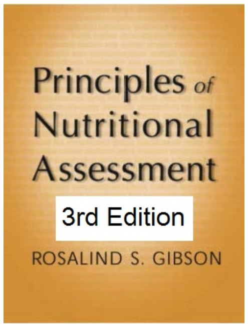

Arimond M, Deitchler M: Principles of Nutritional Assessment: Dietary Guidelines and Assessing Diet Quality

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Abstract

Abstract goes here

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https://nutritionalassessment.org/diet/
Email: arimond.nutrition@gmail.com

8c. Dietary Guidelines and Assessing Diet Quality

This chapter covers two related but distinct topics: Food-based dietary guidelines, often provided by national health authorities, and assessment of diet quality. The section on assessment of diet quality has a primary focus on applications at the population level, for monitoring diet quality, assessing diet-disease associations, and evaluating policy and programmatic interventions. The two topics in this section are linked in this population-level focus, and because assessment of diet quality is sometimes approached through assessing adherence to national food-based dietary guidelines. However, the section also covers a range of other approaches to assessing diet quality in populations. Learning objectives for readers include gaining understanding of:

- The role of food-based dietary guidelines in communicating guidance from national health authorities;
- The range of topics covered by food-based dietary guidelines, and some areas of consistency and difference across various national guidelines;
- The evolution of definitions of diet quality, and how this has influenced assessment of diet quality;

Contents:

- The wide diversity of diet quality indices currently in use;
- Some of the main types of indices, including those based on national food-based dietary guidelines, on regional diets, and on other summaries of evidence for diet-health relationships;
- How indices differ in their development, measurement (data sources), calculation and use;
- Which indices have lower data requirements for their calculation;
- How new concerns with sustainability and planetary health may affect diet quality definitions and assessment.

8c.1 Food-based dietary guidelines

This section provides a brief overview of the development and communication of food-based dietary guidelines (FBDGs), with a focus on those developed by national authorities. The section also describes a global archive for FBDGs and comments on areas of consistency across national guidelines. The section concludes with comments on likely future directions for FBDGs.

Science-based guidance on healthy diets is available from a variety of sources, including from national governments, international authorities such as the World Health Organization (WHO), the Food and Agriculture Organization of the United Nations (FAO), and medical or dietetic professional societies, among others.

FBDGs translate current scientific knowledge about relationships between food intakes and health outcomes into clear population-level guidance. They are "food-based" in contrast to guidance on nutrient intakes such as various Nutrient Reference Values (see Section X). They often provide advice and guidance on dietary patterns — what to eat and drink, how often, and in what amount. In this Section, we focus on FBDGs developed at the national level.

The earliest dietary guidance from national governments was focused on ensuring nutrient adequacy of diets (Harper, 1987). However, by the late 20th century the focus shifted to include a strong emphasis on reducing risks for non-communicable diseases (NCDs, such as cardiovascular diseases, metabolic syndrome, type 2 diabetes, and cancers), while still ensuring nutrient adequacy.

More recently, there have been calls to integrate considerations of environmental sustainability into FBDGs; however, to date this has been rare (Gonzalez Fischer & Garnett, 2016; Springmann et al., 2020). Some FBDGs also integrate guidance on physical activity, food safety, food skills (such as choosing healthier foods while shopping, and preparing meals), the role of ultra-processed foods, and other topics.

8c.1.1 Development of national-level food-based dietary guidelines

WHO and FAO have provided guidance to countries on how to develop FBDGs (WHO/FAO, 1998). This development process for national FBDGs was summarized by the European Food Safety Authority (European Food Safety Authority (EFSA), 2010) as including the following steps:

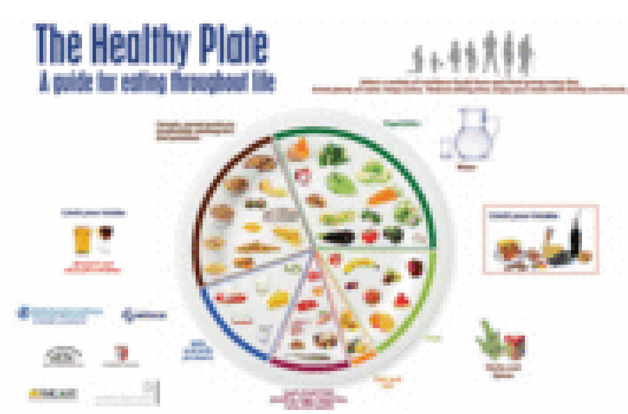
- Identify diet-health relationships (based on national but also global evidence);
- Using national data sources, identify:
  - Diet-related health problems;
  - Nutrients of public health importance;
  - Food groups relevant for FBDGs (for example, food groups with known links to health outcomes, and for sources of nutrients of public health importance);
  - Food consumption patterns;
- Test FBDGs with audiences and refine them;
- Develop graphical representations of FBDGs.

The development of FBDGs requires synthesis of a wide range of evidence and contextual information, although in practice some types of information may not be available. For example, many countries lack recent and nationally representative information on food consumption patterns.

The process also calls for the involvement of multiple stakeholders and can be both a technical and a political process. Through considering food consumption patterns and cultural dietary preferences, the resulting guidelines should allow for flexibility in food choices, addressing socioeconomic constraints and respecting cultural diversity within national populations (WHO/FAO 1998).

A majority of national FBDGs include some type of summary graphic, sometimes called a food guide, to convey concepts like diversity and proportionality among different food groups. The graphics sometimes also include specific details on quantities (standard servings per day or per week) for various food groups.

Examples of summary graphics include images of healthy plates, food pyramids, food baskets, or other cultural shapes Three examples are shown in Figure 8c.1 — Malta, Oman, and Estonia.



Malta

(Altamirano Martínez et al. 2015; van't Erve et al., 2017; Herforth et al., 2019). Some countries provide several graphic images, such as both a pyramid and a healthy plate. See, for example, images for the Finnish FBDGs and the Swiss FBDGs

8c.1.2 Communication and implementation of national-level food-based dietary guidelines

FBDGs aim to provide actionable guidance for consumers and for public health and medical practitioners. Full implementation of FBDGs includes not only development of a variety of targeted consumer

[Oman]

[Estonia]

Figure 8c.1: Figure 8c.1 Examples of graphic images from national food guides from Malta, Oman and Estonia. Reproduced with permission from....

education strategies and materials, but also integration within a range of sectoral policies and programs to help ensure that healthy diets are available, accessible, and affordable ([Wijesinha-Bettoni et al., 2021]). Policies and programs include those related to public procurement of foods (for example, for feeding in schools and other institutions), taxes and food subsidies, and various food security, nutrition and agricultural policies and programs. More information on implementation of FBDGs is available at FAO.

Given these varied uses, governments develop a variety of documents and tools to communicate and implement the FBDGs. These may include:

- Technical documents detailing the process of evidence review and justifying each guideline statement, or key message. Technical documents may include results of systematic reviews of evidence on diet-health relationships, diet modeling studies, and/or references to systematic reviews from other sources (see, for example, [New Zealand's documentation of evidence]);
- Sector-specific policies, regulations and guidance; for example, policies and guidance for implementation of school meals programs that incorporate the national FBDGs (see, for example, [U.S. regulations for school meals programs]);
- Guidance for public-health and medical practitioners, which may be at an intermediate technical level, and with a practical focus to help them translate the FBDGs for consumers (see, for example, [Canada's Dietary Guidelines for Health Professionals and Policy Makers]);
- Short, simple consumer-facing documents such as brochures, posters, and brief graphical food guides with advice on food groups (see, for example, [the food guide graphic and tri-fold brochure from Benin]);
- Consumer-facing internet pages and applications that provide a variety of tools for learning and self-assessment (see, for example, [Canada's Food Guide webpage]).

When evaluating of the impact of programs and policies, it is often desirable to measure and assess adherence to dietary guidance. See Section 8c.2 for a discussion of different approaches to assessing diet quality and adherence to dietary guidance. Once fully implemented, the FBDGs themselves should also be evaluated for their effectiveness; however, up to the present, information on effectiveness is limited.

8c.1.3 Repository of national food-based dietary guidelines

The FAO maintains a repository of national FBDGs, which currently (December, 2021) includes FBDGs for 95 countries. Each country page includes standard information provided by national authorities for most or all countries (see Box 8c.1). In addition to the information in Box 8c.1, available for most or all countries, newly updated country pages also include information on implementation, evaluation, and incorporation of sustainability concerns.

Box 8c.1 Information on national food-based dietary guidelines.

- Official name of the country's dietary guidelines;
- Publication year of the most recent guidelines;
- Development process and stakeholders involved;
- Intended audience and age groups covered;
- Description of the food guide graphic;
- Key messages;
- Links to a variety of downloadable materials, including food guides and technical documents, and to relevant government websites if applicable.

FBDGs are currently (December, 2021) available at the repository for 33 European countries, 31 countries in the Americas, and 18 countries in the Asia-Pacific region, but for only 7 African countries. Availability varies by country income classification, with FBDGs available for slightly over half of all high- and upper-middle-income countries, just over one-quarter of lower-middle-income countries, and for fewer than one in ten low-income countries (based on World Bank 2021 country income classifications).

8c.1.4 Coverage of sub-populations

Countries have taken different approaches to providing guidance for specific age groups and physiological conditions:

- Some countries have taken a life-cycle approach in a single dietary guidelines document, and included sections with specific guidance for infants, young children, school-aged children, adolescents, and for pregnant and lactating women (see, for example, Kenya's National Guidelines for Healthy Diets and Physical Activity).
- Other countries have developed separate technical documents and/or consumer-facing guidance documents for some or all age and physiological groups (see, for example, New Zealand's technical background papers and consumer resources for different age groups).
- Other countries state that the main dietary guidelines document and key messages apply to all healthy individuals 2 years of age and older, but they may still highlight the needs of age groups or other sub-groups (vegetarians, pregnant or lactating women) within the main guidelines document (see, for example, Lebanon's Food-based Dietary Guidelines).
- The most common age group with separate and specific guidance is infants and young children under two years of age (see, for example, Technical and consumer-facing FBDG for Panama.

8c.1.5 Consistency of national food-based dietary guidelines

Commonalities and differences among national FBDGs graphics and key messages were described in several recent reviews (Altamirano Martínez et al. 2015; van't Erve et al., 2017; Herforth et al., 2019). All reviews summarized food guide graphics and noted that the two most commonly used graphics were versions of a pyramid or a plate/food circle. The remainder of this section is based on the review by Herforth et al. (2019).

Nearly all food guide graphics conveyed the importance of food group diversity and proportionality — that is, that some food groups should be consumed in larger quantities than others. However, only about one-third gave quantitative information on recommended amounts per day or per week (either in grams or as number of servings). Most graphics included depiction of fats and oils and of sugars/sweets, showing them as small in proportion to other groups. About one-third included depictions of other foods to be consumed in moderation, such as pizza, hamburgers, or salty snacks. About half included depictions of water, and about half included depictions of physical activity.

Excluding depiction of food groups to consume in moderation, the most common number of food groups depicted was four or five, with the most common groupings being: (1) Starchy staple foods; (2) Fruits and vegetables (either as one group or as two separate groups); (3) Dairy; and (4) Other protein foods (meat, poultry, fish, eggs, legumes, and sometimes nuts).

