RAE. Table 19 summarizes the equivalence between the two systems.

Table 19 Equivalence between Retinol Equivalents (RE) and Retinol Activity Equivalents (RAE).

Substance in food	Micrograms of RE per microgram of the substance	Micrograms of RAE per microgram of the substance
Retinol	1	1
Beta-carotene	1/6	1/12
Other provitamin-A carotenoids (alpha-carotene and beta-cryptoxanthin)	1/12	1/24

Unit of expression of vitamin A in food composition tables and databases

FAO and INFOODS recommend that FCTs/FCDBs express total Vitamin A activity in either RAE or RE, and that the use of IU be discontinued (FAO and INFOODS, 2012a). Since 2001, the RAE unit of expression has been used in many FCTs/FCDBs (Grande *et al.*, 2015); based on a review of 69 FCTs/FCDBs, 23 tables/databases express total vitamin A only in RAE, while 24 express it only in RE (see Appendix 2).

Some recent FCTs/FCDBs report not only vitamin A, but also micrograms of retinol, beta-carotene, and, sometimes, other provitamin A carotenoids, which would aid in the conversion of total vitamin A activity from RE into RAE and vice versa.

The vitamin A activity of provitamin A carotenoids other than beta-carotene, (such as alpha-carotene and beta-cryptoxanthin), is thought to be half that of beta-carotene. Thus, all provitamin A carotenoids can be expressed in terms of beta-carotene equivalents, which is the sum of beta-carotene plus half the quantity of other carotenoids with vitamin A activity, as shown in Equation 11.

Equation 11

$$1\ \mu g\ \beta.\text{carotene equivalent} = 1\ \mu g\ \beta.\text{carotene} + 0.5\ \text{alpha.carotene} + 0.5\ \text{beta.cryptoxanthin}$$

Accordingly, Equation 8 for the conversion of retinol and provitamin A carotenoids into vitamin A in RE could also be expressed as in Equation 12:

Equation 12

$$\text{Vitamin A in µg RE} = \text{µg retinol} + \frac{\text{µg β.carotene equivalents}}{6}$$

Equation 10 for the conversion of retinol and provitamin A carotenoids into vitamin A in RAE could also be expressed as in Equation 13:

Equation 13

$$\text{Vitamin A in µg RAE} = \text{µg retinol} + \frac{\text{µg β.carotene equivalents}}{12}$$

Tagnames for vitamin A in FCTs/FCDBs

A list of INFOODS Tagnames (i.e. identifiers) for vitamin A and provitamins is presented in Table 20.

Table 20 INFOODS Tagnames for vitamin A and provitamins.

INFOODS Tagname	Definition
<VITA_RAE>	Vitamin A; calculated by summation of the vitamin A activities of retinol and the active carotenoids Total vitamin A activity expressed in mcg retinol activity equivalent (RAE) = mcg retinol + 1/12 mcg beta- carotene + 1/24 mcg other provitamin A carotenoids (or mcg RAE = mcg retinol + 1/12 mcg beta-carotene equivalent)
<VITA>	Vitamin A; calculated by summation of the vitamin A activities of retinol and the active carotenoids. Total vitamin A activity expressed in mcg retinol equivalent (RE) = mcg retinol + 1/6 mcg beta-carotene + 1/12 mcg other pro-vitamin A carotenoids (or mcg RE = mcg retinol + 1/6 mcg beta-carotene equivalent)
<VITAA>	Vitamin A; determined by bioassay Unit: IU
<CARTA>	Alpha-carotene All-trans alpha-carotene only
<CARTB>	Beta-carotene All-trans beta-carotene only
<CRYPXB>	Beta-cryptoxanthin
<CARTBEQ>	Beta-carotene equivalents. This value is the sum of the beta-carotene + 1/2 quantity of other carotenoids with vitamin A activity

INFOODS Tagname	Definition
	beta-carotene equivalent = mcg beta-carotene + 0.5 mcg alpha-carotene + 0.5 mcg beta-cryptoxanthin
<RETOL>	Retinol (synonyms of preformed vitamin A) All-trans retinol only

Table 21 shows vitamin A consumption, expressed in RAE and RE, in *Country 2*. The source of the vitamin A requirements expressed in RAE is the United States Health and Medicine Division (NAS, 2006), while requirements expressed in RE are from FAO and WHO (FAO and WHO, 2004).

The results show that consumption of vitamin A increases with income. The exception is the highest income quintile, which has a lower vitamin A consumption than the fourth quintile. This is due to a lower consumption of dry sweet potatoes (not shown in the table). Estimated vitamin A requirements increase with income quintile due to the differing composition of households; generally, richer households have fewer children than poorer ones.

In terms of units of expression, as expected, values of vitamin A consumption expressed in micrograms of RAE are lower than in micrograms of RE. On the contrary, values of vitamin A requirements expressed in micrograms of RAE, are higher than in micrograms of RE. Both cases are explained by the fact that RE attribute a higher conversion of provitamins to retinol than RAE, and because the criteria between the United States Health and Medicine Division and FAO/WHO differs; therefore, statistics of vitamin A expressed in or derived from different units are not comparable. For this reason, the analyst has to compile the vitamin A content in foods expressed in the same unit as the vitamin A requirements of choice; and he/she has to pay especial attention when compiling vitamin A values from more than one food composition table to ensure that they have the same unit of expression.

Table 21 Vitamin A consumption and Estimated Average Requirements (EAR) expressed in RAE and RE at national level, urban-rural levels, and by income quintile levels, in *Country 2.*

				Income Quintile				
	National	Urban	Rural	Lowest	2	3	4	Highest
Vitamin A Consumption (mcg RAE/capita/day)[a]	886	624	935	654	869	971	1 022	985
Vitamin A EAR (mcg RAE/capita/day)[b]	450	466	447	427	440	450	461	489
Vitamin A Consumption (mcg RE/capita/day)[c]	1 737	1 195	1 838	1 301	1 722	1 914	1 992	1 877
Vitamin A EAR (mcg RE/capita/day)[d]	280	284	280	273	276	282	285	291

[a] The vitamin A content by food item was compiled from the national FCT in mcg of RAE.
[b] The EAR by sex and age are from NAS. The extra energy requirements for pregnant and lactating women were not taken in consideration.
[c] The content of vitamin A by food item expressed in mcg of RE was computed using the formula: retinol + beta-carotene equivalents/6.
[d] The EAR by sex and age are from FAO and WHO. The extra energy requirements for pregnant and lactating women were not taken in consideration.

4.4 Haem and non-haem iron

Iron has several vital functions in the body, including the transportation of oxygen to tissues from the lungs via red blood cell haemoglobin (FAO and WHO, 2004). Iron deficiency is the most common and widespread nutritional disorder in the world (WHO, 2016). Its major health consequences include impaired physical and cognitive development, reduced learning ability and work capacity, maternal or perinatal mortality, and low birth weight (Abbaspour *et al.*, 2014, WHO, 2016).

Iron deficiency affects a large number of children and women of childbearing age, particularly pregnant women, in developing countries; yet, it is the only nutrient deficiency also extremely prevalent in industrialized countries. It is estimated that 2 billion people are anaemic, mainly, due to iron deficiency (WHO, 2016). There are multiple causes of iron deficiency, but it occurs most frequently due to inadequate iron intake. This may result from a combination of low total dietary intake, heavy reliance on foods with low iron content, and/or a diet that hinders iron absorption.

Dietary iron is found in one of two forms in foods with respect to the mechanism of absorption: haem and non-haem. Haem iron is derived mainly from haemoglobin and myoglobin and thus is found in animal-source products, especially meat, fish, and poultry. However, haem iron can be degraded and converted to non-haem iron if foods are exposed to a high temperature for a too long period of time (FAO and WHO, 2004). Non-haem iron is found primarily in plant foods (cereals, nuts, fruits, vegetables, tofu) and dairy products (milk, cheese, eggs), although dairy products contain very little iron (Gropper and Smith, 2013). Nevertheless, animal-source products provide both chemical forms of iron (Abbaspour *et al.*, 2014); the content of each depending on the animal tissue in question. Foods of plant origin provide only non-haem iron (i.e. 100 percent of total iron is under the form of non-haem).

An analysis of various animal tissues found that haem iron represented 30 to 40 percent of the iron in pork, liver, and fish and 50 to 60 percent of the iron in beef, lamb, and chicken (Cook and Monsen, 1976). However, the authors argued that these differences were not of sufficient magnitude to use separate factors for each type of animal use; and in a subsequent study they assumed that the content of haem iron in all animal tissues was 40 percent of total (Monsen *et al.*, 1978). More recent studies have found that a single percentage value of total iron inadequately expresses the chemical forms present in animal source foods, biasing the amount of bioavailable iron (Wheal *et al.*, 2016).

Published data on the percentages of haem iron contained in raw and cooked meat and fish are available in the literature (Carpenter and Clark, 1995, Rangan *et al.*, 1997, Lombardi-Bocciaa *et al.*, 2002, Kongkachuichai *et al.*, 2002, Turhan *et al.*, 2004, Turhan *et al.*, 2006, Cross *et al.*, 2012, Wheal *et al.*, 2016). The values for each of the cited studies are presented in Appendix 6.

The amount of iron absorbed by an individual is determined by physiologic variables such as body iron status in combination with the presence of inhibitors (e.g. tannins, calcium, polyphenols, phytate, zinc and copper) and enhancers (e.g. vitamin C, amount of haem iron as meat) in the food (Collings *et al.*, 2013). Haem iron is usually more absorbable than non-haem iron (Hurrell and Egli, 2010, FAO and WHO, 2004, Lombardi-Bocciaa *et al.*, 2002), in part because dietary factors have little effect on haem iron. The bioavailability for the two chemical forms is estimated at 2%-20% for non-haem and 15-35% for haem (Abbaspour *et al.*, 2014, Hurrell and Egli, 2010). However, the higher contributor to iron nutrition is in general the non-haem form (Abbaspour *et al.*, 2014). In populations with a high intake of meat products, haem iron is estimated to contribute 10–15% of total iron intake, yet, because its higher absorption, it is thought to contribute ≥40% of total absorbed iron (Hurrell and Egli, 2010).

Whenever the analyst compiles the information on the content of haem and non-haem iron for each food item in the input file COUNTRY_NCT, ADePT-FSM estimates the average consumption of each form of iron and identifies the main food sources of these forms within a population. Information on the consumption of the different chemical forms of iron by different population groups can be useful for identifying the iron-rich food sources accessed by households, and for the development of nutrition education programs that promote dietary practices to increase iron bioavailability (FAO, 2014b).

Table 22 shows total iron and haem iron (percent) consumption in *Country 2* at national and urban-rural levels, and by income quintiles. The percentages of haem iron are very low. The main food sources of total iron (not shown here) are dry beans, cooked banana, and some types of cereals; while the principal sources of haem iron are beef and dried/smoked fish.

Table 22 Total iron and haem iron consumption at national level, by urban-rural area, and by income quintile levels in *Country 2.*

				Income Quintile				
	National	Urban	Rural	Lowest	2	3	4	Highest
Total iron (mg/capita/day)	14.7	14.2	14.8	10.8	13.7	15.8	17.0	18.2
Haem iron (%)	2.1	3.3	1.9	0.9	1.5	1.9	2.6	3.6

4.5 Assessing micronutrient content in foods consumed away from home

Over the last decades, there has been a precipitous increase in food consumed away from home (FAFH) worldwide (Smith *et al.*, 2014). Therefore, capturing FAFH cannot be disregarded when conducting HCES, as it is becoming an increasing share of total household food consumption. Neglecting the collection and/or analysis of FAFH may result in serious omissions and large biases in food consumption estimates.

Smith *et al.* (2014) judged the reliability of FAFH data collected in HCES against three criteria: 1) whether FAFH data are explicitly and deliberately collected; 2) whether the recall period for collection of the data is less than or equal to two weeks[33]; and 3) whether data on in-kind food received are collected. In-kind foods include food from school meal programs (see box below), received at work as payment, food aid, etc. Smith and colleagues concluded that only forty two percent of the assessed HCES[34] satisfied the three minimum reliability criteria.

School meal programs

School meal programs represent a substantive contribution to FAFH, but often they are not captured in HCES. Omitting data on food received through school meal programs may lead to biased food consumption estimates, as found in an analysis of Brazil's 2008-09 HCES data (Borlizzi *et al.*, 2017).

Globally, about 368 million pre-primary, primary, and secondary school children receive food through school meal programs of various kinds. The region with the largest number of beneficiaries is South Asia, followed by Latin America and the Caribbean (WFP, 2013).

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[33] The longer the recall period, the more difficult it is for respondents to remember true acquisition or consumption, so these may be under reported; this is known as "recall error". On the other hand, the shorter the recall period the more likely a respondent is to include events that occurred before the recall period. Such "telescoping error" leads to over-reporting (Smith *et al*., 2014).

[34] The assessment was performed to 100 household surveys from low- and middle-income countries.

The largest programs are in India, Brazil, the United States of America, and China. The school feeding program in India provides around 35% of the Recommended Dietary Allowance (RDA) for energy (Drake *et al.*, 2016); in 2012, more than 31.6 million children in the United States of America got their lunch through the National School Lunch Program (USDA (United States Department of Agriculture), 2013); and in 2014, 43 million school children in Brazil received at least 30 percent of their daily nutritional needs through the school meal program (FAO, 2014c).

At least 43 countries have programs that serve more than one million children, contributing a significant amount of dietary energy and nutrients to their diets. For example, the school meal program in Côte d'Ivoire provides over 50% of the RDA of energy, while in South Africa it provides 18% of the RDA (Drake *et al.*, 2016).

In HCES, the foods consumed away from home could be classified in three categories based on how precisely each can be described, or defined:

- very well defined food items, such as *Coke, Beer* and *Hot Dog*;
- fairly well defined food items, such as *Chicken with Rice, Hamburger with fries,* and *Spring Rice; and*
- poorly defined food items such as *Dinner in restaurant*, *Lunch at work* and *Meal at a street vendor.*

In the ADePT-FSM input file COUNTRY_NCT, each food from the HCES food module is matched with a food item from the FCT/FCD of choice. Very well defined foods can be matched directly. Fairly well defined foods cannot be matched directly, so estimating their nutrient content is necessary in order to know the ingredients in the dish and their approximate amounts. Thus, the recommendation is to develop recipes[35]—in consultation with local people and/or with online research/searches—to understand and obtain indications on the prevailing local composition of the specific food (Bermudez *et al.*, 2012). Poorly defined foods cannot be matched to food items in a FCT/FCD because

[35] For information about recipe calculation consult EuroFIR's Report on collection of rules on use of recipe calculation procedures including the use of yield and retention factors for imputing nutrient values for composite foods (Vásquez-Caicedo *et al.*, 2007).

their ingredients are not known, thus their nutrient content cannot be estimated this way. Nevertheless, to estimate total nutrient consumption, it is necessary to have information on the micronutrient content provided by all FAFH. Thus, it is of paramount importance to develop guidelines on best practices for collecting information on food consumption when conducting HCES, and for national FCTs to include the most commonly eaten FAFH in a particular country. Until this becomes common practice, there exists a need to develop a methodology to estimate the micronutrient content of poorly defined food items.

The following is a discussion of two different approaches that were considered for estimating the micronutrient content in poorly defined food items in HCES: 1) using at-home median micronutrient unit values, and 2) using at-home median micronutrient densities, along with the rationale for why the first approach was selected and implemented in ADePT-FSM.

Estimating the micronutrient content of poorly defined foods using at-home median micronutrient unit values

ADePT-FSM estimates that the dietary energy provided by poorly defined foods—of which there is information on the associated expenditure—by applying median[36] dietary energy at-home unit values to the amount spent to acquire these foods (Moltedo *et al.*, 2014). Even though this approach might lead to an overestimation[37] of dietary energy, it can be applied relatively easily to micronutrients as well. This approach would still be prone to measurement error, as the estimated value of a unit of micronutrient derived from the detailed information available on the at-home consumed food may be imprecise. Despite this, it may be the only feasible approach when food quantities cannot be transformed into a standard unit of measurement (e.g. grams), when the only information

[36] At region, urban or rural area, and income quintile level.

[37] Food consumed at restaurants has a higher dietary energy unit value than food consumed at home. However, street vendors and fast food places sell dietary energy at a lower price than restaurants. So, when computing dietary energy=monetary values/dietary energy unit value, the overestimation of FAFH will also depend on where most of the people acquired the food (i.e. street vendors versus restaurants).

available is the associated expenditure, or when there is no information on the nutrient content of the food.

Estimating nutrient content of poorly defined food items using at-home median micronutrient densities

The second approach considered (but not adopted) consists of estimating the micronutrient content of FAFH with poorly defined food labels using median[38] at-home nutrient densities. Nutrient density (nutrient-to-dietary energy density) is the vitamin or mineral content of a food or diet per unit of dietary energy, usually expressed per 1000 Kcal. Density values vary per food; for instance, nutrient-dense foods, such as fruits and vegetables, provide substantial amounts of vitamins and minerals and relatively little dietary energy. On the other hand, foods and beverages with a high content of sugar and fat (naturally occurring or added during processing) and alcoholic beverages have a low nutrient density as they supply dietary energy but a relatively small amount of micronutrients (USDA, 2005).

There is a dearth of studies comparing the micronutrient content of foods consumed at home with FAFH, and most of them have been conducted in the United States of America. Lin and Mentzer (2012) analysed data from the 2005-2007 United States of America National Health and Examination Survey (NHANES) and found that FAFH was denser in total fat, saturated fat, sodium, and cholesterol but contained less calcium, fibre and iron than at-home food. Mancino *et al.* (2010) used data from two national surveys—the 1994-96 CSFII and the 2003-04 NHANES- and concluded that FAFH lowered the daily diet quality of older children; using these same datasets, Todd et al. found that FAFH increased daily dietary energy intake and lowered diet quality in adults. The analysis of data from seven NHANES (Lin *et al.*, 1999), revealed that:

- Calcium density in home foods showed a general upward trend, while in FAFH foods declined slightly. The calcium density of school foods across survey cycles was considerably higher than that of restaurant or fast foods, or even home foods.

[38] At region, urban or rural area, and income quintile level.

- Iron density of home foods rose more rapidly than that of FAFH. The increased iron density in home foods could be partially attributed to increased home consumption of iron-fortified breakfast cereals. Iron densities of fast food, school food, and restaurant food have shown a general upward trend.

Application of the two approaches to five datasets

Tables 23 to 27 show the average micronutrient consumption when the micronutrient content of poorly defined foods (consumed at home or away from home) is estimated using at-home median micronutrient unit values and micronutrient densities. The results show that both methodologies derive similar estimates. However, the estimates using at-home micronutrient densities are thought to be more biased than those derived from the at-home micronutrient unit values. This is because the former approach uses the dietary energy previously estimated using at-home dietary energy unit values, which are already affected by measurement error. On the contrary, using at-home micronutrient unit values relies on the monetary values spent to acquire the foods. For this reason, it was decided that ADePT-FSM would use median at-home nutrient unit values to estimate the micronutrient content of poorly defined food items. Appendix 7 presents a numeric example built on 19 households using the chosen approach, as well as two examples of survey modules that were used in different HCES for collecting FAFH.

