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Review Article

Diet Quality and Its Assessment Methods: A Narrative Review

Sayed Reza Hojati[1], Fatemeh Rostamian[1], Sareh Eghtesad[2], Mojtaba Farjam[3], Jalaledin Mirzay Razzaz[4,*], Seyed Hossein Davoodi[5], Elham Ehrampoush[3], Reza Homayounfar[6,*]

1- Student Research Committee, Fasa University of Medical Sciences, Fasa, Iran

2- Liver and Pancreatobiliary Diseases Research Center, Digestive Diseases Research Institute, Tehran University of Medical Sciences, Tehran, Iran

3- Noncommunicable Diseases Research Center, Fasa University of Medical Sciences, Fasa, Iran

4- Department of Community Nutrition, Faculty of Nutrition and Food Technology, National Nutrition and Food Technology Research Institute, Shahid Beheshti University of Medical Sciences, Tehran, Iran

5- Department of Clinical Nutrition and Dietetics, National Nutrition and Food Technology Research Institute, Faculty of Nutrition Science and Food Technology, Shahid Beheshti University of Medical Sciences, Tehran, Iran

6- National Nutrition and Food Technology Research Institute, Shahid Beheshti University of Medical Sciences, Tehran, Iran

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ABSTRACT

Background and Objectives: Most studies in the field of nutrition focus on diet quantity and its relationships with health and diseases. However, effects of diet quality on disease development have not been investigated. Diet quality is a novel concept but its assessment is not carried out frequently because of difficulties in carrying out accurate assessments. Several indices have been developed to assess the overall diet quality of individuals and populations. Indices are diverse and each is used in a specific condition to achieve a certain goal. This article aimed to introduce the most importantly useful diet-quality indices and their uses to encourage their widespread uses.

Materials and Methods: Using PubMed, Scopus, Elsevier and Google Scholar databases, keywords such as “diet”, “diet quality”, “diet quality index”, “diet quality score”, “nutritional assessment”, “food intake pattern” and “nutritional pattern” were used to gather data from 45 associated articles, all of which were used in this manuscript to introduce in detail and assess 13 diet quality indices.

Results: For each index, previous research, current uses and use criteria were reported.

Conclusions: To assess risks of chronic diseases and mortality from cardiovascular diseases, diet quality index, healthy eating index, alternative healthy eating index and healthy diet indicator can be used. For predicting breast cancer risks, diet quality index-revised and alternative healthy eating index can be benefitted. Assessing diet quality parallel to diet quantity renders a further complete assessment of the relationships between diet and disease.

Keywords: Nutritional assessment, Diet quality index, Diet quality, Diet quality score

Highlights

- Assessing diet quality parallel to diet quantity renders a further assessment of the relationships between diet and disease.
- For assessing the risk and mortality from CVDs, AHEI is more reliable because
- To predict mortality from food patterns, MDS versions are the best choices.

***Address for correspondence:** Reza Homayounfar, Associate Professor, National Nutrition and Food Technology Research Institute, Shahid Beheshti University of Medical Sciences, Tehran, Iran E-mail address: homayounfar@sbmu.ac.ir
Jalaledin Mirzay Razzaz, Associate Professor, Department of Community Nutrition, Faculty of Nutrition and Food Technology, National Nutrition and Food Technology Research Institute, Shahid Beheshti University of Medical Sciences, Tehran, Iran. E-mail address: jmrazaz2018@gmail.com

Introduction

When the term "diet" is encountered, most people think of a routine diet program for losing weight or disease control and prevention. In contrast, "diet" is a general term and in fact means the total quantity of food and drink habitually consumed by an individual or population. Diet is one of the most important aspects of individuals' lives. Diet and its associated nutrients highly affect longevity (1–4), weight (5–9), development of diseases (10–12) and disorders such as depression (13–16). A healthy diet contains adequate quantities of all macronutrients (proteins, carbohydrates and beneficial fats), all of which are necessary for the human health. In contrast, an unhealthy diet can result in poor growth (17), decreased fertility (18, 19), decreased immunity and increased risk of diseases (20). Comparing and differentiating healthy diets from unhealthy diets is part of a subject called "diet quality".

