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Review

Measuring Adherence to Sustainable Healthy Diets: A Scoping Review of Dietary Metrics

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A B S T R A C T

Comprehensive metrics that provide a measure of dietary patterns at global and national levels are needed to inform and assess the effectiveness of policy actions that promote sustainable healthy diets. In 2019, the Food and Agriculture Organization of the United Nations and the World Health Organization reported 16 guiding principles of sustainable healthy diets, but it is still unknown how these principles are considered in dietary metrics. This scoping review aimed to explore how principles of sustainable healthy diets are considered in dietary metrics used worldwide. Forty-eight food-based, investigator-defined dietary pattern metrics assessing diet quality in free-living, healthy populations at the individual or household level were assessed against the 16 guiding principles of sustainable healthy diets, which was used as a theoretical framework. A strong adherence of the metrics to health-related guiding principles was found. Metrics had a weak adherence to principles related to environmental and sociocultural aspects of diets, except for the principle related to diets being culturally appropriate. No existing dietary metric captures all principles of sustainable healthy diets. Notably, the significance food processing, environmental, and sociocultural aspects of diets are generally understated. This likely reflects the lack of focus on these aspects in current dietary guidelines, which highlights the importance of including these emerging topics in future dietary recommendations. The absence of quantitative metrics that comprehensively measure sustainable healthy diets limits the body of evidence that would otherwise inform national and international guideline developments. Our findings can help grow the quantity and quality of the body of evidence available to inform policy activities to realize 2030 Sustainable Development Goals of multiple United Nations. *Adv Nutr* 2022;x:xx.

Keywords: dietary pattern, diet quality metrics, nutrition surveillance, healthy and sustainable diets, double burden of malnutrition, sustainability, sociocultural indicator

Abbreviations used: AHEI-2010, Alternative Healthy Eating Index; DDS, Dietary Diversity Score; DGAI, Dietary Guidelines for Americans Adherence Index; DGI-2013, Australian Dietary Guideline Index; DHD15-index, Dutch Healthy Diet Index; DQI-I, Diet Quality Index International; EAT-LDI, EAT-Lancet Diet Index/Planetary Health Diet; E-CDS, Evolutionary-Concordance Diet Score; EDI, Elderly Dietary Index; FBDG, Food-Based Dietary Guidelines; FCS, World Food Programme's Food Consumption Score; FVS, Food Variety Score; GDQS, Global Diet Quality Score; HDDS, Household Dietary Diversity Score; HEI-2010/2015, Healthy Eating Index; HNFI, Healthy Nordic Food Index; hPDI, Health Plant-Based Diet Index; HSENS, Household share of energy consumed from nonstaples; IDI, Ideal Diet Index; IYCMDD, Infant and young child minimum dietary diversity; JFGST, Japanese Food Guide Spinning Top; KIDMED, Mediterranean Diet Quality Index for Children and Teenagers; MDD-W, Minimum Dietary Diversity for Women; MED, Mediterranean Diet Score; MIND, Mediterranean-DASH Intervention for Neurodegenerative Delay; MQHD, Moderation-Quantified Healthy Diet; NCD, noncommunicable disease; NRFS, Nonrecommended Food Score; ODI-R, Overall Dietary Index-Revised; OPDI, Obesity Protective Dietary Index; PDI, The Overall Plant-based Diet Index; PNNS, French National Nutrition and Health Program; PURE, Prospective Urban Rural Epidemiology Diet Score; PVFP, The Pro-Vegetarian Food Pattern; QDGs, Qatar Dietary Guidelines; RFS, Recommended Foods Score; SAFBDG, South African food-based dietary guidelines score; SEAD, Southern European Atlantic Diet; SENC, Spanish Dietary Guidelines; TSD, Traditional Sami Diet Score; WCRF-AICR, World Cancer Research Fund and American Institute for Cancer Research Dietary Recommendations; WDDS and IDDS, Women's Dietary Diversity Score and Individual Dietary Diversity Score; WHO-HDI, WHO Healthy Diet Indicator.

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Introduction

Malnutrition in all its forms, such as undernutrition, obesity, and diet-related noncommunicable diseases (NCDs) and environmental degradation, are among the most urgent societal challenges of the 21st century [1]. These intersecting global challenges share unhealthy and unsustainable food systems as a core driver [1, 2]. Current food systems are failing to meet the needs of current and future generations, by operating outside several planetary boundaries and, at the same time, provisioning inequitable and insufficient quantities, quality, and diversity of safe, affordable and nutritious foods [3–5].

Promoting healthy diets from sustainable food systems for current and future generations is central to realizing the 2030 Sustainable Development Goals of multiple United Nations (UN) [1]. There is expert consensus on the urgent need that generate transformative food systems change, as evidenced by over 40 global, high-level reports calling for system-wide actions to address these challenges [6, 7]. In addition, actions to promote sustainable, resilient food systems for healthy diets is the first of six "pillars of action" in the UN Decade of Action on Nutrition (2016–2025) [1].

In October 2019, the Food and Agriculture Organization (FAO) of the UN and the World Health Organization (WHO) launched a report on guiding principles to define "Sustainable Healthy Diets" as dietary patterns that promote all dimensions of health and wellbeing; have low environmental pressure and impact; are accessible, affordable, safe and equitable; and are culturally acceptable [8]. Sustainable healthy diets are aimed to achieve optimal growth and development of all individuals and support functioning and physical, mental, and social wellbeing at all life stages for present and future generations; contribute to preventing all forms of malnutrition; reduce the risk of diet-related NCDs; and support the preservation of biodiversity and planetary health [8].

The 16 guiding principles presented in the report are divided into three aspects of sustainable healthy diets: health (e.g., diets are adequate to meet the needs for an active and healthy life across the lifecycle and reduce the risk of NCDs), environmental (e.g., maintain greenhouse gas emissions in line with a 1.5C target, water and land use within set targets, and preserve biodiversity), and sociocultural (e.g., built on and respect local culture, affordable, accessible, and desirable). These principles are intended to guide the actions and communication activities of governments and other stakeholders aiming at transforming food systems to deliver on sustainable healthy diets [8].

Comprehensive metrics of dietary patterns at global and national levels are needed to monitor characteristics of diets and to inform and assess the effectiveness of policy actions that promote sustainable healthy diets. Although rigorous metrics are underpinned by scientific recommendations, they have potential to, in turn, generate evidence to inform subsequent formulation and revision of recommendations, including of dietary guidelines [9, 10]. Moreover, this notion is consistent with recent attempts to develop comprehensive indicators for the broader sustainability assessment of food systems [10, 11].

Dietary patterns consider the combinations, types, and amounts of foods consumed in the diet on a regular basis [12]. Investigator-defined dietary patterns (also referred to as a priori methods) describe intakes according to previous knowledge, guidelines, and recommendations using prespecified criteria. They are most commonly referred to as indices or "diet quality scores" operationalizing national dietary recommendations (e.g., dietary guidelines and nutrient reference values). Furthermore, they may reflect other selective or predefined diets, such as vegetarian diets, or have a focus on single attributes, such as dietary diversity or food processing [13, 14].

