

## Title

Development of the Healthy Eating Food Index (HEFI)-2019 measuring adherence to Canada's Food Guide 2019 recommendations on healthy food choices

## Authors names

Brassard, Didier (1)  
Elvidge Munene, Lisa-Anne (2)  
St-Pierre, Sylvie (2)  
Guenther, Patricia M. (3)  
Kirkpatrick, Sharon I (4)  
Slater, Joyce (5)  
Lemieux, Simone (1)  
Jessri, Mahsa (6)  
Haines, Jess (7)  
Prowse, Rachel (8)  
Olstad, Dana Lee (9)  
Garriguet, Didier (10)  
Vena, Jennifer (9, 11)  
Hassan Vatanpatast (12)  
L'Abbe, Mary R. (13)  
Lamarche, Benoît (1)

## Authors' Affiliations

- (1) Centre Nutrition, santé et société (NUTRISS), Institut sur la nutrition et les aliments fonctionnels (INAF), Université Laval, Québec City, QC, G1V 0A6, Canada
- (2) Office of Nutrition Policy and Promotion, Health Canada, Ottawa, K1A 0K9 Canada
- (3) Department of Nutrition and Integrative Physiology, University of Utah, Salt Lake City, Utah 84112, USA
- (4) School of Public Health Sciences, University of Waterloo, Waterloo, ON, N2L 3G1, Canada
- (5) Department of Food and Human Nutritional Sciences, University of Manitoba, Winnipeg, MB, R3T 2N2, Canada
- (6) Human Nutrition and Dietetics, Food, Nutrition and Health Program, University of British Columbia, Vancouver, BC V6T 1Z4

- (7) Department of Family Relations and Applied Nutrition, University of Guelph, Guelph, ON, N1G 2W1, Canada
- (8) Health Promotion, Chronic Disease and Injury Prevention, Public Health Ontario, Toronto, ON, M5G 1V2, Canada
- (9) Department of Community Health Sciences, Cumming School of Medicine, University of Calgary, Calgary, AB T2N 4Z6 Canada
- (10) Health Analysis Division, Statistics Canada, Ottawa, ON, K1A 0T6, Canada
- (11) Alberta's Tomorrow Project, Cancer Research & Analytics, Cancer Care Alberta, Alberta Health Services, Calgary, AB, T2T 5C7, Canada
- (12) College of Pharmacy and Nutrition, School of Public Health, University of Saskatchewan, Saskatoon, SK S7V 2Z4, Canada
- (13) Department of Nutritional Sciences, Temerty Faculty of Medicine, University of Toronto, Toronto ON M5S 1A8, Canada, and Director WHO Collaborating Centre on Nutrition Policy for Chronic Disease Prevention

### **Corresponding author:**

Benoît Lamarche, PhD, FAHA

Pavillon des Services, Université Laval

2440, Hochelaga Boulevard, Quebec City, Canada, G1V 0A6

Tel : 418-656-2131 ext 4355; Fax: 518-656-5877

Email: [benoit.lamarche@fsaa.ulaval.ca](mailto:benoit.lamarche@fsaa.ulaval.ca)

**Word count:** 9547 words

**Number of figures and tables:** 1 figure, 2 tables

**Running title:** Development of the HEFI-2019

**Abstract**

The release of Canada's Food Guide (CFG) in 2019 by Health Canada prompted the development of indices to measure adherence to these updated dietary recommendations for Canadians. This study describes the development and scoring standards of the Healthy Eating Food Index (HEFI)-2019, which is intended to measure alignment of eating patterns with CFG-2019 recommendations on food choices among Canadians aged 2 years and older. Alignment with the intent of each key recommendation in the CFG-2019 was the primary principle guiding the development of the HEFI-2019. Additional considerations included previously published indices, data on Canadians' dietary intakes from the 2015 Canadian Community Health Survey (CCHS) – Nutrition, and expert judgement. The HEFI-2019 includes 10 components: *Vegetables and fruits* (20 points), *Whole-grain foods* (5 points), *Grain foods ratio* (5 points), *Protein foods* (5 points), *Plant-based protein foods* (5 points), *Beverages* (10 points), *Fatty acids ratio* (5 points), *Saturated fats* (5 points), *Free sugars* (10 points), and *Sodium* (10 points). All components are expressed as ratios (e.g., proportions of total foods, total beverages, or total energy). The HEFI-2019 score has a maximum of 80 points. Potential uses of the HEFI-2019 include research as well as monitoring and surveillance of food choices in population-based surveys.

**Novelty bullet**

- The Healthy Eating Food Index-2019 was developed to measure adherence to the 2019 Canada's Food Guide recommendations on healthy food choices.
- The HEFI-2019 includes 10 components, of which 5 are based on foods, 1 on beverages and 4 on nutrients, for a total of 80 points.

24    **Keywords**

25    Canada's Food Guide, Canadian Community Health Survey, nutrition survey, 24-hour  
26    dietary recalls, diet quality, Healthy Eating Food Index, HEFI-2019, food choices,  
27    adherence, dietary guidelines.

## 29 Introduction

30 Suboptimal dietary patterns are among the leading risk factors for morbidity and  
 31 mortality in Canada (Alam et al, 2019) and worldwide (G. B. D. Risk Factors  
 32 Collaborators, 2020). Healthy eating is therefore a critical component of chronic disease  
 33 prevention and management. In this regard, several countries have proposed food-  
 34 based dietary recommendations (Food and Agriculture Organization of the United  
 35 Nations, 2021) that guide consumers towards achieving healthy dietary patterns.  
 36 National dietary guidelines also present key information for health professionals as well  
 37 as policy-makers to support strategies that promote healthy eating (Health Canada,  
 38 2019a). Finally, dietary guidelines are often used as a reference by food services,  
 39 government programs and the food industry to support the development of healthier  
 40 food environments.

41  
 42 In 2019, Health Canada released an updated Canada's Food Guide (CFG-2019) that  
 43 promotes healthy eating and overall nutritional well-being and supports improvements to  
 44 the food environment (Health Canada, 2019b; 2021). Unlike the previous CFG-2007,  
 45 CFG-2019 no longer provides dietary guidance based on age-sex recommendations for  
 46 the number of servings per day and servings sizes. Rather, CFG-2019 recommends  
 47 eating a variety of healthy foods each day, including fruits and vegetables, whole grains  
 48 and protein foods emphasizing plant-based protein foods more often (Health Canada,  
 49 2019b). The 2019 Canada's food guide plate is an illustration of the desirable  
 50 proportions of food categories in relation to one another and can be used as a visual  
 51 cue or reminder to follow when building healthy meals and snacks. Recommendations

in CFG-2019, which are less prescriptive than previous recommendations in Canada, also provide guidance not only on what to eat, but also on how our eating habits and food environments can promote health and reduce the risk of nutrition-related chronic diseases. Healthy food choices and healthy eating habits within CFG-2019 are promoted through a suite of targeted web pages that communicate information to a variety of users including the public, policy-makers and health professionals (Health Canada, 2019a). For example, Health Canada's Dietary Guidelines are intended primarily for health professionals and policy-makers, while the Healthy Eating Recommendations and the plate snapshot translate Health Canada's Dietary Guidelines into simple and applicable messages for consumers (Health Canada, 2019a).

For research and surveillance purposes, it is important to evaluate the extent to which individuals and populations adhere to dietary guidelines. In this regard, the development of an index reflecting the degree to which patterns of eating align with dietary guidelines is invaluable. Such indices are often used as a proxy measure of overall diet quality and can track temporal trends and changes in population-based studies and in national surveys (Kirkpatrick et al, 2018; Krebs-Smith et al, 2015; Ocke, 2013; Wirt & Collins, 2009). Specific components of such indices may also be used to assess adherence of the population or subgroups of the population to specific recommendations (Kirkpatrick et al, 2018). Indices reflecting alignment of dietary patterns to dietary guidelines may be used to measure associations between specific dietary recommendations and health outcomes (Krebs-Smith et al, 2015; Liese et al, 2015; Miller et al, 2020), thus providing key data to inform future guidelines. In 2009, Garriguet (Garriguet, 2009) developed the

Canadian Healthy Eating Index (C-HEI) to measure adherence to recommendations in the CFG-2007. The C-HEI was inspired by the HEI-2005, which was designed to measure adherence to the Dietary Guidelines for Americans 2005 (Guenther et al, 2008). As indicated above, there are fundamental differences in the recommendations found in the 2007 and 2019 versions of CFG. Thus, the C-HEI 2007 could not be used to assess adherence to the most recent dietary recommendations in Canada and the development of an entirely new adherence index was warranted. This paper describes the development and provides a detailed description of the Healthy Eating Food Index 2019 (HEFI-2019), which aims to measure alignment of dietary patterns to the “Healthy Food Choices” recommendations of the CFG-2019 (also referred to as the “What to Eat” recommendations). The evaluation of the HEFI-2019 is presented in an accompanying paper (Brassard et al, In press).

## Materials and methods

The development of the HEFI-2019 involved three steps: 1- a scan of the literature for existing indices, 2- defining general guiding principles and 3- development of the HEFI-2019 components and standards for scoring based on an iterative process.

### *Literature scan of existing tools*

A scan of the literature was first performed to explore the possibility of adapting or adopting existing dietary guidance adherence indices for use in Canada. The scan also assessed how different countries or organizations approached the development of their dietary guidance adherence indices. Although no existing index was adequately tailored to the content and intention behind each recommendation in the CFG-2019, the scan provided insightful methodological information regarding the development of such indices. Notably, the scan highlighted the challenge of translating flexible and non-quantitative recommendations into scalable standards (Gabe & Jaime, 2019). It also provided inspiration to develop a framework that translates recommendations into components of an adherence index (Romaguera et al, 2012; Shams-White et al, 2019).

### *Defining guiding principles*

In March 2020, Health Canada in collaboration with the Knowledge Translation Strategy Unit of the Canadian Institutes of Health Research, held a one-day “Best Brains Exchange” meeting of experts from Canada, the USA and Brazil to initiate the development of different indices to measure adherence to CFG-2019 recommendations. Stakeholders represented a wide array of expertise, including nutrition policy and public

health, nutritional epidemiology, implementation research, dietary intake assessment methods and index development and validation. A summary of this event is available online (Canadian Institutes of Health Research & Health Canada, 2020). Participants of the meeting agreed that more than one dietary guidance adherence index was needed to measure both dimensions of the CFG-2019, i.e., recommendations on healthy food choices and on healthy eating habits. There was also strong consensus among participants regarding the considerations leading to the development of the HEFI-2019 (Box 1).

- Have clearly defined guiding principles for decision-making;
- Include all recommendations on healthy food choices in CFG-2019;
- Have clear definitions of each component score and accompanying documentation on the interpretation of the total HEFI-2019 score and component scores;
- Rationalize the attribution of equal or unequal number of points to each of the components of the HEFI-2019 (i.e., whether or not the components should receive equal points);
- Ensure that the HEFI-2019 has satisfactory psychometric properties;
- The final decisions regarding each component's justification, structure and scoring standard of the HEFI-2019 would rest with Health Canada.
- Update subsequent versions of the HEFI-2019 (with future revisions of the CFG) only if significant changes are required.

**Box 1.** Key considerations towards the development of the HEFI-2019

Participants were invited to provide feedback and comments during the subsequent phases of development of the HEFI-2019, described below, and its evaluation (Brassard et al, In press).