Recently, diet quality has attracted attention of researchers in the field of nutrition (21). The term "diet quality" is widespread and complex. This term assesses personal food tastes and food diversity of various cultures (22). Diet quality encompasses the diversity, balance and healthfulness of a diet. A diet is addressed to include good quality when it provides the adequate quantities of energy and nutrients needed for growth as well as having a healthy and active life. Food diversity is critical in meeting people's nutritional requirements. It is important to pay attention to diet quality to maintain physiological homeostasis, enhance development and physical activity and prevent the spread of infectious diseases (23).

Several analytical methods are available to quantitatively assess diet quality, such as assessing dietary recall questionnaires for a specific time and assessing food intake quantities. It is difficult to assess diet quality; however, as it includes a detailed assessment of the types of foods and number and size of the meals and their frequency. Diet quality may be associated to eating styles, snacking and other food habits. In addition, microbiological quality and ingredient details of a single food such as meat, dairy or vegetables may be variable and must be addressed (22). A number of assessment indices are currently available, the use of which is increasing. These indices are used to assess epidemiological relationships between diets and their associated health outcomes (24). However, there is no agreements on how to define diet quality or how to set a specific framework for indices for its assessment (21). Therefore, the aim of this study was to compare available diet quality-assessment indices from the literature and assess their weaknesses and strengths to present the most useful indices in assessing diet quality.

Materials and Methods

Through the PubMed, Scopus, Elsevier and Google Scholar databases, keywords such as "diet", "diet quality", "diet quality index", "diet quality score", "nutritional assessment", "food intake pattern" and "nutritional pattern" were used to gather data of 45 associated articles, all of which were used in this manuscript to introduce in detail and assess 13 diet quality indices.

Results

Indices of diet quality assessment

The 13 diet-quality indices assessed in this study as well as their use are listed in Table 1 and further discussed in the following paragraphs.

Diet quality index

Diet quality index (DQI) was first published in 1994 by Patterson (25). This index is not applicable to diseases that are created or treated with a single food or nutrient, but is used to assess the risk of chronic diseases associated with food patterns (25). It is used to investigate mortality from cardiovascular diseases (CVDs), but not other diseases such as cancers. This index consists of eight components that include six micro/macronutrients and two food groups. The micro/macronutrients include total fat, proteins, saturated fatty acids (SFAs), cholesterol, calcium and sodium. Food groups included fruits and vegetables (combined) and the complex carbohydrate groups. The components were scored as follows: if the quantity of a component was equal to, close to and far from the suggested value, it received a score of 0, 1 and 2, respectively. The possible score range was 0–16 (24). The lower the score, the better the diet quality and vice versa (Table 2).

Diet Quality Index-Revised

The original version of DQI was revised in 1999 and diet quality index-revised (DQI-R) was introduced (28). This new index was updated to better reflect the diet quality and improve diet regulation. The assessment of dietary balance and diversity was then added to this index (29). The DQI-R consists of ten components, including cholesterol, fatty acids, total fat, vegetables, fruits, cereals, iron, calcium, dietary diversity score (DDS) and balanced diet score. The first three components represent macronutrient intake. The next three components represent use of the highlighted groups. Calcium and iron components are assessed based on dietary reference intake (DRI). The last two components represent importance of food diversity and controlled consumption of salt, fats and alcoholic beverages and balanced consumption of sugar. The score assigned to each component ranged 0–10, with an overall score of 0–100. In contrast to the original DQI, the higher the score of DQI-R, the better the diet quality (28). It is believed that the 100-point scale made the interpretation of DQI-R easier (29). Differences with the

original DQI are as follows: In the DQI, vegetables and fruits were combined into one group, but are separated in the DQI-R. Iron intake has been added to this index, while protein has been eliminated. Food balance and diversity have been added to the DQI-R (24). The novel index revealed the relationship between this index and plasma biomarkers that reflect nutrient intake (30). Fung used this index to predict breast cancer risks (31). In another study, Fung showed that the DQI-R did not correlate with plasma CVD biomarkers (Table 3) (32).