A range of metrics have been proposed to summarize various components of these different dietary patterns. Such metrics may have different primary aims (e.g., to measure the healthiness and/or sustainability of diets) and require appropriate application in each cultural context. Recent reviews explored their use to assess the healthiness [15–17] or environmental sustainability [18] of diets, but it remains unclear how existing metrics consider more broadly principles of sustainable healthy diets. Martini et al [19] reviewed how these principles were considered in 43 food-based dietary guidelines (FBDGs). The authors assessed broader messages included in the guidelines and found that most guidelines included recommendations related to health principles of sustainable healthy diets, but environmental and sociocultural principles were considered less frequently, especially in the older guidelines [19]. Nevertheless, that review did not examine how these principles that are presented qualitatively were translated into measurable dietary metrics.

Considering the relevance of rigorous dietary metrics to quantitatively evaluate progress against targets and to informing policies to promote sustainable healthy diets, this scoping review aimed to explore how principles of sustainable healthy diets are considered in dietary metrics used worldwide.

Methods

Review method

A scoping review [20] was identified as the most appropriate method as this review aimed to identify key characteristics related to a concept (measures of diet quality) in a body of literature that has not yet been comprehensively reviewed and to bring together literature in disciplines with emerging evidence (particularly on environmental effects of diets within the context of dietary metrics). This scoping review began with the establishment of a research team consisting of researchers with expertise in nutrition science, social science, epidemiology, dietary assessment, environmental sustainability, and research synthesis. The team advised on the research question to be addressed and the study protocol.

Protocol and registration

The Preferred Reporting Items for Systematic reviews and meta-analyses extension for Scoping Reviews (PRISMA-ScR) [21] was followed in reporting this systematic scoping review. A review protocol was registered (OSF Registries: https://osf.io/7c2qa).

Information sources and search strategy

A scoping electronic search occurred in May 2021 and comprised a 2-step process: *1*) a handsearch of metrics included in relevant reviews of the field [15, 16, 18, 22]; and *2*) owing to the novelty of the topic, additional sustainability-focused metrics were identified through a systematic search in Scopus, Web of

Science, and EBSCOHost (Environment Complete, Global Health, MedLine Complete) using the following terms: ("Sustainable diet" OR "healthy and sustainable diet*" OR "sustainability") AND ("diet* pattern*" OR "diet* quality" OR "diet* variety" OR "diet* diversity" OR "diet* quality score*" OR "diet* index" OR "index analysis" OR "diet* guideline*" OR "diet* recommendation*" OR "diet* score*" OR "recommended diet*" OR "diet* goals score" OR "Planetary Health Diet" OR "plant-based diet*" OR "Plant-based Diet" OR "Pro-Vegetarian diet"). In addition, forward citation searching combined with handsearching of the reference lists from retrieved articles were conducted. The original references containing information about the development of the included metrics were handsearched. An update of the search, using identical methodology, occurred in September 2021.

Eligibility criteria

The metrics identified through the electronic search were screened against the eligibility criteria. This review focused on food-based approaches, based on the premise that humans meet nutrient needs through foods and diets, as is consistent with the food-based approach considered in the 16 guiding principles [8]. Inclusion and exclusion criteria are detailed in Table 1. Eligibility criteria were applied to characteristics of the dietary metrics used in each study, rather than the study methods themselves. Metrics were eligible for inclusion if they: *1*) were investigator-defined dietary patterns (also referred to as a priori methods), that is, reflect previous knowledge, guidelines, and recommendations using prespecified criteria, for example, measure adherence to health and/or environmental sustainability-based recommendations, such as indices operationalizing most up to date national FBDG and respective country adaptations; *2*) reflected other selective or predefined diets, for example, vegetarian diets, or focused on single attributes (such as dietary diversity, food processing); *3*) were derived from food or food groups; *4*) assessed diet quality among free-living, healthy populations (at individual or household level); and *5*) were developed, revised, or adapted after 2000 (period when the term "dietary patterns" was coined [23]) in English, Spanish, or Portuguese. Metrics could have different primary aims (e.g., health and/or sustainability) and appropriate application in each cultural context.

Metrics were excluded if they: *1*) were data-driven dietary metrics (e.g., cluster, principal component, or factor analysis) and metrics derived from reduced rank regression (hybrid-method) because they aim to capture variation in intake of foods in the population and are often not generalizable; *2*) were derived from nondietary indicators (e.g., age, body mass index, obesity, socioeconomic status, tobacco use, family history, physical activity, and psychosocial stress); *3*) were calculated based solely on nutrients (single or multiple; and diets described regarding nutrient profile, that is, food intakes not reported), food components (food items or ingredients of a mix food that contain certain amounts of energy, nutrients, and nonnutritive substances, such as artificial sweeteners) or a single food or single food group (e.g., only measuring fruit intake), supplements or enteral and parenteral nutrition, or eating behavior (e.g., eating occasions such as frequency and time, and dieting); *4*) assessed diet quality among individuals with a preexisting medical condition, for example, cancer patients; individuals with elevated blood pressure; secondary prevention of cardiovascular events; overweight/obesity in weight management studies; mental disorders; or focused on specific populations, for example, pregnant, lactating, or premenopausal/perimenopausal/menopausal women; women with fetuses or preterm infants; early life programming; individuals with special needs/disabilities; athletes; focused on specific institutional, for example, school, prisons, workplaces, aged care; *5*) did not assess diet quality at individual/household level (e.g., at national/regional); and *6*) were published before 2000 and not in English, Spanish, or Portuguese.

The compilation of metrics that both did and did not meet the scope of the inclusion criteria is presented in Supplemental Table 1.

Data extraction, analysis, and synthesis of results

Relevant data were extracted using a standardized electronic piloted spreadsheet. The following information was extracted for each dietary metric: name of the metric, original reference, intended purpose, indicator item list (i.e., food components), indicator calculation (i.e., diet quality component, grouping of diet quality component, scoring procedures). CR, KS and SD conducted the data extraction and PM extracted a 10% sample of metrics to check for inter-assessor reliability.

TABLE 1
Eligibility criteria

Inclusion	Exclusion
Dietary metrics	Dietary metrics
Investigator-defined dietary patterns (also referred to as a priori methods)	Data-driven dietary metrics and metrics derived from reduced rank regression; metrics derived from nondietary patterns indicators; metrics calculated based solely on nutrients; food components (12) or a single food or single food group, supplements or enteral and parenteral nutrition, or eating behavior
Population	Population
Free-living, healthy children (0–18 y) and/or adults (≥18 y)	Individuals with a preexisting medical condition or specific populations
Level of dietary assessment	Level of dietary assessment
Individual or household level	Food supply/national/regional level
Publication period	Publication period
Published in or after 2000	Published before 2000
Language	Language
Abstract and full text in English, Spanish, or Portuguese (languages spoken by the team)	Abstract and full text not in English, Spanish, or Portuguese

The assessment of adherence to the guiding principles of sustainable healthy diets [8] was based on both conceptual (intended purpose, food groupings) and technical (applied cut-offs) characteristics of each metric. Three levels of adherence to recommendations were assigned for each principle: fully considered, partially considered, or not considered. To assess these levels of adherence, first, each principle was divided into a number of underlying recommendations that varied from 1 to 3 depending on the principle. For example, Principle 13, "[Sustainable Healthy Diets] reduce food loss and waste," had only one recommendation to be assessed, whereas Principle 2, "[Sustainable Healthy Diets] are based on a great variety of unprocessed or minimally processed foods, balanced across food groups, while restricting highly processed food and drink products," had three recommendations to be assessed—*1*) recommendation for variety of unprocessed and minimally processed foods; *2*) recommendation for balance across food groups; and *3*) recommendation to restrict highly processed food foods. Adherence of the metrics to each principle was fully considered when all recommendations were addressed (1–3 depending on the principle), partially considered when [1] or [2] recommendations were addressed or not considered when none of the recommendations were considered.