Table 23 Daily dietary energy and micronutrient consumption per capita, excluding and including poorly defined food items, calculated using nutrient densities and nutrient unit values in *Country 2.*

	Dietary energy (Kcal)	Vitamin A (mcg RAE)	Vitamin B1 (mg)	Vitamin B2 (mg)	Vitamin B6 (mg)	Vitamin B12 (mcg)	Vitamin C (mg)	Calcium (mg)	Iron (mg)	Zinc (mg)
Excluding poorly defined food items[a]	1 923	845	1.49	1.07	2.79	1.21	129.5	427	13.8	7.2
All food items using nutrient densities	2 068[b]	887	1.59	1.15	2.98	1.29	137.9	457	14.7	7.7
All food items using nutrient unit value	2 068[b]	886	1.59	1.15	2.98	1.29	137.8	457	14.7	7.7
Percentage change between the two methods	-	-0.1	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0

[a] The food items excluded (5.4% of total number of food items) are: "food in restaurants" and "other foods". From the total number of households, 27% reported consumption of at least one of these food items, and 1.7% reported only consumption of these food items. The proportion of food monetary value from these items as total food expenditure is 7.9%.

[b] The dietary energy provided by poorly defined food items was estimated using the median dietary energy unit value.

Table 24 Daily dietary energy and micronutrient consumption per capita, excluding and including poorly defined food items, calculated using nutrient densities and nutrient unit values in *Country 3*.

	Dietary energy (Kcal)	Vitamin A (mcg RAE)	Vitamin B1 (mg)	Vitamin B2 (mg)	Vitamin B6 (mg)	Vitamin B12 (mcg)	Vitamin C (mg)	Calcium (mg)	Iron (mg)	Zinc (mg)
Excluding poorly defined food items[a]	1 646	351	0.80	0.52	1.20	3.48	50.6	423	10.4	7.6
All food items using nutrient densities	1 869[b]	397	0.91	0.59	1.35	3.92	57.5	475	11.7	8.6
All food items using nutrient unit value	1 869[b]	396	0.91	0.59	1.35	3.91	57.4	474	11.7	8.5
Percentage change between the two methods	-	-0.3	0.0	0.0	0.0	-0.3	-0.2	0.2	0.0	1.2

[a] The food items excluded (2.6% of total numbers of food items) are: “cakes, tarts, pies, quiches and “pizzas”; “other food products”; “prepared meals”; “meals at: work, school, restaurants; snacks or coffee or soft drinks, etc.”; “other”. From the total number of households, 86% reported the consumption of at least one of these food items. None of the households reported only consumption of these food items. The proportion of food monetary value from these items as total food expenditure is 10.0%.

[b] The dietary energy provided by poorly defined food items was estimated using the median dietary energy unit value.

Table 25 Daily dietary energy and micronutrient consumption per capita, excluding and including poorly defined food items, calculated using nutrient densities and nutrient unit values in *Country 4*.

	Dietary energy (Kcal)	Vitamin A (mcg RAE)	Vitamin B1 (mg)	Vitamin B2 (mg)	Vitamin B6 (mg)	Vitamin B12 (mcg)	Vitamin C (mg)	Calcium (mg)	Iron (mg)	Zinc (mg)
Excluding poorly defined food items[a]	1 922	N/A	0.93	1.06	1.79	2.68	81.2	391	13.5	8.3
All food items using nutrient densities	2 078[b]	N/A	1.01	1.16	1.94	2.86	88.1	426	14.5	9.0
All food items using nutrient unit value	2 078[b]	N/A	1.00	1.16	1.93	2.84	88.0	426	14.5	9.0
Percentage change between the two methods	-	N/A	-1.0	0.0	-0.9	-0.7	-0.1	0.0	0.0	0.0

N/A, non-available, because the FCT used for *Country 4* does not specify if vitamin A values are expressed in RAE or RE; thus, values are not included.

[a] The food items excluded (6.6% of total number of food items) are: four local dishes and 15 food items with the label "meal". From the total number of households, 21% reported the consumption of at least one of these food items and 0.2% reported only consumption of these food items. The proportion of food monetary value from these items as total food expenditure is 4.3%.

[b] The dietary energy provided by poorly defined food items was estimated using the median dietary energy unit value.

Table 26 Daily dietary energy and micronutrient consumption per capita, excluding and including poorly defined food items, calculated using nutrient densities and nutrient unit values in *Country 5*.

	Dietary energy (Kcal)	Vitamin A (mcg RAE)	Vitamin B1 (mg)	Vitamin B2 (mg)	Vitamin B6 (mg)	Vitamin B12 (mcg)	Vitamin C (mg)	Calcium (mg)	Iron (mg)	Zinc (mg)
Excluding poorly defined food items [a]	2 012	538	1.57	1.02	1.82	1.46	78.1	373	15.3	8.8
All food items using nutrient densities	2 084[b]	548	1.62	1.05	1.87	1.51	80.0	384	15.9	9.1
All food items using nutrient unit value	2 084[b]	548	1.62	1.05	1.87	1.51	80.0	384	15.9	9.1
Percentage change between the two methods	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

[a] The food items excluded (6.3% of total number of food items) are: "canteens"; "food at school"; "other food products"; "other food stuffs"; "pension"; "purchased/ prepared meals consumed at home"; "purchased/prepared tea coffee consumed at home". From the total number of households, 54% reported the consumption of at least one of these food items. None of the households reported only consumption of these food items. The proportion of food monetary value from these items as total food expenditure is 4.4%.
[b] The dietary energy provided by poorly defined food items was estimated using the median dietary energy unit value.

Table 27 Daily dietary energy and micronutrient consumption per capita, excluding and including poorly defined food items, calculated using nutrient densities and nutrient unit values in *Country 6.*

	Dietary energy (Kcal)	Vitamin A (mcg RAE)	Vitamin B1 (mg)	Vitamin B2 (mg)	Vitamin B6 (mg)	Vitamin B12 (mcg)	Vitamin C (mg)	Calcium (mg)	Iron (mg)	Zinc (mg)
Excluding poorly defined food items [a]	1 651	195	0.79	0.44	1.04	1.18	26.4	289	8.3	7.7
All food items using nutrient densities	2 462[b]	287	1.19	0.67	1.55	1.81	39.6	433	12.4	11.5
All food items using nutrient unit value	2 462[b]	285	1.20	0.67	1.56	1.79	39.3	436	12.4	11.5
Percentage change between the two methods	-	-0.7	+0.8	0.0	+0.6	-1.1	-0.7	-0.7	0.0	0.0

[a] The food items excluded (8.4% of total number of food items) are: “outdoors meals”; “others”. From the total number of households, 93% reported the consumption of at least one of these food items and 0.2% reported only consumption of these food items. The proportion of food monetary value from these items as total food expenditure is 29.3%.
[b] The dietary energy provided by poorly defined food items was estimated using the median dietary energy unit value.

5. GROUPING AND PRESENTING FOOD SECURITY STATISTICS

5.1 Subnational level

ADePT-FSM produces statistics at national and subnational levels according to the population groups defined by the analyst. The subnational levels are defined as population groups formed by households disaggregated by geographical location (such as urban or rural) and household characteristics (for example, income and household size), and by demographic profile (such as gender and age) or by socio-economic characteristics (for example, economic activity, occupation, and highest level of education) of the household head. Each population group can be represented by a household level variable in a dataset, where each distinct value corresponds to a category within the group. An example of categories within a population group is: “extreme poor”, “poor” and “non-poor” for the population group “household socio-economic status”. Population groups disaggregated into categories and associated with food consumption statistics are useful for monitoring or identifying target populations by policy makers.

HCES differ on the type of socio-economic information collected. Therefore, the feasibility of deriving indicators disaggregated by specific household socio-economic characteristics depends on the type of survey and data collected wherein. Analysts in each country are responsible for identifying the most relevant socio-economic characteristics for classifying households in different population groups.

Population groups that could be analysed in ADePT-FSM include:

- National
- Regional
- Urban-rural areas
- Quintile of income
- Household size
- Gender of the head of household
- Economic activity of the head of household

- Education level of the head of household
- Occupation of the head of household
- Ethnicity of the head of household
- Household socio-economic status
- Household access to water and sanitation
- Gender of the head of household combined with other head of household characteristics or household characteristics
- Tercile of dietary diversity
- Household food insecurity status, as derived, for example, from data collected through experience-based food insecurity measurement scales

Table 28 lists the main food security statistics (referred to the yearly usual average consumption weighted[39] to infer them at population levels) produced by ADePT-FSM for each category within a population group.

Table 28 Principal food security statistics produced by ADePT-FSM for each category within a population group.

General	Number of sampled households / Number of represented households Average household size Estimated total population
Food consumption	Fruit and vegetable consumption (g/capita/day) Food item consumption (g/capita/day)
Dietary energy and macronutrients	Average dietary energy consumption (kcal/capita/day) Average dietary energy consumption (kcal/adult male equivalent/day) Average protein consumption (g/capita/day) Average carbohydrate consumption (g/capita/day) Average fat consumption (g/capita/day) Average fibre consumption (g/capita/day)
Micronutrients	Average consumption of vitamin A (RAE or RE mcg/capita/day), retinol (mcg/capita/day) and beta-carotene equivalents (mcg/capita/day) Average consumption of vitamins B1, B2, B6 and C (mg/capita/day) and

[39] Population weights (i.e. household weights multiplied by the household size) are used to infer the food security statistics. Household weight is the expansion factor divided by the probability of the household to be sampled.

	vitamin B12 (mcg/capita/day) Average consumption of calcium, zinc, and folate (mg/capita/day) Average consumption of animal, non-animal, haem and non-haem iron (mg/capita/day) Nutrient densities expressed per 1000 kcals Micronutrient adequacy (%) (micronutrient consumption/micronutrient average requirement)
Amino acids	Average consumption of essential amino acids: isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine, histidine, cystine and tyrosine (g/capita/day)
Quality of diet	Proportion of energy consumed as protein (%) Proportion of energy consumed as carbohydrates (%) Proportion of energy consumed as fats (%) Proportion of animal protein in total protein consumed (%)
Monetary value	Average food consumption (Local Currency Unit (LCU)/capita/day) Average total consumption (LCU/capita/day) Average income (LCU/capita/day)
Price	Average dietary energy unit value (LCU/1,000 kcal)
Sources of acquisition	Proportion of purchased food as total food consumed, expressed as % energy Proportion of own produced food as total food consumed, expressed as % energy Proportion of food consumed away from home as total food, expressed as % energy Proportion of food consumed from other sources as total food, expressed as % energy Proportion of purchased food as total food consumed, expressed as % monetary value Proportion of self-produced food as total food consumed, expressed as % monetary value Proportion of food consumed away from home as total food, expressed as % monetary value Proportion of food consumed from other sources as total food, expressed as % monetary value Share of food consumption in total income (%) (Engel ratio)
Responsiveness of demand to income	Income elasticity of the demand of food – dietary energy consumption Income elasticity of the demand of food – food expenditure Income elasticity of the demand of food – Engel ratio
Inequality	Dispersion ratio of food consumption in dietary energy ($80^{th}/20^{th}$ percentiles) Dispersion ratio of food consumption in monetary value ($80^{th}/20^{th}$ percentiles)

	Dispersion ratio of total consumption expenditure ($80^{th}/20^{th}$ percentiles)
Requirements	Minimum[40] and average[41] dietary energy requirements (kcal/capita/day)
Dietary energy inadequacy	Prevalence of undernourishment (%)* Depth of food deficit (kcal/capita/day)*

* These indicators are only produced at national, urban/rural areas, regional or province levels.

Below are fully annotated examples of five sub-population groups that could be used in ADePT-FSM:

- Household socio-economic status;
- Household access to water and sanitation;
- Gender of the head of household combined with other head of household or household characteristics;
- Tercile of dietary diversity using the HCES-DDS; and
- Household food insecurity status, as derived for example from data collected through experience-based food insecurity measurement scales.

Household socio-economic status

HCES data are frequently used to compute national poverty estimates where the household poverty status is defined by comparing a welfare indicator expressed in monetary value (e.g. income or consumption expenditure) with a given poverty line[42] that flags the minimum acceptable level of the welfare indicator (Foster *et al.*, 2013). It is

[40] The definition of MDER is: "In a specified age/sex category, the minimum amount of dietary energy per person that is considered adequate to meet the energy needs at a minimum acceptable BMI of an individual engaged in low physical activity. If referring to an entire population, the minimum dietary energy requirement is the weighted average of the minimum dietary energy requirements of the different age/sex groups." (FAO *et al.*, 2015).

[41] The formulas to estimate the average dietary energy requirement (ADER) are equal to those used in the estimation of MDER; however, some parameters are different. The ADER refers to the amount of energy considered adequate to meet the energy needs for normative average acceptable weight for an attained height while performing moderate physical activity in good health (Moltedo *et al.*, 2014).

[42] There is an internationally comparable poverty line, currently set at the equivalent of 1.90 USD/day in purchasing power parity. In addition, some countries define their own poverty and/or extreme poverty line(s) at national level; others, such as India, define them at urban/rural levels instead of country level.

possible to compute food consumption statistics by household socio-economic status whenever HCES data allow for estimating a welfare indicator[43] that classifies households per given poverty lines. The number of categories (socio-economic statuses) within this population group depends on the number of poverty lines delineated by a country (for example, two poverty lines may classify households into "extreme poor", "poor" and "non-poor"; one poverty line may classify households into "poor" and "non-poor").

Examples of food consumption statistics disaggregated by household socio-economic status are presented in Table 29 and Table 30 for *Country 1*, and in Table 31 and Table 32 for *Country 2*. As expected, in *Country 1 and Country 2* consumption of dietary energy and micronutrients decrease when moving from non-poor to extremely poor households (see Table 29 and Table 31, respectively); however, nutrient densities[44] do not always follow the same pattern. For instance, in both countries, poor households have diets with a higher vitamin A density than diets of non-poor households (see Table 30 and Table 32, respectively). In *Country 1* this is because non-poor households have a higher consumption of energy-high foods such as white sweet potatoes, oil and maize, which are relatively low in vitamin A.

Table 29 Daily dietary energy and micronutrient consumption per capita by household socio-economic status in *Country 1*.

	No. HHs sampled & represented	Dietary energy (kcal)	Vitamin A (mcg RAE)	Vitamin B1 (mg)	Vitamin B2 (mg)	Vitamin B6 (mg)	Vitamin B12 (mcg)	Vitamin C (mg)	Calcium (mg)	Iron (mg)
Extremely poor	2 347 613 403	1 111	345	0.94	0.58	1.94	2.22	125	348	11.3
Poor	2 940 740 156	1 992	518	1.55	0.97	3.29	3.66	209	545	18.5
Non-poor	6 979 1 717 288	3 488	663	2.42	1.66	5.13	6.30	303	778	28.3

No. HHs, number of households.

[43] From an evaluation of 100 HCES questionnaires, Smith *et al.* (2014) concluded that household expenditures could be calculated from the data collected in all the assessed surveys.

[44] Nutrient density (nutrient-to-dietary energy density) is the vitamin or mineral content of a food or diet per unit of dietary energy. It is usually expressed by 1000 Kcal.

Table 30 Daily micronutrient densities in the diet by household socio-economic status in *Country 1**.

	Vitamin A (mcg RAE/1000 Kcal)	Vitamin B1 (mg/1000 Kcal)	Vitamin B2 (mg/1000 Kcal)	Vitamin B6 (mg/1000 Kcal)	Vitamin B12 (mcg/1000 Kcal)	Vitamin C (mg/1000 Kcal)	Calcium (mg/1000 Kcal)	Iron (mg/1000 Kcal)
Extremely poor	432	0.94	0.58	1.65	1.82	120	363	11.2
Poor	349	0.83	0.53	1.53	1.81	105	305	9.7
Non-poor	242	0.71	0.49	1.37	1.76	86	229	8.1

No. HHs, number of households.
*The nutrient density values are computed as the mean of the households' nutrient densities and not as the ratio of the means of nutrient and dietary energy at the population level.

Table 31 Daily dietary energy and micronutrient consumption per capita by household socio-economic status in *Country 2*.

	No. HHs sampled & represented	Dietary energy (kcal)	Vitamin A (mcg RAE)	Vitamin B1 (mg)	Vitamin B2 (mg)	Vitamin B6 (mg)	Vitamin B12 (mcg)	Vitamin C (mg)	Calcium (mg)	Iron (mg)
Poor	1 991 1 384 561	1 407	693	1.19	0.75	2.09	0.78	98	326	11.1
Non-poor	5 428 3 845 083	2 350	968	1.76	1.31	3.36	1.51	155	513	16.3

No. HHs, number of households.

Table 32 Daily micronutrient densities in the diet by household socio-economic status in *Country 2**.

	Vitamin A (mcg RAE/1000 Kcal)	Vitamin B1 (mg/1000 Kcal)	Vitamin B2 (mg/1000 Kcal)	Vitamin B6 (mg/1000 Kcal)	Vitamin B12 (mcg/1000 Kcal)	Vitamin C (mg/1000 Kcal)	Calcium (mg/1000 Kcal)	Iron (mg/1000 Kcal)
Poor	461	0.85	0.55	1.45	0.59	69	246	8.2
Non-poor	391	0.75	0.56	1.41	0.70	66	225	7.0

No. HHs, number of households.
*The nutrient density values are computed as the mean of the households' nutrient densities and not as the ratio of the means of nutrient and dietary energy at the population level.

Household access to water and sanitation

The WHO estimates that 50% of childhood malnutrition is associated with repeated diarrhoea or intestinal worm infections as a result of unsafe water, inadequate sanitation, or insufficient hygiene (Prüss-Üstün *et al.*, 2009). Diarrhoea can be considered both a cause and a consequence of malnutrition. Diarrhoea increases nutritional needs while reducing appetite and intestinal absorption. Moreover, undernourished children have weaker immune defences, which make them more vulnerable to diarrhoea when exposed to poor sanitary conditions, thereby triggering a vicious cycle. Thus, water, sanitation, and hygiene interventions play an important role in preventing or reducing malnutrition, and contributing to reduced poverty and sustainable development (HLPE, 2015).

Improvement of drinking water and sanitation facilities has been on the international agenda for decades. Millennium Development Goal 7, target C was monitored by two indicators based on improved sources of drinkable water[45] and improved sanitation facilities[46] (WHO and UNICEF, 2016, UN (United Nations), 2012). Goal 6 of the 2030 Agenda for Sustainable Development refers exclusively to clean water

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[45] According to the United Nations:

> "An improved drinking water source is a facility that, by nature of its construction, is protected from outside contamination, in particular from contamination with fecal matter. Improved drinking water sources include: piped water into dwelling, plot or yard; public tap/standpipe; borehole/tube well; protected dug well; protected spring; rainwater collection and bottled water. Users of bottled water are considered to have access to improved sources only when they have a secondary source which is of an otherwise improved type. Improved drinking water sources do not include unprotected wells, unprotected springs, water provided by carts with small tanks/drums, tanker truck-provided water and bottled water (if the secondary source is not improved) or surface water taken directly from rivers, ponds, streams, lakes, dams, or irrigation channels" (UN, 2012).

