ADePT-FSM Version 2

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Introduction

The Food Security module of the ADePT software (ADePT-FSM) was jointly created by the World Bank and the Food and Agriculture Organization (FAO) to allow for streamlined and consistent food security analysis of household survey data[1]. Using standardized files as inputs, a variety of food security indicators are produced at the national and subnational levels. The software contributes to increase the transparency of the processing of National Household Surveys (NHS) for the estimation of the Prevalence of Undernourishment (PoU) indicator[2], used in monitoring progress towards eliminating global hunger. The software can be used to derive parameters that describe inequality in food access from household survey data and independently generate the PoU indicator.

The updates documented here for version 2 of ADePT-FSM are made up of computation improvements, an enhanced user-interface, and improved output. The software has also been updated to improve transparency in the calculation of the Prevalence of Undernourishment indicator. Together, these improvements give more flexibility to the user when conducting subnational food security analyses and provide the user with more detailed information. Version 2 of the software will help users more accurately assess and describe the food security situation within a country and design programs which support the fight against global hunger.

In particular, version 2 includes methodological refinements in the calculation of the PoU indicator, improving, firstly, the aim of the software to provide transparency in how undernourishment figures are derived at the FAO. Secondly, version 2 includes computational improvements in how household survey data are processed to derive food security indicators. Thirdly, an enhanced user-interface has been included, to provide the user with increased flexibility in performing food security analyses. Lastly, the new version includes supplementary indicators and information in the form of output messages and additional columns in the existing tables. This document describes the improvements

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[1] The building of ADePT-FSM and of its version 2 has been funded by the "Improved Global Governance for Hunger Reduction" program of the European Union.
[2] For a full description of the PoU indicator, see [1].

introduced in the ADePT-FSM version 2, supplementing the more exhaustive handbook already published to accompany the software [2].

Improving transparency

The Food and Agriculture Organization jointly publishes with the International Fund for Agricultural Development and the World Food Programme undernourishment estimates at the country and global levels in its annual publication titled "The State of Food Insecurity in The World" (SOFI)[3]. For the calculation of the indicator, parameters representing food availability, energy requirement, as well as inequality and asymmetry in food access within the population are needed[4]. The software has been updated to maintain transparency by including the most recent parameters used in SOFI for the calculation of the PoU for each country and year, which the user can select by choosing from drop-down boxes. In this way, the user can compare parameters calculated from the survey to the ones used in the most recent SOFI publication (see [2] for a more in-depth discussion of how the SOFI parameters differ from the survey parameters); in addition, (s)he can manually choose different values for the parameters to investigate the impact on the indicator.

A number of refinements to the FAO methodology for the calculation of the prevalence of undernourishment have been recently introduced. The FAO methodology for this indicator requires the characterization of the distribution of per capita calorie consumption of an individual representative of the population [1]. Under such a framework, it is necessary to specify a functional form for the distribution. One of the refinements introduced and described in detail in [4] is that the software chooses the functional form, selecting either the log-normal, log-skewed-normal, or skewed-normal functional forms. The selection is based on the level of asymmetry in the data.

The inequality in food access parameter, used in the calculation of the PoU indicator, is derived from the distribution of per capita calorie consumption from household survey data. The calculation of the CV in food consumption is broken down into two parts – the variability due to income and the variability due to all other factors orthogonal to income (see [4] for a more detailed discussion). Excess variability in the data, caused by some households boosting their stocks while other households are depleting theirs, by different energy requirements and by other sources of variability in consumption which are unrelated with

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[3] Most recently, the 2015 edition of the publication has been released [3]
[4] For a description of how these parameters are calculated and used in the calculation of the PoU, see [4]

food security, is controlled for by assuming a stable relationship between food consumption and income. As a methodological improvement in the calculation of the CV parameter explained in [4], a linear regression which controls for seasonality in food consumption is used to model this relationship between income and calorie consumption.

To obtain the total variability in food consumption used to calculate the PoU, the CV due to income $(CV \mid y)$ is added to the CV due to all other factors orthogonal to income $(CV \mid r)$ according to the following formula:

$$CV = \sqrt{(CV \mid y)^2 + (CV \mid r)^2} \tag{1}$$

Much of the variability orthogonal to income is due to differences in energy requirement, depending on the sex/age structure of the population [4]. To increase transparency in how distributional parameters are calculated from household survey data, the version 2 of ADePT-FSM displays the different components of the CV. Version 2 produces an annex table to show the breakdown of the total variability in food consumption according to each of the two subcomponents. An example of this annex table can be seen below:

