REVIEW

Foods, Nutrients, and Dietary Patterns: Interconnections and Implications for Dietary Guidelines[1,2]

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ABSTRACT

Dietary guidelines provide evidence-based statements on food choices to meet nutritional requirements and reduce the risk of prevailing chronic disease. They involve a substantial amount of research translation, and their implementation has important health consequences. Foods, however, are complex combinations of nutrients and other compounds that act synergistically within the food and across food combinations. In addition, the evidence base underpinning dietary guidelines accesses research that reflects different study designs, with inherent strengths and limitations. We propose a systematic approach for the review of evidence that begins with research on dietary patterns. This research will identify the combinations of foods that best protect, or appear deleterious to, health. Next, we suggest that evidence be sought from research that focuses on the effects of individual foods. Finally, nutrient-based research should be considered to explain the mechanisms by which these foods and dietary patterns exert their effects, take into account the effects of ingredients added to the food supply, and enable assessments of dietary sufficiency. The consideration of individual nutrients and food components (e.g., upper limits for saturated fat, added sugar, and sodium) provides important benchmarks for evaluating overall diet quality. The concepts of core and discretionary foods (nutrient-rich and nutrient-poor foods, respectively) enable distinctions between foods, and this has implications for the relation between food policy and food manufacturing. In summary, evidence supporting healthy dietary patterns provides the foundation for the development of dietary guidelines. Further reference to individual foods and nutrients follows from the foundation of healthy dietary patterns. *Adv Nutr* 2016;7:445–54.

Keywords: foods, nutrients, dietary patterns, dietary guidelines, food synergy

Introduction

Dietary guidelines are statements that assist populations in choosing foods that *1*) deliver optimal nutrient intake, and *2*) are associated with a reduced risk of noncommunicable diseases (NCDs)[5] (1, 2). The evidence supporting the guidelines has a broad base but focuses on the relation between food consumption and disease prevention. From this evidence base, diet models can be constructed and translated into food guidance tools, including diagrammatic representations, such as plates or pyramids.

Foods deliver energy and nutrients. Nutrients are components of foods that are essential for human health, but other compounds continue to be identified in foods, and their health properties are becoming better understood (3). Nutrient function is reported in the literature, but the nutrient composition of foods varies considerably. In addition, not all nutritional compounds within foods have been fully studied, and there are likely synergistic interactions between components within any given food (4). These same issues are also reflected in our current understanding of dietary patterns regularly consumed by any individual. This critical interrelation between nutrients, foods, and dietary patterns has important implications for the development of dietary guidelines to improve health and prevent diseases.

The evidence review underpinning dietary guidelines is a synthesis and evaluation of the best scientific evidence for the relation between diet and health. The evidence base is subject to the available science at any particular point in time, but problems may arise when the connectedness

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[5] Abbreviations used: CVD, cardiovascular disease; DGAC, Dietary Guidelines Advisory Committee; NCD, noncommunicable disease; PREDIMED, Prevención con Dieta Mediterránea; RCT, randomized controlled trial.

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between nutrients, foods, and dietary patterns is not fully appreciated, or is inadequately aligned to form a coherent position. This may be the case in current debates on the relation between the risk of heart disease and dietary fat, as opposed to food sources of fat, such as nuts and olive oil, and dietary patterns rich in fat, such as the Mediterranean or Western diets (5). It can also reflect a translational problem, in which evidence obtained from the basic sciences is part of a value chain of knowledge (6). At one end of the value chain are questions on disease mechanisms that are largely addressed by studies of nutrient action. At the center are trials testing the effects of single foods or dietary patterns on health outcomes or epidemiologic studies exposing these relations. At the other end are efficacy trials testing the impact of dietary advice strategies on behavioral or clinical endpoints. In this review, we address the question of how the interactions between nutrients, foods, and diets play out across this spectrum in the formulation of dietary guidelines, and we largely focus on cardiovascular disease (CVD) as a referent health outcome. We argue that the development of dietary guidelines is translational in nature, but the foundation of this exercise lies in the identification of healthy dietary patterns.

Current Status of Knowledge

The association between diet and health is underpinned by an interdependent relation between dietary patterns, foods, and food components, including nutrients (**Table 1**). Diets are composed of foods, which in turn are composed of nutrients and other food components. Whereas eating food is essential to health, support for the human physiologic system is based on nutrient requirements. The inadequate consumption of vitamins can lead to deficiencies, and the overconsumption of macronutrients can lead to obesity, so both positive and negative effects are relevant.

