Methodological Aspects of Diet Quality Indicators in Childhood: A Mapping Review

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ABSTRACT

Diet quality indicators (DQIns) are tools that aim to assess an individual's overall diet quality. Previous reviews focused mainly on health-related outcomes but did not provide detailed information about components, assessment variables, or important methodological issues for the development and application of DQIns in the pediatric age. The current mapping review aims to provide comprehensive guidance regarding DQIns developed through a priori methodology in children aged ≤14 y that have been applied worldwide. A mapping review was conducted, whereby 1665 original articles describing the development, modifications, and updates of DQIns, published up to June 26, 2020, in English and Spanish, were retrieved. A total of 139 articles were identified and classified into 13 subgroups. There were 10 overall DQIns: Healthy Eating Indexes ($n = 25$), Dietary Diversity Scores ($n = 20$), Diet Quality Indexes ($n = 16$), Food Variety Scores ($n = 11$), Healthy and Unhealthy Scores ($n = 11$), Feeding and Eating Indexes ($n = 10$), Diet Quality Scores ($n = 5$), Nutritional Adequacy and Micronutrients Indexes ($n = 5$), Dietary Guidelines Indexes ($n = 5$), and Other Healthy Diet Indexes ($n = 13$). Three additional subgroups of dietary and lifestyle indicators found were Mediterranean Diet Indexes ($n = 10$), Diet–Lifestyle Indexes ($n = 5$), and Breakfast Quality Indexes ($n = 3$). This compilation of DQIns will help researchers select the most appropriate tool for future epidemiological studies by considering a careful selection of information about the assessment components, scoring methods, and key methodological issues. The main limitations of this review are that, due to its nature, a risk-of-bias assessment was not performed and the article screening was completed in 2 databases (PubMed/MEDLINE and Scopus). More research is needed to identify health-related outcomes associated with DQIns in the pediatric population, using clearer and more standardized methodological criteria. *Adv Nutr* 2021;12:2435–2494.

Keywords: dietary indicators, diet quality, diet index, dietary assessment, child, adolescent, pediatrics, methodological criteria, index specification, mapping review

Introduction

Nutrition is an essential factor for growth and development during childhood and adolescence (1). In the first years of life, infant feeding practices and dietary patterns transition from breast milk or formula to semisolid food intake and, later, to the adult diet (2). Feeding skills, dietary habits, food preferences, and nutritional knowledge are learned during pediatric age and carried through into adulthood (3).

Recent systematic reviews (SRs), which included dietary patterns, have examined the timing, types, and amounts of foods and beverages during infancy and toddlerhood in relation to growth and developmental outcomes into adulthood (4, 5), but only moderate or limited conclusions were drawn primarily from a lack of available evidence on diet quality (DQ) early in life. Dietary patterns represent a broader picture of food and nutrient consumption, and they may thus be more predictive of disease risk compared with individual foods or nutrients (6).

There can be concerning changes in the dietary pattern and lifestyle during childhood and adolescence, leading

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Supplemental Tables 1–6 and Supplemental Appendix 1 are available from the "Supplementary data" link in the online posting of the article and the same link in the online table of contents at https://academic.oup.com/advances.

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Abbreviations used: DGA, Dietary Guidelines for Americans; DQ, diet quality; DQIn, diet quality indicator; MeSH, medical subject heading; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; SR, systematic review; 24h-DR, 24-h dietary recall.

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to overweight and obesity. Indeed, the risk factors that contribute to the gaining of body weight are the reduced consumption of fruits, vegetables, and legumes; the increased consumption of ultra-processed foods, unhealthy fats, added sugars, and refined carbohydrates; and sedentary habits (7). According to WHO (8), >340 million children and adolescents aged 5–19 y were overweight or obese in 2016, and 38 million children aged <5 y were overweight or obese in 2019. The prevention and treatment of obesity in the pediatric population can reduce long-term comorbidities in adulthood (e.g., arterial hypertension, dyslipidemia, diabetes, and cardiovascular diseases) (7).

An overall dietary assessment is necessary to identify consumption patterns in the pediatric population. In epidemiological research, diet assessment includes valid dietary methods such as diet history, FFQs, 24-h dietary recalls (24h-DRs), and food records. These methods are associated with a high respondent burden; they are time-consuming and need additional analysis (9). However, there are blunt instruments, a priori diet quality indicators (DQIns), that describe an overall dietary pattern based on current nutritional knowledge (10). These tools can represent the combined effects of all foods and evaluate dietary guidelines and recommendations (10).

DQIns use mathematical algorithms to quantify the degree of food and nutrient adequacy (11). DQIns are designed for a specific purpose and population, and they are used to evaluate the overall DQ and to categorize chronic disease risks according to eating behaviors (12). DQIns measure nutrient adequacy, food variety or food diversity, and the moderation of food consumption and nutrients (13). The advantages of DQIns include the possibility of extended use in epidemiological studies because of their rapid assessment and simple interpretation (14).

Although single-nutrient analyses are valuable to nutrition epidemiology, a more recent and informative approach is dietary pattern analysis, which addresses the combined effects that multiple nutrients may have when consumed as foods in the overall diet over time (15). Dietary patterns have also become a foundational core component of the Dietary Guidelines for Americans (DGAs) (16, 17).

Nutritional recommendations refer to the nutrient amount expressed as dietary reference intake—for instance, the RDA, Adequate Intake, or estimated mean requirement (18). Regarding food intake, national nutritional guidelines encourage healthy dietary patterns in the population (19). DQIns have been assessed using those approaches, initially at the population level (20). Later, DQIns were developed or adapted to evaluate consumption patterns in the pediatric population. Some of these instruments were short tools considered according to their reliability and validity for later use as dietary indexes (21).

Compared with the pediatric population, DQIn research is widely extended in the adult population (22). Hence, DQIns play an essential role in identifying modifiable dietary factors that can improve health and nutrition by preventing chronic diseases.

Several SRs on DQIns in the pediatric population have been published since various indexes have been developed. In 2011, an SR that compiled 40 DQIns by identifying a priori methods to assess dietary patterns in children aged 1–5 y and their association with sociodemographic characteristics in high-income countries was published (23). Another SR in low-income countries grouped 90 DQIns by their intended use, such as assessing dietary quality, dietary habits, and association with health-related outcomes (24). Moreover, an SR made an inventory of 119 DQIns and identified applications in low- and high-income countries (25). An update of this SR has been published describing 128 DQIns from 33 countries; the SR focused on the associations between DQIns and health-related outcomes (IQ, quality of life, blood pressure, body composition, and metabolic syndrome) and on the evaluation of validity and reliability of these tools (26).

Previous reviews of DQIns focused essentially on health-related outcomes. Despite their completeness, insufficient detail has been reported about the components, the scoring methods, and the main methodological issues that have been taken into consideration for the development and application of DQIns. Considering that the differences in these methodological features (types of components and scoring methods) are fundamental, it has been necessary to perform a review emphasizing these issues. The current mapping review approach provides the methodological criteria on which a priori DQIns have been developed in children. This compilation aims to be a comprehensive reference to future epidemiological studies conducted in children aged ≤14 y by facilitating the selection of indicators (previously developed, updated, or modified) that assess DQ.

Methods

We conducted a mapping review of DQIns including observational (mainly cross-sectional and cohort studies) and intervention studies (randomized controlled trials) in childhood. The protocol was registered on PROSPERO (International Prospective Register of Systematic Reviews) as CRD42020201571. The review processes were documented following a pre-established protocol for reviews about the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (except the assessment of the risk of bias) (27). It was decided not to assess the risk of bias of selected articles because of the methodological approach of the review that is describing the DQIns main features as instruments of the evaluation of the DQ. The steps are described in more detail later.

Literature search strategy

The research was performed on 2 electronic databases of MEDLINE (PubMed) and Scopus. The literature search included documents published up to June 26, 2020. The years covered by this review were not limited. The search was conducted in articles published in English and Spanish.

We selected keywords that are similar and related to DQIns. We included the following in the research statement:

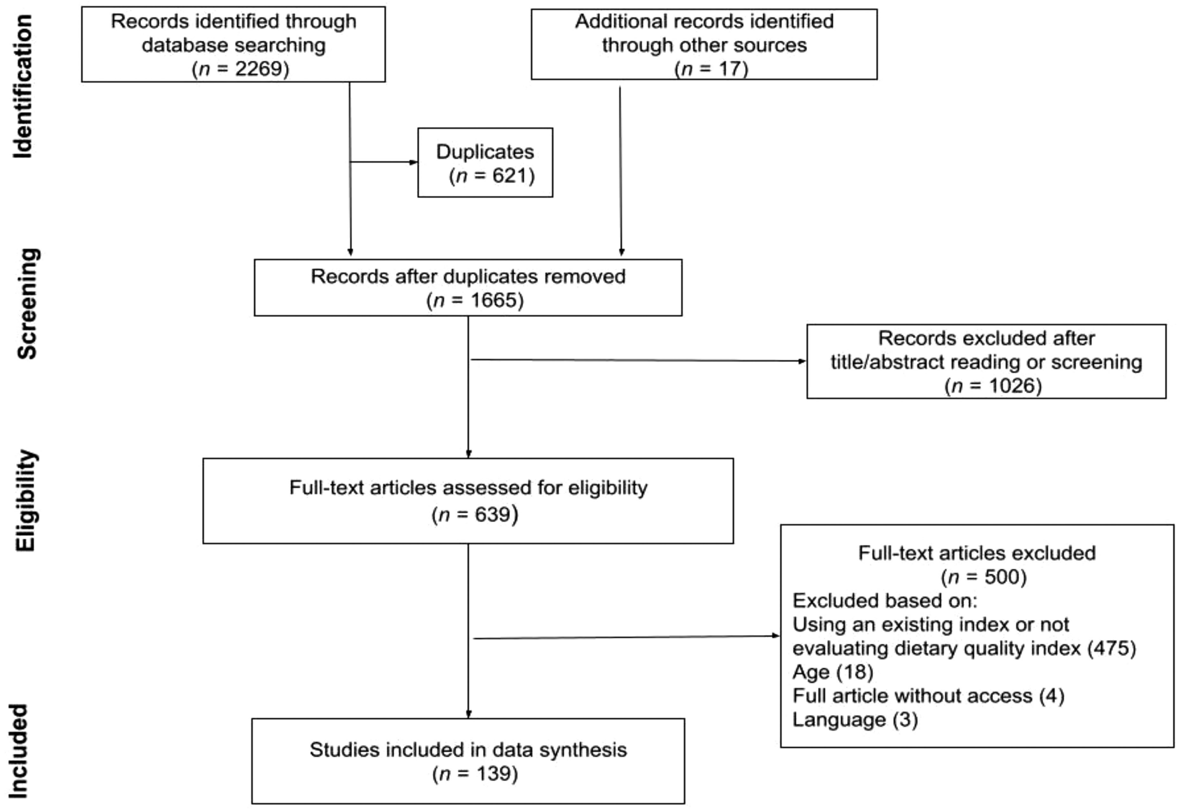

FIGURE 1 PRISMA flow diagram for the selection of studies. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

(diet OR dietary OR food OR meal) and (quality OR diversity OR variety) and (index OR score OR indices). Medical subject heading (MeSH) terms were also identified and included in the search query: (diet OR diet healthy OR diet survey OR nutrition surveys). The search was limited to human studies on infants, preschoolers, children, or adolescents. Excluded health conditions were food hypersensitivity, celiac disease, cognitive dysfunction, diabetes mellitus type 1, depression, severity of illness, irritable bowel, mental disorder, neoplasm, and pregnancy. These were excluded using the appropriate MeSH terms. The search strategy utilized (a combination of MeSH terms, keywords, and Boolean operators) is shown in **Supplemental Table 1**. In addition to the literature search strategy, previous systematic and narrative reviews about DQIns were collected, and their references were checked in order to include them in our mapping review if they did not appear in our original search.

Study eligibility criteria and data synthesis

The inclusion and exclusion criteria were established by the PICOS criteria (population/patient, intervention exposure, comparison, outcome, and setting) (28) and are summarized in **Supplemental Appendix 1**. Inclusion criteria for participants were children and adolescents aged ≤14 y from throughout the world. Publications that evaluated the population level were also included. The outcome of interest included articles that described the development, update, or modification of a DQIn. The selected articles described the scoring system according to the food groups or foods, nutrients, or lifestyle-related factors that were part of the tools. The DQIns had to evaluate ≥1 d of food consumption.

Exclusion criteria were studies that included a health condition, such as a primary disability, or behavioral or learning difficulties. Studies using an existing DQIn without any modification, articles that analyzed mealtimes (except breakfast), or studies that scored for single nutrients such as protein quality index or glycemic index were excluded. Articles with no full text available and no response after contacting the authors were also excluded.

Data collection

The screening process included the review of titles and abstracts first to identify eligible articles. Duplicates were removed. Then, full-text articles were screened to confirm eligibility. Studies were first screened by title and abstract by a first reviewer (LAD-J); the screening was supervised by a second reviewer (ÁH-R). A reverse search was performed by manually checking the references of previously published reviews (ÁH-R). The final study selection was performed based on a full-text review. Any discrepancies were resolved by consulting a third reviewer (MJS-M).

For data extraction, if several tools were developed in the same article, only the most complete DQIn was selected. If 2

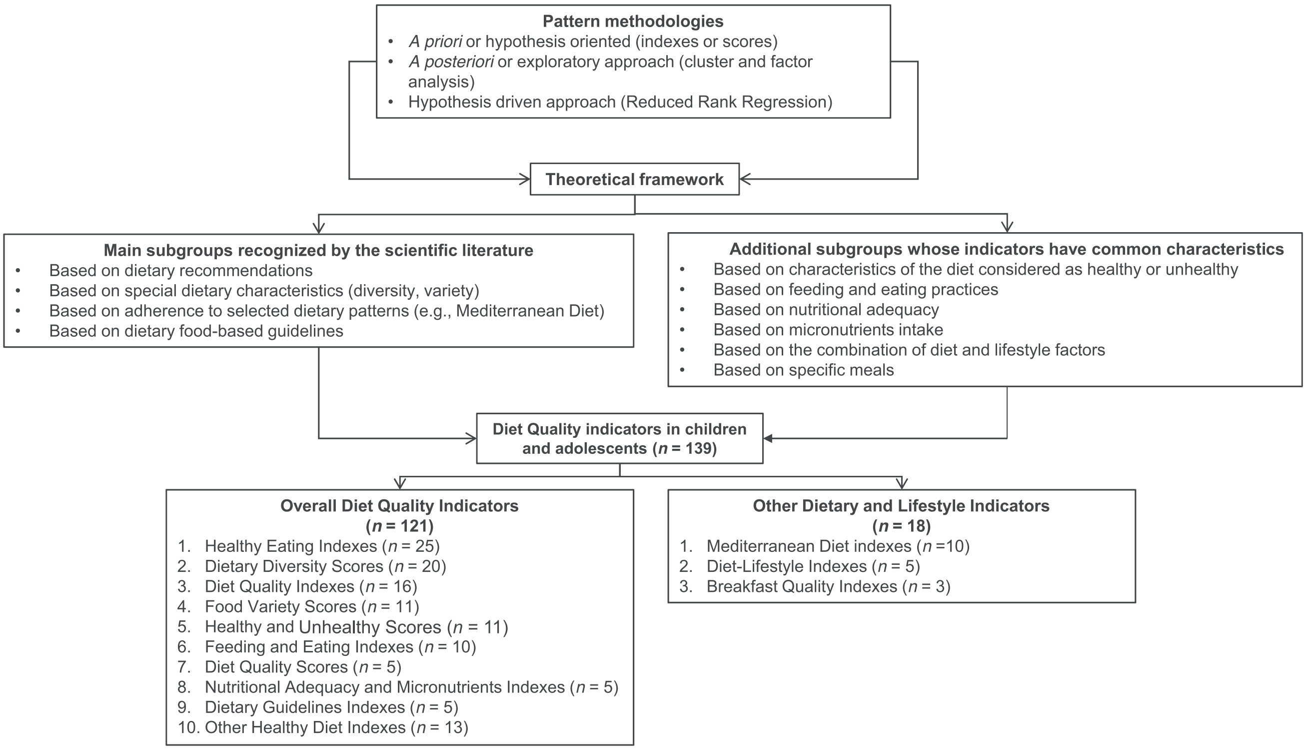

FIGURE 2 Proposed classification of the indicator approaches for assessing diet quality indicators in children and adolescents.

developed DQIns were similarly complex (components and scoring systems), data from both were extracted. If several indicators were applied in a publication, the novel DQIn developed in the manuscript or the indicator with greater modifications was selected. Hence, articles were classified only in a specific subgroup. The initial references of the rest of the instruments used in those articles were retrieved and used in their original version.

Data extraction and management

Data extraction was conducted by 2 reviewers (LAD-J and ÁH-R) through a predefined standardized form to collect the information required: *1*) author, publication year (reference), indicator (abbreviation), indicator subgroup, country, population, year of recruitment, age, sex, study name, study design, main objective, and results; *2)* food and food group, nutrient, and lifestyle-related factor components included in each DQIn; *3)* component information (*n*, and type of component), and global scoring method; *4*) cutoff values, overall score, and methodological issues. If the publication was a population-based study, only the results for children and adolescents were extracted. At this stage, articles that failed to provide all the necessary information to make them applicable were excluded. The references were managed by Mendeley software (29) and checked by data extraction to avoid citation mistakes.

Results

The research strategy resulted in 2269 articles. An additional 17 articles were included by screening the references of previous reviews and eligible articles. After the removal of 621 duplicates, 1665 references were left. The initial title–abstract screening resulted in 639 eligible articles. After reading the methodology, we proceeded to verify whether they were the identical versions of the original articles, modified versions excluding any of the original components, or modified versions adding new information. Five hundred additional articles were excluded, resulting in 139 articles. **Figure 1** shows the PRISMA flow diagram for the selection of studies.

Presentation of the main results

Because all indicators assess the DQ, but from different approaches, a classification of these tools was proposed to improve the understanding of these diverse perspectives. This classification is based on the main subgroups recognized by the scientific literature and additional subgroups whose indicators have common characteristics. In addition, several subgroups of Other Dietary and Lifestyle Indicators have been included that, although not assessing overall DQ in the strict sense, evaluate dietary characteristics associated with a better dietary profile and improved health. **Figure 2** shows this proposed classification of the DQIns or their modifications that were retrieved in this mapping review. The results of all studies included in this mapping review are presented by types of components, scoring methods, and other relevant methodological issues applied to the DQIns. Subsequently, a brief description is given in narrative and tabular forms by the subgroup of key indicators of the most noteworthy aspects.

Supplemental Table 2 shows an overview of all relevant DQIns, including the main indicators' subgroups, ordered according to the number of articles found in each category. The original version and the first modified version were included and placed in chronological order in each DQIns subgroup. A total of 139 original DQIns or their modifications were retrieved; they are mainly classified in the following 10 subgroups: Healthy Eating Indexes (n = 25) (30–54); Dietary Diversity Scores (n = 20) (55–74); Diet Quality Indexes (n = 16) (75–90); Food Variety Scores (n = 11) (91–101); Healthy and Unhealthy Scores (n = 11) (102–112); Feeding and Eating Indexes (n = 10) (113–122); Diet Quality Scores (n = 5) (123–127); Nutritional Adequacy and Micronutrients Indexes (n = 5) (128–132); Dietary Guidelines Indexes (n = 5) (133–137); and Other Healthy Diet Indexes (n = 13) (138–150). Indicators classified as Other Dietary and Lifestyle Indicators were Mediterranean Diet Indexes (n = 10) (151–160), Diet–Lifestyle Indexes (n = 5) (161–165), and Breakfast Quality Indexes (n = 3) (166–168).

Table 1 shows a summary of the main features of the studies retrieved in this mapping review, in which a DQIn was developed or updated through modifications (to components or to scoring methods), chronologically organized according to previously defined subgroups.

Key methodological issues: components and scoring method of the DQIns

Tables 2a–j and **3a–g** describe the components found in the DQIns reviewed. All the components were classified into 3 types: food groups and food, nutrients, and lifestyle-related factors (Supplemental Table 2).

The number of components in each DQIns varied from 3 to 20. Healthy Eating Indexes, Diet Quality Indexes, Healthy and Unhealthy Indexes, and Dietary Guidelines Indexes included all 3 types of components. Feeding and Eating Indexes, Diet–Lifestyle Indexes, and Nutritional Adequacy and Micronutrients used 2 types of components, where the food groups were present in the possible combinations with the other 2 types of components. Last, Dietary Diversity Scores, Food Variety Scores, and Breakfast Quality Indexes evaluated only food group components.

The scoring system included 3 major issues that need to be considered. First is the scaling procedure between dichotomous (2 categories) or polytomous (>2 categories). Second is the appraisal of cutoff values, which can be calculated through fixed criteria (predefined) or by distribution (population-dependent). Finally, the weighting system is an issue that is not usually considered because in the majority of the indicators, all components contribute the same weight to the overall score. The sum of all the scores of each component of DQIns provided the overall score, which is usually interpreted as the higher the score, the better the DQ.

Types of components included in each DQIn

The food groups, foods, nutrients, and lifestyle-related factor components are shown in Tables 2a–j and 3a–g and **Supplemental Tables 3–5**. These components were part of the countries' dietary national guidelines or public health recommendations.

