SUPPLEMENT

Setting the Lipid Component of the Diet: A Work in Process[1–3]

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ABSTRACT

Some of the most relevant yet controversial issues in nutrition are those surrounding the guidelines on quality and quantity of dietary fat in the prevention and treatment of cardiovascular diseases and coronary heart diseases. Conflicting evidence questions the credibility of the previous dietary guidelines, particularly the quality of the evidence on which these recommendations were based. It is therefore important to explore the changes that have occurred in these guidelines and their influence on the adoption of different dietary patterns over time. In this review, we summarize the evolution of the fat component of the dietary guidelines, discuss controversial aspects, and highlight the areas in which additional evidence is still needed. Over the years, the scientific community has shown an obsession for calories in a diet instead of focusing on the quality of the food that makes up the diet. This is why certain authors have identified the importance of evaluating a diet focusing on diet patterns, rather than single isolated nutrients. This approach has been proposed in the most recent Dietary Guidelines for Americans. *Adv Nutr* 2017;8(Suppl):165S–72S.

Keywords: dietary guidelines, dietary fat, cardiovascular diseases, dietary patterns, fat controversy

Introduction

Dietary fat, which contributes to food palatability and preservation, is an essential component of a diet, and the presence of differing types and quantities of fat is strongly associated with different culture and culinary traditions (1). Dietary fats are commonly classified according to their acyl chains and the quantity of links, and are divided into either SFAs or unsaturated FAs. Unsaturated FAs are divided further into MUFAs, PUFAs (including ω-3, ω-6, and certain ω-9 FAs), and *trans* FAs, which are initially unsaturated, but become saturated when they are hydrogenated to give them a solid form (2). Foods contain a mixture of various classes of FAs (saturated and unsaturated fats), limiting the ability of experts to classify any particular FA as a healthy or unhealthy dietary choice with respect to coronary disease risk. Thus, the effects of the consumption of a food product on human health should be measured instead of being predicted from its nutrient composition (3). Consequently, a recommendation based on the proportions of nutrients in a food item could be inaccurate (4).

For many decades, the etiology of atherosclerotic cardiovascular disease (CVD)[4] was associated with the consumption of dietary fats, in particular saturated fat, which was found to increase LDL cholesterol (5). Saturated fat represents a highly heterogeneous category of FAs, with chain lengths ranging from 6 to 24 carbons. These include stearic (18:0), palmitic (16:0), myristic (14:0), and lauric (12:0) acids. The main foods that contain SFAs are palm and coconut oil, although others foods, such as dairy products (cheese, milk, yogurt, and butter), meats (pork, poultry, fish, and red and processed meats), vegetable oils, and nuts, also may contain saturated fat. Nevertheless, these foods also may contain MUFAs or PUFAs (6). Certain products that contain saturated fat, such as dairy products,

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[4] Abbreviations used: CVD, cardiovascular disease; CAD, coronary artery disease; DASH, Dietary Approaches to Stop Hypertension; T2DM, type 2 diabetes mellitus.

nuts, and vegetable oils, actually may promote better cardiovascular health; in the past, the presence of metabolic diseases was thought to be related to increased SFA intake (7). Evidence regarding the association of health outcomes with the long-term intake of various dietary fats has generated controversy. As a result, there have been differing postures regarding the recommendations on fat consumption. Consequently, current dietary guidelines emphasize the quality, rather than the quantity, of dietary fats (8) (**Table 1**).

History of the Dietary Guidelines and Current Status: the Fat Controversy

The theory that an increased dietary intake of saturated fats and cholesterol results in an increase in serum total cholesterol and LDL cholesterol—and therefore an increase in the risk of heart disease—has been accepted since the Framingham Heart Study (9). The study reported that high serum cholesterol was a major risk factor for coronary artery disease (CAD) (10). Several other studies along the same vein were published in the early 1950s. Kritchevsky (11) showed that concentrations of certain lipoprotein classes were related to atherosclerotic heart disease, and implicated dietary fat as a factor in this relation. After this, Keys (12) examined the association between diet and CVD in different countries in the Seven Countries Study. This study revealed that countries in which fat consumption was the highest had the most heart disease, supporting the hypothesis that dietary fat was an important factor in causing heart disease. This observational study gained massive media attention and had a major influence on the dietary guidelines over the following decades. Nevertheless, this theory is still in question years later, largely because of the methodology used and the conclusions that were drawn as a result.