As previously stated, a value chain of knowledge that generates dietary guidelines needs to be recognized. Within this value chain, the impact on health of dietary patterns, foods, and nutrients is exposed by an array of study designs with methodologic and practical limitations (7). Epidemiologic studies have the power to detect relations in very large population samples, but do not usually claim causation, whereas randomized controlled trials (RCTs) may demonstrate causal effects, but are limited in terms of long-term compliance and the population sample (8). Quality review frameworks and evidence review methodologies (9, 10) can overcome a number of these limitations, but, in the end, the totality of evidence is evaluated to develop evidence-based recommendations. This review proposes a systematic approach to that evaluation.

TABLE 1 Summary of evidence underpinning dietary guidelines

Focus	Food patterns	Foods	Nutrients
Nature of evidence	Relation between food patterns and health outcomes	Effects of foods on health outcomes	Mechanisms of action (and effects of concentrations of nutrients) on health outcomes

Why Should the Foundations of Contemporary Dietary Guidelines Be Based on Dietary Patterns?

Dietary patterns should be the first consideration, because the burdens of disease for nutrition have shifted. The focus of study in nutritional epidemiology traditionally has been on nutrients and other food components. This arose when undernutrition and nutritional deficiencies were the prevailing diet-induced disease states. However, demographic and epidemiologic transitions seen in high income countries, and underway in most low- and middle-income countries, have switched disease burdens (11). Chronic diseases such as CVD, cancer, and diabetes now account for 70% of mortality and 58% of morbidity (in terms of disability-adjusted life-years) globally, with the leading cause of death being ischemic heart disease, followed by stroke (12). This changed paradigm has resulted in part from shifts in the food environment. The dietary determinants of these diseases differ from those of undernutrition and nutrient deficiencies that result from insufficient intake or absorption of a particular nutrient. NCDs have multiple interacting dietary determinants consisting of excess (or insufficient) intake, and they cumulatively affect disease risk over decades (13). Consequently, nutritional epidemiologic investigations of these diseases have gone beyond the single-nutrient approach, focusing on foods and food groups, and more recently evaluating the effect of the overall diet (14).

Furthermore, diets focusing on single nutrients have had negative consequences, and the past few decades have witnessed the inadequacy of a primarily reductionist approach to chronic disease prevention (15, 16). A limited focus concurred with the emergence of nutrient-defined diets such as the low-fat and low-carbohydrate diets. The trends toward low-fat, high-carbohydrate diets (which advocated a reduction in total fat consumption without paying attention to the type or quality of fat) led to excess intake of refined carbohydrates and added sugar, which, as we now know, can actually increase the risk of cardiometabolic diseases (17, 18). In fact, substitution analyses have indicated that the effects of one macronutrient on NCD risk largely depend on the replacement macronutrient.

A reductionist approach that focuses only on one nutrient is especially dangerous because it often fails to consider these substitution effects and the associated foods. In weight-stable populations in particular, in which changes in macronutrient composition occur in isocaloric conditions, when testing the effects of reducing a dietary macronutrient, we must consider the alternative macronutrient (13) and its food sources. For instance, higher dietary saturated fat is associated with an increased risk of CVD when it replaces dietary polyunsaturated fats or carbohydrates from high quality foods such as whole grains, but there is no association when it replaces dietary carbohydrates from highly

refined foods (19). A low-fat diet, thus, would have divergent effects on heart health depending on the constituent foods delivering fats and carbohydrates. Hence, there is no effect of a macronutrient in an absolute sense, because this may change based on the replacement nutrient and the foods that deliver them. Dietary guidelines that are based on cohesive dietary patterns have the advantage of inherently capturing these substitution effects.

Another consideration is that synergistic and/or antagonistic interactions exist between nutrients within dietary patterns. From a nutrient perspective, this has been known for some time, e.g., with enhanced absorption of nonheme iron in the presence of vitamin C, and competitive inhibition of zinc absorption by iron (20). From the perspective of dietary patterns, however, focusing on isolated nutrients cannot account for all interactions, and may result in erroneous conclusions (7). Important associations may be missed, or effects may be assumed in which none exist. In the past, for example, the high cholesterol concentrations found in eggs were behind the widespread recommendation to reduce egg intake for heart health (21). However, eggs are rich in amino acids and several micronutrients, and the combined effect of cholesterol and these nutrients is likely to be different than that of cholesterol alone. In fact, recent findings show that consuming up to 1 egg/d has no effect on CVD risk (22). Dietary recommendations based on an evaluation starting with dietary patterns can implicitly account for interactions that are often difficult to identify.