The detailed description of the criteria and underlying premises for each principle is presented in Table 2. The assessment was conducted by PM after pilot testing with the following members of the team: SAM, KML, and ML. The pilot testing examined whether the criteria used to assess the principles were adequate and clearly defined; whether the template for assessment was appropriate; and whether the extracted information was sufficient to assess the principles.

Questions or uncertainties related to metrics screening and the data charting process were resolved by team discussion and consensus. The number of principles considered in each dietary metric was synthesized and visually presented with different colors representing the levels of adherence: fully considered, partially considered, or not considered. An inductive research design was used to examine how the conceptual and technical characteristics of the different dietary metrics might explain observed differences in adherence of the metrics to the guiding principles of sustainable healthy diets. All authors reviewed iterations of the results and final tables and figures.

Results

Dietary metrics

A total of 48 dietary metrics were assessed, with 41 (85%) being indices or "diet quality scores" and 7 (15%) reflecting other selective or predefined diets (vegetarian, vegan, flexitarian, pescatarian, and omnivorous diet) or focusing on single attributes such as food processing (e.g. NOVA system).

Adherence of the dietary metrics to the guiding principles of sustainable healthy diets

The proportion of adherence of the metrics by principle is presented in Figure 1. The analysis revealed a strong adherence (high number) of metrics to health-related guiding principles (particularly, principles 2–4), but a weak adherence (low number) to principles related to environmental and sociocultural aspects of diets (except principle 14). In particular, the guiding principles related to health aspects (i.e., principles 1–8) were included from a minimum of 0% of the time for Principle 8 to 73% and 71% for principles 2 and 3, respectively. Conversely, principles related to the environmental aspects (i.e., principles 9–13) were included at far lower rates. Only principles 9 and 10 featured in one of the metrics. Finally, only Principle 14 was considered within sociocultural aspects of diets (i.e., principles 14–16), and it was considered by 37.5% of the metrics.

Figure 2 outlines the adherence of each of the 48 dietary metrics across the 16 guiding principles of sustainable healthy diets. Complete names and abbreviations of these metrics are presented in Table 3. Metrics with the weakest adherence were HSENS and omnivorous diet (aligned with zero principles), whereas EAT-LDI (aligned with eight principles), DGAI (aligned with six), and PNNS (aligned with six) had the strongest adherence to the guiding principles (Figure 2).

A detailed description and complete reference of the included dietary metrics are provided in Supplemental Table 2. Detailed assessments of the adherence of each dietary metrics to principles of sustainable healthy diets are provided in Supplemental Table 3.

Health aspects

Principle 1: Start early in life with early initiation of breastfeeding, exclusive breastfeeding until 6 mo of age, and continued breastfeeding until 2 y and beyond, combined with appropriate complementary feeding

This principle was not fully considered by any of the metrics. Only the NOVA system partially considered this principle because it includes breast milk within the recommended group of unprocessed foods. Complementary feeding was not specifically considered in the metrics.

Principle 2: Are based on a great variety of unprocessed or minimally processed foods, balanced across food groups, while restricting highly processed food and drink products

This principle was not fully considered by any of the metrics. Only NOVA presents a framework to classify foods based on the level of industrial processing; therefore, most metrics do not include recommendations for a variety of unprocessed or minimally processed foods or restricted intake of highly processed foods. However, some metrics do include recommendations for a variety of foods that are examples of unprocessed and minimally processed foods. For example, the DQI-I scores variety of meat/poultry/fish/egg, dairy/beans, grains, fruits, and vegetables, and the DGI-2013 scores five core food groups. In the MDD-W, processed versions of foods might not be included in the score for diversity. Although NOVA considers level of processing, variety within the unprocessed or minimally processed foods group is not considered in the indicator of percent intake from NOVA groups.

Most of the metrics have recommendations for balance across food groups because they consider at least five core food groups (fruits, vegetables, cereals, legumes, and nuts), with the only exception is the indicator based on NOVA.

NOVA is the only metric to consider restricting highly processed foods (ultra-processed), despite some metrics recommending foods that are examples of ultra-processed foods. For instance, DQI-I recommends restricting sugar-sweetened

TABLE 2
Criteria used to assess adherence of dietary metrics to the FAO/WHO (8) guiding principles of sustainable healthy diets