[46] According to the United Nations:

> "An improved sanitation facility is defined as a facility that hygienically separates human excreta from human, animal, and insect contact. Improved sanitation facilities include flush/pour-flush toilets or latrines connected to a sewer, septic tank or pit; ventilated improved pit latrines; pit latrines with a slab or platform of any material which covers the pit entirely, except for the drop hole; and composting toilets/latrines. Unimproved facilities include public or shared facilities of an otherwise improved type; flush/pour-flush toilets that discharge directly into an open sewer or ditch or elsewhere; pit latrines without a slab; bucket latrines; hanging toilets or latrines; and the practice of open defecation in the bush, field, or bodies of water" (UN, 2012).

and sanitation: "Ensure availability and sustainable management of water and sanitation for all" (UN, 2015).

As previously mentioned, even adequate food consumption in the presence of infectious diseases such as diarrhoea can be insufficient to support children's growth. Therefore, anthropometric and food consumption data in combination with information on access to water and sanitation facilities are useful for analysing nutrient utilization conditions. HCES very rarely carry out anthropometric measures; however, in the absence of such information, presenting food consumption indicators by households' access to safe water and sanitation facilities would help highlight the contexts, in terms of the favourable or unfavourable conditions, for nutrient utilization[47].

Not all HCES collect information on access to drinkable water or sanitation facilities but those that do[48] typically gather highly disaggregated data—up to five or six levels of disaggregation—which may reflect a different classification from the ones used by the United Nations. In these cases, the analyst could create two independent population groups, with more than two categories each, according to household access to: 1) drinkable water and 2) sanitation facilities. The categories of each of these population groups should be defined in such a way that the derived statistics could be considered reliable[49].

Table 33 shows an example, using data collected in *Country 1*, of the type of information that can be derived when households are classified according to their source of drinkable water. The breakdown by sanitation facilities is not presented here but would be similar. The results reveal that households having access to a spring, river, or lake—the worst condition for a good nutrient utilization—as the main source of water also had

[47] "Utilization refers to the ability of individuals to absorb and effectively use the nutrients ingested for normal body functions" (Leroy *et al.*, 2015).

[48] For example, Living Standards Measurement Studies (LSMS) surveys collect data both on food consumption and/or acquisition, and on household access to drinkable water and/or type of sanitation facilities. Appendix 8 shows an example of a question related to household access to drinking water and one related to household sanitation facilitates within a LSMS survey.

[49] The number of sampled households in each category within the population group gives an idea of how reliable the statistics are. The smaller the sample size, the higher likelihood the standard error increases by an order of 1/sqrt(n).

the lowest consumption of vitamins and minerals. It should be noted, however, that this association could not be interpret as causality, since the same factors that lead households to have poor access to water and sanitation are also likely to lead them to suffer from a lack of key nutrients. For instance, lacking income and assets restricts access to basic necessities including food, shelter, and acceptable levels of health (World Bank, 2001). Nevertheless, these categorizations would be useful to flag subpopulation groups who not only have particularly low micronutrient consumption, but also might have their nutrient utilization compromised.

Table 33 Daily micronutrient consumption per capita by source of drinkable water in *Country 1*.

Access to drinkable water	No. HHs sampled & represented	Dietary energy (kcal)	Vitamin A (mcg RAE)	Vitamin B1 (mg)	Vitamin B2 (mg)	Vitamin B6 (mg)	Vitamin B12 (mcg)	Vitamin C (mg)	Calcium (mg)	Iron (mg)
Piped into dwelling	479 91 871	4 114	690	2.45	1. 93	5.71	5.96	334	822	29.1
Piped into yard/plot	810 148 899	3 456	596	2.25	1.63	5.14	6.04	304	693	25.7
Communal standpipe	1 514 365 737	2 895	552	2.01	1.39	4.43	6.06	248	613	22.3
Well	1 751 515 874	2 296	586	1.74	1.14	3.74	4.51	235	604	20.6
Borehole	6 897 1 776 926	2 366	526	1.76	1.14	3.62	4.19	222	601	21.1
Spring/River/ lake	812 170 963	2 158	507	1.65	1.06	3.47	4.10	213	548	19.6

No. HHs, number of households.

Gender of the head of household combined with other head of household or household characteristics

A reduction in food insecurity, micronutrient deficiencies, and rural poverty in low- and middle-income economies are expected effects from the increase of the agricultural productivity and access to markets by vulnerable populations. The gender dimension is critical for achieving these effects given the vital role of women in rural economies where the fight against hunger and poverty is most pressing and where the large majority of the world's poor live (FAO, 2013). Studies show that women generally spend more than men on food, health, clothing, and education for their children. Thus, improvements in health, nutrition and education outcomes are expected when women have control over additional income (FAO, 2011b).

The comparison of indicators across male and female headed households is not considered a proper gender analysis (Doss and Caitlin, 2014). However, combining gender with socio-economic characteristics (such as occupation and economic activity) or households characteristics[50] (for example urban-rural) could help understanding if and how different forms of headship per se relate to food security outcomes (FAO, 2016a). When analysing results, it is important to consider how the household head was defined in the survey (self-defined by the interviewee, the person with the highest income in the household, the oldest person in the household, etc.) and to report this in the write-up of results.

Table 34 shows an example of food consumption statistics disaggregated by gender of the household head and area of residence for *Countries 2,3,4,5* and *6*. Results show that in *Country 3* households in urban areas headed by females had a higher consumption of all the micronutrients analysed (except for calcium) than households headed by males. In *Country 2*, an analysis of differences between male and female-headed households within the same area of residence revealed that the latter had a lower consumption of micronutrients; the only exception was for vitamin A in urban areas where female-headed households had a higher consumption than households headed by males (644 mcg RAE/capita/day and 617 mcg RAE/capita/day respectively).

[50] When choosing variables to group households, one needs to contemplate grouping in such a way that the derived statistics are considered reliable. The number of sampled households in each category within the population group gives an idea of how reliable the statistics are. The smaller the sample size the higher would be the standard error of an order of 1/sqrt(n).

Table 34 Daily micronutrient consumption per capita by gender of the household head and urban-rural areas in *Countries 2*, *3*, *4*, *5* and *6*.

Household head	Urban Rural	No. HHs sampled & represented	Vitamin A (mcg RAE)	Vitamin B1 (mg)	Vitamin B2 (mg)	Vitamin B6 (mg)	Vitamin B12 (mcg)	Vitamin A (mcg RAE)	Calcium (mg)	Iron (mg)	Zinc (mg)
Country 2											
Male	Urban	1 198 644 437	617	1.54	1.14	2.83	1.83	124	464	14.4	7.9
Male	Rural	4 202 3 177 039	939	1.60	1.16	3.03	1.23	142	457	14.8	7.7
Female	Urban	500 267 695	644	1.46	1.04	2.70	1.76	116	436	13.9	7.6
Female	Rural	1 519 1 140 473	920	1.58	1.12	2.95	1.09	136	456	14.8	7.7
Country 3											
Male	Urban	1 800 396 417	594	1.10	0.77	1.60	5.22	98	611	13.5	8.3
Male	Rural	7 579 1 908 223	342	0.85	0.54	1.27	3.52	47	438	11.1	8.5
Female	Urban	584 131 380	624	1.14	0.82	1.75	5.60	98	576	14.2	8.5
Female	Rural	2 007 502 389	384	0.91	0.58	1.35	3.95	52	477	11.9	9.0
Country 4											
Male	Urban	8 291 3 003 894	N/A	1.01	1.28	1.96	3.57	95	470	14.5	9.3
Male	Rural	6 512 1 801 539	N/A	0.97	0.90	1.84	1.45	74	333	14.2	8.1
Female	Urban	2 580 947 658	N/A	1.04	1.33	2.01	3.64	98	486	15.0	9.6
Female	Rural	1 208 343 293	N/A	1.07	1.00	2.00	1.51	77	375	15.8	9.1
Country 5											
Male	Urban	5 203 1 706 161	340	1.41	1.04	1.53	2.05	58	422	15.0	9.2
Male	Rural	2 506 4 379 418	618	1.71	1.06	1.99	1.35	86	376	16.2	9.1
Female	Urban	1 949 669 721	403	1.43	1.06	1.53	2.02	58	401	15.1	9.1
Female	Rural	763 1 304 930	595	1.64	1.03	1.97	1.22	95	359	16.0	8.9

Household head	Urban Rural	No. HHs sampled & represented	Vitamin A (mcg RAE)	Vitamin B1 (mg)	Vitamin B2 (mg)	Vitamin B6 (mg)	Vitamin B12 (mcg)	Vitamin A (mcg RAE)	Calcium (mg)	Iron (mg)	Zinc (mg)
Country 6											
Male	Urban	1 729 4 318 034	338	1.34	0.82	1.70	2.31	53	513	13.2	12.0
Male	Rural	5 342 12 157 364	254	1.12	0.59	1.48	1.50	32	391	11.9	11.2
Female	Urban	920 2 478 802	372	1.42	0.90	1.81	2.55	60	559	13.8	12.4
Female	Rural	1 407 3 321 498	275	1.14	0.63	1.51	1.71	34	425	12.2	11.2

No. HHs: number of households; N/A: non-available, because the FCT used for *Country 4* does not specify if vitamin A values are expressed in RAE or RE; thus, they are not included.

Table 35 displays statistics disaggregated by gender and economic activity of the household head for *Country 2*. Female-headed households performing economic activities other than agriculture had the lowest vitamin A consumption (696 mcg RAE/capita/day). Both female and male-headed households working on agriculture activities had the lowest consumption of vitamin B12, 1.00 mcg/capita/day and 1.19 mcg/capita/day respectively.

Table 35 Daily micronutrient consumption per capita by gender of the household head and economic activity in *Country 2*.

Household head	Economic activity	No. HHs sampled & represented	VIT A (mcg RAE)	VIT B1 (mg)	VIT B2 (mg)	VIT B6 (mg)	VIT B12 (mcg)	VIT C (mg)	Calcium (mg)	Iron (mg)	Zinc (mg)
Male	Agricultural activity	3 175 2 300 099	945	1.60	1.13	3.00	1.19	141	450	14.8	7.7
Male	Other activity	2 225 1 521 377	800	1.59	1.20	3.00	1.53	136	472	14.8	7.9
Female	Agricultural activity	1 238 899 000	951	1.57	1.11	2.93	1.00	134	453	14.7	7.6
Female	Other activity	736 509 168	696	1.53	1.08	2.84	1.65	129	451	14.5	7.8

No. HHs, number of households.

Terciles of dietary diversity using the HCES-DDS

Terciles of the HCES-DDS can be used as a population group in ADePT-FSM to derive food security statistics. This kind of analysis could be useful for setting targets such as improving the diet diversity of households in the lowest tercile by achieving the dietary profile of the higher tercile. It can also be helpful to assess seasonal differences in dietary patterns—as long as the data collection is performed in a panel survey where households are visited at multiple points in time during a year—and to inform the development of agriculture and food security interventions (Thompson *et al.*, 2014).

ADePT-FSM automatically derives food security statistics by HCES-DDS tercile, as previously described. Because household dietary diversity scores, specially derived from HCES data, have not been validated for micronutrient consumption adequacy, the set of food security indicators by terciles of HCES-DDS excludes statistics on apparent consumption of micronutrients and amino acids to avoid misinterpretation of the results.

Table 36 through Table 40 show examples of statistics that could be derived using the HCES-DDS tercile classification.

Table 36 Daily per capita dietary energy and macronutrient consumption and food monetary value by HCES-DDS tercile in *Country 2.*

	No. HHs sampled & represented	Dietary energy (Kcal)	Protein (grams)	Fats (grams)	Carbohydrates (grams)	Food monetary value (local currency)
Lowest HCES-DDS tercile (Score ≤ 6)	2 123 1 536 769	1 748	42.6	15.5	329	373
Mid HCES-DDS tercile (Score ≥ 7 and ≤ 9)	2 703 1 882 822	1 933	48.4	22.0	356	463
Highest HCES-DDS tercile (Score ≥ 10)	2 497 1 744 574	2 386	58.1	31.6	436	718

No. HHs, number of households.

Table 37 Daily per capita dietary energy and macronutrient consumption and food monetary value by HCES-DDS tercile in *Country 3.*

	No. HHs sampled & represented	Dietary energy (Kcal)	Protein (grams)	Fats (grams)	Carbohydrates (grams)	Food monetary value (local currency)
Lowest HCES-DDS tercile (Score ≤ 10)	2 623 656 238	1 847	59.6	22.0	344	2 445
Mid HCES-DDS tercile (Score = 11)	2 859 704 032	1 842	59.1	21.4	345	2 527
Highest HCES-DDS tercile (Score ≥ 12)	6 505 1 577 917	1 913	64.3	26.3	346	3 163

No. HHs, number of households.

Table 38 Daily per capita dietary energy and macronutrient consumption, and food monetary value by HCES-DDS tercile in *Country 4.*

	No. HHs sampled & represented	Dietary energy (Kcal)	Protein (grams)	Fats (grams)	Carbohydrates (grams)	Food monetary value (local currency)
Lowest HCES-DDS tercile (Score ≤ 12)	6 576 1 949 138	1 794	49.1	26.8	327	2.3
Mid HCES-DDS tercile (Score = 13)	2 902 924 391	1 959	58.4	31.6	348	2.6
Highest HCES-DDS tercile (Score ≥ 14)	9 084 3 211 366	2 246	73.0	38.7	388	3.4

No. HHs, number of households.

Table 39 Daily per capita dietary energy and macronutrient consumption, and food monetary value by HCES-DDS tercile in *Country 5.*

	No. HHs sampled & represented	Dietary energy (Kcal)	Protein (grams)	Fats (grams)	Carbohydrates (grams)	Food monetary value (local currency)
Lowest HCES-DDS tercile (Score ≤10)	2 661 2 626 316	1 833	49.1	29.1	313	337
Mid HCES-DDS tercile (Score ≥ 11 and ≤ 12)	3 059 2 605 433	2 025	53.0	36.8	340	429
Highest HCES-DDS tercile (Score ≥ 13)	4 701 2 828 481	2 338	62.2	52.1	375	609

No. HHs, number of households.

Table 40 Daily per capita dietary energy and macronutrient consumption, and food monetary value by HCES-DDS tercile in *Country 6.*

	No. HHs sampled & represented	Dietary energy (Kcal)	Protein (grams)	Fats (grams)	Carbohydrates (grams)	Food monetary value (local currency)
Lowest HCES-DDS tercile (Score ≤ 10)	2 725 5 885 606	2 231	65.2	30.0	414	12.6
Mid HCES-DDS tercile (Score = 11)	2 140 5 042 844	2 422	74.4	37.4	436	16.2
Highest HCES-DDS tercile (Score ≥ 12)	4 516 11 299 409	2 587	83.5	45.9	448	21.8

No. HHs, number of households.

Household food insecurity status, as derived from data collected through experience-based food insecurity measurement scales

Experience-based scales[51] are tools used to measure food insecurity at the individual or household level. Their use, along with other indicators of individual or household socio-economic condition or nutritional status, contributes to a better understanding of the determinants and consequences of individual and household food insecurity (Cafiero *et al.*, 2014).

If the HCES includes a module with an experience-based food security scale, households could be classified based on the so-called "raw score,"[52] the total number of affirmative answers to the questions that compose the module (assuming dichotomous yes/no response categories). If statistical validation confirms the data are consistent with the theoretical construct on which the experience-based scale is built, the raw score is in fact an ordinal measure of the severity of the household food insecurity status and can thus be used to classify respondents in classes of food insecurity of increasing severity (with higher raw scores associated with higher severity) (Nord, 2014). Meaningful classes of food insecurity severity can therefore be formed simply based on the reported raw score.

51 Validated and widely used scales include the United States of America Household Food Security Survey (USDA, 2016), the Latin American and Caribbean Food Security Scale (in Spanish: Escala Latinoamericana y Caribeña de Seguridad Alimentaria) (Pérez-Escamilla *et al.*, 2007), the Brazilian Food Insecurity Scale (in Portuguese: Escala Brasileira de Insegurança Alimentar) (Perez-Escamilla *et al.*, 2004, IBGE (Instituto Brasileiro de Geografia e Estatística), 2014), the Household Food Insecurity Access Scale (Coates *et al.*, 2007), the Household Hunger Scale (Ballard *et al.*, 2011) and the Food Insecurity Experience Scale (Ballard *et al.*, 2013).

52 Thresholds in terms of raw score can be used in multivariate analyses when food insecurity is used as explanatory or dependent variable if the country effect is also taken into account. When direct comparison between food insecurity prevalence rates in different countries is the goal of the analysis, the Voices of the Hungry (VoH) project recommends using more precise and comparable thresholds based on a global standard (FAO, 2016b).

When using the 8-item, dichotomous version of the Food Insecurity Experience Scale (FIES) (Ballard *et al.*, 2013) classifications could be based on a[53]:

- Raw score of 0 to 3 (food secure or mildly food insecure);
- Raw score between 4 and 6 (moderately food insecure);
- Raw score of 7 or 8 (severely food insecure).

Considering the endorsement of the FIES-based “prevalence of food insecurity” as an indicator for global monitoring of SDG Target 2.1, inclusion of the FIES or a compatible scale questionnaire in HCES may become common. However, for results that are more precisely comparable with other countries, an alternative set of variables may be calculated, or provided by FAO, corresponding to the probability of belonging to one of the three classes (“Food Secure,” “Moderately and severe Food Insecure” and “Severely Food Insecure”) associated with each household. This is the approach used by FAO for monitoring Target 2.1.

5.2 Dietary energy consumption expressed in Adult Male Equivalents

Studies that assess food consumption using household level data usually present estimates “per capita”, thereby overlooking the impact of household composition due to the diverse nutritional needs of different family members (Claro et al., 2010). Thus, great care must be paid when interpreting dietary energy consumption statistics across households with different compositions, as average per capita levels may, in fact, be lower in households with young children because children have lower energy requirements and consequently eat smaller food quantities than adults (Weisell and Dop, 2012).

53 These thresholds are still under review and they are the result of a global analysis conducted by the VoH project using the Gallup World Poll (GWP) data and have been found to provide the closest prevalence rates to the ones calculated using a comparable procedure for the majority of countries. While the VoH project does not report the “mild food insecurity” category from the GWP survey data, having this category could be useful for analysis of causes and consequences of food insecurity. However, there may be substantial measurement error around the threshold between “food secure” and “mild” categories, so for purposes of population assessment, it is prudent to only publish estimates of the prevalence of respondents classified as “moderately” and “severely” food insecure (FAO, 2016b).

Adult Male Equivalents (AME) have been proposed as a tool for reducing the gap between estimates derived from household level data and individual level data, and for comparing dietary energy consumption among households of various sizes and compositions (Claro *et al.*, 2010, Weisell and Dop, 2012). In dietary studies, AME are based on the relative energy requirements of the different age and sex groups of the population being expressed as a proportion of the requirements of an adult male.