However, there was variability in whether legumes were grouped with protein foods, with vegetables, or with both. Dairy was frequently a separate group but was sometimes grouped with other protein foods. Many countries did not depict nuts or grouped them with fats and oils rather than with protein foods. Other inconsistencies related to how potatoes were classified (as starchy staples, or as vegetables) and in whether fruit juice was depicted with whole fruits.

Herforth et al. (2019) analyzed key messages in addition to graphics. The most consistent key messages were aligned with quantitative global guidance from the WHO, including messages on ample consumption of fruits and vegetables and moderation in intake of salt, added sugar, and fats (particularly saturated and trans-fats). Only about one-half of countries emphasized whole grain intake. Key messages encouraging dairy intake were nearly universal in Europe and North America but were less common in Asia, Africa, and Latin America. Some FBDGs provide “mixed” messages on unsaturated fats, with positive key messages indicating to choose them but with graphics grouping the healthier choices (nuts and oils) together with less healthy ones (saturated fats) as groups to moderate.

8c.1.6 Future directions for food-based dietary guidelines

Recent FBDGs from several countries have highlighted the need to consider environmental sustainability in addition to concerns with nutrient adequacy and NCD risk reduction. For example, Brazil (2014), Uruguay (2016), Ecuador (2018), and Sweden (2015) all identify environmental sustainability as a guiding principle or central focus for their FBDGs, and Qatar (2015) also includes a key message on environmental protection. WHO and FAO have also articulated guiding principles for sustainable healthy diets (FAO & WHO, 2019). As noted above, the FAO repository for FBDG has begun documenting country-level attention to sustainability.

Several recently published FBDGs also include a stronger focus on behaviors to help achieve healthy eating patterns. Several of the same countries noted above (Brazil, Ecuador, Uruguay), as well as Canada, include key messages and guidance around food skills, social aspects of eating (enjoying meals with family and with others), and/or being an informed consumer through reading labels and understanding food industry marketing practices. A number of countries also provide guidance to reduce intake of highly processed foods.

In summary, future FBDGs will likely continue to focus on nutrient adequacy and NCD risk reduction, but may move toward incorporating new themes of sustainability, skills, and messaging around highly processed foods. In addition, increased attention to go beyond careful development of FBDGs to thorough implementation and evaluation is also warranted (Wijesinha-Bettoni et al., 2021). Finally, FBDGs will continue to be updated to reflect new knowledge as well as changes in lifestyles and food supplies.

8c.2 Assessing diet quality

This section starts with brief comments on definitions of diet quality, and how these have changed over time. We then provide detailed discussion of the various ways researchers have measured diet quality, both in high-income "data-rich" settings, and in more resource-constrained settings. As noted earlier, our focus is on measurement for population-level applications. Numerous metrics (indicators, indices, and scores) have been developed to measure the quality of the diet. See Box 8c.2 for comments on vocabulary for metrics.

Box 8c.2 Metrics, indicators, indices and scores. "Metric" is a general term meaning a standard against which something is evaluated. Other similar terms include "indicator" or "index" — indicators are sometimes thought of as simple and reflecting only one dimension, and indices as composites summarizing across multiple dimensions. However, these terms are used differently by different authors. Metrics discussed in this section may be called indicators, indices, or scores. We use the name used by the authors who first developed or reported on the metric. Since many of the most common diet quality metrics are called an "index", we generally use "index" or "indices".

Some indices are based on national FBDGs but others are not, and have a different rationale. For recent reviews of diet quality indices, see: Burggraf et al., 2018; Trijsburg et al., 2019; Aljuraiban et al., 2020; and Miller et al., 2020).

The section covers:

- How the definition of diet quality has changed over time
- The basis, or rationale for various diet quality indices
- Uses of diet quality indices
- development process for diet quality indices
- Detailed examples of different types of diet quality indices

By providing detailed examples of diet quality indices, we aim to illustrate their variety and uses. The section closes with a brief discussion of new efforts to incorporate the idea of environmental sustainability into diet quality definitions and indices.

8c.2.1 Changing definitions of diet quality

Diet quality indices have evolved along with changing definitions of diet quality (see Box 8c.3). Early indices such as the "Mean Adequacy Ratio" (Guthrie et al., 1972) aimed to summarize nutrient adequacy only. Newer diet quality indices often aim to reflect multiple characteristics of diets. Many indices aim to reflect both nutrient adequacy and characteristics of diets related to NCD risk. Currently, efforts are underway to also incorporate sustainability concerns.

> **Box 8c.3 Evolution of diet quality definitions** Historically, ideas about diet quality were a response to deprivation, whether due to poverty or the demands of wartime economies. Healthy and high-quality diets were defined as those that were sufficient: first in calories and protein, and later in vitamins and minerals. Fruits, vegetables, and animal-source foods (dairy, meat, fish and eggs) were considered "protective" against deficiencies (see Harper, 1987 for a history of dietary guidance).
>
> However, as the food supply and food consumption patterns changed in many parts of the world, the second half of the 20th century brought new concerns and new diet quality concepts. Relationships between dietary patterns and non-communicable disease (NCD) risk were illuminated, and a large body of evidence emerged regarding a different type of 'protective' diet, one protective against NCDs (Mozaffarian, Rosenberg, and Uauy 2018)
>
> Evidence of benefit accumulated for particular regional diets, which could be adapted to suit other settings (for example, the Mediterranean and "alternate" Mediterranean patterns), for diets designed to reduce hypertension (for example, the "Dietary Approaches to Stop Hypertension" (DASH) diet) and others focused on NCD risk reduction more broadly.
>
> Other specific recent concerns related to diet quality include the inflammatory effects of dietary components and consequent NCD risk (Shivappa et al., 2014). and the impact of ultra-processed foods on nutrient intakes and health risks (Elizabeth et al. 2020). Food safety risks are not new but continue as a concern in all contexts. Beyond human health effects, there is increasing recognition of the effect of diets and food systems on planetary health, and these concerns are now incorporated in some definitions of diet quality (FAO & WHO, 2019).
>
> Global concerns thus now include sufficiency/adequacy, NCD risk reduction, food safety, and sustainability, and these concerns are relevant in all countries (GBD 2017 Diet Collaborators 2019).

8c.2.2 Basis for diet quality indices

Indices used for assessing diet quality may be based on national or global dietary guidelines, or they may be based on other assessments of evidence for diet-health relationships. Depending on the underlying definition of diet quality as well as on intended uses, diet quality indices may be designed to capture one, several, or all of the following characteristics of diets:

- Food groups consumed: Quantities, diversity between and/or within food groups, and/or balance (proportionality) among food groups;
- Macronutrient balance (for example, percent of energy from protein, carbohydrates and fat);
- Nutrient density of the diet (for example, nutrients per 1000 kilocalories);
- Nutrient adequacy of the diet relative to requirements;
- Moderation in consumption of foods and food groups that elevate NCD risk;

- Adherence to dietary patterns designed to minimize risk of NCDs;
- Adherence to defined healthy cultural dietary patterns;
- Environmental impact and/or sustainability of the diet;
- Adherence to dietary guidance from national or global health authorities, such as national FBDGs or World Health Organization (WHO) guidance.

There is much overlap among these characteristics. For example, measures of adherence to healthy cultural dietary patterns may capture food group diversity, proportionality, macronutrient balance, nutrient adequacy and NCD risk reduction. Examples include indices for regional diets such as Mediterranean diets (D'Alessandro & De Pergola, 2018) and "adapted" Mediterranean diets (Fung et al., 2006), Japanese diets (Kanauchi & Kanauchi, 2019), and Nordic diets (Hillesund et al., 2014).

As noted above, national FBDGs also generally have multiple objectives, including ensuring nutrient adequacy and reducing NCD risks. Increasingly, as noted in Section 8.c1, FBDGs may also aim to address environmental impacts of diets (Gonzalez Fischer & Garnett, 2016) and/or to specifically advise moderation in consumption of certain types of highly processed food (Ministry of Health of Brazil, 2014; Health Canada 2019).

Thus, diet quality indices designed to reflect adherence to national or global guidelines will reflect the definitions of diet quality and the diverse aspects of diets and dietary patterns that are described in the particular guidelines.

8c.2.3 Uses of diet quality indices

Diet quality indices have been developed and used for a variety of purposes, including:

- Assessment and monitoring
  - Describing diet quality for an individual
  - Describing diet quality among a population
  - Estimating distributions of diet quality among a population
  - Describing trends in population diet quality over time
- Epidemiological research
  - Examining associations between diet quality and a dependent variable (for example, does adherence to a dietary pattern reduce risk of a particular NCD?)
  - Examining associations between an independent variable and diet quality (for example, do lower income groups have lower diet quality?)
- Programmatic and policy uses
  - Targeting programs
  - Assessing the effects of policy and programmatic interventions on diet quality
  - Advocacy and informing policy development

Just as with nutrient intake assessment (Chapter 8b), diet quality assessment often requires accounting for day-to-day variation in intakes. See Sections 3.3, 8.2 and 8.3 for discussions of appropriate dietary measurement and analytic methods for various objectives.

Certain characteristics of indices may be more or less important depending on intended uses. For example, when an index will be used to compare diet quality across countries (or across regions or cultures within countries), the index should have the same meaning — that is, have the same association to outcomes — across diverse cultural dietary patterns (Frongillo et al., 2019). In some contexts, when an index is needed for frequent monitoring of trends (for example, annually or biannually), lower cost, lower burden indices may be required due to resource constraints. When an index will be used to summarize diet quality for the purposes of communicating or advocating with non-technical audiences (whether consumers or policymakers) the index should be amenable to simple, clear presentation and interpretation. Finally, for most uses, and particularly for use in assessing trends and in evaluating impacts of policy and programmatic interventions, indices should be responsive — that is, they should change in response to meaningful changes in diet quality.

8c.2.4 Development of diet quality indices

There are two general approaches to assessing dietary patterns of individuals, and to development of indices. One approach assesses the diet relative to a pre-defined set of criteria ("*a priori*" dietary patterns) such as national or global recommendations, or a defined cultural dietary pattern.

The second general approach ("*a posteriori*" dietary patterns, sometimes called "exploratory") is data driven, involving the examination of clustering of diet characteristics in a particular study sample (Gleason et al., 2015). There are several analytic approaches to defining a data-driven dietary pattern, including factor analysis, principal components analysis, and cluster analysis. Reduced rank regression is a hybrid approach, with a priori identification of characteristics combined with data-driven identification of patterns. Because data-driven dietary patterns are difficult to generalize beyond a particular study setting, they are not further discussed in this section.

For *a priori* dietary patterns, selection of index components (foods, nutrients, etc.) and quantitative criteria for intakes may be well-defined (for example, based on guidelines), but there are still many decisions to be taken during development of indices (Box 8c.4). In the next Section, many of these decisions will be illustrated with a detailed example describing development of the U.S. "Health Eating Index" (HEI), which measures adherence to the U.S. dietary guidelines.

Box 8c.4 Examples of decisions to be taken during development of diet quality indices

What are the component parts of the diet quality index?

- Should it include food items, food groups, nutrients, and/or food substances such as dietary fiber, polyphenols, or sugar?