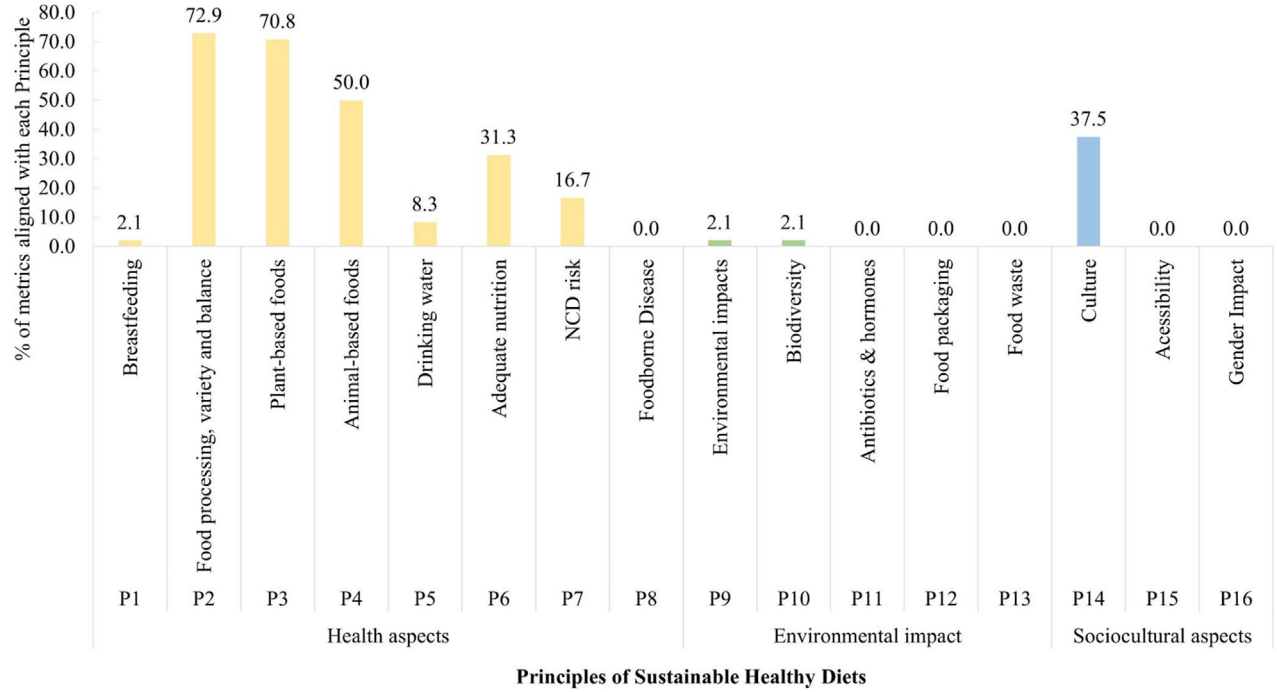
FAO/WHO Guiding principles of sustainable healthy diets[1] (8)			Assessment criteria of adherence of dietary metrics to the principles[2]		
			Fully considered: The dietary metric	Partially considered	Not considered
Health aspects	1	"start early in life with early initiation of breastfeeding, exclusive breastfeeding until 6 mo of age, and continued breastfeeding until 2 y and beyond, combined with appropriate complementary feeding."	(1) Includes recommendation for breastfeeding and (2) Includes recommendation for appropriate complementary feeding	(1) or (2) is addressed	None is addressed
	2	"are based on a great variety of unprocessed or minimally processed foods, balanced across food groups, while restricting highly processed food and drink products."	(1) Includes recommendation for variety of unprocessed and minimally processed foods *Premise: only metrics using a framework to classify foods based on level of processing scored in this criterion* and (2) Includes recommendation for balance across food groups *Premise: if included recommendations for at least five core groups (fruits, vegetables, cereals, legumes, and nuts) it was considered in this criterion regardless of using level of processing to identify these foods* and (3) Includes recommendation to restrict highly processed food (ultraprocessed foods) *Premise: only metrics using a framework to classify foods based on level of processing were considered in this criterion (i.e., focused on an entire group, not only specific foods groups, e.g., sugar-sweetened beverages)*	(1), (2), or (3) is addressed	None is addressed
	3	"include whole grains, legumes, nuts and an abundance and variety of fruits and vegetables."[3]	(1) Includes recommendation for whole grains, legumes, nuts *Premise: it was scored if included recommendation for at least two of them* and (2) Includes recommendation for abundance of fruits and vegetables *Premise: abundance was not defined in the report (8). Thus, any recommendation that includes amounts (through cutoffs or population distribution) was considered in this criterion.* and (3) Includes recommendation for variety of fruits and vegetables *Premise: any attempt to account for variety (i.e., considering two or more groups within fruits or vegetables) was considered*	(1), (2), or (3) is addressed	None is addressed
	4	"can include moderate amounts of eggs, dairy, poultry and fish; and small amounts of red meat."	(1) Includes recommendation for moderate consumption of eggs, dairy, poultry, and fish and (2) Includes recommendation for small amounts of red meat *Premise: moderate or small amounts were not defined in the report (8). Thus, any recommendation that includes amounts (through cutoffs or population distribution) was considered in this criterion*	(1) or (2) is addressed	None is addressed
	5	"include safe and clean drinking water as the fluid of choice."	(1) Includes recommendation for drinking water as the fluid of choice and (2) Includes recommendation on safety and cleanliness of drinking water	(1) or (2) is addressed	None is addressed
	6	"are adequate (i.e., reaching but not exceeding needs) in energy and nutrients for growth and development, and to meet the needs for an active and healthy life across the lifecycle."	(1) Includes recommendation for adequacy of energy for a healthy state and (2) Includes recommendation for adequacy of nutrients for a healthy state *Premise: if the intended purpose of the metric includes nutrient or energy adequacy, this criterion was considered.*	(1) or (2) is addressed	None is addressed
	7	"are consistent with WHO guidelines to reduce the risk of diet-related NCDs, and ensure health and wellbeing for the general population."[4]	(1) Includes complete recommendation for all nutrients and salt *Premise: both free and added sugar were considered.*	Includes recommendation for at least two nutrients/ salt, but not all of them	None is addressed
	8	"contain minimal levels, or none if possible, of pathogens, toxins and other agents that can cause foodborne disease."	(1) Includes recommendation about pathogens, toxins and other agents that can cause foodborne disease.	—	None is addressed

(*continued on next page*)

TABLE 2 (*continued*)

FAO/WHO Guiding principles of sustainable healthy diets[1] (8)			Assessment criteria of adherence of dietary metrics to the principles[2]		
			Fully considered: The dietary metric	Partially considered	Not considered
Environmental effect	9	"maintain greenhouse gas emissions, water and land use, nitrogen and phosphorus application and chemical pollution within set targets."	(1) Includes recommendation to maintain greenhouse gas emissions, water and land use, nitrogen, and phosphorus application within set targets. *Premise: if the intended purpose of the metric included dietary recommendations within set targets, this criterion was considered.*	—	None is addressed
	10	"preserve biodiversity, including that of crops, livestock, forest-derived foods and aquatic genetic resources, and avoid overfishing and overhunting."	(1) Includes recommendation to preserve biodiversity. and (2) Includes recommendation to avoid overfishing and overhunting.	—	None is addressed
	11	"minimize the use of antibiotics and hormones in food production."[5]	(1) Includes recommendation to minimize the use of antibiotics and hormones in food production.	—	None is addressed
	12	"minimize the use of plastics and derivatives in food packaging."	(1) Includes recommendation to minimize the use of plastic and derivatives in food packaging.	—	None is addressed
	13	"reduce food loss and waste."	(1) Includes recommendation to reduce food loss and waste.	—	None is addressed
Sociocultural aspects	14	"are built on and respect local culture, culinary practices, knowledge and consumption patterns, and values on the way food is sourced, produced and consumed."	(1) Recommendations are built on and respect local culture, culinary practices, knowledge, and consumption pattern. (Cultural aspect) *Premise: metrics derived from food-based dietary guidelines, that represents traditional diets of a specific culture/region or designed to accommodate a variety of culturally diverse eating patterns were automatically scored for this this criterion.* and (2) Recommendation values on the way food is sourced and produced. (Food systems aspect)	(1) or (2) is addressed	None is addressed
	15	"are accessible and desirable."	(1) Includes recommendation about being accessible. (Food environment, e.g., cost, physical access) and (2) Includes recommendation about being desirable. (Personal preferences)	(1) or (2) is addressed	None is addressed
	16	"avoid adverse gender-related impacts, especially with regard to time allocation (e.g., for buying and preparing food, water and fuel acquisition)."	(1) Includes recommendation to avoid adverse sex-related effects	—	None is addressed

[1]The wording in this section follows the same presented in the FAO/WHO 2019 Report (8). [2]Fully considered: all recommendations were addressed by the metric; partially considered: at least one recommendation was addressed by the metric; not considered: none of the recommendations were addressed by the metric. [3]Potatoes, sweet potatoes, cassava, and other starchy roots are not classified as fruits or vegetables. [4]They include ≤30%–35% of total energy intake from fats, with a shift in fat consumption away from saturated fats to unsaturated fats and toward the elimination of industrial trans fats; <10% of total energy intake from free sugars (possibly <5%) and not >5 g/d of salt (to be iodized) (41). [5]From FAOSTAT presented in the FAO/WHO 2019 Report (8).



NCD, Non-communicable diseases; P, Principles.

FIGURE 1. Proportion of dietary metrics aligned with each FAO/WHO guiding principle of sustainable healthy diets (8).