### **Key sources of information considered**

The HEFI-2019 aims to measure alignment of dietary patterns, hence adherence, to the “Healthy Food Choices” recommendations in the CFG-2019. It was agreed that the HEFI-2019 be developed for an application to 24-hour dietary recall data, since 24-hour dietary recall is considered the best dietary assessment instrument for use in population-based and national surveys (Thompson et al, 2015).

The primary source of information was CFG-2019. In particular, individual components of the HEFI-2019 and the overall index needed to be fully aligned with the wording and intention behind each healthy food choice recommendation in CFG-2019. Other sources of information were data-based evidence and expert judgment. Data-based evidence included the literature scan of existing tools described above as well dietary intake data among Canadians based on the 2015 Canadian Community Health Survey (CCHS) - Nutrition. The 2015 CCHS – Nutrition is the most recent national nutrition survey conducted in Canada and provides data on foods and nutrient intakes as well as other data to support interpretation of dietary intake information. Data from the 2015 CCHS – Nutrition was used to inform aspects of the scoring standards, along with the comparison of scoring standards with dietary intakes of Canadians. The simplicity of use of the HEFI-2019 and consistency in the definition of all components of the index

were identified as overarching guiding principles. The HEFI-2019 also needed to demonstrate satisfactory psychometric properties (Bland & Altman, 2002; Kirkpatrick et al, 2019). Those were examined in a concurrent study (Brassard et al, In press).

Information in CFG-2019 included i) Canada’s Dietary Guidelines, primarily targeting health professionals and policy-makers (Health Canada, 2019a); ii) the Healthy Eating Recommendations, primarily targeting consumers (see Appendix A in (Health Canada, 2019a)); and iii) the Food Guide Snapshot (Health Canada, 2019b). Canada’s Dietary Guidelines encompass three main guideline components. Guidelines #1 and #2 relate to the foundation of healthy eating and foods and beverages that undermine healthy eating, respectively. Guideline #3 relates to healthy eating habits (“how to eat”) and was not considered in the present work.

**Identification of the HEFI-2019 Components**

**Table 1** presents the key recommendations on healthy food choices in CFG-2019 and how they were translated into the corresponding components of the HEFI-2019. Based on the alignment with key recommendations, 10 components were identified, of which five are based on foods, one on beverages, and four on nutrients. The broad recommendation that “*nutritious foods are the foundation for healthy eating*” was not assessed independently.

Seven of the HEFI-2019 components are “adequacy” components, i.e., greater adherence is defined by greater relative consumption, while 3 components are “moderation” components that relate to nutrients of concern, namely saturated fats, free sugars and sodium (Table 1), for which greater adherence is defined by lower relative

consumption. CFG-2019 neither dissuades nor encourages the consumption of sugar substitutes or artificial sweeteners (Table 1) and further indicates that nutritious foods and beverages should be promoted instead of artificially or sugar-sweetened foods and beverages (Health Canada, 2019a). The recommendation related to sugar substitutes is captured in the *Beverages* component, since artificially sweetened beverages are important contributors to the intake of sugar substitutes. Alcohol consumption is also considered in the *Beverages* component.

**[Table 1 goes here]**

#### *Reference metrics to assess proportionality of food-based recommendations*

As indicated above and unlike previous editions, CFG-2019 does not provide specific guidance on food portion size and recommended servings per day. Although the proportions of vegetables and fruits (50%), whole-grain foods (25%) and protein foods (25%) in the CFG-2019 plate's snapshot are not specific quantitative targets per se, they were used as a benchmark to develop the HEFI-2019. Components expressed as ratios of intakes (i.e., densities or proportions) are more likely to reflect the quality of foods rather than the quantity, which is desirable for an adherence index (Krebs-Smith et al, 2018). Different options were considered to represent the proportions of the various food categories within an eating pattern, including volumes, weights and reference amounts (RAs). Using volumes is challenging since some solid foods such as whole fruits or muffins, cannot easily be expressed in volumes. Using weights was also ruled out because consumption of nutritionally dense foods (e.g. leafy greens) and

energy-dense foods (e.g. nuts) cannot be easily compared based on weights. RAs were therefore chosen as the metric to assess the proportional nature of the recommendations on healthy food choices in CFG-2019. RAs represent the amount of food (grams for solid foods, ml for liquids), typically consumed in one sitting and are available for most foods in Canada (Health Canada, 2016). The use of RA as a reference unit to translate each food-based recommendation into a scalable metric also circumvented the absence of recommended numerical amounts of food for each food category in CFG-2019. All food-based components expressed in RAs (*Vegetable and fruits, Whole-grains foods, Grains foods ratio, Protein foods, Plant-based protein foods*) are calculated as ratios to all (total) foods consumed, also expressed as RAs. Total foods consumed include all vegetables and fruits, all whole and non-whole grains foods as well as all protein foods, including unsweetened and protein-rich beverages (> 2.5g protein/100ml; (Health Canada, 2002)), which are considered protein foods in the CFG-2019. Total foods also include all foods not recommended in CFG-2019 such as processed or prepared foods (e.g., processed meats, sugary breakfast cereals, biscuits and cakes, confectioneries). The amount for total foods is calculated by adding up the number of RAs of all foods consumed. Culinary ingredients (e.g., spices, baking soda), beverages without protein (e.g., water, coffee, tea, almond, cashew, rice, coconut) as well as oils and spreads are not included in the calculation of total foods. Beverages without protein are accounted for in the *Beverages* component. Oils and spreads are accounted for in the calculation of the nutrient-based *Fatty acids ratio* and *Saturated fats* components. The **Table A1** in the appendix provides complete details about which foods and beverages are considered in each component of the HEFI-2019.

### *Reference metrics to assess the Sodium component*

The CFG-2019 sets the recommended limit for sodium at the 2300 mg/d chronic disease risk reduction threshold established by the National Academies of Sciences, Engineering, and Medicine (NASEM) (National Academies of Sciences Engineering Medicine, 2019). As such, one would opt to use absolute sodium intake values to score this component. However, sodium and energy intakes are strongly correlated (Health Canada, 2018b; World Health Organization, 2012). Using absolute sodium intake to calculate the *Sodium* component increases the likelihood of a strong association between the HEFI-2019 score and total energy intakes, and thus with the amount of food consumed as well, which is not consistent with the index' purposes.

On the other hand, using a density approach attenuates the association between energy intake and indices of diet quality (Krebs-Smith et al, 2018; Reedy et al, 2018), thus yielding an index that is less reliant on the amount of foods consumed. Other advantages of using the density approach are a higher sensitivity to detect changes over time due to smaller "ceiling" and "floor" effects and consistency of scoring standards among all components of the HEFI-2019, which are calculated as ratios of all foods or beverages consumed or the percentage of total energy (%E).

### ***Weighting of components***

As indicated above, a total of 10 components were mapped to healthy food choices recommendations in CFG-2019 (Table 1). One option considered was to attribute the same number of points to each component. However, some components are addressed by complementary recommendations in CFG-2019. For example, the components

*Protein foods* and *Plant-based protein foods* both relate to protein foods in the diet. Had both components been scored equally (i.e., 10 points each), recommendations on protein foods would have had more weight in the total HEFI-2019 (i.e., 20/100 points) than other individual recommendations, e.g., *Beverages* (10/100 points). To achieve equal weighting of individual vs. sets of two complementary components, the latter received 5 points each, so that their combined weight was equal to other single component or sets of related components in the total HEFI-2019 score. As shown below, this was the case for three sets of complementary recommendations: the two protein-related components, the two grains-related components and the two fat-related components. The only exception to the equal weighting approach pertained to the vegetables and fruits recommendation, for which there is substantial evidence and little debate as to their importance in healthy dietary patterns (Health Canada, 2019b; c). For this reason and as detailed below, the *Vegetables and fruits* component was weighted more heavily (20 points) than all other components or sets of components (up to 10 points). The total HEFI-2019 is scored on a scale of 0 to 80 points.

## **Statistical analyses**

Dietary intake data for Canadians aged 2 years and older measured using 24h dietary recalls were obtained from the 2015 CCHS-Nutrition to guide decisions around the HEFI-2019 components and scoring. Complete details of the survey methods are presented elsewhere (Brassard et al, In press; Health Canada, 2017). First, distributions of intakes on a given day (i.e., first 24-hour recall) were estimated to derive scoring standards in the absence of a benchmark in CFG-2019 or of empirical data supporting

specific limits. This was the case for the HEFI-2019 components *Fatty acids ratio*, *Free Sugars*, *Saturated fats* and *Sodium*.

Second, distributions of usual intakes (i.e., long-term average) were estimated to compare scoring standards to dietary intakes of Canadians aged 2 years and older. Repeated 24h dietary recalls were collected in approximately 37% of the 2015 CCHS-Nutrition respondents. Taking advantage of the repeated 24h dietary recalls, usual intake distributions of foods and nutrients among Canadians were estimated using the National Cancer Institute's bivariate method (Freedman et al, 2010; Kipnis et al, 2016). The models were stratified according to age and sex to better reflect random variations in intake. The three strata used were children and adolescents 2-18 years, males 19 years and older and females 19 years and older. Estimated intakes among pseudo-individuals generated in the Monte Carlo simulation step within each stratum were pooled before estimating distribution of intakes in the overall sample. The covariates included in the models were age, categorized according to Dietary Reference Intake groups, sex (only for 2-18 years), an indicator variable for sequence of 24-hour recalls (first or second when appropriate) and an indicator variable weekend days (Friday, Saturday, Sunday). All analyses were weighted with survey weights provided by Statistics Canada. Secondary analyses conducted using data from the 2015 CCHS - Nutrition conducted by Statistics Canada do not require additional ethics approval.

**Results**

**Table 2** presents the HEFI-2019 components, points allocated and the standards for scoring according to thresholds for each component. Points between the minimum and maximum scores are attributed proportionately for all components.

***Component #1 Vegetables and fruits***

The component is calculated as the ratio of vegetables and fruits (expressed in RAs) to total foods (also expressed in RAs). The 50% proportion of vegetables and fruits in the CFG-2019 snapshot is used as a benchmark to assess adherence to this recommendation. The *Vegetables and fruits* component refers to whole, dried and canned vegetables and fruits, regardless of their saturated fat, free sugar or sodium content, which are assessed separately. All types of potatoes irrespective of preparation method (e.g., oven-cooked, boiled, fried) are also included (Table A1). Fruit juices are excluded because they are considered sugary drinks in CFG-2019. Maximum points (20 points) are given when the ratio of vegetables and fruits in RAs to total foods in RAs is equal to or greater than 0.5 or 50%, indicating that half or more of all foods consumed are vegetables and fruits. Minimum points (0 pts) are given when the consumption of vegetables and fruits equals 0. As shown in **Figure 1** and based on usual dietary intake data among Canadians aged 2 years and older, the 50% cut-off allows for a score distribution that is not limited by an important “ceiling” or “floor” effect (i.e., very few individuals receive maximum or minimum points).

**[Figure 1 goes here]**

### **Components related to grain foods**

Adherence to the recommendation related to whole-grain foods is assessed using two components (components #2 and #3), which add up to a total of 10 points in the HEFI-2019. The first of these two components captures the amount (quantity) of whole-grain foods relative to total foods consumed. The second of these two components captures the quality of all grains consumed, i.e., whether they are whole or not. Assessing whole grain consumption both from a relative quantity (component #2) and a relative quality perspective (component #3) ensures that diets very low in grain foods do not receive maximum points, even when only small amounts of whole-grain foods are consumed.