Finally, people choose to eat foods, not nutrients. Findings of nutritional research on foods and dietary patterns are more amenable to translation and public health practice (23). These findings can be translated into dietary guidelines and policy applications even before the mechanisms underlying the observed associations are fully understood. In addition, dietary recommendations based on foods and dietary patterns are likely to be more accessible, because it would be easier for people to understand and adopt recommendations regarding cohesive dietary patterns, as opposed to those regarding a number of different nutrients.

To put all this in context, the 2015 US Dietary Guidelines Advisory Committee (DGAC) (24) evaluated the effects of the totality of diet on several health outcomes in its report. Based on a systematic review of the evidence to date, the Committee identified 3 dietary patterns that are associated with a reduced risk of chronic diseases and improved diet quality: the healthy US-style pattern, the healthy Mediterranean-style pattern, and the healthy vegetarian pattern. Importantly, these patterns had several elements in common, in particular, a higher intake of fruits, vegetables, whole grains, nuts, and legumes; a moderate intake of alcohol; and a lower intake of red and processed meats, sugar-sweetened foods and drinks, and refined grains. The DGAC review showed that the core features of a healthy diet can be obtained through many different healthy dietary patterns, potentially accommodating varying individual needs and sociocultural preferences.

How Can Research on Individual Nutrients and Food Components Also Be Considered in Developing Dietary Guidelines?

Having identified healthy dietary patterns, research on nutrients and food components will always be important, not least because it is impossible to separate out nutrients from foods, and foods from dietary patterns in this context. There is an important interactive relation that needs to be part of the analysis. Dietary pattern research is unable to identify the nutrients or interaction patterns involved in disease etiology, so nutrient-based research is needed to isolate the true causative agents. Nutrient-focused research enhances the mechanistic understanding of food and diet effects.

A consideration of nutrients serves the purpose of disseminating knowledge about essential nutrients and the quantities required from foods. This is especially important because poor food choices can result in suboptimal nutrient intake. Thus, guidelines can discuss how nutrients have an impact on health, as well as address ways to consume them optimally through appropriate food choices.

Taking this argument further, the concept of nutrient-poor or discretionary foods exposes the significance of nutrients in the diet health debate. Foods are considered to be discretionary when, overall, they do not provide enough limited nutrients, but are high in calories, as well as saturated fat, added sugar, and sodium, e.g., sugar-sweetened beverages, sweets, and other processed foods (25). These latter components tend to enhance the food's shelf life while increasing palatability, and can be easily manipulated and added to foods during processing. Unsurprisingly, the food supply is replete with discretionary foods. In this context, and as discussed later, even otherwise healthy foods can become unhealthy through the addition of ingredients. Discretionary foods deserve separate and more detailed consideration in the development of dietary guidelines. This is beginning to emerge, with the categorization of processed foods becoming more prevalent in the literature (26), and underpinning dietary guidance recently released in Brazil (27). This effort in turn can be used to inform policy and food regulations to ensure that the quality of foods available in the supply system meets certain standards.

To put this in context, since 2005, the US Dietary Guidelines have recommended a 10% upper limit on total dietary saturated fat. Although this is a nutrient-based dietary recommendation, it has implications for discretionary foods in particular, and the 2015 US DGAC report supports retaining this recommendation (24). As discussed earlier, the application of this nutrient limit needs to consider carefully alternative food choices, particularly as the limit relates to carbohydrate-rich foods. Retaining the limit on saturated fat remains justified, because the evidence base continues to support the benefits of replacing saturated fats with unsaturated fats (24). Given how easily saturated fat can be added to foods, meals, or habitual diets in the form of butter, cooking fats, or processed/packaged foods, a focus on this nutrient covers a range of foods that individuals need to be aware of in making healthy food choices. It can also

help set appropriate meal standards for schools and other programs.