Dietary metrics	Principles of Sustainable Healthy Diets																Alignment per metric	
	Health aspects								Environmental impact					Sociocultural aspects				
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16		
	Breastfeeding	Food processing, variety & balance	Plant-based foods	Animal-based foods	Drinking water	Adequate nutrition	NCD risk	Foodborne disease	Environmental impacts	Biodiversity	Antibiotics & hormones	Food packaging	Food waste	Culture	Acessibility	Gender Impact	n	%
DQI-I		/	/			/	/							/			5	31.3
AHEI-2010		/	/	/			/							/			5	31.3
DASH		/	/	/													3	18.8
DGAI		/	√	/		/	/							/			6	37.5
HEI-2010/2015		/	/			/								/			4	25.0
KIDMED		/	/											/			3	18.8
MED		/	/	/		/								/			5	31.3
MIND		/	/	/													3	18.8
PURE			/														1	6.3
RFS		/	/														2	12.5
NRFS				/													1	6.3
WHO-HDI			/				/										2	12.5
WCRF-AICR			/	/													2	12.5
DDS		/															1	6.3
FCS		/				/											2	12.5
FVS		/															1	6.3
HDDS		/				/											2	12.5
IYCMDD		/	/			/											3	18.8
MDD-W		/	/			/											3	18.8
WDDS & IDDS		/	/			/											3	18.8
DHD15-index		/	/	/													3	18.8
HNFI		/				/								/			3	18.8
DGI-2013		/	√		/									/			4	25.0
PNNS		/	/	/	/	/								/			6	37.5
SEAD		/	/			/								/			4	25.0
SENC		/	/	/	/									/			5	31.3
QDGs		/	/											/			3	18.8
SAFBDG			/	/			/							/			4	25.0
JFGST		/	/	/										/			4	25.0
EDI		/	/	/													3	18.8
E-CDS		/	/	/													3	18.8
IDI		/	/	/			/										4	25.0
TSD														/			1	6.3
MQHD		/	/			/											3	18.8
EAT-LDI		/	/	√		√	/		√	/				√			8	50.0
PDI		/	/	√													3	18.8
hPDI		/	/	√													3	18.8
PVFP		/	/	√													3	18.8
Vegetarian				√													1	6.3
Vegan				√													1	6.3
Flexitarian				√													1	6.3
Pescatarian				√													1	6.3
Omnivorous																	0	0.0
NOVA	/	/			/												3	18.8
HSENS																	0	0.0
GDQS		/	√	/		/								/			5	31.3
ODI-R		/	√				/										3	18.8
OPDI			/											/			2	12.5
n	1	35	34	24	4	15	8	0	1	1	0	0	0	18	0	0		
%	2.1	72.9	70.8	50.0	8.3	31.3	16.7	0.0	2.1	2.1	0.0	0.0	0.0	37.5	0.0	0.0		

√ Principle fully considered / Principle partially considered Empty cell: Principle not considered
P, Principles; NCD: non-communicable disease

FIGURE 2. Adherence of dietary metrics across the FAO/WHO guiding principles of sustainable healthy diets (8).

TABLE 3
List of included metrics

AHEI-2010	Alternative Healthy Eating Index	MED	Mediterranean Diet Score
DASH	Dietary Approaches to Stop Hypertension	MIND	Mediterranean-DASH Intervention for Neurodegenerative Delay
DDS	Dietary Diversity Score	MQHD	Moderation-Quantified Healthy Diet
DGAI	Dietary Guidelines for Americans Adherence Index	NOVA	NOVA system
DGI-2013	Australian Dietary Guideline Index	NRFS	Nonrecommended Food Score
DHD15-index	Dutch Healthy Diet Index	ODI-R	Overall Dietary Index-Revised
DQI-I	Diet Quality Index International	Omnivorous	Omnivorous diet
EAT-LDI	EAT-Lancet Diet Index	OPDI	Obesity Protective Dietary Index
E-CDS	Evolutionary-Concordance Diet Score	PDI	The Overall Plant-based Diet Index
EDI	Elderly Dietary Index	Pescatarian	Pescatarian diet
FCS	Food Consumption Score	PNNS	French National Nutrition and Health Program
Flexitarian	Flexitarian diet	PURE	Prospective Urban Rural Epidemiology Diet Score
FVS	Food Variety Score	PVFP	The Pro-Vegetarian Food Pattern
GDQS	Global Diet Quality Score	QDGs	Qatar Dietary Guidelines
HDDS	Household Dietary Diversity Score	RFS	Recommended Foods Score
HEI-2010/ 2015	Healthy Eating Index	SAFBDG	South African Food-based Dietary Guidelines Score
HNFI	Healthy Nordic food index	SEAD	Southern European Atlantic Diet
hPDI	Health Plant-Based Diet Index	SENC	Spanish Dietary Guidelines
HSENS	Household Share of Energy Consumed from Nonstaples	TSD	Traditional Sami Diet score
IDI	Ideal Diet Index	Vegan	Vegan diet
IYCMDD	Infant and Young Child Minimum Dietary Diversity	Vegetarian	Vegetarian diet
JFGST	Japanese Food Guide Spinning Top	WCRF-AICR	World Cancer Research Fund and American Institute for Cancer Research dietary recommendations
KIDMED	Mediterranean Diet Quality Index for Children and Teenagers	WDDS and IDDS	Women's Dietary Diversity Score and Individual Dietary Diversity Score
MDD-W	Minimum Dietary Diversity for Women	WHO-HDI	WHO Healthy Diet Indicator

beverages, DGI-2013 recommends avoiding discretionary foods, and WCRF-AICR recommends avoiding processed meat and limiting consumption of energy-dense foods and sugary drinks.

Principle 3: Include whole grains, legumes and nuts intake, and abundance and variety of fruits and vegetables

This principle had the highest level of adherence among the metrics. It was fully considered by DGAI, DGI-2013, GDQS, and ODI-R.

Most of the metrics (DQI-I, AHEI-2010, DASH, DGAI, HEI-2010/15, KIDMED, MED, MIND, PURE, RFS, IYCMDD, MDD-W, WDDS and IDDS, DHD15-index, DGI-2013, PNNS, SENC, SEAD, QDGs, SAFBDG, EDI, IDI, MQHD, EAT-LDI, PDI, hPDI, PVFP, GDQS, and ODI-R) have a recommendation for whole-grain, legume, and/or nut intake.

Most of the metrics (DQI-I, AHEI-2010, DASH, DGAI, HEI-2010/15, KIDMED, MED, PURE, WHO-HDI, WCRF-AICR, DHD15-index, DGI-2013, PNNS, SEAD, SENC, QDGs, SAFBDG, JFGST, IDI, E-CDS, EAT-LDI, PDI, hPDI, PVFP, GDQS, and OPD) recommend an abundance of fruits and vegetables. The DQI-I, AHEI-2010, DGAI, KIDMED, WHO-HDI, WCRF-AICR, DHD15-index, DGI-2013, PNNS, QDGs, IDI, EAT-LDI, GDQS, ODI-R, and OPDI have cutoffs for fruit and vegetable intake (e.g., higher scores ranged from $\geq\geq$400 g/d of fruit and vegetable intake for WHO-HDI, WCRF-AICR, and DHD15-index to $\geq$300 g/d of fruit and vegetable intake in EAT-LDI; $\geq$2 and $\geq$3 servings/d of fruits and vegetables, respectively, in DQI-I, QDGs and ODI-R to $\geq$4 and $\geq$5 servings/d of fruits and vegetables, respectively, in AHEI-2010; or if consumed more than once a day in KIDMED). Other metrics are based on the distribution of the consumption in the population (e.g., highest score if higher quintiles of fruit and vegetable consumption in DASH, PURE, SAFBDG, PDI, hPDI, and PVFP or intake above or at the population median in MED, SEAD, and E-CDS).