When components are food groups, how are they defined? For example:

- Should potatoes or legumes "count" as vegetables?
- Should juice "count" as fruit?
- Should snails or insects "count" as "meat"?

Are energy intakes accounted for, to distinguish the impact of quantity of food from quality? If so, how? For example:

- Should food group intakes be "counted" in absolute terms, such as in grams? Or should food group intakes be counted in relative terms (for example, grams per 1000 kilocalories of total intake)?

How are components scored? For example:

- Is scoring based on absolute criteria, or on relative criteria, such as study-specific distributions of intake for each component?
- Does scoring differ for different age/sex groups, or other groupings?
- How many points per component?
- For scoring based on criteria (not distributions), should scoring be:
  - Dichotomous? (1 point if the criterion is achieved, and 0 points if not)?
  - Proportional (ranging from lowest score to highest depending on how closely intake adheres to the criterion or recommendation)?
  - Scored in some other way?

How are components weighted? How are sub-indices weighted? For example:

- Should all components be given the same "weight" in the total score? Or should some components be given heavier "weight" based on knowledge of associations to benefits or risks?
- For indices with both "adequacy" and "moderation" components, how should the total score for the set of all adequacy components be weighted relative to the total score for the set of moderation components?

Both during development of indices and afterwards, performance is evaluated in several ways. Indices should be valid and reliable and well-suited for intended uses. Validation of indices aims to answer the following questions, among others:

- Is the index well-grounded in theory?
- Does it cover all dimensions / characteristics of interest (content validity)?
- Does it perform in a way that is consistent with theory (construct validity)?

Kirkpatrick et al. (2019) provide a detailed discussion of validation issues for dietary assessment measures. For a discussion of validation concepts more broadly, see Frongillo et al. (2019).

8c.3 Examples of diet quality indices

This Section presents a series of specific examples of diet quality indices. Literature reviews have identified hundreds of diet quality indices; some are study- or context-specific, while others are proposed for national, regional or global use (Burggraf et al., 2018; Trijsburg et al., 2019; Aljuraiban et al., 2020; Miller et al., 2020). The purpose of this Section is to provide a small set of examples of diverse types of indices, with differing origins and intended uses.

Most indices have been developed for adult populations, though they have sometimes been adapted for children and adolescents. Indices developed or adapted for children and adolescents were recently reviewed by Dalwood et al. (2020).

Historically, most diet quality indices were initially developed in high-income countries and rely on quantitative dietary recall data from validated food frequency questionnaires and/or quantitative 24hr recalls for their measurement. These indices also require availability of detailed and comprehensive food composition data. However, several recent initiatives have aimed to develop lower burden proxy indices measuring one or more diet quality characteristics, with less costly data requirements, for use in global and/or national monitoring. Table 8c.1 presents some examples of some of the most widely used indices, as well as some newer indices intended for global use.

Name	Basis of Index
Food and/or nutrient-based indices	
Healthy Eating Index (HEI)	Measures adherence to key recommendations in the Dietary Guidelines for Americans
Alternate Healthy Eating Index (AHEI)	Measures consumption of a literature-based selection of foods and nutrients consistently associated with decreased risk of NCDs
Mediterranean Diet Score (MDS)	Measures adherence to one of the traditional dietary patterns of the Mediterranean region, or adapted versions of these
Dietary Approaches to Stop Hypertension diet index (DASH)	Measures adherence to a dietary pattern originally developed in a randomized controlled trial for reducing hypertension
Healthy Diet Indicator (HDI)	Measures adherence to WHO global dietary recommendations for the prevention of chronic disease
Indices based on other characteristics	
Dietary Inflammatory Index (DII)	A scoring system summarizing the inflammatory potential of the diet; inflammatory diets have been linked to NCDs
Percent of energy from ultra-processed foods (% UPF)	Metric based on evidence that intakes of UPF are associated with poor quality diets and health risks
Lower-burden indices designed for settings where quantitative data are not feasible	
Minimum dietary diversity (MDD)	Proxy for micronutrient density of infant and young child diets
Minimum dietary diversity for women of reproductive age (MDD-W)	Proxy for micronutrient adequacy of women's diets
Global Dietary Recom-mendations Score (GDR)	Adherence to WHO Healthy Diet guidance and World Cancer Research Fund / American Institute for Cancer Research recommendations; proxy for HDI
Global Diet Quality Score (GDQS)	Measures consumption of a literature-based selection of food groups that contribute to nutrient intake and NCD risk reduction across a variety of global dietary patterns.

Table 8c.1 Examples of diet quality indices

The first set of food and/or nutrient-based indices in Table 8c.1 — the HEI, AHEI, MDS, DASH, and HDI — have a longer history of use, and most have been updated several times to reflect evolutions in national or global recommendations and/or newer syntheses of epidemiological evidence. Figure 8c.2 shows results from simple searches of the PubMed database, showing the volume of studies mentioning each type of index before 2015 as compared to in the years 2015–2020. The Healthy Eating Index (HEI) has been widely used over several decades and very well documented. Information on recommended presentation and interpretation is also available. Because of this, we use the HEI as a detailed example.

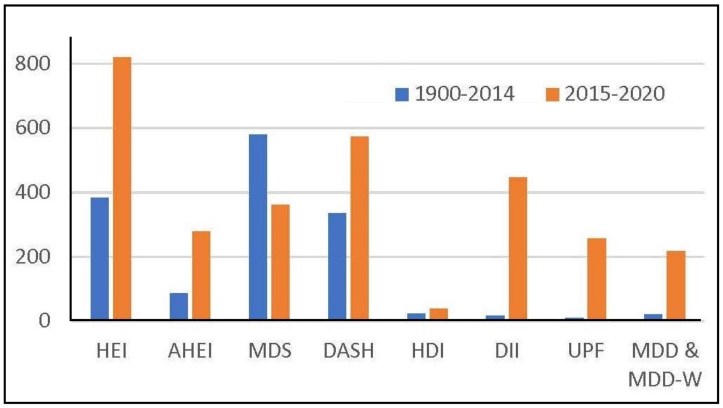


Figure 8c.2. Volume of studies mentioning various diet quality indices.

The PubMed database was searched on 15 February 2021, for the following terms, in all fields: for HEI, "Healthy Eating Index"; AHEI, "Alternate Healthy Eating Index"; MDS, "Mediterranean Diet Score"; DASH, "Dietary Approaches to Stop Hypertension"; HDI, "Healthy Diet Indicator"; DII, "Dietary Inflammatory Index"; UPF, "Ultra-processed Food"; MDD, "Minimum Dietary Diversity". Additional PubMed search terms were: for HEI: "NOT alternate NOT alternative"; for AHEI: "alternative healthy eating index"; for UPF: "NOVA classification". The GDR Score and the GDQS are not included because they are too recent; the GDR Score was published in November 2020 and the basis for the GDQS was not yet published in 2020.

Examples of other indices follow but are described in less detail.

8c.3.1 Basis, development, and scoring of the Healthy Eating Index

The Healthy Eating Index (HEI) was designed to reflect adherence to the U.S. national dietary guidelines, which apply to all individuals 2 years of age and older. The dietary guidelines are intended both to ensure nutrient adequacy and to reduce risks of NCDs, and hence the HEI also reflects both adequacy and NCD risk reduction. The HEI can be used to characterize diets of children > 2y as well as adults.

The US dietary guidelines are updated every five years. The HEI was first published in 1995 (Kennedy et al., 1995), and was updated in 2005, 2010 and 2015 to reflect new and revised guidance (Krebs-Smith et al., 2018); the HEI will be updated again in 2022.

The HEI can be calculated using data from quantitative 24hr recalls, food records, or food frequency questionnaires. The appropriate method of calculation depend on the data type and on intended uses. For most uses, the HEI should be calculated based on usual dietary intake (i.e., accounting for day-to-day variability in intakes) (Kirkpatrick et al., 2018).

The original HEI included 10 components: five food groups reflecting adequacy, four nutrients reflecting moderation, and a measure of variety in food intake. Each component was scored from 0 to 10, with adequacy components (food group scores) based on total intake, yielding a total possible score of 100. Table 8c.2 shows scoring for the newer HEI 2015, which includes nine adequacy components, and four moderation components.

Component	Max. points[a]	Standard for maximum score	Standard for minimum score
Adequacy			
Total fruits[b]	5	≥ 0.8 cup equivalent per 1000kcal	No fruit
Whole fruits[c]	5	≥ 0.4 cup equivalent per 1000kcal	No whole fruit
Total vegetables[d]	5	≥ 1.1 cup equivalent per 1000kcal	No Vegetables
Greens and beans[d]	5	≥ 0.2 cup equivalent per 1000kcal	No dark-green vegetable or legumes

Component	Max. points[a]	Standard for maximum score	Standard for minimum score
Whole grains	10	≥ 1.5 ounce equivalent per 1000kcal	No whole grains
Dairy[e]	10	≥ 1.3 cup equivalent per 1000kcal	No dairy
Total protein foods[d]	5	≥ 2.5 ounce equivalent per 1000kcal	No protein foods
Seafood and plant proteins[d,f]	5	≥ 0.8 ounce equivalent per 1000kcal	No seafood or plant proteins
Fatty acids[g]	10	(PUFA + MUFA)/SFAs ≥ 2.5	(PUFA + MUFA)/SFAs ≤ 1.2
Moderation			
Refined grains	10	≤ 1.8 ounce equivalent per 1000kcal	≥ 4.3 ounce equiv-alent per 1000kcal
Sodium	10	≤ 1.1 grams per 1000kcal	≥ 2 grams per 1000kcal
Added sugars	10	≤ 6.5% of energy	≥ 26% of energy
Saturated fats	10	≤ 8% of energy	≥ 16% of energy

Table 8c.2 Components and scoring standards for the Healthy Eating Index 2015. Source: U. S. Department of Agriculture Food and Nutrition Service

[a] Intakes between the minimum and maximum standards are scored proportionately.

[b] Includes 100% fruit juice.

[c] Includes all forms except juice.

[d] Includes legumes (beans and peas).

[e] Includes all milk products, such as fluid milk, yogurt and cheese, and fortified soy beverages.

[f] Includes seafood, nuts, seeds, soy products (other than beverages), and legumes (beans and peas).

[g] Ratio of poly- and mono-unsaturated fatty acids (PUFAs and MUFAs) to saturated fatty acids (SFAs).

The scoring for the HEI illustrates some of the many decisions made during development of diet quality indices more generally. These include:

- Nature of component parts (for example, food groups, nutrients, or both);
- Operational definition of what food items “count” for each component.
- Decision on how to account for energy intakes;
- Criteria for scoring of each component, including quantity of intake for maximum score;
- Relative scoring of components (i.e., weighting), and range for total score;

Krebs-Smith et al. (2018) describe the rationale for all decisions taken during development of the HEI 2015. In brief, selection of component parts reflects key recommendations in the 2015 Dietary Guidelines for Americans (U.S. Department of Health and Human Services and U.S. Department of Agriculture 2015). Footnotes to Table 8c.2 provide some information on how foods groups are defined and operationalized and additional details are available on the HEI website.