Coefficients of variation

	Number of sampled households	Empirical Coeficient of Variation	Variation due to income	Variation due to other factors	CV used for calculation of PoU Indicator
Total	7,419	0.54	0.27	0.18	0.33
Area location of household					
Urban	1,698	0.68	0.24	0.19	0.31
Rural	5,721	0.51	0.25	0.18	0.31
Regional location od household					
Central	2,099	0.57	0.24	0.18	0.30
Eastern	1,929	0.46	0.24	0.18	0.30
Northern	1,623	0.53	0.28	0.18	0.33
Western	1,768	0.51	0.22	0.18	0.29

Computational improvements

Version 2 of the ADePT-FSM software also includes improvements in the computational procedures the software uses to generate food consumption statistics. Firstly, the imputation procedure performed in the software for food records with missing quantities has been improved. In general, grams of macronutrients and alcohol are computed from grams of food using nutrient densities (grams of nutrient per 100 grams of food) provided in a

Nutrient Conversion Table. From the quantities of macronutrients, calories are computed using the Atwater formula:

$$Calories\ (Kcal) = Proteins(g) * 4 + Fats(g) * 9 + Available\ Carbohydrates * 4 + Fiber(g) * 2 + Alcohol(g) * 7,$$ **Equation 1**

where *Available Carbohydrates* is the amount of available carbohydrates in a food, after subtracting the amount of fiber from total carbohydrates [2]. Alternatively, calories can be computed directly from a user-supplied calorie density specifying calorie contents of various foods.

When information on the food quantity is missing in the Food file, the procedure uses a median calorie cost at the level of region, area (urban/rural) and income quintile to impute missing information from food expenditure. This imputation procedure was previously performed exclusively at the level of calories and nutrients, without updating the statistics that are presented in terms of food quantities. The relationship between quantities and calories from Equation 1 is one-to-one when calorie or nutrient densities are included in the Nutrient Conversion Table[5]. Therefore, when possible, the quantities themselves are now imputed using the inverse mapping from calories to quantities. The percentage of food records for which quantities were imputed, as well as the percentage of food records for which only calories were imputed are displayed in the output messages of the software. This improvement allows for the generation of more accurate statistics on food consumption in terms of food quantities.

A second computational improvement brought about in version 2 concerns the storage of variables used for the creation of statistics on the head of the household. These variables include the occupation, economic activity, age group, and educational level of the household head (see [2] for a more detailed description of these variables). Previously, these variables were stored in the Individual file, although they are actually household-level characteristics. Therefore, for efficiency, these variables are now required to be stored in the Household file, hence a separate tab has been included in the software named "HH Head", where these variables are to be assigned by the user. The layout of the additional tab is shown below:

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[5] On the other hand, in the case of general food items consumed outside of the home such as "Meal at Restaurant", this relationship is not one-to-one.

Lastly, version 2 has an improved management of the expansion factors. When presenting per capita statistics, the expansion factors are defined as the household sampling weight times the household size, and they are required for producing statistics representative of the population. Previously, these expansion factors were calculated from the number of records in the Individual file. However, the user may know the household size (from a question included in the survey) but not have information on individual members. To overcome this problem, expansion factors are now calculated from the user-inputted variable, instead of from the number of members in the Individual file. Nonetheless, a warning is issued when the number of members in the Individual file does not match the user-inputted household size variable.