Construction of AME factors and household AME units

Construction of AME factors[54] is straightforward: the estimated dietary energy requirements of the different sex-age population groups are divided by the estimated energy requirement[55] of an adult male. The AME factors can be sample-specific if information on the age, sex, height (to impute Body Mass Index), physical activity level, and physiological status of the different household members is available and used to calculate their energy requirements (see Weisell and Dop (2012) and (Dop *et al.*, 2012). Alternatively, standard factors based on the needs derived using typical characteristics of the individuals in the population of analysis could be used; this is the approach taken in many studies. (See, for example, Imhoff-Kunsch *et al.* (2012) and Dary and Jariseta (2012)).

The characteristics of the reference adult (i.e., gender, age range, height/weight, physical activity level), and methodology for determining energy requirements used in the construction of AME factors vary among studies. (See Appendix 9 for a discussion on this topic.)

In ADePT-FSM, the AME factors are survey-specific (i.e., they are calculated based on the energy requirements of the individuals in the sampled households). The characteristics of the reference adult used to construct the AME factors in ADePT-FSM are presented in Table 41. Women are treated as non-pregnant and non-lactating[56] and all

[54] AME factors are not household-specific.

[55] FAO's energy requirement methodology FAO (2004) is generally used to determine energy requirements in analyses of HCES data.

[56] This is so because the identification of women as pregnant or lactating is often not available in HCES.

children under 1 year of age have the same AME factor. ADePT-FSM uses the FAO methodology to determine energy requirements (FAO, 2004).

Table 41 Characteristics of the reference adult used in ADePT-FSM for the construction of AME factors.

Gender	Male
Age range	18-30 years
Height	Population-specific (if available)
Physical activity level	1.85 (moderate)
Body Mass Index	50^{th} percentile (23.1)

To construct household AME units, the AME factors of household members are summed for each household, the result being a rescaled household size. For this purpose, basic demographic information is needed including the age and sex of household members (Imhoff-Kunsch *et al.*, 2012).

Using AME to express mean dietary energy consumption in ADePT-FSM

Dietary energy consumption can be expressed "per person", "per capita" or "per AME" basis. The mean dietary energy consumption derived from surveys that measure food consumption at the individual level is expressed on a "per person" basis. Whereas, in HCES, the mean dietary energy consumed is derived from an aggregate value of dietary energy per household, thereby expressed in "per capita" terms. However, as explained above, to reveal meaningful differences across households that differ in their demographic composition, average dietary energy consumption should be expressed "per AME".

ADePT-FSM produces estimates of daily mean dietary energy consumption per capita and per AME for each population group of analysis. An example is shown in Table 42 for *Country 2*. As can be seen, the household size in AME units is smaller because it has been rescaled; consequently, the mean dietary energy consumption per AME is higher than per capita.

Table 42 Dietary energy consumption per capita and per Adult Male Equivalent (AME) in *Country 2*.

	HHs sampled & represented	Average household size	Dietary Energy Consumption (Kcal/capita/day)	Average household AME	Dietary Energy Consumption (Kcal/AME/day)
National	7 419 5 229 645	5.4	2 068	3.8	2 999
Urban	1 698 912 132	4.9	2 179	3.5	3 010
Rural	5 721 4 317 512	5.5	2 047	3.8	2 997
Income Quintile					
Lowest	1 488 1 045 693	6.4	1 329	4.1	2 077
2	1 476 1 045 854	5.9	1 820	4.0	2 754
3	1 483 1 045 784	5.6	2 200	3.9	3 224
4	1 488 1 045 725	5.1	2 490	3.6	3 563
Highest	1 484 1 046 588	4.1	2 860	3.2	3 774

No. HHs, number of households.

5.3 Indicators based on monetary values

When a HCES is conducted over a significant amount of time, such as several months to a year, the monetary value of food and non-food commodities vary over the survey period due to price fluctuations or economic factors. Therefore, when estimating food expenditure, total consumption expenditure, and income, it is important to consider inflation and deflation. If expenditures and income have not been deflated before executing ADePT-FSM, it can be done within the program by adjusting monetary values using monthly deflators (Moltedo *et al.*, 2014). Therefore, when reporting statistics on income and/or expenditures, it is important to report whether the monetary values refer to a yearlong average, a year-end, or a year-beginning.

5.4 Food group level

ADePT-FSM produces food consumption statistics by a food group classification of choice as defined by the analyst when preparing the COUNTRY_NCT input file. When processing HCES, the Statistic Division of the FAO uses the Food Balance Sheet classification (FAO, 2001). Nevertheless, there are other internationally accepted food groupings that might be relevant when processing HCES data. For instance, the 16-food group classification from the dietary diversity questionnaire used as a base to create the Household Dietary Diversity Score (HDDS) or the 12-food group classification of the HDDS (Kennedy *et al.*, 2011), the classification used to derive the Minimum Dietary Diversity for Women (MDD-W) Indicator[57] (FAO and FHI 360, 2016), the Classification of Individual Consumption According to Purpose (COICOP) designed to reflect differences in income elasticities (United Nations Statistics Division, 2016), or the food classification and description system FoodEx2 developed to describe food in data collection across different food safety domains (EFSA, 2015).

The final decision on which food group classification to use should be made by the analyst based on the main purpose of the analysis and on the disaggregation of the survey food list. Following are examples of analyses that the user could perform using statistics derived by ADePT-FSM. The first example employs the FBS food group classification and the second the 16-food group classification from the dietary diversity questionnaire used as a base to create the HDDS.

Food Balance Sheet grouping

If the purpose of the analysis is estimating patterns of food consumption to reconcile FBS and HCES (Grünberger, 2014), the FBS classification (see Table 43) should be used.

[57] The MDD-W indicator was developed by FAO and the FANTA III Project for assessing the quality of the diets of women of reproductive age (FAO and FHI 360, 2016). The questionnaire used to derive this indicator includes 22 mutually exclusive food groups and categories (FAO and FHI 360, 2016), including foods such as red palm oil, and, insects and other small protein foods (for example snails). This classification would be preferred when there is a special interest in analysing consumption of highly-processed products (sweets, sugar-sweetened beverages, and savoury and fried snacks) or insects and other small protein foods, as well as vitamin A and iron rich foods.

Reconciling FBS with HCES is useful across multiple purposes such as identifying under or over reporting in FBS and identifying food items widely available in a country but not included in the food list of the HCES.

The reconciliation between FBS and HCES data could be performed comparing food quantities, dietary energy and/or nutrients. However, the comparison should not be performed using the quantities, dietary energy supply, or nutrients as published by the FAO Corporate Statistical Database (FAOSTAT)[58] but only after having subtracted the food wasted during the retail distribution of food within the food chain. FAO published percentages of food wasted for each food commodity group in different regions around the world (FAO, 2011a).

Furthermore, FBS show food quantities in kilograms of primary commodities (e.g. rice grain and wheat grain). To illustrate, wheat can be available for consumption under the form of grain, flour, or processed food such as bread. FBS publish the total amount of wheat available for consumption in wheat grain equivalents. To do this, the quantities of wheat under the form of flour or processed food are converted into wheat grain equivalents using technical conversion factors such as extraction rates[59] (FAO, 2001). Thus, it is not a good practice to perform the direct comparison of food quantities consumed as derived from HCES with food quantities from FBS. The comparison should be done after the quantities derived from HCES are converted into primary commodity equivalent quantities using technical conversion factors.

FBS and HCES data are used to derive estimates of dietary energy consumption, the former using macro level data at country level (supply perspective) and the latter using household level data (consumption perspective). Both methodologies have advantages and disadvantages, neither being better than the other but rather complementing each other, except in that in per capita basis, the dietary energy supply equals the dietary energy consumption. Therefore, to identify the reasons for discrepancies between supply and consumption, an in-depth analysis should focus on the

[58] See FAOSTAT website: http://faostat3.fao.org/download/FB/FBS/E

[59] Conversion factors can be found at the FAO website: http://www.fao.org/fileadmin/templates/ess/documents/methodology/tcf.pdf

food groups contributing considerably different amounts of dietary energy, the proportion that each food group contributes to the total dietary energy, and/or a dietary energy supply lower than consumption (see Table 44 for an example of this kind of analysis). These reasons typically include: an over or underestimation of the amount of food item produced, traded or used for feed and seed in FBS; in HCES households may wrongly declare quantities of food harvested instead of consumed from own production, the food list within the HCES excludes food items highly consumed in the country or a region (which would therefore not be counted), and/or the survey not capturing the food consumed away from home. However, the comparison of dietary energy by food item should be performed with caution. This is the case of sugar, which is distributed among processed foods (e.g. carbohydrates beverages, juices, pastries, cookies and sweets) and so the dietary energy from refined sugar estimated using HCES should not be compared to the dietary energy available from sugar in FBS.

Table 43 Food group classification used in Food Balance Sheets (FBS).

Code	Food Group
1	Cereals and derived products
2	Roots and tubers and derived products
3	Sugar crops and sweeteners and derived products
4	Pulses and derived products
5	Nuts and derived products
6	Oil-bearing crops and derived products
7	Vegetables and derived products
8	Fruits and derived products
9	Stimulant crops and derived products
10	Spices
11	Alcoholic beverages
12	Meat (including poultry and pork) and derived products
13	Eggs
14	Seafood and derived products
15	Milk cheese and derived products
16	Vegetable oils and fats
17	Animal oils and fats

18	Non-alcoholic beverages
19	Miscellaneous and prepared food

Source: FAO (2001).

Table 44 shows an example comparing total levels of dietary energy consumption (DEC) from HCES data and dietary energy supply (DES) from FBS—after subtracting the food wasted at the retail distribution level—for *Country 5*. The DES from the FBS is 2 215 Kcal/capita/day and the estimated food waste at the retail level is 53 Kcal/capita/day; so, the DES minus the food waste at the retail level is 2 137 Kcal/capita/day, which is higher than the DEC from HCES (2 084 Kcal/capita/day). In the case of cereals, there is a difference of 166 Kcal/capita/day between supply and consumption. A more in depth analysis of this discrepancy (not shown in the tables) revealed that the dietary energy from maize consumption (from HCES data) is 730 Kcal/capita/day, but the national dietary energy supply (as in FBS) from maize is 521 Kcal/capita/day.

Table 44 Daily dietary energy consumption and supply per capita, in *Country 5* using data from a HCES and FBS, respectively, from the same year.

Food group	FBS: Dietary Energy Supply, DES (Kcal)	Waste at the retail level (%)	DES – food wasted (Kcal)	HCES: Dietary Energy Consumption, DEC (Kcal)	Difference: DES – food wasted – DEC (Kcal)
All	2 215		2 137	2 084	53
Cereals and derived products	960	2	941	1 107	-166
Roots and tubers and derived products	317	5	301	232	69
Sugar crops and sweeteners and derived products	97	N/A	97	84	13
Pulses and derived products	201	2	197	97	100
Nuts and derived products	4	N/A	4	32	-28
Oil-bearing crops and derived products	86	2	84	60	24
Vegetables and derived	21	17	17	30	-13

Food group	FBS: Dietary Energy Supply, DES (Kcal)	Waste at the retail level (%)	DES – food wasted (Kcal)	HCES: Dietary Energy Consumption, DEC (Kcal)	Difference: DES – food wasted – DEC (Kcal)
products					
Fruits and derived products	127	17	105	75	30
Stimulant crops and derived products	0	N/A	0	0	0
Spices	3	N/A	3	1	2
Alcoholic beverages	70	N/A	70	52	18
Meat (including poultry and pork) and derived products	42	7	39	54	-15
Eggs	3	N/A	3	5	-2
Seafood and derived products	18	15	15	35	-20
Milk cheese and derived products	54	10	49	24	25
Vegetable oils and fats	196	N/A	196	108	88
Animal oils and fats	16	N/A	16	0	16
Non-alcoholic beverages	N/A	N/A	N/A	5	N/A
Miscellaneous and prepared food	N/A	N/A	N/A	81	N/A

N/A, non-available.

Household Diet Diversity Score classification of 16-groups

If the analyst were interested in focusing the analysis on dietary diversity and/or on vitamin A and iron, the classification used in the food group classification from the dietary diversity questionnaire used as a base to create the HDDS would be more appropriate. The household dietary diversity questionnaire uses a list of 16-food groups[60] and considers differences in the content of vitamin A and iron among food items (Kennedy *et al.*, 2011). Table 45 presents the 16-food group list.

Table 45 Food group classification used in the household dietary diversity questionnaire used to construct the HDDS.

[60] The list is aggregated from 16 to 12 food groups to create the HDDS.

Code	Food group	Examples
1	Cereals	corn/maize, rice, wheat, sorghum, millet or any other grains or foods made from these (i.e. bread, noodles, porridge or other grain products) + insert local foods i.e. ugali, nshima, porridge or paste
2	White roots and tubers	white potatoes, white yam, white cassava, or other foods made from roots
3	Vitamin A rich vegetables and tubers	pumpkin, carrot, squash, or sweet potato that are orange inside + other locally available vitamin A rich vegetables (i.e. red sweet pepper)
4	Dark green leafy vegetables	dark green leafy vegetables, including wild forms + locally available vitamin A rich leaves such as amaranth, cassava leaves, kale, spinach
5	Other vegetables	other vegetables (i.e. tomato, onion, eggplant) + other locally available vegetables
6	Vitamin A rich fruits	ripe mango, cantaloupe, apricot (fresh or dried), ripe papaya, dried peach, and 100% fruit juice made from these + other locally available vitamin A rich fruits
7	Other fruits	other fruits, including wild fruits and 100% fruit juice made from these
8	Organ meat	liver, kidney, heart or other organ meats or blood-based foods
9	Flesh meats	beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds, insects
10	Eggs	eggs from chicken, duck, guinea fowl or any other egg
11	Fish and seafood	fresh or dried fish or shellfish
12	Legumes, nuts and seeds	dried beans, dried peas, lentils, nuts, seeds or foods made from these (e.g. hummus, peanut butter)
13	Milk and milk products	milk, cheese, yogurt or other milk products
14	Oils and fats	oil, fats or butter added to food or used for cooking
15	Sweets	sugar, honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolates, candies, cookies and cakes
16	Spices, condiments, beverages	spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages

Source: Kennedy et al. (2011).

The purpose of the second example is the analysis of the main sources of dietary vitamin A and iron. Table 46 displays estimates of vitamin A and iron consumption by food group and income quintile. The main food sources of vitamin A for all the income quintiles are vegetables and tubers contributing up to 74 percent in poor households (the percentages are not shown in the table). The main sources of iron are cereals, which account for 50 percent of total iron intakes in the richest households and 63 percent in the poorest ones.

Table 46 Daily vitamin A and iron consumption per capita using the food group classification from the household dietary diversity questionnaire in *Country 5*.

	Income Quintile									
	Lowest		2		3		4		Highest	
Food group	Vitamin A (mcg RAE)	Iron (mg)	Vitamin A (mcg RAE)	Iron (mg)	Vitamin A (mcg RAE)	Iron (mg)	Vitamin A (mcg RAE)	Iron (mg)	Vitamin A (mcg RAE)	Iron (mg)
Total	517	12	501	15	575	16	538	17	564	18
Cereals	6	7.6	2	8.8	1	9.3	1	9.3	1	9.0
White roots and tubers	21	1.4	33	1.7	30	1.4	36	1.3	29	1.3
Vitamin A rich vegetables and tubers	384	0.3	330	0.3	403	0.4	344	0.3	308	0.3
Dark green leafy vegetables	65	0.3	69	0.3	62	0.3	62	0.3	70	0.3
Other vegetables	21	0.4	29	0.3	31	0.3	36	0.4	58	0.6
Vitamin A rich fruits	4	0.0	6	0.0	9	0.0	11	0.0	13	0.0
Other fruits	0	0.1	1	0.2	1	0.3	1	0.5	2	0.6
Organ meat	1	0.0	2	0.0	3	0.0	6	0.0	21	0.0
Flesh meats	0	0.1	1	0.2	1	0.2	1	0.3	2	0.7
Eggs	1	0.0	4	0.0	6	0.0	9	0.1	15	0.1
Fish and seafood	1	0.1	2	0.2	2	0.2	3	0.3	2	0.3
Legumes, nuts and seeds	3	1.9	8	2.8	3	3.2	4	3.7	4	4.7
Milk and milk products	9	0.0	13	0.0	22	0.0	23	0.0	34	0.0
Oils and fats	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0
Sweets	0.0	0.0	0	0.1	0	0.1	0	0.2	0	0.3
Spices, condiments, beverages	0	0.0	0	0.1	0	0.2	1	0.2	1	0.3

Food group	Income Quintile									
	Lowest		2		3		4		Highest	
	Vitamin A (mcg RAE)	Iron (mg)	Vitamin A (mcg RAE)	Iron (mg)	Vitamin A (mcg RAE)	Iron (mg)	Vitamin A (mcg RAE)	Iron (mg)	Vitamin A (mcg RAE)	Iron (mg)
Miscellaneous and prepared food	4	0.1	8	0.2	11	0.4	15	0.6	38	1.8

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APPENDICES

Appendix 1 Reporting of folate, iodine, phytate and zinc in food composition tables and databases

Table 47 Food composition tables and databases containing information on folate, iodine, phytate, and zinc by country.