Table 1. An overall view of the indices

	Index	Components	Details	References
1	DQI (Diet Quality Index)	Total fat, Cholesterol, Saturated fatty acid, Vegetables and fruit and, Protein, Complex carbohydrates, Sodium, Calcium	assesses the risk of chronic diseases associated with the food pattern, investigates mortality from cardiovascular diseases	(24-27, 50)
2	DQI-R (Diet Quality Index-Revised)	total fat, fatty acids, cholesterol, fruits, vegetables, cereals, calcium, iron, dietary diversity score (DDS) and balanced diet score	The relationship between this index and plasma biomarkers was studied, which indicate nutrient intake. predict breast cancer risk	(24, 27-30, 32, 51)
3	DQI-I (Diet Quality Index-International)	diversity, adequacy, moderation and balance	compares diet quality among nations, compares the diet quality in different cultures and to carry out a global monitoring and investigation on the diet quality	(33)
4	HEI (Healthy Eating Index)	fruits, vegetables, grains, milk, meat and beans, Total fat, Saturated fatty acid, Cholesterol, Sodium, Variety	shows changes in food patterns and also promotes health status and proper nutrition education	(28, 34)
5	Alternative Healthy Eating Index (AHEI)	vegetables, fruits, nuts and soybeans, white-red meat ratio, the percentage of energy derived from trans-fat (trans-unsaturated fatty acids), cereal fiber, polyunsaturated fatty acids (PUFA)-saturated fat ratio, daily alcohol consumption and the duration of taking multivitamins	confirms the benefits of unsaturated fats, distinguishes quality in different food groups	(27, 36)
6	HDI (Healthy Diet Indicator)	Protein, Complex carbohydrates, Dietary fiber, Saturated fatty acids, Polyunsaturated fatty acid, Pulses/ nuts/seeds, Fruits and vegetables, Mono-and disaccharides, Cholesterol	It was used for the prevention of chronic diseases, It was associated with a reduction in all mortality factors	(37, 38)
7	Healthy Food Index (HFI)	lack of taking margarine / butter / fats, consuming raw or boiled vegetables at least for one time, using at least one white bread or large rye bread and consuming fruits at least for one time	Investigates the relationship between diet quality and all mortality factors	(19, 33, 34)
8	Mediterranean Diet Score (MDS)	high MUFA to saturated fats proportion, high consumption of legumes, high intake of vegetables, fruits, grains, moderate consumption of alcohol, low intake of milk and dairy products and low intake of meat and meat products	Evaluates the overall diet quality according to the traditional Mediterranean diet in Mediterranean populations	(24, 26, 27, 41)
9	Mediterranean Adequacy Index (MAI)	Mediterranean food group includes cereals, legumes, vegetables, fruits, starches, fish, MUFA and liquor. The non-Mediterranean food group includes milk/dairy products, meat/poultry, eggs, sugar and saturated fats	Total Mediterranean food groups were divided by the total non-Mediterranean food groups. It related to mortality rates	(24, 44)
10	Food Variety Score (FVS)	the number of different foods that a person consumes in a given time period	consumption frequency and consumption rate are not investigated	(46, 47)
11	Dietary Diversity Score (DDS)	the number of food groups used usually based on food pyramid groups	widely used by researchers in the nutrition field	(47, 48)
12	Nutritional Adequacy Ratio (NAR)	indicates the adequacy of nutrients intake based on the recommended dietary allowance (RDA)	the amount of nutrient intake is divided by the recommended amount and is reported as a percentage	(26, 45, 49)
13	Mean Adequacy Ratio (MAR)	By calculating of the average NARs	presented as a general index for nutrient adequacy	(26, 45, 49)

Table 2. Component guide table and scoring method of diet quality index (26, 27)