Except for the first (1995) version, HEI scoring has been based on on amounts per 1000kcal (i.e., density), rather than on total amounts. One rationale for use of the density approach is that the HEI can then be applied at different levels (individuals, groups of people, food environments, food supply).

The density approach also has the effect of minimizing (though not eliminating) differences in food group quantity recommendations across differing energy intake levels (which in turn correspond to differences in age, size and activity level). To allow for consistent scoring, the HEI takes the least restrictive (easiest to achieve) target for density of intakes for energy intake levels ranging from 1200–2400kcal.

For most adequacy components (food groups) the maximum score is given for intake at or above the target density, and a minimum score of "0" is given for no intake. For fatty acids adequacy, and for the moderation components, the rationale for minimum and maximum scores is somewhat more complex (see Krebs-Smith et al., 2018 for details).

For all components, densities between the minimum and maximum standards are scored proportionally. For example, consuming no whole grains is scored at zero, and consuming 1.5 ounces of whole grains per 1000kcals is scored at the maximum of 10 points. Consuming 0.75 ounces per 1000kcals is scored at 5 points since it is halfway from zero to the target density.

While the HEI 2015 has more "adequacy" components than the original HEI (9 vs.5), the original total score of 100 is maintained. Certain original food groups are sub-divided: for example, the original HEI awarded up to 10 points for vegetables, whereas HEI 2015 awards 5 points for "greens and beans" and an additional 5 points for "total vegetables".

Considering the broader food groups (vs. subgroups, that is: fruits; vegetables; whole grains; dairy; and protein foods), each is equally weighted in HEI 2015, with a maximum score of 10 points, and fatty acids and each of the 4 moderation components also have maximum scores of 10 points. Overall, the adequacy components total 60 of the 100 points, whereas the moderation components total 40 of the 100 points.

The rationale for equal weighting of components is that the Dietary Guidelines for Americans are meant to be considered as a whole and that all concepts are equally important; further, there is currently no evidence to support unequal weighting (Krebs-Smith et al., 2018). Equal weighting of components is a feature of many other diet quality indices, and for the same reasons.

8c.3.2 Evaluation of Healthy Eating Index — 2015

The validity of the HEI 2015 has been assessed in several ways. Krebs-Smith et al. (2018) report on content validity — that is, the extent to which the index captures relevant dimensions of a healthy diet, as defined in the U.S. dietary guidance.

Reedy et al. (2018) report on construct and criterion-related validity. Construct validity was assessed in several ways. "Exemplary menus" were shown to receive high HEI 2015 scores; scores in a nationally representative sample demonstrated sufficient variation (range from 1st–99th percentile was from 33 to 81 points) and scores were significantly different between smokers and non-smokers, as expected *a priori.* Scores were shown to reflect multiple dimensions, and were independent of energy intakes, i.e., reflective of quality, rather than quantity of intakes.

Criterion-related validity was demonstrated in a prospective cohort, where the highest vs the lowest quintiles of the HEI 2015 scores were associated with a decreased risk of all cause, cancer, and cardiovascular disease mortality. In addition, previous versions of the HEI had been shown to be associated with reduced risks of NCDs and mortality in numerous studies (see, for example, Liese et al., 2015; Schwingshackl & Hoffmann, 2015).

8c.3.3 Interpretation of the Healthy Eating Index

For descriptive purposes, total scores can be complemented by graphical representations and by a grading scale (Krebs-Smith et al., 2018). Radar graphs (Figure 8c.3) can be used to visualize population-level dietary patterns. In the radar graph, each component score is plotted as a percent of maximum points, on an axis. The perimeter illustrates a perfect score. Radar graphs are also useful because they show how the same total score can represent different patterns (sets of component scores).

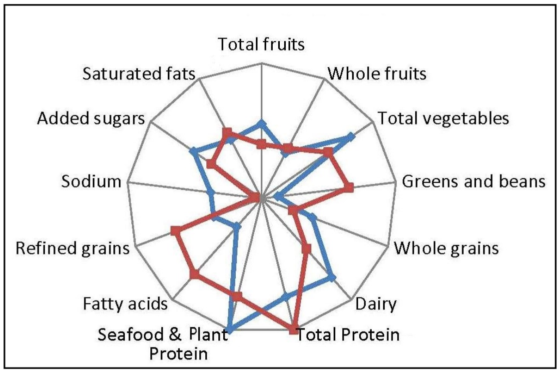


Figure 8c.3 Radar graph depicting a perfect score for the Healthy Eating Index 2015 (100 points) and two identical total scores (50 points) with different component scores. Redrawn from data in Krebs-Smith et al., 2018, p.1800.

To qualitatively describe population-level scores, a graded approach can be used, with 90 to 100 points an “A”, 80 to 89 a ‘“B”, etc. Similarly, each component score can be graded (Krebs-Smith et al., 2018). However, categorized scores (translated into “grades”) should not be used for analysis purposes as categorization results in loss of information and may result in misclassification.

To interpret the magnitude of a difference in scores between groups, or across time in the same population, a difference (or change) of 5–6 points was shown to represent a “moderate” effect size for the U.S. population (Kirkpatrick et al., 2018). However, the authors caution that this may not apply to other populations, since effect sizes are calculated in relation to the typical dispersion of scores (standard deviations), which may vary across populations.

More generally, the radar graph or graded approach could be used for descriptive purposes with a variety of multi-component diet quality indices. Determining meaningful differences could similarly be informed by examination of standard deviations of the score in the population of interest, ideally in multiple studies. A difference (or change) in scores of approximately one-half of a standard deviation is considered to be a moderate effect size (Kirkpatrick et al., 2018).

Box 8c.5 summarizes key points about the HEI.

Box 8c.5 Summary of Healthy Eating Index 2015

- Measures adherence to 2015–2020 U.S. dietary guidelines;
- Applies to children two years of age and older, adolescents and adults;
- Component parts are food and beverage groups, nutrients (fatty acids, sodium), and added sugar;
- Components are expressed as densities (usually, per 1000kcal);
- Can be used to assess at various levels (for example, diet quality of individuals and populations, menus, food supplies);

- Requires detailed quantitative dietary intake data (grams or standard servings consumed);
- Scoring is absolute, based on a priori criteria for intakes as found in the U.S. guidelines;
- Intakes between minimum and maximum scores (per component) are scored proportionally;
- Sixty points are awarded for "adequacy" components and 40 points for "moderation" components;
- Guidance on presentation is provided, including visual presentation, use of "grades", and the interpretation of effect sizes.

8c.3.4 Adaptation of the Healthy Eating Index concept

In addition to the periodic updates related to updated U.S. dietary guidelines, the HEI concept has also been adapted for other contexts. Similar indices measuring adherence to national guidelines were developed for many countries, including:

- Australia (Roy et al., 2016)
- Brazil (Previdelli et al., 2011; Andrade et al., 2013)
- Canada (Garriguet, 2009; Jessri, Ng, and L'Abbé, 2017)
- Chile (Universidad de Chile 2014)
- China (Yuan et al., 2017; 2018)
- Denmark (Bjerregaard et al., 2019)
- France (Estaquio et al., 2009; Chaltiel et al., 2019)
- Germany (Moon et al., 2017; Mader et al., 2020)
- Korea (Yook et al. 2015; Park et al., 2020)
- Malaysia (Pondor, Gan, & Appannah, 2017)
- Mexico (López-Olmedo et al., 2019)
- The Netherlands (Looman et al., 2017)
- Russia (Martinchik et al., 2019)
- Spain (Norte Navarro & Ortiz Moncada, 2011)
- Thailand (Taechangam, Pinitchun, & Pachotikarn, 2008)

In Ethiopia, development of food-based dietary guidelines is underway and an Ethiopian HEI will also be developed (Bekele et al., 2019). HEI were also created for children 1y and older in Finland (Kyttälä et al., 2014), pregnant women in Singapore (Han et al., 2015), and adolescents in Taiwan (Y. C. Chen et al., 2018). Many of these indices are also scored from 0 to 100, but some have different numbers of components and different ranges for scoring.

8c.4 Alternate Healthy Eating Index

While the HEI and similar indices in other countries measure adherence to current national dietary guidelines, another very widely used index, the "Alternate Healthy Eating Index" (AHEI), was developed to reflect additional evidence related to NCDs, which had not been incorporated in the US national guidance at the time.

As first developed by McCullough et al. (2002), the AHEI incorporated some of the same elements as the original HEI, but in addition emphasized: consumption of whole grains; a favorable ratio of fish and poultry to red and processed meats; intake of nuts and soy foods; and a favorable ratio of polyunsaturated to saturated fats. Unlike the HEI, dairy is not included in the scoring. The AHEI showed stronger associations than the original HEI to cardiovascular disease outcomes. (McCullough, et al. 2000; McCullough, et al. 2000) The authors noted that this evidence could help inform future revisions of dietary guidelines.

Component	Standard for Maximum. score (10)[a]	Standard for minimum score (0)
Vegetables, servings/d [b]	≥ 5	0
Fruit, servings/d [c]	≥ 4	0
Whole grains, g/d [d] — Women	75	0
Whole grains, g/d [d] — Men	90	0
Sugar-sweetened beverages and fruit juice, servings/d [e]	0	≥ 1
Nuts and legumes, servings/d [f]	≥ 1	0
Red/processed meat, servings /d [g]	≤ 1	≥ 1.5
Trans fat, % of energy	≤ 0.5	≥ 4
Long-chain (n-3) fats (EPA + DHA), mg/d [h]	250	0
PUFA, % of energy	≥ 10	≤ 2
Sodium, mg/d [i]	Lowest decile	Highest decileepidemiological
Alcohol, drinks/d [j] — Women	0.5-1.5	≥ 2.5
Alcohol, drinks/d [j] — Men	0.5-2.0	≥ 3.5
Total points	110	0

Table 8c.3 Adapted from Chiuve et al. (2012),

Several apparent errors in original paper were corrected in the table above, by referring to Liese et al. (2015), Supplemental material p. 6.

PUFA = polyunsaturated fatty acids.

[a]Intakes between the minimum and maximum standards are scored proportionately.

[b] Includes all vegetables except potatoes. One serving is 0.5cup of vegetables or 1cup of green leafy vegetables.

[c] Does not include fruit juice. One serving is 1 medium piece of fruit or 0.5cup of berries.

[d] Use of grams of whole grains accounts for the variability of the percentages of whole grain in various. One serving of a 100% whole-grain product (i.e., 0.5cup of oatmeal or brown rice) contains ≈ 15–20g of whole grains (per dry weight).

[e] One serving is 8oz.

[f] One serving is 1oz of nuts or 1 tablespoon (15mL) of peanut butter.

[g] One serving is 4oz of unprocessed meat or 1.5 oz of processed meat.

Like the HEI, the AHEI was later revised to reflect new epidemiological evidence on relationships of dietary components to NCD risks, and the newer version is referred to as the AHEI 2010 (Chiuve et al., 2012). As in the original versions, the rationale for the AHEI 2010 was a comprehensive review of clinical and epidemiological research by the authors, with selection and scoring of components that were deemed to be consistently associated with NCD risk. As with the original, the AHEI 2010 did not fully align with the HEI.