#### ***Component #2 Whole-grain foods***

The *Whole-grain foods* component is scored as the ratio of whole-grain foods measured in RAs to total foods measured in RAs. Whole-grain foods include all foods in which the first ingredient is a whole grain or whole wheat. All whole-grains and whole-wheat foods are included regardless of their saturated fat, free sugar or sodium content. The 25% proportion of whole-grain foods on CFG-2019 snapshot is used as a benchmark, with ratios  $\geq 0.25$  receiving the maximum of 5 points. The minimum score (0 point) is given when no whole-grain foods are consumed. As shown in Figure 1, the 0.25 cut-off for maximum points allows for a score distribution that has no “ceiling” or “floor” effect.

**Component #3 Grain foods ratio**

The second of the two components related to recommendations on whole grains in CFG-2019 is calculated as the ratio of whole-grain foods to the sum of all grain foods, both measured in RAs. The numerator of this component is the same as the numerator of the *Whole-grain foods* component (component #2). The denominator includes all foods in which the first ingredient is a grain (whole or not), regardless of their saturated fat, free sugar or sodium content. A ratio equal to 1 indicates that all grain foods consumed are whole-grain, aligned with CFG-2019 recommendations (Table 1), and is given the maximum of 5 points, while the minimum score (0 point) is given when no whole-grain foods are consumed. No consumption of grain foods (whole or not) is also given 0 points.

**Components related to protein foods**

Adherence to recommendations on dietary proteins is also assessed using two components to reflect relative quantity (component #4) and quality (component #5). Each component is given a maximum score of 5 points, for a maximum total of 10 points for the two protein-related components. Component #4 assesses alignment with the recommendation targeting total protein food consumption as shown in the CFG-2019 snapshot. Component #5 assesses alignment with the recommendation targeting plant-based protein food consumption.

#### **Component #4 Protein foods**

The *Protein foods* component is calculated as the ratio of protein foods measured in RAs to total foods measured in RAs. Protein foods include fish, shellfish, eggs, poultry, red meat, dairy foods and plant-based protein foods (e.g., legumes, nuts, seeds, tofu) (Table A1). Even though CFG-2019 recommends consuming lean red meat, lower fat milk, yogurts, kefir, and cheeses lower in fat and sodium, all protein foods are included in the *Protein foods* component regardless of their saturated fat, free sugar and sodium content, which are considered separately. Unsweetened milk and unsweetened (fortified or not) plant-based beverages (proteins >2.5g/100ml) are considered as protein foods in CFG-2019 and thus are included in this component, irrespective of fat and sodium content. Sugar-sweetened milk and sugar-sweetened plant-based beverages with proteins are considered sugary drinks in CFG-2019 (Health Canada, 2019a). Thus, the intake of these sugary drinks is not considered in the *Protein foods* component (neither in the numerator nor the denominator), but is rather considered in the *Beverages* component. Processed meats, which are not considered as protein foods in CFG-2019, are accounted for only in the denominator of this component.

The proportion of protein foods in the CFG-2019 snapshot (25%) is used as a benchmark to define the scoring standards. Thus, ratios  $\geq 0.25$  are given the maximum of 5 points, while the minimum score (0 point) is given when no protein foods are consumed. Of note, this scoring scale creates an important ceiling effect, with close to

50% of Canadians 2 years and older receiving the maximum score for this component in 2015 (Figure 1).

**Component #5 Plant-based protein foods**

The CFG-2019 recommends to “choose protein foods that come from plants more often”. To derive workable scoring rules, “more often” was interpreted as more than half (>50%) of all protein foods consumed as being plant-based. All plant-based protein foods are included in the numerator of this component, regardless of their saturated fat, free sugar or sodium content. Unsweetened (fortified or not) plant-based beverages (>2.5g protein/100ml) are also included in the numerator, regardless of their saturated fat or sodium content. The denominator of this component is the total protein foods, as described above (numerator of component #4). A ratio of plant-based protein foods measured in RAs to total protein foods measured in RAs > 0.50 is given the maximum number of points for this component (5 points). The minimum score (0 point) is given when no plant-based protein foods are consumed. This component also receives 0 point when no protein foods (plant-based or not) are consumed.

**Component #6 Beverages**

CFG-2019 emphasizes the importance of water as the beverage of choice, but healthy beverage guidance also includes unsweetened lower fat milk, unsweetened (fortified or not) plant-based beverages and unsweetened coffee and tea. The main intention behind the recommendation on healthy beverages is that Canadians replace sugary drinks by healthy beverages.

The *Beverages* component is calculated as the ratio of water and other unsweetened beverages to all beverages, all converted in grams of intake, to avoid an unnecessary calculation in the number of RAs. Specifically, the numerator of this component includes plain water (including carbonated), unsweetened tea or coffee, unsweetened milk (irrespective of fat content or sodium content) and unsweetened plant-based beverages (fortified or not; irrespective of fat or sodium content). Regular fat milk (3.25% fat) is included in the numerator of this component because the main intent behind the recommendation is to reduce consumption of sugary drinks and because intake of saturated fats is accounted for in two other components. The denominator of the *Beverages* component's ratio includes all of the above plus all sugary drinks such as sodas, sugar-sweetened milks and sugar-sweetened plant-based beverages (i.e., beverages that can contribute to excess free sugars (Health Canada, 2019a)), artificially sweetened beverages (including plant-based beverages) and alcohol. Excluding artificially sweetened beverages from the numerator of the *Beverages* component was justified by the fact that there is no evidence of health benefits associated with the consumption of such beverages (Dietary Guidelines Advisory Committee, 2015; World Cancer Research Fund/American Institute for Cancer Research, 2018) and because CFG-2019 states that nutritious foods and beverages that are unsweetened should be promoted instead of artificially sweetened beverages (Health Canada, 2019a).

There are no pre-specified standards to score this component in CFG-2019. An ideal consumption is 0 g per day of sugary drinks, artificially sweetened beverages or alcohol.

The standard is therefore based on no consumption of such drinks. Maximum points for the beverage component (10 points) are given when the ratio = 1.0, and minimum points (0 points) are given when all beverages consumed are sugary drinks, artificially sweetened beverages and alcohol.

**Components related to fats**

The CFG-2019 has several recommendations that aim to limit the consumption of saturated fats and increase the consumption of unsaturated fats. The HEFI-2019 comprises two components that are related to saturated fat intake (components #7 and #8). Component #7 is calculated as the ratio of unsaturated to saturated fats and captures the recommendations that “Foods that contain mostly unsaturated fat should replace foods that contain mostly saturated fat” and to “Choose foods with healthy fats instead of saturated fat” (Health Canada, 2019b). This approach is consistent with the supporting evidence for this recommendation (Health Canada, 2019c). Component #8 captures the recommendation to limit intakes of saturated fats below 10%E. Each of the two components is scored on a scale of 0 to 5, so that the total number of points related to saturated fats in the HEFI-2019 is 10, consistent with the relative weight given to other nutrients of concern in the HEFI-2019.

**Component #7 Fatty acids ratio**

The score of this component is based on the ratio of unsaturated fat to saturated fat (both measured in grams). A ratio of unsaturated to saturated fat > 2.6 is given 5 points. This threshold for maximum points corresponds to the 1<sup>st</sup> percentile of the unsaturated

to saturated fat ratio in simulated diets that align with CFG-2019 recommendations (Health Canada, personal communication, unpublished data). This threshold is also consistent with the threshold used in the HEI-2015 (Guenther et al, 2013; Krebs-Smith et al, 2018). There is no evidence to determine a lower threshold for the unsaturated to saturated fat ratio. To limit a floor effect (i.e., many individuals getting 0 points) and consistent with the methodology employed for the HEI-2015 (Guenther et al, 2013; Krebs-Smith et al, 2018), the 15<sup>th</sup> percentile of the unsaturated/saturated fats ratio distribution among Canadians (first 24-hour recall, 2 years and older; 2015 CCHS-Nutrition) corresponding to a ratio of 1.1 is used as the standard for scoring 0 points.

#### ***Component #8 Saturated fats***

This component is calculated as the percentage of energy (%E) from saturated fats, with maximum points (5 points) for values <10%E as per the recommendation in CFG-2019. There is no empirical data supporting an upper limit for saturated fat intake. The various iterations of the US HEIs (Guenther et al, 2013; Guenther et al, 2008; Krebs-Smith et al, 2018) used the 85<sup>th</sup> percentile of saturated fat intake (as %E) in NHANES based on dietary intake data from one 24h recall to determine the upper limit for the minimum score of 0 points. Consistent with this approach, the 85<sup>th</sup> percentile of the distribution of saturated fat intakes among Canadians in the 2015 CCHS-Nutrition (first 24-h recall; 2 years and older) is used (Figure 1). This corresponds to a saturated fat intake  $\geq 15\%$ E.

**Component #9 Free sugars**

Free sugars are also considered a nutrient of concern in CFG-2019 with the recommendation that intake should be below 10%E. Intakes below this limit receive the maximum number of points (10 points). There is no accepted threshold for maximal free sugars intake. Similar to the *Saturated fats* component, the standard is based on the 85<sup>th</sup> percentile of the distribution of free sugars intake among Canadians in the 2015 CCHS-Nutrition (first 24-hour recall; 2 years and older), i.e.,  $\geq 20\%$ E. The Canadian Nutrient File (Health Canada, 2018a), from which the dietary intake data are calculated in 2015 CCHS-Nutrition, does not include information on free sugars. However, Health Canada has constructed a database of the free sugars content for foods and ingredients included in the Canadian Nutrient File v2015 (Rana et al, 2021).

**Component #10 Sodium**

As described in the methods, the *Sodium* component is calculated using a density (energy-adjusted) approach. Using such an approach requires that the cut-off for maximum points needs to be set to a specific amount of energy intake. The HEI-2015 set the 2300 mg/d cut-off for the sodium component to the median energy intake of the US population (Krebs-Smith et al, 2018). Transposed to the Canadian context (median energy intake in Canada according to data from the 2015 CCHS – Nutrition), the 2300 mg/d cut-off for maximum points for the *Sodium* component would be set at 1800 kcal/day. This implies that maximum points may be given to individuals with sodium intakes exceeding 2300 mg/d. For example, someone reporting 2500 kcal/day would get 10 points for the *Sodium* component if the corresponding sodium intake was

478 approximately equal to or below 3200 mg/day. To limit the proportion of individuals  
479 receiving maximum points for the *Sodium* component when sodium intake is greater  
480 than 2300 mg/d, the scoring standard for maximum points of the HEFI-2019 is set at the  
481 90<sup>th</sup> percentile (i.e., 2600 kcal/d) of the usual energy intake distribution in the 2015  
482 CCHS – Nutrition in participants aged 2 years and older. As a result, no more than 10%  
483 of the population (those above the 90<sup>th</sup> percentile of the energy intake distribution) may  
484 get maximum points even with sodium intakes above 2300 mg/d. This also implies that  
485 the scoring standard for the *Sodium* component is stringent because the cut-off for  
486 maximum points declines proportionately to energy intake. Maximum points are  
487 attributed to the *Sodium* component when the ratio of sodium to energy intake is  $< 0.9$   
488 (2300 mg/2600 kcal). The standard for minimum points is based on the 85<sup>th</sup> percentile  
489 of the sodium to energy intake ratio distribution, based on data from the 2015 CCHS –  
490 Nutrition (first 24-hour recall; 2 years and older), i.e., a ratio  $\geq 2$ .

**Discussion - Interpretation of the HEFI-2019**

This paper describes the development of the HEFI-2019, which is designed to measure alignment of eating patterns to recommendations on healthy food choices in CFG-2019. The index has a maximum of 80 points when scores of each of the 10 components are summed up. All components are based on ratios to either total food, beverage or energy intake, so that the overall HEFI-2019 reflects adherence to recommendations on food choices rather than amount of food consumed (Brassard et al, In press).

