PERSPECTIVE

Perspective: The Application of A Priori Diet Quality Scores to Cardiovascular Disease Risk—A Critical Evaluation of Current Scoring Systems

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ABSTRACT

Healthy dietary habits are the cornerstone of cardiovascular disease (CVD) prevention. Numerous researchers have developed diet quality indices to help evaluate and compare diet quality across and within various populations. The availability of these new indices raises questions regarding the best selection relevant to a given population. In this perspective, we critically evaluate a priori–defined dietary indices commonly applied in epidemiological studies of CVD risk and mortality. A systematic literature search identified 59 observational studies that applied a priori–defined diet quality indices to CVD risk factors and/or CVD incidence and/or CVD mortality. Among 31 different indices, these scores were categorized as follows: *1*) those based on country-specific dietary patterns, *2*) those adapted from distinct dietary guidelines, and *3*) novel scores specific to key diet-related factors associated with CVD risk. The strengths and limitations of these indices are described according to index components, calculation methods, and the application of these indices to different population groups. Also, the importance of identifying methodological challenges faced by researchers when applying an index are considered, such as selection and weighting of food groups within a score, since food groups are not necessarily equivalent in their associations with CVD. The lack of absolute cutoff values, emphasis on increasing healthy food without limiting unhealthy food intake, and absence of validation of scores with biomarkers or other objective diet assessment methods further complicate decisions regarding the best indices to use. Future research should address these limitations, consider cross-cultural and other differences between population groups, and identify translational challenges inherent in attempting to apply a relevant diet quality index for use in CVD prevention at a population level. *Adv Nutr* 2020;11:10–24.

Keywords: cardiovascular disease, CVD risk factors, blood pressure, diet quality score, diet index, dietary patterns

Introduction

Cardiovascular disease (CVD), the major cause of death worldwide, is multifactorial and influenced largely by environmental factors, including dietary habits and other lifestyle behaviors (1). Unhealthy dietary behaviors are associated with about a third of global mortality (2).

In 1908, Alexander Ingatowski reported a link between high cholesterol intake and atherosclerosis in rabbits (3). Over the second half of the 20th century, the landmark Seven Countries Study demonstrated undesirable associations of dietary lipids with CVD based on this large-scale cohort study that was among the first to describe food patterns relative to CVD outcomes (4). Numerous later cohort studies investigated the role of single nutrients associated with CVD and its risk factors (5–7). These early investigations provided essential results demonstrating a nutritional relation with CVD, but the presence of highly correlated nutrients may attenuate effects, especially if nutrient adjustment methods are not properly applied (8). More recently developed dietary guidelines encompass both nutrients and food groups known to act synergistically and shown to provide protective benefit against development of CVD, while accounting for previous limitations (9, 10). The translation of such dietary patterns to public health guidelines was likewise applied to the 2015–2020 Dietary Guidelines for Americans (11).

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The term "diet quality" refers to the nutrient adequacy or nutritional value of a dietary pattern as a whole (12). To assess diet quality, Patterson and colleagues first developed a "diet quality index score" in 1994 (13). The 2 main methods used to determine diet quality of a population are a priori and a posteriori. An a priori diet quality index score is based on predefined algorithms to quantify food and nutrient intake relative to nutritional recommendations (14). Each food or nutrient is assigned a score, and a total score is then calculated. The higher the score, the greater the adherence to the predefined diet pattern. A posteriori scores are derived from statistical techniques such as factor, cluster, or principle component analysis and are therefore specific to the population they are calculated from (15). Here we focus on a priori scores as these are applied across different cohorts.

A crude search on PubMed for publications containing a reference to a form of dietary score ("diet", or "food" or "nutrient" AND "index" or "score" or "quality" or "pattern" AND "CVD") illustrates that publication of cohort studies applying a dietary score or index to determine associations with CVD outcomes has increased exponentially, with a steady rise from an average of 302 publications per y between 2000 to 2004 to an average of 765 per year over the last 5 y (**Figure 1**).

The plethora of new diet quality indices has raised questions among researchers regarding the optimal choice for studies of CVD prevention. Understanding what the different scores measure and how they are calculated is essential for interpretation of their relations with CVD outcomes and their application to research studies. This narrative review was designed to *1*) identify current a priori dietary scores reported in relation to CVD outcomes and risk factors in cohort studies, *2*) evaluate the application of the most frequently used scores in the study of diet and CVD, and *3*) consider the strengths and limitations of these scores based on calculation methods and their application to different population groups. We also provide recommendations for considering the potential application of predefined diet quality scores to CVD outcomes, based on our findings.

Methods to Identify Current A Priori Dietary Scores

Study design

As the aims of this review were to identify and describe the current scores used in nutritional epidemiological studies of dietary patterns and CVD, we first systematically searched the recent published literature to identify the scores, and then we synthesized our findings in a critical narrative review. As we did not aim for an exhaustive search or quantification of evidence, the study design we adopted differs from a systematic review where formal quality assessment procedures are followed.

Inclusion criteria

Inclusion criteria in the present narrative review were *1*) observational study design, *2*) investigation on diet quality indices and CVD risk factors and/or CVD incidence and/or CVD mortality in adults, *3*) publication between 1 January 2015 to 31 October 2018, and *4*) full-text, peer-reviewed, and in English. All studies in the present review met these inclusion criteria; studies featuring a priori diet quality index scores that quantified food and nutrient intake using predefined algorithms were also included if they met the inclusion criteria.

Search strategy

A systematic article search was carried out between October and November of 2018 (see **Supplemental Table 1** for search criteria). During manuscript preparation, a weekly search was maintained to capture new publications; however, none were identified. The following databases were searched: NCBI Pubmed, Web of Science, the Cochrane Library, and SpringerLink. The search terms used were the following: "diet" OR "food" OR "nutrient" AND "pattern" OR "index" OR "indices" OR "score" OR "quality" OR "adherence" OR "adequacy" AND "cardiovascular disease" OR "coronary disease" OR "myocardial infarction" OR "stroke" OR "peripheral vascular diseases" OR "arterial disease" OR "peripheral arterial disease" OR (hypertension OR blood pressure) OR (cholesterol AND HDL) OR (cholesterol AND LDL). Retrieved articles were imported into Mendeley reference management software (Glyph and Cog, LLC). **Figure 2** presents a flow chart of the systematic search.

Overall, the search found 3072 citations; 20 articles were eliminated as duplicates and 2929 due to irrelevancy or to not being full-text peer-reviewed research articles. Two independent reviewers (GSA and RG) assessed abstracts of the remaining 170 articles; 111 failed to meet the inclusion criteria. Studies were excluded if they were not CVD specific, were feeding trials, did not include a diet quality index score, were not on adults, or a combination of any of

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Supplemental Tables 1–3 are available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at https://academic.oup.com/advances/.

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Abbreviations used: AHEI, alternative Healthy Eating Index; BP, blood pressure; CAD, coronary artery disease; CVD, cardiovascular disease; DASH, Dietary Approaches to Stop Hypertension; DII, Dietary Inflammatory Index; DQI-I, Diet Quality Index-International; EPIC, European Prospective Investigation into Cancer and Nutrition; HEI, Healthy Eating Index; hPDI, healthful Plant-based Diet Index; IMI, Italian Mediterranean Index; MDS, Mediterranean Diet Score; MI, myocardial infarction; NFI, Nordic Food Index; NPS, Nutrient Profile Score; PDI, Plant-based Diet Index; RCI, Recommendation Compliance Index; uPDI, unhealthful Plant-based Diet Index.

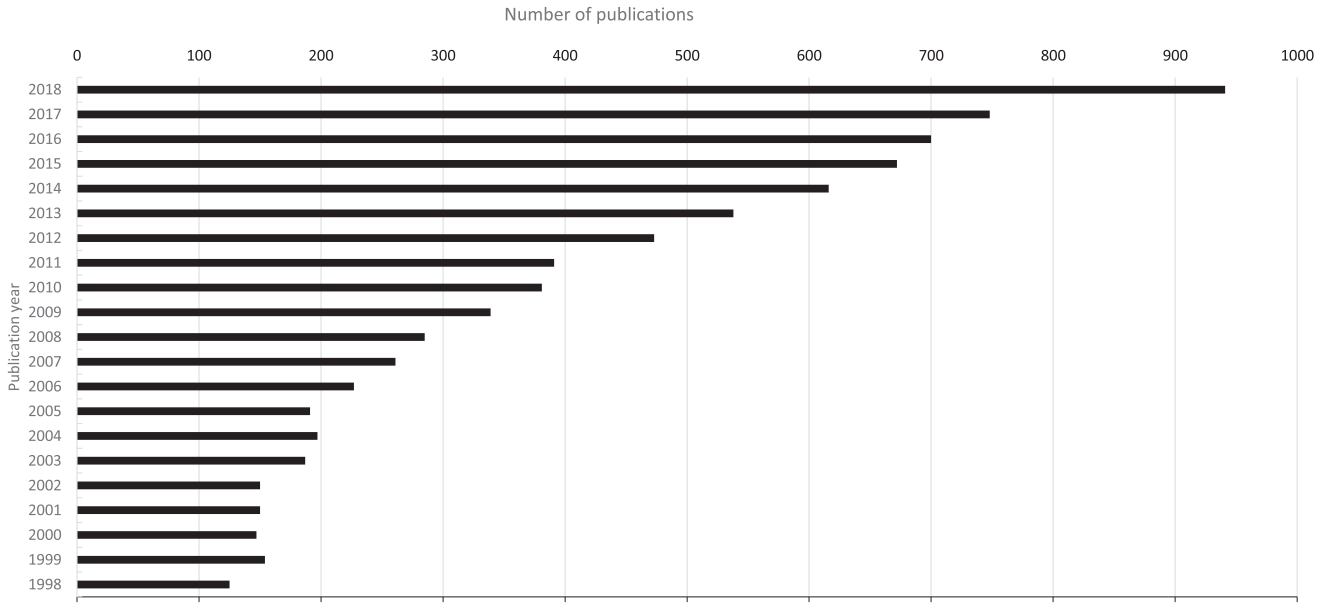

FIGURE 1 Number of publications per year listed in PubMed that contained reference to diet/food/nutrient score/index/pattern and cardiovascular disease up to 31 October 2018 (data extracted 12 December 2018).

these. Both reviewers thoroughly assessed the remaining 59 articles in full text. All were included in the review. The review identified 31 different dietary scores (Figure 2). **Supplemental Table 2** summarizes the main characteristics of the included studies and **Table 1** the main findings, including observational studies (16–74).

The indices were categorized as follows: *1*) country-specific dietary patterns, like the Mediterranean Diet Score (MDS) (75), the Dietary Approaches to Stop Hypertension (DASH) score (76), and the Nordic Food Index (NFI) (77); *2*) adaptations from recommended dietary guidelines, like the Healthy Eating Index (HEI) (78) and the UK Nutrient Profile Score (NPS) (54); and *3*) novel empirically derived scores focusing on specific properties or components, like the Dietary Inflammatory Index (DII) (79) as they may influence health outcomes. A narrative synthesis of studies is shown in **Supplemental Table 3**, where we present the number and percentage of studies that report a null or protective relation between CVD outcomes and each diet quality score reviewed. Additionally, we constructed a Venn diagram (**Figure 3**) using 4 diet scores: the 2 most commonly applied country-specific (DASH and MDS) and the 2 most commonly applied guideline intake scores (HEI and NPS) to identify and illustrate common components across a sample of scores.