Food groups and food components

The most prevalent food components found were fruits, milk and dairy products, and vegetables; they were mentioned in 116, 104, and 100 DQIns, respectively (Tables 2a–j, Supplemental Table 3). In order of frequency, additional food components found included the following: legumes, fish, eggs, water, and nuts.

Regarding the fruit component, some DQIns included fruit and fruit juices or consider fruit and vegetables in the same component. In the vegetable component, it is noteworthy that most of the indicators also included potatoes; however, many other DQIns included potatoes in the cereal component.

Concerning the dairy component, it is noteworthy that most of the DQIns valued total consumption, without distinction by product type or fat content. Regarding the dairy component, it is notable that in children, it is considered positive in the majority of the DQIns without distinction by product type or fat content. In reference to the components concerning protein-rich foods (meat, fish, eggs, and legumes), some authors have considered all these foods in the same component. However, most of the DQIns considered them individually due to their different effects on health. Most indicators contemplated total meat consumption (including all types of meat and processed meat) as a negative component. Nevertheless, other DQIns included red and white meat or only white meat and value them as positive or negative.

Moreover, food components that required moderation in their consumption were identified; the most prevalent were meat, sweets and confectionery items, and sugar-sweetened beverages. These components were mentioned in 91, 49, and 46 indicators, respectively. Other food components that required moderation, in order of frequency, were fats and oils, snacks, juices, fast food, coffee, and alcoholic drinks.

The sweets component sometimes also included bakery products, which at other times are classified in the cereals component. It is noteworthy that in some DQIns, the sweets and snacks components are combined. In numerous cases, the snacks component refers to salty snack products. In other cases, it also includes sweet products.

Nutrient components

Tables 3a–g and Supplemental Table 4 show the nutrient components. This type of component was less frequently used in comparison to the food groups component. The

TABLE 1 Main characteristics of the first study in children involving each diet quality indicator ($n = 139$)[1]

Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Overall diet quality indicators				
Healthy Eating Indexes				
Kennedy et al., 1995 (30)	Healthy Eating Index (HEI)	United States $n = 7463$ 1989–1990 ≥2 y Female percentage not found	Cross-sectional study	Nutrient adequacy Correlation coefficient of the HEI and the intake of nutrients 0.06—0.42
Feskanich et al., 2004 (31)	Youth Healthy Eating Index (YHEI)	United States $n = 16,540$ 1996 9–14 y Female (54%)	Growing Up Today Study Cohort study	Assessed healthful and unhealthful foods and eating behaviors There was no strong correlation with total energy intake ($r = 0.12$) and an inverse association with time spent in inactive pursuits ($r = -0.27$)
Knol et al., 2004 (32)	Healthy Eating Index Variety Score (HEI-variety)	United States $n = 2748$ 1994–1996, 1998 2–8 y Female, percentage not found	Cross-sectional study	Relation between food sufficiency status and dietary variety Variety scores were low for all children but did not differ by food sufficiency status
Pinheiro and Atalah, 2005 (33)	Healthy Eating Index Chile (HEI-CHL)	Chile $n = 536$ Date not found 13.4 y Female, percentage not found	Exposure to environmental arsenic in children from Chile Cross-sectional study	Characteristics of the nutrition intake The scores revealed that most of the study population needed changes in their diet
Glanville and McIntyre, 2006 (34)	Healthy Eating Index Canada 2006 (HEI-C06)	Canada $n = 303$ 1999–2000 1–14 y Female (50%)	Cross-sectional study	Nutritional characteristics of food-insecure households Younger children scored ∼22% higher than mothers and 12% higher than their older siblings ($P < 0.05$)
Guenther et al., 2008 (35)	Healthy Eating Index 2005 (HEI-2005)	United States $n = 8650$ 2001–2002 ≥2 y Female, percentage not found	Cross-sectional study	Measure of nutrient density Nutrient density was calculated for 1000–3200 kcal
Garriguet, 2009 (36)	Healthy Eating Index Canada modified (HEI-C-mod)	Canada $n = 33,664$ 2004 ≥2 y Female, percentage not found	Cross-sectional study	Characteristics of the nutrition intake and dietary, socioeconomic, and lifestyle factors Children had a mean score of 65 and adolescents 55

(*Continued*)

TABLE 1 (*Continued*)

Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
De Andrade et al., 2010 (37)	Healthy Eating Index Brazil (HEI-BRA14)	Brazil $n = 1584$ 2001–2002 12–20 y Female (51%)	ISA-SP Cross-sectional study	Characteristics of the nutrition intake according to age, sex, and lifestyle factors There was a significant difference in the mean scores by sex, age, physical activity, and type of housing ($r^2 = 0.027$, $P < 0.001$)
Woodruff and Hanning, 2010 (38)	Healthy Eating Index Canada (HEIC-2009)	Canada $n = 405$ 2001 9–13 y Female (52%)	Cross-sectional study	Characteristics of the nutrition intake and comparison with the Healthy Eating Index Canada tool 75% of the participants were classified as needing improvements in their diet compared with 71% of the HEI-C
Rydén and Hagfors, 2011 (39)	Healthy Eating Index 2005 (HEI-2005)	Sweden $n = 2160$ 2003 4–11 y Female (49%)	Cross-sectional study	Assessment of dietary intake by food group, BMI, and sociodemographic factors Children with more educated parents had higher scores. The highest cost quintile consumed a better diet
González Rosendo et al., 2012 (40)	Healthy Eating Index Mexico (HEI-MEX)	Mexico $n = 5140$ Date not found 11–16 y Female	Cross-sectional study	Characteristics of the nutrition intake Only 1% had a healthy nutrient intake, 75% needed modifications in their diet, and 24% had an unhealthy diet
He et al., 2012 (41)	Healthy Eating Index 2005 Canadian Modification (HEIC-2005)	Canada $n = 810$ 2006–2007 11–14 y Female (52%)	Cross-sectional study	Relation between the neighborhood food environment and dietary intake Close proximity to convenience stores was associated with low scores ($P = 0.03$)
Guenther et al., 2013 (42)	Healthy Eating Index 2010 (HEI-2010)	United States 2001–2002 ≥2y Female, percentage not found	Update of the HEI	Capture the recommendations of the 2010 Dietary Guidelines for American population New components were added
Nyaradi et al., 2013 (43)	Youth Healthy Eating Index Australia (YHEI-AUS)	Australia $n = 2868$ 1991–1995 1–3 y Female (49%)	Raine Cohort study	Association between diet during the first 3 y of life and cognitive outcomes at 10 y A better DQ during the early years may have a positive effect on cognitive ability later in life (ß: 0.12; 95% CI: 0.05, 0.19)
Kyttälä et al., 2014 (44)	Finnish Children Healthy Eating Index (FCHEI)	Finland $n = 1639$ 2003–2005 1–6 y Female, percentage not found	The type 1 diabetes prediction and prevention nutrition study Cross-sectional study	Nutritional recommendations and relation with family characteristics Lowest scores were associated with semi-urban areas of residence and low maternal education and smoking
Rauber et al., 2014 (45)	Healthy Eating Index Brazil (HEI-BRA14)	Brazil $n = 652$ 3–4 y, 7–8 y 2001, 2002 Female (57%)	Healthy feeding infants: São Leopoldo Cohort study	Changes in children's dietary pattern Scores changed from 65.7 ± 11.2 at 3–4 y to 65.0 ± 8.8 at 7–8 years. The score correlates positively with the dietary variety

(*Continued*)

TABLE 1 (*Continued*)

Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Wahlqvist et al., 2014 (46)	Youth Healthy Eating Index Taiwan (YHEI-TW)	Taiwan $n = 2389$ 2001–2002 6–13 y Female (46.3%)	Cross-sectional study	Intergenerational association of DQ
Dahm et al., 2016 (47)	High School Alternative Healthy Eating Index (HS-AHEI)	United States $n = 42{,}112$ 1998 14–18 y Female	Nurses' Health Study Cohort study	Association of diet and risk of developing cardiovascular disease risk factors Higher scores were associated with lower risk of developing ≥1 risk factor. HR comparing the highest with the lowest quintile: 0.82 (0.77—0.87)
Tugault-Lafleur et al., 2017 (48)	School Healthy Eating Index (School-HEI)	Canada $n = 35{,}107$ 2004 6–17 y Female (49%)	Cross-sectional study	Differences between school-hours and non-school-hours dietary intakes and demographic and socioeconomic characteristics The mean score was 53.4. There was a difference between school-hours and non-school-hours dietary intakes. Demographic and socioeconomic characteristics show a weak correlation with school-hours DQ
Yuan et al., 2017 (49)	Healthy Eating Index China (HEI-CHN)	China $n = 14{,}584$ 2011 ≥2 y Female (52%)	Cross-sectional study	Assess DQ and its association with sociodemographic factors There is an association between education ($P < 0.001$) and urbanization levels ($P < 0.001$)
Conceição et al., 2018 (50)	Healthy Eating Index Brazil Infants (HEI-BRA-I)	Brazil $n = 1185$ 1–2 y 2001, 2002 Female (49%)	BRISA Cohort study	Food intake dimension, energy intake, and components The mean score was 74.8 ± 13. Components presented low correlations with total energy intake ($r = 0.29$), and the correlation of individual food types was moderate ($r = 0.53$)
Hooshmand et al., 2018 (51)	Healthy Eating Index Iran (HEI-IRN)	Iran $n = 424$ 6–18 y 2006–2011 Female (57%)	Tehran Lipid and Glucose Study Cohort study	Assess the relation between the tool and the development of metabolic syndrome Metabolic syndrome decreased in the highest score quartile compared with the lowest quartile (OR: 0.35; 95% CI: 0.13, 0.98; P for trend = 0.025)
Nshimyumukiza et al., 2018 (52)	Healthy Eating Index Canada (HEI-C-2010)	Canada $n = 18{,}409$ 2004,2015 ≥2 y Female, percentage not found	Cross-sectional study	Assess the changes in DQ and the associated economic burden On average, there were temporal improvements on DQ

(*Continued*)

TABLE 1 (*Continued*)

Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Reedy et al., 2018 (53)	Healthy Eating Index 2015 (HEI-2015)	United States $n = 7935$; $n = 422{,}928$ 1994–2012 ≥2 y Female, percentage not found	Update of the HEI	Capture the recommendations of the 2015–2020 Dietary Guidelines for American population. Components showed construct validity, reliability, and criterion validity
Brownlee et al., 2019 (54)	Healthy Eating Index Singapur (HEI-SGP)	Singapore $n = 561$ 2014–2015 2–6 y Female (53%)	Cross-sectional study	Overall DQ and association with demographic factors and BMI The median score was 65.4. There is a statistical difference in the DQ and demographic factors/BMI category ($P > 0.05$)
Dietary Diversity Scores				
Arimond and Ruel, 2004 (55)	Dietary Diversity Score (DDS-04)	11 low- and middle-income countries $n = 958$; $n = 3662$ 1999–2001 6–23 mo Female, percentage not found	Cross-sectional study	Assessed DD and anthropometric parameters Association between DD and height-for-age *z* score was significant as a main effect in 7 countries
Mirmiran et al., 2004 (56)	Dietary Diversity Score Iran (DDS-IRN)	Iran $n = 304$ 1999–2001 10–18 y Female (53%)	Cross-sectional study	Nutrient adequacy Mean of DDS 6.25 ± 1.08. Pearson correlation and MAR was 0.42
Kennedy et al., 2007 (57)	Dietary Diversity Score Filipinas (DDS-PHI)	Philippines $n = 3164$ 1993 24–71 mo Female (49%)	Cross-sectional study	Nutrient adequacy The Pearson's correlation coefficient between DDS and MAR was 0.36 ($P < 0.001$) and between DDS 10 g and MAR was 0.44 ($P < 0.001$)
Mpontshane et al., 2008 (58)	Dietary Diversity Score South Africa (DDS-ZAF)	South Africa $n = 381$ Date not found 6–28 mo Female, percentage not found	Randomized controlled trial	Assessed dietary intake in an area with a high prevalence of HIV HIV-infected children's diet was significantly less diverse than the diet of uninfected children
Roche et al., 2008 (59)	Traditional Food Diversity Score (TFDS)	Peru $n = 36$ 2004 3–6 y Female, percentage not found	Cross-sectional study	Assessed the strengths of the traditional food system The TFDS ranged from 2 to 17, with a median of 8. Higher scores were correlated with higher nutrient intakes

(*Continued*)

TABLE 1 (*Continued*)

Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Enneman et al., 2009 (60)	Dietary Diversity Score Guatemala–USAID (DDS-GT-US-CP-INCAP)	Guatemala $n = 128$ 2007, 2008 6–12 mo Female (39%)	Cross-sectional study	Difference in the distributions according to food characteristics and between 1-d and 3-d intake Median score was 18 for the 3-d DR
Kennedy et al., 2010 (61)	Individual Dietary Diversity Score (IDDS)	Guideline to measure DDS in developing countries	Cross-sectional study	Nutrient adequacy
Li et al., 2011 (62)	Dietary Diversity Score China (DDS-CHN10)	China $n = 13,770$ 2002 2–17 y Female (46%)	Cross-sectional study	Associations between dietary food/nutrient intake and plasma lipid profiles related to stunting and overweight status The ORs for prevalent dyslipidemia were as follows: OR: 1.32; 95% CI: 1.13, 1.53 (stunted); OR: 1.76; 95% CI: 1.48, 2.09 (overweight); and OR: 2.59; 95% CI: 1.65, 4.07 (stunted–overweight)
Belachew et al., 2013 (63)	Dietary Diversity Score Ethiopia (DDS-ETH)	Ethiopia $n = 2084$ 2005–2006 13–17 y Female (49%)	Adolescents in Jimma Zone Cohort study	Association between food insecurity and dietary practices Food insecurity was negatively associated with the likelihood of having a diversified diet ($P < 0.001$)
Darapheak et al., 2013 (64)	Dietary Diversity Score WHO modification (DDS-WHOm)	Cambodia $n = 6209$ 12–59 mo 2005 Female, percentage not found	Cross-sectional study	Association between DD and stunting, underweight, wasting, and diarrhea Stunting was negatively associated with DD (OR: 0.95; 95% CI: 0.91, 0.99). The consumption of animal source foods was associated with reduced risk of stunting (OR: 0.69; 95% CI: 0.54, 0.89) and underweight (OR: 0.74; 95% CI: 0.57, 0.96; $P = 0.03$)
Gewa et al., 2014 (65)	Dietary Diversity Score Kenya (DDS-KEN)	Kenya $n = 529$ 1998–2000 4–15 y Female, percentage not found	Cross-sectional study	Nutrient adequacy A 1-unit increase in the DDS was associated with a significant increase in the mean probability of adequacy

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TABLE 1 (*Continued*)

Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Mundo-Rosas et al., 2014 (66)	Dietary Diversity Score Mexico (DDS-MX)	Mexico $n = 955$ 2012 24–59 mo Female (49%)	Cross-sectional study	Nutrient adequacy and food insecurity level The DDS is associated with food insecurity
Amugsi et al., 2015 (67)	Dietary Diversity Score Ghana 2015 (DDS-GHA15)	Ghana $n = 1187$ 2008 6–36 mo Female (49%)	Cross-sectional study	Association between maternal and child DD A difference of 1 food group in mother's consumption was associated with a difference of 0.72 food groups in the child's food consumption (95% CI: 0.63, 0.82)
Ali and Abizari, 2018 (68)	Dietary Diversity Score Ghana 2018 (DDS-GHA18)	Ghana $n = 366$ 2017 10–19 y Female (50%)	Cohort study	Characterization of dietary patterns and body weight changes during Ramadan The mean DD was statistically significant across the assessment stages ($F = 7.152$, $P < 0.001$)
Meng et al., 2018 (69)	Dietary Diversity Score China 2018 (DDS-CHN18)	China $n = 2012$ 2011 3–17 y Female (47.8%)	Cross-sectional study	Nutrient adequacy DDS was positively associated with dietary micronutrient intake and negatively associated with micronutrient inadequacy
Morseth et al., 2018 (70)	Dietary Diversity Score WHO modification (DDS-WHOm)	Nepal $n = 229$ 2010–2012 9–24 mo Female (46%)	MAL-ED Cohort study	Assessed the DDS and the sociodemographic factors associated with tracking complementary feeding practices Low SES significantly increased the odds of tracking of low vs. high DDS (OR: 3.31; 95% CI: 1.44, 7.60) and meal frequency (OR: 3.46; 95% CI: 1.54, 7.76)
Iqbal et al., 2019 (71)	Dietary Diversity Score Bangladesh (DDS-BGD)	Bangladesh $n = 324$ 2015–2017 2–3 y Female (50%)	Cross-sectional study	Association between dietary intakes and DNA methylation Lower dietary intakes increased global methylation (OR: 3.05; 95% CI: 0.24, 38.7)
Thorne-Lyman et al., 2019 (72)	Individual Dietary Diversity Score modification (mIDDS)	Nepal $n = 305$ 14 y 2013–2014 Female (48%)	Cohort study	Association between diet and child development (OR: 4.6; 95% CI: –2.0, 11.2)
Yang et al., 2019 (73)	Dietary Diversity Score China 2019 (DDS-CHN19)	China $n = 553$ 2015 3–5 y Female (45%)	Cluster randomized trial	Relation between food insecurity and undernutrition Food-insecure households presented stunting 6.5 times more compared with food-secure households (OR: 6.5; 95% CI: 1.60, 7.54)

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TABLE 1 (*Continued*)

Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Sebayang et al., 2020 (74)	Dietary Diversity Score Indonesia (DDS-IDN)	Indonesia $n = 11,687$ 2012 and 2017 0–23 mo Female (49%)	Cross-sectional study	Assessed the determinants of DD Age and antenatal care were associated with DD consumption
Diet Quality Indexes				
Alexy et al., 2003 (75)	Diet Quality Index Germany (DQI-DEU)	Germany $n = 842$ 1985 2–18 y Female (51%)	Dortmund Nutritional and Anthropometric Longitudinal Designed (DONALD) study Cohort study	Characterized sugar intake and DQ 13% of boys and 21% of girls had very low DQ
Kranz et al., 2004 (76)	Diet Quality Index for Children (C-DQI)	United States $n = 8628$ 1997–1998 2–5 y Female (~50%)	Cross-sectional study	Determined the DQ trends between 1977 and 1998 The mean total scores were 43.7, 45.0, and 45.7 in the 3 national surveys
Mariscal-Arcas et al., 2007 (77)	Diet Quality Index International adaptation (DQI-Ia)	Spain $n = 288$ 2002–2005 6–18 y Female (44%)	Cross-sectional study	Evaluated the diet of young Mediterranean population The DQI was significantly associated with the breakfast duration ($P = 0.029$)
McArthur et al., 2008 (78)	Rapid Assessment Diet Quality Index (RADQI)	Latin America $n = 1279$ No date found 12–19 y Female (54%)	Cross-sectional study	Characterized dietary and physical activity patterns and the association with socioeconomic characteristics and BMI The RADQI scores ranged from 53.0 points (±10.5) in Panama City to 44.7 points (±8.3) in Santiago
Huybrechts et al., 2010 (79)	Diet Quality Index for Flemish Preschoolers (DQI-FP)	Belgium $n = 568$ 2002–2013 2.5–6.5 y Female, percentage not found	Cross-sectional study	Validity and reproducibility of the DQI The reproducibility correlation was 0.82. Actual values for surrogate FFQ tertiles showed a progressive increase in DQI score ($P < 0.001$)
De Vriendt et al., 2012 (80)	Diet Quality Index for Adolescents 2012 (DQI-A-12)	Europe $n = 704$ 2006–2007 12.5–17.5 y Female (62%)	Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) Cross-sectional part	Relation of level of perceived stress and the overall DQ Stress influences dietary behavior (ß: – 0.02; $P = 0.040$)

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Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Fokeena and Jeewon, 2012 (81)	Diet Quality Index Mauritius (DQI-MUS)	Mauritius $n = 200$ No date mentioned 12–15 y Female (52%)	Cross-sectional study	Association between SES and BMI mediated by physical activity and DQ Mean score in higher SES 6.48 ± 1.86 and in lower SES 5.87 ± 1.95 were significantly different ($P = 0.02$)
Li et al., 2012 (82)	Diet Quality Index Australian Children and Adolescents (DQI-AUS-CA)	Australia $n = 1629$ 2003–2006 1–14 y Female (49%)	Western Australian Pregnancy Cohort study	Examined the impact of parental work hours from age 1 y to age 14 y on adolescent DQ. The mean working hours of mothers who worked full-time were negatively associated with adolescent DQ
Bel et al., 2013 (83)	Diet Quality Index for Adolescents with Meal Index (DQI-AM)	Europe $n = 1522$ 2006–2007 12.5–17.5 y Female (47%)	Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) Cross-sectional study	Association between self-reported sleep duration and DQ There is a significant negative association between the mean sleep duration and the DQI-AM (ß: 0.027; 95% CI: 0.018, 0.037)
Vyncke et al., 2013 (84)	Diet Quality Index for Adolescents 2013 (DQI-A-13)	Europe $n = 1804$ 2006–2007 12.5–17.5 y Female (53%)	Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) Cross-sectional study	Association between the DQI scores and nutritional biomarkers A positive association was found with 25-hydroxyvitamin D (ß: 0.30; 95% CI: 0.16, 0.44), holotranscobalamin (ß: 1.01; 95% CI: 1.00, 1.01), and n–3 fatty acid serum levels (ß: 0.38; 95% CI: 0.11, 0.65)
Wong et al., 2013 (85)	Diet Quality Index for New Zealand Adolescents (NZDQI-A)	New Zealand $n = 41$ 2010–2011 14–18 y Female (61%)	Cross-sectional study	Assessed a DQI and examined the relative validity The score showed good reliability ($r = 0.65$) and a reasonable agreement in ranking participants by scores ($r = 0.39$)
Röytiö et al., 2015 (86)	Diet Quality Index for Finland Children (FINDQI-C)	Finland $n = 374$ 2–6 y 2009–2010 Female (52%)	Cross-sectional study	Assessed diet in young children The diet was good in 29.8%, moderate in 43.7%, and poor in 26.5%
Collins et al., 2016 (87)	Revised Children's Diet Quality Index Australia (RC-DQI-AUS)	Australia $n = 244$ 2008–2013 3.6 y Female (50%)	Melbourne Infant Feeding, Activity, and Nutrition Trial Trial study	Assessed diet and its predictors Breastfeeding status (OR: 3.09; 95% CI: 1.63, 5.85) and modeling (OR: 2.01; 95% CI: 1.04, 3.88)
Ríos et al., 2016 (88)	Diet Quality Index Score for Puerto Rico Infants (DQIS-PRIn)	Puerto Rico $n = 296$ 2014–2015 8–24 mo Female, percentage not found	Cross-sectional study	Assessed diet of infants There was a trend for higher odds of excessive weight in those with poor diets compared with those with excellent diets (OR: 2.01; 95% CI: 0.85, 5.18)