Three basic steps are needed before calculating the HEFI-2019. First, foods and beverages consumed are classified according to the various food and beverage categories used to calculate the numerator and denominator of each of the HEFI-2019 components. Second, the amount of food and beverages for each category, measured in RAs for foods and in grams for beverages, is determined. Third, total intakes of nutrients (mono- and polyunsaturated fats, saturated fats, free sugars measured in grams; sodium, measured in milligrams) and energy (measured in calories) are calculated. This information is used to arrive at the final HEFI-2019 score. The scoring methods and code for its application to data from population-based surveys, such as the 2015 CCHS-Nutrition, are presented in supplementary material (Supplementary file S1). The calculation of the HEFI-2019 applied to dietary intake data from 24-hour dietary recalls requires the concurrent use of available databases on RAs and on the free sugars content of foods in the Canadian Nutrient File 2015. The Reference Amounts of each food can be found on Government of Canada website (Health Canada, 2016). The

free sugars estimates of foods in the Canadian Nutrient File can be found elsewhere (Rana et al, 2021).

The scoring standards of the HEFI-2019 components are generally consistent with the actual wording of and intent behind the recommendations on food choices in CFG-2019, with some exceptions. For example, the *Beverages* component does not directly capture the recommendation that “water be the beverage of choice”, but was rather developed to reflect one of the main intents behind the recommendation, that is, to replace the consumption of sugary drinks and artificially sweetened beverages by healthier options. Another example of a slight divergence between scoring standards and the wording of the recommendations pertains to the *Protein foods* component, in which all proteins foods are included, irrespective of saturated fat, free sugar and sodium content. These nutrients of concern are considered apart from the food-based components of the HEFI-2019, despite the fact that the recommendation for *Protein foods* explicitly recommends the consumption of lower fat protein foods.

Individual components may be used to assess adherence to specific recommendations on food choices in CFG-2019, provided that information on total food, beverage and energy intake is also available. Component scores may also be useful to explain differences between population subgroups or temporal changes in total HEFI-2019 scores. Of note, the component scores for *Protein foods*, *Saturated fats* and *Free sugars* are characterized by non-trivial floor/ceiling effects (see Figure 1), indicating that important proportions of the Canadian population are already meeting

recommendations for these foods and nutrients, as worded in CFG-2019. This implies that the *Protein Foods*, *Saturated fats* and *Free sugars* components may be less sensitive to detecting differences among population subgroups or temporal changes. For example, a “perfect” score for the *Free sugars* component indicates that free sugars intake is below the 10%E recommendation in CFG-2019. As such, any difference or temporal change in free sugars intake below this 10%E cut-off would not be revealed by the *Free sugars* component score.

**Strengths and limitations**

Strengths of this work include the iterative process implemented to develop the HEFI-2019 and consensus among researchers with recognized expertise in dietary intake assessment and in the development of diet quality scores, the alignment of the index with key recommendations in CFG-2019 and the involvement of Health Canada to ensure the index captured the intent of the CFG-2019 recommendations on healthy food choices. Limitations must also be addressed. As indicated above, the presence of floor/ceiling effects for some components may limit the ability of the HEFI-2019 to be sensitive to dietary intake changes that are beyond CFG-2019 recommendations. A specific HEFI-2019 score threshold above which dietary patterns are considered to be fully aligned with CFG recommendations on food choices is currently unknown. Interpreting the HEFI-2019 based on relative differences (e.g., between groups or over time) is therefore recommended to circumvent the lack of a specific score threshold. Considering that the HEFI-2019 has been developed using dietary intake data obtained from 24-hour recalls, more research is needed for its application to data obtained from

other comprehensive dietary assessment methods such as FFQ. Finally, the HEFI-2019 does not measure adherence to CFG-2019 recommendations on healthy eating habits, for which other adherence tools are under development.

## Conclusion

The HEFI-2019 has been developed to assess adherence to recommendations on healthy food choices in the updated CFG-2019. Being characterized by satisfactory psychometric properties (see accompanying paper on the evaluation of the tool (Brassard et al, In press)), the HEFI-2019 does reflect overall diet quality according to these new recommendations. Future research will help reveal the extent to which the HEFI-2019, hence adherence to CFG-2019, is associated with chronic disease risk.

**Authors statements**

All authors have read and approved the final version of this manuscript.

**Acknowledgements**

Data presented in this article are adapted from Statistics Canada, Canadian Community Health Survey - Nutrition: Public Use Microdata File, 2015, March 2021. This does not constitute an endorsement by Statistics Canada of this product.

**Competing interests statement**

BL has the following disclosures: he has received funding from the Canadian Institutes for Health Research (on going), the Fonds de recherche du Québec – Santé (FRQS) (on going), Fonds de recherche du Québec – Nature et technologies (NT) (on going), the Ministère de la santé et des services sociaux (MSSS) du Québec (on going), Health Canada (on-going) and Atrium Innovations [completed in 2019]). BL is an Advisory Board member of the Canadian Nutrition Society. DB has been a casual employee of Health Canada (2019-2020), contributing to the present work and holds a doctoral training award from the *Fonds de recherche du Québec - Santé*. DLO has received funding from the Canadian Institutes of Health Research, the Social Sciences and Humanities Research Council of Canada, Alberta Innovates, Alberta Blue Cross, the O'Brien Institute for Public Health, the Libin Cardiovascular Research Institute, the Calgary Centre for Clinical Research, the Petro-Canada Young Innovator Award in Community Health, the Canadian Foundation for Dietetic Research and I Can For Kids (a not-for-profit organization). JV has received funding on behalf of the Alberta's Tomorrow Project program funding from Alberta Health, Alberta Cancer Foundation, Canadian Partnership Against Cancer and Health Canada and in-kind funding from Alberta Health Services as well as project-

specific funding from Public Health Agency of Canada and the Canadian Institutes for Health Research; the work described herein represent the views of the authors and not of Alberta's Tomorrow Project or any of its funders. ML has received research funding from the Canadian Institutes of Health Research, Sanofi-Pasteur – University of Toronto – Université Paris-Descartes International Collaboration Research Pilot and Feasibility Program, Lawson Centre for Child Nutrition, Public Policy and Child Nutrition, University of Toronto Collaborative Grant, International Development Research Centre, (IDRC) NCDPP, Burroughs-Wellcome Foundation, Heart and Stroke Foundation, and research contracts from the PAHO Regional Office of the WHO, Health Canada, Ontario Public Health Association, Vital Strategies: Resolve to Save Lives Initiative, and the World Health Organization. JH has received funding from the Canadian Institutes for Health Research, National Institutes of Health, Danone Institute North America, the Canadian Foundation for Dietetic Research, and Health Canada. RP has received funding from Health Canada. SIK has received funding from Canadian Institutes of Health Research, the Social Sciences and Humanities Research Council of Canada, Ontario Ministry of Research and Innovation, AI for Good, Health Canada and the National Institutes of Health.

### **Contributors' statement**

DB and BL wrote the first draft of this paper. DB was responsible for all statistical analyses. All authors have contributed to this work by providing feedback throughout the development of the HEFI-2019 as well as by critically reviewing this paper. BL obtained funding from Health Canada for this work and had final responsibility in finalizing this paper.

616

617 **Funding statement**

618 This work has been partly funded by Health Canada through a contract with Laval

619 University. Health Canada played a significant role in all phases of the work leading to

620 the development of the HEFI-2019.

621 **Data availability statement**

622 Data pertaining to the 2015 Canadian Community Health Survey - Nutrition (Public Use

623 Microdata Files) are available upon request to Health Canada online:

624 <https://www150.statcan.gc.ca/n1/en/catalogue/82M0024X2018001>

## References

- Alam, S., Lang, J. J., Drucker, A. M., Gotay, C., Kozloff, N., Mate, K., Patten, S. B., Orpana, H. M., Afshin, A. & Cahill, L. E. (2019) Assessment of the burden of diseases and injuries attributable to risk factors in Canada from 1990 to 2016: an analysis of the Global Burden of Disease Study. *CMAJ Open*, 7(1), E140-E148. doi:10.9778/cmajo.20180137. PMID:30819694.
- Bland, J. M. & Altman, D. G. (2002) Statistics Notes: Validating scales and indexes. *BMJ*, 324(7337), 606-7. doi:10.1136/bmj.324.7337.606. PMID:11884331.
- Brassard, D., Elvidge, L. A., St-Pierre, S., Gonzalez, A., Guenther, P. M., Jessri, M., Vena, J., Olstad, D. L., Vatanparast, H., Prowse, R., Lemieux, S., L'Abbe, M. R., Garriguet, D., Kirkpatrick, S. I. & Lamarche, B. (In press) Evaluation of the Healthy Eating Food Index (HEFI)-2019 measuring adherence to Canada's Food Guide 2019 recommendations on healthy food choices. *Appl Physiol Nutr Metab*(Accepted manuscript).
- Canadian Institutes of Health Research & Health Canada (2020) *Developing tools to measure adherence to Canada's new Food Guide*. Available online: <https://irsc-cihr.gc.ca/e/52142.html> [Accessed 2021-03-31].
- Dietary Guidelines Advisory Committee (2015) *Scientific Report of the 2015 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Health and Human Services and the Secretary of Agriculture*. U.S. Department of Agriculture. Agricultural Research Service, Washington, DC: Available online: <https://health.gov/our-work/nutrition-physical-activity/dietary-guidelines/previous-dietary-guidelines/2015/advisory-report> [Accessed 2021-11-01].
- Food and Agriculture Organization of the United Nations (2021) *Food-based dietary guidelines*. Available online: <http://www.fao.org/nutrition/education/food-dietary-guidelines> [Accessed 2021-03-31].
- Freedman, L. S., Guenther, P. M., Dodd, K. W., Krebs-Smith, S. M. & Midthune, D. (2010) The population distribution of ratios of usual intakes of dietary components that are consumed every day can be estimated from repeated 24-hour recalls. *J Nutr*, 140(1), 111-6. doi:10.3945/jn.109.110254. PMID:19923394.
- G. B. D. Risk Factors Collaborators (2020) Global burden of 87 risk factors in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet*, 396(10258), 1223-1249. doi:10.1016/S0140-6736(20)30752-2. PMID:33069327.
- Gabe, K. T. & Jaime, P. C. (2019) Development and testing of a scale to evaluate diet according to the recommendations of the Dietary Guidelines for the Brazilian Population. *Public Health Nutr*, 22(5), 785-796. doi:10.1017/S1368980018004123. PMID:30744711.
- Garriguet, D. (2009) Diet quality in Canada. *Health Rep*, 20(3), 41-52. doi. PMID:19813438.