Country-Specific Dietary Patterns and Associations with CVD

The most commonly applied score was MDS (Figure 1), but it is essential to recognize that there is no one or standard definition of the Mediterranean diet. The term generally refers to the diet typically consumed among people living in various countries surrounding the Mediterranean Basin as observed by Ancel Keys in the 1960s (80). For example, based on the traditional Greek diet, Trichopoulou and colleagues initially developed an MDS (81) using 9 foods and nutrients, others calculated MDS using up to 15 foods and nutrients (33, 49). Thus, calculation of the score is relative, based on the distribution of intakes observed within the population being studied, e.g., as quartiles or tertiles of intake. Each category is given a point, with equal weights assigned to each category, and the final score is the sum of total points. Most components included in the MDS are rich in antioxidants, but some have minimal or no known protective benefits, such as high intakes of refined grains and cereals, shown to have an adverse effect on CVD (82).

Trichopoulou et al. reported that adherence to MDS in a sample of 182 elderly Greeks was significantly associated with a 17% increased survival (81). Further development of MDS, studied in small- (83–85) and large-scale observational studies (53, 75, 84), demonstrated inverse relations between variations of MDS and all-cause mortality and cardiovascular events. Data from the European Prospective Investigation into Cancer and Nutrition (EPIC), including 22,043 Greeks, showed that higher conformity to MDS was inversely related to mortality from coronary artery disease (CAD) (75). Numerous meta-analyses of the relation between adherence to MDS and CVD incidence and mortality have found inverse associations (86–90); however, these meta-analyses suffered from methodological issues, such as incomplete literature searches, lack of sensitivity analyses, different selection of food groups for MDS among studies, and lack of

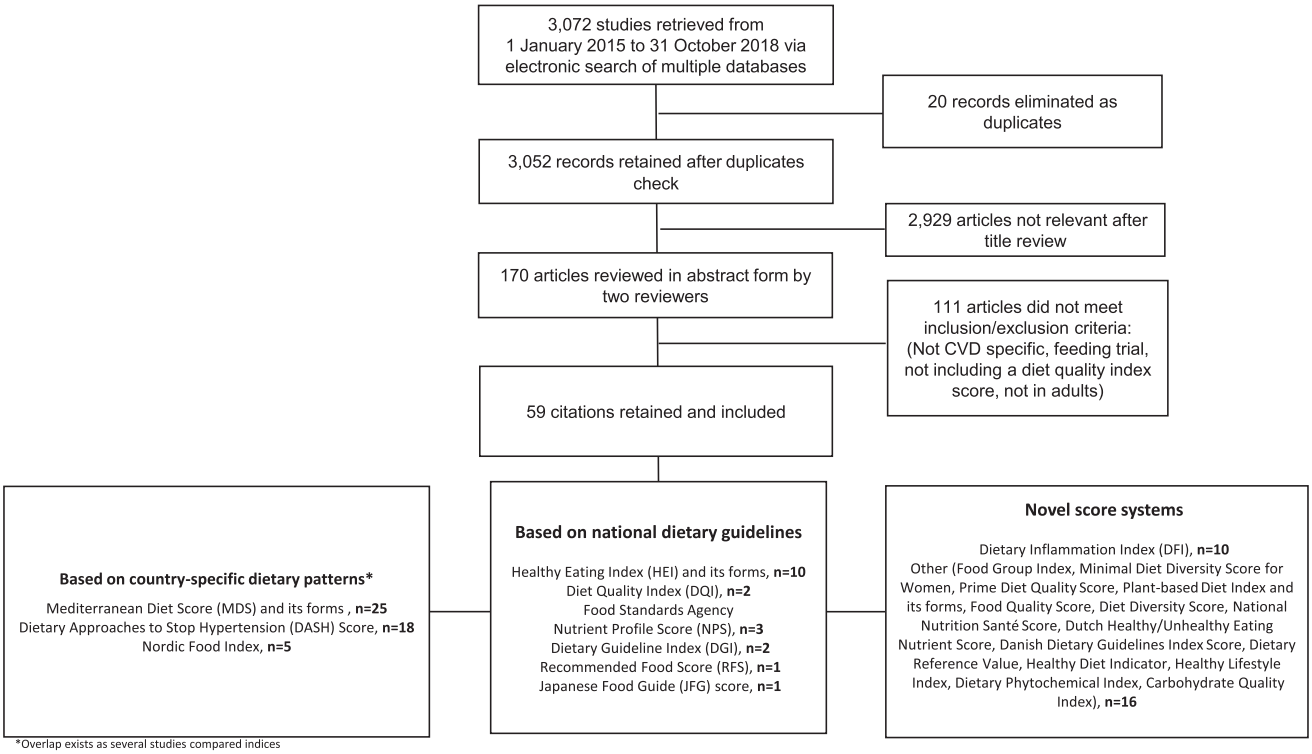

FIGURE 2 Search flow diagram of literature review process for studies investigating dietary patterns and CVD risk factors and/or CVD incidence and/or mortality. CVD, cardiovascular disease.

differentiation between types of CVD. Rosato and colleagues addressed these limitations in a recent meta-analysis of observational studies and demonstrated a 20–25% reduction in CAD and/or acute myocardial infarction (MI) with high adherence to MDS, showing stronger associations among participants residing in the Mediterranean region versus elsewhere (91).

Although some of the methodological limitations of previous systematic reviews were addressed in these analyses—others were not, such as applying MDS to populations outside the Mediterranean Basin where foods like olive oil are limited. In China, a high MDS was an independent predictor for low systolic blood pressure (BP) variability (35), but in the Czech Republic, Poland, and the Russian Federation, a significant but weak association between adherence to MDS and CVD mortality was reported (25). In Germany, MDS was also weakly associated with severity of CAD (36), and in Iran MDS was not associated with C-reactive protein (CRP), an inflammatory biomarker related to CVD (37). Other unaddressed methodological issues include lack of an agreed-upon definition of MDS identifying foods included or excluded and absence of any cutoff values (29, 47) (Supplemental Table 3).

The DASH score, developed by Dixon et al. in 2007, was based on food groups and nutrients encouraged or limited in the DASH diet (92). Score components range between 6 and 8 foods and nutrients (17, 55). Similar to MDS, the DASH scoring system is relative—based on quantiles of sex-specific intakes, with equal weights assigned to each component; the overall score is the sum of all individual scores.

A recent systematic review and meta-analysis of prospective cohort studies totaling 260,011 men and women showed that, compared with the lowest compliance to the DASH diet, the highest compliance was associated with a 20% reduction in the risk of CVD (93). Another form of the score, the Modified DASH score, which does not account for sodium intake, also showed inverse associations with incidence of CAD (17). Fung and colleagues also found beneficial effects of adhering to the DASH diet in reducing inflammation at the 24-y follow-up in women from the Nurses' Health Study, with no previous history of CVD (76). The recent systematic review and meta-analysis of randomized controlled trials by Soltani et al. confirmed findings by Fung and colleagues: the beneficial effects of the DASH diet are due not only to reductions in BP but also to improvements in inflammatory biomarkers, which are suggested to reduce CVD events (94). Based on these findings, the American Heart Association recommended the DASH diet in their Guidelines on Lifestyle Management to Reduce Cardiovascular Risk, with a strong level of evidence for reducing CVD risk (95).

However, the cardioprotective effects of the DASH diet were more prominent in hypertensive than in normotensive individuals (96) and in individuals from ethnic minority backgrounds than in Caucasians (97). Moreover, the asso-

TABLE 1 Summary of main findings of observational studies investigating the relation between CVD and CVD risk factors and dietary scores[1]

Study (reference)	Country	Dietary score	Main findings
USA			
Aigner et al, 2018 (16)	USA	HEI, AHEI, DASH	All scores: low-quality diet associated with ↑ risk of stroke mortality (4.6-y follow-up); HEI-2010 was strongest predictor. Associations varied by ethnicity
Dijousse et al, 2018 (17)	USA	Modified DASH	↑ Modified DASH score associated with ↓ CAD
Fung et al, 2018 (18)	USA	FGI, MDDS for women, PDQS	FGI not associated with total IHD in any cohort (26-y follow-up) PDQS ↓ IHD in all 3 cohorts MDDS ↓ IHD in 2 of 3 cohorts
Satija et al, 2017 (19)	USA	PDI, hPDI, uPDI	↑ PDI independently associated with ↓ CAD ↑ hPDI independently associated with ↓ CAD ↑ uPDI associated with ↑ CAD
Shivappa et al, 2017 (20)	USA	DII	DII (proinflammatory diet tertile 3 vs. tertile 1) ↑ associations for CVD mortality
Fung et al, 2016 (21)	USA	FQS	Comparing top to bottom deciles, ↓ total CAD (26-y follow-up), independent of established risk factors (body weight, physical activity, smoking)
Li et al, 2016 (22)	USA	DASH, AHEI, AMD	AHEI, AMDS, DASH ↓ risk of hypertension (18.5-y follow-up). Comparing the extreme quartiles (highest and lowest) AMDS largest effect size
Mattei et al, 2016 (23)	USA	AHEI	↓ MetS (modified by ethnic background), ↓ waist circumference, BP, and glucose (Mexicans and Puerto Ricans) and with ↓ TAG (Mexicans) ↑ HDL cholesterol (Puerto Ricans and Central Americans)
Frazier-Wood et al, 2015 (24)	USA	HEI	Women: HEI score not associated with any CVD risk factors Men: HEI score associated with ↓ fasting insulin, ↓ HOMA-IR, ↓ HDL-C, ↓ TAG and ↓ CRP (not significant post adjustment for BMI)
Sotos-Prieto et al, 2015 (25)	USA	HEI, AHEI, modified MDS, DASH	Compared diet stability in each 4-y period, ↑ diet quality scores associated with ↓ CVD risk in the subsequent 4-y period
Tsivgoulis et al, 2015 (26)	USA	MDS	MDS ↓ incident ischemic stroke no association with incident hemorrhagic stroke (6.5-y follow-up)
Southern Europe			
Shivappa et al, 2018 (27)	Italy	DII	DII (proinflammatory diet tertile 3 vs. 1) ↑ CVD mortality
Verde et al, 2018 (28)	Italy	MDS	↑ MDS associated with ↓ hypertension
Vitale et al, 2018 (29)	Italy	Relative-MDS	↑ R-MDS associated with ↓ plasma lipids, BP, and BMI
Bendinelli et al, 2018 (30)	Italy	HEI, DASH, MDS, IMI	IMI, DASH, and HEI were significantly and inversely associated with SBP and DBP. Strongest association between IMI and both SBP and DBP Women: ↓ association between IMI, SBP, and DBP Men: ↓ association between DASH and DBP MDS not associated with SBP or DBP
Bonaccio et al, 2017 (31)	Italy	MDS, Diet Diversity Score	2-point increase in MDS associated ↓ CVD risk (4.3-y follow-up). Stronger association in high income groups
Alvarez-Alvarez et al, 2018 (32)	Spain	MDS (4 versions), DASH	Compared with the lowest category of adherence to the 3 of the 4 MDS (MEDAS no significant association), higher adherence associated with ↓ CVD (10.4-y follow-up) DASH: no significant associations across extreme score categories, ↓ linear trend
Aleman et al, 2016 (33)	Spain	MDS	Lower MSD associated with ↑ prevalence of hypertension
Eguaras et al, 2015 (34)	Spain	MDS	↑ Risk of CVD across categories of BMI with ↓ adherence to MDS
Garcia-Arellano et al, 2015 (35)	Spain	DII	Risk ↑ across the quartiles (increasing inflammatory potential) incidence CVD (4.8-y follow-up)
Ramallal et al, 2015 (36)	Spain	DII	DII (proinflammatory diet highest vs. lowest quartile) ↑ CVD event (8.9-y follow-up)
Georgousopoulou et al, 2016 (37)	Greece	DII	Higher DII (anti-inflammatory diet): borderline association with ↓ 10-y CVD incidence