The first formal recommendations regarding the consumption of dietary fat for the overall population were published in 1957 by the AHA. This guideline recognized that diet plays an important role in the pathogenesis of atherosclerosis and that the ratio of saturated and unsaturated fat, in addition to lifestyle variables such as physical activity and smoking, also could be determinant factors of the disease. However, although the guideline placed limits on fat intake, it did not distinguish between the different types of fats (13, 14). The guideline published in 1961 has a form still recognizable today: it recommends the practice of moderate-intensity exercise; the maintenance of a healthy body weight; an increase in the intake of PUFAs; and a reduction in the intake of total fat, SFAs, and cholesterol. Additional specific guidance was included in 1968, and included advice to reduce animal-fat intake and the incorporation of these dietary recommendations in the diet of the whole family, even young children (11).

Subsequently, in 1977, the US Senate Select Committee on Nutrition and Human Needs recommended the following: a reduction in overall fat intake from 40% to 30% of caloric intake; a reduction in calories from SFA to <10% of total caloric intake and maintenance of the ratio of SFA, MUFA, and PUFA consumption, with a contribution of 10% for each; a reduction in total cholesterol intake to <300 mg/d; lower consumption of simple sugars (≤15% of carbohydrate intake); and a reduction in salt consumption to ≤3 g/d. In essence, the dietary goals were to eat less fat, cholesterol, and refined and processed sugars, and to eat more complex carbohydrates, vegetables, fruits, and whole grains. These guidelines effectively proposed an increase in the consumption of carbohydrates to between 40% and 60% of total energy intake (15).

All of the above recommendations appeared to be consistent with observational studies, in which the dietary intake of specific types of fat, particularly SFAs, tended to be positively correlated with CAD (10, 16, 17). In addition, the Medical Research Council Soybean Oil Study (18) and LA Veterans Study (19), relevant randomized controlled studies, showed that reducing the intake of SFAs and increasing the intake of PUFAs resulted in decreased serum total cholesterol concentrations and a lower prevalence of CAD (18, 19). However, it is important to note that in the Medical Research Council Soybean Oil Study, despite the numerically fewer deaths and relapses encountered in the intervention group (diet low in fat and cholesterol) than in the control group, this result was not statistically significant (18). Furthermore, in the LA Veterans Study, there were important demographic differences between study groups; this finding led to debate regarding the validity of the results (19).

The findings of the Oslo Diet-Heart Study (20) were in line with the results reported in the LA Veterans Study (19). This study showed that a diet low in animal fats and cholesterol but rich in vegetable oil reduced serum cholesterol values on average by 29% over the 5 y study period. However, despite this change, no differences were found between groups in the incidence of death from CVD (20). In contrast, The Finnish Mental Hospital Study reported a beneficial effect on CAD morbidity (45% in men and 35% in women) associated with the use of a diet low in SFAs and

TABLE 1 Key messages

- Evidence regarding health outcomes and the long-term intake of various dietary fats has generated controversy. As a consequence, recommendations regarding fat consumption differ. In the past, there has been a trend toward a restrictive position for fat intake, particularly for saturated fats.
- Current dietary guidelines emphasize the quality, rather than the quantity, of dietary fats in order prevent nutrition-related chronic diseases.
- Dietary recommendations should focus on dietary patterns instead of particular nutrient groups. The cultural traditions of users should be incorporated into such recommendations. Dietary priorities include increasing intake of fruits, vegetables, nuts, legumes, fish, vegetable oils, yogurt, and minimally processed whole grains; and decreasing intake of red and processed meats and foods rich in refined grains, added sugars, salt, or *trans* fat. The benefits of this approach require outcome-based evidence.
- A low-fat diet is a heterogeneous food pattern and should not be considered synonymous with a healthy diet.
- The principal contribution of this document is to review the evidence behind current dietary guidelines and to highlight areas of opportunity to improve the health impact of the recommendations.

cholesterol and high in PUFAs compared with a control diet referred to as a normal hospital diet (21, 22). Other studies, such as the Sydney Diet Heart Study, that were carried out around the same time did not arrive at similar conclusions when examining similar fat-restrictive diets or diets incorporating corn oil supplementation (23–25). After this, attempts were made to reduce major cardiac events or reduce recurrence through the prescription of a diet low in fat and restrictive in cholesterol intake. To date, these efforts have been unclear because of mixed results.