Country / region	Folate* (µg)	Iodine (µg)	Phytate (mg)	Zinc (mg)	Reference
Africa					
Ethiopia	No	No	No	No	Ethiopian Nutrition Institute. 1998. Expanded food composition table for use in Ethiopia. Addis Ababa, Ethiopia.
Gambia	No	No	Yes	Yes	Medical Research Council. 2011. *Food composition table for use in The Gambia*. Cambridge, UK. URL: http://www.fao.org/fileadmin/templates/food_composition/documents/pdf/Gambia04082011.pdf
Kenya	Yes	No	Yes	No	Ministry of Health. 1993. *National food composition tables and the planning of satisfactory diets in Kenya*. Nairobi, Kenya.
Lesotho	Yes	No	No	Yes	Department of Agricultural Research, FAO. 2006. *Lesotho food composition table. Maseru, Lesotho*. URL: http://www.fao.org/infoods/infoods/tables-and-databases/africa/en/
Mali	Yes	No	No	Yes	Barikmo I, Ouattara F, Oshaug A. 2004. *Table de composition d'aliments du Mali*. Akershus University College. Norway. URL: https://www.haugenbok.no/Fagb-ker/Fysioterapi/Table-de-composition-d-aliments-du-Mali/I9788248800187
Mozambique	Yes	No	No	Yes	University of Helsinki. 2011. *Food composition tables for Mozambique*. Mozambique. URL: http://www.fao.org/infoods/infoods/tables-and-databases/africa/en/
Nigeria	Yes	No	No	No	Oguntona E, Akinyele I. 1995. *Nutrient composition of commonly eaten foods in Nigeria - Raw, processed and prepared*. Food Basket Foundation Publication Series. Nigeria.
South Africa	Yes	No	No	Yes	Wolmarans P, Danster N, Dalton A, Rossouw K, Schönfeldt H (eds). 2010. *South African food composition database*. Medical Research Council. Cape Town, South Africa. URL: http://safoods.mrc.ac.za/softwaredisclaimer.htm
Sudan	Yes	No	No	No	Ministry of Health. 1986. *Sudan food composition tables 2 ed*. Khartoum, Sudan.
Tanzania	Yes	No	Yes	Yes	Muhimbili University of Health and Allied Sciences, Tanzania Food and Nutrition Centre, Harvard School of Public Health. 2008. *Tanzania food composition tables. Dar es Salaam, Tanzania*. URL: http://www.hsph.harvard.edu/nutritionsource/food-tables/
Tunisia	Yes	Yes	No	Yes	Institut de Recherche pour le Développement, Institut National de Nutrition et de Technologie Alimentaire. 2007. Table de composition des aliments Tunisiens. Tunisia.
Uganda	Yes	No	No	Yes	Hotz C, Lubowa A, Sison C, Moursi M, Loechl C. 2012. *A food composition table for Central and Eastern Uganda*. HarvestPlus Technical Monograph 9. International Food Policy Research

Country / region	Folate* (µg)	Iodine (µg)	Phytate (mg)	Zinc (mg)	Reference
					Institute (IFPRI), International Center for Tropical Agriculture (CIAT). Washington DC. URL: http://www.harvestplus.org/content/food-composition-table-central-and-eastern-uganda
West Africa	Yes	No	No	Yes	FAO. 2012. *West African food composition table*. URL: http://www.fao.org/documents/card/en/c/238ce5e9-acd5-5cb2-8442-6498506aee1c/
Zimbabwe	Yes	No	No	No	Chitsiku IC. 1989. *Nutritive value of foods of Zimbabwe*. Zambezia 16 (i):67-97. URL: http://www.fao.org/fileadmin/templates/food_composition/documents/regional/zim_food_omposition_table__1_.pdf
Asia					
Bangladesh	Yes	No	Yes	Yes	Shaheen N, Torab A, Mohiduzzaman,Parvin C, Bari L,Basak A, Mannan MA, Bhattacharjee L, Stadlmayr B. 2013. *Food composition table for Bangladesh*. Institute of Nutrition and Food Science, Centre for Advanced Research in Sciences, University of Dhaka. Dhaka, Bangladesh. URL: http://www.fao.org/infoods/infoods/tables-and-databases/asia/en/
Cambodia	Yes	No	No	Yes	Ministry of Agriculture, Forestry and Fisheries of Cambodia, Ministry of Health, Wageningen University. 2013. *Food composition table for Cambodia*. Cambodia. URL: http://www.nutrition-smiling.eu/content/view/full/48718
China	No	No	No	Yes	China Food Composition Network. 2010. *Food composition database*. China. URL: http://www.neasiafoods.org/index.do?language=us
India	Yes	No	Yes	No	Gopala C, Rama Sastri BV, Balasubramanian SC. 1989. *Nutritive value of Indian foods*. National Institute of Nutrition. India. URL: http://www.eeb.cornell.edu/biogeo/nanc/Food_Feed/table%201%20gopalan%20et%20al%201989.pdf
Indonesia	Yes	No	No	Yes	Ministry of Health, Ministry of Education, Wageningen University. 2013. *Food composition table for Indonesia. Indonesia*. URL: http://www.nutrition-smiling.eu/content/view/full/48718
Japan	Yes	Yes	No	Yes	Ministry of Education, Culture, Sports, Science, and Technology. 2015. *Standard tables of food composition in Japan*. Japan. URL: http://www.mext.go.jp/english/science_technology/1347490.htm
Lao	Yes	No	No	Yes	The National Institute of Public Health, Wageningen University. 2013. *Food composition table for Laos*. Lao PDR. URL: http://www.nutrition-smiling.eu/content/view/full/48718
Nepal	No	No	No	No	Ministry of Agriculture Development. 2012. *Food composition table for Nepal*. National Nutrition Program. Kathmandu, Nepal. URL: http://www.nutrition-smiling.eu/content/view/full/48718
Pakistan	No	Yes	No	Yes	Agricultural University Peshawar, UNICEF, Ministry of Planning and Development. 2001. *Food composition table for Pakistan*. Islamabad, Pakistan. URL: http://www.fao.org/infoods/infoods/tables-and-databases/asia/en/
Republic of	No	No	No	No	Rural Development Administration. 2011. *Korean standard food composition table V 8.0.* Suwon,

Country / region	Folate* (µg)	Iodine (µg)	Phytate (mg)	Zinc (mg)	Reference
Korea					Republic of Korea. URL: http://koreanfood.rda.go.kr/eng/fctFoodSrchEng/list
Singapore	No	No	No	No	Health Promotion Board. 2011. *Energy and nutrient composition of food*. Singapore. URL: http://focos.hpb.gov.sg/eservices/ENCF/
South Asia	No	No	No	Yes	Mahidol University. 2014. *ASEAN food composition database V 1.0*. Thailand. URL: http://www.inmu.mahidol.ac.th/aseanfoods/composition_data.html
Thailand	Yes	No	No	Yes	Mahidol University, Wageningen University. 2013. *Food composition table for Thailand*. Thailand. URL: http://www.nutrition-smiling.eu/content/view/full/48718
Thailand	No	No	No	No	Bureau of Nutrition. 2001. *Thai food composition tables.* Thailand. URL: http://nutrition.anamai.moph.go.th/temp/main/view.php?group=1&id=614
Vietnam	Yes	No	No	Yes	National Institute of Nutrition, Wageningen University. 2013. *Food composition table for Vietnam*. Vietnam. URL: http://www.nutrition-smiling.eu/content/view/full/48718
Europe					
Armenia	Yes	Yes	No	Yes	Ministry of Agriculture, National Statistical Office, FAO. 2010. *Armenian food composition table*. Armenia. URL: http://www.fao.org/fileadmin/templates/food_composition/documents/ArmenianFoodCompositionTable2010.pdf
Belgium	No	Yes	No	Yes	Ministry of Health. 2012. *NUBEL - Database of trade names*. Belgium. URL: http://www.internubel.be/
Czech Republic	Yes	Yes	No	Yes	Institute of Agricultural Economics and Information, Food Research Institute Prague. 2015. *Czech food composition database V 5.15*. Czech Centre for Food Composition Database. Czech Republic. URL: http://www.nutridatabaze.cz/en/
Denmark	Yes	Yes	No	Yes	Denmark National Food Institute - Fødevaredatabanken. 2015. *Danish food composition databank.* Denmark. URL: http://frida.fooddata.dk/index.php?lang=en
Estonia	Yes	Yes	No	Yes	National Institute for Health Development. 2014.
Finland	Yes	Yes	No	Yes	National Institute for Health and Welfare. 2011. *Fineli national food composition database. Finland*. URL: https://fineli.fi/fineli/en/index?
France	Yes	Yes	No	Yes	The French agency for food, environmental and occupational health safety. 2013.
Greece	No	No	No	Yes	Hellenic Health Foundation. 2007. *Estonian food composition database*. Estonia. URL: http://tka.nutridata.ee/index.action?request_locale=en
Italy	No	No	No	Yes	Consiglio per la Ricerca in Agricoltura e l'analisi dell'Economia Agraria. 1993. *Tabelle di composizione degli alimenti*. Italy. URL: http://nut.entecra.it/646/tabelle_di_composizione_degli_alimenti.html
Netherlands	Yes	Yes	No	Yes	National Institute for Public Health and the Environment - Ministry of Health, Welfare and Support. 2013. *Dutch food composition database (NEVO) V 4.0*. Netherlands. URL: http://www.rivm.nl/en/Topics/D/Dutch_Food_Composition_Database

Country / region	Folate* (µg)	Iodine (µg)	Phytate (mg)	Zinc (mg)	Reference
Norway	Yes	Yes	No	Yes	Norwegian Food Safety Authority. 2015. *The Norwegian food composition table*. Norway. URL: http://www.matvaretabellen.no/
Portugal	Yes	No	No	Yes	Serviço Nacional de Saúde. 2002. *Food composition table*. Portugal. URL: http://www.insa.pt/sites/INSA/Portugues/AreasCientificas/AlimentNutricao/AplicacoesOnline/TabelaAlimentos/Paginas/TabelaAlimentos.aspx
Spain	Yes	Yes	No	Yes	Ministerio de Ciencia e Innovación, Ministerio de Sanidad, Servicios Sociales e Igualdad. 2010. *Spanish food composition database*. Spain. URL: http://www.bedca.net/bdpub/index.php
Sweden	Yes	No	No	No	National Food Agency. 2009. *The food database*. Sweden. URL: http://www.livsmedelsverket.se/en/food-and-content/naringsamnen/livsmedelsdatabasen/
Switzerland	Yes	Yes	No	Yes	Swiss Federal Office of Public Health. 2015. *Swish food composition database V 5.2.* Switzerland. URL: http://www.naehrwertdaten.ch/request?xml=MessageData&xml=MetaData&xsl=Start&lan=de&pageKey=Start
Turkey	Yes	Yes	No	Yes	Ministry of Health, Ministry of Food, Agriculture and Livestock, TÜBİTAK- MAM Food Institute. 2014. *Turkish food composition database. Turkey*. URL: http://www.turkomp.gov.tr/
United Kingdom	Yes	Yes	No	Yes	Finglas P, Roe M, Pinchen H, Berry R, Church S, Dodhia S, Powell N, Farron-Wilson M, McCardle J, Swan G. 2015. *Composition of foods integrated dataset (CoFID).* Public Health England. United Kingdom. URL: https://www.gov.uk/government/publications/composition-of-foods-integrated-dataset-cofid?utm_source=MW7+List+March+2015&utm_campaign=947c9d4b28-Newsletter_2_December_2013_FINAL12_13_2013&utm_medium=email&utm_term=0_3b8ecbdaea-947c9d4b28-95444717
Latin America					
Argentina	No	No	No	Yes	Universidad Nacional de Luján. 2010. *Tablas nacionales de composición de alimentos. Argentina*. URL: http://www.unlu.edu.ar/~argenfoods/Tablas/Tabla.htm
Bolivia	Yes	No	No	Yes	Ministerio de Salud y Deportes. 2005. *Tabla Boliviana de composición de alimentos*. Bolivia.
Brazil	No	No	No	No	Universidade de São Paulo. 2008. *Tabela Brasileira de composição de alimentos (TBCA-USP).* Brazil. URL: http://www.intranet.fcf.usp.br/tabela/
Brazil	No	No	No	Yes	UNICAMP. 2011. *TACO - Tabela Brasileira de composição de alimentos 4. ed*. Brazil. URL: http://www.unicamp.br/nepa/taco/
Brazil	No	No	No	No	Ministério da Saúde. 2015. *Alimentos regionais brasileiros 2. ed*. Brazil. URL: http://189.28.128.100/dab/docs/portaldab/publicacoes/livro_alimentos_regionais_brasileiros.pdf
Brazil	No	No	No	No	Rodrigues-Amaya, Délia B. 2008. Tabela Brasileira de Composição de Carotenóides em Alimentos. Ministério do Meio Ambiente. Brazil. http://www.mma.gov.br/estruturas/sbf_agrobio/_publicacao/89_publicacao09032009113306.pdf

Country / region	Folate* (µg)	Iodine (µg)	Phytate (mg)	Zinc (mg)	Reference
Central America	Yes	No	No	Yes	Menchú M, Méndez, H (eds). 2007. *Tabla de composición de alimentos de Centroamérica 2. ed*. INCAP. Guatemala. URL: http://www.incap.int/biblio/index.php/es/publi-a-la-venta/843-tabla-de-composicion-de-alimentos-de-centroamerica2
Chile	No	No	No	Yes	Schmidt-Hebbel H, Pennacchiotti I, Masson L, Mella M. 1990. *Tabla de composición química de alimentos Chilenos 8. ed*. Facultad de Ciencias Químicas y Farmacéuticas - Universidad de Chile. Chile. URL: http://www.libros.uchile.cl/files/presses/1/monographs/426/submission/proof/files/assets/common/downloads/publication.pdf
Colombia	No	Yes	No	Yes	Ministerio de Salud Pública. 1978. *Tabla de composición de alimentos colombianos*. Bogota, Colombia. URL: http://alimentoscolombianos.icbf.gov.co/alimentos_colombianos/consulta_alimento.asp
Costa Rica	No	No	No	No	Monge R, Campos N. 2013, 2006. *Tablas de composición de alimentos de Costa Rica: ácidos grasos, y carotenoides y tocoferoles*. INCIENSA. Costa Rica. URL: http://www.inciensa.sa.cr/actualidad/Tabla%20Composicion%20Alimentos.aspx
Latin America	No	No	No	Yes	LATINFOODS. 1997. *Tabla de composición de alimentos de América Latina*. Latin America.
Mexico	Yes	No	No	Yes	Chávez A, Ledesma J, Mendoza E, et al. 2014. *Tablas de uso práctico de los alimentos de mayor consumo "Miriam Muñoz" 3*. ed. McGraw-Hill. Mexico.
Peru	No	No	No	Yes	García M, Gómez-Sánchez I, Espinoza C. 2013. Tablas peruanas de composición de alimentos. Ministerio de Salud, Instituto Nacional de Salud. Lima, Peru. http://www.bvs.ins.gob.pe/insprint/CENAN/Tablas_peruanas_composici%C3%B3n_alimentos_2013.pdf
Peru	No	No	No	No	Ministerio de Salud. 1993. *Tabla de composición de alimentos industrializados*. Lima, Peru. URL: http://cienciaysalud.laverdad.es/lanutricionesconciencia/03-Alimentos/Complementario/TablaComposicionalimentosIndustrializados.pdf
Uruguay	No	No	No	Yes	Ministerio de Trabajo y Seguridad Social. 2002. *Tabla de composición de alimentos de Uruguay*. Montevideo, Uruguay. URL: http://www.mercadomodelo.net/c/document_library/get_file?uuid=4b90584d-ab86-4546-a5c8-fca03188a4b1&groupId=10157
Venezuela	No	No	No	Yes	Ministerio del Poder Popular para la Alimentación. 1999. *Tabla de composición de alimentos de Venezuela*. Venezuela. URL: http://www.slan.org.ve/publicaciones/completas/evolucion_tabla_composicion_alimentos_venezuela.asp#top"
Middle East					

Country / region	Folate* (µg)	Iodine (µg)	Phytate (mg)	Zinc (mg)	Reference
Bahrain	Yes	Yes	No	Yes	Arab Center for Nutrition. 2011. *Food composition tables for Kingdom of Bahrain*. Bahrain. URL: http://www.acnut.com/v/index.php?option=com_content&view=article&id=521%3Afood-compositon-tables-for-kingdom-of-bahrain-&catid=70%3Apublications&Itemid=147&lang=en
North America					
Canada	Yes	No	No	Yes	Health Canada. 2015. *The Canadian Nutrient File*. Canada. URL: http://www.hc-sc.gc.ca/fn-an/nutrition/fiche-nutri-data/index-eng.php
United States of America	Yes	No	No	Yes	USDA. 2015. *USDA national nutrient database for standard reference V 28*. United States. URL: https://ndb.nal.usda.gov/
Oceania					
Australia	Yes	Yes	No	Yes	Food Standards Australia New Zealand. 2010. *Nutrient tables for use in Australia (NUTTAB) online searchable database*. Australia. URL: http://www.foodstandards.gov.au/science/monitoringnutrients/nutrientables/nuttab/Pages/default.aspx
New Zealand	Yes	Yes	No	Yes	Ministry of Health. 2015. *New Zealand food composition database*. The New Zealand Institute for Plant & Food Research. New Zealand. URL: http://www.foodcomposition.co.nz/
Pacific Islands	No	No	No	No	Dignan CA, Burlingame C, Kumar S, Aalbersberg W. 2004. *Pacific Islands food composition tables 2. ed*. FAO. URL: ftp://ftp.fao.org/docrep/fao/007/y5432e/y5432e00.pdf

* Folate as dietary folate equivalents, total folate, food folate and/or folic acid.

Total number of FCTs/FCDBs reviewed = 68

Table 48 Number of FCTs/FCDBs reporting folate, iodine, phytate and zinc, by region.

Country	Folate*	Iodine	Phytate	Zinc
Africa (n=14)	12	1	3	9
Asia (n=15)	8	2	2	10
Europe (n=17)	14	13	0	16
Latin America (n=16)	3	1	0	11
Middle East (n=1)	1	1	0	1
North America (n=2)	2	0	0	2
Oceania (n=3)	2	2	0	2
All regions (n= 68)	42	20	5	51

* Folate as dietary folate equivalents, total folate, food folate, and/or folic acid.

Appendix 2 Reporting of vitamin A in food composition tables and databases

Table 49 Food composition tables and databases containing information on total vitamin A (in IU, RE, RAE, and undefined), retinol, β-carotene, β-carotene equivalents, and other provitamin A carotenes (α-carotene and β–cryptoxantin), by country.

Country / Region	Total vitamin A				Retinol (µg)	β-carotene (µg)	β-carotene eqs. (µg)	Other provitamin A carotenes (µg)	Remarks	Citation
	IU	RE	RAE	Vitamin A undefined						
Africa										
Ethiopia	No	Yes	No	No	No	No	No	No	Total vitamin A is expressed as RE. It seems to only reflect beta-carotene values, but not retinol.	Ethiopian Nutrition Institute. 1998.
Gambia	No	No	No	No	No	No	Yes	No	The FCT/FCD reports carotene expressed as beta-carotene equivalents (<CARBEQ>).	Medical Research Council. 2011.
Kenya	No	No	No	No	Yes (see remarks)	Yes	No	No	Retinol is expressed in IU. Beta-carotene is expressed in mcg.	Ministry of Health. 1993.
Lesotho	No	Yes (see remarks)	No	No	No	Yes	No	No	The documentation states that total vitamin A is expressed as RAE, however the values published appear to be RE. Documentation for carotene does not specify if it is beta-carotene or beta-carotene. equivalents.	Department of Agricultural Research, FAO. 2006.
Mali	No	No	Yes (see remarks)	No	Yes	Yes	No	No	Documentation states total vitamin A is expressed as RE, but the formula used is for RAE. It is assumed that it is RAE. It also reports retinol and beta-carotene.	Barikmo I, Ouattara F, Oshaug A. 2004.
Mozambique	No	No	Yes	No	Yes	Yes	No	Yes	The FCT/FCD reports beta-carotene, alpha-carotene, cryptoxanthin, Lycopene, Lutein. Total vitamin A is expressed as	University of Helsinki. 2011.