(*Continued*)

TABLE 1 (*Continued*)

Study (reference)	Country	Dietary score	Main findings
Kastorini et al, 2016 (38)	Greece	MDS	Per 10% increase MDS ↓ CVD incidence (8.4-y follow-up)
Northern Europe			
Adriouch et al, 2017 (39)	France	FSA-NPS	↑ CVD risk with lower diet quality (12.4-y follow-up). Association stronger in overweight
Lelong et al, 2016 (40)	France	PNNS score, DASH, MDS	PNNS, DASH, and MDS ↓ associated with systolic BP (women only) No significant association found in men
Neufcourt et al, 2016 (41)	France	DII	DII (proinflammatory diet highest vs. lowest quartile) ↑ MI (11.4-y follow-up)
Alkerwi et al, 2015 (42)	Luxembourg	DQI-I, DASH, MDS, DII	↑ DASH score and MDS were associated with ↓ DBP
Sijtsma et al, 2015 (43)	Netherlands	DHNaFS, DUNaFS	Q5 vs. Q1 DHNaFS: 30% ↓ CVD risk DUNaFS not related to CVD risk
Lemming et al, 2018 (44)	Sweden	Modified MDS, Healthy NFI	MDS (mMED) and NFI high-adherence categories vs. low-adherence categories ↓ mMED showed stronger association
Boden et al, 2017 (45)	Sweden	DII	Male participants with the most proinflammatory DII scores ↑ risk of MI (6.4-y follow-up). No association found between DII and MI in women
Roswall et al, 2015 (46)	Sweden	NFI	No association between the healthy NFI and overall CVD (21.3-y follow-up)
Tektonidis et al, 2015 (47)	Sweden	Modified-MDS	↑ MDS associated with ↓ risk of MI
Galbete et al, 2018 (48)	Germany	NFI, MDS,	Nordic diet, MDS, and MedPyr not associated with incidence of MI
Waldeyer et al, 2018 (49)	Germany	MDS	↑ MDS associated with ↓ SYNTAX score
Phillips et al, 2018 (50)	Ireland	DASH score	↑ DASH score associated with ↓ BMI, tumor necrosis factor α (TNF-α), interleukin 6 (IL-6) Q4 of DASH score associated with lower obesity and metabolic syndrome, respectively, compared to Q1
Arentoft et al, 2018 (51)	Denmark	Danish Dietary Guidelines Index	Lower score: ↓ LDL:HDL ratio, ↑ HDL-cholesterol; Men: ↓ BMI, trunk fat, high-sensitivity C-reactive protein, HbA1c; Women: ↑ systolic BP
Hansen et al, 2018 (52)	Denmark	Danish Dietary Guidelines Index	Higher Danish Dietary Guidelines Index score ↓ total incidence stroke in men but not in women. In women, ↓ total incidence ischemic stroke
Stefler et al, 2017 (53)	Czech Republic, Poland, and the Russian Federation	MDS	One SD increase in the MDS ↓ associated with CVD mortality but not with CAD
Eriksen et al, 2018 (54)	UK	FSA-NPS, UK DRV score	2-point increase in NP score associated with ↓ total cholesterol and HbA1c 2-point increase in DRV score associated with ↓ waist circumference, BMI, total cholesterol and HbA1c
Gibson et al, 2018 (55)	UK	DASH	Lower DASH (poor diet quality) ↑ cardiometabolic risk (metabolic syndrome)
Jones et al, 2018 (56)	UK	DASH	Compared with participants with the least DASH-accordant diets, those with the most DASH-accordant diets ↓ risk incident stroke and total incident CVD (12.4-y follow-up). No association with risk of CAD
Mytton et al, 2018 (57)	UK	FSA-NPS	No association between consumption of less-healthy food and incident CVD or CVD mortality (fully adjusted)
Maddock et al, 2018 (58)	UK	DASH	Across quintiles, higher DASH-type diet ↓ BP, TAG, PWV, ↑ HDL-cholesterol (30-y follow-up)
Tong et al, 2016 (59)	UK	MDS (4 versions: pyramid-based MDS, literature-based MDS, median MDS and tertile MDS)	All MDS ↓ incidence of the cardiovascular outcomes, MDS dietary pyramid showed strongest effect (17-y follow-up)
Lassale et al, 2016 (60)	Pan-Europe (10 countries)	NFI, MDS (3 versions), HLI, WHO HDI, DASH, DQI	All dietary scores: ↓ associations CVD mortality (12.8-y follow-up), stratified results by country showed differential associations between scores and CVD mortality)
Asia			
Bai et al, 2017 (61)	China	DASH	Stratified results reported: normal BMI, DASH-style diet and physical activity: ↓ incidence hypertension (11-y follow-up)

(*Continued*)

TABLE 1 (*Continued*)

Study (reference)	Country	Dietary score	Main findings
Lau et al, 2015 (62)	China	MDS	↑ MDS was an independent predictor for ↓ systolic BPV
Murakami et al, 2018 (63)	Japan	JFG score, MDS, DASH	JFG and mJFG scores ↑ LDL-cholesterol, MDS ↓ HDL cholesterol No associations of DASH score with BP
Kim et al, 2018 (64)	Korea	CQI	Highest quintile CQI ↓ prevalence of obesity and hypertension
Tiong et al, 2018 (65)	Philippines and Malaysia	Modified DASH score	Modified DASH score not significantly associated with CVD risk in the Malaysian cohort ↑ Modified DASH score associated with ↓ SBP, ↓ DBP, ↓ total cholesterol, ↓ LDL, and ↓ triglyceride in the Philippines cohort
Neelakantan et al, 2018 (66)	Singapore	AHEI, Modified-MDS, DASH, HDI	↑ diet index scores associated with a ↓ risk of CVD mortality
Australia			
Hodge et al, 2018 (67)	Australia	DII, MDS	MDS and DII (less inflammatory) diets ↓ total, CVD, and CAD mortality. No difference in effect size between DII and MDS with CVD mortality
Livingstone et al, 2018 (68)	Australia	DGI	DGI associated with ↓ glucose, BMI, waist circumference
Livingstone et al, 2016 (69)	Australia	DGI, RFS	DGI and RFS (highest vs. lowest tertile) ↓ hypertension (DGI stronger effect size, and stronger in obese) in men not women
Vissers et al, 2016 (70)	Australia	DII	DII (proinflammatory diet) ↑ risk of myocardial infarction (no association fully adjusted models), no association found for total CVD, IHD, or cerebrovascular disease
Middle East			
Daneshzad et al, 2018 (71)	Iran	Modified-NFI	↑ modified-NFI associated with ↓ LDL, ↓ SBP, ↓ risk of obesity
Sakhaei et al, 2018 (72)	Iran	DASH, MDS	↑ DASH diet associated with ↓ serum CRP concentrations but not with IL-17A concentrations; ↑ MDS associated with ↓ circulating IL-17A concentrations but not with hs-CRP concentrations
Saraf-Bank et al, 2017 (73)	Iran	HEI	HEI (highest vs. lowest quartile) ↓ risk of MetS and individual risk factors
Golzarand et al, 2015 (74)	Iran	DPI	No association with systolic and diastolic blood pressure across Q categories of DPI

[1]Direction of associations based on headline results reported in the study between dietary score exposure and cardiovascular outcomes. ↑ denotes increase/direct and ↓ decrease/inverse. AHEI, alternative HEI; AMDS, alternative MDS; BMI, body mass index; BP, blood pressure; CAD, coronary artery disease; CQI, carbohydrate quality index; CVD, cardiovascular disease; DASH, Dietary Approaches to Stop Hypertension Trial; DBP, diastolic blood pressure; DGI, Dietary Guideline Index; DII, Dietary Inflammation Index; DPI, Dietary Phytochemical Index; DQI-I, Diet Quality Index-International; DRV, dietary reference value; DHNaFS, Dutch Healthy Nutrient and Food Score; DUNaFS, Dutch Undesirable Nutrient and Food Score; FSA-NPS, Food Standards Agency nutrient profile score; hPDI, healthful PDI; HbA1c, glycated hemoglobin; HEI, Healthy Eating Index; IHD, ischemic heart disease; IMI, Italian Mediterranean Index; JFG, Japanese Food Guide; MDDS, minimal diet diversity score; MEDAS, Mediterranean Diet Adherence Screener; MDS, Mediterranean Diet Score; MetS, metabolic syndrome; NFI, Nordic Food Index; mMED, modified Mediterranean Diet score; PDQS, prime diet quality score; PNNS, Program National Nutrition Santé; Q, quartile of score; RFS, Recommended Food Score; SBP, systolic blood pressure; TAG, triacylglycerol; uPDI, unhealthful Plant-based Diet Index.

ciation of DASH score with CVD risk factors differed by country in which it was applied (65). The DASH dietary score does not apply a cutoff value for maximum intake, which may overestimate the final score. In addition, the score does not differentiate between types of dietary fat nor account for intake of other foods associated with CVD risk, like fish (98). The DASH diet was initially based on dietary factors that were shown to lower BP, including reduced intake of sodium, alcohol, and red and processed meat and higher intake of fruits, vegetables, and low-fat dairy foods (96), thereby supporting cardiometabolic health. Basing the DASH diet score on an FFQ raises concerns, especially for quantifying sodium intake. For large-scale cohort studies, an alternative approach for measuring sodium intake used a salt-based questionnaire that improved accuracy by 7–13% (99).