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Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Kunaratnam et al., 2018 (89)	Diet Quality Index for Australian Preschoolers (DQI-AusP)	Australia $n = 62$ 2007–2008 2–5 y Female (55%)	Cross-sectional study	Assessed the association between DQI scores and nutrients The analysis indicated that increases in the DQI scores were related to increases in carbohydrate, folate, β-carotene, magnesium, calcium, protein, and total fat and to decreases in sugar, starch, niacin, vitamin C, phosphorus, polyunsaturated fat, and monounsaturated fat (adjusted $r^2 = 0.426$, $P < 0.05$)
Hamner and Moore, 2020 (90)	Diet Quality Index Score for American Infants (DQIS-USIn)	United States $n = 2675$ 2011–2016 6 mo–4 y Female, percentage not found	Cross-sectional study	Assessed diet of children The mean score was 22.4. There were significant differences between races
Food Variety Scores				
Cox et al., 1997 (91)	Variety Index for Toddlers (VIT)	United States $n = 124$ 1997 2–3 y Female (44%)	Cross-sectional study	Dietary adequacy VIT scores were strongly correlated to the MAR score of nutrient adequacy ($r = 0.74$, $P < 0.01$)
Hatløy et al., 1998 (92)	Food Variety Score (FVS)	Mali $n = 77$ 1995 <5 y Female (55%)	Cross-sectional study	Nutritional adequacy A positive correlation was found between FVS and MAR ($r = 0.33$, $P < 0.001$). With cutoff points for FVS at 23, the indexes had a high ability to identify those with a nutritionally inadequate diet. MAR increased with increasing FVS
Vereecken et al., 2008 (93)	Variety Index	Belgium, Italy $n = 226$ 2008 11–12 y Female (56%)	Cross-sectional study	Food group intakes and dietary indexes The Variety Index was significantly correlated with fiber intake (0.26)
Falciglia et al., 2009 (94)	Three types of dietary variety	United States $n = 72$ 2005 9–12 y Female (53%)	Prospective study	Predicted 15-d cumulative dietary variety score from 3 consecutive days and 3 interval days of dietary data Three days of dietary data accurately estimated dietary variety over time using the predictive equation. Three interval days predicted 15-d food variety more precisely than did 3 consecutive days

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TABLE 1 (*Continued*)

Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Saibul et al., 2009 (95)	Food Variety Score (FVS)	Malaysia $n = 284$ 2002–2005 2–9 y Female (47%)	Cross-sectional study	Association between burden households and weight Dual-burden households were associated with women's employment status (OR: 3.18) and FVS of children (OR: 0.71). The FVS of children (OR: 0.49) remained significant even when dual-burden households were compared with only households with normal-weight mother/normal-weight child
Scott et al., 2012 (96)	Core Food Variety Score (CFVS); Fruit and Vegetable Variety Score (FVVS)	Australia $n = 2868$ 1989–1992 <2 y Female (48%)	Western Australian Pregnancy Cohort (Raine) study Longitudinal study	Duration of breastfeeding Breastfeeding duration was independently and directly associated with the CFVS ($P < 0.001$). Maternal age was independently and directly associated with the CFVS ($P < 0.001$). The presence of older siblings was independently and inversely associated with the CFVS ($P = 0.003$)
Zimmer et al., 2012 (97)	Food Variety (FV) score	United States $n = 44$ 1999 8 y Female (32%)	Case–control study	Nutritional status Children with autism had a higher mean intake of magnesium and lower mean intake of protein, calcium, vitamin B-12, and vitamin D
Jones et al., 2015 (98)	Healthy Plate Variety Score (HPVS)	United Kingdom, France, Portugal, Greece $n = 14{,}763$ 1991–2007 2–4 y Female (47%)	ALSPAC, EDEN, Generation XXI Birth Cohort, Greek EuroPrevall Cohort studies	Maternal diet and early infant feeding experiences Most children were not eating a full variety of healthy foods. There was no consistent association between the timing of complementary feeding and HPVS
Zaborowicz et al., 2015 (99)	Food Intake Variety Questionnaire (FIVeQ)	Poland $n = 186$ 2011–2012 13–21 y Female	Gebahealth project Pilot project	Attitudes Girls from the upper tertile with favorable attitudes on food health benefits had an OR for adequate fat intake of 3.1 ($P < 0.05$) compared with those from the middle-neutral attitudes tertile (OR 1.05, not significant)
Fernández et al., 2016 (100)	Overall Variety Score	United States $n = 340$ Date not found 4.2 y Female (51%)	Follow-up study	Association between variety of diet and BMI z score. Overall variety and annual increases in BMI z score (β: 0.007; $P = 0.02$)

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Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Barros et al., 2019 (101)	Healthy Dietary Variety Index (DVI)	Portugal $n = 8495$ 4 y 2006 Female (49%)	Generation XXI Cohort studies	Dietary variety and adequacy and screen time, participation in sports, breastfeeding duration, siblings, family structure Screen time (≥120 vs. <120 min/d: β: −0.012), no regular participation in sports (β: −0.022), underweight status (β: −0.081), shorter breastfeeding duration (<4 vs. ≥6 mo: β: −0.012), no siblings (0 vs. ≥2: β: −0.023), and a 2-parent family structure (vs. single-parent; β: −0.010)
Healthy and Unhealthy Scores				
Yannakoulia et al., 2004 (102)	Unhealthy Food Choices Score (UFCS)	Greece $n = 4211$ 1997–1998 11–15 y Female (52%)	Health Behavior in School Aged Children Cross-sectional study	Characterization of nutrition-related habits Girls were found to have lower score values compared with boys (24.7 ± 4.6 vs. 24.1 ± 4.5, respectively; $P < 0.001$)
Jacka et al., 2011 (103)	Healthy (HDS-A) and unHealthy Diet Scores Australia (uHDS-A)	Australia $n = 3040$ 2005–2008 11–18 y Female (44%)	Prospective study	Association between DQ and adolescent mental health There was a significant association between both scores and adolescent mental health. HDS-A is a stronger predictor: Healthy (β: 0.14; 95% CI: 0.10, 0.18; $P < 0.001$); unhealthy (β: –0.009; 95% CI: –0.13, –0.6; $P < 0.001$)
Truthmann et al., 2012 (104)	Indicator Food Index (IFI)	Germany $n = 5198$ 2003–2006 12–17 y Female (49%)	Cross-sectional study	Association of dietary indexes with biomarkers of dietary exposure and cardiovascular status Fruit/vegetable intake was associated with the IFI for boys. Among girls, positive associations were seen between vitamin B-12 and the IFI and between diastolic blood pressure and the IFI as well as fruit/vegetable intake. A negative association was found between homocysteine and the IFI

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Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Monjardino et al., 2014 (105)	Oslo Health Study Dietary Index (OHS)	Portugal $n = 1264$ 2003–2008 12–17 y Female (54%)	The EPITeen cohort Cohort study	Association between dietary patterns defined a priori and bone mineral density There is a lack of clear association between a priori dietary patterns and bone mineral density (girls OR: −0.29; 95% CI: −0.93, 0.34; boys OR: −0.59; 95% CI: 1.28, 0.084)
Vilela et al., 2014 (106)	Healthy Eating Index Score Portugal (HEIS-PRT)	Portugal $n = 705$ 2006 2–24 y Female (49%)	Generation XXI prospective Cohort study	Association between the consumption of less-healthy foods at age 2 y and the consumption of foods at age 4 y Consumption of energy-dense foods at age 2 y was associated with lower healthy eating score at age 4 y (IRR: 0.75; 95% CI: 0.58, 0.96; IRR: 0.56; 95% CI: 0.41, 0.77)
Anderson et al., 2015 (107)	Healthy (HDS-USA15) and unHealthy Diet Scores USA 2015 (uHDS-USA15)	United States $n = 357$ 2012–2013 2–5 y Female (49%)	Cross-sectional study	Association between healthy and unhealthy foods and differences in younger and older children. The number of healthy diet behaviors was not related to the number of unhealthy diet behaviors or the unhealthy diet score (P trend values ranged from 0.26 to 0.90)
Anderson et al., 2016 (108)	Healthy (HDS-USA16) and unHealthy Diet Scores USA 2016 (uHDS-USA16)	United States $n = 8900$ 2001 52.5 mo Female (49%)	Early Childhood Longitudinal Study–Birth cohort Cohort study	Relation between frequency of healthy foods intake and intake of unhealthy foods The rank correlation between healthy and unhealthy diet scores was positive ($r = 0.09$). The relation between healthy and unhealthy scores differed by household income-to-poverty ratio (P-interaction = 0.01), child racial–ethnic group ($P = 0.005$), and maternal education ($P < 0.001$)
Sluik et al., 2016 (109)	Dutch Healthy Diet index (DHD-index)	Netherlands $n = 1713$ 2007–2010 7–18 y Female (50%)	Cross-sectional study	Assessed overall DQ and estimated the intake of total sugars Total sugar consumption was 136–153 g in boys and 125–138 g in girls

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Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Arvidsson et al., 2017 (110)	Healthy Dietary Adherence Score (HDAS)	Europe $n = 7675$ 2007–2008 2–9 y Female (49%)	Prevention of dietary-lifestyle-induced health effect in children and infants. Cohort study	Association between children's adherence to healthy dietary guidelines and their well-being. A higher HDAS at baseline was associated with better self-esteem (OR: 1.2; 95% CI: 1.0, 1.4) and fewer emotional problems (OR: 1.2; 95% CI:1.1, 1.3) and peer problems (OR: 1.3; 95% CI: 1.2, 1.4)
Martins et al., 2019 (111)	Healthy (HDS-BRA) and unHealthy (uHDS-BRA) Diet Scores Brazil	Brazil $n = 102{,}072$ 2015 11–19 y Female, percentage not found	Cross-sectional study	Association between eating meals with parents and DQ Eating meals with parents was positively associated with healthy diet scores (β: 1.86; $P < 0.001$) and inversely associated with unhealthy diet scores (β: –0.62; $P < 0.001$)
Wadolowska et al., 2019 (112)	Pro-Healthy Diet Index (pHDI); non-Healthy Diet Index (nHDI)	Poland $n = 464$ 2015–2016 11–12 y Female (54%)	Intervention study	Sustainability of education on a sedentary and active lifestyle, DQ, and body composition . The chance of adherence to the nHDI was significantly lower (35%; $P < 0.05$) after 9-mo intervention
Feeding and Eating Indexes				
Arimond and Ruel, 2002 (113)	Infant and Child Feeding Index (ICFI)	Ethiopia $n = 4624$ 2002 6–36 mo Female, percentage not found	Cross-sectional study	Association between infant and child feeding practices with nutritional status DD and frequency of feeding component were positively associated with height-for-age z score
Ruel and Menon, 2002 (114)	Child Feeding Index (CFI)	Latin America $n = 23{,}016$ 1994–1999 6–36 mo Female, percentage not found	Cross-sectional study	Association between child feeding practices and nutritional status according to characteristics of the child, mother, or household Child feeding practices were associated with better nutritional status, especially for children with lower SES
Dewey et al., 2006 (115)	Food Group Indicator–8 (FGI-8)	Peru, Bangladesh, Ghana, Honduras $n = 1866$ 6–9 mo Female, percentage not found	Cross-sectional study	Mean micronutrient density adequacy Mean nutrient density adequacy increased with increasing DD, although the relation was not always linear. It ranged from 0.37 to 0.74

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Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Food and Nutrition Technical Assistance Project, 2006 (116)	Food Group Indicator (FGI)	Africa, Asian, Latin America $n = 10{,}014$ 1994–2004 6–23 mo Female, percentage not found	Cross-sectional study	Mean micronutrient density adequacy. For practical purposes, 1 g restriction is better than 10 g restriction. The association between mean micronutrient density adequacy and DD was significant
Bork et al., 2012 (117)	Infant and Child Feeding Index Senegal (ICFI-Sen)	Senegal $n = 1060$ 2009 6–36 mo Female, percentage not found	Cross-sectional study	Association between height-for-age *z* score and feeding indicator Height-for-age *z* score was positively associated with the ICFI-Sen ($P < 0.05$)
Golley et al., 2012 (118)	Complementary Feeding Utility Index (CFUI)	United Kingdom $n = 6065$ 1991 6 mo, 8 mo, and 3 y Female, percentage not found	The Avon Longitudinal Study of Parents and Children (ALSPAC) Cohort study	Association between index scores, sociodemographic factors, food and nutrient intakes, and dietary patterns The index score was associated with "processed" (β: –0.234; 95% CI: –0.260, –0.209) and "healthy" (β: 1.185; 95% CI: 0.155. 0.215) dietary patterns
Jones, 2015 (119)	Infant and Child Feeding Index modification (ICFIm)	Bolivia $n = 252$ 2009 6–23 mo Female (~50%)	Cross-sectional study	Association between infant and child feeding index and factors related to agricultural production There was a positive association with score and the length-for-age *z* score, the energy intake, and the micronutrient adequacy
Monterrosa et al., 2015 (120)	Infant and child Feeding Index Mexico	Mexico $n = 370$ 1999–2001 1–2 y Female (43%)	Cross-sectional study	Association between maternal pre-pregnancy BMI and feeding practices. Maternal pre-pregnancy BMI was not associated with children feeding practices and breastfeeding
Delshad et al., 2019 (121)	Diet Index for a Child's Eating (DICE)	New Zealand $n = 65$ 2007–2008 2–8 y Female (55%)	Cross-sectional study	DICE and assessment of adherence to nutritional guidelines Correlation coefficients showed significance ($P < 0.001$) between 4-d food record and DICE. Analysis showed that increases of vitamin C, vitamin A, vitamin D, and calcium were associated with increasing tertiles of DICE
Ferreira et al., 2019 (122)	Child Feeding Index modification (CFIm)	Brazil $n = 617$ 2008–2010 6–15 mo Female (47%)	Randomized controlled trial	Assessed feeding practices in intervention compared with control group Children from the intervention group showed a higher score index in comparison to the control group (mean difference: 0.22; 95% CI: 0.24, 1.11) at 6 mo (mean difference: 0.23; 95% CI: 0.35, 0.56)

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TABLE 1 (*Continued*)

Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Diet Quality Scores				
Crombie et al., 2009 (123)	Scottish Diet Quality Score (SDQS)	Scotland $n = 300$ 2005–2006 2 y Female, percentage not found	Cross-sectional study	Assessed maternal factors associated with poor diet among disadvantaged children 85% of the children had a poor DQ: lack of limitation of sweets (OR: 21.63; 95% CI: 2.70, 173.30) and difficulties for providing fruits (OR: 2.94; 95% CI: 1.0, 7.95)
Kohlboeck et al., 2012 (124)	German Optimized Mixed Diet Quality Score (GOMDQS)	Germany $n = 3361$ 1995–1999 ~11 y Female (49%)	The German Infant Nutritional Intervention, GINI-plus; and Influences of Lifestyle-Related Factors on the Immune System and the Development of Allergies in Childhood, LISA-plus	Association between food intake, DQ, and behavioral problems A higher DQS was associated with a lower likelihood of emotional symptoms (OR: 0.89; 95% CI: 0.80, 0.98)
Perry et al., 2015 (125)	Diet Quality Score Ireland (DQS-IRL)	Ireland $n = 8136$ 2007–2008 9 y Female (48.7%)	Growing Up in Ireland Cross-sectional study	Association between DQ and childhood overweight or obesity Childhood obesity was significantly associated with poor DQ (OR: 1.56; 95% CI: 1.02, 2.38)
Voortman et al., 2015 (126)	Diet Quality Score The Netherlands (DQS-NL)	Netherlands $n = 3629$ 2001–2005 12–19 mo Female (51%)	Generation R Cohort study	Identified the sociodemographic and lifestyle determinants of the DQ A higher score was associated with maternal folic acid supplement during pregnancy, no smoking during pregnancy, and children watching less television
Gasser et al., 2017 (127)	Dietary Quality Score Australia 2017 (DQS-AUS17)	Australia $n = 9774$ 2004 2–15 y Female (49%)	Baby (B) cohort study and Kindergarten (K) cohort study	Derived and compared dietary score and pattern trajectories from a parallel population-based cohort Similar trajectories of dietary scores emerged for B and K cohorts, respectively: never healthy (8.8% and 11.9%), moderately healthy (24% and 20.7%), becoming less healthy (16.6% and 27.3%), and always healthy (50.7% and 40.2%)

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Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Nutritional Adequacy and Micronutrients Indexes				
Fulgoni et al., 2009 (128)	Nutrient-Rich Foods Index	United States $n = 15{,}537$ 1999–2002 ≥4 y Female (50%)	NHANES Cross-sectional study	Validation against the HEI Maximum variance in HEI was explained using 6 or 9 nutrients to encourage; index performance declined with the inclusion of additional vitamins and minerals
Libuda et al., 2009 (129)	Nutrient-based Nutritional Quality Score (NQI)	Germany $n = 1069$ 1985 2–19 y Female (51%)	Dortmund Nutritional and Anthropometric Longitudinally Study Designed (DONALD) study Open cohort study	Association between SSB consumption and nutrient intake SSB consumption was positively associated with percentage total energy from carbohydrates and added sugars and negatively with percentage total energy from protein and fat. SSB consumption was negatively associated with folate and calcium intake, for which mean intake levels were inadequate in girls
Chiplonkar and Tupe, 2010 (130)	Adolescent Micronutrient Quality Index (AMQI)	India $n = 630$ 2006–2007 10–16 y Female	Cross-sectional study	Micronutrient adequacy The AMQI was correlated with nutrient intakes and the ratio of observed intake to reference intake ($P < 0.01$). Higher AMQI scores were associated with higher concentrations of plasma vitamin C ($r = 0.26$), β-carotene ($r = 0.34$), and zinc ($r = 0.12$)
Alexy et al., 2011 (131)	Nutrient Quality Index (NQI)	Germany $n = 585$ 2004–2008 3–18 y Female (49%)	Dortmund Nutritional and Anthropometric Longitudinally Study Designed (DONALD) study Open cohort study	Body weight status The NQI showed a significant negative trend with increased consumption of convenience foods ($P = 0.0013$)
Lee and Park, 2015 (132)	Index of Nutritional Quality (INQ)	Korea $n = 1969$ 1998–2012 2–18 y Female (42%)	Korean National Health and Nutrition Examination Survey (KNHANES) Cross-sectional study	Poor micronutrition and diet Calcium was the most commonly underconsumed micronutrient. More than half of the sons and daughters showed insufficient vitamin A, vitamin C, and iron intake. The correlation between a poor diet in parents and that in offspring was 0.17 ($P < 0.001$). Eating breakfast provided a significant protective effect against the risk of poor nutrition in offspring

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Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Dietary Guidelines Indexes				
Golley et al., 2011 (133)	Dietary Guideline Index for Children and Adolescents (DGI-CA)	Australia $n = 3416$ 2006 4–10 y Female, percentage not found	Australian National Children's Nutrition and Physical Activity Survey Cross-sectional study	Index scores, food and nutrient intake, sociodemographic characteristics, and measures of adiposity DGI-CA was associated with socioeconomic characteristics and measures of family circumstance. Weak positive associations were observed between DGI-CA and BMI or waist circumference z scores in the 4- to 10-y and 12- to 16-y age groups only
Lioret et al., 2014 (134)	Dietary Guideline Index (DGI)	Australia $n = 216$ 2007 5–12 y Female (56%)	Resilience for Eating and Activity Despite Inequality (READI) study Cohort study	Relation between diet quality and BMI *z* score Change in DQ was found to be inversely associated with a change in BMI *z* score only in children who were overweight at baseline ($P = 0.035$)
Mohseni-Takalloo et al., 2016 (135)	Dietary Guidelines for Americans Adherence Index (DGAI)	Iran $n = 722$ 2008–2011 10–19 y Female (54%)	Tehran Lipid and Glucose Study Cross-sectional study	Obesity-associated phenotypes No association was observed between different types of obesity and DGAI
Rohde et al., 2017 (136)	Diet Quality Index based on the Danish national guidelines (DQI-Danish national guidelines)	Denmark $n = 635$ 2009–2011 2–6 y Female (42%)	Healthy Start Study Randomized controlled trial	Macronutrient profile Children in the intervention group had a lower energy intake after the 15-mo intervention ($P = 0.02$) compared with the control group. There were lower intakes of carbohydrates and added sugar in the intervention group compared with the control group after the intervention ($P = 0.002$ and $P = 0.01$, respectively)