Scoring for the AHEI 2010 is shown in Table 8c.3. Both versions of the AHEI were developed using semi-quantitative food frequency data from prospective cohort studies of U.S. health professionals. However, subsequent users have also calculated the AHEI from quantitative 24hr recall data and for other population groups, including adolescents (see, for example Dalwood et al., 2020; Ducharme-Smith et al., 2021); however, Dalwood et al. caution against application of indices developed for adults in pediatric populations.

Like the HEI, the AHEI includes both foods and nutrients (fatty acids) among the component parts, but it also includes sweet beverages and alcohol. Unlike the HEI, the AHEI is not scored based on densities (quantities per 1000kcal), but instead based on total consumption per day. Unlike in the HEI, fruit juice is included with sugar-

[h] Optimal intake (250mg/d) is ≈ two 4oz servings of fish per week.

[i] Cutoffs for sodium were based on deciles of distribution in the data sets used to develop the index. This was due to lack of brand specificity on the food frequency questionnaire, such that absolute intakes could not be accurately estimated. This implies users would also base cutoffs on deciles of distribution in the data set analyzed.

[j] Highest scores are for moderate alcohol intake, and the worst score is for heavy consumption. Nondrinkers receive an intermediate score of 2.5.

sweetened beverages rather than with fruit.

Highest scores are based on literature-based judgments of minimum risk. As for the HEI, intakes that are intermediate between the minimum and maximum are generally scored proportionally. However, alcohol has “U-shaped” scoring, such that the highest score is given for moderate intake and lower scores for “0” or for excessive intake. Sodium intakes are scored based on the study specific distribution. Also as for the HEI, components each have a maximum of 10 points, in this case yielding a range of up to 110 points (11 components), with 6 “positive” components, 4 “negative” components and alcohol (U-shaped). Box 8c.6 summarizes key points about the AHEI.

Box 8c.6 Summary of Alternate Healthy Eating Index 2015

- Measures adherence to an alternate set of recommendations based on review of epidemiological evidence by researchers;
- Developed for adults;
- Component parts are food and beverage groups and nutrients (fatty acids), mostly expressed as quantities consumed per day;
- Requires detailed quantitative dietary intake data (grams or standard servings consumed);
- Scoring is absolute, based on a priori criteria for intakes with the exception of sodium, which is scored based on deciles in the data set under study;
- Intakes between minimum and maximum scores (per component) are scored proportionally;
- Sixty points are awarded for adequacy components and 40 points for moderation components; for alcohol, scoring is “U-shaped”

8c.5 Mediterranean Diet Score or Index

Evidence on the healthfulness of various Mediterranean regional diets has been accumulating since the mid-20th century (Menotti & Puddu, 2015). Generally, Mediterranean diets are characterized by a high intake of plant-based foods including olive oil, fruit, nuts, vegetables, and cereals; a moderate intake of fish and poultry; a low intake of dairy products, red meat, processed meats, and sweets; and a moderate amount of wine. However, unlike the dietary patterns captured by the HEI and AHEI, which each have a single definition, there are numerous Mediterranean diets and numerous scores and indices (see: Milà-Villarroel et al., 2011; D'Alessandro & Pergola, 2018; Zaragoza-Martí et al., 2018).

In contrast to the HEI and AHEI, Mediterranean Diet Scores (MDSs) are generally based on foods and beverages only, rather than on a mix of foods and nutrients. Intended uses of MDSs are not always clearly stated in papers reporting on their development. They are frequently used in epidemiological studies investigating associations of diets to morbidity and mortality. MDSs vary widely in their scoring range (for example, possible scores of 0–8 vs. 0–100) and in the rationale and method of scoring, as illustrated in the following examples.

8c.5.1 Mediterranean Diet Score of Trichopoulou

MDSs with the narrowest ranges are scored as "yes" (1) or "no" (0) for a set of food groups. Trichopoulou et al. (1995) developed one of the first MDS and demonstrated an association with mortality in a Greek population. The original analysis was based on semi-quantitative food frequency data from adults over 70y. This MDS was designed for individual-level use in an epidemiological study. The MDS of Trichopoulou et al. is an 8-point score including the following elements:

- High consumption of legumes
- High consumption of cereals (including bread and potatoes)
- High consumption of fruits
- High consumption of vegetables
- Low consumption of meat and meat products
- Low consumption of milk and dairy products
- High ratio of monounsaturated to saturated fat
- Moderate alcohol consumption

This score has 5 "positive" 2 "negative" and one "U-shaped" component like the AHEI, for moderate alcohol intake. Dairy is included as a "negative" component; this is typical of many MDSs. "High" intake was defined as intake above the sex-specific median quantity consumed by their study subjects rather than in relation to a set of recommended intakes, and therefore scoring for this MDS is dependent on study-specific distributions of intake. This approach to scoring is useful for study-specific comparisons but less useful for comparing across contexts. Several other MDSs are scored in this way.

8c.5.2 "MedDietScore" of Panagiotakos

For a prospective cohort study of adults in Athens, Panagiotakos et al. (2007) developed a 55-point "MedDietScore" where scoring did not depend on the distribution of intake among study subjects. Instead, each component was scored from 0–5 based on respondent report of frequency of consumption (never, rare, frequent, very frequent, weekly or daily), based on data from a semi-quantitative food frequency questionnaire covering the past year.

Component scores increased with frequency for 7 "positive" components — non-refined cereals, fruits, vegetables, legumes, olive oil, fish and potatoes — and decreased with frequency for 3 "negative" components — red meat and products, poultry and full-fat dairy products. As with several other indices, there were more "positive" components than "negative"' components.

This MedDietScore was negatively associated with hypertension, hypercholesterolemia, diabetes and obesity in the initial study and was later shown to be negatively associated with 10-year incidence of cardiovascular disease (Panagiotakos et al., 2015) and diabetes (Filippatos et al., 2016).

8c.5.3 "MEDI-LITE" Score of Sofi

Sofi et al. (2014) developed an 18-point "literature-based" adherence score, shown in Table 8c.4. This adherence score, the "MEDI-LITE" score, was designed for both epidemiological and clinical use; however, a primary aim was to develop a simple tool feasible for use at the individual level, within clinical practice.

Component	Low intake (score)	Moderate intake (score)	High intake (score)
Fruit (1 portion = 150g)	< 1 portion/d (0)	1–1.5 portions/d (1)	> 2 portions/d (2)
Vegetables (1 portion = 100g)	< 1 portion/d (0)	1–2.5 portions/d (1)	> 2.5 portions/d (2)
Legumes (1 portion = 70g)	< 1 portion/wk (0)	1–2 portions/wk (1)	> 2 portions/wk (2)
Cereals (1 portion = 130g)	< 1 portion/d (0)	1–1.5 portions/d (1)	> 1.5 portions/d (2)
Fish (1 portion = 100g)	< 1 portion/wk (0)	1–2.5 portions/wk (1)	> 2.5 portions/wk (2)
Meat/meat products (1 portion = 80g)	< 1 portion/d (2)	1–1.5 portions/d (1)	> 1.5 portions/d (0)
Dairy products (1 portion = 180g)	< 1 portion/d (2)	1–1.5 portions/d (1)	> 1.5 portions/d (0)
Alcohol (1 alcohol unit (AU) = 12g)	< 1 AU/d (1)	1–2 AU/d (2)	> 2 AU/d (0)
Olive oil	Occasional use (0)	Frequent use (1)	Regular use (2)

Table 8c.4 Components and scoring for MEDI-LITE. Adapted from Sofi et al. (2014),
Note these authors use the term “portion” in the way the term “serving” is used here — that is, as a defined standard quantity.

Component scoring was based on a more geographically diverse set of prospective cohort studies, published between 2010 and 2013. The studies were primarily from Europe and included the multi-country European Prospective Investigation into Cancer and Nutrition (EPIC) study as well as additional studies from some of the EPIC study countries (Denmark, France, Germany, Greece, Italy, The Netherlands, Norway, Spain, Sweden, and the UK). Several studies were from the U.S., and no studies were from Asia, Africa, or Latin America. All studies included adult participants only.

For each component, intakes were categorized into three levels after calculating weighted averages (weighted by study size) and standard deviations of intakes across all studies. The score includes six “positive” components, two “negative” components, and U-shaped scoring for alcohol.

Construct validity for the MEDI-LITE score was demonstrated by comparing it to the previously validated MedDietScore of Panagiotakos (above).

8c.5.4 Mediterranean-Style Dietary Pattern Score of Rumawas

More recently, some Mediterranean diet indices have been proposed with wider scoring ranges and with scoring based on criterion values (recommended intakes). Rumawas et al. (2009) developed a 100-point Mediterranean-Style Dietary Pattern Score (MSDPS) based on the Mediterranean Diet Pyramid of Willett et al. (1995); scoring is shown in Table 8c.5. The MSDPS was also explicitly intended for use in non-Mediterranean populations. During development, performance of the MSDPS was assessed among adults using data from a semi-quantitative food frequency questionnaire covering the past year.

The thirteen components are each scored from 0–10, then summed. The total score is standardized to 100 by dividing the calculated sum by the theoretical maximum sum of 130 and

Component	Standard for maximum score of 10[a]	Score[b]
	Servings/day	Points/serving
Whole grains	8	1.25
Fruits	3	3.33
Vegetables	6	1.67
Dairy	2	5.0
Wine - Women	1.5	6.67
Wine - Men	3	3.33

Component	Standard for maximum score of 10[a]	Score[b]
	Servings/week	Points/serving
Fish and other seafood	6	1.67
Poultry	4	2.5
Olives, legumes, and nuts	4	2.5
Potatoes, starchy roots	3	3.33
Eggs	3	3.33
Sweets	3	3.33
Meat	1	10.0
	Practice	Points
Olive oil	Use only olive oil	0 (for no use) 5 (for use of olive and other vegetables oils)

Table 8c.5 Components and scoring for the Mediterranean-Style Dietary Pattern Score. Adapted from Rumawas et al. (2009), p. 1152.

[a] Each component of the score is calculated based on the recommended intakes of food in the Mediterranean Diet Pyramid of Willett et al. (1995).

[b] Except olive oil, all other components are continuous, ranging from 0–10 and computed proportionately.

If consumption exceeds the recommended intake, the score is deducted proportionally to the number of servings consumed that exceed the recommended intake; the lowest possible score due to deduction is zero.

multiplying by 100. To account for foods not on the Mediterranean Diet Pyramid the standardized score is weighted by the proportion of total energy intake derived from foods on the pyramid. For example, if 20% of kilocalories are from foods not on the pyramid, the standardized score is multiplied by 0.8.

As for the HEI and AHEI, intakes that are lower than recommended are scored proportionately to the recommended amounts. Scoring is for total quantities (as for the AHEI) and not for densities (as for the HEI).

Unlike some other indices, scoring for the MSDPS "penalizes" overconsumption of a given food group by subtracting points in proportion to the amount of excess — for example, exceeding the recommended intake by 60% would result in a score of 4 for a given component. The lowest possible score for each component is zero. This means, for example, that both 2 servings of meat/week and 10 servings of meat/week are scored identically as zero.

Construct validity was demonstrated through expected positive associations with intakes of dietary fiber, fatty acids, antioxidant vitamins, calcium, magnesium, and potassium, and inverse associations with a glycemic index and with intakes of added sugar, saturated fat, and *trans*-fat.