The NFI, less commonly used, is based on frequently consumed foods in the Nordic countries (the Scandinavian region), such as whole grains, fruits, low-fat dairy products, fatty fish such as salmon, and cabbage and root vegetables, with a focus on the intake of organic foods and healthy fat (100). The number of components included in the score range between 6 and 9 (48, 71). The Nordic scoring system is relative and is based on distribution of intake above and below median consumption, with equal weights assigned to each category, and without applying a cutoff value for maximum intake. The overall score is the sum of individual scores.

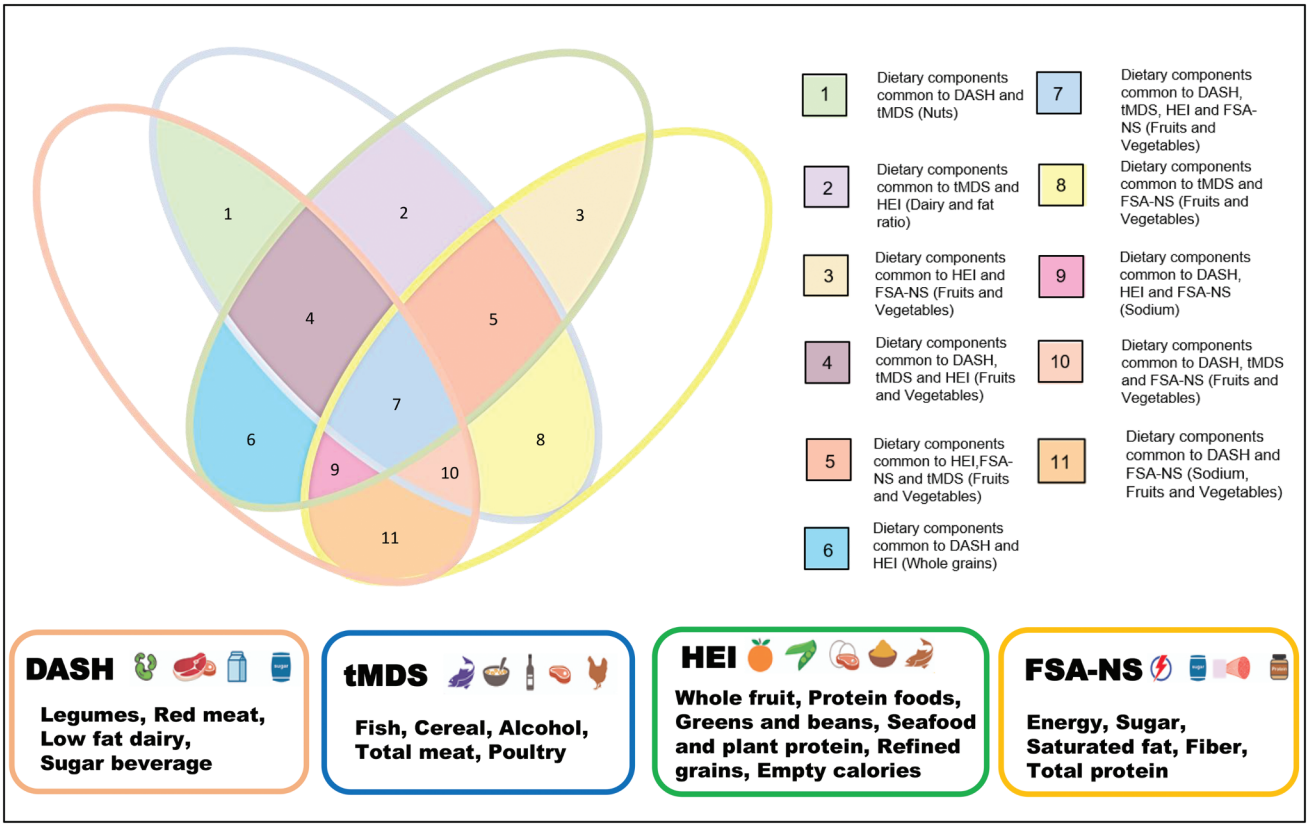

FIGURE 3 Venn Diagram illustrating unique and shared food and nutrient groups of 4 predominantly food-based scores: DASH, Dietary Approaches to Stop Hypertension Trial; FSA-NP, Food Standards Agency Nutrient Profile; HEI, Healthy Eating Index; tMDS, Traditional Mediterranean Diet Score. Across the 4 scores there were 13 duplicate and 20 unique dietary components or grouping of components.

Adherence to the NFI showed inconsistent results (46, 66). In German participants, there was no significant association between higher adherence to the score and MI (48). Likewise in an Iranian population, after adjustment for dietary and lifestyle confounders, no significant association between the score and BP was observed (71). Nonadherence to the diet, especially in non–Nordic region populations, and lack of a uniform Nordic diet (46, 77) are likely confounders.

Dietary guidelines–based scores

The HEI was originally developed in 1995 to evaluate level of adherence to US dietary guidelines (78). The index was updated several times, with the most widely used version in our review being the HEI-2010, although there is now an updated 2015 version. The HEI-2010 includes 12 components of foods and nutrients, based on amounts per 1000 kcal (101). Each component has a minimum score of zero and a maximum score of 10 using weighted means, with the sum of all scores used as the final score.

An alternative version [alternative HEI (AHEI)-2010] was developed based on absolute values (102), with both scores (HEI and AHEI) used widely in relation to CVD (103). Data from a large prospective cohort study of 424,662 participants aged 50–71 y showed that the reductions in CVD mortality associated with the highest and lowest HEI and AHEI scores were 15% and 26%, respectively (104), although the risk of CVD mortality in obese women was not reported, raising issues regarding generalizability (105). HEI-2010 includes both foods and nutrients that may overlap, such as total vegetables and plant proteins that may alter the score, especially when an FFQ was the source of intake data, including sodium.

Another dietary index, the UK Nutrient Profile Score (NPS), scores foods and nutrients as either beneficial (negative score), such as fruits and vegetables, or detrimental (positive score), like total sugar and sodium (57). This score was originally designed to identify less healthy foods in order to restrict TV advertisement to children and not to prevent CVD specifically (106). Regardless, researchers have explored the utility of this score system in CVD prevention in adult populations (54, 57), but no significant associations between consumption of less healthy food assessed using UK NPS and incident CVD were observed in the EPIC-Norfolk cohort (57). UK NPS does not account for important nutrients like mono- and polyunsaturated fats and does not differentiate between refined and whole grains. Thus, certain scoring systems may not be applicable to other diseases or population groups.

An additional score based on the UK dietary guidelines is the Dietary Reference Values index, which reflects the adherence to Public Health England dietary policy for optimal

health and prevention of CVD (54). Higher adherence to the score was inversely associated with BMI in the Airwave Health Monitoring cohort, but not with BP (54).

Novel scores

Conceptually, a dietary index or score has evolved to become more specialized as more detailed associations between certain foods/nutrients/diets and biologic outcomes or mechanisms are identified. Recently, the NHANES III follow-up study of 12,366 participants reported a positive association between a proinflammatory diet and CVD mortality (20). The DII focuses on potential inflammatory aspects of the diet thought to be associated with development of risks for a variety of diseases (79). After an extensive review of the literature, Shivappa et al. compiled the DII using data from 11 countries for the effects of 45 food components on several inflammatory biomarkers. A higher DII score correlates with a proinflammatory, less healthy dietary profile and, conversely, a lower DII score correlates with an anti-inflammatory, healthier dietary profile (79).

The DII is calculated based on intakes of foods and nutrients using standard global means for reference, where the standard mean is subtracted from the actual intake and divided by its standard deviation. Values are then converted to percentiles to minimize the effect of right skewing. Foods and nutrients are scored between −1 (maximally anti-inflammatory) and +1 (maximally proinflammatory), with each percentile score doubled, and 1 is subtracted and multiplied by its respective "overall food parameter–specific inflammatory effect score" to obtain the "food parameter–specific DII score." The overall score is the sum of all individual scores.

However, the DII is mainly based on nutrients that are difficult to estimate from dietary recording methods (e.g., use of herbs, including pepper and thyme), which adds to the complexity of index calculation. Due to this limitation, we found studies that have modified this score to include a reduced number of components (36, 41, 45) (Supplemental Table 2).

Sijtsma and colleagues developed 2 dietary scores, the Dutch Undesirable Nutrient and Food Score, including 13 food groups, and the Dutch Healthy Nutrient and Food Score, including 11 food groups, and investigated their relations to CVD mortality risk in 4837 patients with MI undergoing drug treatment (43). Calculation of the score is relative, where nonconsumers are coded 0 and consumers are divided into quartiles of intake (1 to 4), with equal weights given to each food group and no cutoffs used for maximum intake. Since a large number of components are included in the score, an overlap between foods and nutrients (e.g., processed meat and sodium) may exist, causing large variations in the scores.

In recent years, increased attention has been given to plant-based foods and CVD and its risks. Plant-based diets have previously been linked with a lower incidence of CVD than animal-based diets (107, 108). Available evidence, however, has focused mainly on the relation between vegetarian diets and CVD risk and has showed inconsistent results (109–111). Many prospective cohort studies and trials on the relation between plant-based diets and CVD (109, 110, 112–114) have limitations. Some investigations consider plant-based diets to be "vegetarian" diets; some investigations fail to distinguish between types of plant-based foods, like refined grains and sugar-sweetened beverages. To address these limitations, Satija et al. (19) created an overall, graded plant-based diet index (PDI) with positive scores for plant foods and reverse scores for animal foods, totaling 18 food groups. The authors then derived from the PDI a healthful PDI (hPDI) and an unhealthful PDI (uPDI).

Calculation of the score is based on quintiles of intake, with a score of 5 given to participants above the highest quintile of a food group and a score of 1 to those below the lowest quintile. The scoring system is inversed for reverse scores. Therefore, PDI is calculated by giving positive scores to plant foods and reverse scores to animal foods, hPDI is calculated by giving positive scores to healthy plant food groups and reverse scores to less healthy plant food groups and animal food groups, uPDI is calculated by giving positive scores to less healthy plant food groups and reverse scores to healthy plant food groups and animal food groups. The overall score is the sum of all scores. This score is unique in that it distinguishes between healthful and unhealthful plant foods. However, similar to previous scores, equal weights are assigned to each food group and no cutoffs are used for maximum intake, which may lead to an overestimation of the overall score. Moreover, an overlap may exist, with scoring of some components, like animal fat and meat, causing large variations in the scores.

Studies that compare different scores

Due to the plethora of diet quality indices, some studies compared the association between adherence to the above-mentioned indices and CVD and its risk factors (25, 42). Sotos-Prieto and colleagues compared AHEI, modified MDS, and DASH score in relation to CVD risk during the first 4-y follow-up in the Health Professionals Follow-up Study involving 29,343 men and the Nurses' Health Study including 51,195 women (25). Higher AHEI and DASH scores and a higher modified MDS were inversely associated with long-term CVD risk. Sotos-Prieto and colleagues concluded that AHEI and DASH scores have more components in common (e.g., sugar-sweetened beverages, red and processed meat, and sodium intake) than they have with modified MDS. AHEI and modified MDS both include alcohol, whereas the DASH score does not. When alcohol was removed from AHEI and modified MDS in sensitivity analysis, the association between AHEI and CVD/CAD risk was attenuated to null for the highest quintile of change in AHEI (25).