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TABLE 1 (*Continued*)

Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Er et al., 2018 (137)	Children's Food Trust guidelines (CFT guidelines) and NAP SACC UK Nutrition Best Practice Standards score	England $n = 150$ 2015–2016 2–4 y Female (52%)	NAP SACC UK study Cross-sectional study	Association between PA parameters and BMI *z* scores Minutes spent in light PA (β: 0.08; 95% CI: 0.0, 0.15) and active time (β: 0.07; 95% CI: 0.01, 0.12) were positively associated with BMI *z* scores
Other Healthy Diet Indexes				
Kleiser et al., 2009 (138)	Healthy Nutrition Score (HuSKY)	Germany $n = 14{,}105$ 2003–2006 3–17 y Female (49%)	German Health Interview and Examinations Study for Children and Adolescents (KiGGS)	Association between DQ and nutritional recommendations The score was significantly associated with age, sex, lower socioeconomic status R^2
Lazarou et al., 2009 (139)	Foods E-KINDEX score (E-KINDEX)	Cyprus $n = 622$ 2004–2005 9–13 y Female (52%)	Cross-sectional study	Association between DQ and children's obesity status and blood pressure levels Compared with children with a low diet score, those with at least an average Foods E-KINDEX score were 57% (OR: 0.43; 95% CI: 0.19, 0.98) less likely to have elevated systolic blood pressure levels
Bisi Molina et al., 2010 (140)	School Child Diet Index (ALES)	Brazil $n = 1282$ 2007 7–10 y Female (58%)	Cross-sectional study	Association between socioeconomic factors and low DQ Low maternal level of education (OR: 3.93; 95% CI: 2.58, 5.99), father not present in the household (OR: 2.03; 95% CI: 1.68, 2.99), and not having lunch at the table (OR: 1.47; 95% CI: 1.1, 1.93) were associated with low DQ
Marshall et al., 2012 (141)	Australian Child and Adolescent Recommended Food Score (ACARFS)	Australia $n = 691$ 2005 9–12 y Female (56%)	Cross-sectional study	Evaluation of the DQ and nutrient intakes. Statistically significant correlations between scores and all vitamins, minerals and energy intake, were moderate to strong and positive ($r = 0.42$–0.70)

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TABLE 1 (*Continued*)

Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Spence et al., 2013 (142)	Obesity Protective Dietary Index (OPDI)	Australia $n = 398$ 2008–2010 ~4 y Female (47%)	The Melbourne InFANT program cluster Randomized controlled trial	Effect of healthy eating and PA intervention on dietary patterns Energy-adjusted model regression coefficient (β: 1.33; 95% CI: 0.28, 2.39; $P = 0.01$)
Durksen et al., 2015 (143)	Unhealthy Eating Index Canada (UEI-Ca15)	Canada $n = 330$ 2008 9–17 y Female, percentage not found	Cross-sectional study	Association between unhealthy diet and light, moderate, or vigorous PA There was no statistical difference in the consumption of unhealthy food between levels of PA (OR: 1.01; 95% CI: 0.41, 2.46; $P = 0.8$)
Haapala et al., 2015 (144)	Baltic Sea Diet Score (BSDS)	Finland $n = 428$ 2007–2009 6–8 y Female (50%)	Physical Activity and Nutrition in Children (PANIC) intervention study	Association between diet and cognition DQ was directly associated with cognition test (ß: 0.122; $P = 0.012$)
Hardiansyah et al., 2015 (145)	Balanced Diet Index (BDI)	Indonesia $n = 10{,}221$ 2010 4–6 y Female, percentage not found	Cross-sectional study	Assessed nutritional adequacy Pearson correlation coefficient, $r = 0.42$
Cheng et al., 2016 (146)	Chinese Children Dietary Index (CCDI)	China $n = 1719$ 2013 7–15 y Female (49%)	Cross-sectional study	Characterization of DQ and associated factors Mean score 88.1. Age, paternal education level, and family size were associated with DQ
Verger et al., 2016 (147)	Diet Quality Index Based on the Probability of Adequate Nutrient Intake (PANDiet)	United Kingdom $n = 1152$ 2011 2–18 mo Female (49%)	Cross-sectional study	Nutritional adequacy according to the consumption of formula and infant foods A lower score was associated with lower intakes of formula, infant foods, vegetables, and fruits
Winpenny et al., 2018 (148)	Dietary Approaches to Stop Hypertension index (DASH index)	United Kingdom $n = 2957$ 2008–2016 13–30 y Female (51%)	Cross-sectional study	Association between DQ and age The regression showed no significant change in DQ. There was a slight improvement among older females (ß: 2.39; 95% CI: 0.53, 4.26)
Kunto and Bras, 2019 (149)	Berry Index (BI)	Indonesia $n = 6478$ 2000–2015 7–12 y Female, percentage not found	Cross-sectional study	DQ and sociodemographic characteristics Sex and household SES were associated with the DQ

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TABLE 1 (*Continued*)

Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Liu et al., 2020 (150)	American Heart Association Score (AHAS)	United States $n = 31,420$ 1999–2016 2–19 y Female (49%)	Cross-sectional study	Trends in DQ in youth Youth with poor diets declined from 76.8% to 56.1% and with intermediate diets increased from 23.2% to 43.7% ($P < 0.001$ for each trend)
Other Dietary and Lifestyle Indicators				
Mediterranean Diet Indexes				
Serra-Majem et al., 2004 (151)	Mediterranean Diet Quality Index for Children and Adolescents (KIDMED)	Spain $n = 3850$ 2000 2–24 y Female, percentage not found	EnKid study Cross-sectional study	Levels of adherence Lower percentages of high DQ were observed in low socioeconomic groups compared with middle and upper income cohorts (42.8%, 47.6%, and 54.9%, respectively)
Jennings et al., 2011 (152)	Modified Mediterranean Diet Score (mMDS)	United Kingdom $n = 1700$ 2007 9–10 y Female (56%)	Sport, Physical Activity, and Eating Behaviour: Environmental Determinants in Young People (SPEEDY) study Cross-sectional study	Adherence to the Med diet and anthropometric parameters No significant associations were observed with the MDS and weight status, waist circumference, and body fat
Schroder et al., 2011 (153)	Brief Mediterranean Diet Screener (bMDSC): 2 subscores—Antioxidant Food Score (ANTOX-S) and Modified Mediterranean Diet Score (mMDS)	Spain $n = 6352$ 2004–2006 3–80 y Female (52%)	Cross-sectional study	Valid assessments of DQ for use in time-limited settings Correlated ($P < 0.001$) with the corresponding 24h-DR ($r = 0.45$). Dietary intakes of fiber, vitamin C, vitamin E, magnesium, and potassium reported on the 24h-DR were positively associated ($P = 0.04$) with ANTOX-S and mMDS
Lazarou and Matalas, 2015 (154)	Modified Mediterranean Diet Quality Index for Children and Adolescents (mKIDMED)	Cyprus $n = 83$ 2006–2007 9.2 y Female (37%)	Cross-sectional study	Med diet adherence, PA, obesity, selected cardiovascular risk markers, and iron status Breakfast skippers vs. regular breakfast eaters were 40% more likely to have a Modified Mediterranean DQI score higher by 1 point (OR: 1.41; 95% CI: 1.05, 1.84). Combining breastfeeding percentage and waist circumference into a composite variable (OR: 0.20; 95% CI: 0.06, 0.69)

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Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Kastorini et al., 2016 (155)	Modified Mediterranean Diet Quality Index for Children and Adolescents (mKIDMED)	Greece $n = 3941$ 2012–2013 3–18 y Female (52%)	DIATROFI study Cohort study	Evaluation of the effects of healthy nutrition program. Modified Mediterranean DQI increased statistically significantly in adolescent girls ($P = 0.042$), whereas the consumption frequency of all foods promoted by the intervention—milk, fruits, vegetables, and whole-grain products—increased for children and adolescents, boys and girls ($P = 0.002$)
Rivas et al., 2016 (156)	Mediterranean Diet Score (MDS)	Spain $n = 132$ 2014 6–8 y Female (43%)	Cross-sectional study	Bisphenol A migration and exposure Significant association between the MDS and low bisphenol A exposure. Bisphenol A exposure below the median level was significantly associated with a higher score ($P < 0.05$)
Haapala et al., 2017 (157)	Mediterranean Diet Score (MDS)	Finland $n = 471$ 2007–2009 6–8 y Female (46%)	Physical Activity and Nutrition in Children (PANIC) study Intervention study	Academic achievement MDS was positively associated with reading comprehension in a group of children (β: 0.167; $P = 0.032$)
Montero et al., 2017 (158)	Mediterranean Adequacy Index (MAI)	Morocco, Spain $n = 327$; $n = 77$ 2007–2010 12–19 y Female (59%); female (51%)	Cross-sectional study	Eating patterns of teenagers from Morocco living in Madrid Teenagers from Morocco living in Madrid consumed more calories, proteins, saturated fats, and simple sugars ($P < 0.001$) than those living in Morocco. Their diet was of lower quality than that of their peers in Morocco

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TABLE 1 (*Continued*)

Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Carvalho et al., 2018 (159)	Adolescent Mediterranean Diet Score (aMDS)	European countries $n = 242$ 2005 12.5–17.5 y Female (57%)	Healthy Lifestyle in Europe by Nutrition in Adolescence Cross-Sectional Study (HELENA-CSS) Cross-sectional study	Association between cortisol levels, inflammation, and Med diet. Cortisol levels were inversely associated with adherence to the Med diet (β: −1.023; $P = 0.002$). Adolescents with higher adherence to the Med diet had lower levels of IL-1, IL-2, IL-6, and TNF-α compared with those who did not adhere
Aparicio-Ugarriza et al., 2019 (160)	Adapted Mediterranean Diet Score for Adolescents (MDS_A) Adapted Mediterranean Diet Quality Index for Children and Adolescents (KIDMED_A)	European countries $n = 2330$ 2005 14.7 y Female (56%)	Healthy Lifestyle in Europe (HELENA) study Cross-sectional study	Better food/nutrient intakes and nutritional biomarkers Positive associations for KIDMED_A with serum levels of vitamin D, vitamin C, plasma folate, holotranscobalamin, β-carotene, and n–3 fatty acids, whereas there was a negative association with *trans*-fatty acid serum levels. KIDMED_A positive associations with vegetables and fruits intake and negative associations with energy-dense and low-nutritious foods
Diet–Lifestyle Indexes				
Kosti et al., 2009 (161)	Diet–Lifestyle Index	Greece $n = 2008$ 2004–2008 12–17 y Female (49%)	Cross-sectional study	Prevalence of overweight/obesity The index was inversely associated with the odds of being obese/overweight (OR: 0.93; 95% CI: 0.90, 0.96). An 11/57–unit increase of the index was associated with a 6% and 9% decrease in the odds of being overweight/obese in boys and girls ($P < 0.001$)
Manios et al., 2010 (162)	Preschoolers Diet–Lifestyle Index (PDL-Index)	Greece $n = 2287$ 2003–2004 2–5 y Female (48%)	Exercise and Nutrition Epidemiological Study in preSchoolers (GENESIS) study Cross-sectional study	Obesity It was observed that a 1/44-unit increase in the score of the PDL-Index was associated with ∼5% and ∼3% lower odds of being obese and overweight/obese, respectively

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Authors, publication year (Ref)	Indicator	Country, population, year of recruitment, age, sex	Study name, study design	Main objective and results
Manios et al., 2010 (b) (163)	Healthy Lifestyle–Diet Index (HLD-Index)	Greece $n = 729$ 2007 10–12 y Female, percentage not found	Healthy Growth Study Cross-sectional study	IR 20.9% of participants were found to be IR. A 1-unit increase in the score is associated with ∼8% lower odds for being IR
Manios et al., 2015 (164)	Revised Healthy Lifestyle–Diet Index (R-HLD-Index)	Greece $n = 2660$ 2007 9–13 y Female (49%)	Healthy Growth Study Cross-sectional study	Obesity and iron deficiency An increase in the R-HLD-Index score by 1 unit was associated with a 6% lower odds for obesity. No significant association was observed between the R-HLD-Index score and iron deficiency
Ertaş Öztürk et al., 2018 (165)	Healthy Lifestyle–Diet for Turkey (HLD-TR)	Turkey $n = 164$ 2015 9–13 y Female (42%)	Cross-sectional study	IR A 1-unit increase in the index score decreased the IR risk (OR: 0.91; 95% CI: 0.85, 0.97)
Breakfast Quality Indexes				
Radcliffe et al., 2004 (166)	Five food groups in Australian Guide to Healthy Eating (AGHE) Food Group Score (FGS)	Australia $n = 832$ 2002 11–12 y Female (50%)	Queensland School Breakfast Project (QSBP) study Cross-sectional study	Breakfast characteristics The most common breakfast item reported was breakfast cereal (55%), and 22% of children consumed energy-dense, micronutrient-poor foods or beverages
Herrero Lozano and Fillat Ballesteros, 2006 (167)	enKID study criteria	Spain $n = 141$ 2006 12–13 y Female (50%)	Cross-sectional study	Intellectual performance The mean mark systematically increased as breakfast quality increased from a mean score of 5.63 in the group with poor-quality breakfast to a mean score of 7.73 in the group with a good-quality breakfast
Hallström et al., 2012 (168)	Breakfast Quality Index (BQI)	European cities $n = 2672$ 2006–2007 12–17 y Female (53%)	Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) study Cross-sectional study	Breakfast habits and sociodemographic factors Most of the adolescents reported a breakfast that scored poorly on the BQI. Older adolescents, adolescents from the southern area of Europe, and adolescents from families with low SES were more likely to consume a low-quality breakfast

[1] DD, dietary diversity; DDS, Dietary Diversity Score; DQ, diet quality; DQI, diet quality index; DR, dietary recall; FVS, Food Variety Score; HEI, Healthy Eating Index; IR, insulin resistance; MAR, mean adequacy ratio; Med diet, Mediterranean diet; PA, physical activity; SES, socioeconomic status; SSB, sugar-sweetened beverage.

TABLE 2a Food group components included in the Healthy Eating Indexes diet quality indicators[1]

Authors, publication year (Ref)	Indicator	Vegetables	Fruits	Cereals	Legumes	Nuts	Fats	Dairy	Eggs	Fish	Meat	Snacks	SSBs
Kennedy et al., 1995 (30)	Healthy Eating Index (HEI)	✓ (+)	✓ (+)	✓ (+)	✓ (+)[2]	✓ (+)[2]		✓ (+)[3]			✓ (+)[2]		
Feskanich et al., 2004 (31)	Youth Healthy Eating Index (YHEI)	✓ (+)	✓ (+)	✓ (+)[4]	✓ (+)[2]	✓ (+)[2]	✓ (–)[5]	✓ (.)[6]	✓ (+)[2]	✓ (+)[2]	✓ (.)[2,7]	✓ (–)[8]	✓ (–)
Knol et al., 2004 (32)	Healthy Eating Index Variety Score (HEI-variety)	✓ (+)	✓ (+)	✓ (+)	✓ (+)[2]	✓ (+)[2]		✓ (+)[3]			✓ (+)[2]		
Pinheiro and Atalah, 2005 (33)	Healthy Eating Index Chile (HEI-CHL)	✓ (+)	✓ (+)[9]	✓ (+)[10]	✓ (+)[2]	✓ (+)[2]		✓ (+)[11]	✓ (+)[2]	✓ (+)[2]	✓ (.)[2]		
Glanville and McIntyre, 2006 (34)	Healthy Eating Index Canada 2006 (HEI-C06)	✓ (+)[12]	✓ (+)[9]	✓ (+)	✓ (+)[2]	✓ (+)[2]	✓ (+)	✓ (+)	✓ (+)[2]		✓ (+)[2]	✓ (–)[8]	✓ (–)
Guenther et al., 2008 (35)	Healthy Eating Index 2005 (HEI-2005)	✓ (+)[13]	✓ (+)[9]	✓ (+)[14]	✓ (+)[2]		✓ (+)[15]	✓ (+)[11]			✓ (+)[2]		
Garriguet, 2009 (36)	Healthy Eating Index Canada modification (HEI-C-mod)	✓ (+)[13]	✓ (+)	✓ (+)[14]	✓ (+)[2]		✓ (+)[15]	✓ (+)[11]			✓ (+)[2]		
De Andrade et al., 2010 (37)	Healthy Eating Index Brazil (HEI-BRA14)	✓ (+)	✓ (+)	✓ (+)[10]	✓ (+)			✓ (+)	✓ (+)[2]		✓ (+)[2]		
Woodruff et al., 2010 (38)	Healthy Eating Index Canada (HEIC-2009)	✓ (+)[13]	✓ (+)	✓ (+)				✓ (+)[16]	✓ (+)[2]		✓ (+)[2,17]		
Rydén and Hagfors, 2011 (39)	Healthy Eating Index 2005 (HEI-2005)	✓ (+)[13]	✓ (+)[9]	✓ (+)[14]	✓ (+)[2]		✓ (+)[15]	✓ (+)[11]			✓ (+)[2]		
González Rosendo et al., 2012 (40)	Healthy Eating Index Mexico (HEI-MEX)	✓ (+)	✓ (+)	✓ (+)	✓ (+)			✓ (+)			✓ (.)		
He et al., 2012 (41)	Healthy Eating Index 2005 Canadian modification (HEIC-2005)	✓ (+)	✓ (+)[9]	✓ (+)[14]	✓ (+)[2]			✓ (+)[2]		✓ (+)[2]	✓ (+)[2]		
Guenther et al., 2013 (42)	Healthy Eating Index 2010 (HEI-2010)	✓ (+)	✓ (+)	✓ (.)[14]	✓ (+)[2]	✓ (+)[18]		✓ (+)[11]	✓ (+)[2]	✓ (+)[18]	✓ (+)[2]		

(Continued)

TABLE 2a (*Continued*)

Authors, publication year (Ref)	Indicator	Vegetables	Fruits	Cereals	Legumes	Nuts	Fats	Dairy	Eggs	Fish	Meat	Snacks	SSBs
Nyaradi et al., 2013 (43)	Youth Healthy Eating Index Australia (YHEI-AUS)	✓ (+)	✓ (+)	✓ (+)[4]	✓ (+)[2]	✓ (+)[2]		✓ (+)[11]	✓ (+)[2]		✓ (+)[2,7]	✓ (–)[8]	✓ (–)
Kyttälä et al., 2014 (44)	Finnish Children Healthy Eating Index (FCHEI)	✓ (+)	✓ (+)				✓ (+)	✓ (+)[16]		✓ (+)			✓ (–)
Rauber et al., 2014 (45)	Healthy Eating Index Brazil (HEI-BRA14)	✓ (+)	✓ (+)[9]	✓ (+)[10]	✓ (+)[2]	✓ (+)[2]		✓ (+)[11]	✓ (+)[2]		✓ (+)[2]		
Wahlqvist et al., 2014 (46)	Youth Healthy Eating Index Taiwan (YHEI-TW)	✓ (+)	✓ (+)	✓ (+)[7]	✓ (+)[2]				✓ (+)[2]	✓ (+)[2]	✓ (+)[2,7]	✓ (–)[8]	✓ (–)
Dahm et al., 2016 (47)	High School Alternative Healthy Eating Index (HS-AHEI)	✓ (+)	✓ (+)	✓ (+)[4]	✓ (+)[18]	✓ (+)[18]				✓ (+)	✓(-)[19]		✓ (–)
Tugault-Lafleur et al., 2017 (48)	School Healthy Eating Index (School-HEI)	✓ (+)[13]	✓ (+)	✓ (+)[14]			✓ (+)	✓ (.)			✓ (.)	✓(–)[21]	✓(–)[21]
Yuan et al., 2017 (49)	Healthy Eating Index China (HEI-CHN)	✓ (+)[13]	✓ (+)	✓(+)[12,14]	✓ (+)		✓ (+)[15]	✓ (+)	✓ (+)	✓ (+)	✓ (.)[20]		
Conceição et al., 2018 (50)	Healthy Eating Index Brazil Infants (HEI-BRA-I)	✓ (+)	✓ (+)	✓ (+)[10]	✓ (+)[2]			✓ (+)	✓ (+)[2]		✓ (+)[2]		
Hooshmand et al., 2018 (51)	Healthy Eating Index Iran (HEI-IRN)	✓ (+)	✓ (+)	✓ (+)[10]			✓ (+)[5]	✓ (+)			✓ (+)[7]	✓ (–)[8]	✓ (–)

(*Continued*)

TABLE 2a (*Continued*)

Authors, publication year (Ref)	Indicator	Vegetables	Fruits	Cereals	Legumes	Nuts	Fats	Dairy	Eggs	Fish	Meat	Snacks	SSBs
Nshimyumukiza et al., 2018 (52)	Healthy Eating Index Canada (HEI-C-2010)	✓ (+)	✓ (+)	✓ (+)[14]	✓ (+)			✓ (+)		✓ (+)	✓ (.)		
Reedy et al., 2018 (53)	Healthy Eating Index 2015 (HEI-2015)	✓ (+)	✓ (+)	✓ (.)[14]	✓ (+)			✓ (+)	✓ (+)[2]	✓ (+)	✓ (+)[2]		
Brownlee et al., 2019 (54)	Healthy Eating Index Singapur (HEI-SGP)	✓ (+)	✓ (+)	✓ (+)[14]				✓ (.)			✓ (.)		
No. of studies using the particular component in this indicators subgroup		25	25	24	20	9	9	23	12	10	24	6	8

[1]Check symbol denotes that a component is included in the indicator. +, the component is scored positively or as improving the DQ; –, the component is scored negatively or as decreasing the DQ; dot, the component gets a higher score when it fits within a specific range or the score is unspecified. DQ, diet quality; SSBs, sugar-sweetened beverages.
[2]Included in the meat component.
[3]Milk.
[4]Whole grains only.
[5]Margarine and butter.
[6]Includes ice cream and whole-fat milk.
[7]Ratio from the consumption of meat and other protein sources, where the denominator included dark meat, including beef, pork, lamb, liver, and cold cuts; and the numerator included poultry, fish, dried beans, tofu, eggs, nuts, and seeds.
[8]Salty snacks (e.g., potato chips, corn chips, nachos, popcorn, pretzels, and crackers) and snacks with added sugar (e.g., cake, snack cake, toaster pastry, sweet roll/Danish/pastry, doughnut, brownie, cookies, pie, chocolate, candy bar with chocolate, candy without chocolate, fruit rollup, popsicle, and flavored gelatin).
[9]Includes fruit juices.
[10]Cereal, tubers, and roots.
[11]Cow milk, goat milk, and soy drinks.
[12]Includes potatoes.
[13]Includes dark green and orange vegetables.
[14]Whole grains as separate component.
[15]Nonhydrogenated vegetable oils and oils in fish, nuts, and seeds.
[16]Skimmed milk and alternatives.
[17]Lean meat and alternatives.
[18]Plant proteins.
[19]Red processed meats.
[20]Red meat and poultry.
[21]As other food component.

