Calculating Health Eating Food Index – 2019 Scores (HEFI-2019)

Introduction

The Healthy Eating Food Index -2019 (HEFI-2019) assesses the extent to which food choices align with 2019 Canada's food guide (CFG) recommendations on healthy food choices ("what to eat"). The amount of food and beverages (herein referred to as foods) reported by a person during a period of 24 hours (24-h dietary recall), is used to calculate the total HEFI-2019 and its component scores.

The higher the scores, the higher the level of alignment with the healthy food choice recommendations.

A detailed description of the development and validation of the HEFI-2019 can be found in two scientific articles. [1]

The HEFI-2019 has 10 components:

- 5 based on food intake
- 1 based on beverage intake
- 4 based on nutrient intake

The HEFI-2019 assesses the 5 food-based components independently of their content of free sugars, saturated fat and sodium.

Specific nutrient-based components assess the total diet content of free sugars, saturated fat and sodium, in line with the recommended limits for these nutrients in CFG.

Each of the 10 components are allocated points. The HEFI-2019 scores are on a scale of 0 to 80 points. All components are ratios with the denominator either total food, beverage or energy intake. This is so that the total HEFI-2019 score remains as independent as possible from total energy intake, that is, to the total amount of food consumed.

Table 1 presents the:

- components and how they relate to CFG
- points allocated to each of the components
- standards for scoring according to thresholds for each component

Points between the minimum and maximum scores are attributed proportionately for all components.

[1] https://doi.org/10.1139/apnm-2021-0415 ; https://doi.org/10.1139/apnm-2021-0416

Table 1. Healthy Eating Food Index (HEFI)-2019 components, points and standards for scoring

# Component name	Measurement	Maximum Points	Unit	Minimum score	Maximum score	Relates to Canada's food guide (CFG)
1 Vegetables and Fruits	*Ratio:* total vegetables and fruit [2] / total foods [3]	20	RA/RA	No vegetables and no fruit	≥ 0.50	Guideline 1 Eat plenty of vegetables and fruit
2 Whole-grain foods	Ratio: total whole-grain foods [4] / Total foods [3]	5	RA/RA	No whole-grain Foods	≥ 0.25	Guideline 1 Choose whole grains
3 Grain foods ratio	Ratio: total whole-grain foods[4] / total grain foods [5]	5	RA/RA	No whole-grain foods	= 1.0	Guideline 1 Choose whole grains
4 Protein foods	Ratio: total protein foods [6] / total foods [3]	5	RA/RA	No protein foods	≥ 0.25	Guideline 1 Eat protein foods
5 Plant-based protein foods	Ratio: total plant-based protein foods [7] / total foods [3]	5	RA/RA	No plant-based protein foods	> 0.50	Guideline 1 Eat protein foods
6 Beverages	Ratio: water (plain or carbonated), unsweetened beverages [8]/ total beverages [9]	10	g/g	No water and no unsweetened beverages	= 1.0	Guideline 1 Make water your drink of choice

[2] All vegetables and fruit regardless of sodium, free sugars, or saturated fat content; excludes fruit juice as it is considered as sugary drinks in CFG

[3] Includes all foods consumed, as well as beverages considered in protein foods (for example, unsweetened milk and unsweetened plant-based beverages that contain protein); excludes all other beverages, fats and oils and culinary ingredients (for example, spices and baking soda).

[4] Foods where the first ingredient is either whole grains or whole-wheat, regardless of sodium, free sugars, or saturated fat content.

[5] Foods where the first ingredient is a grain (whole or not) regardless of sodium, free sugars, or saturated fat content.

[6] All protein foods regardless of saturated fat, sodium or free sugars content; excludes processed meats as they are not considered protein foods in CFG and sweetened milks as they are considered sugary drinks in CFG.

[7] All plant-based protein foods regardless of saturated fat, sodium or free sugars content.

[8] Unsweetened beverages include (unsweetened) coffee and tea, (unsweetened) milk and plant-based beverages.