8c.5.5 Summary of Mediterranean Diet Scores

There is no consensus on a single or "best" Mediterranean Diet Score or Index, and this depends on intended uses; see D'Alessandro and De Pergola (2018) for a discussion. Although many MDSs were originally developed based on analyses of data from adult populations, including elders, MDSs have been adapted and used in studies of children and adolescents (Dalwood et al., 2020).

Finally, concerning the potential to adapt the MDS for relevance in other regions, there is more experience in high-income countries and in the global north. The applicability of this pattern in some other regions is not established, particularly in regions where some of the distinctive components are not available and/or are not part of cultural dietary patterns (for example, olive oil, red wine, nuts, legumes, and/or fish).

However, reporting on a global World Heart Federation Consensus Conference, Anand et al. (2015) suggest that the evidence base for the Mediterranean diet is sufficiently consolidated that it can be recommended globally, and they provide suggestions for its adaptation with foods from other regions.

Once the dietary pattern is adapted to other regions, adapted scores could also be developed (as, for example, in Echeverría et al., 2019; El Kinany et al., 2020). Box 8c.7 summarizes key points about MDSs.

Box 8c.7 Summary of Mediterranean diet scores and indices

- There are a large number of scores and indices measuring adherence to different versions of the Mediterranean diet;
- The original scores were developed based on data from older adults, but currently there are many versions adapted for children and adolescents;
- MDSs have been adapted for several other regions, but certain characteristic foods are not consumed or are rarely consumed in some other global regions;
- Component parts are usually food groups; olive oil and alcohol are also often included;
- Components are usually expressed as quantities, not densities;
- Most MDSs requires detailed quantitative dietary intake data (grams or standard servings consumed);
- Most MDSs were developed for individual-level use (for example, in epidemiological studies) but are appropriate to describe diet quality of populations;
- Scoring for components is sometimes absolute (based on *a priori* criteria for intakes) but for many MDSs, scoring is not absolute and instead is based on distributions of intake in the study sample (for example, with high points given to the highest quartile or quintile of intakes);
- Both the complexity of scoring and the balance between positive and negative scores vary widely among MDSs.

8c.6 Dietary Approaches to Stop Hypertension scores

Scores reflecting adherence to the Dietary Approaches to Stop Hypertension (DASH) dietary pattern have also been widely used, particularly in studies investigating associations of dietary patterns and NCDs. The original DASH diet and scoring were developed for a randomized controlled feeding trial investigating the impact of a prescribed dietary pattern on blood pressure. The trial, initiated in 1994, compared a typical U.S. dietary pattern to one high in fruits, vegetables, and low-fat dairy products, that emphasized fish and chicken rather than red meat, and was low in saturated fat, cholesterol, sugar, and refined carbohydrate.

The original study demonstrated reductions in blood pressure after the 8-week intervention (Sacks et al., 1999). Follow-up work demonstrated additional benefits from reductions in sodium intake; sodium intake had not been manipulated in the original trial (Sacks et al., 2001). While the DASH diet was originally developed to lower blood pressure, subsequent studies have linked higher adherence to the DASH diet with lower risks for a range of outcomes, including all-cause mortality, cardiovascular disease incidence or mortality, cancer incidence or mortality, type 2 diabetes, and neurodegenerative disease (Morze et al., 2020).

As for Mediterranean diets, there have been several specific scores developed to reflect adherence to the DASH diet, and DASH scores have also been developed for pediatric populations. Table 8c.6 shows

Component	Standard for maximum score	Standard for minimum score
Whole grains	Highest quintile	Lowest quintile
Vegetables (excluding potatoes)		
Fruit		
Nuts and legumes		
Low-fat dairy		
Red and processed meat	Lowest quintile	Highest quintile
Sugar-sweetened beverages		
Sodium		

Table 8c.6 Components and scoring for an example Dietary Approaches to Stop Hypertension diet adherence score. Scoring as in Fung et al., 2008 and Liese et al., 2015.

one commonly used scoring system with 8 components, each worth 5 points, for a total of 40 points. The scoring system is based on sex-specific quintile rankings within the study population.

With the exception of sodium, this DASH adherence score is based on foods rather than nutrients. As with the HEI, AHEI and MDS above, the eight components are given equal weight. As with many of the score described above, there are slightly more "positive" than "negative" components, implying an overall heavier weighting of positive food groups. Unlike in many MDSs, low-fat dairy is scored positively.

Like some versions of the MDS, and also like some other versions of DASH diet scores, scoring is dependent on study-specific distributions of intake. This type of scoring can maximize contrasts for studies investigating associations between dietary patterns and outcomes. However as noted above, it is less useful for comparing intakes across contexts.

8c.7 Healthy Diet Indicator

Just as the HEI was developed to capture adherence to U.S. national dietary guidance, the Healthy Diet Indicator (HDI) was developed to capture adherence to global guidance from the WHO (Huijbregts et al., 1997) and was updated to reflect updated guidance (Stefler et al., 2014; Jankovic et al., 2015). Both the original and the updated versions demonstrated associations to mortality in multi-country studies (Huijbregts et al., 1997; Stefler et al., 2014), although the associations were not entirely consistent (Jankovic et al., 2015).

The original HDI study analyzed data from cohorts of older men in three western European countries (Huijbregts et al., 1997), while the later updates included adults from Eastern Europe (Stefler et al., 2014) and elders from the U.S. and Europe (Jankovic et al., 2015). To our knowledge, the HDI has not been widely used in studies of children.

Unlike all the previous scores and indices, most of the components in the HDI are nutrients or food substances rather than food groups. This reflects the fact that the WHO "Healthy Diet Fact Sheet" currently gives quantitative guidance for intakes of sugars, various types of fatty acids, and salt, but limited guidance on quantitative intakes for food groups.

	Component	Standard for scoring (quantitative intake in one day)
1	Fruits, vegetables	≥ 400g
2	Beans and other legumes	> 0g
3	Nuts and seeds	> 0g

The original HDI included 9 components, each scored "0" for not meeting or "1" for meeting the WHO recommendation, for a total range of 0-9 points. Components were: saturated fatty acids; polyunsaturated fatty acids; protein; "complex carbohydrates"; and mono- and disaccharides (all as percent of energy), and quantities for cholesterol; fiber; fruits and vegetables; and

	Component	Standard for scoring (quantitative intake in one day)
4	Whole grains	> 0g
5	Dietary fiber	> 25g
6	Total fat	< 30% total energy
7	Saturated fat	< 10% total energy
8	Dietary sodium	< 2g
9	Free sugars	< 10% total energy
10	Processed meat	0g
11	Unprocessed red meat	≤ 71g[a]

Table 8c.7 Components and scoring for the Healthy Diet Indicator 2020. Eleven components are scored “0” or “1”. Components 1–5 are used in a sub-index for healthy dietary components (maximum score, 5), and components 6–10 are used in a sub-index for dietary components to limit (maximum score, 6).
[a] Upper end of the recommendation to consume no more than 350–500 grams/week divided by 7 days. Adapted from Herforth et al (2020).

pulses/nuts/seeds. As with all others above, the components were equally weighted. The updated score included similar components, but each component was scored from 0 to 10, to better capture variation among study subjects.

Most recently, Herforth et al. (2020) have once again updated the HDI, reflecting the current WHO Healthy Diet recommendations but also incorporating World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) recommendations on the consumption of red and processed meats. Table 8c.7 shows the components and scoring for the HDI-2020

Eleven components are scored “0” or “1” as in the original HDI. Several positive components are scored “1” for any non-zero consumption, based on WHO guidance that indicates that healthy diets include these items, but without specifying recommended quantities (whole grains, beans and other legumes, and nuts and seeds). Components are equally weighted. Unlike many of the examples above, the total weight for all moderation / unhealthy components is slightly higher than the weight for healthy components. The revised HDI-2020 has not yet been evaluated for associations to health outcomes. Box 8c.8 summarizes key points about HDIs.

Box 8c.8 Summary of several versions of a Healthy Diet Indicator

- All versions of the HDI measure adherence to World Health Organization guidance; the most recent version also incorporates guidance from the World Cancer Research Fund/American Institute for Cancer Research;
- Focus is on NCD risk;
- Based on guidance for adults;
- Component parts are food groups, fiber, nutrients (fatty acids, sodium) and free sugars;
- Components are expressed in absolute terms, not as densities;
- Requires detailed quantitative dietary intake data (grams or standard servings consumed); as well as linkage to databases with information on nutrients
- Scoring is based on *a priori* criteria for intakes as found in global guidance; scoring is not study-specific and relative (for example, quartiles)
- In the HDI-2020, There are five healthy components and six components to limit, all weighted equally;
- In the HDI-2020, scoring is a simple count — with each of eleven components scored “0” or “1”

8c.8 Dietary Inflammatory Indices

Recently, several diet quality indices have been developed to capture the inflammatory potential of the diet (Tabung et al. 2016; 2017; Hébert et al., 2019). Such indices were developed in recognition of the key role of chronic low-grade inflammation in the etiology of NCDs, and the role of dietary factors in chronic inflammation. In this section, we describe one widely used index, the Dietary Inflammatory Index (DII).

The DII was designed for global relevance, regardless of the cultural dietary pattern (Hébert et al., 2019). The DII is scored primarily based on nutrients and food substances. Selection of and weighting of components were based on a comprehensive literature review spanning 1950–2010 and including studies from diverse populations that assessed the relationships of nutrients, foods, and food substances to six inflammatory biomarkers (Cavicchia et al., 2009; Shivappa et al., 2014).

The DII has been applied in studies of a wide range of NCDs and risk factors. A recent review documented associations between the DII and certain cancers, cardiovascular disease and its associated mortality, adverse mental health, and musculoskeletal disorders. Evidence on DII and respiratory health, neurodevelopmental outcomes, the metabolic syndrome, obesity and diabetes is either conflicting or limited to date (Phillips et al., 2019).

Scoring for the DII is based on 45 components, consisting mainly of macro- and micronutrients and food substances (for example, flavonoids, caffeine) but also including several foods, herbs/spices (garlic, ginger, onion, pepper, rosemary, saffron, thyme, and turmeric), and beverages (tea and alcohol). In the most recent version, scoring cut-offs were determined based on examination of intake data from eleven countries in all global regions except Africa. (Shivappa et al., 2014).

Each of the 45 components has a score indicating its pro- or anti-inflammatory potential, with positive scores for pro-inflammatory components and negative scores for anti-inflammatory components. The DII is the sum of the component scores. Unlike many indices described above, the components of the DII are not equally weighted. The total range in “example scenarios” provided by the developers was from +7.98 (strongly pro-inflammatory) to −8.87 (i.e. strongly anti-inflammatory); the example scenarios were created by the authors to illustrate various combinations of plausible intakes for the 45 components (Shivappa et al., 2014). Note that — also unlike other indices — a negative score is better than a positive one.

The DII has been further adapted in a version that adjusts for total energy (E-DII) and in a version for children (C-DII), validated for children 6–14y. The C-DII predicted blood concentration of one inflammatory marker (C-reactive protein) in children (Khan et al., 2018). Construction of the DII requires data on all components, though it has also been adapted for use when data for some components are not available Davis et al., 2021).