Finally, it is important to acknowledge unique aspects of foods and food components that may affect disease risk independent of the overall diet. This may be the case in diseases in which one nutrient is the predominant etiologically relevant dietary component [e.g., folate intake for the prevention of neural tube defects (13) and *trans* FAs from partially hydrogenated oils and heart disease risk]. In these cases, a focus on nutrients may be important when making recommendations tailored to at-risk populations, such as pregnant women and older people.

How Can the Formulation of Dietary Guidelines Integrate Evidence for Dietary Patterns, Foods, and Nutrients?

For all the reasons discussed above, formulating dietary guidelines should begin with evidence of the relation between dietary patterns and health outcomes. Previously referred to as a top-down approach (5, 28), starting with dietary patterns, then foods, then nutrients enables greater accuracy between dietary guidance and research outcomes. This is a systematic approach that acknowledges and works with the fact that dietary patterns, foods, and nutrients are all inter-related.

From the dietary patterns perspective, there is ample evidence that healthy diets have an impact on CVD (29), as well as weight management (30) and hypertension (31). The body of evidence underpinning dietary guidelines will reflect the volume of published research, but currently the Mediterranean and Dietary Approaches to Stop Hypertension diets provide good examples of healthy dietary patterns, at least in Western societies. In addition to specific diets such as these, healthy dietary patterns can be identified as a set of discrete food choices reflected in diet indexes or scores (which are based on the quality of nutrient content) (32).

The next step is to review the evidence for foods. Dietary patterns expose the health attributes of certain food groups. Currently, foods such as vegetables, fruit, nuts, legumes, whole grains, and olive oil consistently have emerged as important foods in dietary patterns supportive of weight control and prevention of NCDs (30). Inverse associations with weight gain over a 4-y period have been shown for the intake of vegetables, whole grains, fruits, nuts, and yogurt (33). In a recent meta-analysis in which healthy dietary patterns were shown to be associated with significantly lower blood pressure, key foods were identified as vegetables, fruit, wholegrains, legumes, seeds, nuts, fish, and low-fat dairy foods (31). Thus, research indicates consistencies in the categories of foods that form healthy dietary patterns, and this would form a logical basis for evaluation in dietary guidelines.

The third step is to consider the actions of nutrients present in these foods. The relative influence of each food may be revealed by a consideration of nutrient effects. Reviews can be found in the literature that outline nutrient effects emerging in association with consumption of individual foods, such as vegetables (34), nuts (35), and whole grains (36). For example, the beneficial effects of nuts and seeds are likely to be attributable to high amounts of unsaturated fats, soluble fiber, plant protein, vitamins, minerals, and phytochemicals, although separating the effects of individual components is exceedingly difficult because of the synergistic effects of multiple components.

What Have We Learned from Studies of the Mediterranean Diet?

The Mediterranean diet is one of the most reported in the scientific literature. We have learned that the positive effects on cardiovascular health are relatively consistent, and, over time, the research has helped to improve study designs. Importantly, studies on the Mediterranean diet and its components have demonstrated the feasibility and value of starting with research on dietary patterns and then moving down to considerations of individuals foods and the effects of the nutrients contained therein.

The first trial on the benefits of the Mediterranean diet was the Lyon Diet Heart Study (37), which was conducted in France and tested the effects of a modern Mediterranean diet on the recurrence of myocardial infarction. The advice focused on bread, vegetables, fish, and fruit, and included olive oil, with minimized red meat intake. Participants were supplied with rapeseed oil products. In comparison, the control group received "usual care" from external dietitians or physicians. The risk of myocardial infarction recurrence, other cardiac events, and total mortality were significantly reduced after 27 mo (37) and this continued after 46 mo (38). The implications were debated in the literature, particularly because rapeseed oil was not considered to be a traditional component of the Mediterranean diet, and the benefits of the diet were attributed to its α-linoleic acid content. Likewise, "usual care" in the control group needed to be better defined. This was an important study design feature that improved with new studies over time.

Some 20 y after the Lyon Diet Heart Study, the PREDIMED (Prevención con Dieta Mediterránea) trial (conducted in Spain), tested the effects of a Mediterranean diet supplemented with olive oil or nuts (39) compared with a control low-fat diet aligned with an early version of the AHA guidelines (21). A significantly reduced risk of ~30% for myocardial infarction, stroke, and CVD mortality was reported after 4.8 y for both of the Mediterranean diet groups supplemented with olive oil and nuts. Despite improved controls, criticisms around foods and nutrients remained. It was noted, for example, that the difference between groups in fat intake was only 4%, and that the supplemented foods (olive oil and nuts) provided the greatest differences between groups, raising questions about whether the study really tested the Mediterranean diet, and highlighting challenges in conducting research on dietary patterns (40).