1	Total fat	<30 energy % 30-40 energy % >40 energy %	0 1 2
2	Saturated fatty acid	<10 energy% 10-13energy % >13energy %	0 1 2
3	Cholesterol	<300 mg 300-400 mg >400 mg	0 1 2
4	Fruit and vegetables	5+ serving 3-4 serving 0-2 serving	0 1 2
5	Complex carbohydrates	6+ serving 4-5 serving 0-3 serving	0 1 2
6	Protein	≤100% RDA 100-150% RDA ≥150% RDA	0 1 2
7	Sodium	<2400 mg 2400-3400 mg >3400 mg	0 1 2
8	Calcium	≥ RDA 2/3 RDA <2/3 RDA	0 1 2

Table 3. Component guide table and scoring method of diet quality index-revised (27, 28)

1	Total fat ≤ 30%	≤ 30 energy % >30 energy % > 40 energy %	10 5 0
2	Saturated fatty acids ≤ 10% energy intake	≤ 10 energy % 10≤13 energy % >13 energy %	10 5 0
3	Cholesterol	≤300 mg >300, ≤400 mg >400 mg	10 5 0
4	2-4 serving fruit per day	≥ 100% 99%-50% <50%	0-10*
5	3-5 serving vegetables per day	≥ 100% 99%-50% <50%	0-10*
6	6-11 serving grains per day	≥ 100% 99%-50% <50%	0-10*
7	Calcium intake	≥ 100% 99%-50% <50%	0-10*
8	Iron intake	≥ 100% 99%-50% <50%	0-10*
9	Dietary diversity score	≥6 ≥3 ,<6 <3	0-10
10	Dietary moderation score	≥7 ≥4, <7 <4	0-10

*Depending on energy intake

Diet quality index-international

Diet quality index-international (DQI-I) was proposed to fill for the lack of an index to compare diet quality among nations. This index was released in 2003 to compare diet quality in various cultures and to carry out global monitoring and investigation on diet quality. The DQI-I has outperformed previous versions of DQI and the healthy eating index (HEI) thus appearing to be more reliable. It includes many aspects of diet quality, measuring diversity, adequacy, moderation and balance (Table 4) (33).

Table 4. Component guide table and scoring method of diet quality index-international (33)

A	**Variation**		**0-20**
1	All food groups (fish/poultry/meat/eggs; beans/dairy; grain; vegetable; fruit)	≥1 serving from each food group/d = 15 Any 1 food group missed/d = 12 Any 2 food groups missed/d = 9 Any 3 food groups missed/d = 6 ≥4 food groups missed/d = 3 None of any food groups = 0	0-15
2	Within-group diversity for protein source (fish, poultry, meat, eggs, dairy, beans)	≥3 different origins/d = 5 2 different origins /d = 3 From 1 origins /d = 1 None = 0	0-5
B	**Adequacy**		**0-40**
3	Vegetable group	≥3–5 servings/d = 5 0 servings/d = 0	0-5
4	Fruit group	≥2–4 servings/d = 5 0 servings/d = 0	0-5
5	Grain group	≥6–11 servings/d = 5 0 servings/d = 0	0-5
6	Fiber	≥20–30 g/d = 5 0 g/d = 0	0-5
7	Protein	≥10% of energy/d = 5 0% of energy/d = 0	0-5
8	Iron	≥100% of RDA (AI)/d = 5 0% of RDA (AI)/d = 0	0-5
9	Calcium	≥100% AI/d = 5 0% AI/d = 0	0-5
10	Vitamin C	≥100% of RDA (RNI)/d = 5 0% of RDA (RNI)/d = 0	0-5
C	**Restraint**		**0-30**
11	Total fat	≤20% total energy/d = 6 >20–30% total energy/d = 3 >30% total energy/d = 0	0-6
12	Saturated fat	≤7% total energy/d = 6 >7–10% total energy/d = 3 >10% total energy/d = 0	0-6
13	Cholesterol	≤300 mg/d = 6 >300–400 mg/d = 3 >400 mg/d = 0	0-6
14	Sodium	≤2400 mg/d = 6 2400–3400 mg/d = 3 >3400 mg/d = 0	0-6
15	Empty calorie foods	≤3% of total energy/d = 6 >3–10% of total energy/d = 3 >10% of total energy/d = 0	0-6
D	**Total balance**		**0-10**
16	Macro-nutrient ratio (carbohydrate:protein:fat)	55 ~ 65:10 ~ 15:15 ~ 25 = 6 52 ~ 68:9 ~ 16:13 ~ 27 = 4 50 ~ 70:8 ~ 17:12 ~ 30 = 2 Otherwise = 0	0-6
17	Fatty acid ratio (PUFA:MUFA:SFA)	P/S = 1 ~ 1.5 and M/S = 1 ~ 1.5 = 4 Else if P/S = 0.8 ~ 1.7 and M/S = 0.8 ~ 1.7=2 Otherwise = 0	0-4