- 666 Guenther, P. M., Casavale, K. O., Reedy, J., Kirkpatrick, S. I., Hiza, H. A., Kuczynski, K.  
667 J., Kahle, L. L. & Krebs-Smith, S. M. (2013) Update of the Healthy Eating Index: HEI-  
668 2010. *J Acad Nutr Diet*, 113(4), 569-80. doi:10.1016/j.jand.2012.12.016.  
669 PMID:23415502.
- 670 Guenther, P. M., Reedy, J. & Krebs-Smith, S. M. (2008) Development of the Healthy  
671 Eating Index-2005. *J Am Diet Assoc*, 108(11), 1896-901.  
672 doi:10.1016/j.jada.2008.08.016. PMID:18954580.
- 673 Health Canada (2002) *Interim Marketing Authorization to permit the optional addition of*  
674 *vitamins and mineral nutrients to plant-based beverages*. Available online:  
675 [https://www.canada.ca/en/health-canada/services/food-nutrition/legislation-](https://www.canada.ca/en/health-canada/services/food-nutrition/legislation-guidelines/interim-marketing-authorizations/permit-optional-addition-vitamins-mineral-nutrients-plant-based-beverages.html)  
676 [guidelines/interim-marketing-authorizations/permit-optional-addition-vitamins-mineral-](https://www.canada.ca/en/health-canada/services/food-nutrition/legislation-guidelines/interim-marketing-authorizations/permit-optional-addition-vitamins-mineral-nutrients-plant-based-beverages.html)  
677 [nutrients-plant-based-beverages.html](https://www.canada.ca/en/health-canada/services/food-nutrition/legislation-guidelines/interim-marketing-authorizations/permit-optional-addition-vitamins-mineral-nutrients-plant-based-beverages.html) [Accessed 2021-05-01].
- 678 Health Canada (2016) *Nutrition Labelling: Table of Reference Amounts for Food*.  
679 Ottawa: Available online: <http://publications.gc.ca/site/fra/9.829061/publication.html>  
680 [Accessed 2021-03-31].
- 681 Health Canada (2017) *Reference Guide to Understanding and Using the Data: 2015*  
682 *Canadian Community Health Survey - Nutrition*. 978-0-660-08450-3. Available online:  
683 [https://www.canada.ca/en/health-canada/services/food-nutrition/food-nutrition-](https://www.canada.ca/en/health-canada/services/food-nutrition/food-nutrition-surveillance/health-nutrition-surveys/canadian-community-health-survey-cchs/reference-guide-understanding-using-data-2015.html)  
684 [surveillance/health-nutrition-surveys/canadian-community-health-survey-](https://www.canada.ca/en/health-canada/services/food-nutrition/food-nutrition-surveillance/health-nutrition-surveys/canadian-community-health-survey-cchs/reference-guide-understanding-using-data-2015.html)  
685 [cchs/reference-guide-understanding-using-data-2015.html](https://www.canada.ca/en/health-canada/services/food-nutrition/food-nutrition-surveillance/health-nutrition-surveys/canadian-community-health-survey-cchs/reference-guide-understanding-using-data-2015.html) [Accessed 2021-03-31].
- 686 Health Canada (2018a) *Canadian Nutrient File (CNF) 2015*. Available online:  
687 <https://food-nutrition.canada.ca/cnf-fce/index-eng.jsp> [Accessed
- 688 Health Canada (2018b) *Sodium Intake of Canadians in 2017*. Ottawa: Health Canada:  
689 Available online: [https://www.canada.ca/en/health-canada/services/publications/food-](https://www.canada.ca/en/health-canada/services/publications/food-nutrition/sodium-intake-canadians-2017.html)  
690 [nutrition/sodium-intake-canadians-2017.html](https://www.canada.ca/en/health-canada/services/publications/food-nutrition/sodium-intake-canadians-2017.html) [Accessed 2021-03-31].
- 691 Health Canada (2019a) *Canada's Dietary Guidelines - for Health Professionals and*  
692 *Policy Makers*. Available online: <https://food-guide.canada.ca/en/guidelines/> [Accessed  
693 2021-03-31].
- 694 Health Canada (2019b) *Canada's food guide*. Ottawa: Health Canada: Available  
695 online: <https://food-guide.canada.ca/en/> [Accessed 2021-03-31].
- 696 Health Canada (2019c) *Food, Nutrients and Health: Interim Evidence Update 2018 for*  
697 *Health Professionals and Policy Makers*. Ottawa: Health Canada: Available online:  
698 [https://www.canada.ca/content/dam/hc-sc/documents/services/canada-food-](https://www.canada.ca/content/dam/hc-sc/documents/services/canada-food-guide/resources/evidence/food-nutrients-health-interim-evidence-update-2018/pub1-eng.pdf)  
699 [guide/resources/evidence/food-nutrients-health-interim-evidence-update-2018/pub1-](https://www.canada.ca/content/dam/hc-sc/documents/services/canada-food-guide/resources/evidence/food-nutrients-health-interim-evidence-update-2018/pub1-eng.pdf)  
700 [eng.pdf](https://www.canada.ca/content/dam/hc-sc/documents/services/canada-food-guide/resources/evidence/food-nutrients-health-interim-evidence-update-2018/pub1-eng.pdf) [Accessed 2021-03-31].
- 701 Health Canada (2021) *Revision process for Canada's food guide*. Available online:  
702 [https://www.canada.ca/en/health-canada/services/canada-food-guide/about/revision-](https://www.canada.ca/en/health-canada/services/canada-food-guide/about/revision-process.html)  
703 [process.html](https://www.canada.ca/en/health-canada/services/canada-food-guide/about/revision-process.html) [Accessed 2021-03-31].
- 704 Kipnis, V., Freedman, L. S., Carroll, R. J. & Midthune, D. (2016) A bivariate  
705 measurement error model for semicontinuous and continuous variables: Application to  
706 nutritional epidemiology. *Biometrics*, 72(1), 106-15. doi:10.1111/biom.12377.  
707 PMID:26332011.

- 708 Kirkpatrick, S. I., Baranowski, T., Subar, A. F., Tooze, J. A. & Frongillo, E. A. (2019)  
 709 Best Practices for Conducting and Interpreting Studies to Validate Self-Report Dietary  
 710 Assessment Methods. *J Acad Nutr Diet*, 119(11), 1801-1816.  
 711 doi:10.1016/j.jand.2019.06.010. PMID:31521583.
- 712 Kirkpatrick, S. I., Reedy, J., Krebs-Smith, S. M., Pannucci, T. E., Subar, A. F., Wilson,  
 713 M. M., Lerman, J. L. & Tooze, J. A. (2018) Applications of the Healthy Eating Index for  
 714 Surveillance, Epidemiology, and Intervention Research: Considerations and Caveats. *J*  
 715 *Acad Nutr Diet*, 118(9), 1603-1621. doi:10.1016/j.jand.2018.05.020. PMID:30146072.
- 716 Krebs-Smith, S. M., Pannucci, T. E., Subar, A. F., Kirkpatrick, S. I., Lerman, J. L.,  
 717 Tooze, J. A., Wilson, M. M. & Reedy, J. (2018) Update of the Healthy Eating Index: HEI-  
 718 2015. *J Acad Nutr Diet*, 118(9), 1591-1602. doi:10.1016/j.jand.2018.05.021.  
 719 PMID:30146071.
- 720 Krebs-Smith, S. M., Subar, A. F. & Reedy, J. (2015) Examining Dietary Patterns in  
 721 Relation to Chronic Disease: Matching Measures and Methods to Questions of Interest.  
 722 *Circulation*, 132(9), 790-3. doi:10.1161/CIRCULATIONAHA.115.018010.  
 723 PMID:26260734.
- 724 Liese, A. D., Krebs-Smith, S. M., Subar, A. F., George, S. M., Harmon, B. E.,  
 725 Neuhouser, M. L., Boushey, C. J., Schap, T. E. & Reedy, J. (2015) The Dietary Patterns  
 726 Methods Project: synthesis of findings across cohorts and relevance to dietary  
 727 guidance. *J Nutr*, 145(3), 393-402. doi:10.3945/jn.114.205336. PMID:25733454.
- 728 Miller, V., Webb, P., Micha, R., Mozaffarian, D. & Global Dietary, D. (2020) Defining diet  
 729 quality: a synthesis of dietary quality metrics and their validity for the double burden of  
 730 malnutrition. *Lancet Planet Health*, 4(8), e352-e370. doi:10.1016/S2542-  
 731 5196(20)30162-5. PMID:32800153.
- 732 National Academies of Sciences Engineering Medicine (2019) *Dietary Reference*  
 733 *Intakes for Sodium and Potassium*. Translated from English by. Washington, DC: The  
 734 National Academies Press.
- 735 Ocke, M. C. (2013) Evaluation of methodologies for assessing the overall diet: dietary  
 736 quality scores and dietary pattern analysis. *Proc Nutr Soc*, 72(2), 191-9.  
 737 doi:10.1017/S0029665113000013. PMID:23360896.
- 738 Rana, H., Mallet, M.-C., Gonzalez, A., Verreault, M.-F. & St-Pierre, S. (2021) Free  
 739 Sugars Consumption in Canada. *Nutrients*, 13(5), 1471. doi:10.3390/nu13051471.  
 740 PMID:33925303.
- 741 Reedy, J., Lerman, J. L., Krebs-Smith, S. M., Kirkpatrick, S. I., Pannucci, T. E., Wilson,  
 742 M. M., Subar, A. F., Kahle, L. L. & Tooze, J. A. (2018) Evaluation of the Healthy Eating  
 743 Index-2015. *J Acad Nutr Diet*, 118(9), 1622-1633. doi:10.1016/j.jand.2018.05.019.  
 744 PMID:30146073.
- 745 Romaguera, D., Vergnaud, A. C., Peeters, P. H., van Gils, C. H., Chan, D. S., Ferrari,  
 746 P., Romieu, I., Jenab, M., Slimani, N., Clavel-Chapelon, F., Fagherazzi, G., Perquier, F.,  
 747 Kaaks, R., Teucher, B., Boeing, H., von Rusten, A., Tjonneland, A., Olsen, A., Dahm, C.  
 748 C., Overvad, K., Quiros, J. R., Gonzalez, C. A., Sanchez, M. J., Navarro, C., Barricarte,  
 749 A., Dorronsoro, M., Khaw, K. T., Wareham, N. J., Crowe, F. L., Key, T. J., Trichopoulou,

750 A., Lagiou, P., Bamia, C., Masala, G., Vineis, P., Tumino, R., Sieri, S., Panico, S., May,  
 751 A. M., Bueno-de-Mesquita, H. B., Buchner, F. L., Wirfalt, E., Manjer, J., Johansson, I.,  
 752 Hallmans, G., Skeie, G., Benjaminsen Borch, K., Parr, C. L., Riboli, E. & Norat, T.  
 753 (2012) Is concordance with World Cancer Research Fund/American Institute for Cancer  
 754 Research guidelines for cancer prevention related to subsequent risk of cancer?  
 755 Results from the EPIC study. *Am J Clin Nutr*, 96(1), 150-63.  
 756 doi:10.3945/ajcn.111.031674. PMID:22592101.

757 Shams-White, M. M., Brockton, N. T., Mitrou, P., Romaguera, D., Brown, S., Bender, A.,  
 758 Kahle, L. L. & Reedy, J. (2019) Operationalizing the 2018 World Cancer Research  
 759 Fund/American Institute for Cancer Research (WCRF/AICR) Cancer Prevention  
 760 Recommendations: A Standardized Scoring System. *Nutrients*, 11(7).  
 761 doi:10.3390/nu11071572. PMID:31336836.

762 Thompson, F. E., Kirkpatrick, S. I., Subar, A. F., Reedy, J., Schap, T. E., Wilson, M. M.  
 763 & Krebs-Smith, S. M. (2015) The National Cancer Institute's Dietary Assessment  
 764 Primer: A Resource for Diet Research. *J Acad Nutr Diet*, 115(12), 1986-95.  
 765 doi:10.1016/j.jand.2015.08.016. PMID:26422452.

766 Wirt, A. & Collins, C. E. (2009) Diet quality--what is it and does it matter? *Public Health*  
 767 *Nutr*, 12(12), 2473-92. doi:10.1017/S136898000900531X. PMID:19335941.