TABLE 2b Food group components included in the Dietary Diversity Scores diet quality indicator[1]

Authors, publication year (Ref)	Indicator	Vegetables	Fruits	Cereals	Legumes	Nuts	Fats	Dairy	Eggs	Fish	Meat	Snacks	Sweets	SSBs
Arimond and Ruel, 2004 (55)	Dietary Diversity Score (DDS04)	✓ (+)[2]	✓(+)[3,4]	✓ (+)[5]	✓ (+)		✓ (+)[6]	✓ (+)[7]	✓ (+)[8]	✓ (+)[8]	✓ (+)[8,9]			
Mirmiran et al., 2004 (56)	Dietary Diversity Score Iran (DDS-IRN)	✓ (+)[3]	✓ (+)[3,4]	✓ (+)				✓ (+)	✓ (+)[8]	✓ (+)[8]	✓ (+)[8,9]			
Kennedy et al., 2007 (57)	Dietary Diversity Score Filipinas (DDS-PHI)	✓ (+)[3]	✓ (+)[3]	✓ (+)[5]	✓ (+)[10]	✓ (+)[10]	✓ (+)	✓ (+)	✓ (+)	✓ (+)[8]	✓ (+)[8,9]			
Mpontshane et al., 2008 (58)	Dietary Diversity Score South Africa (DDS-ZAF)	✓ (+)[10]	✓ (+)[10]	✓ (+)[11]	✓ (+)			✓ (+)[12]	✓ (+)[8]	✓ (+)[8]	✓ (+)[8]	✓ (–)[13]	✓ (–)[13]	✓ (–)[13]
Enneman et al., 2009 (60)	Dietary Diversity Score Guatemala USAID (DDS-GT-US-CP-INCAP)	✓ (+)[2,3]	✓ (+)[3]	✓ (+)	✓ (+)	✓ (+)	✓ (+)	✓ (+)	✓ (+)	✓ (+)	✓ (+)	✓ (–)	✓ (–)	✓ (–)
Kennedy et al., 2010 (61)	Individual Dietary Diversity Score (IDDS)	✓ (+)[2,3]	✓ (+)[3]	✓ (+)[5]	✓ (+)[10]	✓ (+)[10]		✓ (+)	✓ (+)	✓ (+)[8]	✓ (+)[8,14]			
Li et al., 2011 (62)	Dietary Diversity Score China (DDS-CHN10)	✓ (+)[2]	✓ (+)	✓ (+)[5]	✓ (+)			✓ (+)	✓ (+)	✓ (+)	✓ (+)			
Belachew et al., 2013 (63)	Dietary Diversity Score Ethiopia (DDS-ETH)	✓ (+)[2,3]	✓ (+)[3]	✓ (+)	✓ (+)[8]	✓ (+)[8]	✓ (+)[6]	✓ (+)[16]	✓ (+)[8]	✓ (+)[8]	✓ (+)[8,9]			✓ (–)
Darapheak et al., 2013 (64)	Dietary Diversity Score WHO modification (DDS-WHOm)	✓ (+)[2,3]	✓ (+)[3]	✓ (+)[5]	✓ (+)		✓ (+)	✓ (+)	✓ (+)	✓ (+)[8]	✓ (+)[8,14]			
Gewa et al., 2014 (65)	Dietary Diversity Score Kenya (DDS-KEN)	✓ (+)[2,3,15]	✓ (+)[3]	✓ (+)[5]	✓ (+)[10]	✓ (+)[10]		✓ (+)	✓ (+)[8]	✓ (+)[8]	✓ (+) [8,9]			
Mundo-Rosas et al., 2014 (66)	Dietary Diversity Score Mexico (DDS-MX)	✓ (+)[3]	✓ (+)[3]	✓ (+)	✓ (+)		✓ (+)	✓ (+)	✓ (+)[3]	✓ (+)[8]	✓ (+)[8,9]		✓ (–)	✓ (–)
Amugsi et al., 2015 (67)	Dietary Diversity Score Ghana (DDS-GHA)	✓ (+)[2,3]	✓ (+)[3]	✓ (+)[5]	✓ (+)[10]	✓ (+)[10]	✓ (+)	✓ (+)	✓ (+)	✓ (+)	✓ (+)		✓ (–)	
Ali and Abizari, 2018 (68)	Dietary Diversity Score Ghana 2018 (DDS-GHA18)	✓ (+) [2,3]	✓ (+)[3]	✓ (+)[5]	✓ (+)[10]	✓ (+)[10]	✓ (+)	✓ (+)	✓ (+)	✓ (+)	✓ (+)[14]			
Meng et al., 2018 (69)	Dietary Diversity Score China (DDS-CHN18)	✓ (+)[17]	✓ (+)[4]	✓ (+)[5]	✓ (+)[10]	✓ (+)[10]		✓ (+)	✓ (+)	✓ (+)	✓ (+)	✓ (–)	✓ (–)	✓ (–)

(*Continued*)

TABLE 2b (*Continued*)

Authors, publication year (Ref)	Indicator	Vegetables	Fruits	Cereals	Legumes	Nuts	Fats	Dairy	Eggs	Fish	Meat	Snacks	Sweets	SSBs
Morseth et al., 2018 (70)	Dietary Diversity Score (DDS-NPL17)	✓ (+)[3]	✓ (+)[3]	✓ (+)[5]	✓ (+)[10]	✓ (+)[10]			✓ (+)		✓ (+)			
Iqbal et al., 2019 (71)	Dietary Diversity Score Bangladesh (DDS-BGD)	✓ (+)[3]	✓ (+)[3]	✓ (+)[5]	✓ (+)[10]	✓ (+)[10]		✓ (+)	✓ (+)		✓ (+)	✓ (–)	✓ (–)	✓ (–)
Thorne-Lyman et al., 2019 (72)	Individual Dietary Diversity Score (IDDS)	✓ (+)[3]	✓ (+)[3]	✓ (+)[5]	✓ (+)[10]	✓ (+)[10]	✓ (+)	✓ (+)	✓ (+)	✓ (+)	✓ (+)			
Yang et al., 2019 (73)	Dietary Diversity Score China 2019 (DDS-CHN19)	✓ (+)[2]	✓ (+)	✓ (+)[5]	✓ (+)[10]	✓ (+)[10]		✓ (+)	✓ (+)	✓ (+)	✓ (+)[9]			
Sebayang et al., 2020 (74)	Dietary Diversity Score Indonesia (DDS-IDN)	✓ (+)[3]	✓ (+)[3]	✓ (+)[5]	✓ (+)[10]	✓ (+)[10]		✓ (+)	✓ (+)		✓ (+)			
No. of studies using each component in this indicator subgroup		19	19	19	16	12	9	17	19	16	19	4	6	6

[1]Check symbol denotes that a component is included in the indicator. +, the component is scored positively or as improving the DQ; –, the component is scored negatively or as decreasing the DQ; dot, the component gets the higher score when it fits within a specific range or the score is unspecified. DQ, diet quality; SSBs, sugar-sweetened beverages.
[2]Green leafy vegetables as separate component.
[2]Vitamin A–rich group as separate component.
[3]Fruit juices.
[4]Cereal, tubers, and roots.
[5]Oil and butter or fat.
[6]Dairy other than breast milk, cheese, or yogurt.
[7]In the same component as meat or protein.
[8]Including meat and poultry.
[9]In the same component.
[10]Bread, cereal porridge, and maize meal.
[11]Breast milk and formula milk are included as a separate component.
[12]In the same component as snacks.
[13]Including organ meat.
[14]Vitamin C–rich group as a separate component.
[15]Milk and cheese.
[16]Vegetable juices.

TABLE 2c Food group components included in the Diet Quality Indexes diet quality indicator[1]

Authors, publication year (Ref)	Indicator	Water	Vegetables	Fruits	Juice	Cereals	Legumes	Nuts	Fats	Dairy	Eggs	Fish	Meat	Snacks	FF	Sweets	SSBs	Alcohol
Alexy et al., 2003 (75)	Diet Quality Index Germany (DQI-DEU)	✓ (+)																
Kranz et al., 2004 (76)	Diet Quality Index for Children (C-DQI)		✓ (+)[2]	✓ (+)[2]	✓ (+)	✓ (+)				✓ (.)								
Mariscal-Arcas et al., 2007 (77)	Diet Quality Index International adaptation (DQI-Ia)		✓ (+)	✓ (+)		✓ (+)	✓ (+)[3]		✓ (+)[4]	✓ (.)[3]	✓ (+)[3]	✓ (+)[3]	✓ (+)[3,5]	✓ (–)[4]		✓ (–)[4]		✓ (–)[4]
McArthur et al., 2008 (78)	Rapid Assessment Diet Quality Index (RADQI)		✓ (+)[6]	✓ (+)[7]	✓ (+)[8]	✓ (+)[9]				✓ (.)[10]		✓ (+)[2]	✓ (+)[2,11]	✓ (–)		✓ (–)	✓ (–)[8]	
Huybrechts et al., 2010 (79)	Diet Quality Tool for Flemish Preschoolers (DQT-FP)	✓ (+)[12]	✓ (+)	✓ (+)	✓ (+)	✓ (+)[13]				✓ (.)[14]		✓ (+)[2]	✓ (+)[2,15]	✓ (–)		✓ (–)	✓ (–)	
De Vriendt et al., 2012 (80)	Diet Quality Index for Adolescents (DQI-A)	✓ (+)	✓ (+)	✓ (+)	✓ (–)[8]	✓ (+)[13]			✓ (+)	✓ (.)[16]	✓ (+)[2]	✓ (+)[2]	✓ (+)[17]	✓ (–)[4]		✓ (–)[4]	✓ (–)[8]	✓ (–)[8]
Fokeena and Jeewon, 2012 (81)	Diet Quality Index Mauritius (DQI-MUS)		✓ (+)[18]	✓ (+)		✓ (+)[19]			✓ (+)	✓ (.)[10]		✓ (+)[3]	✓ (+)[3]			✓ (–)[2]	✓ (–)[2]	
Li et al., 2012 (82)	Diet Quality Index Australian Children and Adolescents (DQI-AUS-CA)		✓ (+)	✓ (+)		✓ (+)	✓ (+)[3]	✓ (+)[3]		✓ (+)[3]	✓ (+)[3]	✓ (+)[3]	✓ (+)[3,11]	✓ (–)[2]	✓ (–)[2]	✓ (–)[2]	✓ (–)[2]	
Bel et al., 2013 (83)	Diet Quality Index for Adolescents with Meal Index (DQI-AM)	✓ (+)	✓ (+)	✓ (+)		✓ (+)[13]				✓ (+)[16]		✓ (+)[3]	✓ (+)[3,17]	✓ (–)[2]		✓ (–)[2]	✓ (–)[2]	
Vyncke et al., 2013 (84)	Diet Quality Index for Adolescents 2013 (DQI-A-13)	✓ (+)	✓ (+)	✓ (+)		✓ (+)[13]			✓ (+)	✓ (+)[16]	✓ (+)[3]	✓ (+)[3]	✓ (+)[3]					
Wong et al., 2013 (85)	Diet Quality Index for New Zealand Adolescents (NZDQI-A)		✓ (+)[20,21]	✓ (+)[20]		✓ (+)				✓ (+)	✓ (+)[3]	✓ (+)[3]	✓ (+)[3,11,17]					
Röytiö et al., 2015 (86)	Diet Quality Index for Finland Children (FINDQI-C)		✓ (+)	✓ (+)		✓ (+)[22]												

(Continued)

TABLE 2c (*Continued*)

Authors, publication year (Ref)	Indicator	Water	Vegetables	Fruits	Juice	Cereals	Legumes	Nuts	Fats	Dairy	Eggs	Fish	Meat	Snacks	FF	Sweets	SSBs	Alcohol
Collins et al., 2016 (87)	Revised Children's Diet Quality Index Australia (RC-DQI-AUS)		✓ (+)	✓ (+)	✓ (+)	✓ (+)[19]				✓ (+)								
Kunaratnam et al., 2018 (89)	Diet Quality Index for Australian Preschoolers (DQI-AusP)	✓ (+)	✓ (+)	✓ (+)	✓ (+)					✓ (+)[23]			✓ (–)[24]	✓ (–)	✓ (–)	✓ (–)	✓ (–)	
Hamner and Moore, 2020 (90)	Diet Quality Index Score for American Infants (DQIS-USIn)		✓ (+)[2]	✓ (+)	✓ (+)	✓ (+)[19]	✓ (+)[2]			✓ (+)[23,25]	✓ (.)[3]	✓ (.)[3]	✓ (.)[3]	✓ (–)		✓ (–)	✓ (–)	
No. of studies using each component in this indicator subgroup		6	14	14	7	13	3	1	4	13	6	10	11	8	2	9	8	2

[1]Check symbol denotes that a component is included in the indicator. +, the component is scored positively or as improving the DQ; –, the component is scored negatively or as decreasing the DQ; dot, the component gets the higher score when it fits within a specific range or the score is unspecified. DQ, diet quality; FF, fast food; SSBs, sugar-sweetened beverages.
[2]Classified in the same component.
[3]As protein component.
[4]As empty calorie food component or low-nutrient energy dense.
[5]Cold meats and pate considered as empty-calorie food.
[6]Including canned vegetables and starchy vegetables such as potatoes.
[7]Including canned fruits.
[8]As low-nutrient energy-dense drinks.
[9]Including breakfast cereal.
[10]Whole milk and low-fat milk.
[11]Meat and poultry.
[12]Including all drinks except drinks from other mentioned groups.
[13]Bread and cereals as one component and potatoes and grains as another component.
[14]Milk, yogurt, milk desserts, and soy drinks.
[15]Including meat, poultry, and game.
[16]Milk, yogurt, and milk desserts as one component, and cheese as another component.
[17]Including vegetarian substitutes.
[18]Raw and cooked vegetables as separate components.
[19]Whole grains and refined cereals as separate components.
[20]Fresh, frozen, and canned.
[21]Including potatoes.
[22]Whole grains.
[23]Milk.
[24]Processed meat.
[25]Includes breastfeeding or formula feeding.

TABLE 2d Food group components included in the Food Variety Scores diet quality indicator[1]

Authors, publication year (Ref)	Indicator	Cereals	Vegetables	Fruits	Dairy	Meat	Fish	Eggs
Cox et al., 1997 (91)	Variety Index for Toddlers (VIT)	✓ (.)[2]	✓ (.)[3]	✓ (.)[4]	✓ (.)[5]	✓ (.)[6]		✓ (.)[6]
Vereecken et al., 2008 (93)	Variety Index	✓ (.)[7]	✓ (.)	✓ (.)	✓ (.)[8]			✓ (.)[6]
Saibul et al., 2009 (95)	Food Variety Score (FVS)	✓ (.)[9]	✓ (.)	✓ (.)	✓ (.)[10]	✓ (.)[11]	✓ (.)	✓ (.)[11]
Scott et al., 2012 (96)	Core Food Variety Score (CFVS)	✓ (.)[12]	✓ (.)[13]	✓ (.)	✓ (.)	✓ (.)[14]	✓ (.)[14]	✓ (.)[14]
Jones et al., 2015 (98)	Healthy Plate Variety Score (HPVS)[15]	✓ (.)[2]	✓ (.)[15]	✓ (.)[4]	✓ (.)[5]	✓ (.)[6]		✓ (.)[6]
Barros et al., 2019 (101)	Dietary Variety Index (DVI)	✓ (.)[16]	✓ (.)	✓ (.)	✓ (.)	✓ (.)[17]	✓ (.)[17]	✓ (.)[17]
No. of studies using each component in this indicator subgroup		6	6	6	6	5	3	6

[1]Check symbol denotes that a component is included in the indicator. +, the component is scored positively or as improving the DQ; −, the component is scored negatively or as decreasing the DQ; dot, the component gets the higher score when it fits within a specific range or the score is unspecified. DQ, diet quality.
[2]Bread, cereal, pasta, rice, crackers, and sweets.
[3]Vegetables, processed or cooked; potatoes; vegetables, raw leafy and whole raw.
[4]Fruit, large raw (apple, banana); fruit, small raw (apricot, plum); and fruit, processed (applesauce).
[5]Milk, yogurt, pudding, cheese, natural, and ice cream.
[6]Meat, eggs, peanut butter, beans, and nuts.
[7]Brown bread.
[8]Whole-fat milk, semi-skimmed milk, cheese, and other milk products.
[9]Rice/rice porridge, wet noodles, rice vermicelli, instant noodles, traditional pancake, white bread, filled bun, unleavened bread, corn, crackers/biscuits, tapioca, sweet potato, yam, potato, traditional cakes.
[10]Chocolate milk (ultra-high-temperature), powdered full-cream milk, soy milk, and sweet condensed milk.
[11]Beef, chicken, egg, pork.
[12]Breakfast cereals, breads and rolls, rice and pasta, crackers, pretzels, rice cakes, cereal or granola bars, pizza/savory pastry/pies, and other grains and grain products.
[13]Vegetables, potatoes, and French fries/hot chips.
[14]Meat and other nondairy protein sources (eggs, nuts and seeds, dried beans and peas, vegetarian meat substitutes, red meat, chicken or turkey, fish and shellfish, hot dogs, sausages, cold cuts, offal, and other unspecified meats).
[15]Cakes, biscuits/cookies, puddings, and fried potatoes were excluded from the VIT.
[16]Bread, cookies, rice, pasta, and potatoes.
[17]Eggs, white meats, meat, pork products, and fish.