Total score of these four components is summed, with a maximum score of 100. The DQI-I includes its own grouping. For example, empty-calorie foods, which have not been addressed in other indices, are a food group in this index. The DQI-I requires a lot of diet information, which is collected through several-day diet recalls, making it time consuming to carry out (33).

Healthy eating index

The HEI, introduced by Kennedy (34), is an assay that briefly assesses diet quality and can be used to show changes in food patterns and promote health status and appropriate nutrition education. The US Department of Agriculture (USDA) includes a plan to use the HEI as a base for nutrition promotion programs (34). Components of this index are divided into two categories of adequacy and moderation. Adequacy subcategories are addressed to ensure adequate intake of nutrients, while the intake of nutrients should be limited in moderation subcategories. Technically, HEI consists of ten components of determining compliance with the number of servings recommended by the Food Guide Pyramid regarding five major food groups (grains, vegetables, fruits, milks, meats and beans); the total intake of sodium; saturated fats and total intake of fat as part of the energy intake; quantity of cholesterol intake; and diet diversity. Each component is assigned a score of 0–10 with the final score of 0–100, indicating the worst and the best diets, respectively (Table 5) (28).

Alternative healthy eating index

Alternative healthy eating index (AHEI) was assessed for disease risk prediction, compared to HEI. The AHEI verifies benefits of unsaturated fats (USFs) (similar to HEI), yet distinguishes quality in various food groups and removes potatoes and its products from the vegetables group. It consists of nine components, including vegetables, fruits, nuts and soybeans, white-red meat ratios, energy proportions derived from trans-fat [trans-unsaturated fatty acids (trans-UFAs)], cereal fibers, polyunsaturated fatty acids (PUFAs)-saturated fat (SF) ratios, daily alcohol consumption and duration of multivitamin use. The total scores of all components show the AHEI score, ranging from 87.5 (the best diet) to 2.5 (the worst diet) (24). Results of a study showed that the incidence of breast cancer decreased by 11% with a 10% increase in AHEI (31, 35). Another study showed that AHEI predicts risks of chronic diseases better than those the HEI does, which is due to the strong inverse relationships between AHEI and CVDs (Table 6) (36).

Table 5. Component guide table and scoring method of healthy eating index (26–28, 34)

	Adequacy		
1	Grain	6-11 serving	0-10
2	Vegetables	3-5 serving	0-10
3	Fruits	2-4 serving	0-10
4	Milk	2-3 serving	0-10
5	Meat and beans	2-3 serving	0-10
	Moderation		
6	Total fat	<30 % energy	0-10
7	Saturated fatty acid	<10 % energy	0-10
8	Cholesterol	<300 mg	0-10
9	Sodium	<2400 mg	0-10
10	Variety	16 different food items/3d	0-10

The criteria depend on energy intake. 0 servings score=0

Table 6. Component guide table and scoring method of alternative healthy eating index (27, 36)

