**ReadMe file for ASA24-2016 to ASA24-2018**

**HEI-2015 Population Ratio Method**

This ReadMe file describes the methodology implemented in the SAS program, HEI2015\_ASA24-2016\_MC\_PopulationScore.sas. The principles underlying this approach are described in Freedman et al., J Nutr, 2008, 138(9):1725-9 ([see abstract in PubMed](http://www.ncbi.nlm.nih.gov/pubmed/18716176)). The provided SAS program calculates mean Healthy Eating Index-2015 (HEI-2015) component and total scores and corresponding standard errors and confidence intervals for a population, subpopulation, or group using 24-hour recall data from ASA24-2016 or ASA24-2018. The specific instructions on how to successfully run the HEI procedure are within the provided SAS program.

The program can be adapted to calculate HEI-2015 scores for other data sources that use complex sampling strategy.

Only participants aged 2 years and older should be included in calculations of HEI-2015 scores because the Dietary Guidelines for Americans were not designed for younger children.

**NOTE:** Another version of this program for complex survey datasets is also available and used data from the 2011-2012 National Health and Nutrition Examination Survey (NHANES) as an example. Also, additional code that calculates HEI-2015 component and total scores at the individual level, for each day or multiple days of 24-hour recalls or food records are available on the [NCI Healthy Eating Index website](https://epi.grants.cancer.gov/hei/sas-code.html). Sample Analysis Files and Data Dictionaries can be downloaded from the [ASA24 Researcher website page](https://epi.grants.cancer.gov/asa24/researcher/sample.html).

Because the HEI-2015 is a multi-dimensional construct involving 13 densities (amounts of food groups per 1,000 calories and ratios of fatty acids), a simple method for estimating standard errors is not available. In this code, a Monte Carlo simulation step is included for the calculation of standard errors; this step simulates the densities for 10,000 samples to allow stable estimation of the standard errors.

The SAS program includes three main sections:

1. Calculations at the individual participant level to obtain variables needed to calculate HEI-2015 scores.
2. Calculation of weighted means and a variance-covariance matrix and generation of a Monte Carlo dataset, enabling standard errors to be calculated.
3. Calculation of mean HEI-2015 component and total scores and their standard errors and confidence intervals.

***Required dataset:***

* Totals file from ASA24-2016 or ASA24-2018

***Required macro****:* *available on the* [*NCI Healthy Eating Index website*](https://epi.grants.cancer.gov/hei/sas-code.html)*.*

* [hei2015.score.macro.sas](https://epi.grants.cancer.gov/hei/sas-code.html)

The 13 components of the HEI-2015 calculated by the macro are:

* Total Vegetables (HEI2015C1\_TOTALVEG)
* Greens and Beans (HEI2015C2\_GREEN\_AND\_BEAN)
* Total Fruit (HEI2015C3\_TOTALFRUIT)
* Whole Fruit (HEI2015C4\_WHOLEFRUIT)
* Whole Grains (HEI2015C5\_WHOLEGRAIN)
* Dairy (HEI2015C6\_TOTALDAIRY)
* Total Protein Foods (HEI2015C7\_TOTPROT)
* Seafood and Plant Proteins (HEI2015C8\_SEAPLANT\_PROT)
* Fatty Acids (HEI2015C9\_FATTYACID)
* Sodium (HEIC10\_SODIUM)
* Refined Grains (HEI2015C11\_REFINEDGRAIN)
* Saturated Fats (HEI2015C12\_SFAT)
* Added Sugars (HEI2015C13\_ADDSUG)

Some of the variables needed to calculate these components come directly from ASA24-2016 and 2018 output, but others are created as part of the SAS program.

The ASA24-2016 and ASA24-2018 daily totals data provide the following components used directly in the calculation of HEI-2015: Total Fruit; Whole Grains; Refined Grains; Dairy; Saturated Fats; Added Sugars and Sodium.

*Additional steps are necessary to create the remaining components that are a combination of variables: Total Vegetables; Greens and Beans; Whole Fruit; Total Protein; Seafood and Plant Proteins and Fatty Acids.*

**This SAS program carries out 5 steps:**

1. **Reads in ASA24 daily totals data.**

The TOTALS files contain the values from the Food and Nutrient Database for Dietary Surveys (FNDDS) 2011-2012, and the Food Patterns Equivalents Database for USDA Survey Food Codes (FPED).

1. **Creates additional required variables: FWHOLEFRT, MONOPOLY, VTOTALLEG, VDRKGRLEG, PFALLPROTLEG, and PFSEAPLANTLEG.**

Calculation note for FWHOLEFRT: FWHOLEFRT sums up Citrus, Melons and Berries with Other Fruits to calculate the value for Whole Fruit (non-juice) consumption. (FWHOLEFRT = F\_CITMLB + F\_OTHER).

Calculation note for MONOPOLY: MONOPOLY sums up monounsaturated and polyunsaturated fatty acids (MONOPOLY = MFAT + PFAT).  To estimate the fatty acid ratio of unsaturated fatty acids to saturated fatty acids, the scoring macro divides this summed value by saturated fatty acids (MONOPOLY/Total saturated fatty acids (g)).

Calculation note for VTOTALLEG and VDRKGRLEG: VTOTALLEG sums up all vegetables and legumes (VTOTALLEG = V\_TOTAL (cups) + V\_LEGUMES (cups)); and VDRKGRLEG sums up dark green vegetables and legumes (VDRKGRLEG = V\_DRKGR (cups) + V\_LEGUMES (cups)).