TABLE 2e Food group components included in the Healthy and Unhealthy Scores diet quality indicator[1]

Authors, publication year (Ref)	Indicator	Vegetables	Fruits	Cereals	Legumes	Dairy	Eggs	Fish	Meat	Snacks	FF	Sweets	SSBs	Coffee
Jacka et al., 2011 (103)	Unhealthy Food Choices Score (UFCS)	✓ (+)[2]	✓ (+)	✓ (.)[3]		✓ (+)[4]				✓ (–)	✓ (–)	✓ (-)	✓ (–)	✓ (.)
Truthmann et al., 2012 (104)	Healthy (HDS-A) and unHealthy Diet Scores Australia (uHDS-A)	✓ (+)	✓ (+)							✓ (–)	✓ (–)	✓ (–)	✓ (–)	
Monjardino et al., 2014 (105)	Healthy Eating Index Score Portugal (HEIS-PRT)	✓ (+)[2]	✓ (+)			✓ (+)[6]	✓ (+)[7]	✓ (+)[7]	✓ (.)[7,8]	✓ (–)	✓ (–)[8]	✓ (–)	✓ (–)[9]	
Vilela et al., 2014 (106)	Indicator Food Index (IFI)	✓ (+)	✓ (+)	✓ (+)[5]						✓ (–)	✓ (–)	✓ (–)	✓ (–)	
Anderson et al., 2015 (107)	Pro-Healthy Diet Index (pHDI) and Non-Healthy Diet Index (nHDI)	✓ (+)	✓ (+)			✓ (+)		✓ (+)			✓ (–)	✓ (–)	✓ (–)[11]	
Anderson et al., 2016 (108)	Healthy (HDS-USA15) and unHealthy Diet Scores USA 2015 (uHDS-USA15)	✓ (+)	✓ (+)[12]			✓ (.)				✓ (–)	✓ (–)	✓ (–)	✓ (–)	
Sluik et al., 2016 (109)	Healthy (HDS-USA16) and unHealthy Diet Scores USA 2016 (uHDS-USA16)	✓ (+)	✓ (+)			✓ (+)[13]				✓ (–)	✓ (–)	✓ (–)	✓ (–)	
Arvidsson et al., 2017 (110)	Dutch Healthy Diet index (DHD-index)	✓ (+)	✓ (+)					✓ (+)					✓ (–)	

(*Continued*)

TABLE 2e (*Continued*)

Authors, publication year (Ref)	Indicator	Vegetables	Fruits	Cereals	Legumes	Dairy	Eggs	Fish	Meat	Snacks	FF	Sweets	SSBs	Coffee
Arvidsson et al., 2017 (110)	Healthy Dietary Adherence Score (HDAS)	✓ (+)	✓ (+)	✓ (+)[14]				✓ (+)						
Martins et al., 2019 (111)	Healthy (HDS-BRA) and unHealthy (uHDS-BRA) Diet Scores Brazil	✓ (+)	✓ (+)		✓ (+)					✓ (–)	✓ (–)	✓ (–)	✓ (–)	
Wadolowska et al., 2019 (112)	Oslo Health Study Dietary Index (OHS)	✓ (+)[10]	✓ (+)[10]										✓ (–)	
No. of studies using each component in this indicators subgroup		11	11	3	1	5	1	4	1	7	7	8	10	1

[1]Check symbol denotes that a component is included in the indicator. +, the component is scored positively or as improving the DQ; –, the component is scored negatively or as decreasing the DQ; dot, the component gets the higher score when it fits within a specific range or the score is unspecified. DQ, diet quality; FF, fast food; SSBs, sugar-sweetened beverages.
[2]Includes raw and cooked vegetables.
[3]Whole and white bread.
[4]Whole-fat and low-fat milk.
[5]Whole bread.
[6]Semi-skimmed milk, skimmed milk, cheese, and yogurt.
[7]Part of the meat component.
[8]Red meat and white meat.
[9]Part of the snack component.
[10]Fresh, canned, or juice.
[11]Includes carbonated drinks and energy drinks.
[12]Juice.
[13]Milk.
[14]Whole meal.

TABLE 2f Food group components included in the Feeding and Eating Indexes diet quality indicator[1]

Authors, publication year (Ref)	Indicator	Water	Vegetables	Fruits	Cereals	Legumes	Nuts	Fats	Dairy	Eggs	Fish	Meat	Snacks	Sweets	SSBs	Coffee/tea
Arimond and Ruel, 2002 (113)	Infant and Child Feeding Index (ICFI)		✓ (+)[2]	✓ (+)[2]	✓ (+)[3]	✓ (+)		✓ (.)	✓ (+)[4,5]	✓ (+)[5]	✓ (+)[5]	✓ (.)[5,6]				
Ruel and Menon, 2002 (114)	Child Feeding Index (CFI)				✓ (+)				✓ (+)[7]	✓ (+)[8]	✓ (+)[8]	✓ (.)				
Dewey et al., 2006 (115)	Food Group Indicator–8 (FGI-8)		✓ (+)[9]	✓ (+)[9]	✓ (+)[3]	✓ (+)[10]	✓ (+)[10]	✓ (.)	✓ (.)	✓ (+)	✓ (+)[5]	✓ (.)[5,6]			✓ (−)	
Food and Nutrition Technical Assistance Project, 2006 (116)	Food Group Indicator (FGI-7)		✓ (+)[9]	✓ (+)[9]	✓ (+)[3]	✓ (+)[10]	✓ (+)[10]		✓ (+)	✓ (+)[5]	✓ (+)[5]	✓ (.)[5,6]				
Bork et al., 2012 (117)	Infant and Child Feeding Index Senegal (ICFI-Sen)		✓ (+)[9]	✓ (+)[9]	✓ (+)[3]	✓ (+)[10]	✓ (+)[10]	✓ (.)	✓ (+)[7]	✓ (+)[5]	✓ (+)[5]	✓ (.)[5,6]				
Golley et al., 2012 (118)	Complementary Feeding Utility Index (CFUI)		✓ (+)	✓ (+)	✓ (+)				✓ (+)	✓ (+)[5]	✓ (+)[5]	✓ (.)[5]	✓ (−)	✓ (−)	✓ (−)	✓ (−)
Jones, 2015 (119)	Infant and Child Feeding Index modification (ICFIm)		✓ (+)[9]	✓ (+)[9]	✓ (+)[3]	✓ (+)[10]	✓ (+)[10]		✓ (+)	✓ (+)[5]	✓ (+)[5]	✓ (.)[5,6],				
Monterrosa et al., 2015 (120)	Infant and Child Feeding Index Mexico		✓ (+)	✓ (+)	✓ (+)[3]	✓ (+)[10]	✓ (+)[10]		✓ (.)[5]	✓ (+)	✓ (+)[5]	✓ (.)[5]				
Delshad et al., 2019 (121)	Diet Index for a Child's Eating (DICE)	✓ (+)	✓ (+)	✓ (+)	✓ (+)[11]	✓ (+)[10]	✓ (+)[10]		✓ (+)[10]	✓ (+)[10]	✓ (+)[10]	✓ (.)[10]	✓ (−)	✓ (−)	✓ (−)	✓ (−)
Ferreira et al., 2019 (122)	Child Feeding Index modification (CFIm)		✓ (+)	✓ (+)	✓ (+)[3]	✓ (+)				✓ (+)[10]	✓ (+)[10]	✓ (.)[10]				
No. of studies using this component in this indicators subgroup		1	9	9	10	8	6	3	9	10	10	10	2	2	3	2

[1]Check symbol denotes that a component is included in the indicator. +, the component is scored positively or as improving the DQ; –, the component is scored negatively or as decreasing the DQ; dot, the component gets the higher score when it fits within a specific range or the score is unspecified. DQ, diet quality; SSBs, sugar-sweetened beverages.
[2]Includes juices.
[3]Grains, roots, and tubers.
[4]Yogurt.
[5]Animal protein component.
[6]Meat and poultry.
[7]Milk.
[8]Foods in the same component; includes poultry.
[9]Vitamin A–rich food.
[10]In the same component.
[11]Whole-grain products as different component.

TABLE 2g Food group components included in the Diet Quality Scores diet quality indicator[1]

Authors, publication year (Ref)	Indicator	Water	Vegetables	Fruits	Cereals	Legumes	Fats	Dairy	Eggs	Fish	Meat	Snacks	FF	Sweets	SSBs
Crombie et al., 2009 (123)	Scottish Diet Quality Score (SDQS)		✓ (+)[2]	✓ (+)[2]	✓ (+)[3]			✓ (+)[4]		✓ (+)[5]	✓ (+)[5,6]	✓ (–)[7]		✓ (–)[7]	
Kohlboeck et al., 2012 (124)	German Optimized Mixed Diet Quality Score (GOMDQS)		✓ (+)	✓ (+)	✓ (+)[8]		✓ (.)	✓ (.)	✓ (.)	✓ (+)	✓ (.)[6]	✓ (–)		✓ (–)	✓ (–)
Perry et al., 2015 (125)	Diet Quality Score Ireland (DQS-IRL)	✓ (+)[9]	✓ (+)[10]	✓ (+)	✓ (+)			✓ (.)[11]	✓ (.)	✓ (+)	✓ (.)[12]	✓ (–)	✓ (–)	✓ (–)	✓ (–)[13]
Voortman et al., 2015 (126)	Diet Quality Score The Netherlands (DQS-NL)		✓ (+)	✓ (+)	✓ (+)[2,8]	✓ (+)[2]	✓ (.)	✓ (.)	✓ (.)[5]	✓ (+)	✓ (.)[5,14]	✓ (–)		✓ (–)	✓ (–)
Gasser et al., 2017 (127)	Dietary Quality Score Australia 2017 (DQS-AUS17)	✓ (+)	✓ (+)[10]	✓ (+)				✓ (.)[15]				✓ (–)[2]	✓ (–)[2]	✓ (–)	✓ (–)
No. of studies using this component in this indicators subgroup		2	5	5	4	1	2	5	3	4	4	5	2	5	4

[1]Check symbol denotes that a component is included in the indicator. +, the component is scored positively or as improving the DQ; –, the component is scored negatively or as decreasing the DQ; dot, the component gets the higher score when it fits within a specific range or the score is unspecified. DQ, diet quality; FF, fast food; SSBs, sugar-sweetened beverages.
[2]In the same component.
[3]Includes breakfast cereal and potatoes.
[4]All milk was included irrespective of fat content or type.
[5]In the meat component.
[6]Includes meat and poultry, processed and nonprocessed.
[7]In the same component as snacks.
[8]Bread and cereals in one component; potatoes, pasta, and rice in another component.
[9]Includes juice.
[10]Cooked and raw vegetables.
[11]Different components for full-cream milk, skimmed milk, cheese and yogurt, and low-fat cheese and yogurt.
[12]Meat and poultry in one component; meat pie sausage in another component.
[13]Includes diet soft drinks.
[14]Includes meat substitutes.
[15]Full-cream milk and products, skimmed milk and products, and soya drink and products.

TABLE 2h Food group components included in the Nutritional Adequacy and Micronutrients Indexes diet quality indicator[1]

Authors, publication year (Ref)	Indicator	Vegetables	Fruits	Cereals	50% whole grains	Legumes	50% legumes, micronutrient dense	Dairy	Fats	Fried foods	Variety	Fermented foods/salads	Sugar	Tea/coffee with meals
Chiplonkar and Tupe, 2010 (130)	Adolescent Micronutrient Quality Index (AMQI)	✓ (+)[2]	✓ (+)	✓ (+)	✓ (+)	✓ (+)	✓ (+)[3]	✓ (+)	✓ (.)	✓ (−)	✓ (+)[4]	✓ (+)	✓ (.)	✓ (−)

[1] Check symbol denotes that a component is included in the indicator. +, the component is scored positively or as improving the DQ; −, the component is scored negatively or as decreasing the DQ; dot, the component gets the higher score when it fits within a specific range or the score is unspecified. DQ, diet quality.
[2] Green leafy, roots and tubers, and other vegetables.
[3] Micronutrient-dense legumes (e.g., chick peas, moth beans, or lentils).
[4] Food variety based on all subgroups and weekly variety in vegetables and fruits.

nutrient components were selected by their health-related outcomes. In order of frequency of appearance, the nutrient components found were calcium, iron, fiber, vitamin C, vitamin A, protein, thiamin, folate, zinc, and niacin. Moreover, the most frequently identified nutrients that required moderation to prevent chronic diseases were sodium, total fat, saturated fat, sugar, cholesterol, and *trans* fats. Fat-related components warrant special note because they are the most frequently negatively scored.

One issue to be noted is that when DQIns use food components, the majority of food groups or items included are those to be scored as positive (e.g., fruits, vegetables); on the contrary, when DQIns considered nutrients as components, the majority listed are those to be scored as negative.

Finally, Supplemental Table 5 shows lifestyle-related factor components. These were less frequently used in comparison with the other types of components (food groups and nutrients).

Scoring methods applied to the DQIns

Supplemental Table 6 shows the essential methodological issues identified in each indicator. Scoring methods for each component regarding the type of cutoff values, the interpretation of the overall score, and other relevant methodological considerations (e.g., description of the dietary assessment instrument used to evaluate the indicator) are described in-depth.

Cutoff values

The cutoff values were classified as predefined (fixed criteria) or population-dependent (by distribution) (169). The cutoff values were established beforehand according to fixed amounts of dietary intake described by several criteria. For food groups and foods, these cutoff points are defined by servings per day (or week) or grams (or milliliters) per day (or week), by the percentage of the frequency of consumption, or by the score according to adherence to dietary guidelines. For nutrients, the percentage of the energy intake per day or the nutritional recommendations—milligrams (nutrient) per day or nutrient density (per 1000 kcal)—were used. Some DQIns considered cutoff values fixed through a variety of components per day or the number of different food items eaten during the registration period.

The population-dependent cutoff values vary based on the distribution of the dietary intake in the studied population, using quantiles. The cutoff points most frequently applied in this approach were medians (or sex- and age-specific medians), tertiles, quartiles, quintiles, or deciles. Other indicator components were calculated as algorithms based on multiple criteria or as the individual harmonic mean of the individual intake.

Dietary assessment methods

The dietary assessment instrument most frequently used was the 24h-DR, followed by the FFQ, the diet record, the weight record, and nutritional surveys. The 24h-DR was used in more than half of the articles reviewed and assessed a single day or multiple days. The FFQ considered different periods

TABLE 2i Food group components included in the Dietary Guidelines Indexes diet quality indicator[1]

Authors, publication year (Ref)	Indicator	Fruits	Vegetables	Cereals	Whole-grain cereals	Meat, alterna-tives	Dairy	Fish	Reduced-fat dairy	Beverages	Extra foods	Healthy fats	Legumes	Eggs	Dietary variety	SFI	Oil	Dessert	Snacks
Golley et al., 2011 (133)	Dietary Guideline Index for Children and Adolescents (DGI-CA)	✓ (.)[2]	✓ (.)[3]	✓ (.)[4]	✓ (.)[4]	✓ (.)[5]	✓ (.)	✓ (.)[5]	✓ (.)	✓ (.)	✓ (.)[6]	✓ (.)[7]	✓ (.)[3]		✓ (.)[8]				
Lioret et al., 2014 (134)	Dietary Guideline Index (DGI)	✓ (+)	✓ (+)[3]	✓ (+)[4]	✓ (+)[4]	✓ (+)[5]	✓ (+)[9]		✓ (+)[9]	✓ (+)[9]	✓ (–)[10]					✓ (+)[11]			
Mohseni-Takalloo et al., 2016 (135)	Dietary Guidelines for Americans Adherence Index (DGAI)	✓ (+)	✓ (+)	✓ (+)	✓ (+)	✓ (–)[12]	✓ (–)[13]						✓ (–)[12]				✓ (-)		
Rohde et al., 2017 (136)	Diet Quality Index based on the Danish national guidelines (DQI-Danish national guidelines)	✓ (+)[14]	✓ (+)[14]	✓ (+)[15]				✓ (+)											
Er et al., 2018 (137)	Children's Food Trust guidelines (CFT guidelines) and NAP SACC UK Nutrition Best Practice Standards score	✓ (+)[14]	✓ (+)[14]	✓ (+)[16]		✓ (+)[17]		✓ (+)[17]		✓ (-)[18]			✓ (+)[17]	✓ (+)[17]				✓ (–)[19]	✓ (–)[20]
No. of studies using this component in this indicators subgroup		5	5	5	3	4	3	3	2	3	2	1	3	1	1	1	1	1	1

[1]Check symbol denotes that a component is included in the indicator. +, the component is scored positively or as improving the DQ; –, the component is scored negatively or as decreasing the DQ; dot, the component gets the higher score when it fits within a specific range or the score is unspecified. DQ, diet quality; SFI, saturated fat intake.
[2]Maximum 125 mL 100% fruit juice.
[3]Including nonfried potatoes and legumes.
[4]Eat plenty of cereals (including breads, rice, pasta, and noodles), preferably whole grain.
[5]Meat alternatives (excluding processed meats).
[6]Choose foods low in salt; consume only moderate amounts of foods containing sugar; moderate total fat.
[7]Healthy fats, oils, nuts, and seeds: kilojoules from healthy fats as a proportion of total fats and oils.
[8]Sum of food types within core food groups over 2 d (0.5 minimum serving).
[9]Preference for low-fat dairy products.
[10]Potatoes cooked in fat, crisps, confectioneries, cakes, and sweet biscuits, savory pastries, fast foods, pizzas, meat products, flavored milks, soft drinks, and fruit juices.
[11]Saturated fat intake: trimming of fat from meat.
[12]Includes in the same component meats and legumes.
[13]Milk.
[14]Fruit and vegetables in the same component.
[15]Potatoes, rice, or pasta (whole-grain bread not included).
[16]Starchy foods (bread, crackers, pizza, rice, pasta, high-fiber cereals, and other cereals; exclude, croissant, cakes, chips, and sugar-coated cereal).
[17]Meat, fish, eggs, beans, and other nondairy sources of protein.
[18]Drinking chocolate, fizzy drink, squash, fruit drink diet, and low-calorie drink.
[19]Yogurt or fromage frais, fruit salad (tinned or fresh), mousse, milk puddings (e.g., rice pudding), ice cream, frozen dessert, cream, custard, cakes, buns, sponge pudding, sweet pies, tarts, and crumbles.
[20]High-sugar or high-fat snacks (crisps, savory snacks, cereal bars, biscuits, cakes, ice cream, frozen dessert, cream, custard mousse, puddings, buns, sponge pudding, sweets, toffees, mints, and chocolate bars).

TABLE 2j Food group components included in the Other Healthy Diet Indexes diet quality indicator[1]

Authors, publication, year (Ref)	Indicator	Water	Vegetables	Fruits	Cereals	Legumes	Nuts	Fats	Dairy	Eggs	Fish	Meat	Snacks	FF	Sweets	SSBs	Miscellaneous
Kleiser et al., 2009 (138)	Healthy Nutrition Score (HuSKY)	✓ (+)[2]	✓ (+)	✓ (+)	✓ (+)[3,4]			✓ (.)[5]	✓ (.)	✓ (+)	✓ (+)	✓ (+)[6]	✓ (–)[7]	✓ (–)[7]	✓ (–)[7]	✓ (–)[2]	
Lazarou et al., 2009 (139)	Foods E-KINDEX score (E-KINDEX)		✓ (+)	✓ (+)[8]	✓ (+)[9]	✓ (+)			✓ (.)			✓ (.)[10]	✓ (-)[7]		✓ (-)[7]	✓ (-)	
Bisi Molina et al., 2010 (140)	School Child Diet Index (ALES)		✓ (+)	✓ (+)[8]		✓ (+)		✓ (–)[11]	✓ (+)[12]		✓ (+)		✓ (–)	✓ (–)	✓ (–)	✓ (–)	
Marshall et al., 2012 (141)	Australian Child and Adolescent Recommended Food Score (ACARFS)	✓ (+)	✓ (+)	✓ (+)[13]	✓ (+)[14]	✓ (+)[15]	✓ (+)[15]		✓ (.)[16]	✓ (+)[17]	✓ (+)[17]	✓ (+)[17]					✓ (.)
Spence et al., 2013 (142)	Obesity Protective Dietary Index (OPDI)		✓ (+)[4]	✓ (+)									✓ (–)[7]	✓ (–)[7]	✓ (–)[7]	✓ (–)[7]	
Durksen et al., 2015 (143)	Unhealthy Eating Index Canada (UEI-Ca15)		✓ (+)	✓ (+)	✓ (+)				✓ (+)				✓ (–)[7]	✓ (–)[7]	✓ (–)[7]	✓ (–)[7]	
Haapala et al., 2015 (144)	Baltic Sea Diet Score (BSDS)		✓ (+)[7]	✓ (+)[7]	✓ (+)[3]	✓ (+)[7]					✓ (+)	✓ (–)[17]					
Hardiansyah et al, 2015 (145)	Balanced Diet Index (BDI)		✓ (+)	✓ (+)		✓ (+)[15]			✓ (+)	✓ (+)[7]	✓ (+)[7]	✓ (+)[7]					
Cheng et al., 2016 (146)	Chinese Children Dietary Index (CCDI)	✓ (+)	✓ (+)	✓ (+)	✓ (.)	✓ (+)			✓ (.)	✓ (.)	✓ (+)	✓ (.)				✓ (–)	
Winpenny et al., 2018 (148)	Dietary Approaches to Stop Hypertension index (DASH index)		✓ (+)	✓ (+)	✓ (.)[3]	✓ (+)[15]	✓ (+)[15]	✓ (–)	✓ (.)[16]	✓ (.)[7]	✓ (.)[7]	✓ (.)[7]			✓ (–)		
Kunto and Bras, 2019 (149)	Berry Index (BI)		✓ (+)	✓ (+)					✓ (.)	✓ (.)	✓ (.)	✓ (.)					
Liu et al., 2020 (150)	American Heart Association Score (AHAS)		✓ (+)	✓ (+)	✓ (+)[18]	✓ (+)[15]	✓ (+)[15]				✓ (+)	✓ (–)[19]				✓ (–)	
No. of studies using this component in this indicators subgroup		3	12	12	8	8	3	3	9	6	9	9	5	5	6	7	1

[1] Check symbol denotes that a component is included in the indicator. +, the component is scored positively or as improving the DQ; –, the component is scored negatively or as decreasing the DQ; dot, the component gets the higher score when it fits within a specific range or the score is unspecified. DQ, diet quality; FF, fast food; SSBs, sugar-sweetened beverages.
[2] Beverages components.
[3] Whole grains as single component.
[4] Includes potatoes.
[5] Butter and margarine.
[6] Meat, poultry, and sausage.
[7] In the same component.
[8] Includes juices.
[9] Bread as single component.
[10] Salted and smoked meat as single component.
[11] Mayonnaise.
[12] Milk.
[13] Includes fresh, canned, and dried fruit.
[14] Includes whole grain.
[15] Plant proteins.
[16] Includes whole-fat and skim milk and soy drinks.
[17] Includes sausage.
[18] Only tubers.
[19] Processed meat.