Both of these debates expose the problem of focusing the argument back on individual foods and nutrients without consideration for the synergistic effects of the dietary pattern. Effects of single nutrients and food will be seen only in the context of a dietary pattern, and background diets are confounders for these studies. Indeed, controlling

for the background diet, e.g., through secondary analyses of data from clinical trial cohorts, may better expose the effects of single foods and nutrients (41). In this case, the study of the dietary pattern is the starting point, and the evidence for effects of component foods and the mechanisms by which the nutrients may act become secondary and explanatory.

As a case in point, a number of secondary analyses from the PREDIMED trial addressed the health potential of individual foods, such as extra virgin olive oil (42) and nuts (43), and implicated nutrients such as FAs (42, 43) and polyphenolic compounds (44). One secondary analysis (42) showed that participants with the highest energy-adjusted consumption of total and extra virgin olive oil had a 35% and 39% lower risk of CVD, respectively, and that each increase of 10 g extra virgin olive oil/d consumed was associated with a 10% reduced risk of CVD. From a nutrient perspective, in the PREDIMED study, nuts would have delivered phytosterols [known to reduce cholesterol absorption and increase fecal cholesterol excretion (45, 46)] and polyphenols with known antioxidant capacity. Another analysis of the PREDIMED cohort revealed a 46% reduction in the risk of CVD for participants with the highest polyphenol content compared with the lowest (44). Thus, considering the contribution of individual foods within the dietary patterns puts the dietary effects in context. As previously stated, the focus on food patterns implicitly accounts for interactions between food components that are difficult to identify in isolation.

Study design features and a priori decisions on dietary variables may limit the ability to examine the full range of foods in this way, and many other foods could be argued to be part of the Mediterranean diet. For example, the consumption of fish has long been associated with improved cardiovascular health. A meta-analysis (47) showed significant reductions in the risk of coronary heart disease mortality with both low (1 serving/wk) and moderate (2–4 servings/wk) fish intake. The beneficial effects of fish consumption on cardiovascular outcomes traditionally have been attributed to long-chain n–3 PUFAs, but fish also contains other nutrients, such as protein, vitamin D, and selenium, that may interact synergistically to deliver the cardiovascular outcomes. Although long-chain n–3 PUFAs may modulate CVD risk through the reduction of plasma TGs and platelet aggregation, and via anti-inflammatory effects (48), preliminary evidence comparing consumption of fish with long-chain n–3 PUFA supplements suggests that consumption of the whole food may deliver additional benefits not obtained with the single-nutrient supplementation (49, 50). Thus, studies of the Mediterranean diet have demonstrated the utility of starting with dietary patterns and working through to the evidence for component foods and nutrients, but, as is always the case, gaps may remain in the available evidence base.

How Do We Deal with Deleterious Foods and Dietary Patterns?

Although there is clearly evidence of dietary patterns that are associated with reduced disease risk, certain dietary patterns or components also can be detrimental. Establishing evidence of dietary patterns that appear to be deleterious is more problematic. Trials of deleterious effects carry ethical problems, and the very wide range of foods appearing to be implicated makes them more difficult to conduct. However, studies reporting the nutritional composition of dietary patterns are abundant (51, 52). These have associated dietary patterns characterized by excess dietary saturated fat, sodium, and added sugars with increased disease risk (53–58). The current literature carries considerable debate on these issues, but we argue that these dietary factors remain pertinent, if not for different reasons.

One way of dealing with deleterious dietary patterns is to examine the underpinnings of poor diet quality. Foods high in SFAs, sugar, and sodium are beginning to emerge as markers of poor diet quality (32, 59). These ingredients are used substantially in food processing, and appear in a very wide range of foods and beverages (in the case of sugar) that are difficult to classify. From a nutrient perspective, only sodium represents a single chemical entity with a defined physiologic role. There is strong evidence of a dose–response relation between increasing sodium intake and increasing blood pressure (60) that underpins national efforts to set informative dietary reference values (61). Saturated fat represents a class of FAs, and research implies that not all in that class have the same deleterious effects (62). This may reflect differences in the food source, and, in any case, people consume foods, not individual FAs. However, most SFAs increase LDL cholesterol concentrations (63, 64), a major risk factor for heart disease, although high dietary saturated fat also may be a marker of poor food choices. Sugar, on the other hand, is readily identifiable as a single food. People can choose to add sugar to their food and beverages or the sugar can be added in manufacturing. More recent research has focused on the evidence for health and dietary outcomes associated with added sugar (59).