Alkerwi and colleagues also compared diet quality indices [Recommendation Compliance Index (RCI), Diet Quality Index-International (DQI-I), DASH score, MDS, and DII] in relation to CVD risk factors (42). Adherence to the diet quality indices was assessed in 1352 participants using an FFQ and results showed inverse associations with lipids.

DASH and MDS, but not RCI or DQI-I, showed inverse relations with diastolic BP (42). It is noteworthy that RCI and DQI-I treat poultry, fish, dairy, beans, and eggs as one group.

In a cross-sectional analysis of the EPIC-Norfolk, the relations of HEI-2010, DASH score, MDS, and the Italian Mediterranean Index (IMI) to BP were compared (30). IMI is similar to MDS but includes additional food groups commonly consumed in Italy, such as soft drinks, alcohol, butter, red meat, and potatoes. All dietary indices were inversely associated with both systolic and diastolic BP, with strongest associations observed between IMI and both systolic and diastolic BP in women only and between DASH score and diastolic BP in men only (30).

Perspectives

A closer examination of the components of diet quality scores reveals that protective effects against CVD stem from components such as fruit, vegetables, legumes, nuts, fish, and moderate amounts of alcohol (115, 116). Many of these scores include monounsaturated fatty acids, fiber from vegetables, fruit, cereals, and legumes and contain high amounts of antioxidants like vitamins C and E in addition to flavonoids and polyphenols (81). All nutrients and nonnutrient compounds within the food matrix work synergistically and some specific combinations may directly protect against CVD. For example, the combination of compounds found in olive oil and green leafy vegetables, a characteristic of the Mediterranean diet, modified signaling pathways related to BP control (117). Other benefits of adhering to diet quality scores may occur through improvements in CVD risk factors, such as normalization of triglyceride concentrations, total blood cholesterol, low-density lipoprotein, high-density lipoprotein, and BP (28).

We highlight 2 beneficial food groups consistently included in some of the most common score algorithms—fruit and vegetables (Figure 3). Strong and consistent evidence shows that higher fruit and vegetables intake is beneficial to cardiometabolic health (118), since these foods are rich in fiber, vitamins, and phytochemicals and low in energy density. The equal weighting given to these food groups makes it challenging to determine whether they drive the effect of diet quality scores on CVD. Some scores have specified subgroups within fruits and vegetables (NFI, dietary phytochemical index; Supplemental Table 2); use of such scores is challenging in regions with infrequent or varied intake.

Moreover, the dietary collection tool needs to capture intake of these specific components—which may be a limitation of some established predefined FFQ lists. Although detailed categorization presents challenges in assessment, clarity is needed when broad fruit and vegetable categories are reported in a score. The traditional Greek MDS includes potato (a source of potassium) in the vegetables category, a food group later excluded from alternative MDS (119) when adapted to the US population. Additionally, there are variations in the assessment of fruit and vegetables; AHEI distinguishes whole fruit from other sources such as fruit juice (23).

Additionally, we found the majority of indices to assign equal weighting to all foods in a score, leading to an overestimation of the final score. Not all foods, however, contribute equally to a health outcome. Some indices combined certain groups; for example, the DQI-I treats poultry, fish, dairy, beans, and eggs as 1 group without differentiating their effects on CVD and its risk factors.

It is also important to understand how diet components are converted to a score. Scores can be calculated either by using absolute cutoff values (e.g., higher or lower than a predefined level, as usually applied to scores based on country-specific intake guidelines) or based on the relative distribution of intakes within a population (e.g., DASH score is based on quantiles of sex-specific intakes). Compared with relative intake score systems, absolute cutoff values can limit score overestimation and allow comparison and pooling of studies for meta-analyses. For example, the dietary profile of a high MDS in a southern European population will be quite different from a high score in a northern European population. In the original MDS study (81), the median intake cutoff value used was ∼360 g/d of fruit and nuts in a Greek population, whereas in a UK study the value used was 213 g/d (59). Moreover, the ratio of MUFA to SFA was ∼1.7 in the Greek cohort and 0.9 in the UK cohort. This example illustrates the challenge of comparing outcomes across different population groups using relative scores. An important question when interpreting the utility of the MDS in different population groups is whether intakes of the food reflect the levels typically observed in southern Mediterranean populations.

We also observed that the number of dietary components can vary greatly across different scores from the carbohydrate quality index and versions of the NFI with 4 and 6 components, respectively, to the DII with up to 45 different components. Figure 3 compares dietary components across a sample of scores reviewed. The components are often weighted as "positive" (healthy) or "negative" (unhealthy) in scores. Most scores have focused on increasing the intake of healthy foods rather than limiting unhealthy foods, resulting in a higher number of positively scored components than negatively scored components. For example, DASH includes 5 healthy and 3 unhealthy components and MDS includes 7 healthy and 2 unhealthy. Therefore, we need to consider uncontrolled confounding by "healthy" foods and if there should be more emphasis on avoiding "unhealthy" foods.

The positive or negative classification is also differentially weighted between scores. For example, in the traditional MDS algorithm, dairy is classified as a component to limit, based on the traditional MD, whereas evidence from the DASH trial has shown that low-fat dairy is beneficial in relation to BP management (120). The alternative MDS published in 2005 omitted dairy from the scoring algorithm based on the benefit of low-fat dairy on cardiometabolic health (119). Another important example is the inclusion of alcohol in the traditional MDS but not in DASH. Red wine

was traditionally consumed in the Southern Mediterranean (121). However, in the MDS, alcohol (ethanol grams/day) is included in the score but the source (e.g., wine) is not specified. Alcohol is a nonessential nutrient contributing significantly to energy intake. Evidence on the benefits of moderate alcohol intake on cardiometabolic health is contradictory. As part of the MDS, moderate alcohol intake may prove beneficial (75). However, excessive alcohol intake is associated with CVD intermediaries including hypertension and atrial fibrillation (122). The moderate alcohol consumption levels suggested by the MDS (up to 3 units per d) contradict UK Public Health England guidance of a safe limit for alcohol consumption (123).

It is important to consider how much of a population's typical diet is represented by any score. The food standard agency NPS includes all items consumed in a population's diet, whereas the DASH score covers only part of the diet (39, 55). The impact of partial diet representation in these scores depends on whether the dietary components included in the score drive health outcomes or the dietary components not included are highly correlated with those driving benefit.

A final consideration is that even when the same score system was used across studies, various modifications were found (17, 22, 29, 71). Lack of consensus in defining different scores leads to variations that may cause misclassification of score categories. As presented in this review, there is a large amount of heterogeneity across families of diet quality scores in terms of food groups included and cutoffs applied in calculations (Supplemental Table 3). Assessing the relations between the different diet quality scores and individual CVD outcomes is outside the scope of this review. Although we have constructed a narrative summary to illustrate the general direction of associations with combined CVD outcomes, researchers should be cautious in the pooling of studies for analytical assessment based on the heterogeneity in the calculation and application of seemingly similar diet quality scores.

Challenges in universal application

In review of diet quality indices, it is important to account for cultural differences when applying a score, such as in the availability of various foods (e.g., olive oil), or in food preparation and consumption. Cooking methods vary across cultures; chicken can be boiled, deep fried, or roasted, each producing a different dietary quality. Reflecting cultural differences, the MDS was found to have stronger inverse associations with CVD mortality in Spain than in the Netherlands (60). Applying Western developed scores like the DASH score in China is challenging because dairy intake, especially low-fat dairy, is generally low in Chinese populations (124). Other factors like age, gender, race, physical activity level, and presence of comorbidities are also important considerations when applying diet quality indices.

Methods of dietary data collection are important in the use of diet quality indices. Use of 24-h dietary recalls and FFQs may fail to capture seasonal variations in intake, and use of single measures of FFQ, as seen in many of the studies reviewed here, is particularly subject to measurement error and may not accurately assess intake of certain nutrients like sodium, a major component of the DASH score.

Moreover, there is a lack of objective validated measures of diet quality scores. Although the field of metabolomics is progressing in the use of objective measures of specific foods and nutrients (125), only 2 studies investigating the use of metabolomic profiles distinguished high and low adherence to a priori dietary patterns (126). Advances in molecular epidemiology also have the potential to elucidate mechanisms linking dietary patterns to cardiometabolic outcomes (125).

Finally, identifying diet quality based on the indices discussed here is a challenge. Because scores can assess only one aspect of food intake, implementation at a population level will be the future challenge for public health nutrition practitioners considering several factors like social status, education, accessibility to healthy food stores, compliance, and other lifestyle and behavioral aspects that can affect adherence to a healthy dietary pattern (127).

Conclusions

The present review identifies a pressing need for population-specific dietary indices that can accurately monitor CVD risk and related risk factors based on cultural patterns and lifestyles. **Box 1** lists recommendations for the future application and interpretation of dietary indices in nutritional epidemiologic studies investigating diet quality and cardiovascular health.

Box 1:
Recommendations for the future application and interpretation of dietary indices in nutritional epidemiologic studies investigating diet quality and cardiovascular health.

- Clearly define foods/beverages, nutrients, or other food components included in scores for replication of calculations on other population cohorts.
- If modifying a previously reported score, state the modification and the rationale.
- Use clearly defined cutoff values, or scoring systems based on specified amounts (e.g., per 1000 kcal).
- Report systematic statistical identification of key components within each score that drive association with outcomes [e.g., testing independent associations between individual dietary components in a score and cardiovascular disease (CVD) outcomes].
- Consider food as well as nutrients when interpreting a score. For example, scores that rely only on foods may overlook the importance of the intercorrelation of nutrients such as calcium and magnesium with CVD outcomes.