DGAI, RFS, IYCMDD, MDD-W, WDDS and IDDS, DGI-2013, E-CDS, GDQS, and ODI-R have recommendations for a variety of fruits and vegetables, mostly by splitting the group into dark green and orange/vitamin A–rich fruits and vegetables and a number of different types of fruits and vegetables.

Principle 4: Can include moderate amounts of eggs, dairy, poultry and fish, and small amounts of red meat

This principle was fully considered in the eight metrics with specific recommendations for plant-based diets (vegetarian, vegan, flexitarian, pescatarian, EAT-LDI, PDI, hPDI, and PVDI). Vegetarian, vegan, flexitarian, and pescatarian are diets with low or any intake of animal products; thus, they fully considered the principle, despite the absence of a cutoff for animal intake in the metric.

Eight metrics (MED, PNNS, JFGST, EAT-LDI, PDI, hPDI, PVFP, and GDQS) recommend moderate consumption of animal products. Moderate consumption of dairy is more commonly considered than other animal products (e.g., 300–450 g/d in DHD15-index, a low score for consumption >3.5 servings/d in PNNS and E-CDS). The GDQS scores lower for both low (<35 g/d) and high (>734 g/d) consumption of high fat dairy. Fish and meat dishes are grouped together in JFGST and meat, poultry, and eggs are grouped together in PNNS. EAT-LDI scores higher scores if egg consumption $\leq$25 g/d, dairy $\leq$500 g/d, poultry $\leq$58 g/d, and fish $\leq$100 g/d.

Sixteen metrics (AHEI-2010, DASH, MIND, NRFS, WCRF-AICR, DHD15-index, SENC, SAFBDG, EDI, E-CDS, IDI, EAT-LDI, PDI, hPDI, PVFP, and GDQS) recommend small amounts of red

meat, with highest scores ranging from consumption of <71 g/d in WCRF-AICR to ≤28 g/d in EAT-LDI for red meat and from <9 g/d in GDQS to 0 g/d in DHD15-index for processed meat. DASH, MED, SAFBDG, E-CDS, PDI, hPDI, and PVFP are based on the distribution of the consumption in the population (e.g., higher quintiles of red and processed meats consumption receive the lowest score in DASH, SAFBDG, PDI, hPDI, and PVFP, and intake above the median receives lowest score in MED and E-CDS). SENC scores higher for consumption of red and processed meats of <1 serving/d.

Principle 5: Include safe and clean drinking water as the fluid of choice

This principle was not fully considered by any of the metrics. Only the DGI-2013, PNNS, SENC, and NOVA recommend water as fluid of choice. DGI-2013 scores higher if proportion of water to total beverage intake per day is ≥50%, whereas PNNS scores higher when consumption is ≥1 L/d of water and ≤250 mL/d of soda. SENC scores higher for consumption of ≥4 water servings/d, and NOVA considers water in the recommended group of unprocessed and minimally processed foods.

Principle 6: Are adequate (i.e., reaching but not exceeding needs) in energy and nutrients for growth and development, and to meet the needs for an active and healthy life across the lifecycle

Only EAT-LDI fully considered this principle because food group intakes are based on recommendations to ensure nutritional adequacy. Most metrics with dietary diversity focus were developed for describing micronutrient or energy adequacy (e.g., FCS, HDDS, IYCMDD, MDD-W, and WDDS and IDDS). DQI-I considers thresholds for vegetables, fruit, grain, fiber, protein, iron, calcium, and vitamin C (adequacy groups), depending on the percentage of recommended daily allowances met, whereas GDQS scores aim to reflect nutrient adequacy. In HEI-2010/15, adequacy is considered as achieving maximum intake of recommended groups within the construct "adequacy." Energy adequacy is considered only in DGAI, PNNS, and JFGST.

Principle 7: Are consistent with WHO guidelines to reduce the risk of diet-related NCDs, and ensure health and wellbeing for the general population

This principle was not fully considered by any of the metrics. This principle was partially considered in eight metrics. Recommendations for free/added sugar are included in HEI-2010/15, WHO-HDI, SAFBDG, IDI, EAT-LDI, and ODI-R; saturated fat in DQI-I, DGAI, HEI-2010/15, WHO-HDI, SAFBDG, and IDI; total fat in DQI-I, DGAI, WHO-HDI, and SAFBDG; transfat in AHEI-2010 and DGAI; ratio of unsaturated-to-saturated fats in DQI-I, HEI-2010/15, WHO-HDI, EAT-LDI, and ODI-R; and sodium/salt in DQI-I, DGAI, HEI-2010/15, IDI, and ODI-R (cutoffs) and in AHEI-2010 and SAFBDG (population distribution).

Principle 8: Contain minimal levels, or none if possible, of pathogens, toxins, and other agents that can cause foodborne disease

This principle was not considered in any of the assessed metrics.

Environmental aspects

Principle 9: Maintain greenhouse gas emissions, water and land use, nitrogen and phosphorus application, and chemical pollution within set targets

This principle was fully considered by EAT-LDI. Only the EAT-LDI reported that the recommendations set ranges of intakes for food groups to ensure planetary boundaries.

Principle 10: Preserve biodiversity, including that of crops, livestock, forest-derived foods and aquatic genetic resources, and avoid overfishing and overhunting

This principle was not fully considered by any of the metrics. Only the EAT-LDI reported that the recommendations set ranges of intakes for food groups to ensure preservation of the biodiversity.

Principle 11: Minimize the use of antibiotics and hormones in food production

This principle was not considered in any of the assessed metrics.

Principle 12: Minimize the use of plastic and derivatives in food packaging

This principle was not considered in any of the assessed metrics.

Principle 13: Reduce food loss and waste

This principle was not considered in any of the assessed metrics.

Sociocultural aspects

Principle 14: Are built on and respect local culture, culinary practices, knowledge and consumption patterns, and values on the way food is sourced, produced and consumed

This principle was fully considered by EAT-LDI. All metrics derived from FBDGs (DGI-2013, PNNS, SENC, QDGs, SAFBDG, and JFGST) and from territorial/traditional dietary patterns (e.g., MED, HNFI, SEAD, and TSD) include recommendations for culturally appropriate diets because recommendations aim to reflect foods consumed in the countries/territories. In addition, the DQI-I, AHEI-2010, DGAI, HEI-2010/15, and GDQS include recommendations for culturally appropriate diets because the generic food groups aims to accommodate a variety of culturally diverse dietary patterns.

The EAT-LDI was the only metric with the intended purpose of valuing the way food is sourced and produced as it considers planetary boundaries for food production to ensure a stable Earth system.

Principle 15: Are accessible and desirable

This principle was not considered in any of the assessed metrics.

Principle 16: Avoid adverse gender-related impacts, especially with regard to time allocation (e.g., for buying and preparing food, water, and fuel acquisition)

This principle was not considered in any of the assessed metrics.

Discussion

This review aimed to explore how the 16 guiding principles of sustainable healthy diets defined by the FAO/WHO in 2019 [8] are considered in dietary metrics used worldwide. Our findings show that among the 48 assessed dietary metrics, none of them captures all components of sustainable healthy diets. Overall, there is a poor adherence of the metrics to these principles, particularly the environmental and sociocultural aspects of sustainable healthy diets. Regarding conceptual underpinnings, very few metrics were developed with the intended purpose of reflecting simultaneously health, environmental, and sociocultural aspects of diets.