1	Vegetables	0 serving 5 serving	0 10
2	Fruits	0 serving 4 serving	0 10
3	Nuts and soy protein	0 serving 1 serving	0 10
4	Ratio of white to red meat	0 4	0 10
5	Cereal fiber g/d	0 15	0 10
6	Trans fat	≥4 energy % ≤0.5 energy%	0 10
7	Polyunsaturated: saturated fatty acid ratio	≤0.1 ≥1	0 10
8	Duration of multivitamins use	< 5 years ≥ 5 years	0 10
9	Alcohol	Men: 0 or >3.5 Women: 0 or >2.5	0
		Men: 1.5-2.5 Women: 0.5-1.5	10

Healthy diet indicator

Healthy diet indicator (HDI) is based on the dietary recommendations of World Health Organization (WHO) for chronic disease prevention. This index is associated with a decrease in all mortality factors and, in particular, significantly decreased mortality from CVDs (37). It has been shown that the rate of cognitive impairment decreases with increases in HDI (38). This index consists of nine components. The scoring method is as follows: In each component "Score 1" is assigned for intake rates that are within the suggested range and "Score 0" for anything otherwise, adding up to a possible score of 9. The HDI is most commonly used to assess the relationship between mortality and food patterns (Table 7) (37).

Healthy food index

Healthy food index (HFI) was based on previous diet quality assessment indices in 2001. It consists of four components; to which, a score of 1 is assigned in case a desired behavior is carried out daily, otherwise a score of 0 is received. Components include lack of margarine/butter/fat use, consuming raw or boiled vegetables at least once, using at least one white bread or large rye bread and consuming fruits at least once. The total scores range 0–4 and a higher score indicates a better diet quality. This index has been used to investigate the relationship between diet quality and all mortality factors in various research and shown to include an inverse relationship (Table 8) (24, 39, 40).

Mediterranean diet score

Mediterranean diet score (MDS) assesses overall diet quality based on the traditional Mediterranean diet in Mediterranean populations. It was first introduced by Trichopoulou in 1995 (41). Later, new versions were released over the years. Although there are slight differences between the various versions, they include significant effects on scoring, classification and relationship with health outcomes. Further studies are needed to assess which version of MDS is the best choice for investigating the relationship between diet quality and health outcomes (26).

MDS (1): The basic or original version of MDS consists of eight components, including high MUFA to SF proportions, high intakes of legumes, grains, vegetables and fruits, low intakes of milk and dairy products and moderate intakes of alcohol, meat and meat products. Scoring is carried out based on the average intake for each gender. If intake of the first five components exceeds the median, a score of 1 is assigned to that component and if it is less than the average, a score of 0 is assigned. For the rest of three components, scores 1 and 0 are assigned if the quantity consumed is less and greater than the average value, respectively. The possible score range is 0–8, with higher scores indicating better quality. This index was used to investigate the relationship between diet and survival. There are reports that 1 score increase in MDS decreases the overall mortality in elderly people by 17% (Table 9) (24, 26, 27, 41).

Table 7. Component guide table and scoring method of healthy diet indicator (26, 27, 37)

1	Saturated fatty acids	0-10 energy %	1
2	Polyunsaturated fatty acid	3-7 energy %	1
3	protein	10-15 % energy	1
4	Complex carbohydrates	50-70 % energy	1
5	Dietary fiber (g)	27-40 % energy	1
6	Fruits and vegetables(g)	>400 g/d	1
7	Pulses, nuts, seeds (g)	>30 g/d	1
8	Mono-and disaccharides	0-10 energy %	1
9	Cholesterol(mg)	0-300 mg/d	1

If percent or quantities are not in the ranges=0

Table 8. Component guide table and scoring method of healthy food index

1	Not consuming margarine, butter or lard	If met daily	1
		If not met daily	0
2	Consumption of boiled or raw vegetables at least once	If met daily	1
		If not met daily	0
3	Consumption of coarse rye or white bread at least once	If met daily	1
		If not met daily	0
4	Consumption of fruit at least once	If met daily	1
		If not met daily	0

Table 9. Component guide table and scoring method of all Mediterranean diet score versions