The 2000 US diet report recommended restricting dietary fat to ≤30% of total caloric intake, with SFA constituting <10% of these calories and the daily cholesterol intake limited to <300 mg/d. This statement was widely accepted, to the point at which many international organizations adopted similar recommendations (26, 27). Subsequent guidelines in 2005 and 2010 recommended restricting total fat to 20–35% of total calorie intake. These guidelines recommended adjusting SFA consumption for adults on the basis of their LDL concentrations. For those with LDL cholesterol concentrations <130 mg/dL, SFA consumption should be <10% of calories. However, for individuals with elevated LDL cholesterol (>130 mg/dL), ≤7% of calorie intake should be derived from SFAs (28). Calories from SFAs should be replaced with calories from unsaturated fat (29). The USDA recommendations in 2010 advised consumption of <10% of calories from SFAs, with daily cholesterol intake limited to ≤300 mg/d. These recommendations also advised people to keep *trans* FA consumption as low as possible by limiting foods that contain synthetic sources of *trans* fats, such as partially hydrogenated oil, limiting other solid fats, and reducing the intake of calories from added sugars, as well as reducing sodium intake (30). Changes in SFA intake were identified as a critical component of the actions to decrease the incidence of CAD. However, the available data provided by randomized controlled trials is scant (31). Over 40 y, it was recommended that the consumption of dietary lipids be limited to <30–35% of total calories with the difference in energy they provide being compensated for by carbohydrates. But an interesting fact is that, since the late 1970s, with the introduction of and adjustments in these dietary recommendations, rates of diabetes, obesity, and other chronic diseases have significantly increased (32).

In order to aid in the prevention of nutrition-related chronic diseases, the recommendations of the most recent Dietary Guidelines for Americans (2015) (8) emphasize the quality of food and the health outcomes associated with their regular intake. One change in the report that has received media attention is that the Dietary Guidelines for Americans did not make a recommendation on daily dietary cholesterol intake, as it had done in previous reports. The authors did not find enough scientific evidence to recommend a specific cholesterol threshold or evidence that foods containing cholesterol should be limited. The principal contribution of this document is that dietary guidelines are now based on dietary patterns and their impact on health and disease, instead of the theoretical distribution of macronutrients (5).

Although the first guidelines attempted to provide recommendations based on the evidence of their times, more recent observational and controlled dietary intervention studies have shown the need to move away from the reductionist perspective that focused on single nutrients or specific foods. Rather, dietary recommendations should take into account overall diet, food groups, and nutrients, as well as food combinations, frequency, quality, and quantity (33).

Dietary FAs and Their Impact on Health

The discrepancy in the results examining the effects of dietary fat on health can be explained by the quality of FAs contained in food (34). For decades, SFAs generally were thought to have detrimental effects on health (35); therefore, high intake of saturated fat and *trans* FAs from industrial sources and dairy products, especially the saturated fats 12:0, 14:0, and 16:0, was linked to an increased risk of CVD (36). Consequently, only low-fat and fat-free milk products were recommended by the dietary guidelines as part of a healthy diet in order to reduce the risk of CVD (29). However, the situation is not as clear cut now. The findings indicate that the majority of observational studies fail to show an association between the intake of dairy products and increased risk of CVD, CAD, and stroke, regardless of milk fat concentrations (37–39). In addition, a recent meta-analysis of randomized studies also concluded that neither low-fat nor whole-fat dairy foods have significant effects on traditional CVD risk factors (40). These results agree with pooled analyses of observational studies that found beneficial or neutral associations between CVDs and total dairy, low-fat dairy, whole-fat dairy, milk, and cheese (41, 42). Yakoob et al. (43) studied dairy food FAs and found that the intake of the SFAs pentadecanoic acid (15:0) and heptadecanoic acid (17:0) and *trans* palmitoleate (t-16:1n–7) were associated with a lower incidence of diabetes. These results generally were consistent with those of Micha et al. (34), who found that SFA consumption was not linked to the incidence of diabetes. Results from short-term intervention studies on CVD biomarkers indicated that a diet higher in saturated fat from whole milk and butter increases LDL cholesterol when these are substituted for carbohydrates or unsaturated FAs; however, they may also increase HDL, and therefore might not affect or even lower the ratio of total to HDL cholesterol (44, 45). Another meta-analysis concluded that a modest increase in daily intake of dairy products may contribute to the prevention of type 2 diabetes mellitus (T2DM), even if these are whole dairy products (46). The authors found an inverse association between total dairy intake and T2DM risk in all strata except European studies and studies not adjusting for family history of T2DM. They also found a nonlinear association between total dairy product intake and T2DM, with most of the risk reduction occurring with intake up to ~200 g/d; a higher intake was associated with a further but more modest decrease in risk. The relation between