TABLE 3a Nutrient components included in the Healthy Eating Indexes diet quality indicator[1]

Authors, publication year (Ref)	Indicator	Macronutrients						Mineral
		Sugar	Alcohol	Total fat	Saturated fat	Cholesterol	*Trans* fat	Sodium
Kennedy et al., 1995 (30)	Healthy Eating Index (HEI)			✓	✓	✓		✓
Pinheiro and Atalah, 2005 (33)	Healthy Eating Index Chile (HEI-CHL)	✓		✓	✓	✓		✓
Glanville and McIntyre, 2006 (34)	Healthy Eating Index Canada 2006 (HEI-C06)	✓		✓	✓			✓
Guenther et al., 2008 (35)	Healthy Eating Index 2005 (HEI-2005)	✓	✓		✓			✓
Garriguet, 2009 (36)	Healthy Eating Index Canada modification (HEI-C-mod)	✓		✓	✓			✓
De Andrade et al., 2010 (37)	Healthy Eating Index Brazil (HEI-BRA14)			✓		✓		✓
Woodruff et al., 2010 (38)	Healthy Eating Index Canada (HEIC-2009)			✓	✓	✓		
Rydén and Hagfors, 2011 (39)	Healthy Eating Index 2005 (HEI-2005)	✓	✓	✓	✓			✓
González Rosendo et al., 2012 (40)	Healthy Eating Index Mexico (HEI-MEX)	✓		✓	✓	✓		✓
He et al., 2012 (41)	Healthy Eating Index 2005 Canadian modification (HEIC-2005)	✓			✓			✓
Guenther et al., 2013 (42)	Healthy Eating Index 2010 (HEI-2010)	✓			✓			✓
Kyttälä et al., 2014 (44)	Finnish Children Healthy Eating Index (FCHEI)	✓						
Rauber et al., 2014 (45)	Healthy Eating Index Brazil (HEI-BRA14)			✓	✓	✓		✓
Dahm et al., 2016 (47)	High School Alternative Healthy Eating Index (HS-AHEI)						✓	✓
Tugault-Lafleur et al., 2017 (48)	School Healthy Eating Index (School-HEI)	✓			✓			✓
Yuan et al., 2017 (49)	Healthy Eating Index China (HEI-CHN)	✓	✓					✓
Conceição et al., 2018 (50)	Healthy Eating Index Brazil Infants (HEI-BRA-I)			✓	✓	✓		✓
Nshimyumukiz et al., 2018 (52)	Healthy Eating Index Canada (HEI-C-2010)		✓		✓			✓
Reedy et al., 2018 (53)	Healthy Eating Index 2015 (HEI-2015)	✓			✓			✓
Brownlee et al., 2019 (54)	Healthy Eating Index Singapur (HEI-SGP)	✓		✓	✓			✓
No. of studies using this component in this indicators subgroup		13	4	11	16	7	1	18

[1]Check symbol denotes that a component is included in the indicator.

TABLE 3b Nutrient components included in the Diet Quality Indexes diet quality indicator[1]

		Macronutrients										Vitamins					Minerals		
Authors, publication year (Ref)	**Indicator**	**Pro**	**Fiber**	**Sugar**	**TF**	**UF**	**SF**	**Cholesterol**	**Fatty acid ratio**	**Empty calories**	**Macro-nutrient ratio**	**C**	**E**	**A**	**B_1**	**Folate**	**Calcium**	**Iron**	**Sodium**
Alexy et al., 2003 (75)	Diet Quality Index Germany (DQI-DEU)		✓		✓		✓	✓				✓	✓	✓	✓	✓	✓	✓	
Kranz et al., 2004 (76)	Diet Quality Index for Children (C-DQI)			✓	✓		✓											✓	
Mariscal-Arcas et al., 2007 (77)	Diet Quality Index International adaptation (DQI-Ia)	✓	✓		✓	✓[2]		✓	✓	✓	✓	✓					✓	✓	✓
Li et al., 2012 (82)	Diet Quality Index Australian Children and Adolescents (DQI-AUS-CA)	✓	✓		✓		✓		✓[3]			✓		✓			✓	✓	
Röytiö et al., 2015 (86)	Diet Quality Index for Finland Children (FINDQI-C)			✓		✓[4]	✓										✓		
Collins et al., 2016 (87)	Revised Children's Diet Quality Index Australia (RC-DQI-AUS)				✓	✓[2]													
No. of studies using this component in this indicators subgroup		2	3	2	5	3	4	2	2	1	1	3	1	2	1	1	4	4	1

Pro, protein; TF, Total Fat, UF, Unsaturated Fat; SF, Saturated Fat.
[1]Check symbol denotes that a component is included in the indicator.
[2]Linoleic acid, linolenic acid, DHA + EPA.
[3]Omega-6: omega-3.
[4]MUFAs and PUFAs.

TABLE 3c Nutrient components included in the Healthy and Unhealthy Scores diet quality indicator[1]

Authors, publication year (Ref)	Indicator	Macronutrients						Minerals
		Fiber	Sugar	Alcohol	Total fat	Saturated fat	*Trans* fat	Sodium
Sluik et al., 2016 (109)	Dutch Healthy Diet index (DHD-index)	✓	✓	✓		✓	✓	✓
Arvidsson et al., 2017 (110)	Healthy Dietary Adherence Score (HDAS)		✓		✓			
No. of studies using this component in this indicators subgroup		1	2	1	1	1	1	1

[1]Check symbol denotes that a component is included in the indicator.

(more frequently past month or year), the more frequent are those of a qualitative or semiquantitative approach with between 120 and 170 items. The diet records evaluated at least 3–4 d of dietary intake. Moreover, only 2 articles used a nutritional survey, and 1 article used a weighed dietary record. In addition, in some studies, researchers used 2 dietary assessment methods, usually the 24h-DR and the FFQ.

Other relevant considerations found in the methodology were as follows: the energy adjustment, a trained interviewer or the dietitian's participation in the face-to-face interview or by phone, if the dietary assessment was self-administered, the use of paper or electronic-based tools (computer or smartphone), and the possibility of asking and resolving questions during the evaluation.

A synthesis of the main issues analyzed in this mapping review in terms of components, scoring and statistical methods, and other relevant considerations is shown in **Figure 3**.

Main features of the subgroups of the DQIns

Overall DQIns.

Indicator subgroup: Healthy Eating Indexes. A total of 25 DQIns based on the concept of Healthy Eating Indexes were classified in this subgroup with different modifications (30–54). For this subgroup, 6 population-based studies were found. In general, this group of DQIns was developed based on the most important recommendations of the DGAs (170). These guidelines and the indexes account for the population older >2 y and have been updated every 5 y. Originally, the components included were food groups, nutrients, and variety (30). The score was based on adequacy, moderation, and frequency of consumption. For the food group, higher scores represented higher adequacy. The score for the moderation component is reversed: lower consumption accounted for a higher score. Since 2005, the adequacy and moderation components have been expressed based on energy density, allowing the evaluation of mixed dishes (35). Modifications and updates in the food components have been made from the original Healthy Eating Index to evaluate food and dietary intakes of children and adolescents. This process included evaluating whole cereals, snack foods, sugar-sweetened drinks (31, 43), and fish (47). Moreover, adjustments in food components to assess diet in different settings were found. For instance, in Brazil, the researchers included the beans food group component (45).

Indicator subgroup: Dietary Diversity Scores. Twenty-one indicators were collected to assess DQ from a dietary diversity approach (55–74). Diversity is one of the dimensions of DQ and is the desirable consumption of foods or food groups; these indicators are usually used in low-income countries (13). The components of these indicators were the food groups. The scoring system is dichotomous, and it accounted for each item consumed with or without the number of servings or cutoff limits during a given time (171). The food groups selected in each index considered the nutritional aspects and the local food culture (60). For instance, the group of fruits and vegetables were classified as sources of vitamin A, or the meat group included other food sources of protein such as fish or eggs. The primary reference for Dietary Diversity Scores is that proposed by WHO, the minimum dietary diversity with 7 food groups: *1*) grains, roots, and tubers; *2*) legumes and nuts; *3*) dairy (milk, yogurt, and cheese); *4*) flesh foods (meat, fish, poultry, and liver/organ meats); *5*) eggs; *6*) vitamin A–rich fruits and vegetables; and *7*) other fruits and vegetables (172).

Indicator subgroup: Diet Quality Indexes. The Diet Quality Indexes subgroup had the third most prevalent indicators found in this mapping review. We found 16 indexes (75–90). All evaluated food group components, excluding 1 publication that evaluated only the nutrient components (75).

TABLE 3d Nutrient components included in the Feeding and Eating Indexes diet quality indicator[1]

Authors, publication year (Ref)	Indicator	Protein
Golley et al., 2012 (118)	Complementary Feeding Utility Index (CFUI)	✓

[1]Check symbol denotes that a component is included in the indicator.

TABLE 3e Nutrient components included in the Nutritional Adequacy and Micronutrients Indexes diet quality indicator[1]

Authors, publication year (Ref)	Indicator	Macronutrients					Vitamins											Minerals						
		Protein	Fiber	Added sugar	MUFA	SFA	C	D	E	K	B_1	B_2	B_3	B_5	B_6	B_9	B_{12}	Calcium	Iron	Zinc	Potassium	Magnesium	Phosphorus	Sodium
Fulgoni et al., 2009 (128)	Nutrient-Rich Foods Index	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓				✓	✓	✓	✓	✓	✓			✓
Libuda et al., 2009 (129)	Nutrient-based Nutritional Quality Score (NQI)						✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Alexy et al., 2011 (131)	Nutrient Quality Index (NQI)						✓		✓		✓					✓		✓	✓	✓	✓	✓		
Lee and Park, 2015 (132)	Index of Nutritional Quality (INQ)	✓					✓				✓	✓	✓					✓	✓				✓	
No. of studies using this component in this indicators subgroup		2	1	1	1	1	1	1	3	1	4	3	2	1	1	3	2	4	4	3	3	2	2	1

MUFA, Monounsaturated Fatty Acids; SFA, Saturated Fatty Acids.
[1]Check symbol denotes that a component is included in the indicator.

Different from previous subgroups, Diet Quality Indexes included the assessment of water, fruit juices, and alcohol. Five publications also considered the nutrient components in addition to food (77, 82, 86, 87, 173), and only 3 evaluated the lifestyles component (77, 87, 173). The scoring method varied per component, and each component was weighted. In 4 publications, the score per component considered diversity, quality, equilibrium, and adequacy for each food group (79, 80, 83, 84).

Indicator subgroup: Food Variety Scores. In this mapping review, 11 studies were found in which different indicators were developed or updated to assess DQ by Food Variety Scores (91–101). Dietary variety has been considered a desirable feature of most dietary patterns because a greater variety of foods means a greater likelihood of meeting nutritional requirements (1). For this reason, the development of indicators from the perspective of variety is a fundamental issue for children and adolescents. Variety can be defined from several approaches; one of the most frequent is the number of different food items eaten during the registration period, most often between 60 and 75 items (92, 95, 99). The main foods to assess the DQ according to variety belong to cereals, vegetables, fruits, milk and dairy products, meat, and fish.

Indicator subgroup: Healthy and Unhealthy Scores. A total of 11 indicators were classified in this group, assessing different aspects considered healthy or unhealthy (102–112). The Healthy and Unhealthy Scores are presented independently of each other or in combination. Independent scores are compared to each other by showing their percentage of consumption. In combination, higher scores can indicate better DQ or adherence to dietary guidelines. The components were food groups. The healthy index included food groups such as fruits and vegetables that are considered beneficial for health. The Unhealthy Scores included food groups such as sugar-sweetened drinks that are considered risky for human health. The scores were based on the frequency of consumption of the food groups. DQIns were used to evaluate health-related outcomes such as blood pressure (104), mineral density (105), and mental health (103), or they were used to compare food intake patterns in populations (111).

Indicator subgroup: Feeding and Eating Indexes. In this indicator subgroup, 10 tools were classified that assessed different aspects related to feeding and eating practices (113–122). The Feeding and Eating Indexes assess the DQ through a combination of indicators composed by independent elements. These combinations included food groups that assess diet diversity; diet variety; frequency of consumption; and lifestyle feeding practices such as breastfeeding, baby-bottle use, and food consistency (solid food). Therefore, the scoring system was more complicated. First, each component was scored separately according to its criteria and cutoff points. Then, the score was added together or transformed into a

TABLE 3f Nutrient components included in the Dietary Guidelines Indexes diet quality indicator[1]

Authors, publication year (Ref)	Indicator	Macronutrients							Mineral
		Fiber	Added sugar	Fat	Low-fat choices	SFA	*Trans* fatty acids	Cholesterol	Sodium
Mohseni-Takalloo et al., 2016 (135)	Dietary Guidelines for Americans Adherence Index (DGAI)	✓		✓	✓		✓	✓	✓
Rohde et al., 2017 (136)	Diet Quality Index based on the Danish national guidelines (DQI-Danish national guidelines)		✓	✓		✓			
No. of studies using this component in this indicators subgroup		1	1	1	1	1	1	1	1

SFA, Saturated Fatty Acids.
[1]Check symbol denotes that a component is included in the indicator.

probability function to derive a unit-free component (118). Moreover, the score for each component was dependent on the infants' age. For instance, breastfeeding had a higher score at 6–12 mo, and food frequency of consumption evaluated the consumption of fruits and vegetables separately after 12 mo (122).

Indicator subgroup: Diet Quality Scores. In this mapping review, 5 DQIns were recovered and classified in this subgroup (123–127). The main components of the Diet Quality Scores were the food groups, which were assessed by an FFQ. All the Diet Quality Scores represented different national nutritional guidelines; consequently, the scores had cutoff points dependent on each population under study. The scores account for a positive total. Three indicators had a dichotomous score (123, 124, 126). One indicator scored according to the consumption level of food groups, and if the food group required moderation, a higher score was given with less consumption (127). In the last indicator, the food groups were added or subtracted from the score if they were considered healthy or unhealthy, respectively (125).

Indicator subgroup: Nutritional Adequacy and Micronutrients Indexes. To evaluate DQ from the perspective of nutritional adequacy, 5 indicators were found (128–132). Intake of certain nutrients, especially some micronutrients, is critical in some periods of childhood and adolescence for adequate growth and development. Therefore, one way of assessing the quality of the diet is to consider dietary components in the form of nutrients rather than foods, as it is more common in most indicator subgroups. The indicators that assess nutritional adequacy are characterized by micronutrient components, with the most common being vitamins A, C, E, thiamine, and riboflavin, and the most common minerals being calcium, iron, zinc, and potassium. The least frequent vitamins were vitamins D, K, pantothenic acid, and B_6. Among the minerals, sodium and phosphorus were the least frequent.

Indicator subgroup: Dietary Guidelines Indexes. In this subgroup, 5 publications were collected (133–137). These indicators are based on dietary guidelines from different countries. For instance, the Australian guidelines and the DGA Adherence Index (174) are remarkable references for many countries and institutions globally. Regarding the food or nutrient components, those related to the lipid profile are highlighted. This subgroup excludes indicators based on the recommendations of DGA within the concept of Healthy Eating Indexes, which, in this mapping review, constitute an independent subgroup.

Indicator subgroup: Other Healthy Diet Indexes. In this subgroup, indicators that evaluate certain aspects of healthy patterns or characteristics of the diet and that have not been studied much in the scientific literature in this population group have been compiled, obtaining 13 tools (138–150). In this classification, the indexes were developed or modified

TABLE 3g Nutrient components included in the Other Healthy Diet Indexes diet quality indicator[1]

Authors, publication year (Ref)	Indicator	Macronutrients								Vitamins					Minerals								
		Protein	Carbohydrates	Fiber	Sugar	Total fat	Unsaturated fat	SFA	PUFA:SFA	A	C	B[2]	D	Folate	Calcium	Zinc	Sodium	Potassium	Iron	Selenium	Phosphorus	Copper	Iodine
Haapala et al., 2015 (144)	Baltic Sea Diet Score (BSDS)			✓		✓			✓														
Hardiansyah et al., 2015 (145)	Balanced Diet Index (BDI)				✓	✓		✓									✓						
Cheng et al., 2016 (146)	Chinese Children Dietary Index (CCDI)			✓			✓		✓	✓													
Verger et al., 2016 (147)	Diet Quality Index Based on the Probability of Adequate Nutrient Intake (PANDiet)	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Liu et al., 2020 (150)	American Heart Association Score (AHAS)							✓									✓						
No. of studies using this component in this indicators subgroup		1	1	2	2	3	2	3	2	2	1	1	1	1	1	1	3	1	1	1	1	1	1

SFA, Saturated Fatty Acids; PUFA, Polyunsaturated Fatty Acids.
[1]Check symbol denotes that a component is included in the indicator.
[2]Vitamin B: thiamin, riboflavin, niacin, B_6, and B_{12}.

according to the studies' needs by adapting characteristics of the previous described indexes. The components were food groups, nutrients, or lifestyles. The Baltic Sea Diet Score (175), American Heart Association Score (176), the PAN diet (177), and the Dietary Approaches to Stop Hypertension-DASH score (178) were developed initially for adults with the purpose of measuring the adherence to dietary guidelines or the associations with health conditions.

Other dietary and lifestyle indicators.

A detailed description of the types of components of other dietary and lifestyle indicators (Mediterranean Diet Indexes, Diet–Lifestyle Indexes, and Breakfast Quality Indexes) is shown in Supplemental Tables 3–5.

Indicator subgroup: Mediterranean Diet Indexes. In this mapping review, 11 studies were retrieved in which Mediterranean Diet Indexes were developed or applied in children (151–160). The indexes based on the adherence to the Mediterranean diet pattern have been developed with the concept of assessing adherence to an established healthy dietary pattern and with scientific evidence of its association with the prevention of chronic diseases, especially in the adult population (169). Numerous indexes of this subgroup have been developed, presenting concepts such as those applied to the adult population. However, it is necessary to highlight the main controversies and differences in these indexes when applied to children and adolescents. Many authors have eliminated the alcohol component or have included it as negative because its consumption is not recommended in children and adolescents. Regarding dairy products, although many authors do not consider it a traditional characteristic component of the Mediterranean diet pattern, and therefore it is usually included as a negative component in the indexes, other authors have modified their assessment, considering it a positive component because of its richness in nutrients, especially in critical nutrients in the pediatric population (179).

Indicator subgroup: Diet–Lifestyle Indexes. Five studies assessing DQ in conjunction with lifestyle characteristics have been included in the current mapping review (161–165). Lifestyle characteristics have been included less as components in the DQIns. This subgroup is characterized by the inclusion of components related to lifestyles in conjunction with dietary components. The beneficial one is the practice of moderate to vigorous physical activity, and the harmful one is watching television. Most of these indicators were characterized by the inclusion of food and food groups (vegetables, fruits, and cereals most frequently) and the importance of valuing sweets, added sugars, and soft drinks.

Discussion

The current mapping review provides a practical compilation of 139 overall DQIns developed through a priori methodology in the pediatric population and classified into 13

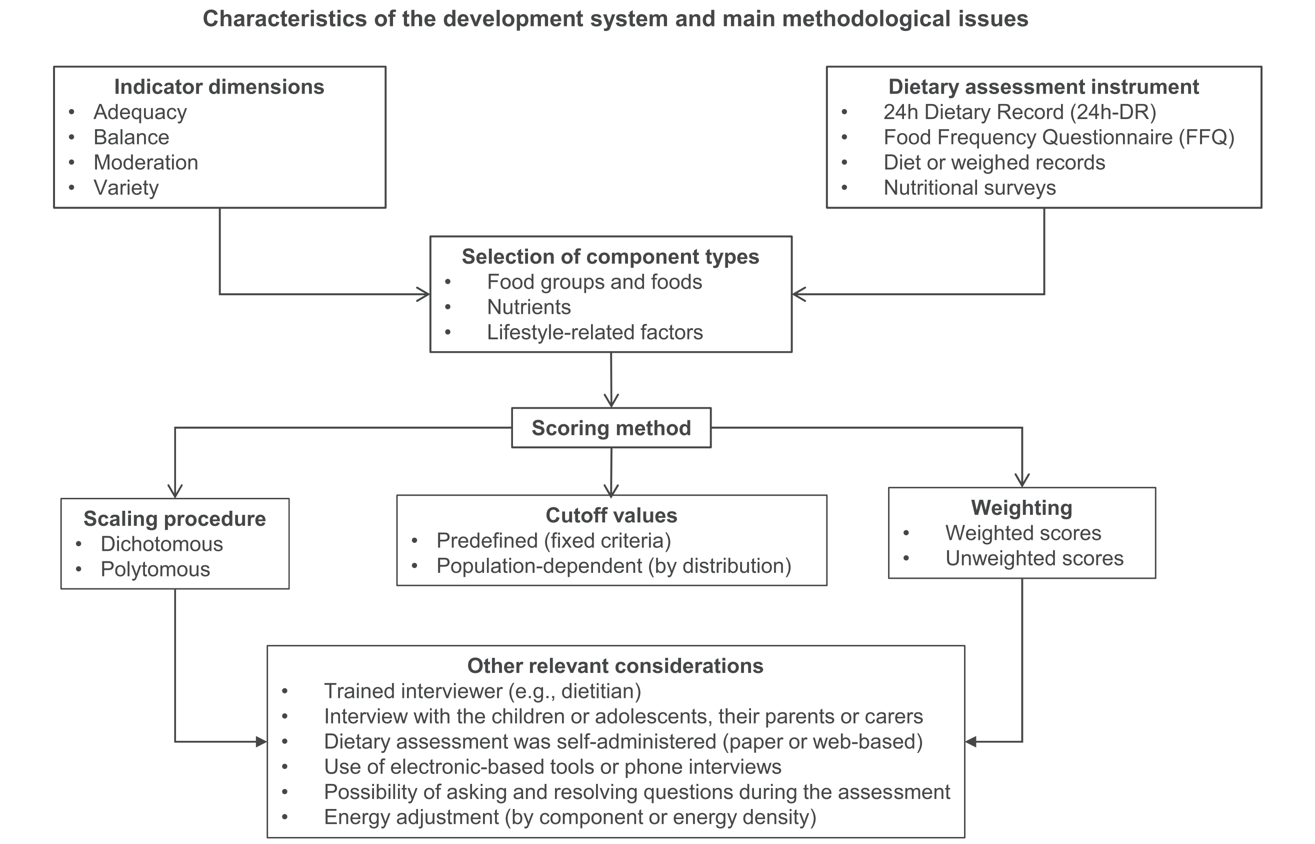

FIGURE 3 Synthesis of the main issues analyzed in terms of components and scoring methods.

subgroups: Healthy Eating Indexes, Dietary Diversity Scores, Diet Quality Indexes, Food Variety Scores, Healthy and Unhealthy Scores, Mediterranean Diet Indexes, Feeding and Eating Indexes, Diet Quality Scores, Nutritional Adequacy and Micronutrients Indexes, Dietary Guideline Indexes, Diet–Lifestyle Indexes, Breakfast Quality Indexes, and Other Healthy Diet Indexes. We have also included a description of the DQIns according to the components information, scoring method, and key methodological issues. This compilation of DQIns will facilitate the researcher in selecting the most appropriate tool for future epidemiological studies, considering, in a special way, the main methodological aspects collected in this mapping review.