	MDS (1)	MDS (2)	MDS (3)	MDS (4)	Criteria	
1	Monounsaturated: saturated fatty acids ratio	Monounsaturated: saturated fatty acids ratio	Monounsaturated: saturated fatty acids ratio	Monounsaturated: saturated fatty acids ratio	<median ≥median	0 1
2	Legumes	Legumes	-	Legumes, Nuts and Seeds	<median ≥median	0 1
3	Cereals	Cereals	Cereals (starchy roots excluded)	Cereals	<median ≥median	0 1
4	Fruits and nuts	Fruits and nuts	Fruits and nuts	Fruits	<median ≥median	0 1
5	Vegetables	Vegetables	Vegetables (starchy roots included)	Vegetables and Potatoes	<median ≥median	0 1
6	Meat and meat products	Meat and meat products	Meat and meat products	Meat and poultry	≥median <median	0 1
7	Milk and dairy products	Milk and dairy products	Milk and dairy products	Milk and dairy products	≥median <median	0 1
8	-	Fish	-	Fish	<median ≥median	0 1
9	Alcohol	-	Alcohol	Alcohol	≥median <median	0 1
10	-	Alcohol	-		Men (10-50 g/d) Women (5-25 g/d) otherwise	1 1 0

MDS (2): The second version of MDS was released in 2003. It is quite similar to the original version and only a few minor improvements were created. Fish consumption was added as a new component. The scoring system is the same as the original version, with fish consumption receiving a score similar to the first five components. Another change was created for scoring alcohol consumption. If daily alcohol intakes for men and women were 10–50 and 5–25 g, respectively, score 1 is assigned, otherwise score 0 is assigned. The possible score range is 0–9, with score of 9 representing the highest compliance with the Mediterranean diet. This version has been used to investigate the relationship between diet quality and overall mortality rate, A 2-point increase in MDS (2) was associated with a 25% decrease in the overall mortality rate in elderly people (24, 42).

MDS (3): This version of MDS is similar to the first version overall except elimination of legumes, leaving a score range of 0–7. Higher scores indicate better food behaviors. This version is used to investigate the relationship between all types of diet-related deaths. It was shown that the overall mortality rate in the elderly people decreased by 21% with 1-score increase in this version of MDS. Higher scores corresponded with higher serum carotene levels and an inverse relationship between serum carotene level and mortality rate was observed (24, 43).

MDS (4): The fourth version of the MDS differs from the original version in that the legume group was changed to the legumes/nuts/seeds group, the vegetable group was changed to the vegetables/starch groups and the meat and meat products group was changed to the poultry and meat group. Fish was added as a separate group. Nine food groups were created with a total score of 0–9. Results of studies show a clear inverse relationship between this index or HDI and the Mediterranean adequacy index (MAI) and all mortality factors. In addition, a direct relationship was observed between the consumption of SFAs and mortality (24, 44).

Mediterranean adequacy index

The MAI consists of two versions of one original and another one modified. In the modified version, the total Mediterranean food groups (cereals, legumes, vegetables, fruits, starches, fish, MUFAs and liquors) were divided by the total non-Mediterranean food groups (milk/dairy products, poultry/meat, sugar, eggs and SFs). Vegetable oils are used as an alternative of MUFAs and animal fats and margarines shifted to SFAs in the original version. The food groups are articulate as a total daily energy intake percentage in the original version, while consumption values are based on the daily intake of men and women in the modified version (24, 44). Recent researches have shown that the MAI score to be inversely associated to mortality rates (44).

$$MAI = \frac{Sum\ of\ mediterranean\ food\ groups}{Sum\ of\ non-mediterranean\ food\ groups}$$

Food variety score

Food variety score (FVS) simply is the number of various foods that a person consumes within a specific time. Consumption frequency and consumption rate are not investigated (45). Various studies have used this index (46, 47).

Dietary diversity score

The DDS is based on the number of consumed food groups from the food pyramid groups. For each group, scores 1 and 0 are assigned for consuming and not consuming a food groups, respectively, and the sum of

scores is expressed as DDS (45). The FVS and DDS can be addressed equivalent to food group indicators (FGI) (22). The DDS has widely been used by researchers in the nutrition field (47, 48).