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References

1. Forouzanfar MH, Alexander L, Anderson HR, Bachman VF, Biryukov S, Brauer M, Burnett R, Casey D, Coates MM, Cohen A, et al. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks in 188 countries, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet 2015;386(10010):2287–323.
2. Global Burden of Disease Study. Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet 2015;385(9963):117–71.
3. Konstantinov IE, Jankovic GM, Alexander I. Ignatowski: a pioneer in the study of atherosclerosis. Texas Heart Inst J 2013;40(3):246–9.
4. Keys A. Coronary heart disease in seven countries. 1970. Nutrition 1997;13(3):250–2.
5. Aburto NJ, Hanson S, Gutierrez H, Hooper L, Elliott P, Cappuccio FP. Effect of increased potassium intake on cardiovascular risk factors and disease: systematic review and meta-analyses. BMJ 2013;346:f1378.
6. Del Gobbo LC, Imamura F, Wu JH, de Oliveira Otto MC, Chiuve SE, Mozaffarian D. Circulating and dietary magnesium and risk of cardiovascular disease: a systematic review and meta-analysis of prospective studies. Am J Clin Nutr 2013;98(1):160–73.
7. Clifton PM, Keogh JB. A systematic review of the effect of dietary saturated and polyunsaturated fat on heart disease. Nutr Metab Cardiovasc Dis 2017;27(12):1060–80.
8. Rhee JJ, Cho E, Willett WC. Energy adjustment of nutrient intakes is preferable to adjustment using body weight and physical activity in epidemiological analyses. Public Health Nutr 2014;17(5):1054–60.
9. Estruch R, Ros E, Salas-Salvadó J, Covas M-I, Corella D, Arós F, Gómez-Gracia E, Ruiz-Gutiérrez V, Fiol M, Lapetra J, et al. Primary prevention of cardiovascular disease with a Mediterranean diet supplemented with extra-virgin olive oil or nuts. N Engl J Med 2018;378(25):e34.
10. Sacks FFMF, Svetkey LLP, Vollmer WWM, Appel LJ, Bray GA, Harsha D, Obarzanek E, Conlin PR, Miller ER, 3rd, Simons-Morton DG, et al. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. N Engl J Med 2001;344(1):3–10.
11. US Department of Agriculture, US Department of Health and Human Services. Dietary guidelines for Americans. 8th Edition. Washington, DC: US Government Printing Office; 2015.
12. Wirt A, Collins CE. Diet quality—what is it and does it matter? Public Health Nutr 2009;12(12):2473–92.
13. Patterson RE, Haines PS, Popkin BM. Diet quality index: capturing a multidimensional behavior. J Am Diet Assoc 1994;94(1):57–64.
14. Guerrero MLP, Pérez-Rodríguez F. Diet quality indices for nutrition assessment: types and applications, functional food. In: Functional food—improve health through adequate food. 2017. IntechOpen, doi:10.5772/intechopen.69807.
15. Panagiotakos D. α-Priori versus α-posterior methods in dietary pattern analysis: a review in nutrition epidemiology. Nutr Bull 2008;33(4):311–5.
16. Aigner A, Becher H, Jacobs S, Wilkens LR, Boushey CJ, Le Marchand L, Haiman CA, Maskarinec G. Low diet quality and the risk of stroke mortality: the multiethnic cohort study. Eur J Clin Nutr 2018;72(7):1035–45.
17. Djoussé L, Ho Y, Nguyen XT, Gagnon DR, Wilson PWF, Cho K, Gaziano JM; VA Million Veteran Program. DASH score and subsequent risk of coronary artery disease: the findings from Million Veteran Program. J Am Heart Assoc 2018;7(9):e008089.
18. Fung TT, Isanaka S, Hu FB, Willett WC. International food group–based diet quality and risk of coronary heart disease in men and women. Am J Clin Nutr 2018;107(1):120–9.
19. Satija A, Bhupathiraju SN, Spiegelman D, Chiuve SE, Manson JE, Willett W, Rexrode KM, Rimm EB, Hu FB. Healthful and unhealthful plant-based diets and the risk of coronary heart disease in U.S. adults. J Am Coll Cardiol 2017;70(4):411–22.
20. Shivappa N, Steck SE, Hussey JR, Ma Y, Hebert JR. Inflammatory potential of diet and all-cause, cardiovascular, and cancer mortality in National Health and Nutrition Examination Survey III Study. Eur J Nutr 2017;56(2):683–92.
21. Fung TT, Pan A, Hou T, Mozaffarian D, Rexrode KM, Willett WC, Hu FB. Food quality score and the risk of coronary artery disease: a prospective analysis in 3 cohorts. Am J Clin Nutr 2016;104(1):65–72.
22. Li S, Zhu Y, Chavarro JE, Bao W, Tobias DK, Ley SH, Forman JP, Liu A, Mills J, Bowers K, et al. Healthful dietary patterns and the risk of hypertension among women with a history of gestational diabetes mellitus. Hypertension 2016;67(6):1157–65.
23. Mattei J, Sotres-Alvarez D, Daviglus ML, Gallo LC, Gellman M, Hu FB, Tucker KL, Willett WC, Siega-Riz AM, Van Horn L, et al. Diet quality and its association with cardiometabolic risk factors vary by Hispanic and Latino ethnic background in the Hispanic community health study/study of Latinos. J Nutr 2016;146(10):2035–44.
24. Frazier-Wood AC, Kim J, Davis JS, Jung SY, Chang S. In cross-sectional observations, dietary quality is not associated with CVD risk in women; in men the positive association is accounted for by BMI. Br J Nutr 2015;113(08):1244–53.
25. Sotos-Prieto M, Bhupathiraju SN, Mattei J, Fung TT, Li Y, Pan A, Willett WC, Rimm EB, Hu FB. Changes in diet quality scores and risk of cardiovascular disease among US men and women. Circulation 2015;132(23):2212–9.
26. Tsivgoulis G, Psaltopoulou T, Wadley VG, Alexandrov AV, Howard G, Unverzagt FW, Moy C, Howard VJ, Kissela B, Judd SE. Adherence to a Mediterranean diet and prediction of incident stroke. Stroke 2015;46(3):780–5.
27. Shivappa N, Tavani A, Hébert JR, Rosato V, La Vecchia C. Dietary inflammatory index and acute myocardial infarction in a large Italian case–control study. Eur J Public Health 2018;28(1):161–6.
28. La Verde M, Mulè S, Zappalà G, Privitera G, Maugeri G, Pecora F, Marranzano M. Higher adherence to the Mediterranean diet is inversely associated with having hypertension: is low salt intake a mediating factor? Int J Food Sci Nutr 2018;69(2):235–44.
29. Vitale M, Masulli M, Calabrese I, Rivellese A, Bonora E, Signorini S, Buzzetti R, Sartore G, Babini AC, Gregori G, et al. Impact of a Mediterranean dietary pattern and its components on cardiovascular risk factors, glucose control, and body weight in people with type 2 diabetes: a real-life study. Nutrients 2018;10(8):1067.
30. Bendinelli B, Masala G, Bruno RM, Caini S, Saieva C, Boninsegni A, Ungar A, Ghiadoni L, Palli D. A priori dietary patterns and blood pressure in the EPIC Florence cohort: a cross-sectional study. Eur J Nutr 2019;58(1):455–66.
31. Bonaccio M, Di Castelnuovo A, Pounis G, Costanzo S, Persichillo M, Cerletti C, Donati MB, de Gaetano G, Iacoviello L; Moli-sani Study Investigators. High adherence to the Mediterranean diet is associated with cardiovascular protection in higher but not in lower socioeconomic groups: prospective findings from the Moli-sani study. Int J Epidemiol 2017;46(5):1478–87.
32. Alvarez-Alvarez I, de Rojas JP, Fernandez-Montero A, Zazpe I, Ruiz-Canela M, Hidalgo-Santamaría M, Bes-Rastrollo M, Martínez-González MÁ. Strong inverse associations of Mediterranean diet, physical activity and their combination with cardiovascular disease: The Seguimiento Universidad de Navarra (SUN) cohort. Eur J Prev Cardiol 2018;25(11):1186–97.
33. Abellán Alemán J, Zafrilla Rentero M, Montoro-García S, Mulero J, Pérez Garrido A, Leal M, Guerrero L, Ramos E, Ruilope LM. Adherence to the "Mediterranean Diet" in Spain and its