[9] Total beverages include water (plain or carbonated), coffee, tea, milk and plant-based beverages, fruit and vegetable juices, alcoholic drinks, artificially-sweetened beverages and sugary drinks.

# Component name	Measurement	Maximum Points	Unit	Minimum score	Maximum score	Relates to Canada's food guide (CFG)
7 Fatty acids ratio	Ratio: mono- + polyunsaturated fat / saturated fat	5	g/g	≤ 1.1[10]	≥ 2.6[11]	Guideline 1 Choose foods with healthy fats
8 Saturated fats	Ratio: total saturated fat intake / energy intake	5	%E (kcal/kcal)	≥ 15%E [12]	< 10%E	Guideline 2 Limit highly processed foods
9 Free sugars	Ratio: total free sugars intake / energy intake	10	%E (kcal/kcal)	≥ 20%E [12]	< 10%E	Guideline 2 Limit highly processed foods
10 Sodium	*Ratio*: total sodium intake / energy intake	10	mg / kcal	≥ 2.0 [12]	< 0.9 [13]	Guideline 2 Limit highly processed foods

RA = Reference Amounts (amount of food usually eaten by an individual at one sitting, defined as the Table of Reference Amounts; %E = percent of total energy; CFG = Canada's food guide
Table is adapted from: https://doi.org/10.1139/apnm-2021-0415

[10] Approximately the **15th percentile** of intake based on data (single 24-hour recall) in Canadians from the 2015 Canadian Community Health Survey (CCHS) - Nutrition.
[11] Corresponds to the **1st percentile** of unsaturated fat to saturated fat ratio among simulated diets developed to be consistent with the recommendations in CFG.
[12] Approximately the **85th percentile** of intake based on data (single 24-hour recall) in Canadians from the 2015 CCHS - Nutrition.
[13] Standard for maximum points based on the Chronic Disease Risk Reduction (CDRR) for 14 + years (for example, 2300 mg) over the 90th percentile of usual energy intakes in respondents 2 years of age and older from the 2015 CCHS – Nutrition (for example, approximately 2600 kcal)

This document describes how to calculate HEFI-2019 scores using the SAS macro "HEFI2019score.sas"

Section A describes **how to prepare a file** that will become the **input of the SAS macro** "HEFI2019score.sas".

Preparation of the input file is different depending on which food reference database and what accompanying information you have access too. We have prepared files for three possible scenarios and an appendix outlines the steps involved in the event none of these scenarios apply.

Section B describes **how to create the derived variables** once your input file has been created.

Section C provides **links to the SAS file** and

Section D **links to important information** to consider for your **analysis.**

Section A

Please refer to the appropriate scenario below. The options depend on how the 24-hr dietary recall information is collected:

1. The 2015 Canadian Community Health Survey (CCHS) – Nutrition

   This information applies if you are analyzing data collected from the 2015 CCHS – Nutrition survey

2. The 2018 Canadian Automated Self-Administered 24-Hour Dietary Assessment Tool (ASA24)

   This information applies if you have collected 24-hour recall or food records data using the 2018 Canadian ASA24.

3. A different dietary collection method linked to the 2015 version of the Canadian Nutrient File (CNF)

   This information applies if neither scenario 1 or 2 applies to your research but you have linked your recall data to the 2015 CNF version.

NOTE: If you use other databases or collection tools then the ones listed above, please see Appendix I.

1. The 2015 Canadian Community Health Survey (CCHS) – Nutrition

This section applies if you are using data collected through the 2015 Canadian Community Health Survey (CCHS) – Nutrition.

The following table lists the relevant HEFI-2019 files that are required for your analysis.

#	File name	Description/Notes
1	HEFI2019Cat_V2	For each CCHS-2015 food in the file, Health Canada has provided a Reference Amount (RA), a HEFI category and a free sugars estimate per gram of food. "HEFI2019Cat_V2" contains 2015 CNF basic foods as well as recipes/mixed dishes that Health Canada decided to "roll-up" (see Box 1). i.e. assign a HEFI category to the recipe as a whole. This file is an update to V1: "HEFI2019Cat", where some recipes that were previously rolled down are now rolled up. More items will be found in this file then in V1.