Country / Region	Total vitamin A: IU	RE	RAE	Vitamin A undefined	Retinol (µg)	β-carotene (µg)	β-carotene eqs. (µg)	Other provitamin A carotenes (µg)	Remarks	Citation
									RAE.	
Nigeria	No	No	No	No	Yes	Yes	No	Yes		Oguntona E, Akinyele I. 1995.
South Africa	No	Yes	No	No	No	No	No	No	The FCT/FCD reports total vitamin A in RE.	Wolmarans P, Danster N, Dalton A, Rossouw K, Schönfeldt H (eds). 2010.
Sudan	No	No	No	No	No	No	No	No		Ministry of Health. 1986.
Tanzania	No	No	Yes	No	Yes (see remarks)	No	No	No	The FCT/FCD reports total vitamin A (including animal and plant sources) in RAE. Animal-source vitamin A is expressed in RE, however, this is taken to be retinol.	Muhimbili University of Health and Allied Sciences, Tanzania Food and Nutrition Centre, Harvard School of Public Health. 2008.
Tunisia	No	Yes	No	No	No	Yes	No	Yes	The unit of expression of total vitamin A is not clearly defined. It is assumed that it is expressed as RE. However, if this table is to be used it is suggested to contact the authors of the FCT/FCD for clarification.	Institut de Recherche pour le Développement, Institut National de Nutrition et de Technologie Alimentaire. 2007.
Uganda	Yes	No	Yes	No	Yes	Yes	No	Yes	The FCT/FCD reports IU, RAE, retinol, beta-carotene, alpha-carotene and beta-cryptoxanthin.	Hotz C, Lubowa A, Sison C, Moursi M, Loechl C. 2012.
West Africa	No	No	Yes	No	Yes	No	Yes	No	The FCT/FCD reports total vitamin A in RAE (<VITA_RAE>), retinol	FAO. 2012.

Country / Region	Total vitamin A				Retinol (µg)	β-carotene (µg)	β-carotene eqs. (µg)	Other provitamin A carotenes (µg)	Remarks	Citation
	IU	RE	RAE	Vitamin A undefined						
									(<RETOL>) and beta-carotene equivalents (<CARTBEQ>) or [beta-carotene (<CARTB>)].	
Zimbabwe	No	Yes	No	No	No	No	No	No	Total vitamin A is expressed as RE.	Chitsiku IC. 1989.
Asia										
Bangladesh	No	No	Yes	No	Yes	No	Yes	No	The FCT/FCD reports total vitamin A in RAE (<VITA_RAE>), retinol (<RETOL>) and beta-carotene equivalents (<CARTBEQ>) or [beta-carotene (<CARTB>)].	Shaheen N, Torab A, Mohiduzzaman,Parvin C, Bari L,Basak A, Mannan MA, Bhattacharjee L, Stadlmayr B. 2013.
Cambodia	No	No	Yes	No	Yes	Yes	Yes	Yes	The FCT/FCD reports RAE (<VITA_RAE>), retinol (<RETOL>), beta-carotene (<CARTB>), alpha-carotene <CARTA> and beta-carotene equivalents (<CARTBEQ>).	Ministry of Agriculture, Forestry and Fisheries of Cambodia, Ministry of Health, Wageningen University. 2013.
China	No	Yes	No	No	No	No	No	No		China Food Composition Network. 2010.
India	No	No	No	Yes (see remarks)	No	Yes (see remarks)	No	No	The FCT/FCD reports beta-carotene. Total vitamin A is included for animal products; it is not clearly defined but may be calculated neither as RE nor RAE but as retinol + 1/4beta-carotene.	Gopala C, Rama Sastri BV, Balasubramanian SC. 1989.
Indonesia	No	No	Yes	No	Yes	Yes	No	Yes	The FCT/FCD reports total vitamin A in RAE (<VITA_RAE>), retinol	Ministry of Health, Ministry of Education,

Country / Region	Total vitamin A: IU	RE	RAE	Vitamin A undefined	Retinol (µg)	β-carotene (µg)	β-carotene eqs. (µg)	Other provitamin A carotenes (µg)	Remarks	Citation
									(<RETOL>), beta-carotene (<CARTB>) and other carotenes.	Wageningen University. 2013.
Japan	No	No	Yes	No	Yes	Yes	Yes	Yes	The FCT/FCD reports total vitamin A in RAE (<VITA_RAE>), retinol (<RETOL>), beta-carotene (<CARTB>), alpha-carotene <CARTA>, beta-cryptoxanthin (<CRYPXB>) and beta-carotene equivalents (<CARTBEQ>).	Ministry of Education, Culture, Sports, Science, and Technology. 2015.
Laos	No	Yes	No	No	Yes	No	No	No	The FCT/FCD reports total vitamin A in RAE (<VITA>) and retinol (<RETOL>).	The National Institute of Public Health, Wageningen University. 2013.
Nepal	No	No	No	No	No	No	No	No	The FCT/FCD reports "carotene", but it is not clear if this is beta-carotene, beta-carotene equivalents or total carotenoids.	Ministry of Agriculture Development. 2012.
Pakistan	No	No	No	Yes (see remarks)	No	Yes	No	No	The FCT/FCD purportedly reports total vitamin A in RE, however, it is not clear from the data how it was calculated.	Agricultural University Peshawar, UNICEF, Ministry of Planning and Development. 2001.
Republic of Korea	No	Yes	No	No	Yes	Yes	No	No		Rural Development Administration. 2011.
Singapore	No	No	No	Yes (see remarks)	No	Yes	No	No	The FCT/FCD reports total vitamin A, but the unit of expression is not known.	Health Promotion Board. 2011.
South Asia	No	No	Yes	No	Yes	Yes	No	No	The FCT/FCD reports total vitamin A in RAE (<VITA_RAE>), retinol (<RETOL>) and beta-carotene	Mahidol University. 2014.

Country / Region	Total vitamin A				Retinol (µg)	β-carotene (µg)	β-carotene eqs. (µg)	Other provitamin A carotenes (µg)	Remarks	Citation
	IU	RE	RAE	Vitamin A undefined						
									(<CARTB>).	
Thailand	No	No	Yes	No	Yes	Yes	No	No	The FCT/FCD reports total vitamin A in RAE (<VITA_RAE>), retinol (<RETOL>) and beta-carotene (<CARTB>).	Mahidol University, Wageningen University. 2013.
Thailand	No	Yes	No	No	Yes	Yes	No	No	The FCT/FCD reports total vitamin A in RE, retinol and beta-carotene. It does not state how RE was calculated.	Bureau of Nutrition. 2001.
Vietnam	No	Yes	Yes	No	No	No	No	No	The FCT/FCD reports total vitamin A in RAE (<VITA_RAE>) and RE (<VITA>).	National Institute of Nutrition, Wageningen University. 2013.
Europe										
Armenia	No	No	Yes	No	Yes	No	Yes	No	The FCT/FCD reports total vitamin A in RAE (<VITA_RAE>), retinol (<RETOL>) and beta-carotene (<CARTB>).	Ministry of Agriculture, National Statistical Office, FAO. 2010.
Belgium	No	No	No	Yes (see remarks)	No	No	No	No	The FCT/FCD reports "vitamin A activity" but it's not specified if it is expressed in RE or RAE. By looking at the data, it is assumed to be RAE.	Ministry of Health. 2012.
Czech Republic	No	No	Yes (see remarks)	No	Yes	Yes	No	No	It reports RE, but the formula used to calculate total vitamin A is that of RAE.	Institute of Agricultural Economics and Information, Food Research Institute

Country / Region	Total vitamin A				Retinol (μg)	β-carotene (μg)	β-carotene eqs. (μg)	Other provitamin A carotenes (μg)	Remarks	Citation
	IU	RE	RAE	Vitamin A undefined						
										Prague. 2015.
Denmark	No	No	Yes	No	Yes	Yes	No	No	The FCT/FCD reports total vitamin A in RAE, retinol and beta-carotene.	Denmark National Food Institute - Fødevaredatabanken. 2015.
Estonia	No	No	Yes (see remarks)	No	Yes	No	Yes	No	The FCT/FCD reports total vitamin A, retinol and beta-carotene equivalents. The formula used to calculate total vitamin A is that of RAE.	National Institute for Health Development. 2014.
Finland	No	No	Yes	No	No	No	No	No	The FCT/FCD reports total vitamin A in RAE and carotenoids. The sum of carotenoids includes the total amount of all carotenoids: beta-carotene, alfa-carotene, canthaxanthin, lycopene, cryptoxanthin and lutein. Some carotenoids are provitamin A, but not all.	National Institute for Health and Welfare. 2011.
France	No	No	No	No	Yes	Yes	No	No	The FCT/FCD reports retinol and beta-carotene.	The French agency for food, environmental and occupational health safety . 2013.
Greece	No	Yes	No	No	Yes	No	Yes	No	Total vitamin A in RE, retinol and beta-carotene equivalents are reported.	Hellenic Health Foundation. 2007.
Italy	No	Yes	No	No	No	No	No	No	The FCT/FCD reports total vitamin A in RE.	Consiglio per la Ricerca in Agricoltura e l'analisi dell'Economia Agraria. 1993.

Country / Region	Total vitamin A: IU	RE	RAE	Vitamin A undefined	Retinol (µg)	β-carotene (µg)	β-carotene eqs. (µg)	Other provitamin A carotenes (µg)	Remarks	Citation
Netherlands	No	Yes	No	No	Yes	Yes	Yes	No	The FCT/FCD reports total vitamin A in RE and REA, retinol, alpha-carotene, beta-carotene and beta-cryptoxantin.	National Institute for Public Health and the Environment - Ministry of Health, Welfare and Support. 2013.
Norway	No	No	Yes	No	Yes	Yes	No	No	The FCT/FCD reports total vitamin A in RAE, retinol and beta-carotene.	Norwegian Food Safety Authority. 2015.
Portugal	No	Yes	No	No	No	No	No	No	The FCT/FCD reports total vitamin A in RE, and carotene. Carotene is defined as the total of carotenoids with vitamin A activity expressed in µg of carotene; it's likely that this is beta-carotene equivalents, but it'd be necessary to contact the authors of the table (at tabela.alimentos@insa.min-saude.pt) to confirm.	Serviço Nacional de Saúde. 2002.
Spain	No	Yes	No	No	No	No	No	No	The FCT/FCD reports total vitamin A in RE.	Ministerio de Ciencia e Innovación, Ministerio de Sanidad, Servicios Sociales e Igualdad. 2010.
Sweden	No	Yes	No	No	Yes	Yes	No	No	The FCT/FCD reports total vitamin A in RE, retinol and beta-carotene.	National Food Agency. 2009.
Switzerland	No	Yes	No	No	No	Yes	Yes	No	The FCT/FCD reports total vitamin A in RE, retinol, beta-carotene and beta-carotene equivalents.	Swiss Federal Office of Public Health. 2015.

Country / Region	Total vitamin A: IU	RE	RAE	Vitamin A undefined	Retinol (µg)	β-carotene (µg)	β-carotene eqs. (µg)	Other provitamin A carotenes (µg)	Remarks	Citation
Turkey	No	No	Yes	No	Yes	Yes	No	Yes	The FCT/FCD reports total vitamin A in RAE (it states that it's RE, but the formula used to calculate it is that of RAE), retinol, beta-carotene and other carotenoids.	Ministry of Health, Ministry of Food, Agriculture and Livestock, TÜBİTAK- MAM Food Institute. 2014.
United Kingdom	No	Yes	No	No	Yes (see remarks)	No	Yes	No	The FCT/FCD reports total vitamin A in RE, retinol (expressed as the weight of all-trans-retinol equivalent; which is slightly lower than the standard definition) and beta-carotene equivalents.	Finglas P, Roe M, Pinchen H, Berry R, Church S, Dodhia S, Powell N, Farron-Wilson M, McCardle J, Swan G. 2015.
Latin America										
Argentina	No	No	No	No	No	No	No	No		Universidad Nacional de Luján. 2010.
Bolivia	No	No	No	Yes (see remarks)	No	No	No	No	The FCT/FCD reports total vitamin A but the mode of expression is not clear.	Ministerio de Salud y Deportes. 2005.
Brazil	No	Yes	No	No	No	No	No	No		Universidade de São Paulo. 2008.
Brazil	No	Yes	Yes	No	Yes	No	No	No	The FCT/FCD reports total vitamin A in RAE and RE, and retinol.	UNICAMP. 2011.
Brazil	No	No	No	No	Yes	No	No	No	The FCT/FCD reports retinol.	Ministério da Saúde. 2015.
Brazil	No	No	Yes	No	No	Yes	No	Yes	The FCT/FCD reports RAE, beta-carotene, alpha-carotene, beta-cryptoxantin, and other carotenoids.	Rodrigues-Amaya, Délia B. 2008.

Country / Region	Total vitamin A				Retinol (µg)	β-carotene (µg)	β-carotene eqs. (µg)	Other provitamin A carotenes (µg)	Remarks	Citation
	IU	RE	RAE	Vitamin A undefined						
Central America	No	No	No	Yes (see remarks)	No	No	No	No	The FCT/FCD reports total vitamin A but the mode of expression is not clear.	Menchú M, Méndez, H (eds). 2007.
Chile	Yes	Yes	No	No	No	No	No	No	The FCT/FCD reports total vitamin A in IU and RE.	Schmidt-Hebbel H, Pennacchiotti I, Masson L, Mella M. 1990.
Colombia	No	Yes (see remarks)	No	No	No	No	No	No	The FCT/FCD reports total vitamin A, but the unit of expression is not known. It is assumed that it is RE.	Ministerio de Salud Pública. 1978.
Costa Rica	No	No	No	No	No	Yes	No	Yes	The FCT/FCD reports beta-carotene (<CARTB>), alpha-carotene (<CARTA>), cryptoxanthin (<CRYPX>), and other carotenoids.	Monge R, Campos N. 2013, 2006.
Latin America	No	No (see remarks)	No (see remarks)	No	No	No	No	No	The FCT/FCD reports total vitamin A (mcg), using a conversion factor of 1/4 for beta-carotene and 1/8 for other carotenes.	LATINFOODS. 1997.
Mexico	No	No	Yes	No	Yes	No	No	No		Chávez A, Ledesma J, Mendoza E, et al. 2014.
Peru	No	No	No	Yes (see remarks)	Yes	No	Yes	No	The FCT/FCD reports total vitamin A as RE, retinol and beta-carotene equivalents. However, there seems to be an error in the way these are reported, as some plant foods (e.g. carrots) present large amounts of retinol and no beta-carotene. It is advisable to contact the authors of this table	García M, Gómez-Sánchez I, Espinoza C. 2013.

Country / Region	Total vitamin A IU	RE	RAE	Vitamin A undefined	Retinol (μg)	β-carotene (μg)	β-carotene eqs. (μg)	Other provitamin A carotenes (μg)	Remarks	Citation
									prior to its use for a vitamin A analysis.	
Peru	No	No	No	No	No	No	No	No		Ministerio de Salud. 1993.
Uruguay	No	Yes	No	No	No	No	Yes	No	The FCT/FCD reports RE (<VITA>) and beta-carotene equivalents (<CARTBQ>).	Ministerio de Trabajo y Seguridad Social. 2002.
Venezuela	No	Yes	No	No	No	See remarks	No	No	The FCT/FCD reports total vitamin A in RE and carotene. It is not clear what carotene refers to.	Ministerio del Poder Popular para la Alimentación. 1999.
Middle East										
Bahrain	No	No	No	No	Yes	No	No	No	The FCT/FCD reports retinol.	Arab Center for Nutrition. 2011.
North America										
Canada	No	No	Yes	No	Yes	Yes	No	Yes		Health Canada. 2015.
United States of America	Yes	No	Yes	No	Yes	Yes	No	Yes		USDA. 2015.
Oceania										
Australia	No	Yes	No	No	Yes	Yes	Yes	Yes	The FCT/FCD reports total vitamin A in RE, retinol, beta-carotene, beta-carotene equivalents, alpha-carotene and cryptoxanthin	Food Standards Australia New Zealand. 2010.

Country / Region	Total vitamin A: IU	RE	RAE	Vitamin A undefined	Retinol (µg)	β-carotene (µg)	β-carotene eqs. (µg)	Other provitamin A carotenes (µg)	Remarks	Citation
New Zealand	No	Yes	No	No	Yes	No	Yes	No	The FCT/FCD reports total vitamin A in RE (<VITA>), retinol (<RETOL>) and beta-carotene equivalents (<CARTBEQ>).	Ministry of Health. 2015.
Pacific Islands	No	No	Yes (see remarks)	No	Yes	No	Yes	No	The FCT/FCD reports total vitamin A in RAE (although it incorrectly uses the Tagname for RE), retinol (<RETOL>) and beta-carotene equivalents (<CARTBEQ>).	Dignan CA, Burlingame C, Kumar S, Aalbersberg W. 2004.

IU, International Units; RE, Retinol Equivalents; RAE, Retinol Activity Equivalents.

Table 50 Number of FCTs/FCDBs reporting total vitamin A (in IU, RE, RAE, or undefined), retinol, β-carotene, β-carotene equivalents, and other provitamin A carotenoids (α-carotene and β–cryptoxantin), by region.

INFOODS Tagname	RETOL	CARTB	CARTBEQ	CARTA CRYPXB	VITAA	VITA	VITA_RAE	VITA-
Unit of expression REGION	Retinol (µg)	Beta-carotene (µg)	Beta-carotene equivalents (µg)	Other provitamin A carotenoids (µg)	IU	RE	RAE	Undefined
Africa (n=14)	7	7	2	4	1	5	5	0
Asia (n=15)	9	10	3	3	0	5	7	3
Europe (n=17)	11	8	6	1	0	8	7	1
Latin America (n=16)	4	2	2	2	1	6	3	3
Middle East (n=1)	1	0	0	0	0	0	0	0
North America (n=2)	2	2	0	2	1	0	2	0
Oceania (n=3)	3	1	3	1	0	2	1	0
All regions (n= 69)	37	30	16	13	3	26	25	7

Table 51 Number of FCT/FCD that express total vitamin A in IU, RE, RAE, or in both RE and RAE, by region.

Unit of expression	Only IU	Only RE	Only RAE	RE and RAE
Africa (n=14)	0	5	5	0
Asia (n=15)	0	4	6	1
Europe (n=17)	0	8	7	0
Latin America (n=16)	0	5	2	1
Middle East (n=1)	0	0	0	0
North America (n=2)	0	0	2	0
Oceania (n=3)	0	2	1	0
All regions (n=69)	0	24	23	2

Appendix 3 Guide to improve classification of problematic food items

In the computation of the HCES-DDS, each food group counts as 1 point towards the overall score regardless of how many foods fall into that food group (i.e. the score is not weighted by the number of foods falling into a given food group).

- when necessary, make attempts to not falsely inflate food group diversity by counting a food group as consumed when/if there is some doubt;
- if a food item is a mixed dish that contains an animal-source food, it should be counted under the corresponding animal-source food group (and not under plant-source foods);
- if food items are poorly described, they should not be counted towards the final score.

Table 52 presents some food classification challenges which have been adapted from the Minimum Dietary Diversity for Women: A Guide for Measurement (FAO and FHI 360, 2016). A standard approach is recommended for the classification of food items to minimize the number of items misclassified or not classified at all. The classification decisions follow three principles:

- when necessary, make attempts to not falsely inflate food group diversity by counting a food group as consumed when/if there is some doubt;
- if a food item is a mixed dish that contains an animal-source food, it should be counted under the corresponding animal-source food group (and not under plant-source foods);
- if food items are poorly described, they should not be counted towards the final score.

Table 52 How to classify problematic food items in HCES.

Problematic food items	Questionnaire category and comments
Well defined food items	
Avocado	"Other fruits"
Blended (fortified) foods, such as corn-soy blend, wheat-soy blend, donated commodities or local	Classify with main ingredient (usually cereals).