768 World Cancer Research Fund/American Institute for Cancer Research (2018) *Diet,*  
 769 *nutrition, physical activity and cancer: a global perspective. Continuous Update Project*  
 770 *Expert Report 2018*. Washington: American Institute for Cancer Research. Available  
 771 online: [https://www.wcrf.org/wp-content/uploads/2021/02/Summary-of-Third-Expert-](https://www.wcrf.org/wp-content/uploads/2021/02/Summary-of-Third-Expert-Report-2018.pdf)  
 772 [Report-2018.pdf](https://www.wcrf.org/wp-content/uploads/2021/02/Summary-of-Third-Expert-Report-2018.pdf) [Accessed 2021-11-01].

773 World Health Organization (2012) *Guideline: Sodium Intake for Adults and Children*.  
 774 9789241504836. Geneva: World Health Organization:  
 775

776 **Tables and figures**777 **Table 1.** Key healthy food choices recommendations in CFG-2019 and corresponding

## 778 components of the HEFI-2019

| Source of information                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                               |                                                           |                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|----------------------------------|
| Dietary Guidelines                                                                                                                                                       | Healthy Eating Recommendations<br>and/or Other CFG Guidance                                                                                                                                                                                                                                                                                                   | Component #                                               | Component Name                   |
| Nutritious foods are the foundation for healthy eating.                                                                                                                  | Make it a habit to eat a variety of healthy foods each day                                                                                                                                                                                                                                                                                                    | Not independently assessed (see various components below) | n/a                              |
| Vegetables, fruit, whole grains, and protein foods should be consumed regularly                                                                                          | Eat plenty of vegetables and fruits                                                                                                                                                                                                                                                                                                                           | <b>1</b>                                                  | <b>Vegetables and fruits</b>     |
|                                                                                                                                                                          | Eat whole-grain foods                                                                                                                                                                                                                                                                                                                                         | <b>2</b>                                                  | <b>Whole-grain foods</b>         |
|                                                                                                                                                                          | Eat protein foods                                                                                                                                                                                                                                                                                                                                             | <b>3</b>                                                  | <b>Grain foods ratio</b>         |
| Among protein foods, consume plant-based more often.                                                                                                                     | Choose protein foods that come from plants more often                                                                                                                                                                                                                                                                                                         | <b>4</b>                                                  | <b>Protein foods</b>             |
| Water should be the beverage of choice.                                                                                                                                  | Choose protein foods that come from plants more often                                                                                                                                                                                                                                                                                                         | <b>5</b>                                                  | <b>Plant-based protein foods</b> |
|                                                                                                                                                                          | Make water your drink of choice<br>• Replace sugary drinks with water<br><br><i>Healthy drink options other than water can include:</i><br><br>• <i>white milk (unsweetened 0% and 1% milk)</i><br>• <i>unsweetened fortified plant-based beverages such as:</i><br>◦ <i>soy beverage</i><br>◦ <i>almond beverage</i><br>• <i>unsweetened coffee and teas</i> | <b>6</b>                                                  | <b>Beverages</b>                 |
|                                                                                                                                                                          | Sugar substitutes do not need to be consumed to reduce the intake of free sugars                                                                                                                                                                                                                                                                              |                                                           |                                  |
| There are health risks associated with alcohol consumption                                                                                                               | n/a                                                                                                                                                                                                                                                                                                                                                           |                                                           |                                  |
| Foods that contain mostly unsaturated fat should replace foods that contain mostly saturated fat.                                                                        | Choose foods with healthy fats instead of saturated fats                                                                                                                                                                                                                                                                                                      | <b>7</b>                                                  | <b>Fatty acids ratio</b>         |
| Processed or prepared foods and beverages that contribute to excess sodium, free sugars, or saturated fat undermine healthy eating and should not be consumed regularly. | Limit highly processed foods. If you choose these foods, eat them less often and in small amounts.<br>• Prepare meals and snacks using ingredients that have little to no added sodium, sugars or saturated fat<br>• Choose healthier menu options when eating out                                                                                            | <b>8</b>                                                  | <b>Saturated fats</b>            |
|                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                               | <b>9</b>                                                  | <b>Free sugars</b>               |
|                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                               | <b>10</b>                                                 | <b>Sodium</b>                    |

**Table 2.** Healthy Eating Food Index (HEFI)-2019 components, points and standards for scoring

| #  | Component name                   | Measurement                                                                                                   | Maximum Points | Unit           | Standard for minimum score            | Standard for maximum score |
|----|----------------------------------|---------------------------------------------------------------------------------------------------------------|----------------|----------------|---------------------------------------|----------------------------|
| 1  | <b>Vegetables and fruits</b>     | Ratio: Total vegetables and fruits <sup>a</sup> / Total foods <sup>b</sup>                                    | 20             | RA/RA          | No vegetables and no fruits           | ≥ 0.50                     |
| 2  | <b>Whole-grain foods</b>         | Ratio: Total whole-grain foods <sup>c</sup> / Total foods <sup>b</sup>                                        | 5              | RA/RA          | No whole-grain foods                  | ≥ 0.25                     |
| 3  | <b>Grain foods ratio</b>         | Ratio: Total whole-grain foods <sup>c</sup> / Total grain foods <sup>d</sup>                                  | 5              | RA/RA          | No whole-grain foods                  | = 1.0                      |
| 4  | <b>Protein foods</b>             | Ratio: Total protein foods <sup>e</sup> / Total foods <sup>b</sup>                                            | 5              | RA/RA          | No protein foods                      | ≥ 0.25                     |
| 5  | <b>Plant-based protein foods</b> | Ratio: Plant-based protein foods <sup>f</sup> / Total protein foods <sup>e</sup>                              | 5              | RA/RA          | No plant-based protein foods          | > 0.50                     |
| 6  | <b>Beverages</b>                 | Ratio: (Plain water including carbonated + unsweetened beverages) <sup>g</sup> / Total beverages <sup>h</sup> | 10             | g/g            | No water and no unsweetened beverages | = 1.0                      |
| 7  | <b>Fatty acids ratio</b>         | Ratio: (Mono- + polyunsaturated fat) / Total saturated fat                                                    | 5              | g/g            | ≤ 1.1 <sup>i</sup>                    | ≥ 2.6 <sup>j</sup>         |
| 8  | <b>Saturated fats</b>            | Ratio: Total saturated fat / energy                                                                           | 5              | %E (kcal/kcal) | ≥ 15%E <sup>k</sup>                   | < 10%E                     |
| 9  | <b>Free sugars</b>               | Ratio: Total free sugars / energy                                                                             | 10             | %E (kcal/kcal) | ≥ 20%E <sup>k</sup>                   | < 10%E                     |
| 10 | <b>Sodium</b>                    | Ratio: Total sodium / energy                                                                                  | 10             | mg / kcal      | ≥ 2.0 <sup>k</sup>                    | < 0.9 <sup>l</sup>         |

<sup>a</sup> All vegetables and fruits regardless of saturated fat, sodium or free sugar content; excludes fruit juice (i.e., considered as sugary drinks in CFG-2019).

<sup>b</sup> Includes all foods consumed as well as beverages considered in protein foods (i.e., unsweetened milk and unsweetened plant-based beverages that contain protein); excludes all other beverages as well as solid fats, oils and spreads and culinary ingredients (e.g., spices and baking soda).

<sup>c</sup> Foods where the first ingredient is either whole grains or whole wheat, regardless of saturated fat, sodium or free sugar content.

<sup>d</sup> Foods where the first ingredient is a grain (whole or not) regardless of saturated fat, sodium or free sugar content.

<sup>e</sup> All protein foods regardless of fat, sodium or sugars content; excludes processed meats (i.e., not considered protein foods in CFG-2019) and sweetened milks (i.e., considered as sugary drinks in CFG-2019).

<sup>f</sup> All plant-based protein foods, regardless of saturated fat, sodium or free sugar content.

<sup>g</sup> Unsweetened beverages include unsweetened coffee and tea, unsweetened milk and unsweetened plant-based beverages.

<sup>h</sup> 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.

<sup>i</sup> Approximately the **15<sup>th</sup> percentile** of intake based on data (single 24-hour recall) in Canadians from the 2015 CCHS – Nutrition.

<sup>j</sup> Corresponds to the **1<sup>st</sup> percentile** of unsaturated to saturated fats ratios among simulated diets developed to be fully consistent with all recommendations in CFG-2019.

<sup>k</sup> Approximately the **85<sup>th</sup> percentile** of intake based on data (single 24-hour recall) in Canadians from the 2015 CCHS – Nutrition.

<sup>l</sup> Standard for maximum points based on the Chronic Disease Risk Reduction (CDRR) for 14 y and older (i.e., 2300 mg) over the 90<sup>th</sup> percentile of usual energy intakes in respondents 2 y and older from the 2015 CCHS – Nutrition (i.e., approximately 2600 kcal, see methods for detail).

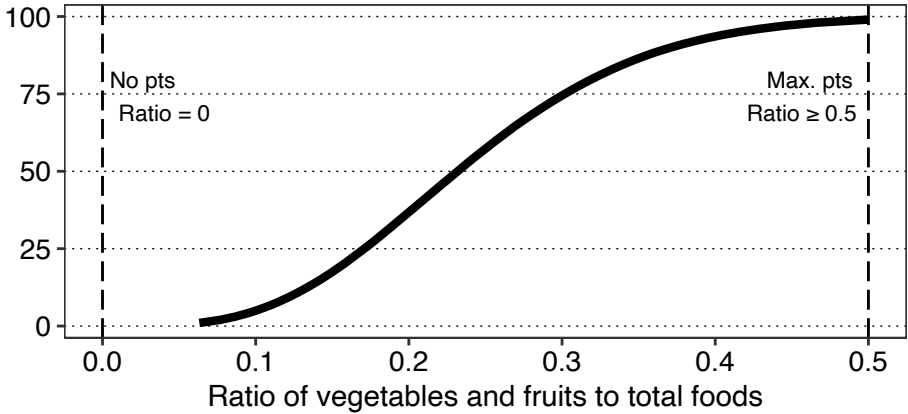
CCHS, Canadian Community Health Survey; CFG, Canada's food guide; RA, Reference Amounts (amount of food usually eaten by an individual at one sitting, defined as the Table of Reference Amounts in (Health Canada, 2016)); %E, percent of total energy.

## Figure legends

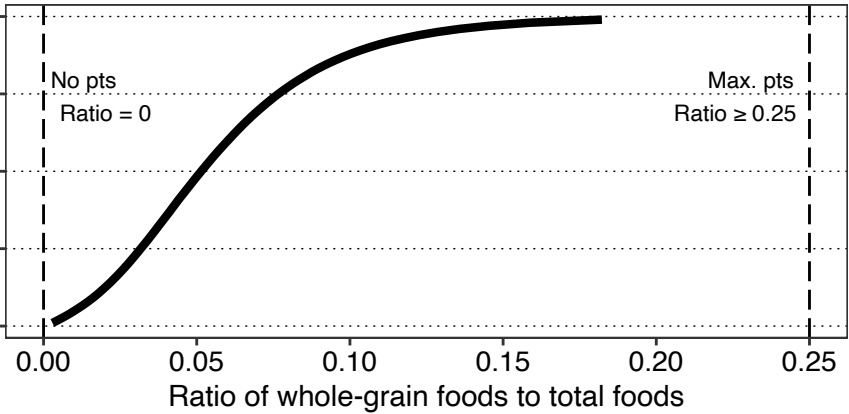
**Figure 1 legend:** Estimated cumulative distributions of each component of the HEFI-2019 as well as scoring standards (thresholds for minimum and maximum points, vertical dashed lines), based on usual intake data in Canadians aged 2 years and older (2015 CCHS - Nutrition). The National Cancer Institute bivariate method was used to estimate distributions of usual intakes for each component. CCHS, Canadian Community Health Survey; HEFI, Healthy Food Choice Index

For personal use only. This Just-IN manuscript is the accepted manuscript prior to copy editing and page composition. It may differ from the final official version of record.