Enhanced user-interface

The user-interface of the software of version 2 has additional and improved features. The user can cross-tabulate any pair of variables from the Household file to calculate a number of descriptive statistics (such as the mean, median, total, proportion, etc.) of an outcome variable. By clicking on "Tools" > "Show custom table tab", the additional box below appears. The outcome variable can either be a third user-inputted variable or one of three constructed variables computed in the software. The options for the constructed outcome variable include, among others, the average dietary energy consumption (DEC), the minimum dietary energy requirement (MDER), or the average dietary energy requirement (ADER), all of which are expressed in terms of kilocalories.
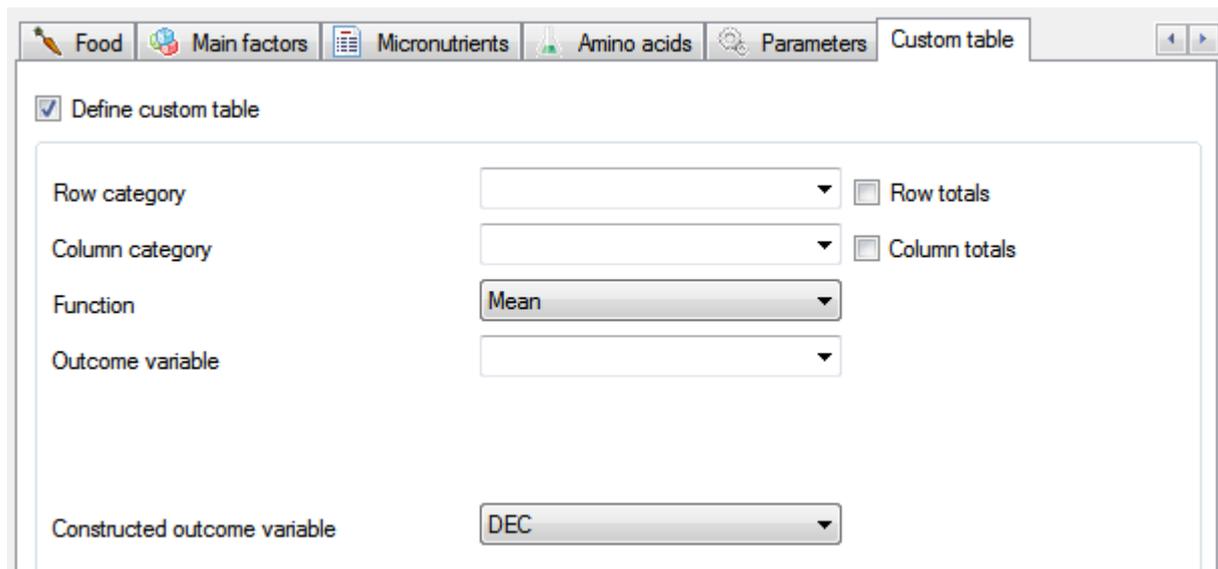
As an example of how to use the custom table feature of the new release, suppose that a user wanted to do a gender-sensitive analysis by cross-tabulating gender and region to look at dietary energy consumption. By inputting the region to the row category, gender to the column category, and DEC for the constructed outcome variable option, the following table is generated:

Custom table

	Male	Female	Total
Region 1	2,200.2	2,396.9	2,226.3
Region 2	2,252.9	2,020.4	2,193.0
Region 3	1,970.3	1,906.9	1,954.3
Region 4	2,134.9	2,093.2	2,128.2
Region 5	1,915.4	1,774.8	1,892.8
Region 6	1,989.6	2,059.3	2,007.7
Total	2,022.2	1,953.6	2,006.2

This option allows the user to better identify more specifically who the food insecure are and where they live.

Improved output

Version 2 has also improved the information contained in the output tables that ADePT-FSM generates. Many of the statistics produced by the software are in per capita terms, and these are generated by dividing by the household size. An alternative way to display per capita statistics is in terms of adult equivalent units. Average dietary energy requirements, or recommended levels of dietary intake, are calculated for age intervals for a given gender and height [6]. Adult-equivalencies are defined as the ratio of an individual's average requirement to that of an adult male between 30 and 35 years of age.

Appendix 1 demonstrates adult-equivalent values for the age intervals corresponding to those from [6], along with those heights included in the table, for males vs. females. By summing up the adult equivalent units of each individual within a household, an adult-equivalent household size can also be generated. This approach has been taken to display all of the statistics of average dietary energy consumption in Table 1.3 of the ADePT-FSM output, and these values can be seen in the fourth column of Appendix 2. By examining this column for the different household size categories, we can see how the difference in calorie consumption in per capita vs. adult-equivalent units tends to grow as the household size grows. The display of calorie consumption statistics in terms of adult equivalent units helps the user to examine consumption statistics after controlling for differences in household composition and also helps the user to more easily interpret the results.

Last but not least, the output of version 2 also provides the user with the number of households that are involved in the calculation of each statistic. This addition can be seen in the first column of Appendix 2. The national level statistics will use information from all households with food consumption data, while other statistics, such as those for individual food items, may involve much fewer households. It is extremely difficult to calculate confidence intervals for these statistics, as they combine information at several different levels of aggregation. However, the number of households still gives the user an indication of how reliable the results are.

References:

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3. Food and Agriculture Organization of the United Nations (FAO). "The state of food insecurity in the world." (2015).

4. Wanner, Nathan, Carlo Cafiero, Nathalie Troubat, and Piero Conforti. *Refinements to the FAO Methodology for Estimating the Prevalence of Undernourishment Indicator*. ESS Working Paper Series, The Food and Agriculture Organization of the United Nations. http://www.fao.org/3/a-i4046e.pdf

5. *Proceedings: Measurement and Assessment of Food Deprivation and Undernutrition: International Scientific Symposium, Rome, 26-28 June 2002*. Rome: Food and Agriculture Organization of the United Nations, 2003.