The DII has primarily been used to further elucidate the relationship between the inflammatory potential of overall diets and various health outcomes. Box 8c.9 summarizes key points about the DII.

Box 8c.9 Summary of the Dietary Inflammatory Index

- The DII measures the inflammatory potential of the diet;
- Originally developed for adults, but a version has been developed for children 6–14y

- Component parts are primarily nutrients, food substances, and herbs and spices, with few foods or beverages — and no food groups — in the index;
- The DII requires detailed quantitative dietary intake data, including on intake of herbs and spices, and the availability of food composition data that includes many food substances;
- To date, the primary use of the DII has been in epidemiological studies.

8c.9 Diet quality based on level of food processing

Another recent approach to assessment of diet quality is based on classification of foods and beverages according to the level of processing in their production. Monteiro et al. (2010) first proposed a system of classification, which was subsequently modified to include four groups:

- Unprocessed or minimally processed foods;
- Processed culinary ingredients;
- Processed foods; and
- Ultra-processed food and drink products.

The modified classification scheme is referred to as the "NOVA" classification (Monteiro et al., 2016). Particular attention has been paid to the role of ultra-processed products (UPF) in diets. While the classification is at the level of food and beverage items, the quality of the overall diet is then characterized by the proportion of UPF in the diet (usually, as a percent of total energy) (Monteiro et al., 2011; Chen et al., 2020).

Machado et al. (2019) describe UPF as "formulations of low-cost ingredients, many of non-culinary use, that result from a sequence of industrial processes (hence ultra-processed)" The identification and classification of UPF have recently been clarified:

> "A practical way to identify an ultra-processed product is to check to see if its list of ingredients contains at least one item characteristic of the NOVA ultra-processed food group, which is to say, either food substances never or rarely used in kitchens (such as high-fructose corn syrup, hydrogenated or interesterified oils, and hydrolysed proteins), or classes of additives designed to make the final product palatable or more appealing (such as flavours, flavour enhancers, colours, emulsifiers, emulsifying salts, sweeteners, thickeners, and anti-foaming, bulking, carbonating, foaming, gelling and glazing agents)" (Monteiro et al. 2019, p. 936).

Examples of UPF include packaged instant soups and noodles, carbonated beverages, reconstituted meat products, many sweet and savory packaged snacks, frozen "ready meals", and fast food dishes. Some UPF provide substantial nutrients, either from food ingredients (for example, packaged sweetened yogurts) or from fortification (for example, highly processed but fortified breakfast cereals), leading to challenges on definition of categories, and some disagreement on the value of the NOVA classification (Gibney, 2019; Jones, 2019).

The percent of energy from UPF has been shown to be high or very high in some countries; for example, UPF comprise from 40%–50% of energy intake in Australia (Machado et al., 2019), Brazil (Siqueira et al., 2020) and Canada (Polsky, Moubarac, & Garriguet, 2020) and nearly 60% in the United States (Martínez-

Steele et al., 2017). While similar intake data are not available for most low- and middle-income countries, sales of UPF are growing rapidly in Asia and Africa (Vandevijvere et al., 2019; Baker et al., 2020). Assessment of the role of UPFs in the diet has been undertaken for a wide range of age groups, beginning in infancy.

A higher proportion of total intake from UPF has been associated with lower intakes of some micronutrients and higher intakes of sugar, salt, and saturated and trans-fatty acids (see for example Martínez-Steele et al., 2017; Moubarac et al., 2017; Machado et al., 2019). However, several studies documented higher calcium intakes with higher UPF consumption, perhaps due to consumption of sweetened and/or other processed dairy products (Louzada et al., 2015; Batal et al., 2018; Cornwell et al., 2018). Recent reviews have summarized associations with a wide range of risk factors and negative health outcomes, including overweight, obesity and cardiometabolic risks, some cancers, type 2 diabetes and cardiovascular diseases, irritable bowel syndrome, depression and all-cause mortality (Chen et al., 2020; Elizabeth et al., 2020). Box 8c.10 summarizes key points about the percent of energy from UPF.

Box 8c.10 Summary of percent of energy from ultra-processed foods

- Differs from other indices through its focus on one characteristic, processing level and this characteristic cuts across foods, beverages and food/beverage groups;
- Classification by processing level is done at the level of individual food and beverage item;
- Does not involve scoring based on consumption of food groups, nutrients, or food substances;
- The percent UPF is a density indicator, because it is expressed as a percent of energy;
- Like the HEI, it can be used for different age groups and at different levels, to characterize diets, menus, food supplies etc.;
- Requires detailed quantitative dietary intake data (grams or standard servings consumed).

8c.10 Lower-burden diet quality indices

Most diet quality indices described above require quantitative dietary intake data, for example from validated food frequency questionnaires, quantitative 24hr recalls, or other detailed quantitative approaches. Obtaining accurate quantitative dietary intake data is resource intensive. Because of the resource requirements, many low- and middle-income countries do not currently have nationally representative dietary intake data, and even high-income countries may not collect such data sufficiently frequently to meet all needs.

To meet needs for basic information on intake patterns in contexts where quantitative data are not available, several “lower-burden” approaches have been developed, particularly for use in global and national monitoring under resource constraints. These lower-burden approaches are all food group-based and/or ask behavioral questions (rather than including nutrient intakes for their calculation) and do not require that food composition data for tabulation.

8c.10.1 Global surveillance of dietary behaviors

Many lower-burden survey tools (often called "screeners") have been developed to capture only one or several components of intake, and/or dietary habits. Examples of screeners developed for global use are the questionnaires for the WHO Stepwise Approach to NCD Surveillance (STEPS) and the Global School-Based Student Health Survey (GSHS; Currently, the WHO STEPS questionnaire includes questions on fruit, vegetable, and salt/salty condiment consumption. The GSHS questionnaire is under revision; previously, it included core questions on fruits, vegetables, carbonated soft drinks, and food from fast food restaurants. To date, neither of these surveys captures the "whole of diet", and data from these surveys have not been used to develop overall indices of diet quality.

8c.10.2 Food group diversity proxy indicators for micronutrients

Some food group diversity indicators have demonstrated associations with micronutrient adequacy of diets (Verger et al., 2021). Because of this, several have been developed as simple proxies for micronutrient adequacy, for use when more complex indices are not feasible. These indicators do not require use of food composition data, and they do not require detailed quantitative dietary intake data.

They were developed primarily for use in resource-poor environments, where diets may be very impoverished, low in food group diversity, and consequently provide inadequate micronutrients. They are intended for population-level use — for example, in monitoring trends — and not to describe diets of individuals.

Indices were developed for several demographic groups, including infants and young children and women of reproductive age. In both cases, construct validity was evaluated cross-sectionally by comparing the simple indices to micronutrient density or adequacy of diets, in data sets from studies in multiple low- and lower-middle income countries. (Working Group on Infant and Young Child Feeding Indicators 2006; Arimond et al., 2010; Martin-Prevel et al., 2017).

A "Minimum Diet Diversity" (MDD) indicator was developed as a proxy indicator of the micronutrient density of the diet for infants and young children (IYC) 6–23mos (WHO 2008; 2010). MDD data can be collected using a lower-burden non-quantitative recall questionnaire for food groups fed to the infant or young child the day before the survey.

An updated version includes 8 food groups (below; WHO/UNICEF, 2021). Infants and young children fed five or more of the eight food groups, in any amount, meet the criterion for MDD. Groups of infants and young children meeting MDD are likely to have a diet higher in micronutrient density than those who consume fewer food groups. Food groups are:

1. Breast milk
2. Grains, white/pale starchy roots, tubers and plantains
3. Beans, peas, lentils, nuts and seeds
4. Dairy products (milk, infant formula, yogurt, cheese)
5. Flesh foods (meat, fish, poultry, organ meats)
6. Eggs
7. Vitamin A-rich fruits and vegetables
8. Other fruits and vegetables

The MDD has been widely used and reported, with main global data sources being the Demographic and Health Surveys (DHS) Program and the UNICEF Multiple Indicators Cluster Surveys (MICS). Prevalence data for MDD are available at the UNICEF infant and young child feeding indicators database.

Recently, the World Health Organization and UNICEF have developed additional feeding indicators relevant to diet quality of IYC, including indicators for sweet beverage consumption and consumption of selected unhealthy food groups that may displace nutrient-dense foods in IYC diets. However, there is no overall summary index for IYC diet quality that covers both micronutrient density and non-recommended food groups (WHO/UNICEF, 2021).

A simple food group diversity indicator, MDD-W, was also developed for non-pregnant women of reproductive age as a proxy for micronutrient adequacy of the diet, particularly for use in settings where poverty results in monotonous diets (Martin-Prevel et al., 2017; FAO, 2021).

Like the IYC MDD indicator, data can be collected using a lower-burden non-quantitative recall questionnaire for food groups consumed the day before the survey. The recommended data collection methods are designed to exclude very small quantities of consumption (< 15g) (FAO, 2021).

Groups of women consuming five or more of the ten defined food groups are likely to have higher micronutrient adequacy than women consuming fewer food groups. The underlying 10-point score is also associated with micronutrient adequacy.

The 10 food groups differ slightly from the IYC food groups, as follows:

1. Grains, white roots and tubers, and plantains
2. Pulses (beans, peas, and lentils)
3. Nuts and seeds
4. Dairy
5. Meat, poultry and fish
6. Eggs
7. Dark-green leafy vegetables
8. Other vitamin-A rich fruits and vegetables
9. Other vegetables
10. Other fruit

MDD-W data are increasingly available, including from the 8th phase of the DHS Program (2018–2023;) Both the original IYC MDD and the MDD-W have also been evaluated for their usefulness in predicting micronutrient adequacy for other demographic groups (for example, Ganpule-Rao et al., 2021; Diop et al., 2021).

Like the IYC MDD, the MDD-W was not developed to capture other characteristics of diet quality, such as NCD risk reduction. This is a key limitation, because in many resource-poor environments, there is a growing burden of overweight, obesity and associated NCDs, following on rapid nutrition transitions (Popkin, Corvalan, & Grummer-Strawn, 2020). This limitation has been addressed in several recent efforts to develop more comprehensive indices that can still be captured using lower-burden data collection methods.

8c.10.3 Global Dietary Recommendations Score

In addition to proposing an updated HDI-2020 based on global recommendations from the WHO and the World Cancer Research Fund / American Institute for Cancer Research; (as described above), Herforth et al. (2020) also developed a Global Dietary recommendations (GDR) Score. The GDR Score is a lower-burden index capturing adherence to these global recommendations. It was explicitly developed as a complement to the MDD-W, to fill a gap in low burden indices reflecting NCD risk reduction.

Like the MDD-W, the GDR Score is meant for use in assessing and monitoring diets at population level, not at individual level. Construct validity was assessed by comparing the GDR Score to the HDI-2020 in two nationally representative data sets, from Brazil and the United States, using data for ages ≥15y.

GDR-Healthy (positively scored)
Dark-green leafy vegetables
Vitamin A-rich orange-colored vegetables, roots, tubers
Other vegetables
Vitamin A-rich fruits
Citrus fruits
Other fruits (including red/purple/blue fruits)
Legumes
Nuts/seeds
Whole grains
GDR-Limit (negatively scored)
Sodas/sugar-sweetened beverages
Baked/grain-based sweets
Other sweets
Processed meat (double weight)
Unprocessed red meat
Deep-fried foods
Food from a fast-food restaurant, or Instant noodles
Packaged salty snacks

Table 8c.8 Food groups in the Global Dietary recommendations Score, based on a one-day non-quantitative recall. Adapted from Herforth et al., (2020).