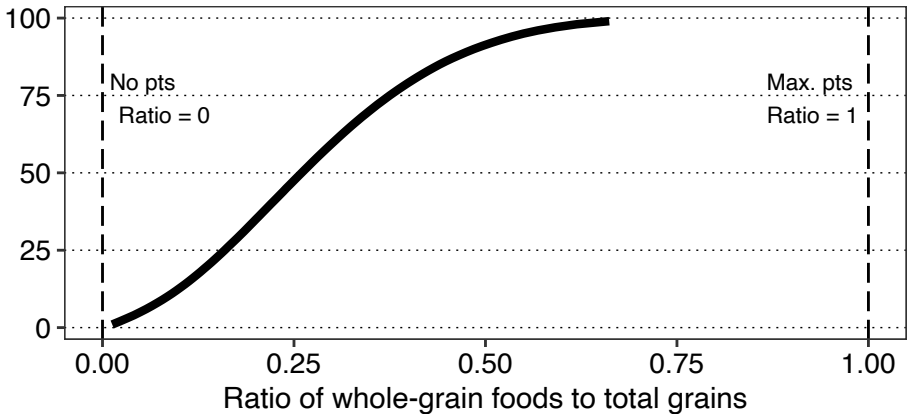
**Vegetables and fruits**



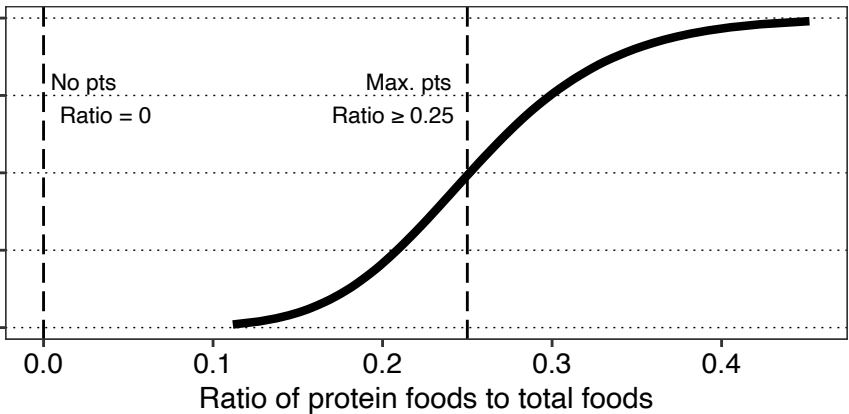
**Whole-grain foods**



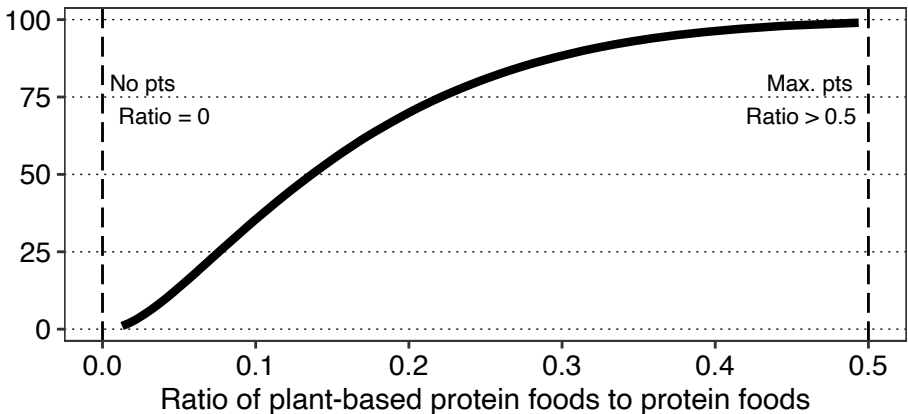
**Grain foods ratio**



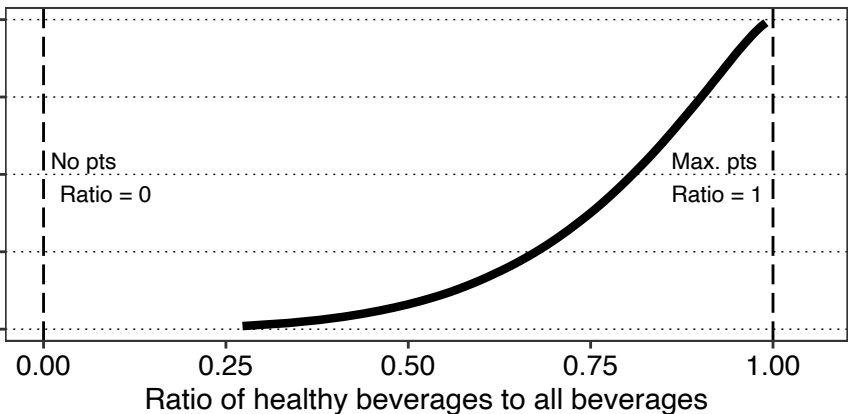
**Protein foods**



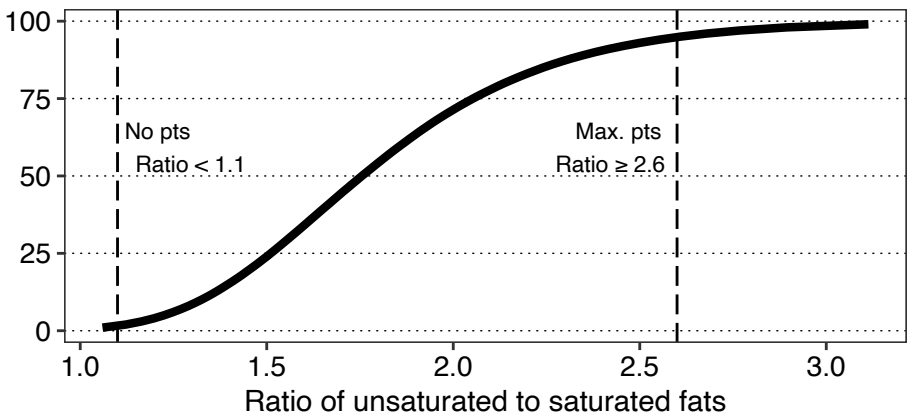
**Plant-based protein foods**



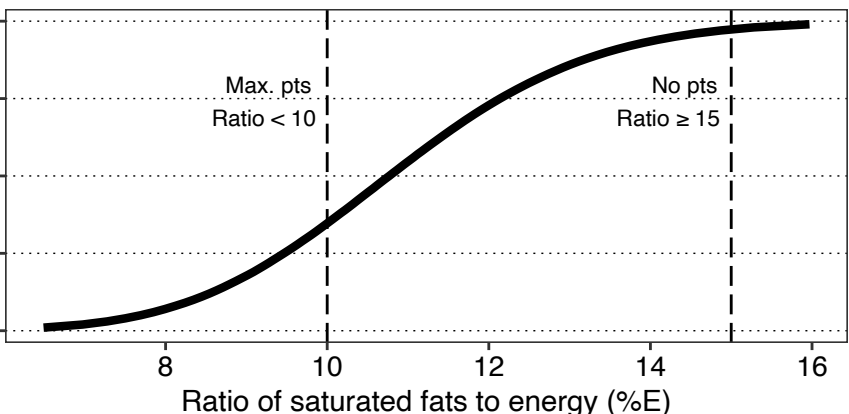
**Beverages**



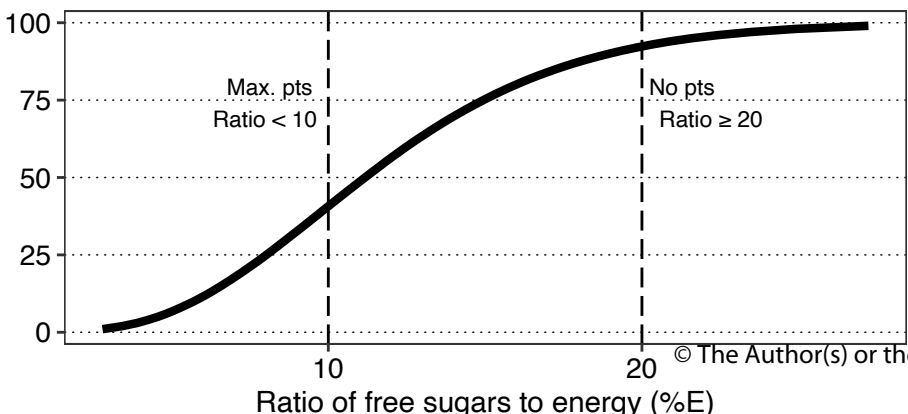
**Fatty acids ratio**



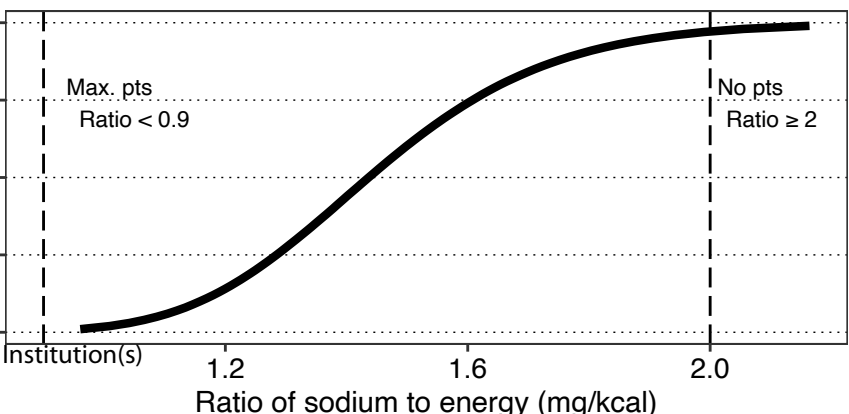
**Saturated fats**



**Free sugars**



**Sodium**



Brassard et al. Appl Physiol Nutr Metab 2022

**Table A1.** Classification of foods and nutrients according to the Healthy Eating Food Index (HEFI)-2019

| HEFI-2019 components          | Dietary constituents                                             |                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                          |                                                 | Example of foods equivalent to one reference amount |
|-------------------------------|------------------------------------------------------------------|-----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|-----------------------------------------------------|
|                               | Numerator or denominator of ratio                                | Inclusion                                                       | Details                                                                                                                                                                                                                                                                                                                                                                                                  | Exclusion                                       |                                                     |
| <b>Vegetables and fruits*</b> | Numerator (vegetables and fruits)                                | Fruit                                                           | All types of fruit, includes fruit purees                                                                                                                                                                                                                                                                                                                                                                | Fruit juice (included in other beverages below) | Apple, 140g                                         |
|                               |                                                                  | Dark green vegetables                                           | All dark leafy greens and other vegetables that are dark green in color.                                                                                                                                                                                                                                                                                                                                 |                                                 | Spinach, 85g                                        |
|                               |                                                                  | Deep yellow or orange vegetables                                | All carrots, winter squash and other deep yellow or orange vegetables.                                                                                                                                                                                                                                                                                                                                   | Sweet potatoes (included in starchy vegetable)  | Carrots, 85g                                        |
|                               |                                                                  | Starchy vegetables                                              | All types of potato, white and yellow corn, sweet potato, yam, parsnip, plantain, cassava, bread fruit, taro root, burdock root and lotus root; regardless of preparation<br>All remaining vegetables that do not fit into any of the other vegetable subgroups.                                                                                                                                         |                                                 | Mashed potatoes, 140g                               |
|                               |                                                                  | Other vegetables                                                | Includes tomato sauce.                                                                                                                                                                                                                                                                                                                                                                                   |                                                 | Tomato sauce, 62g                                   |
| <b>Whole-grain foods*</b>     | Numerator (whole grain, whole grain foods and whole wheat foods) | whole grain, whole grain foods and whole wheat foods            | All whole grains that are 100% whole grain and all grain products with whole grain or whole wheat as the first ingredient                                                                                                                                                                                                                                                                                |                                                 | Oatmeal, 40g dry                                    |
| <b>Grain foods ratio</b>      | Numerator (whole grain, whole grain foods and whole wheat foods) | whole grain, whole grain foods and whole wheat foods            | All whole grains that are 100% whole grain and all grain products with whole grain or whole wheat as the first ingredient                                                                                                                                                                                                                                                                                |                                                 | Oatmeal, 40g dry                                    |
|                               | Denominator (non-whole grain and non-whole wheat foods)          | Non-whole grain and non-whole wheat foods                       | All refined grain products that do not have whole grain or whole wheat as the first ingredient. Includes cornmeal; tapioca and other plant-based starchy items.                                                                                                                                                                                                                                          |                                                 | Bread, 75g                                          |
| <b>Protein foods*</b>         | Numerator (plant-based protein foods)                            | Plant-based yogurts                                             | Fortified Yogurt, yogurt drinks, kefir and similar products made from plant-based sources that contain protein<br>All fortified cheese-like products made from plant-based sources that contain sufficient protein. The protein content must be not less than 25g of per 100g of food. For products intended to resemble fresh cheese, the protein content must be not less than 15g per 100g of food. † |                                                 | (Plant-based) yogurt, 175g                          |
|                               |                                                                  | Fortified plant-based cheeses (that contain sufficient protein) |                                                                                                                                                                                                                                                                                                                                                                                                          |                                                 | (Plant-based) cheese, 30g                           |

Brassard et al. Appl Physiol Nutr Metab 2022

|                                        |                                                         |                                                                                                                                                                |                                                                                     |                               |
|----------------------------------------|---------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------|
| Numerator (animal-based protein foods) | Legumes                                                 | Beans, dried peas, lentils, soybeans and tofu (excluding soy beverages) Note: Peanuts are in nuts, fresh peas are in other vegetables                          | Soy beverages (included in beverages or protein foods, depending on sugars content) | Tofu, 85g                     |
|                                        | Simulated meats                                         | Simulated meat products such as veggie/meatless patties, nuggets. Foods are typically made with protein isolates.                                              |                                                                                     | Simulated meats, 60g (cooked) |
|                                        | Nuts and seeds                                          | All nuts and seeds, including peanuts.                                                                                                                         |                                                                                     | Nuts, 50g                     |
|                                        | Plant-based beverages (that contain sufficient protein) | All fortified and non fortified plant-based beverages, including soy, that contain sufficient protein. The protein content must be not less than 2.5g/100mL. † | Sweetened plant-based beverages (included in other beverages below)                 | Plant-based beverages, 258g   |
|                                        | Yogurts and kefir                                       | Yogurt, yogurt drinks, kefir and similar products made from the milk of cows, goats and other animals                                                          |                                                                                     | Yogurt, 175g                  |
|                                        | Cheeses                                                 | All types of cheese made from the milk of animals such as cow, goat and buffalo cheese. Include cheese with ingredients such as herbs, flavourings, spices.    |                                                                                     | Cheese, 30g                   |
|                                        | Other milk-based foods                                  | All types of dairy-based desserts, dairy-based soups and dairy-based sauces                                                                                    |                                                                                     | Fresh dairy desserts, 100g    |
|                                        | Red meats                                               | All beef, pork, lamb and goat meat from domesticated animals                                                                                                   | Processed meats (included in the denominator total foods)                           | Meat, 100g (cooked)           |
|                                        | Game meats                                              | Meat from all wild land and sea mammals                                                                                                                        |                                                                                     | Meat, 100g (cooked)           |
|                                        | Poultry and wild birds                                  | Meat from all types of birds                                                                                                                                   |                                                                                     | Poultry, 100g (cooked)        |
|                                        | Eggs                                                    | All eggs                                                                                                                                                       |                                                                                     | Eggs, 100g                    |
|                                        | Fish and shellfish                                      | All fish and shellfish                                                                                                                                         |                                                                                     | Fish, 100g (cooked)           |
|                                        | Organ meats                                             | The organs of all wild and domesticated animals                                                                                                                |                                                                                     | Meat, 100g (cooked)           |
|                                        | Milks                                                   | All animal-based milks such as cow, goat or buffalo milk as well as milk-based beverages. Includes skim milk powder                                            | All sweetened milks (included in sugary drinks)                                     | Milk, 258g                    |