To our knowledge, this is the first review to explore the cross-cutting aspects of sustainable healthy diets using the FAO/WHO 2019 report [8] as a theoretical framework to assess dietary metrics. Previously, Miller et al. [15] assessed the validity of dietary metrics against health outcomes and found that, although numerous metrics were designed and used to assess the dietary risks of NCDs, most of them were not validated against health outcomes in meta-analyses or were based on narrative reviews (except convincing evidence of protective associations for MED, AHEI, HEI, and DASH). Importantly, dietary metrics were not designed or validated to characterize the double burden of malnutrition [15].

Regarding environmental effects of diets, a systematic review of population-level dietary patterns found that plant-based diets (such as vegetarian), Mediterranean-style diets, the DASH, and others correlate strongly with reduced environmental effects (e.g., lower greenhouse gas emissions) compared with current average dietary intakes [18]. Moreover, modeling studies assessing plant-based diets have found a strong evidence of low environmental effects on greenhouse gas emissions, water, and land use [24]. Although the reduced effect of these dietary patterns compared with that of average intakes may not represent the ideal diets to ensure planetary health and/or were not based on actual consumption (e.g., in the case of modeling studies), these findings suggest that diets with low intake of animal products might contribute significantly to environmental-related principles of sustainable healthy diets [25]. Evidence of the potential of these metrics to assess the nexus between human and planetary health (e.g., crop diversity, air quality, and pesticide toxicity) is still lacking [26, 27]. Of note, air quality and pesticide toxicity were not incorporated within the FAO/WHO guiding principles.

The concept of territorial diets informs several metric developments, as shown in this review, but other sociocultural aspects have not yet been considered. Indicators of affordability and cultural acceptability of diets have been proposed [28]. However, evidence of inclusion of these indicators in dietary metrics and development of indicators for desirability and adverse sex-related effects are still lacking [28].

The absence of cross-cutting health, environmental, and sociocultural indicators in dietary metrics might be explained by the fact that most metrics were developed with the aim of measuring the healthiness of diets. We assessed the metrics based on the purpose and technical aspects of their development (e.g., dimensions of diet quality considered, such as adequacy and moderation), and we did not include additional empirical evidence supporting their validity against health, environmental, and sociocultural outcomes. We followed this strict interpretation and operationalization of the principles included in the FAO/WHO report to make this review feasible and robust. This may have underestimated the adherence of some metrics to some principles. For instance, plant-based diet metrics such as PDI, PVFP, vegan, and MED have strong potential to be aligned particularly with principles 9 and 10 [29, 30]. However, they were not developed with the purpose to reduce environmental effect (but to address reasons such as human health or animal welfare concerns); thus, they were not considered aligned with the environmental principles.

Although not using additional empirical evidence is a limitation of this review, this only partially explains the lack of adherence to the principles. Many of the metrics included in our analysis did not align with the environmental and sociocultural aspects of diets, which is likely to be a reflection of the dietary guidelines that were used to underpin these metrics developments. Using the same theoretical framework as in this study, Martini et al. [19] assessed 43 national FBDGs and found that most of them scored well for health aspects but not for environmental and sociocultural aspects of diets, which, therefore, explain similarities with the results of this study. Although sustainability-related recommendations in national FBDGs is increasing over time, few countries have included such recommendations to date [31, 32], and these have not yet been translated into quantitative metrics measuring diet quality. The challenges of translating qualitative recommendations into measurable metrics is of important note. Conversely, the absence of quantitative metrics that comprehensively measure sustainable healthy diets limit the body of evidence that would otherwise inform national and international dietary guidelines developments.

In this review, we also found that dietary metrics varied substantially in their composition and scoring, mostly based on their purpose. For instance, the FCS scores eight food groups focused on energy adequacy only, whereas DQI-I considers 20 food groups and nutrients, weighted and scored differently according to variety, adequacy, moderation, and balance for prevention of NCDs. In addition, the underlying dietary data needed to apply the metrics are quite variable, which affects both their usefulness and validity depending on the measured outcome [15, 33]. For example, the FCS was developed for contexts where dietary surveillance is limited (e.g., in low-income countries), and therefore, a simpler data collection instrument is needed; whereas DQI is often applied to assess population's dietary intake when more detailed dietary instruments (e.g., 24-h recalls) are available. An important limitation of current metrics is that they may not be able to measure diet quality of vegetarians and vegans adequately. For example, vegetarians may score lower than nonvegetarians in some metrics owing to animal foods scoring more favorably than plant foods [34]. Further metric developments should ensure that metrics allow for flexibility on food groupings to account for these plant-based diets.

Other key findings from our review are the lack of dietary metrics for children younger than 2 y, likely a consequence of lacking dietary data collected in this population or dietary guidelines focused on younger children, which also explains the poor adherence to Principle 1. Level of food processing is a

dimension that has not regularly been included in metrics assessing diet quality to date. The benefits of industrial processing are unquestionable, creating safe, secure, and convenient products. However, the problem is not food processing per se, but ultra-processing of foods. Given the growing evidence linking the broader category of ultra-processed food consumption with adverse human and planetary health outcomes [35, 36], future measures of diet quality may need to address this gap. The only known attempt to propose a tool that incorporates both health and sustainability considerations (EAT-Lancet Planetary Health Diet) [12] paid limited attention to the degree of processing, leaving unanswered questions about the risk of consuming ultra-processed plant-based meat (or meat "alternatives") in plant-based diets, in particular, and all ultra-processed foods in general [4]. This might be a consequence of the lack of tools to assess the risk and monitor trends in ultra-processed food consumption globally alongside other indicators.

Applied groupings and cutoffs varied widely among the metrics, especially to the amounts of animal food intake, potentially a consequence of the different conceptual underpinnings. Most of metrics consider intake of animal products within health aspects (e.g., as a source of saturated fat and thus cutoffs would reflect intakes to achieve saturated fat recommendation) and not more broadly within the sustainability agenda. For example, the DGI-2013, solely focused on healthiness of diets, has recommendations for red meat intake significantly higher than that of the EAT-Lancet Planetary Health Diet, which accounted for both health and environmental sustainability outcomes. In general, scientific evidence to support the applied cutoffs was not clearly stated for most of the metrics; thus, uncertainties accompanying the index construction process should be considered.

Strengths and limitations

This scoping review presents insights into dietary metrics development, particularly given the increased call from the WHO to achieve a global framework for monitoring healthy diets. Our review has several strengths. To our knowledge, this is the first study to conduct an extensive review of adherence of dietary metrics to principles of sustainable healthy diets, using the most recent high-level report published by FAO/WHO as a theoretical framework. We undertook systematic searches and conducted pilot testing for data synthesis and analysis using rigorous and transparent methods throughout the process, guided by a protocol reviewed by a multidisciplinary research team.