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Appendix 1: Example of adult equivalencies by sex/age

	Male				Female			
Age Interval	Gender	Height	Avg Req	Adult Eq	Age Interval	Gender	Height	Avg Req	Adult Eq
[0,1)	Male	67	721	0.24	[0,1)	Female	63	627	0.21
[1,2)	Male	80	895	0.29	[1,2)	Female	78	813	0.27
[2,3)	Male	89	1074	0.35	[2,3)	Female	88	994	0.33
[3,4)	Male	96	1167	0.38	[3,4)	Female	96	1104	0.36
[4,5)	Male	104	1297	0.43	[4,5)	Female	103	1213	0.40
[5,6)	Male	109	1382	0.45	[5,6)	Female	106	1255	0.41
[6,7)	Male	114	1480	0.49	[6,7)	Female	110	1329	0.44
[7,8)	Male	119	1590	0.52	[7,8)	Female	114	1415	0.46
[8,9)	Male	124	1710	0.56	[8,9)	Female	118	1511	0.50
[9,10)	Male	129	1840	0.60	[9,10)	Female	123	1614	0.53
[10,11)	Male	134	1975	0.65	[10,11)	Female	127	1718	0.56
[11,12)	Male	139	2132	0.70	[11,12)	Female	131	1838	0.60
[12,13)	Male	144	2304	0.76	[12,13)	Female	135	1964	0.64
[13,14)	Male	148	2491	0.82	[13,14)	Female	139	2086	0.68
[14,15)	Male	153	2679	0.88	[14,15)	Female	144	2195	0.72
[15,16)	Male	158	2863	0.94	[15,16)	Female	148	2288	0.75
[16,17)	Male	163	3035	1.00	[16,17)	Female	152	2364	0.77
[17,18)	Male	168	3195	1.05	[17,18)	Female	156	2425	0.80
[18,19)	Male	171	3073	1.01	[18,19)	Female	159	2380	0.78
[19,20)	Male	171	3092	1.01	[19,20)	Female	159	2385	0.78
[20,25)	Male	170	3142	1.03	[20,25)	Female	158	2369	0.78
[25,30)	Male	170	3142	1.03	[25,30)	Female	158	2369	0.78
[30,35)	Male	171	3050	1.00	[30,35)	Female	159	2380	0.78
[35,40)	Male	170	3034	0.99	[35,40)	Female	158	2370	0.78
[40,45)	Male	169	3017	0.99	[40,45)	Female	157	2360	0.77
[45,50)	Male	168	3000	0.98	[45,50)	Female	156	2349	0.77
[50,55)	Male	168	3000	0.98	[50,55)	Female	156	2349	0.77
[55,60)	Male	168	3000	0.98	[55,60)	Female	156	2349	0.77
[60,65)	Male	168	2501	0.82	[60,65)	Female	156	2096	0.69
[65,70)	Male	168	2501	0.82	[65,70)	Female	156	2096	0.69
>= 70	Male	168	2501	0.82	>= 70	Female	156	2096	0.69

Appendix 2: Table 1.3 of ADePT-FSM Version 2

1.3 Selected food consumption statistics by population groups								
	Number of sampled households	Average household size	Average dietary energy consumption (kcal/person/day)	Average dietary energy consumption per adult equivalent	Minimum dietary energy requirement (kcal/person/day)	Average food consumption in monetary value (LCU/person/day)	Average dietary energy unit value (LCU/1000kcals)	Average total consumption in monetary value (LCU/person/day)
Total	7,419	5.4	2006	2,598.8	1718	542.64	282.28	1268.18
Quintiles of income								
Lowest quintile	1,488	6.4	1283	1,792.0	1643	239.64	203.83	405.21
2	1,476	5.9	1745	2,357.8	1684	382.98	237.96	679.62
3	1,483	5.6	2136	2,795.0	1720	510.62	260.34	981.69
4	1,488	5.1	2422	3,096.9	1751	687.05	302.39	1494.50
Highest quintile	1,484	4.2	2807	3,308.3	1842	1103.65	406.77	3548.15
Area location of household								
Urban	1,698	4.9	2146	2,646.5	1767	831.59	391.45	2469.86
Rural	5,721	5.5	1980	2,589.8	1709	488.55	259.21	1043.21
household size categories								
One person	732	1.0	3803	3,771.3	2093	1363.15	349.64	3384.28
2 to 4 people	2,349	3.2	2283	2,861.7	1743	685.26	295.55	1515.55
More than 5 people	4,338	7.4	1901	2,510.8	1704	490.83	263.86	1162.91
Gender								
Male	5,400	5.7	2022	2,610.7	1721	549.78	285.18	1270.79
Female	2,019	4.7	1954	2,559.5	1709	519.21	274.40	1259.62
Age household head								
Less than 35	2,809	4.3	1978	2,717.9	1622	585.47	303.81	1280.22
35-59	3,428	6.4	1998	2,530.6	1758	522.59	272.63	1271.40
60 or more	1,182	5.3	2088	2,602.2	1769	528.58	258.16	1233.72