You first need to merge the Food and Ingredient Details (FID) file with the file "HEFI2019Cat_V2".

The linkage should be performed using column "FID_CDE".

Merging both files will add fields "FDC_DEN", "FDC_DEN_FR", "RA_g", "HEFI2019Cat" and "Free_sugars_g" to your file.

Field "FDC_DEN" contains the food or recipe description
Field "FDC_DEN_FR" contains the food or recipe description in French
Field "RA_g" contains the Reference Amount in grams of the food or recipe
Field "HEFI2019Cat" contains the HEFI-2019 category
Field "Free_sugars_g" contains estimated gram amounts of free sugars per gram of food (for more information see: https://www.mdpi.com/2072-6643/13/5/1471)

Please see Section B to calculate the derived variables

2. The 2018 Canadian Automated Self-Administered 24- Hour Dietary Assessment Tool (ASA24)

This section applies if you are using data collected through the 2018 Canadian Automated Self-Administered 24- Hour Dietary Assessment Tool (ASA24)

The following table lists the relevant HEFI-2019 files that are required for your analysis.

#	File name	Description/Notes
1	**ASA24_2018_Complete_Database**	Indicates whether items are foods or recipes. For recipes, column "Recipe_Type" indicates which recipes Health Canada decided to "rolled-down" (i.e. separate into recipe ingredients) and which recipes were kept "rolled-up" (i.e. kept as a whole and assigned to a unique HEFI category). See Box 1 for more information.
2	**ASA24_Food_HEFI**	Contains items - foods as well as recipes/mixed dishes - that Health Canada decided to "roll-up". For each item, Health Canada has provided a Reference Amount (RA), a HEFI category and a free sugars estimate per gram of food.
3	**ASA24_Recipes_HEFI**	Contains recipes that Health Canada decided to "roll-down". For each recipe/mixed dish, Health Canada has estimated the number of RAs of each HEFI category found in the recipe and the amount of free sugars per gram of recipe.

If you have collected 24-hour recall or food records using the 2018 Canadian ASA24, you need to merge your survey result file with file "**ASA24_Food_HEFI**" using column "FoodCode". The same process needs to be completed for file "**ASA24_Recipes_HEFI**".

For the file "**ASA24_Food_HEFI**" merging files will add fields "Main_Food_Description ", "Main_Food_Description_FR", "RA_g", "HEFI2019Cat" and "Free_sugars_g" to your file.

Field "Main_Food_Description" contains the food or recipe description
Field "Main_Food_Description_FR" contains the food or recipe description in French
Field "RA_g" contains the Reference Amount in grams of the food or recipe
Field "HEFI2019Cat" contains the HEFI-2019 category for foods.
Field "Free_sugars_g" contains estimated amounts of free sugars in grams per gram of food (for more information see: https://www.mdpi.com/2072-6643/13/5/1471)

For the file "**ASA24_Recipes_HEFI**" merging files will add fields "Main_Food_Description", "Main_Food_Description_FR", "Free_sugars_g", "RA_vegfruits", "RA_wholegrfoods", "RA_nonwholegrfoods", "RA_profoodsanimal", "RA_profoodsplant", "RA_otherfoods", "RA_waterhealthybev", "RA_unsweetmilk", "RA_unsweetplantbevpro", "RA_otherbeverages "and "RA_not_considered" to your file.