Considerations of deleterious dietary patterns need to keep pace with developments in the food supply. New food components are being added to the food supply system as a result of improvements in food production and processing. Evaluating the evidence based on these new food components is a key consideration of dietary guidelines, because, as with added sugar, these components could be associated with deleterious effects on health. A prime example is *trans* FAs, which were developed first to stabilize vegetable fat at room temperature. Their shelf-stable property and affordability made them popular in food manufacturing processes in the early 20th century. However, epidemiologic and experimental evidence soon accumulated to demonstrate their strong and consistent association with an increased risk of cardiometabolic diseases (65).

To put these issues in context, historically, *trans* FAs were first mentioned in the US Dietary Guidelines in 2000, with a clear recommendation to reduce their intake being endorsed 5 y later. Meanwhile, the FDA approved a proposal for manufacturers to list *trans* FAs in the nutrition facts panel (66), and in 2013, took preliminary steps to phase out *trans* FAs

altogether by deeming them to be not generally recognized as safe (67). A focus on food components in scientific research and in developing the Dietary Guidelines was essential for each of these actions. On the issue of added sugars, the 2015 US DGAC report recommended reducing added sugar intake to <10% of total calories/d (24). This would mean that a revision to the nutrition facts panel proposed by the FDA to display the total amount of added sugar in food products (68) would receive strong backing.

From a study design perspective, dietary patterns deleterious to health tend to be exposed through epidemiologic studies and with the use of exploratory methods such as factor analysis and cluster analysis (14). In these cases, dietary patterns characterized by foods high in saturated fat, sodium, and/or added sugar tend to emerge as negatively associated with health (53–58). Some foods have been implicated in epidemiologic studies. For example, an analysis of the Nurses' Health Study and Health Professionals Follow-Up Study showed that weight gain over a 4-y period was positively associated with a higher intake of potato chips, sugar-sweetened beverages, and processed meats (33). These foods are also considered to be ultraprocessed foods (69). Research such as these analyses will support the evidence base that provides more detail in identifying discretionary foods as actual foods, rather than being defined simply by nutrient means, as previously discussed. Although debates remain on the negative consequences of overconsuming saturated fat, sodium, and sugar, if the focus were to shift to identifying foods that contain excess amounts of these components, and the relative position of these foods in the total dietary pattern, the situation may become clearer for consumers. Because saturated fat, sugar, and salt are common ingredients in manufactured foods, the implications are important, both for the development of dietary guidelines and for their practical application.

How Can Evidence-Based Reviews Contribute to Food-Based Guidelines?

As stated earlier, starting with the evidence for dietary patterns, then adding component foods and associated nutrients, provides a valid systematic approach to the development of food-based dietary guidelines. Reviews of the evidence underpinning dietary guidelines consider the totality and amount of scientific evidence available. Guidelines for grading the literature typically consider RCTs to provide the highest level of scientific evidence (9, 10), although some guidelines allow for upgrading of evidence from high-quality observational studies in which strong and consistent effects are found (70). The grading of these levels is based on drug-based trials, although these differ substantially from food-based RCTs (7). Central tenets of RCT design, such as double-blinding and the use of placebos, are relatively simple to plan and maintain in drug-based trials, but can be highly problematic when the intervention is food (7). Although poor compliance with interventions can confound the results of both food- and drug-based RCTs, the position of food as a major element of daily life with both cultural and biological roles means that maintaining compliance over the long run can be challenging. In addition, food-based interventions may not be feasible because of cost and ethical considerations. Therefore, although RCTs have clear advantages in terms of controlling confounding to interventions, such as control diets, aspects of typical RCT design may not lend themselves well to exploring long-term relations between diets and disease. Observational evidence from prospective cohort studies enables the exploration of long-term associations between diet and health outcomes. Although confounding cannot be ruled out completely in observational studies, the convergence of data from observational studies and small RCTs on intermediate outcomes would strengthen the evidence base and enhance the robustness of dietary recommendations (7).