relationship with cardiovascular risk (DIMERICA Study). Nutrients 2016;8(11):680.
34. Eguaras S, Toledo E, Hernández-Hernández A, Cervantes S, Martínez-González M. Better adherence to the Mediterranean diet could mitigate the adverse consequences of obesity on cardiovascular disease: the SUN prospective cohort. Nutrients 2015;7(11):9154–62.
35. Garcia-Arellano A, Ramallal R, Ruiz-Canela M, Salas-Salvadó J, Corella D, Shivappa N, Schröder H, Hébert JR, Ros E, Gómez-Garcia E, et al. Dietary inflammatory index and incidence of cardiovascular disease in the PREDIMED study. Nutrients 2015;7(6):4124–38.
36. Ramallal R, Toledo E, Martínez-González MA, Hernández-Hernández A, García-Arellano A, Shivappa N, Hébert JR, Ruiz-Canela M. Dietary inflammatory index and incidence of cardiovascular disease in the SUN cohort. PLoS One 2015;10(9):e0135221.
37. Georgousopoulou EN, Kouli G-M, Panagiotakos DB, Kalogeropoulou A, Zana A, Chrysohoou C, Tsigos C, Tousoulis D, Stefanadis C, Pitsavos C. Anti-inflammatory diet and 10-year (2002–2012) cardiovascular disease incidence: The ATTICA study. Int J Cardiol 2016;222:473–8.
38. Kastorini C-M, Panagiotakos DB, Chrysohoou C, Georgousopoulou E, Pitaraki E, Puddu PE, Tousoulis D, Stefanadis C, Pitsavos C; ATTICA Study Group. Metabolic syndrome, adherence to the Mediterranean diet and 10-year cardiovascular disease incidence: the ATTICA study. Atherosclerosis 2016;246:87–93.
39. Adriouch S, Julia C, Kesse-Guyot E, Ducrot P, Péneau S, Méjean C, Assmann KE, Deschasaux M, Hercberg S, Touvier M, et al. Association between a dietary quality index based on the food standard agency nutrient profiling system and cardiovascular disease risk among French adults. Int J Cardiol 2017;234:22–7.
40. Lelong H, Blacher J, Menai M, Galan P, Fezeu L, Hercberg S, Kesse-Guyot E. Association between blood pressure and adherence to French dietary guidelines. Am J Hypertens 2016;29(8):948–58.
41. Neufcourt L, Assmann KE, Fezeu LK, Touvier M, Graffouillère L, Shivappa N, Hébert JR, Wirth MD, Hercberg S, Galan P, et al. Prospective association between the dietary inflammatory index and cardiovascular diseases in the SUpplémentation en VItamines et Minéraux AntioXydants (SU.VI.MAX) cohort. J Am Heart Assoc 2016;5(3):e002735.
42. Alkerwi A, Vernier C, Crichton GE, Sauvageot N, Shivappa N, Hébert JR. Cross-comparison of diet quality indices for predicting chronic disease risk: findings from the Observation of Cardiovascular Risk Factors in Luxembourg (ORISCAV-LUX) study. Br J Nutr 2014;113(2):1–11.
43. Sijtsma FPC, Soedamah-Muthu SS, de Goede J, Oude Griep LM, Geleijnse JM, Giltay EJ, de Boer MJ, Jacobs DR, Jr., Kromhout D. Healthy eating and lower mortality risk in a large cohort of cardiac patients who received state-of-the-art drug treatment. Am J Clin Nutr 2015;102(6):1527–33.
44. Warensjö Lemming E, Byberg L, Wolk A, Michaëlsson K, Lemming EW, Byberg L, et al. A comparison between two healthy diet scores, the modified Mediterranean diet score and the Healthy Nordic Food Index, in relation to all-cause and cause-specific mortality. Br J Nutr 2018;119(7):836–46.
45. Bodén S, Wennberg M, Van Guelpen B, Johansson I, Lindahl B, Andersson J, Shivappa N, Hebert JR, Nilsson LM. Dietary inflammatory index and risk of first myocardial infarction; a prospective population-based study. Nutr J 2017;16(1):21.
46. Roswall N, Sandin S, Scragg R, Löf M, Skeie G, Olsen A, Adami HO, Weiderpass E. No association between adherence to the healthy Nordic food index and cardiovascular disease amongst Swedish women: a cohort study. J Intern Med 2015;278(5):531–41.
47. Tektonidis TG, Åkesson A, Gigante B, Wolk A, Larsson SC. A Mediterranean diet and risk of myocardial infarction, heart failure and stroke: a population-based cohort study. Atherosclerosis 2015;243(1):93–8.
48. Galbete C, Kröger J, Jannasch F, Iqbal K, Schwingshackl L, Schwedhelm C, Weikert C, Boeing H, Schulze MB. Nordic diet, Mediterranean diet, and the risk of chronic diseases: the EPIC-Potsdam study. BMC Med 2018;16(1):99.
49. Waldeyer C, Brunner FJ, Braetz J, Ruebsamen N, Zyriax B-C, Blaum C, Kroeger F, Kohsiack R, Schrage B, Sinning C, et al. Adherence to Mediterranean diet, high-sensitive C-reactive protein, and severity of coronary artery disease: contemporary data from the INTERCATH cohort. Atherosclerosis 2018;275:256–61.
50. Phillips CM, Harrington JM, Perry IJ. Relationship between dietary quality, determined by DASH score, and cardiometabolic health biomarkers: a cross-sectional analysis in adults. Clin Nutr 2018, pii:S0261−5614(18)32422–1.
51. Arentoft JL, Hoppe C, Andersen EW, Overvad K, Tetens I. Associations between adherence to the Danish Food-Based Dietary Guidelines and cardiometabolic risk factors in a Danish adult population: the DIPI study. Br J Nutr 2018;119(6):664–73.
52. Hansen SH, Overvad K, Hansen CP, Dahm CC. Adherence to national food-based dietary guidelines and incidence of stroke: a cohort study of Danish men and women. PLoS One 2018;13(10): e0206242.
53. Stefler D, Malyutina S, Kubinova R, Pajak A, Peasey A, Pikhart H, Brunner EJ, Bobak M. Mediterranean diet score and total and cardiovascular mortality in Eastern Europe: the HAPIEE study. Eur J Nutr 2017;56(1):421–9.
54. Eriksen R, Gibson R, Lamb K, McMeel Y, Vergnaud A-C, Spear J, Aresu M, Chan Q, Elliott P, Frost G. Nutrient profiling and adherence to components of the UK national dietary guidelines association with metabolic risk factors for CVD and diabetes: Airwave Health Monitoring Study. Br J Nutr 2018;119(6):695–705.
55. Gibson R, Eriksen R, Singh D, Vergnaud A-C, Heard A, Chan Q, Elliott P, Frost G. A cross-sectional investigation into the occupational and socio-demographic characteristics of British police force employees reporting a dietary pattern associated with cardiometabolic risk: findings from the Airwave Health Monitoring Study. Eur J Nutr 2018;57(8):2913–26.
56. Jones NRV, Forouhi NG, Khaw K-T, Wareham NJ, Monsivais P. Accordance to the Dietary Approaches to Stop Hypertension diet pattern and cardiovascular disease in a British, population-based cohort. Eur J Epidemiol 2018;33(2):235–44.
57. Mytton OT, Forouhi NG, Scarborough P, Lentjes M, Luben R, Rayner M, Khaw KT, Wareham NJ, Monsivais P. Association between intake of less-healthy foods defined by the United Kingdom's nutrient profile model and cardiovascular disease: a population-based cohort study. PLOS Med 2018;15(1):e1002484.
58. Maddock J, Ziauddeen N, Ambrosini GL, Wong A, Hardy R, Ray S. Adherence to a Dietary Approaches to Stop Hypertension (DASH)-type diet over the life course and associated vascular function: a study based on the MRC 1946 British birth cohort. Br J Nutr 2018;119(05):581–9.
59. Tong TYN, Wareham NJ, Khaw K-T, Imamura F, Forouhi NG. Prospective association of the Mediterranean diet with cardiovascular disease incidence and mortality and its population impact in a non-Mediterranean population: the EPIC-Norfolk study. BMC Med 2016;14(1):135.
60. Lassale C, Gunter MJ, Romaguera D, Peelen LM, Van der Schouw YT, Beulens JWJ, Freisling H, Muller DC, Ferrari P, Huybrechts I, et al. Diet quality scores and prediction of all-cause, cardiovascular and cancer mortality in a pan-European cohort study. PLoS One 2016;11(7):e0159025.
61. Bai G, Zhang J, Zhao C, Wang Y, Qi Y, Zhang B. Adherence to a healthy lifestyle and a DASH-style diet and risk of hypertension in Chinese individuals. Hypertens Res 2017;40(2):196–202.
62. Lau K-K, Wong Y-K, Chan Y-H, Li O-Y, Lee PY-S, Yuen GG, Wong YK, Tong S, Wong D, Chan KH, et al. Mediterranean-style diet is associated with reduced blood pressure variability and subsequent stroke risk in patients with coronary artery disease. Am J Hypertens 2015;28(4):501–7.
63. Murakami K, Livingstone MBE, Sasaki S. Diet quality scores in relation to metabolic risk factors in Japanese adults: a cross-sectional analysis

from the 2012 National Health and Nutrition Survey, Japan. Eur J Nutr 2018;http://doi.org/10.10007/s00394-018-1762-6.
64. Kim D-Y, Kim SH, Lim H. Association between dietary carbohydrate quality and the prevalence of obesity and hypertension. J Hum Nutr Diet 2018;31(5):587–96.
65. Tiong XT, Nursara Shahirah A, Pun VC, Wong KY, Fong AYY, Sy RG, Castillo-Carandang NT, Nang EEK, Woodward M, van Dam RM, et al. The association of the Dietary Approach to Stop Hypertension (DASH) diet with blood pressure, glucose and lipid profiles in Malaysian and Philippines populations. Nutr Metab Cardiovasc Dis 2018;28(8):856–63.
66. Neelakantan N, Koh W-P, Yuan J-M, van Dam RM. Diet-quality indexes are associated with a lower risk of cardiovascular, respiratory, and all-cause mortality among Chinese adults. J Nutr 2018;148(8):1323–32.
67. Hodge AMM, Bassett JKK, Dugué P-AA, Shivappa N, Hébert JRR, Milne RL, English DR, Giles GG. Dietary inflammatory index or Mediterranean diet score as risk factors for total and cardiovascular mortality. Nutr Metab Cardiovasc Dis 2018;28(5):461–9.
68. Livingstone KM, McNaughton SA. Association between diet quality, dietary patterns and cardiometabolic health in Australian adults: a cross-sectional study. Nutr J 2018;17(1):19.
69. Livingstone KM, McNaughton SA. Diet quality is associated with obesity and hypertension in Australian adults: a cross sectional study. BMC Public Health 2016;16(1):1037.
70. Vissers LET, Waller MA, van der Schouw YT, Hebert JR, Shivappa N, Schoenaker DA, Mishra GD. The relationship between the dietary inflammatory index and risk of total cardiovascular disease, ischemic heart disease and cerebrovascular disease: findings from an Australian population-based prospective cohort study of women. Atherosclerosis 2016;253:164–70.
71. Daneshzad E, Emami S, Darooghegi Mofrad M, Saraf-Bank S, Surkan PJ, Azadbakht L. Association of modified Nordic diet with cardiovascular risk factors among type 2 diabetes patients: a cross-sectional study. J Cardiovasc Thorac Res 2018;10(3):153–61.
72. Sakhaei R, Shahvazi S, Mozaffari-Khosravi H, Samadi M, Khatibi N, Nadjarzadeh A, Zare F, Salehi-Abargouei A. The Dietary Approaches to Stop Hypertension (DASH)-style diet and an alternative Mediterranean diet are differently associated with serum inflammatory markers in female adults. Food Nutr Bull 2018;39(3):361–76.
73. Saraf-Bank S, Haghighatdoost F, Esmaillzadeh A, Larijani B, Azadbakht L. Adherence to Healthy Eating Index-2010 is inversely associated with metabolic syndrome and its features among Iranian adult women. Eur J Clin Nutr 2017;71(3):425–30.
74. Golzarand M, Bahadoran Z, Mirmiran P, Sadeghian-Sharif S, Azizi F. Dietary phytochemical index is inversely associated with the occurrence of hypertension in adults: a 3-year follow-up (the Tehran Lipid and Glucose Study). Eur J Clin Nutr 2015;69(3):392–8.
75. Adherence to a Mediterranean Diet and Survival in a Greek Population—NEJM [Internet]. [cited 8 March 2015]. Available from: http://www.nejm.org/doi/full/10.1056/NEJMoa025039.
76. Fung TT, Chiuve SE, McCullough ML, Rexrode KM, Logroscino G, Hu FB. Adherence to a DASH-style diet and risk of coronary heart disease and stroke in women. Arch Intern Med 2008;168(7):713–20.
77. Marklund M, Magnusdottir OK, Rosqvist F, Cloetens L, Landberg R, Kolehmainen M, Brader L, Hermansen K, Poutanen KS, Herzig KH, et al. A dietary biomarker approach captures compliance and cardiometabolic effects of a healthy Nordic diet in individuals with metabolic syndrome. J Nutr 2014;144(10):1642–9.
78. National Center for Health Statistics, What We Eat in America/National Health and Nutrition Examination Survey, 2013–2014. Healthy eating index-2015, scores—U.S. Department of Agriculture, Center for Nutrition Policy and Promotion.
79. Shivappa N, Steck SE, Hurley TG, Hussey JR, Hébert JR. Designing and developing a literature-derived, population-based dietary inflammatory index. Public Health Nutr 2014;17(08):1689–96.
80. Keys A, Keys M. Eat well and stay well. Garden City, New York: Doubleday; 1959.
81. Trichopoulou A, Kouris-Blazos A, Wahlqvist ML, Gnardellis C, Lagiou P, Polychronopoulos E, Vassilakou T, Lipworth L, Trichopoulos D. Diet and overall survival in elderly people. BMJ 1995;311(7018):1457–60.
82. Mozaffarian D. Dietary and policy priorities for cardiovascular disease, diabetes, and obesity. Circulation 2016;133(2):187–225.
83. Kouris-Blazos A, Gnardellis C, Wahlqvist ML, Trichopoulos D, Lukito W, Trichopoulou A. Are the advantages of the Mediterranean diet transferable to other populations? A cohort study in Melbourne, Australia. Br J Nutr 1999;82(1):57–61.
84. Osler M, Schroll M. Diet and mortality in a cohort of elderly people in a north European community. Int J Epidemiol 1997;26(1):155–9.
85. Lasheras C, Fernandez S, Patterson AM. Mediterranean diet and age with respect to overall survival in institutionalized, nonsmoking elderly people. Am J Clin Nutr 2000;71(4):987–92.
86. Sofi F, Macchi C, Abbate R, Gensini GF, Casini A. Mediterranean diet and health status: an updated meta-analysis and a proposal for a literature-based adherence score. Public Health Nutr 2013;17(12):2769–82.
87. Psaltopoulou T, Sergentanis TN, Panagiotakos DB, Sergentanis IN, Kosti R, Scarmeas N. Mediterranean diet, stroke, cognitive impairment, and depression: a meta-analysis. Ann Neurol 2013;74(4):580–91.
88. Liyanage T, Ninomiya T, Wang A, Neal B, Jun M, Wong MG, Jardine M, Hillis GS, Perkovic V. Effects of the Mediterranean diet on cardiovascular outcomes—a systematic review and meta-analysis. PLoS One 2016;11(8):e0159252.
89. Mente A, de Koning L, Shannon HS, Anand SS. A systematic review of the evidence supporting a causal link between dietary factors and coronary heart disease. Arch Intern Med 2009;169(7):659.
90. Grosso G, Marventano S, Yang J, Micek A, Pajak A, Scalfi L, Galvano F, Kales SN. A comprehensive meta-analysis on evidence of Mediterranean diet and cardiovascular disease: are individual components equal? Crit Rev Food Sci Nutr 2017;57(15):3218–32.
91. Rosato V, Temple NJ, La Vecchia C, Castellan G, Tavani A, Guercio V. Mediterranean diet and cardiovascular disease: a systematic review and meta-analysis of observational studies. Eur J Nutr 2017;https://doi.org/10.1007/s00394-017-1582-0.
92. Dixon LB, Subar AF, Peters U, Weissfeld JL, Bresalier RS, Risch A, Schatzkin A, Hayes RB. Adherence to the USDA Food Guide, DASH eating plan, and Mediterranean dietary pattern reduces risk of colorectal adenoma. J Nutr 2007;137(11):2443–50.
93. Salehi-Abargouei A, Maghsoudi Z, Shirani F, Azadbakht L. Effects of dietary approaches to stop hypertension (DASH)-style diet on fatal or nonfatal cardiovascular diseases—Incidence: A systematic review and meta-analysis on observational prospective studies. Nutrition 2013;29(4):611–8.
94. Soltani S, Chitsazi MJ, Salehi-Abargouei A. The effect of dietary approaches to stop hypertension (DASH) on serum inflammatory markers: A systematic review and meta-analysis of randomized trials. Clin Nutr 2018;37(2):542–50.
95. Eckel RH, Jakicic JM, Ard JD, de Jesus JM, Miller NH, Hubbard VS, Lee IM, Lichtenstein AH, Loria CM, Millen BE, et al. 2013 AHA/ACC Guideline on Lifestyle Management to Reduce Cardiovascular Risk. Circulation 2014;129(25 suppl 2):S76–99.
96. Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, Bray GA, Vogt TM, Cutler JA, Windhauser MM, et al. A clinical trial of the effects of dietary patterns on blood pressure. N Engl J Med 1997;336(16):1117–24.
97. Aljefree N, Ahmed F. Association between dietary pattern and risk of cardiovascular disease among adults in the Middle East and North Africa region: a systematic review. Food Nutr Res 2015;59(1):27486.
98. Chowdhury R, Stevens S, Gorman D, Pan A, Warnakula S, Chowdhury S, Ward H, Johnson L, Crowe F, Hu FB, et al. Association between fish consumption, long chain omega 3 fatty acids, and risk of