obesity and overweight and intake of dairy also has been evaluated. A review showed that a majority of clinical trials in adults found a protective association between dairy consumption and overweight and obesity (47). In this review, only one study showed no protective association, and another study found a protective effect from low-fat dairy but not total dairy. This review concluded that the consumption of dairy products had no harmful effect on weight status, contrary to popular belief. The authors did not find low-fat dairy products to be more beneficial to weight status than regular-fat dairy products. With respect to results from numerous prospective observational studies and meta-analyses, not all, but most, showed no association between the intake of milk fat–containing dairy products and the risk of CVD, CAD, and stroke, although some showed an inverse relation, even with the intake of whole-dairy products (48). In addition, the Women's Health Initiative Diet Modification Trial suggested no benefit from a reduction in SFA intake on the incidence of T2DM (49), Similar results were described in another meta-analysis by Tong et al., who found that daily consumption of dairy products had a beneficial effect in the prevention of T2DM development (50). The differences in the results between studies could be explained by dissimilarities in their methodology and population.

Studies on the effects of *trans* FAs suggest that increased consumption of *trans* FAs is strongly associated with CVD risk, systemic inflammation, and endothelial dysfunction (51–53). The principal food sources for *trans* FAs are margarine, butter, desserts, fried food, processed meat, and some fast food. It is important to keep in mind that multiple *trans* FA isomers exist, and the effect of each isomer is still unclear (54).

Dietary guidelines have consistently recommended replacing calories from SFAs with calories from PUFAs and MUFAs, which, for the majority of the population, come from vegetables oils. However, vegetable oils do not only contain PUFAs and MUFAs, and may actually be an important source of SFAs, as is the case of palm oil and coconut oil (55). The cardiovascular effect of these vegetable oils may vary depending on the precise combination of PUFAs, MUFAs, and SFAs (56). Also, it is important to consider how cooking can change the composition of FAs; for example, vegetable oils are typically heated to high temperatures, which induces lipid peroxidation in the PUFAs, transforming them into SFAs (57, 58).

Different types of foods contain different types of fats that are not homogeneous in their FA or cholesterol content; this heterogeneity may confer different effects on human health and disease. This may well muddy the evidence regarding the replacement of SFAs with PUFAs and MUFAs, with such replacement possibly not having a significant impact on health. In a recent systematic review and meta-analysis, Chowdhury et al. (59) did not find clear supporting evidence for the high consumption of PUFAs and low consumption of SFAs. This contradicts numerous previous reports, including the Prevención con Dieta Mediterránea trial (60), which showed a significant inverse association between a Mediterranean diet (characterized by fats derived from PUFAs) and risk of CAD (59–62). Another study conducted in Costa Rica suggested that the type of oil used for cooking and frying is more important than amount of oil used, so that a decrease in intake of saturated fat may not have a significant effect on public health (63). Indeed, the European Prospective Investigation into Cancer and Nutrition study showed that the consumption of extra-virgin olive oil was associated with a reduced risk of CVD (35). This meta-analysis, while groundbreaking, was criticized for being biased (64). There are arguments against the replacement of SFAs with carbohydrates. First, although decreased intake of SFAs lowers LDL cholesterol, it also lowers HDL cholesterol (65). A recent review by Lawrence (66) highlighted the necessity for a rational reevaluation of dietary recommendations that focus on minimizing dietary SFAs, for which the mechanisms of adverse health effects are lacking (65, 66). Second, excess intake of carbohydrates, such as starches, refined grains, sugar-sweetened beverages, sweets, and fruit juice are associated with weight gain. Only vegetables, nuts, fruits, and whole grains have been associated with healthy body weight (67). In addition, a low-fat, high-carbohydrate diet causes an increase in serum TGs and small, dense LDL particles; this is an atherogenic lipid profile (66).