What Are the Implications of Evidence-Based Guidelines for Nutritional Policies?

Dietary guidelines are instruments of public health policy that target the prevention of NCDs. This is underpinned by known causal links between poor diet quality and morbidity/mortality (71). Research questions methodically address the evidence base for guidelines statements (72, 73), which underpin dietary patterns intended to produce beneficial effects on health outcomes. Research on adherence to dietary guidelines has demonstrated their efficacy across the globe (1, 2).

The final stage in translation involves the translation of guidelines into practical food choices. Although scientific reviews can deduce a set of statements around foods underpinning ideal dietary patterns, the reality is there are a very large number of foods with variable composition. Simple foods such as an apple are easy to identify and associate with a guideline. An apple as an ingredient in a mixed food becomes problematic. The concept of "discretionary foods" or "extra foods" is often used to create this distinction (25, 74). These foods do not fit into the core food groups and tend to be processed foods high in energy, saturated fat, added sugars, added salt, or alcohol (74). Thus, whereas an apple may be a preferred food, a piece of apple pie may be discretionary. From a nutritional perspective, the difference is readily articulated by nutrient means. The apple pie is a processed food that likely contains more saturated fat, sugar, and sodium than the original reference food, and will contribute to these variables in the total diet. In a similar fashion, if most foods in the diet are chosen as mixed versions of the original, the total consumption of saturated fat, sugar, and sodium may end up being very high.

The problem is reflected in current guidelines. For example, the 2013 Australian Dietary Guidelines (25) lists nutritious foods with actual food names, but the "foods to limit" category appears in terms of deleterious nutrient composition (**Table 2**). The dietary modeling for foundation diets is based on foods to enjoy, and foods to limit are referred to as discretionary. Some years later, the evidence reviewed by the 2015 DGAC suggested that a healthy dietary pattern is higher in vegetables, fruits, whole grains, nonfat or low-fat

TABLE 2 Dietary patterns and foods noted in dietary guidelines[1]

Healthy eating patterns, DGA[2]		Recommended foods, ADG[3]	
Components	**Lower in[4]**	**Enjoy**	**Limit[5]**
Vegetables Fruit Grains[7] Dairy products[8] Protein foods[9] Oils	Saturated fats, *trans* fats added sugars, and sodium	Vegetables[6] Fruit Cereal[7] Milk[8] Lean meats[9]	Added sugars, saturated fat, salt, and alcohol

[1] ADG, Australian Dietary Guidelines; DGA, Dietary Guidelines for Americans.
[2] 2015 DGA (75).
[3] 2013 ADG (25).
[4] Fewer than 10% calories/d from added sugars and saturated fats; *trans* fats to be minimized; <2300 mg Na/d; if consumed, alcohol in moderation (up to 1 drink/d for women or 2 drinks/d for men, both of legal drinking age).
[5] Stated as "limit foods with high amounts of" these components.
[6] ADG includes legumes with vegetables.
[7] DGA states "at least half whole grain;" ADG states "mostly whole grain/high fiber."
[8] DGA states "fat-free or low-fat dairy products, including milk, yogurt, cheese, fortified soy beverages;" ADG states as "milk, yoghurt, cheese, or alternatives."
[9] ADG states as "variety of protein foods including seafood, lean meats and poultry, eggs, legumes, nuts, seeds, soy;" ADG states as "lean meats and poultry, fish, eggs, tofu, nuts and seeds, legumes/beans."

dairy products, seafood, legumes, and nuts; contains moderate amounts of alcohol; and is low in processed and red meat, sugar-sweetened products, and refined grains (24).

The most obvious feature of the foods listed as components of healthy dietary patterns or foods to enjoy (Table 2) is that they are relatively unprocessed. In other words, the 2 groups of foods are similar, but the discretionary foods have more ingredients added to them (e.g., apple compared with apple pie). Given the changes in culinary practices and food purchasing behaviors in Western societies, the need for dietary guidelines to identify and deal with discretionary foods is substantial.

Health surveys point further to the problem. For example, in the Nutrition First results of the 2011–12 Australian Health Survey, foods were categorized along the lines of the Australian Dietary Guidelines. On the basis of this categorization, and on a single day of reporting, 35% of energy was consumed by discretionary foods (76). Of the top 4 most reported food categories, 2 were classed as discretionary, and these related to cereals and cereal products (including snack bars, cookies, and pizza) and vegetable products and dishes (including potato chips). Clearly, a focus on cereal and vegetable products is warranted in implementing the intentions of the dietary guidelines. Indeed, a systematic assessment of diet quality in 187 countries has shown that despite continued consumption of healthy foods, the consumption of discretionary foods is trending in the region in which Australia is represented (77), with implications for food product development.