Problematic food items	Questionnaire category and comments
blends/fortified cereals	
Bread	"Cereals"
Chilli peppers, red and green	"Spices, condiments, and beverages"
Coconut flesh	"Other fruits"
Coconut milk[61]	"Spices, condiments, and beverages" or "oils and fats"
Coconut water	"Spices, condiments, and beverages"
Coffee, sweetened, with or without milk or cream	"Sweets", though the amount of milk or cream can vary and be high, very often it is not, and this classification is intended to avoid the risk of falsely inflating the proportion of households reported to apparently consume the nutrient-dense dairy group.
Coffee, unsweetened, with or without milk or cream	"Spices, condiments, and beverages". Rationale as above.
Doughnuts (fried dough)	"Oils and fats"
Dried soup seasoning packets	"Spices, condiments, and beverages". These may be rehydrated and consumed as a main dish in a meal, but are not nutritionally very different from bouillon cubes. They are typically high in sodium and, if they contain dried vegetables, the amounts are typically very small, particularly for lower-cost products.
Fish powder	"Spices, condiments, and beverages".
Fortified foods and products	Classify as if unfortified with main ingredient. For example, fortified oil should be classified with "Other oils and fats".
Fruit juices (100% fruit)	If it is known that 100% fruit juice is commonly consumed, this can be placed in the "vitamin A-rich fruits" (e.g. mango juice) or "other fruits" group, depending on the type of fruit. If this is not certain or feasible, all juices should be placed in the "sweets" category.
Fruits, canned with sugar syrup	"Sweets"
Garlic	"Spices, condiments, and beverages"
Herbs	"Spices, condiments, and beverages"
Ice cream	"Sweets"
Olives	"Spices, condiments, and beverages"

[61] In some areas (particularly poor rural areas), coconut milk may be the predominant fat source in the diet, and there may be an interest in including this in the "oils and fats" category. In other areas, particularly where coconut milk is typically thinned with water, it is more appropriate to consider in the "spices, condiments, and beverages" category.

Problematic food items	Questionnaire category and comments
Palm fruit	"Vitamin A-rich fruits". Note that this may be referred to as "palm nut" in some cuisines because the entire pulp-covered kernel is cooked in stews. It is the oily flesh/pulp of the fruit that is high in vitamin A.
Pastries	"Sweets"
Pickles	"Spices, condiments, and beverages"
Samosas and similar savoury fried pastries	"Oils and fats"
Seaweed	"Other vegetables". Most species/varieties are not vitamin A-rich, but a few are. If a locally consumed type of seaweed is known to be vitamin A-rich (defined as ≥120 RE/100 g, in form as eaten), it can be classified with "dark green leafy vegetables".
Snails and/or insects	"Flesh meats"
Sweet bread	"Sweets"
Sweetened condensed milk	"Sweets"
Sweet drinks with milk (e.g. drinks made with milk and chocolate powder, including fortified powders; sweet tea or coffee with milk)	"Sweets". Though such drinks will provide varying amounts of dairy, they are classified as sweets to avoid the risk of falsely inflating the proportion of households reported to apparently consume the nutrient-dense dairy group because often the amount of dairy is small.
Tea, sweetened, with or without milk	"Sweets". Rationale as for coffee, sweetened, with or without milk or cream.
Tea, unsweetened, with or without milk	"Spices, condiments, and beverages". Rationale as above.
Tomato paste	"Spices, condiments, and beverages"
Vegetable juices (100%)	The issue is the same as for fruit juices. If 100% vegetable juice is commonly consumed, this can be placed in the "Vitamin A rich vegetables and tubers" (e.g. carrot juice) or "other vegetables" group, depending on the type of vegetable. If this is not certain or not feasible, all juices should be placed in the "sweets" category.
Not well defined food items	
Fruit juices, ice-cream and/or non-alcoholic beverages	"Sweets"
Mixed dishes specifying main ingredients (e.g. beef stew with vegetables; tacos with meat; empanadas; toasts with guacamole and beans; chicken with rice)	By construction, in ADePT-FSM food items that contain foods belonging to different groups (e.g. mixed dishes) can **only** be counted as one food group, even if the list of ingredients of the food item is known. If the mixed dish includes an animal-source food, classify under the correspondent group ("meat", "eggs", "fish and seafood" or "milk and milk products"). Otherwise, classify according to main plant-source ingredient, e.g.

Problematic food items	Questionnaire category and comments
	legumes, vegetables. However, if the mixed dish is known to be primarily a starchy staple, then classify as "White roots and tubers".
Plantain and sweet banana	This food item represents two foods belonging to different food groups. This can be classified according to the commodity more largely consumed in the country. If plantain is more consumed place it in "white roots and tubers." If sweet banana is more consumed, place it in "other fruits." If it is not certain, place it in the "white roots and tubers" group.
Sweet potato	This can be placed in the "white roots and tubers" or "vitamin A vegetables and tubers", depending on the main type of sweet potato consumed in the country. Note that orange-sweet potatoes have a colour that ranges from yellow-orange to reddish and are rich in vitamin A. White sweet potatoes should be placed in the "white roots and tubers" group. If it is not certain, place in the "white roots and tubers" group.
Potatoes and sweet potatoes	This food item represents two foods belonging to different food groups. This can be classified based on which of the two commodities is more largely consumed in the country. If potatoes and/or white sweet potatoes are more consumed, place in "white roots and tubers". If orange-sweet potatoes are more consumed place in "vitamin A vegetables and tubers". If it is not certain, place in the "white roots and tubers" group.
Street foods/other mixed foods prepared outside the home broadly defined (e.g. "lunch", "snack", "meal", "dinner")	The list of ingredients is not known, so these items **cannot be** classified.

Appendix 4 Classification of households into terciles of the HCES-DDS

The three examples below show hypothetical cases of the distribution of households according to their HCES-DDS — where the maximum number of reported food groups is 12. Table 53 shows Example 1, where the percentiles 33.33 and 66.66 represent non-consecutive scores (5 and 7 respectively). The percentile 33.33 corresponds to the score 5 because the cumulative proportion of households between 22.89 percent and 33.70 percent have a score of 5. The percentile 66.66 corresponds to the score 7 because the cumulative proportion of households between 56.91 percent and 67.10 percent have a score of 7. Therefore, scores lower than 5 are classified in the lowest tercile, scores 5 and 6 in the mid tercile, and the score 7 and above in the highest.

Table 53 Example 1 - Percentiles 33.33 and 66.66 correspond to non-consecutive scores, 5 and 7 respectively.

Tercile	HCES-DDS	No. HHs	Cumulative No. HHs	Proportion in total No. HHs (%)	Cumulative proportion of HHs (%)
Lowest	1	15	15	1.2%	1.2%
	2	50	65	4.1%	5.3%
	3	75	140	6.1%	11.4%
	4	140	280	11.4%	22.8%
Mid	5	135	415	11.0%	33.7%
	6	285	700	23.2%	56.9%
Highest	7	125	825	10.2%	67.1%
	8	132	957	10.7%	77.8%
	9	89	1046	7.2%	85.0%
	10	85	1131	6.9%	92.0%
	11	57	1188	4.6%	96.6%
	12	42	1230	3.4%	100.0%

No. HHs, number of households.

Table 54 shows Example 2, where the percentiles 33.33 and 66.66 represent consecutive scores. The percentile 33.33 corresponds to the score 5 because the cumulative proportion of households between 14.31 percent and 45.50 percent have a score of 5. The percentile 66.66 corresponds to the score 6 because the cumulative proportion of households between 45.51 percent and 68.70 percent have a score of 6. Therefore, scores lower than 5 are classified in the lowest tercile, a score of 5 in the mid tercile, and scores 6 and above in the highest tercile.

Table 54 Example 2 - Percentiles 33.33 and 66.66 correspond to scores 5 and 6, respectively.

Tercile	HCES-DDS	No. HHs	Cumulative No. HHs	Proportion in total No. HHs (%)	Cumulative proportion of HHs (%)
Lowest	1	15	15	0.8%	0.8%
	2	50	65	2.8%	3.7%
	3	68	133	3.9%	7.5%
	4	120	253	6.8%	14.3%
Mid	5	550	803	31.2%	45.5%
	6	410	1213	23.2%	68.7%
Highest	7	147	1360	8.3%	77.1%
	8	132	1492	7.5%	84.5%
	9	89	1581	5.0%	89.6%
	10	85	1666	4.8%	94.4%
	11	57	1723	3.2%	97.6%
	12	42	1765	2.4%	100.0%

No. HHs, number of households.

Table 55 shows Example 3, where the 33.33 and 66.66 percentiles represent the same score. The percentiles 33.33 and 66.66 correspond to the score 5 because the cumulative proportion of households between 30.41 percent and 67.80 percent have a score of 5. Therefore, scores lower than 5 are classified in the lowest tercile, scores of 5 in the mid tercile, and scores of 6 and above in the highest.

Table 55 Example 3 - Percentiles 33.33 and 66.66 correspond to score 5.

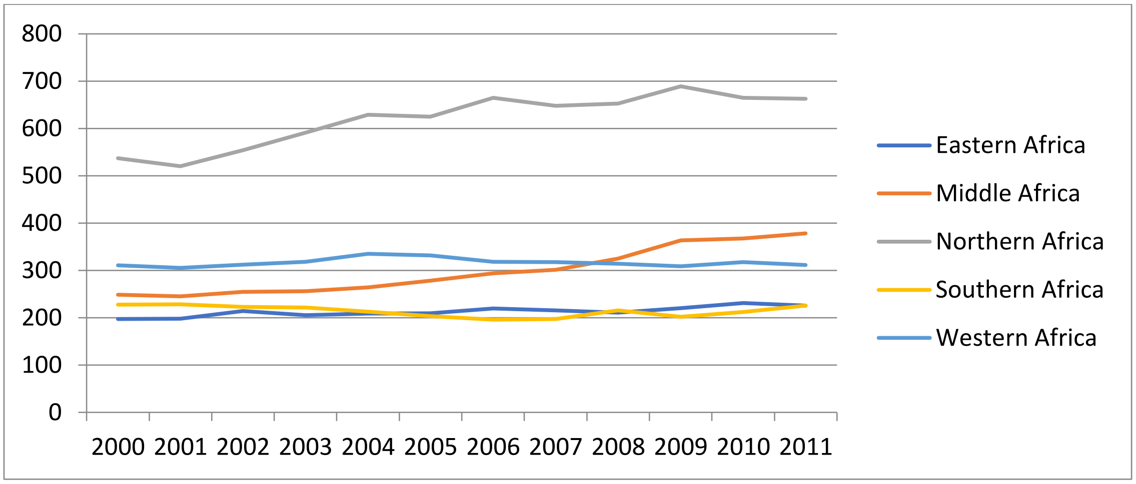
Tercile	HCES-DDS	No. HHs	Cumulative No. HHs	Proportion in total No. HHs (%)	Cumulative proportion of HHs (%)
Lowest	1	90	15	4.8%	4.8%
	2	120	135	6.4%	11.2%
	3	150	285	8.0%	19.2%
	4	210	495	11.2%	30.4%
Mid	5	700	1195	37.4%	67.8%
	6	150	1345	8.0%	75.8%
Highest	7	110	1455	5.9%	81.6%
	8	90	1545	4.8%	86.4%
	9	70	1615	3.7%	90.2%
	10	85	1700	4.5%	94.7%
	11	57	1757	3.0%	97.8%
	12	42	1799	2.2%	100.0%

No. HHs, number of households.

Appendix 5 Availability of fruits and vegetables in Africa, Asia and Latin America

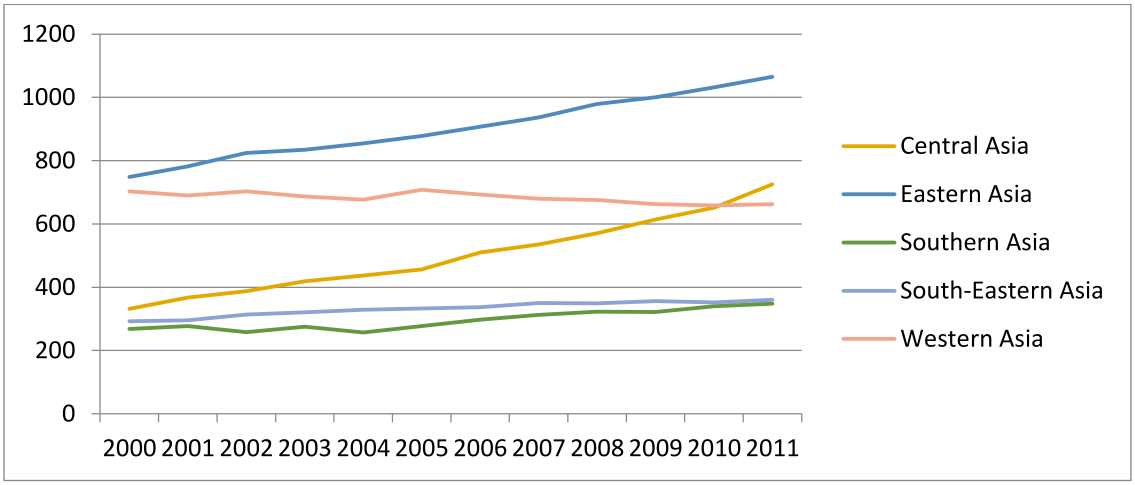
A. Trends of availability of fruits and vegetables for human consumption

Figure 2 Availability of fruits and vegetables for human consumption (g/capita/day) in Africa



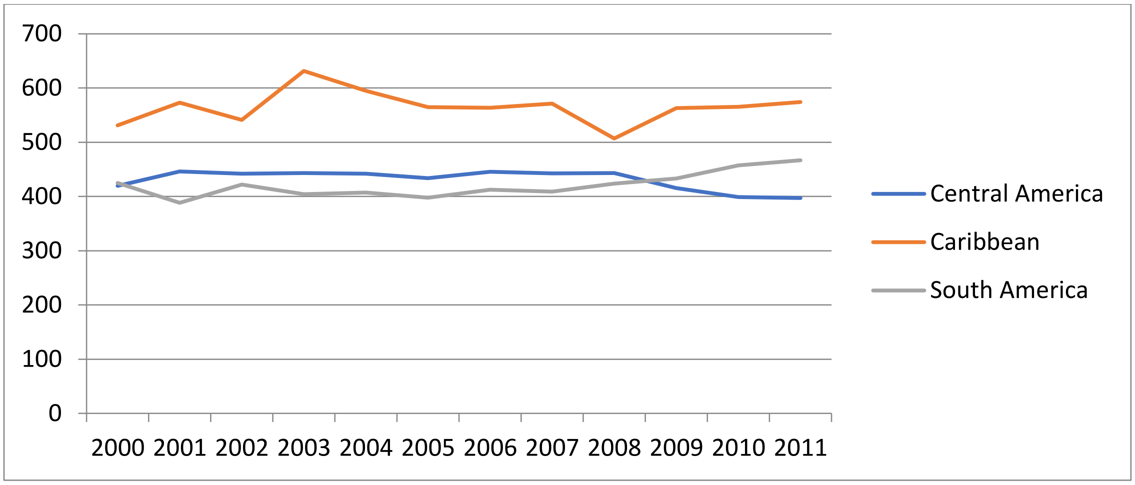
Source: FAO Food Balance Sheets, downloaded September 2015

Figure 3 Availability of fruits and vegetables for human consumption (g/capita/day) in Asia



Source: FAO Food Balance Sheets, downloaded September 2015

Figure 4 Availability of fruits and vegetables for human consumption (g/capita/day) in Latin America



Source: FAO Food Balance Sheets, downloaded September 2015

Appendix 6 Percentage of haem iron in animal products

Table 56 Percentage of haem iron in pork, liver and fish, and beef, lamb and chicken.

Food item	% Fe Haem
Pork, liver and fish	30-40
Beef, lamb and chicken	50-60

Source: Cook and Monsen (1976).

Table 57 Percentage of haem iron in selected raw and cooked meats.

	% Fe Haem	
Food item	Raw	Cooked
Beef, ground	91	79
Beef, round	102	55
Beef, loin	90	75
Pork, fresh loin	69	22
Pork, fresh picnic	81	65
Pork, cured ham	83	79
Lamb, chop	92	80
Chicken, breast	42	25
Chicken, thigh	60	32
Turkey, ground	70	40

Source: Carpenter and Clark (1995).

Table 58 Percentage of haem iron in selected meats by cooking method.

	% Fe Haem				
	Doneness level				
Food item	Standard	Rare	Medium	Well-done	Very well-done
Hamburger, fast-food restaurant	33				
Beef roast, baked		54	23	48	
Hamburger, broiled		52	48	44	51
Hamburger, pan-fried			39	40	46
Hamburger, barbecued			52	45	41
Steak, barbecued			57	48	65
Steak, broiled			41	38	46
Steak, pan-fried			46	50	44

	% Fe Haem			
	Doneness level			
Food item	Standard	Just done	Well-done	Very well-done
Bologna	70			
Luncheon meat	53			
Bacon, broiled		50	44	45
Bacon, microwaved		66		38
Bacon, pan-fried		43		33
Hot dog, barbecued		75	44	82
Hot dog, boiled	68			
Hot dog, broiled		72	60	80
Hot dog, pan-fried			73	68
Pork chop, broiled		21	49	50
Pork chop, pan-fried		47	60	40
Sausage links, pan-fried		55	40	52
Sausage patties, pan-fried		63	48	38
Whole chicken, stewed	57			
Chicken boneless, barbecued			62	24
Chicken boneless, oven broiled		63	41	51
Chicken boneless, pan-fried		21	49	63
Chicken thigh with skin, baked		67	51	47
Chicken thigh with skin, barbecued		50	57	45
Chicken boneless/skinless thigh, baked			40	
Chicken boneless/skinless thigh, barbecued			61	
Chicken breast with skin, baked		66	39	39
Chicken breast with skin, barbecued		36		48

Food item	% Fe Haem			
	Doneness level			
	Standard	Just done	Well-done	Very well-done
Chicken boneless/skinless breast, baked			39	

Source: Cross *et al.* (2012).

Table 59 Percentage of haem iron in selected animal products commonly consumed in Thailand.