Data for the GDR Score can be collected using a non-quantitative recall of food groups consumed the day before the survey. A diet quality questionnaire has been developed for this purpose (Herforth et al., 2019).

The GDR score (Table 8c.8) ranges from −9 to +9, based on sets of positively and negatively scored food groups. Each food group has equal weighting except for processed meat, which has a score of −2. Overall, the score gives equal weighting to “positive” and “negative” components.

The WHO Healthy Diet guidance — one basis for the GDR Score — currently includes no recommendations on animal-source foods, though they can be good sources of bioavailable micronutrients. Processed meat and unprocessed red meat are included as negatively scored items to limit, based on World Cancer Research Fund / American Institute for Cancer Research; recommendations. To capture nutrient adequacy in resource-constrained environments, the GDR Score can be considered alongside food group diversity scores such as the MDD-W, which are designed to reflect nutrient adequacy and include positive scoring for a variety of animal-source foods.

The GDR Score is a recent innovation and should be further assessed in a wider range of country contexts, with diverse cultural dietary patterns. Data to construct the GDR Score at national level will be available for 40 countries from the (2021 Gallup World Poll.). These data could provide baselines for future assessments of trends. Further details and updates on the GDR Score, including country-adapted questionnaires for its measurement, are available from the Global Diet Quality Project (2021).

8c.10.4 Global Diet Quality Score

The Global Diet Quality Score (GDQS) represents another lower-burden approach to characterizing diet quality at population level, including both nutrient adequacy and NCD risk (Bromage et al, 2021). In contrast to the GDR Score, the GDQS is not based on adherence to existing / current global guidance. Its development was similar to that of the AHEI, in that food groups were selected for inclusion based on a review of literature demonstrating relationships of food group intakes to outcomes. Further analyses of multiple data sets, including cross-sectional and cohort data, led to refinement of the food groups and scoring.

The GDQS evolved from an earlier index initially developed for use in the United States as a clinical screener (Rifas-Shiman et al., 2001). The global version was developed for population-level use based on extensive analyses of data sets from Africa (several countries), India, China, Mexico, and the US. Construct validity was assessed relative to nutrient adequacy, biomarkers for NCD risk, metabolic syndrome and incidence of type 2 diabetes (Bromage et al, 2021).

Data requirements for the GDQS are intermediate in complexity and, as for the MDD-W and the GDR Score, no food composition data is needed to construct the GDQS. Semi-quantitative data are needed to distinguish categories for quantity of intake for each of the 25 food group components (Table 8c.9).

	Categories of consumed amounts (g/d)			**Points assigned**		
	Low	**Middle**	**High**	**Low**	**Middle**	**High**
Food Group — Healthy						
Citrus fruits	< 24	24–69	> 69	0	1	2
Deep orange fruits	< 25	25–123	> 123	0	1	2
Other fruits	< 27	27–107	> 107	0	1	2
Dark green leafy vegetables	< 13	13–37	> 37	0	2	4
Cruciferous vegetables	< 13	13–36	>36	0	0.25	0.5
Deep orange vegetables	< 9	9–45	> 45	0	0.25	0.5
Other vegetables	< 23	23–114	> 114	0	0.25	0.5
Legumes	< 9	9–42	> 42	0	2	4
Deep orange tubers	< 12	12–63	> 63	0	0.25	0.5
Nuts and seeds	< 7	7–13	> 13	0	2	4
Whole grains	< 8	8–13	> 13	0	1	2
Liquid oils	< 2	2–7.5	> 7.5	0	1	2
Fish and shellfish	< 14	14–71	> 71	0	1	2
Poultry and game meat	< 16	16–44	>44	0	1	2
Low-fat dairy	< 33	33–132	> 132	0	1	2
Eggs	< 6	6–32	> 32	0	1	2
Food Group — Unhealthy in excessive amounts						
High-fat dairy[a] (in milk equivalents)	< 35	35–142	> 142–734	0	1	2
Red meat	< 9	9–46	> 46	0	1	0
Food Group — Unhealthy						
Processed meat	< 9	9–30	> 30	2	1	0
Refined grains and baked goods	< 7	7–33	> 33	2	1	0
Sweets and ice cream	< 13	13–37	>37	2	1	0
Sugar-sweetened beverages	< 57	57–180	>180	2	1	0
Juice	< 36	36–144	> 144	2	1	0
White roots and tubers	< 27	27–107	>107	2	1	0
Purchased deep fried foods	< 9	9–45	> 45	2	1	0

Table 8c.9 Global Diet Quality Score — food groups and scoring. Adapted from Bromage et al (2021)).

[a] Hard cheese should be converted to milk equivalents using a conversion factor of 6.1 when calculating total consumption of high-fat dairy for the purpose of assigning a GDQS consumption category. Intakes of "High-fat dairy" > 734g are categorized as "Very High" and assigned zero points.

Two food groups (high-fat dairy and red meat), considered unhealthy when consumed in excessive amounts, have "U-shaped" scoring, such that both very low intakes and very high intakes are scored lower than intermediate intakes. Different from the other food groups in the index, which use 3 categories for quantity of intake, the high-fat dairy food group uses 4 categories to classify the quantity of intake for scoring. The "U-shaped" scoring for the high-fat diary and red meat foods groups reflects the role of these food groups both in meeting nutrient adequacy, but also in NCD risk when consumed in excess. Multiple weighting schemes were evaluated, and the selected components are not equally weighted.

In addition to the overall score, ranging from 0 to 49, the GDQS also has two "sub-metrics" reflecting consumption of healthy and unhealthy components (Table 8c.9). Further, two cutoffs have been identified, to allow for reporting the percent of the population at high risk for poor diet quality outcomes (GDQS < 15) and the percent of the population at low risk for poor diet quality outcomes (GDQS ≥ 23).

Like the GDR Score, the GDQS is a recent innovation. Unlike the GDR Score, the semi-quantitative data required to construct the GDQS cannot be derived from non-quantitative food group recalls implemented to date in global survey programs such as the DHS, MICS and Gallup World Poll.

Lower-burden methods for the semi-quantitative recall required for the GDQS are currently under development and include a technology-assisted data collection tool and the use of visual aids (a set of 3D cubes of specified size or playdough for molding by the respondent) for collecting data to categorize the quantity of consumption per GDQS food group (Moursi et al, 2021).

Box 8c.11 summarizes key points about lower burden indices, designed for settings where detailed quantitative dietary intake data collection is infeasible.

Box 8c.11 Summary of lower burden indices

- Lower-burden indices have been developed for assessment and monitoring at population level, and not for use for individuals;
- Food group diversity indicators have been developed for several demographic groups, to proxy for micronutrient density or adequacy;
- These food group diversity indicators were not designed to reflect NDC risk;
- Recently, several new lower burden indices have been developed;
- The Global Dietary Recommendations (GDR) Score is a simple proxy indicator reflecting adherence to global dietary guidance from the World Health Organization and the World Cancer Research Fund, focused on the non-communicable disease risk;
- The Global Diet Quality Score (GDQS) reflects both nutrient adequacy and NCD risk;

- Both new scores — the GDR Score and the GDQS — were developed for adults, but may be evaluated for other groups in future;
- Components for both the GDR Score and the GDQS are food groups, and both have positive/healthy and negative/unhealthy components and sub-indices;
- Neither requires the use of food composition data for tabulation;
- The GDR Score is based on a non-quantitative food group recall data and the GDQS is based on semi-quantitative data.

8c.11 Incorporating sustainability in diet quality definitions and indices

Current food systems are now known to contribute a significant share of global greenhouse gas emissions and to contribute to land conversion, deforestation, and biodiversity loss; agriculture also accounts for the majority of global freshwater withdrawals (FAO & WHO, 2019). Recognition of this has led to efforts to define diets that are both healthy and environmentally sustainable, and to calls for integration of sustainability considerations in national food-based dietary guidelines, as noted above (Gonzalez Fischer & Garnett, 2016; Springmann et al., 2020).

Component	Macronutrient intake (possible range), g/d	Caloric intake, kcal/d
Whole grains[b]		
Rice, wheat, corn and other	232 (total grains 0–60% of energy)	811
Tubers or starchy vegetables		
Potatoes and cassava	50 (0–100)	39
Vegetables		
All vegetables	300 (200–600)	
Dark green vegetables	100	23
Red and orange vegetables	100	30
Other vegetables	100	25
Fruits		
All fruit	200 (100–300)	126
Dairy foods		
Whole milk or derivative equivalents (e.g. cheese)	250 (0–500	153
Protein sources		
Beef and lamb	7 (0–14)	15
Pork	7(0–14)	15
Chicken and other poultry	29 (0–58)	62
Eggs	13 (0–25)	19
Fish[c]	28 (0–100)	40
Dry beans, lentils, and peas[b]	50 (0–100)	172

In 2019, the EAT-Lancet Commission (Willet et al., 2019) addressed sustainability concerns and provided a global "healthy reference diet", with quantitative targets (and ranges) for food group intake, based on a 2500 calorie diet (Table 8c.10). The reference diet was intended to be flexible and adaptable to various cultural contexts. The EAT-Lancet reference diet is high in plant-source foods and with limited amounts of animal-source foods, with the low end of the "healthy" range for these foods set at zero. Currently, there is no established global guidance on the appropriate balance of plant-source and animal-source foods.

Some have raised concerns that the EAT-Lancet reference diet unnecessarily restricts nutrient-dense animal-source foods (Raiten et al., 2020). Vaidyanathan (2020) summarizes some of the controversies and concerns. For nutrition-insecure women in low- and middle-income countries, Hanley-Cook et al. (2021) demonstrated that micronutrient adequacy improved when the EAT-Lancet intake ranges were modified by imposing non-zero minimum quantities for nutrient-dense animal-source food groups.

Component	Macronutrient intake (possible range), g/d	Caloric intake, kcal/d
Soy foods	25 (0–50)	112
Peanuts	25 (0–75)	142
Tree nuts	25	149
Added fats		
Palm oil	6.8 (0–6.8)	60
Unsaturated oils[d]	40 (20–80)	354
Lard or tallow	5 (0–5)	36
Added sugars		
All sweeteners	31 (0–31)	120

Table 8c.10 EAT — Lancet healthy reference diet, for an intake of 2500 kilocalories per day. Adapted from W. Willett et al. (2019)

[b] Wheat, rice, dry beans and lentils are dry, raw.

[c] Consists of fish and shellfish, including both wild and farmed.

[d] Includes olive, soy bean, rapeseed, sunflower, and peanut oil.

Meantime, several groups have proposed indices for healthy, sustainable diets either based on national guidance (Harray et al., 2015) or based on the EAT-Lancet reference diet (Knuppel et al., 2019; Trijsburg et al., 2019). Stubbendorff et al., 2021). Given this is a new area of inquiry, it is likely that additional research on sustainable healthy diets will yield additional indices and measurement tools in coming years.