Conclusions

The fundamental interconnections between nutrients, foods, and diets suggest that the formulation of dietary guidelines should begin with dietary patterns and then work down through identifying component foods and explaining effects through their nutrient composition. Because the development of dietary guidelines is translational in nature, the focus on dietary patterns and their inherent foods enables direct translation to advice statements, while not ignoring key nutrients that may signal overall quality of a diet.

The complex interconnections between nutrients, foods, and dietary patterns imply that no single element of diet can provide the complete picture of dietary effects on health, but a systematic approach to reviewing the evidence starting with dietary patterns is warranted. Each form of research that contributes to the evidence base comes with its own methodologic shortcomings. Studying dietary effects across the spectrum of research offerings decreases the possibility of missing important effects, or of identifying spurious associations. In this manner, convergence across the various research designs, and with consideration of the inter-relations between dietary patterns, foods, and nutrients, strengthens causality, enhancing the quality of evidence on which dietary recommendations are based. As demonstrated by the 2015 US DGAC report, healthy patterns, foods, and food components do overlap (24), which provides a sound scientific basis for comprehensive dietary guidance. The DGAC also spelled out "unhealthy choice" in terms of foods, not just nutrients, and this is important for the public to understand and act upon.

Although foods in a healthy dietary pattern are readily identifiable, the combinations of these foods tend to reflect moderate amounts of saturated fat, sodium, and added sugar. Foods with very high amounts of these components tend to emerge as being associated with negative health outcomes, and the evidence for foods to consume compared with foods to limit is likely to present in different ways. The food industry must be held accountable and responsible for managing the supply and marketing of these foods, and scientists must continue to develop research that underpins dietary guidelines. A framework that recognizes the interrelation between dietary patterns, foods, and nutrients provides a workable platform for driving this effort forward.

Summary Points

1. Dietary patterns, foods, and nutrients are inexorability linked: dietary patterns comprise foods, and foods deliver nutrients.
2. Dietary patterns should be the starting point for evaluating the scientific evidence underpinning dietary guidelines.
   a. Dietary guidelines are a set of statements that together reflect a healthy dietary pattern.
   b. The burden of disease has shifted to conditions in which multiple dietary factors and total energy intake are implicated. Dietary patterns address these issues.
   c. Nutrient-defined diets (e.g., low-fat or low-carbohydrate) are confounded by the food sources of macronutrients, because the effects of one macronutrient on NCD risk largely depend on the replacement macronutrient.
   d. Synergies exist across combinations of foods.

e. Dietary patterns are readily translatable to dietary advice: people choose to eat foods, not nutrients.

3. Reviewing the evidence for nutrients is an important subsequent step in the development of dietary guidelines.
   a. Research on nutrients is required to understand potential mechanisms of action and to isolate causative agents underpinning the evidence of effects of food consumption within dietary patterns.
   b. Advice on healthy food choices references nutritional quality, which is described in terms of nutrient content. These foods are readily identifiable and tend to be fresh and less processed.
   c. Advice on unhealthy food choices is defined in terms of excessive delivery of nutrients or other food components. These foods are less readily identifiable and tend to be processed foods. They can constitute a large proportion of the food supply and food consumption patterns in the population.
4. Evidence for dietary patterns, foods, and nutrients is available in the scientific literature and needs to be addressed in a strategic and systemic manner.
   a. Primary and secondary analyses of large dietary trials, such as the PREDIMED trial, exemplify how a set of analyses can be conducted. This needs to be broadened to a wider range of foods and dietary patterns.
   b. The evidence of deleterious eating patterns is emerging in different ways. More research is required on characterizing actual foods to enable guidance to be more specific and recognizable for consumers.
   c. The established systems of quality review of the body of evidence (provided by RCTs and observational and mechanistic research) can be layered onto the staged framework for examining the evidence for dietary patterns, foods, and then nutrients.
   d. Translating the evidence requires a clear reference to foods. The concept of discretionary foods requires more research, and has strong implications for food regulation standards and the food industry as a whole.

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