**NOTE:** Legumes here are in cup equivalents (for vegetables), not in ounce equivalents (as they would be for protein foods).

Calculation note for PFALLPROTLEG and PFSEAPLANTLEG*:*  PFALLPROTLEG sums together all animal and plant proteins, including meat, poultry, fish, eggs, nuts, seeds, soy , and legumes (PFALLPROTLEG = PF\_MPS\_TOTAL (oz) + PF\_EGGS (oz) + PF\_NUTSDS (oz) + PF\_SOY (oz) + PF\_LEGUMES (oz)); while PFSEAPLANTLEG sums together all fish and plant proteins, including fish, nuts, seeds, soy, and legumes (PFSEAPLANTLEG = PF\_SEAFD\_HI (oz) + PF\_SEAFD\_LOW (oz) + PF\_NUTSDS (oz) + PF\_SOY (oz) + PF\_LEGUMES (oz)).

**NOTE**: Legumes here are in ounce equivalents (for protein foods), not in cup equivalents (as they would be for vegetables).

# Calculates weighted means and a variance-covariance matrix and generates a Monte Carlo dataset, enabling standard errors to be calculated.

This section of the program performs computations necessary for the calculation of standard errors.

1. Calculates the weighted means and the variance/covariance matrix for the dietary variables of interest.
2. A Monte Carlo data set with 10,000 rows is generated using the means and variance/covariance matrix from step i.
3. **Applies the HEI-2015 scoring macro and calculates of HEI-2010 total and component scores and their standard errors and confidence intervals.**

This section of the code calls the macro, [hei2015.score.macro.sas](https://epi.grants.cancer.gov/hei/sas-code.html).

1. This step uses the Monte Carlo dataset with the beans and peas allocated from step 1 and calls the HEI-2015 scoring macro which calculates intake density amounts and HEI scores.
2. Univariate and means procedures to compute one HEI-2015 total score and one set of HEI-2015 component scores and their standard errors and confidence intervals for the group, subgroup, or population.

Below are the HEI-2015 Component Scoring Standards. For more information on HEI components, see [Comparing Versions of the HEI](https://epi.grants.cancer.gov/hei/comparing.html) on the NCI website.

**HEI–2015**[**1**](http://epi.grants.cancer.gov/hei/developing.html#f1) **Components & Scoring Standards**

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Max points** | **Standard for maximum score** | **Standard for minimum score of zero** |
| **Adequacy:** |  |  |  |
| **Total Fruits**[**2**](http://epi.grants.cancer.gov/hei/developing.html#f2) | 5 | ≥0.8 cup equiv. per 1,000 kcal | No Fruits |
| **Whole Fruits**[**3**](http://epi.grants.cancer.gov/hei/developing.html#f3) | 5 | ≥0.4 cup equiv. per 1,000 kcal | No Whole Fruits |
| **Total Vegetables**[**4**](http://epi.grants.cancer.gov/hei/developing.html#f4) | 5 | ≥1.1 cup equiv. per 1,000 kcal | No Vegetables |
| **Greens and Beans**[**4**](http://epi.grants.cancer.gov/hei/developing.html#f4) | 5 | ≥0.2 cup equiv. per 1,000 kcal | No Greens and Beans |
| **Whole Grains** | 10 | ≥1.5 oz equiv. per 1,000 kcal | No Whole Grains |
| **Dairy**[**5**](http://epi.grants.cancer.gov/hei/developing.html#f5) | 10 | ≥1.3 cup equiv. per 1,000 kcal | No Dairy |
| **Total Protein Foods**[**4**](http://epi.grants.cancer.gov/hei/developing.html#f6) | 5 | ≥2.5 oz equiv. per 1,000 kcal | No Protein Foods |
| **Seafood and Plant Proteins**[**6**](http://epi.grants.cancer.gov/hei/developing.html#f6) | 5 | ≥0.8 oz equiv. per 1,000 kcal | No Seafood or Plant Proteins |
| **Fatty Acids**[**7**](http://epi.grants.cancer.gov/hei/developing.html#f7) | 10 | (PUFAs + MUFAs)/SFAs ≥2.5 | (PUFAs + MUFAs)/SFAs ≤1.2 |
| **Moderation:** |  |  |  |
| **Refined Grains** | 10 | ≤1.8 oz equiv. per 1,000 kcal | ≥4.3 oz equiv. per 1,000 kcal |
| **Sodium** | 10 | ≤1.1 gram per 1,000 kcal | ≥2.0 grams per 1,000 kcal |
| **Added Sugars** | 10 | ≤6.5% of energy | ≥26% of energy |
| **Saturated Fats** | 10 | ≤8% of energy | ≥16% of energy |

**1:** Intakes between the minimum and maximum standards are scored proportionately.

**2:** Includes 100% fruit juice.

**3:** Includes all forms except juice.

**4:** Includes legumes (beans and peas).

**5:** Includes all milk products, such as fluid milk, yogurt, and cheese, and fortified soy beverages.

**6:** Includes seafood, nuts, seeds, soy products (other than beverages), and legumes (beans and peas).

**7:** Ratio of poly- and monounsaturated fatty acids (PUFAs and MUFAs) to saturated fatty acids (SFAs).

1. **Displays and saves the** **results** **in the specified output folder** **(see notes in the provided SAS program).**
2. The program saves total score and set of component scores for the population/group of interest, together with minimum and maximum values, standard errors and confidence intervals. An option is provided to export the results into a CSV file that can be opened in Excel.
3. Print

This step is included as a data check. The min and max can be compared to the bounds of HEI-2015 scores – if any scores <0 or >100, this is a red flag.

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