Field "Main_Food_Description" contains recipe description
Field "Main_Food_Description_FR" contains the food or recipe description in French
Field "Free_sugars_g" contains estimated amounts of free sugars in grams per gram of recipe
Field "RA_vegfruits" contains number of Reference Amounts of vegetables and fruit per gram of recipe
Field RA_wholegrfoods" contains number of Reference Amounts of whole grain foods per gram of recipe
Field "RA_nonwholegrfoods" contains number of Reference Amounts of non-whole-grain foods per gram of recipe
Field "RA_profoodsanimal" contains number of Reference Amounts of animal-based protein foods per gram of recipe
Field "RA_profoodsplant" contains number of Reference Amounts of plant-based protein foods per gram of recipe
Field "RA_otherfoods" contains number of Reference Amounts of all other foods (i.e. anything that is not a vegetable and fruit, grain foods, protein foods, beverage, fat and oil or culinary ingredient e.g. spices or baking soda) per gram of recipe
Field "g_waterhealthybev" contains grams of water and other healthy beverages not in unsweetened milks and plant-based protein beverages per gram of recipe
Field "g_unsweetmilk" contains grams of unsweetened milks per gram of total recipe
Field "g_unsweetplantbevpro" contains grams of plant-based protein beverages per gram of recipe
Field "g_otherbeverages" contains grams of other beverages per gram of recipe
Field "RA_not_considered" contains number of Reference Amounts of all foods not assigned to a HEFI food category per gram of recipe

For more details, on how the contribution of each ingredient to the HEFI categories were calculated for rolled-down recipes, please refer to Appendix II. This information is provided for information only.

Please see Section B to calculate the derived variables.

Box 1. Explanation of rolled-up and rolled-down recipes.

Recipes or mixed dishes reported in a survey may be handled two ways:

1. All the foods that are part of the recipe may be assigned a unique HEFI Category. Health Canada considers these recipes to be “rolled-up”.

2. All the ingredients that are part of the recipe may be kept separate. Health Canada considers these recipes to be “rolled-down”. Health Canada usually rolled-down recipes when ingredients could fall under multiple HEFI categories.

For example, since a meat and vegetable lasagna contains ingredients that would belong to different HEFI categories, the recipe must be broken apart into its ingredients in order to assign an accurate HEFI-2019 food category to each of them (e.g. meat assigned to protein foods, vegetables to vegetables and fruit, noodles to total grain foods etc.).

Alternatively, for some recipes, most ingredients could be assign to the same HEFI food category (e.g. blueberry muffin, whole grain bread). In these cases, it may be preferable to assign all the ingredients that make up the recipe to one recipe code and then assign the recipe code to the corresponding HEFI food category (e.g. blueberry muffin to total grains, whole grain bread to whole grains).

3. A different survey linked to the 2015 version of the Canadian Nutrient File (CNF)

This section applies if neither scenario 1 or 2 applies but you have linked your recall data to the 2015 Canadian Nutrient File (CNF) version.

The following table lists the relevant HEFI-2019 files that are required for your analysis.

#	File name	Description/Notes
1	HEFI2019Cat_CNF	"HEFI2019Cat_CNF" contains 2015 CNF foods For each CNF food in the file, Health Canada has provided a Reference Amount (RA), a HEFI category and a free sugars estimate per gram of food.

First, you need to merge your survey result file with file "HEFI2019CatCNF". The linkage should be performed using column "FID_CDE" (i.e. food code) or its equivalent in your file.

Merging both files will add fields "FDC_DEN", "FDC_DEN_FR", "RA_g", "HEFI2019Cat" and "Free_sugars_g" to your file.

Field "FDC_DEN" contains the food description
Field "FDC_DEN_FR" contains the food description in French
Field "RA_g" contains the Reference Amount in grams of the food
Field "HEFI2019Cat" contains the HEFI-2019 category
Field "Free_sugars_g" contains estimated amounts of free sugars in grams per gram of food (for more information see: https://www.mdpi.com/2072-6643/13/5/1471)

Please see Section B to calculate the derived variables.

Section B

Derived Variables

Once you have prepared the files as outlined in section A, you will need to calculate a series of variables derived from the columns found in the merged files you created. These variables are the input for the "HEFI2019score.sas" SAS macro.

The table below lists the required derived variables and their description.