Clinical Practice: Proportions of Total Calories or Dietary Patterns

Dietary patterns are defined as nonrandom combinations of different foods and beverages in diets determined by social or cultural factors (68). The main goal of the dietary guidelines is to provide advice and strategies to the public to optimize their food selection while taking into account the traditions and cultural resources of the users (69). Among the dietary patterns that have been studied are the Mediterranean, Dietary Approaches to Stop Hypertension (DASH), Western, and vegetarian diets (56). The conventional DASH diet is rich in fruits and vegetables; high in potassium, magnesium, and fiber; and low in sodium and SFAs (<7% of energy). The modified DASH diet is similar to a Mediterranean diet, high in vegetable oils and low in carbohydrates. Al-Solaiman et al. (70) examined the effect of the DASH diet in obese hypertensive individuals. That study reported that the DASH diet was more effective in controlling blood pressure than was potassium, magnesium, and fiber supplementation. Evidence from observational studies and randomized controlled trials suggests that high fruit and vegetable consumption is associated with a lower incidence of CAD (3, 71).

Vegetarian diets may result in substantial benefits in weight reduction and arterial blood pressure compared with nonvegetarian diets (3, 72). Several types of vegetarian diets exist, including pesco-vegetarian (includes fish), lacto-vegetarian (includes eggs and dairy products) and vegan (includes no animal products). To date, few studies have focused on these types of dietary patterns; as a consequence, possible cardiometabolic benefits have not been confirmed.

A recent review by Mozaffarian (56) highlights the importance of dietary recommendations that are focused on dietary patterns instead of particular nutrient groups (e.g., dietary fat and cholesterol intake). Previously, dietary recommendations often focused on total calories, body weight, and obesity, rather than cardiovascular and metabolic health. This review emphasizes the importance of targeting specific foods and overall dietary patterns rather than single isolated nutrients in order to maintain cardiometabolic health. Dietary priorities include increasing the intake of fruits, vegetables, nuts, legumes, fish, vegetable oils, yogurt, and minimally processed whole grains; and decreasing the intake of red and processed meats and foods rich in refined grains, added sugars, salt, or *trans* fat.

As a result, recommendations should be adjusted to the characteristics of each target population. Knowledge should be translated into food combinations that provide enough energy and nutrients to maintain physiologic functions and normal body composition (5). Food combinations are not randomly selected: individuals set their dietary preference early in life (73). Food selections become a repetitive, predictable process in which the main sources of calories are usually limited to 20–30 products. Clusters of food can be identified with the use of factorial analyses, a useful approach to integrate the combined effects of mixed foods, instead of considering individual nutrients (74) This approach, known as "dietary patterns," has become popular in epidemiologic studies (75). Indicators have even been developed to qualify the composition of a dietary pattern (e.g., healthy diet indicator, healthy eating index, or the Program National Nutrition Santé guideline score). The search for associations between various dietary patterns and multiple health outcomes (i.e., cognitive decline, diabetes, obesity, and neoplasia) has been a matter for several meta-analyses and systematic reviews (76).

Current guidelines have not been effective in the communication of the main messages on healthy eating patterns. Rather, the majority of these documents suggest "eating plenty of fruits, vegetables, and complex carbohydrates, and choosing foods that are lower in saturated fat, salt, and added sugar" (77). These documents are focused on achieving a caloric content and a prespecified nutrient distribution, as well as limiting the consumption of fat- or carbohydrate-enriched food products. Instead, they should consider that the intake of these products is integrated into a network that should be considered as a whole (78). Certain European governments have designed regionally adapted strategies to improve nutritional status and promote physical activity by delivering clear-cut messages (79). This approach is not focused on single components of a diet but, rather, propose a more broad line of attack to achieve a healthy dietary pattern (77).