Limitations of this study need to be considered when interpreting the results. First, as previously described, the operationalization of the framework may have led to an underestimation of the adherence of the metrics to the FAO/WHO principles. For instance, we did not use additional empirical evidence of the validity of existing dietary metrics against energy, nutrients, and risk of diet-related NCDs, and more broadly with health, environmental sustainability and/or sociocultural outcomes. This would need a broad gathering of evidence (e.g., systematic reviews of a wide range of health and environmental outcomes, costs, and acceptance of diets), which would compromise the feasibility of this study. Second, in cases where the amounts of foods were not defined in the FAO/WHO Report (e.g., abundance of fruits and vegetables; small amounts of red meat), we considered adherence to the principles even when cutoffs were not presented. For example, recommendations of fruits and vegetables based on the highest quintile of consumption may not represent abundance if the consumption is very low in the population. In other cases, we considered adherence even in limited assessments, for example, we scored wholegrain intake in the DGI-2013 even though only whole meal breads are counted in the indicator. Variations in measurement units were not considered when comparing dietary metrics (e.g., serving sizes might differ across metrics). However, we have not applied the assessment criteria considering specific amounts of consumption, and therefore, this is unlikely to have affected our results.

Another limitation is the subjective nature of the design and interpretation of the method for assessing adherence of the dietary metrics to the guiding principles because it was assumed that three levels were sufficient to assess the metrics (fully considered, partially considered, and not considered). Nevertheless, this was determined as the best approach by consensus among the research team.

Implications for diet quality monitoring and surveillance

Several implications for diet quality research, monitoring and surveillance can be drawn from this review. First, it is unclear how to incorporate measurable indicators or proxies of all principles of sustainable healthy diets (e.g., foodborne disease, food waste, use of hormones and antibiotics, and sex-related effects) into a single comprehensive dietary metric, especially considering that many of these indicators are relevant at the food production level and not food consumption level. Related to this, there are challenges, convergences, and divergences when simultaneously addressing the double burden of malnutrition (undernutrition, micronutrient deficiencies, and NCDs), environmental sustainability, and sociocultural aspects of diets (e.g., opposing effects of some foods such as animal-source foods as positively affecting micronutrient deficiencies in certain contexts but related to environmental degradation in others) [37].

From a methodological perspective, how some of the principles can be operationalized into a set of survey instruments and metricized considering whether the metric is designed for monitoring and surveillance, for comparison at national, subnational, or global levels, and the targeted population (children and/or adults). Furthermore, dietary metrics are often developed using food groups as representations of constructs of diet quality, which poses a question on how to use food groups as proxies of the principles. Finally, the burden and pragmatic aspects of including all these principles into survey instruments is an obstacle as the adoption of metrics for policy purposes is likely dependent on cultural appropriateness and ease of collecting and scoring these dietary metrics. Concluding remarks from the recent WHO Report of the Technical consultation on measuring healthy diets state that no one metric can meet all needs; rather, a suite of metrics or a matrix or mapping exercise may be needed [38].

Recommendations for diet quality research

Currently, there is no gold standard to measure sustainable healthy diets. Therefore, novel dietary metrics (entirely new or

TABLE 4
Recommendations of food group level dimensions of the FAO/WHO report (8) to inform future dietary metrics developments

Dimensions	Justification	Recommendation
Food processing	The potential of industrial food processing to predict human and planetary health has been increasingly recognized, particularly the role of ultra-processed foods as a key driver of the nutrition transition.	Apply the NOVA system (42), a food classification that categorizes foods according to the extent and purpose of industrial food processing, as a first step to generate food groups. Ultra-processed foods should not be included in positive constructs of diet quality (e.g., should not count in variety/diversity).
Dietary diversity	As a synonym for variety, it is a key dimension to achieve adequate intake of micronutrients and bioactive compounds, and positively influencing dietary synergies.	Mostly from unprocessed and minimally processed plant foods. FAO Minimum Dietary Diversity (43) could be used a guide to account for the intake of 10 groups: *1*) grain, white roots and tubers, and plantains (starchy staples); *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*) vitamin A–rich fruits and vegetables; *9*) other vegetables; and *10*) and other fruits.
Intake of animal products	Moderate to low intake of animal products have been linked to both positive human (particularly NCD prevention) and planetary health outcomes.	Ultra-processed versions of animal products (and plant-based alternatives) should be avoided. There is no consensus on the optimal amount of animal-source food intake for both human health and planetary boundaries; but an alternative could be applying cutoffs of metrics that consider animal intake in the context of both health and sustainability; or the first quintile of population's consumption as a cutoff point.

adaptations of existing metrics) could be developed considering some key dimensions. When using individual (or household)-level food group consumption as representations of constructs of diet quality, we recommend considering the key dimensions of the FAO/WHO report [8] described in Table 4: food processing; dietary diversity; and intake of animal products. Considering this suggested approach in dietary metrics developments has the potential to address at least eight principles of sustainable healthy diets (principles 1–7 and 9). In addition, development of culturally appropriate metrics or with generic groupings that could be adapted to different cultural and food systems scenarios would help address Principle 14.

Other approaches to address overconsumption and the remaining principles, including composite metrics conceptualizing multiple indices should be further explored. An interesting advance with this attempt was the development of the Sustainable Diet Index [39] aimed to assess the sustainability of French diets at the individual level using a set of instruments to consider environmental, nutritional, economic, and sociocultural aspects of diets. For example, dietary indices are used when measuring nutritional aspects of diets, water and carbon footprint, and other sustainability indicators inform the environmental dimension of the metric, and affordability, locality, and cultural continuity inform the sociocultural dimensions of the metric. Nevertheless, the tool requires imputing data from several sources, with a diet quality index (PANDiet) being one of the indicators. The index was developed for the French context, which implies caution when extrapolating to other populations. Similarly, others have proposed a set of health (e.g., nutritional requirements and diet-related morbidity prevalence), environmental (e.g., rate of local/regional foods, ecotoxicity, and eutrophication), and socioeconomic (e.g., availability, affordability, acceptability, and access equality) indicators and recommendations for assessing sustainable healthy diets [28, 40], but how these could be translated into a dietary metric still need to be further explored.

Moreover, future research could explore the validity of existing dietary metrics against energy and nutrient intakes and risk of diet-related NCDs and, more broadly, with health, environmental sustainability and/or sociocultural outcomes in cross-country studies to support the assessment of the metrics against principles of sustainable healthy diets.

Applications to inform nutrition policy activities

This review can inform the development of new dietary metrics and help assess the relevance of current metrics to monitor characteristics of diets and to inform and assess the effectiveness of policy actions that promote sustainable healthy diets. Our finding suggest that evidence needs to be synthesized and translated to help broaden the scope of dietary guidelines to include emerging topics, such as sustainability recommendations. Up to date recommendations in dietary guidelines have potential to inform a range of policy action developments, such as identifying specific foods that should be targeted in food labeling, marketing restrictions, food procurement, and financial incentives for healthy and sustainable foods and tax on foods belonging to unhealthy and unsustainable dietary patterns. Identifying indices that effectively measure the health and sustainability of diets can also be used to monitor and evaluate policy actions for their performance against these recommendations in a timely manner.

In conclusion, currently, no existing dietary metric captures all principles of sustainable healthy diets, and our findings highlight the challenges of and opportunities to incorporate these principles into measures of diet quality. Notably, the significance of industrial food processing, environmental and sociocultural aspects of diets is generally understated. This highlights the importance of revising current dietary recommendations, especially to include emerging topics. The absence of quantitative metrics that comprehensively measure sustainable healthy diets limit the body of evidence informing national and international guidelines and factsheets developments. Our findings can help grow the quantity and quality of the body of evidence available to inform policy activities to realize the 2030 Sustainable Development Goals of multiple UN.

Ethics Approval

This study was exempted from ethics approval.

Author disclosures

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.advnut.2022.11.006.

Data Availability statement

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

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