Derived Variable Name	Description
Vegfruits	Number of Reference Amounts (RA) of Vegetables and fruit consumed per respondent. Excludes fruit juices.
Wholegrfoods	Number of RA of whole-grain foods including whole wheat consumed per respondent.
nonwholegrfoods	Number of RA of non whole-grain foods consumed per respondent.
profoodsanimal	Number of RA of animal-based protein foods excluding milk consumed per respondent.
profoodsplant	Number of RA of plant-based protein foods excluding all plant-based beverages consumed per respondent.
Otherfoods	Number of RA of all other foods consumed per respondent (i.e. anything that is not a vegetable and fruit, grain foods, protein foods, beverage, fat and oil or culinary ingredient e.g. spices or baking soda)
waterhealthybev	Grams of water and other healthy beverages not in unsweetened milks and plant-based protein beverages consumed per respondent.
unsweetmilk	Grams of unsweetened milks consumed per respondent.
unsweetplantbevpro	Grams of unsweetened plant-based protein beverages consumed per respondent.
otherbeverages	Grams of other beverages consumed per respondent.
Satfat	Grams of fat from saturated fats consumed per respondent.
Mufat	Grams of fat from monounsaturated fats consumed per respondent.
Pufat	Grams of fat from polyunsaturated fats consumed per respondent.
Sodium	Milligrams of sodium consumed per respondent.
Freesugars	Grams of free sugars consumed per respondent.
Energy	Total kcal of energy intake per respondent.

To calculate the number of Reference Amounts consumed per respondent for the Vegfruits, Wholegrfoods, nonwholegrfoods, profoodsanimal, profoodsplant and Otherfoods **HEFI food categories,** divide the amount consumed (reported) for each food code by its RA (both in grams) for each respondent. Then add up all values within the HEFI food category for each respondent.

To calculate the amounts consumed per respondent for waterhealthybev, unsweetmilk, unsweetplantbevpro, otherbeverages, Satfat, Mufat, Pufat, Sodium, Freesugars and Energy, add up all values within the HEFI food category for each respondent.

A brief description of how derived variables are used in the computation of each of the HEFI-2019 component scores follows:

Component 1 (Vegetables and fruit)
Numerator: "vegfruits"
Denominator: "Total Foods" which corresponds to the sum of: "vegfruits", "wholegrfoods", "nonwholegrfoods", "profoodsanimal", "profoodsplant", "otherfoods", "unsweetmilk", and "unsweetplantbevpro".

Component 2 (Whole-grain foods)
Numerator: "wholegrfoods"
Denominator: "Total Foods"
See Component 1 for a description on how "Total Foods" is calculated.

Component 3 (Grain foods ratio)
Numerator: "wholegrfoods"
Denominator: The sum of "wholegrfoods" and "nonwholegrfoods" (i.e. all grains).

Component 4 (Protein foods)
Numerator: The sum of "profoodsanimal", "profoodsplant", "unsweetmilk", and "unsweetplantbevpro".
Denominator: "Total Foods"
See Component 1 for a description on how "Total Foods" is calculated.

Component 5 (Plant-based protein foods)
Numerator: The sum of "profoodsplant" and "unsweetplantbevpro".
Denominator: The sum of "profoodsanimal", "profoodsplant", "unsweetmilk", and "unsweetplantbevpro".

Component 6 (Beverages)
Numerator: The sum of "waterhealthybev", "unsweetmilk", and "unsweetplantbevpro".
Denominator: The sum of the numerator plus "otherbeverages".

Component 7 (Fatty acids ratio).
Numerator: The sum of "mufat" and "pufat".
Denominator: "satfat"

Component 8 (Saturated fats)
Numerator: Calculated by multiplying "satfat" by 9 (i.e. energy from saturated fats).
Denominator: "energy"

Component 9 (Free sugars)
Numerator: Calculated multiplying "freesugars" by 4 (i.e. energy from free sugars).