cerebrovascular disease: systematic review and meta-analysis. BMJ 2012;345:e6698.
99. De Keyzer W, Dofková M, Lillegaard ITL, De Maeyer M, Andersen LF, Ruprich J, Řehůřková I, Geelen A, van 't Veer P, De Henauw S, et al. Reporting accuracy of population dietary sodium intake using duplicate 24 h dietary recalls and a salt questionnaire. Br J Nutr 2015;113(03):488–97.
100. Lacoppidan SA, Kyrø C, Loft S, Helnæs A, Christensen J, Hansen CP, Dahm CC, Overvad K, Tjønneland A, Olsen A. Adherence to a healthy Nordic food index is associated with a lower risk of type-2 diabetes—the Danish Diet, Cancer and Health Cohort Study. Nutrients 2015;7(10):8633–44.
101. Guenther PM, Casavale KO, Reedy J, Kirkpatrick SI, Hiza HAB, Kuczynski KJ, Kahle LL, Krebs-Smith SM. Update of the Healthy Eating Index: HEI-2010. J Acad Nutr Diet 2013;113(4):569–80.
102. Chiuve SE, Fung TT, Rimm EB, Hu FB, McCullough ML, Wang M, Stampfer MJ, Willett WC. Alternative dietary indices both strongly predict risk of chronic disease. J Nutr 2012;142(6):1009–18.
103. Kennedy ET, Ohls J, Carlson S, Fleming K. The healthy eating index. J Am Diet Assoc 1995;95(10):1103–8.
104. Reedy J, Krebs-Smith SM, Miller PE, Liese AD, Kahle LL, Park Y, Subar AF. Higher diet quality is associated with decreased risk of all-cause, cardiovascular disease, and cancer mortality among older adults. J Nutr 2014;144(6):881–9.
105. George SM, Ballard-Barbash R, Manson JE, Reedy J, Shikany JM, Subar AF, Tinker LF, Vitolins M, Neuhouser ML. Comparing indices of diet quality with chronic disease mortality risk in postmenopausal women in the Women's Health Initiative Observational Study: evidence to inform national dietary guidance. Am J Epidemiol 2014;180(6):616–25.
106. Arambepola C, Scarborough P, Rayner M. Validating a nutrient profile model. Public Health Nutr 2008;11(04):371–8.
107. Fraser GE. Vegetarian diets: what do we know of their effects on common chronic diseases? Am J Clin Nutr 2009;89(5):1607S–12S.
108. Hu FB, Willett WC. Optimal diets for prevention of coronary heart disease. JAMA 2002;288(20):2569–78.
109. Huang T, Yang B, Zheng J, Li G, Wahlqvist ML, Li D. Cardiovascular disease mortality and cancer incidence in vegetarians: a meta-analysis and systematic review. Ann Nutr Metab 2012;60(4):233–40.
110. Kwok CS, Umar S, Myint PK, Mamas MA, Loke YK. Vegetarian diet, Seventh Day Adventists and risk of cardiovascular mortality: a systematic review and meta-analysis. Int J Cardiol 2014;176(3):680–6.
111. Appleby PN, Crowe FL, Bradbury KE, Travis RC, Key TJ. Mortality in vegetarians and comparable nonvegetarians in the United Kingdom. Am J Clin Nutr 2016;103(1):218–30.
112. Key TJ, Fraser GE, Thorogood M, Appleby PN, Beral V, Reeves G, Burr ML, Chang-Claude J, Frentzel-Beyme R, Kuzma JW, et al. Mortality in vegetarians and nonvegetarians: detailed findings from a collaborative analysis of 5 prospective studies. Am J Clin Nutr 1999;70(3 Suppl):516S–24S.
113. Orlich MJ, Singh PN, Sabaté J, Jaceldo-Siegl K, Fan J, Knutsen S, Beeson WL, Fraser GE. Vegetarian dietary patterns and mortality in Adventist Health Study 2. JAMA Intern Med 2013;173(13):1230.
114. Crowe FL, Appleby PN, Travis RC, Key TJ. Risk of hospitalization or death from ischemic heart disease among British vegetarians and nonvegetarians: results from the EPIC-Oxford cohort study. Am J Clin Nutr 2013;97(3):597–603.
115. Roerecke M, Rehm J. Alcohol consumption, drinking patterns, and ischemic heart disease: a narrative review of meta-analyses and a systematic review and meta-analysis of the impact of heavy drinking occasions on risk for moderate drinkers. BMC Med 2014;12(1):182.
116. Martínez-González MA, Salas-Salvadó J, Estruch R, Corella D, Fitó M, Ros E. Benefits of the Mediterranean diet: insights from the PREDIMED Study. Prog Cardiovasc Dis 2015;58(1):50–60.
117. Charles RL, Rudyk O, Prysyazhna O, Kamynina A, Yang J, Morisseau C, Hammock BD, Freeman BA, Eaton P. Protection from hypertension in mice by the Mediterranean diet is mediated by nitro fatty acid inhibition of soluble epoxide hydrolase. Proc Natl Acad Sci U S A 2014;111(22):8167–72.
118. Aune D, Giovannucci E, Boffetta P, Fadnes LT, Keum N, Norat T, Greenwood DC, Riboli E, Vatten LJ, Tonstad S. Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality—a systematic review and dose-response meta-analysis of prospective studies. Int J Epidemiol 2017;46(3):1029–56.
119. Fung TT, McCullough ML, Newby P, Manson JE, Meigs JB, Rifai N, Willett WC, Hu FB. Diet-quality scores and plasma concentrations of markers of inflammation and endothelial dysfunction. Am J Clin Nutr 2005;82(1):163–73.
120. Sacks F, Svetkey L, Vollmer WM, Appel LJ, Bray GA, Harsha D, Obarzanek E, Conlin PR, Miller ER, 3rd, Simons-Morton DG, et al. Effects on blood pressure of reduced dietary sodium and the dietary approaches to stop hypertension (DASH) diet. N Engl J Med 2001;344(1):3–10.
121. Estruch R, Salas-Salvadó J. "Towards an even healthier Mediterranean diet". Nutr Metab Cardiovasc Dis 2013;23(12):1163–6.
122. Matsumoto C, Miedema MD, Ofman P, Gaziano JM, Sesso HD. An expanding knowledge of the mechanisms and effects of alcohol consumption on cardiovascular disease. J Cardiopulm Rehabil Prev 2014;34(3):159–71.
123. Rosenberg G, Bauld L, Hooper L, Buykx P, Holmes J, Vohra J. New national alcohol guidelines in the UK: public awareness, understanding and behavioural intentions. J Public Health (Bangkok) 2018;40(3):549–56.
124. He Y, Yang X, Xia J, Zhao L, Yang Y. Consumption of meat and dairy products in China: a review. Proc Nutr Soc 2016;75(3):385–91.
125. Yap IKS, Brown IJ, Chan Q, Wijeyesekera A, Garcia-Perez I, Bictash M, Loo RL, Chadeau-Hyam M, Ebbels T, De Iorio M, et al. Metabolome-wide association study identifies multiple biomarkers that discriminate north and south Chinese populations at differing risks of cardiovascular disease: INTERMAP Study. J Proteome Res 2010;9(12):6647–54.
126. Brennan L. Metabolomics: a tool to aid dietary assessment in nutrition. Curr Opin Food Sci 2017;16:96–9.
127. Hu EA, Toledo E, Diez-Espino J, Estruch R, Corella D, Salas-Salvado J, Vinyoles E, Gomez-Gracia E, Aros F, Fiol M, et al. Lifestyles and risk factors associated with adherence to the Mediterranean diet: a baseline assessment of the PREDIMED Trial. PLoS One 2013;8(4):e60166.