The DQIns in the current mapping review represent a great variety of tools, including those that measure adherence to dietary consumption patterns (13, 23, 180, 181). Several DQIns only contain minor adjustments of the original ones; this is especially the case for the indicator subgroups belonging to Healthy Eating Indexes (50), Dietary Diversity Scores (72), Diet Quality Indexes (77), Food Variety Scores (101), and Healthy and Unhealthy Scores (104). The modifications from the DQIns' original versions included new food components such as fruit juices or lifestyle factor components related to pediatric age; exclusion of specific food components (i.e., alcohol); cutoff values according to the pediatric age recommendations; and other alternatives concerning the scoring method, such as giving more weight to specific components according to the study age (i.e., breastfeeding). These issues hinder comparisons across DQIns regarding their impact on the primary endpoints of interest in child and adolescent growth and development. These tools for assessing eating habits and lifestyles take a holistic perspective, considering both positive and negative interactions (synergism and antagonism) of foods, food groups, nutrients, and lifestyle-related factors (12).

In the current research, the most practical use of DQIns is to associate the DQ with health-related outcomes (chronic diseases or specific-cause mortality). The main objective in these DQIns was to assess the diet globally by categorizing individuals in a population according to their adherence to the pre-established recommendations or dietary patterns. These DQIns measure and quantify the intake of foods, food groups, nutrients, and lifestyle-related factors concerning specific diet recommendations or characteristics considered beneficial or detrimental to health (182). All DQIns included components that expressed a dimension within the indicator and had a specific weight within the overall score. However, the development of a weighting system dependent on the association of each of the components with selected aspects of the diet or with diseases is currently one of the most controversial issues. The global computation of all the components allowed for assessing dietary habits and other

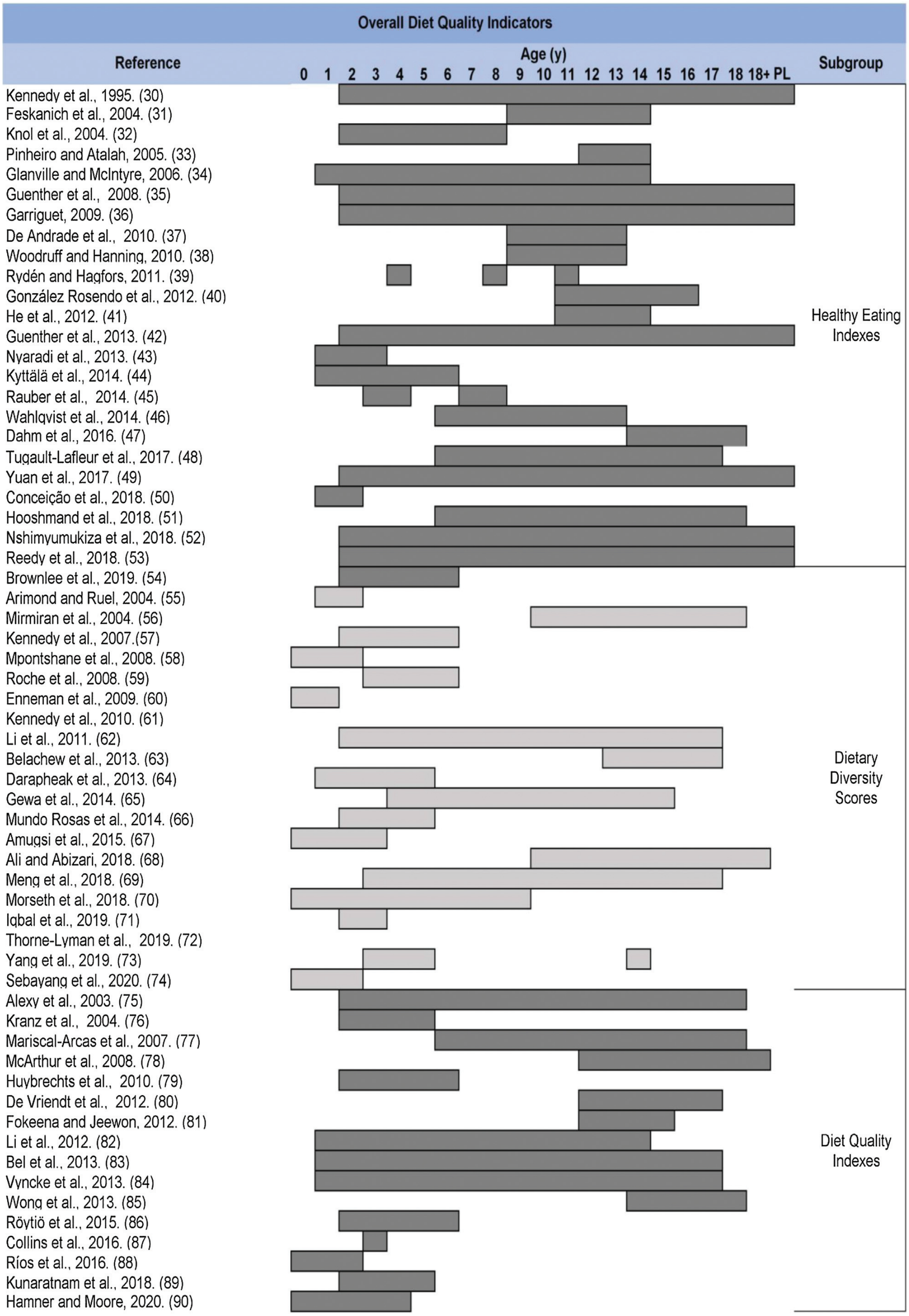

FIGURE 4 Overall distribution of diet quality indicators and other dietary and lifestyle indicators according to covered ages. Dark and light gray bars show the ages covered in each publication. PL, population level.

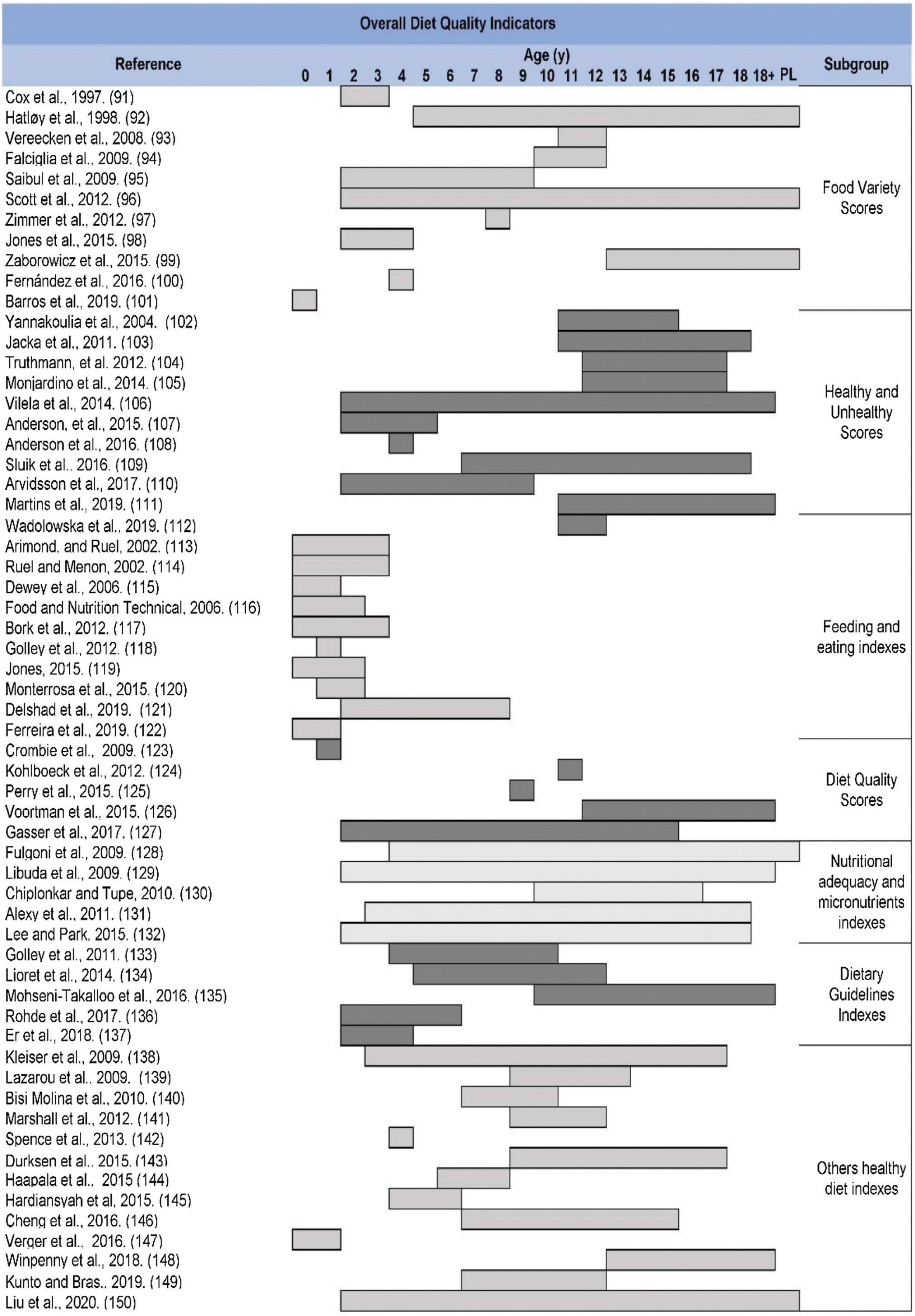

FIGURE 4 *Continued.*

lifestyle aspects related to food intake—for instance, physical activity or anthropometric parameters.

Several studies have found significant associations between the DQIns and health-related outcomes: adiposity and anthropometric parameters (133, 135, 154, 161, 162, 164), lifestyle-related factors (101), insulin resistance (163, 165), growth patterns (100, 134, 137), cognition (43, 144), academic achievement (157, 167), mental health (103),

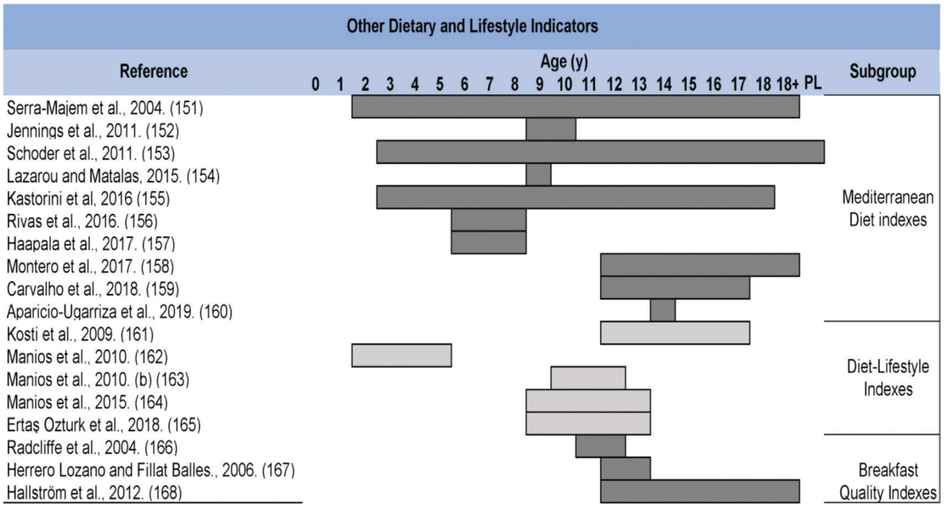

FIGURE 4 *Continued.*

overweight and obesity (125), metabolic syndrome (51), cardiovascular risk factors (47), and levels of biomarkers of inflammation (159). These findings support that higher adherence to predefined dietary patterns with more nutrient-dense foods/components is typically associated with a healthier diet. Therefore, this approach could provide higher protection from diet-related chronic diseases in adulthood, mainly cardiovascular diseases, cancer, diabetes, or metabolic syndrome (183).

Publications were in agreement regarding specific components, despite several disagreements concerning children's DQIns. Among the foods and food groups, the most frequently used were fruits, milk and dairy products, vegetables, cereals, legumes, and fish. Most of these components are considered potentially beneficial to health. Regarding the cereal component, it is notable that few DQIns emphasize the importance of consuming preferably whole-grain cereals because, in general, this component considers all types of cereals and derived products, without considering their fiber content. It is also necessary to emphasize that some researchers name this group starchy foods, including the cereals group, together with bakery and pastry products and some ready-to-eat products (pizza, quiche).

Regarding the dairy component, it generates more controversy because it is considered as positive or negative depending on the indicator. This is perhaps one of the main discrepancies regarding the adult population's indicators; in children, it is considered positive in many more indicators. In the protein-rich foods components, meat is undoubtedly the one that generates more discrepancies, and it must be noted that most of the DQIns consider total consumption and their evaluation is negative. Agreement is more often found when referring to the harmful components to health frequently included in the DQIns: processed meat, sweets, and confectionery items, snacks, and sugar-sweetened beverages.

Nutrient components scored as negative required moderate or limited intake. Those that appeared frequently were sodium, total fat, saturated fat, sugar, cholesterol, and *trans* fats. Nevertheless, it is noteworthy that in childhood, fats are not only a prime source of energy but also provide essential fatty acids and PUFAs, which are critical for appropriate growth, cognitive development, and prevention of chronic disease in adulthood.

Nutrients considered as positive that appeared frequently were calcium, iron, fiber, vitamin C, vitamin A, protein, thiamin, folate, zinc, and niacin. Some of these are antioxidant components that can halt oxidative stress and the subsequent development of oxidative stress-related chronic diseases in adulthood. Moreover, some researchers have provided evidence for a potential beneficial effect of diet quality against the development of certain high-risk micronutrient deficiencies in children (184).

Compared to DQIns developed for the adult population, specific dietary components such as red wine (153) and alcohol intake (35, 39, 49, 52, 80, 109, 160) are considered in a few indicators. The reason is that the benefit that certain types of alcoholic beverages could have for some segments of the population (185) is inapplicable to children and young people for many reasons, and their consumption is discouraged in this population group.

The remarkable components that generate controversy in children's DQIns are dairy products, meat, and fats. Dairy products are not part of specific patterns of consumption, such as the Mediterranean diet pattern. Other authors have described the positive components of dairy consumption, including those related to bone growth (186). In a critical review, the authors summarized studies that evaluate dairy products and the development of obesity. In 9 publications, a positive association was found between milk and other dairy products and body fatness (187).

Regarding meat consumption, high-quality dietary protein and micronutrients can improve the diet, especially in low-income countries (188). In contrast, their consumption is associated with increased risk of chronic diseases, such as cardiovascular disease and cancer (189). The consumption of oils and fats, or specific types of fats (saturated fats, monounsaturated fats, and polyunsaturated fats), can be considered harmful, but olive oil consumption was considered positive in the Mediterranean Diet Indexes (190).

The relation between DQ and certain health-related outcomes in the pediatric population was controversial—for instance, blood pressure levels and the risk of developing high blood pressure (139), bone mineral density and changes in bone mineralization (105), and the association between DQ and metabolic risk factors (191). Other variables that would be of particular interest to study because of their increased prevalence in young people in recent years are alterations in lipid profiles, insulin resistance, and diabetes (192).

Elements that have not been estimated in the developed tools are components related to food safety level, noncaloric sweeteners, salt added at the table, total antioxidant capacity, smoking, sleep, and rest. These components have additional difficulties to be assessed in the child population. Another way to measure the overall DQ or dietary patterns is by estimating the dietary–lifestyle total oxidative capacity with oxidative balance scores. To date, no oxidative balance score has been designed specifically for the youth population (193).

Regarding the scoring methods, some discrepancies and issues to consider are noteworthy. The differences between the cutoff point values hinder comparability, even within each of the 2 approaches (predefined or population-dependent). The fixed criteria are very different between the DQIns (servings per day or week, grams or milliliters per day or week, or the percentage of the frequency of consumption). Concerning the distribution approach, differences have also been observed in relation to the quantile applied (mainly medians, tertiles, and quintiles), even when age- and sex-specific. The establishment of cutoff values based on the distribution of intake of the sample population limits the comparability between studies. In this aspect, the majority of the articles retrieved in this review presented predefined cutoff point values. Consequently, the use of fixed criteria cutoff points could be a successful strategy for comparability between studies.

Therefore, the methodological study (components and scoring systems) of the DQIns is a fundamental issue due to the great heterogeneity with respect to their development, which hinders their comparison, even when studies are performed in similar populations and for a common outcome variable.

Chronic diet-related diseases are a major public health concern; their causes are the interactions between different nutrient and nonnutrient components. Nevertheless, there are gaps in the knowledge concerning the mechanistic effect of nonnutritive components and their impact on health (194).

The dietary patterns of populations can be studied from 3 different and complementary approaches: a priori (indexes or scores), a posteriori (exploratory analyses), and hypothesis-driven (reduced rank regression) approaches (Figure 2) (195). In this mapping review, the focus was the a priori indicators because they are the most studied in the literature (182). The a posteriori approach has been applied in other studies to develop and evaluate dietary patterns in epidemiological research on children (196, 197). This approach has been used less often because of its poor reproducibility, the limitations concerning its interpretation, and its application in public health.

Limitations

This mapping review presents some significant limitations that need to be considered. Only 2 electronic databases were used (MEDLINE-PubMed and Scopus). However, it is necessary to emphasize that the 2 databases selected are the most relevant to the biomedical literature search. It is important to mention that most of the articles identified in this review are observational, predominantly cross-sectional studies.

The global pediatric DQIns research is limited. Despite the relatively high number of indicators found, **Figure 4** shows the distribution of the ages covered by DQIns. This figure shows the gaps in ages 4–8 y, the age group with the fewest indicators. Few DQIns have been validated with different relevant health-related outcomes, such as overweight and obesity (125), metabolic syndrome (51), or cardiovascular risk factors (47). However, studies with an empirical validation have shown more or less the same predictive capacity for the risk of chronic diseases (180).

The conclusions of DQIn studies must be interpreted with great caution for several reasons. One of the most remarkable is that some DQIns have not been specifically developed for children and adolescents because they encompassed all ages of the population (30, 32, 35, 42, 49, 52, 53, 96, 150). The lack of validation studies in some DQIns might yield the wrong results. It is advised to choose DQIns with validation or reproducibility assessment. This assessment is carried out with other instruments widely validated in the scientific literature (associations with nutrient biomarkers and chronic diseases). In addition, the methodological criteria for the development and validation of DQIns were usually based on dietary guidelines (173, 198) and predefined healthy dietary patterns (113, 151). These dietary guidelines are limited by the current knowledge of diet, health, and disease.

Conclusions

We have provided a practical compilation of 139 DQIns developed through a priori methodology in the pediatric population and classified into 13 subgroups. The subgroup differences should be considered because the DQIns include multiple dimensions to evaluate DQ. Some subgroups have greater insight with regard to validity because of their extensive scientific research and scientific literature availability. Therefore, a previous selection of validated DQIns should be taken into account for future epidemiological studies. If the intention is to develop a new tool, the first step should be justifying the need for such an instrument because there are many previously validated DQIns. In addition, careful selection of the indicator components, the scoring system, the applied methodology for its development, a comparison with internationally recognized DQIns, and potential advantages should be reported in detail.

Future research

Development of DQIns is one of the fastest-growing areas in nutritional epidemiology; additional and more specific research is needed in children and adolescents. More studies in which numerous indicators of DQ are developed and validated against instruments widely validated in the literature through the application of robust methodologies are needed. Because of the increasing prevalence of some chronic diseases in the child population, it would be interesting to study the associations between DQIns and the risk of developing risk factors related to blood pressure levels, alterations in lipid profiles or anthropometric parameters, and diseases such as diabetes and obesity.

Acknowledgments

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