Denominator: “energy”

Component 10 (Sodium)
Numerator: “sodium”
Denominator: “energy”

Section C

HEFI-2019 Scores Calculations

Health Canada has made available on Open Government the "HEFI2019score.sas" a SAS macro developed to calculate **HEFI-2019** scores.

For a detailed explanation of how to use the SAS macro with the prepared file, please read the instructions found at the top of the "HEFI2019score.sas" SAS file.

Section D

HEFI Scores Analysis

Now that you have calculated your respondents' HEFI scores, you must use an analysis method consistent with your research question, objectives and data available. For example, if your objective is to estimate the population's mean HEFI-2019 score, you may consider implementing the population ratio method, in which case you only need one 24-h dietary recall per individual. However, if your purpose is to estimate the distribution of HEFI-2019 scores in the population or among various subgroups of the population, you should consider implementing the National Cancer Institute (NCI) methods, devised to addresses (within-individual) random errors. For this, a repeated 24-h dietary recall for at least some individuals is necessary.

The following references will be helpful:

Details regarding the dietary assessment methodology for different objectives:
"Choosing an Approach for Dietary Assessment"

Population Ratio method:
"A population's mean Healthy Eating Index-2005 scores are best estimated by the score of the population ratio when one 24-hour recall is available"

The National Cancer Institute's univariate approach:
Americans Do Not Meet Federal Dietary Recommendations

The National Cancer Institute's bivariate approach:
The population distribution of ratios of usual intakes of dietary components that are consumed every day can be estimated from repeated 24-hour recalls

A bivariate measurement error model for semicontinuous and continuous variables: Application to nutritional epidemiology

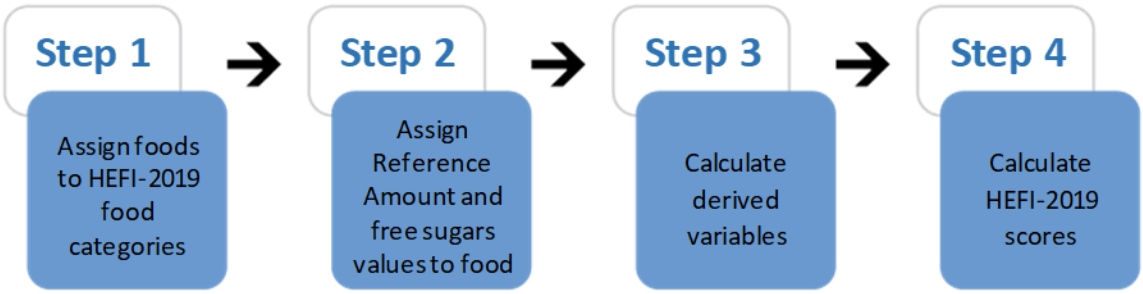
Fitting a bivariate measurement error model for episodically consumed dietary components

National Cancer Institute's multivariate approach:

A new multivariate measurement error model with zero-inflated dietary data, and its application to dietary assessment

Appendix I

If none of the scenarios in Section A apply. The information in the data files provided in Section A can serve as a guide to assign HEFI categories, Reference amounts and free sugars estimates. Below is a diagram that outlines the main steps involved in the process.



Appendix II

When deciding to rolled-down recipes and assign categories to each ingredient as opposed to the recipe as a whole, the following steps are required in order to calculate how much each ingredient contributes to a HEFI category:

1. Assign a HEFI category and Reference Amount to each individual ingredient
2. Calculate the amount each ingredient contributes to a HEFI category per 1 g of total recipe weight using the following formula

$$IngWeight \div TotalRecipeWeight \div RA\_g$$

IngWeight - Weight of ingredient in grams
TotalRecipeWeight - Total weight of the recipe in grams
RA_g - Reference Amount of ingredient in grams

For an example, refer to the file “Recipe_Breakdown” prepared for users of the 2018 ASA24

3. Sum the values calculated in each HEFI grouping within each recipe to create value per total recipe (For an example refer to the file ASA24_Recipes_HEFI prepared for the 2018 ASA24 users)