Food item	% Fe Haem
Beef loin, raw	66.2
Beef loin, boiled	45
Chicken blood curd, raw	79.3
Chicken blood curd, boiled	76.3
Chicken blood curd, boiled	72.2
Chicken breast, raw	30
Chicken breast, boiled	23.4
Chicken drumsticks, raw	33.3
Chicken drumsticks, boiled	22.4
Chicken liver, raw	31.1
Chicken liver, boiled	24.2
Pork blood curd, raw	85.6
Pork blood curd, boiled	81.9
Pork blood curd, boiled	76.3
Pork liver, raw	23.3
Pork liver, boiled	18.2
Pork loin, raw	66.2
Pork loin, boiled	45
Pork tenderloin, raw	40
Pork tenderloin, boiled	30.9
Beef ball, raw	23.6
Beef ball, boiled	19.1
Chicken ball, raw	16.3
Chicken ball, boiled	8.8
Fish ball, raw	5.6
Fish ball, boiled	3.4
Pork ball, raw	16.7
Pork ball, boiled	14.3
Non-smoked chicken sausage, raw	41.3
Non-smoked chicken sausage, boiled	31.6
Non-smoked pork sausage, raw	23.2

Food item	% Fe Haem
Non-smoked pork sausage, boiled	19.5
Smoked chicken, raw	39
Smoked chicken, boiled	33.7
Smoked pork sausage, raw	35.5
Smoked pork sausage, boiled	32.5
Freshwater catfish, raw	36.8
Freshwater catfish, steamed	27.9
Nile tilapia, raw	36.6
Nile tilapia, steamed	27.1
Striped snake-head fish, raw	36.6
Striped snake-head fish, steamed	23.6
Red snapper, raw	33.3
Red snapper, steamed	14.8
Short-bodied mackerel, raw	40
Short-bodied mackerel, steamed	25
Steamed mackerel	37.7
Giant tiger prawn, raw	20
Giant tiger prawn, boiled	10.5
Baby clam, steamed	16.7
Cockle, blanched	51
Cockle, blanched	30.1
Green mussel, raw	40.7
Green mussel, steamed	27.3
Splendid, raw	20
Splendid, boiled	10.5

Source: Kongkachuichai *et al.* (2002).

Table 60 Percentage of haem iron in a selection of raw and cooked meats.

Food item	% Fe Haem	
	Raw	Cooked
Chicken, breast	30	28
Chicken, Leg (lower part)	46	35
Chicken, Leg (thigh)	30	22
Chicken, wing	44	25
Chicken, mean	38	28
Turkey, breast	28	27
Turkey, Leg (thigh)	49	38
Turkey, wing	50	39
Turkey, mean	42	35
Beef, sirloin	83	74
Beef, fillet	90	85
Beef, roastbeef	87	84
Beef, topside	87	66
Beef, mean	87	78
Veal	84	83
Lamb	75	70
Horse	79	71
Ostrich	72	75
Rabbit	56	52
Pork loin	56	46
Pork Chump, chop	66	69
Pork, mean	62	61

Source: Lombardi-Bocciaa *et al.* (2002).

Table 61 Percentage of haem iron in selected Australian meats and fish.

Food item	% Fe Haem	
	Raw	Cooked
Chicken breast	67	70
Chicken thigh	56	54
Snapper fish	62	63
Beef mince	60	48
Rump steak	73	70
Skirt steak	84	65
Rib roast	82	64
Lamb, leg	65	59
Lamb, chop	64	62
Pork, chop	68	66
Bacon	75	67
Beef, sausage	29	36

Food item	% Fe Haem	
	Raw	Cooked
Liver	33	33
Tuna		18
Broth (from skirt steak)		66

Source: Rangan *et al.* (1997).

Table 62 Percentage of haem iron in selected animal products.

Food item	% Fe Haem
Anchovy, raw	42.4
Anchovy, backed	29.8
Anchovy, grilled	26.6
Anchovy, microwaved	31.4
Anchovy, boiled	33.3

Source: Turhan *et al*. (2004).

Table 63 Percentage of haem iron in selected animal products.

Food item	% Fe Haem
Bonito fillet, freeze	48.9
Bluefish fillet, freeze	35.1

Source: Turhan *et al.* (2006).

Table 64 Percentage of haem iron in fish, shrimp, and pram.

Food item	% Fe Haem
Ailia coila	81
Amblypharyngodon mola	61
Amblypharyngodon mola (cultured)	19
Botia dario	80
Chela cachius	85
Colisa fasciata	26
Corica soborna	45
Eleotris fusca	69
Esomus danricus	56
Glossogobius giuris	56
Gudusia chapra	42
Heteropneustes fossilis	80
Hyporhamphus limbatus	64
Lepidocephalichthys guntea	80
Macrognathus aculeatus	52

Food item	% Fe Haem
Mastacembelus pancalus	77
Mystus cavasius	66
Mystus vittatus	53
Osteobrama cotio cotio	68
Pseudambassis ranga	64
Puntius sophore	68
Puntius ticto	91
Stolephorus tri	47
Xenentedon cancila	76
Macrobrachium malcolmsonii	56
Metapenaeus monoceros	37

Source: Wheal et al. (2016).

Appendix 7 Estimating micronutrient availability from food consumed away from home

A. *Estimating micronutrients using median at-home unit value*

An important distinction should be made between household members and food partakers[62]; the former share expenditures of food while the latter share consumption of food. During a given reference period, the number of household members may or may not be the same as the number of food partakers.

ADePT-FSM always estimates per capita food expenditures using the number of household members (i.e. household size). If the HCES collects information on the number of food partakers, ADePT-FSM estimates per capita dietary energy and nutrient consumption using this information. Otherwise it uses the number of household members. Therefore, since per capita nutrient consumption and per capita monetary value may not refer to the same unit of reference, the unit values should not necessarily be computed on a per capita basis.

Furthermore, when a HCES is conducted over a year, the food monetary values used in the computation of nutrient or dietary energy unit values should be deflated. The deflators are calculated based on monthly food values indexes associated with each household according to the month and year in which the household was surveyed.

[62] The number of food partakers corresponds to the number of people who consumed the food during the reference period. It includes household members, guests, and employees.

Table 65 shows a numeric example built on 19 households (urban, income quintile 2, and region 1) illustrating how dietary energy is estimated for poorly defined food items:

1) *Step 1*: Estimate the household dietary energy consumption (not per capita) of well-defined food items[63] (those for which quantities were collected and a nutrient value could be allocated) derived from edible food quantities in grams and dietary energy per 100 grams of edible portion.
2) *Step 2*: Estimate the correspondent household monetary value (not per capita) using deflated values (poorly defined food items are excluded in this step).
3) *Step 3*: Estimate the household dietary energy-unit-value as household dietary energy divided by household monetary values.
4) *Step 4*: Estimate the median dietary energy-unit-value for each combination of region, urban-rural, and income quintile. This median is performed using the population weights (household weight * household size),
5) *Step 5*: The median dietary energy-unit-value corresponding to the region, urban or rural, and income quintile of the household, is combined with the household's expenditure on poorly defined food items, thus estimating their correspondent dietary energy.

[63] Poorly defined food items are excluded in this step

Table 65 Numeric example for estimating micronutrients using median at-home unit value

	Food items with food quantities expressed in standard units and valid nutrient conversion factors			Households characteristics			Urban HHs in Region 1, Income quintile 2	Poorly defined food items	
HH ID	Step1: dietary energy (kcal/HH/day)	Step2: Food expenditure ($/HH/day)	Step3: HH dietary energy unit value ($/kcal)	Region	Urban or Rural	Income Quintile	Step4: Median dietary energy unit value ($/Kcal)	Food expenditure ($/capita/ day)	Estimated dietary energy (Kcal/capita/ day)
1	6077	4.8	0.0008	1	Urban	2	0.00083	1.8	2147.3
2	5058	3.6	0.0007	1	Urban	2	0.00083	1.3	1604.4
3	32860	6.6	0.0002	1	Urban	2	0.00083	1.0	1206.3
4	19789	13.2	0.0009	1	Urban	2	0.00083	1.2	1447.6
5	1922	1.2	0.0006	1	Urban	2	0.00083	0.8	1001.3
6	1199	1.2	0.0010	1	Urban	2	0.00083	1.1	1339.0
7	1539	0.7	0.0005	1	Urban	2	0.00083	0.9	1121.9
8	1959	2.6	0.0013	1	Urban	2	0.00083	0.4	530.8
9	5399	13.2	0.0024	1	Urban	2	0.00083	0.9	1073.6
10	1382	2.3	0.0016	1	Urban	2	0.00083	0.5	639.4
11	9097	6.3	0.0007	1	Urban	2	0.00083	0.7	808.2
12	3942	2.8	0.0007	1	Urban	2	0.00083	1.3	1604.4
13	8777	5.6	0.0006	1	Urban	2	0.00083	0.7	808.2
14	1893	1.4	0.0008	1	Urban	2	0.00083	0.5	639.4
15	7629	3.6	0.0005	1	Urban	2	0.00083	0.6	663.5
16	6234	3.2	0.0005	1	Urban	2	0.00083	0.5	639.4
17	11670	6.0	0.0005	1	Urban	2	0.00083	0.4	434.3
18	5278	5.1	0.0010	1	Urban	2	0.00083	0.5	627.3
19	5474	4.8	0.0009	1	Urban	2	0.00083	0.5	603.2
20	4404	2.0	0.0005	1	Urban	2	0.00083	0.5	603.2

HH ID, household identifying number; HH, household.

B. Examples of food consumption modules collecting FAFH

Figure 5 Example of one food item listed in a food consumption module (aims to capture all FAFH)

				Bought or bartered					self-generated or given			
code	1 Apart from major holidays and clebration, which of the following things has your household consumed in the last 12 months? ask question 1 for all items before starting q. 2-10	mark x if the answer is yes X	quantity unit	2 In how many months, apart from holidays' time, did your household buy or barter in the last 12 months? if nothing write 0 >>7 months	3 How many times a month, on average did your household do it? times	4 The average amount each time? quantity	5 The average value each time? thousand vnd	6 The total purchase value in the past 12 months interviewer calculates him (her)self, column 6 for lines that there are no 'X' mark for question 3,4,5 (q2 x q3 x q5) thousand vnd	7 Has your household consumed any self-generated or given goods over the last 12 months? yes.............................. 1 no........................ 2 (>> next item)	8 For how many months did the household consume the self-generated or given goods in the months	9 What is the quantity of self-generated or given goods that the household has consumed quantity	10 What is the value self-generated or given goods? >> next item thousand vnd
150	Instant coffee ?		X		X	X	X				X	
151	Powdered coffee		Kg									
152	Powdered tea/instant tea?		X		X	X	X				X	
153	Dried tea?		Kg									
154	Cigarettes, tobacco?		X		X	X	X				X	
155	Betel leaf, areca nut, lime?		X		X	X	X				X	
156	Outdoors meals (breakfast, lunch, dinner)		X		X	X	X		X	X	X	X
157	Others?		X		X	X	X				X	

Figure 6 Example of FAFH captured for most of the food items listed in the food consumption module

Item Description	Share Code	Did your household consume [ITEM]? 1= Yes 2=No [>> Next Item]	How many days were [ITEM] consu-med out of the last 7 days?)	Unit of Qty	Consumption out of Purchases			
					Household		Away from home	
					Qty	Value	Qty	Value
CEB01	CEB02	CEB03	CEB04	CEB05	CEB06	CEB07	CEB08	CEB09
Bread	114				.		.	
Millet	115				.		.	
Sorghum	116				.		.	
Beef	117				.		.	
Pork	118				.		.	
Goat Meat	119				.		.	
Other Meat	120				.		.	

Appendix 8 Population group based on household access to water and sanitation

Figure 7 Example of a question for collecting information on household access to drinkable water

(2.19)	Where does your drinking water come from?		
	PIPED WATER SUPPLY	1	
	COVERED WELL	2 ►	(2.22)
	HAND PUMP/ TUBEWELL	3 ►	(2.22)
	OPEN WELL	4 ►	(2.22)
	SPRING WATER	5 ►	(2.22)
	RIVER	6 ►	(2.22)
	OTHER SOURCE	7 ►	(2.22)

Figure 8 Example of a question for collecting information on household access to sanitation facilities

(2.26)	What type of toilet is used by your household?	
	HOUSEHOLD FLUSH (CONNECTED TO MUNICIPAL SEWER)	1
	HOUSEHOLD FLUSH (CONNECTED TO SEPTIC TANK)	2
	HOUSEHOLD NON-FLUSH	3
	COMMUNAL LATRINE	4
	NO TOILET	5

Appendix 9 Characteristics of the reference adult in Adult Equivalent/Adult Male Equivalent factors

A search for peer-reviewed articles that have proposed and/or used the concept of Adult Equivalent (AE)/Adult Male Equivalent (AME)[64] values in the analysis of dietary consumption data derived from HCES resulted in finding four theoretical papers (Weisell and Dop, 2012, Imhoff-Kunsch *et al.*, 2012, Murphy *et al.*, 2012, Fiedler *et al.*, 2012) and nine empirical studies (Engle-Stone and Brown, 2015, Dop *et al.*, 2012, Dary and Jariseta, 2012, Jariseta *et al.*, 2012, Bermudez *et al.*, 2012, Fiedler, 2014, Jones, 2016, Claro *et al.*, 2010, Coates *et al.*, 2016). A summary table of the studies is presented at the end of the Appendix.

Most articles discussed the construction of AE/AME factors based on energy requirements. However, Coates *et al.* (2016) and Murphy *et al.* (2012) refer to the use of AME factors based on nutrient requirements.

All studies, but one (Claro *et al.*, 2010), used FAO's methodology for the construction of AE/AME factors as outlined by Weisell and Dop (2012). The most notable differences among the papers reviewed regarding the construction of AE/AME factors are due to the characteristics of the reference adult (i.e., gender, age range, height/weight, physical activity level), and the source of energy requirements. Another important distinction is whether energy requirements for different sex age-groups are calculated based on the characteristics of household members in the HCES (i.e., energy requirements are sample specific), or derived using the characteristics of typical individuals in the population of analysis.

Gender and age of the reference adult and source of energy requirements

All but one study (Claro *et al.*, 2010) used male adults as the reference. Claro *et al.* (2010) used adult males and females as the reference. Five studies reported using FAO's methodology for determining energy requirements (FAO, 2004) as the age range of the male adult reference 18 to 30 years (Engle-Stone and Brown, 2015, Dop *et al.*,

[64] The study by Claro *et al.* (2010) uses the adult males and females as the referent for the construction of Adult Equivalent factors. In this review, the term Adult Equivalents is used when the reference person is an adult male/female and AMEs when the reference is an adult male.

2012, Bermudez *et al.*, 2012, Weisell and Dop, 2012, Imhoff-Kunsch *et al.*, 2012). Claro and colleagues (2010) and Jones (2016) used energy requirements from the United States of America Health and Medicine Division (NAS, 2006). Three of the empirical studies calculated energy requirements based on the HCES sample (Dop *et al.*, 2012, Jones, 2016, Claro *et al.*, 2010) whereas five used standard energy requirements based on typical individuals (Dary and Jariseta, 2012, Bermudez *et al.*, 2012, Fiedler, 2014, Engle-Stone and Brown, 2015).

Inclusion of pregnant and lactating women, and infants in the scales

Construction of AE/AME factors for pregnant and lactating women and for infants younger than 1 year is possible if the HCES identifies women's physiological status and provides the age of infants in months. However, this is seldom the case, and it is a limitation of studies applying AE/AME factors, as reported by Bermudez *et al.* (2012). Only Claro and colleagues (2010) explicitly referred to the development of AE factors for pregnant and lactating women, and for children.

Table 66 Reference adult in the construction of Adult Equivalent/Adult Male Equivalent factors.

Citation	Gender, Age, Height, Weight & Physical Activity Level (PAL)	Energy requirements	Remarks
Theoretical papers			
Fiedler *et al.* (2012)	Gender: Male Age: NR Height: NR PAL: NR	Source: NR	This is a theoretical paper with no calculations involved. AME factors are constructed per Weisell and Dop (2012).
Imhoff-Kunsch *et al.* (2012)	Gender: Male Age: 18-30 yrs. Height: NR PAL: NR	Source: FAO (2004) Reference "typical" adult male: 3,050 kcal/day	This is a theoretical paper with no empirical application to a survey. Constructed AME factors as per Weisell and Dop (2012).
Murphy *et al.* (2012)	Used "typical adult male" Age, height and PAL: NR	Source: NR Reference "typical" adult male: 3,000 kcal/day	This is a theoretical paper, with no empirical application to a survey. It proposes to extend the AME approach for the evaluation of household energy consumption to nutrients.
Weisell and Dop (2012)	Gender: Male Age: 45 yrs. Height: assumed unknown Weight: average of 64 Kg (assigned based on what would result in ideal BMI) PAL: 1.75 (arbitrary) Other: father & head of household	Source: FAO (2004) Reference adult male: 2813 kcal/day	This is a theoretical paper using hypothetical examples. This is referred to as the FAO method for calculating AMEs.
Empirical studies			
Bermudez *et al.* (2012)	Used "typical adult male" Gender: Male	Source: FAO and WHO (2004)	Used data from the Bangladesh 2005 HCES. Constructed AME factors as per Weisell and Dop

Citation	Gender, Age, Height, Weight & Physical Activity Level (PAL)	Energy requirements	Remarks
	Age: 18-30 yrs. PAL: assumed moderate		(2012).
Claro *et al.* (2010)	Gender: Male and female Age: 19-50 yrs. Height: NR PAL: NR	Source: HMD (Health and Medicine Division) (2006) Mean energy requirements for men and women 19-50 yrs.: 2,550 kcal/day	Used data from the 2002/2003 Brazilian HCES. The construction of the reference Adult Equivalent factors was sample-specific.
Coates *et al.* (2016) (abstract)	Gender: Male Age: NR Height: NR PAL: NR	Source: NR	Used datasets from Bangladesh and Ethiopia that measured both household consumption and individual intakes. Compared the accuracy of using AMEs based on energy with AMEs based on the relevant nutrient, (protein, iron).
Dary and Jariseta (2012)	Used "typical adult male" Gender: Male Age: 18-30 yrs.	Source: NR Reference "typical" adult male: 3,000 kcal/day	Used data from the Uganda 2008 A2Z HCES and the Uganda 2006 HCES, and compared to data collected in a 24-hour recall as part of the 2008 AZ. Constructed AME factors as per Weisell and Dop (2012).
Dop *et al.* (2012)	Gender: Male Age: 18-30 yrs. Height: based on sample Weight: based on sample PAL: 1.51-2.30 (imputed considering occupation and residence)	Source: FAO and WHO (2004)	Used data from the Cape Verde HCES 2001/02. Construction of the AME factors was sample-specific. Constructed AME factors as per Weisell and Dop (2012).
Engle-Stone and Brown (2015)	Gender: Male Gender: Male Age: ≥18 yrs.	Source: FAO and WHO (2004)	Used data from Cameroon HCES and compared it to FFQ and 24-h recall data. Constructed AME factors as per Weisell and Dop

Citation	Gender, Age, Height, Weight & Physical Activity Level (PAL)	Energy requirements	Remarks
	Height: NR PAL: moderate		(2012).
Fiedler (2014)	Gender: NS Age: NR Height: NR PAL: assumed moderate	Source: NR	Used data from the Bangladesh 2010 HCES. Constructed Adult Equivalent factors as per Weisell and Dop (2012).
Jariseta *et al.* (2012)	Gender: Male Age: 18-30 yrs. Height: NR PAL: NR	Source: NR	Used data from the Uganda 2006 HCES, and compared to data collected in a 24-hour recall. Constructed AME factors as per Weisell and Dop (2012).
Jones (2016)	Gender: Male Age: NR PAL: NR Height & weight: Considered anthropometric information from previous studies conducted in Malawi to adjust requirements	Source: NASHMD (Health and Medicine Division) (2006)	Used data from the 2013 Malawi HCES. The construction of the reference AME and AME factors was sample-specific.

NR, non-reported.