Nutritional adequacy ratio

Madden and Yoder published nutritional adequacy ratio (NAR) during a nutrient intake survey in 1972 (49). This ratio indicates the adequacy of nutrient intake based on the dietary reference intakes (DRI), recommended dietary allowances (RDA) or recommended nutrient intakes (RNI) for each age and sex group. In other words, quantity of nutrient intake is divided by the recommended quantity and reported as a percentage (26). The NAR of the energy consumption can be calculated based on the average daily energy requirement or total energy expenditure (TEE). In addition, NAR can be calculated on the basis of reference values for energy derived from various dietary components such as energy from carbohydrates, fats and proteins (45).

Mean adequacy ratio

In addition to NAR, the mean adequacy ratio (MAR) was present as a general index for nutrient adequacy. The MAR is achieved by calculating the average of NARs. To calculate MAR, NARs that are more than 1 or 100% should be truncated at 1 or 100%; thus, high-NAR nutrients do not compensate theoretically low-NAR nutrients. Up-to-date, NAR and MAR indices have been used to investigate diet quality in various studies (26, 45, 49).

$$MAR\ (Mean\ Adequacy\ Ratio) = \frac{\Sigma\ NAR\ (each\ one\ should\ be\ truncated\ at\ 1)}{Number\ of\ nutrients}$$

Discussion

Assessing the diet quality can play a significant role in nutrition-related disease studies, because diseases are not only relevant to nutrient quantity, but they are relevant to the diet quality. Various indices have been formulated to assess diet quality of various populations. Assessing diet quality can play a significant role in nutrition-related diseases to assess the risk of cancers, chronic diseases and all mortality factors. There are specific indices that can be used. In addition, region-specific indices are preferred over general indices to assess diet quality of certain populations.

Conclusion

For assessing the risk of chronic diseases and mortality from CVDs, various indices can be used, but AHEI can be further reliable because it concludes more risk factors than those others do. In the next level, it is better to benefit from DQI and HDI because they show their power in recent studies. To predict breast cancer risk, DQI-R and AHEI can be used but AHEI is used further. To predict mortality from food patterns, MDS versions are the best choices. As studies have revealed that Mediterranean diet is the best diet for people with CVDs, it is better to increase this index in such people. Between MDS versions, MDS (4) is further complete since it includes more diet dimensions than those the others do. The HEI is further useful to educate population how to have appropriate nutrition. It is a good idea to compare diet quality in nations and assess why the prevalence of some diseases is higher in certain countries. Therefore, DQI-I should be used (Table 10).

Table 10. Guide to select the most appropriate index

What are you looking for?	Indexes that can be used
Assessing the risk of chronic diseases associated with the food pattern	DQI, HEI, AHEI, HDI
Investigating mortality from cardiovascular diseases	DQI, HEI, AHEI, HDI
Predicting breast cancer risk	DQI-R, AHEI
Diet quality among nations	DQI-I
Promoting health status and proper nutrition education	HEI
Predicting mortality from food patterns	HDI, HFI, MAI, All versions of MDS
Evaluating the overall diet quality in Mediterranean populations	MDS

Abbreviations

Not applicable

Declaration

Ethics approval and consent to participate

Ethics Committee of the university does not grant a code of ethics for review studies. However, the authors tried to follow all the ethical guidelines.

Availability of data and materials section

Not applicable

Consent for Publication

Not applicable

Financial disclosure

Authors have no competing interests to declare.

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Authors' contributions

All authors have read and approved the manuscript.

Conceptualization RH

Methodology: RH, SRH, FR

Resources: SRH, FR, AR

Validation: JMR, RH

Writing (original draft preparation): SE

Investigation: SRH, FR

Visualization: AH, FR, SRH

Writing (review and editing): JMR, MF, AR, SE

Project administration: RH

Supervision: RH

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