Additional evidence to support the use of dietary patterns in guidelines and research has been provided by the Nutrition and Chronic Diseases Expert Group. This group presented data on the consumption of key dietary items over a period of 20 y in men and women with the use of 325 population-based surveys applied in 187 countries. The group assessed 2 types of dietary patterns: one reflecting the consumption of 10 healthy items (fruit, vegetables, beans and legumes, nuts and seeds, whole grains, skim milk, total PUFAs, fish, plant n–3 FAs, and dietary fiber) and the other based on unhealthy items (unprocessed red meats, processed meats, sugar-sweetened beverages, saturated fat, *trans* fat, dietary cholesterol, and sodium). Each dietary pattern was assessed for every country stratified by age, sex, and national income groups. This large amount of information allowed for the identification of trends in dietary patterns from 1990 to 2010, independent of diet quantity (caloric intake). Among countries, the largest variation was noted in the mean intake of whole grain, fruit juice, nuts and seeds, plant n–3 FAs, sugar-sweetened beverages, and processed meats. Older adults had better dietary patterns than did younger adults; the same was true for women compared with men. The report confirmed the growing trend in the consumption of unhealthy options, especially in low-income countries (80). As a result, policies are needed not only to limit the consumption of unhealthy options, but also to stimulate the intake of healthy food (56). The aim of dietary guidelines should be to provide recommendations for disease prevention, not treatment, and to propose healthy options that can feasibly be adopted by the public.

Guidelines should be translated to messages and strategies easy to implement by the population, regardless of income and education. Figures and icons (i.e., plates or pyramids) are a widely used tool to deliver the messages in an integrative manner. Aspects considered in the educational diagrams depend on the region, culture, and epidemiologic characteristics of each country. Graphic representations have been used as a visual aid in the process of dietary guidance, and images are focused on types of foods, instead of nutrients (81). In the United States, the healthy eating pyramid was published in 2008 in order to give the best possible advice to the population on healthy eating on the basis of current evidence. In 2010, the instrument was changed to have a visual representation of a plate (called MyPlate) (82). As an alternative to the USDA's nutrition advice, the Harvard School of Public Health developed the Healthy Eating Plate in 2011. The main difference between these 2 is that the Harvard Eating Plate emphasizes the intake of whole-grain cereals, low-fat meat, poultry, fish, healthy oils, and water, and includes advice for increasing physical activity (83). Other pyramids or plates also have been developed on the basis of the Mediterranean diet and other dietary patterns. The plate icon recently has been adopted by certain Latin American countries, including Costa Rica, Uruguay, Cuba, Argentina, and Mexico (81).

Conclusion

Over the past few decades, dietary guidelines have moved from being consensus documents to becoming evidence-based recommendations. The total amount and the type of fat has been a focus of these documents for many years. Despite a lack of evidence from methodologically sound

randomized controlled studies, dietary goals for fat intake have been based on the proportions of the 3 main classes of fat. In addition, the recommendations were difficult to communicate to the general public.

It is important to remember that dietary data collection is not without its flaws, in particular memory bias. This is especially important in long-term studies in which changes in diet over time, coupled with possible memory bias, may even lead to misinformation.

Long-term observational studies have provided evidence regarding the benefits and risks associated with the regular consumption of the most common food products. Moreover, these studies have found that food choices follow a common pattern that can be summarized as a single profile. It is evident that a low-fat diet is a heterogeneous food pattern and should not be considered synonymous with a healthy diet. Hence, public nutritional recommendations should leave behind the reductionist information, specifying the intake of specific amounts of macronutrients. New guidelines typically do not set a threshold for total fat and cholesterol intake. Instead, they identify the food type and frequency with which individuals may consume the main sources of fat on the basis of the best available evidence. Furthermore, recommendations should be integrated into food networks, designed to be compatible with the most common food patterns of the target population. Randomized controlled trials are needed to assess the health consequences of the currently recommended dietary patterns. The interpretation of epidemiologic associations should be carried out with care, because even strong associations must be confirmed by well-controlled intervention studies.

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