Brassard et al. Appl Physiol Nutr Metab 2022

|                                                                     |                                             |                                                                                                |                                                                                                                                                                 |                                                             |                                                |
|---------------------------------------------------------------------|---------------------------------------------|------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------|
| <b>Vegetables and fruits, Whole-grain foods and Protein foods ‡</b> | Denominator (total foods)                   | All foods included in numerators of vegetables and fruits, Whole-grain foods and Protein foods | See above                                                                                                                                                       | See above                                                   | See above                                      |
|                                                                     |                                             | Non-whole grain and non-whole wheat foods                                                      | All refined grain products that do not have whole grain or whole wheat as the first ingredient. Includes cornmeal; tapioca and other plant-based starchy items. |                                                             | Bread, 75g                                     |
|                                                                     |                                             | Condiments, sauces and lower fat dressings                                                     | Condiments, non-dary sauces, pickled vegetables, lower fat dressings, fillings and seasonings with salt and sugar added                                         | Unsaturated fats and oils, saturated fats and oils          | Dips or spreads, 30g                           |
|                                                                     |                                             | Other snack foods                                                                              | Chips, pretzels, extruded snacks. Includes "sugar free" versions of these snack foods.                                                                          |                                                             | Chips or pretzels, 50g                         |
|                                                                     |                                             | Higher sugar and/or higher fat foods                                                           | Higher fat and/or sugar foods where the first ingredient is either sugar or fat                                                                                 | Sugary drinks (included in other beverages below)           | Chocolate bars, 40g                            |
|                                                                     |                                             | Processed meats                                                                                | All meats preserved by smoking, curing salting or the addition of chemical preservatives                                                                        |                                                             | Bologna, 55g (cooked)                          |
|                                                                     |                                             | Baby and toddler foods                                                                         | Foods that directed for consumption of infants and toddlers.                                                                                                    |                                                             | Cereals, 30g                                   |
| <b>Plant-based protein foods</b>                                    | Numerator (plant-based protein foods)       | Meal replacements and supplements                                                              | Meal replacements and foods considered to be supplements                                                                                                        |                                                             | Meal replacement ready to drink beverage, 266g |
|                                                                     |                                             | See above                                                                                      | See above                                                                                                                                                       | See above                                                   | See above                                      |
|                                                                     |                                             | See above                                                                                      | See above                                                                                                                                                       | See above                                                   | See above                                      |
| <b>Beverages</b>                                                    | Numerator (water and unsweetened beverages) | Water                                                                                          | All plain still waters (tap and bottled), plain and unsweetened carbonated waters, with or without flavourings. Excludes sweetened waters.                      | Artificially-sweetened waters (included in other beverages) | NA §                                           |
|                                                                     |                                             | Unsweetened coffee and tea                                                                     | Plain and unsweetened coffee and tea                                                                                                                            |                                                             | NA §                                           |
|                                                                     |                                             |                                                                                                |                                                                                                                                                                 |                                                             |                                                |

## Brassard et al. Appl Physiol Nutr Metab 2022

|                          |                                            |                                                    |                                                                                                                                                                         |                                                 |       |
|--------------------------|--------------------------------------------|----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|-------|
|                          |                                            | Plant-based beverages                              | All fortified and non-fortified unsweetened plant-based beverages that contain protein† (e.g., soy) or not (e.g., almond, cashew, rice, coconut)                        |                                                 | NA \$ |
|                          |                                            | Milks                                              | All animal-based milks such as cow, goat or buffalo milk as well as milk-based beverages. Includes skim milk powder                                                     | All sweetened milks (included in sugary drinks) | NA \$ |
|                          |                                            | Fruit juice                                        | All fruit juices without added sugars (100%)                                                                                                                            |                                                 | NA \$ |
|                          |                                            | Vegetable juice                                    | Vegetable juice and cocktail                                                                                                                                            |                                                 | NA \$ |
|                          | Denominator (all other types of beverages) | Sugary drinks and artificially-sweetened beverages | Includes sweetened coffee and tea, club soda, vitamin and flavoured waters, artificially sweetened beverages, juice drinks/cocktails, juice with sugars added and sodas |                                                 | NA \$ |
|                          |                                            | Sweetened plant-based beverages                    | All fortified and non-fortified sweetened plant-based beverages that contain protein (e.g., soy) or not (e.g., almond, cashew, rice, coconut)                           |                                                 | NA \$ |
|                          |                                            | Alcoholic beverages                                | All beverages with alcohol                                                                                                                                              |                                                 | NA \$ |
| <b>Fatty acids ratio</b> | Numerator                                  | Total grams of mono- and polyunsaturated fats      |                                                                                                                                                                         |                                                 |       |
|                          | Denominator                                | Total grams of saturated fats                      |                                                                                                                                                                         |                                                 |       |
| <b>Saturated fats</b>    | Numerator                                  | Total calories from saturated fats                 |                                                                                                                                                                         |                                                 |       |
|                          | Denominator                                | Total calories from all foods and beverages        |                                                                                                                                                                         |                                                 |       |
| <b>Free sugars</b>       | Numerator                                  | Total calories from free sugars                    |                                                                                                                                                                         |                                                 |       |
|                          | Denominator                                | Total calories from all foods and beverages        |                                                                                                                                                                         |                                                 |       |
| <b>Sodium</b>            | Numerator                                  | Total grams from sodium                            |                                                                                                                                                                         |                                                 |       |
|                          | Denominator                                | Total calories from all foods and beverages        |                                                                                                                                                                         |                                                 |       |

\* The denominator for these components is total foods.

† Fortified plant-based cheeses, criteria adapted from (Government of Canada, 2017b) and Plant-based beverages, criteria adapted from (Government of Canada, 2017a)

‡ Totals foods exclude fats and oils (e.g., vegetable oils), all beverages without protein as well as herbs, spices and other culinary ingredients (e.g., baking soda)

§ Grams are used to calculate the amount of beverages consumed

Brassard et al. Appl Physiol Nutr Metab 2022

## References

Government of Canada (2017a) *Interim Policy on the Use of Expired Interim Marketing Authorizations Related to Food Fortification (1)*. Available online: <https://www.canada.ca/en/health-canada/services/food-nutrition/legislation-guidelines/policies/interim-policy-on-use-expired-interim-marketing-authorizations-related-food-fortification.html#a61> [Accessed January 7, 2022].

Government of Canada (2017b) *Interim Policy on the Use of Expired Interim Marketing Authorizations Related to Food Fortification (4)*. Available online: <https://www.canada.ca/en/health-canada/services/food-nutrition/legislation-guidelines/policies/interim-policy-on-use-expired-interim-marketing-authorizations-related-food-fortification.html#a64> [Accessed January 7, 2022].