

Mediterranean diets: historical and research overview^{1,2}

Marion Nestle

ABSTRACT Diets consumed by Mediterranean populations have been a subject of interest since antiquity, with more recent investigations focused on their evident health benefits. The work of Ancel Keys in the 1950s established the largely plant-based Mediterranean diet as the original prototype for current dietary guidelines in the United States and elsewhere. As a cultural model for dietary improvement, the Mediterranean diet can be recommended for both its health benefits and its palatability. Given worldwide trends toward dietary uniformity, classic Mediterranean diets may be becoming endangered species, and much basic and applied research is needed to define the ways in which such traditional and healthful dietary patterns can be preserved and promoted. *Am J Clin Nutr* 1995;61(suppl):1313S-20S.

KEY WORDS Mediterranean diet, dietary guidance, dietary change, nutrition research, vegetarian diets, health promotion, disease prevention

INTRODUCTION

The basic observation that underlies current interest in Mediterranean diets is this: adults living in certain regions bordering the Mediterranean Sea display rates of chronic diseases that are among the lowest in the world and life expectancies that are among the highest (1), and they have done so at least since the early 1960s (2). Such favorable health statistics are not readily explained by educational level, financial status, or health care expenditure, because socioeconomic indicators in these regions are often quite low compared with those of more industrialized countries (3). Thus, attention has focused on diet as the key explanatory factor.

In 1961, overall life expectancy at the age of 45 y was higher in the Greek population than in any other national group tracked by the World Health Organization (WHO) (4). Since the 1960s, the high rankings of life expectancies in Mediterranean countries have dropped slightly, a shift that can be attributed at least in part to undesirable changes in dietary practices (5). Nevertheless, life expectancy at the age of 45 y in Greece was 32.5 y in 1991, ranking second to Japan's 33.3 y. In comparison, life expectancies at the age of 45 y in the United States, United Kingdom, and Canada were 30.8, 30.9, and 32.1 y, respectively, in 1991 (1).

Even these brief observations raise research questions of considerable interest and importance. What, precisely, is the "Mediterranean diet"? What are its health effects? In what ways is the diet changing, and what are the health implications of such changes? Should—and could—a Mediterranean-style

diet be adopted in the United States? What would be the effect of its adoption on agriculture, the food economy, and health patterns? Because such questions address fundamental issues of food and nutrition policy, the Mediterranean diet is well worth examination as a model of a healthful dietary pattern (6, 7).

As background for the consideration of more detailed discussions of such questions, this article presents an overview of the historical antecedents of current interest in Mediterranean diets, identifies key research questions related to the content and effect of such diets, and suggests areas for future research to establish a sound basis for national policies designed to preserve and promote traditional diets within their countries of origin, as well as to encourage the adoption of such diets elsewhere.

HISTORICAL ANTECEDENTS

Diets of the ancient Mediterranean

In the absence of written records, knowledge of ancient diets must be inferred from whatever evidence is available. In the case of Mediterranean diets, such evidence is abundant (8). It includes a vast and extensively documented archaeological record of food debris, and of food-related art, pottery, tools, and inscribed tablets that have been excavated from prehistoric, Neolithic, Bronze Age, and later sites throughout the lands surrounding the Mediterranean Sea and from the many islands within it. Evidence also includes information derived from close textual analysis of the writings of Homer and other classical authors. The many and varied sources of information about the diets of ancient Egyptians, for example, are summarized in Table 1. Inferences based on such sources must take into consideration the difficulties inherent in evaluating such evidence: poor preservation of materials, incomplete fragments, errors of oversight, biased opinions, false information, and problems of translation, classification, dating, and interpretation (9). Despite these difficulties, scholars have used these various sources to firmly document the availability in ancient times of an astonishing variety of plant and animal foods, bread, spices, sweets, and beer and wine (9-12).

The presence of these foods in a region suggests but does not prove that they were routinely consumed. Reports in ancient

¹ From the Department of Nutrition and Food Studies, New York University, New York.

² Reprints not available. Address correspondence to M Nestle, Department of Nutrition and Food Studies, New York University, 35 West 4th Street, 10th Floor, New York, NY 10012-1172.

TABLE 1
Sources of information about diets in ancient Egypt¹

Archeology (preserved remains of animals and plants)
Stomach and intestines of human mummies
Tombs (sealed and opened)
Mud bricks
Art (depictions of foods, food preparation, and domestic animals)
Temple and tomb paintings and reliefs
Statues, models, and dioramas
Literature
Papyrus, tomb, or temple texts
Daily food allowances
Lists of food offerings
Foods in medical prescriptions
Cosmology and mythology texts
Greek, Roman, and Arabic texts
Religious texts
Descriptive accounts by travelers, historians, and naturalists

¹ Adapted from reference 9.

times of actual dietary intake are scanty, especially for diets of the general population. Classic authors often wrote about the diets of warriors or noblemen. Scholars who have analyzed the writings of Homer, for example, have noted that the descriptions of meals made it appear that Hellenic heroes dined almost exclusively on meat served with liberal quantities of bread and wine (12). They found Homeric texts to mention vegetables and fruits only rarely, perhaps because such foods were "... considered beneath the dignity of gods and heroes" (13), and to cite olive oil only as an unguent (12).

Perhaps as a result, some modern scholars have concluded that the typical diet of the common people must have been rather sparse and based mainly on plant foods and bread, with meat and seafood as only occasional additions, much the way these authors observed it to be at the time they were writing (11, 12). In contrast, a second-to-third century AD compendium of excerpts from the texts of classic poets and writers discusses a vast array of foods and drinks in the context of their flavors and aromas, means of preparation, and contributions to simple meals and great banquets, suggesting that they were consumed and enjoyed by people of all classes (13).

Modern scholars have related dietary practices to the health of ancient populations through inferences drawn from the examination of prehistoric remains, analyses of sepulchral inscriptions, and other sources of evidence listed in Table 1. These sources provide evidence of dental and other diseases and suggest that the average life span in ancient Greece and Rome must have been on the order of 20–30 y (14). This brief life expectancy was more likely to have resulted from infection and civil conflict than from starvation, because average citizens seemed to have been well nourished (9), which is consistent with the extraordinary accomplishments of Mediterranean civilizations at that time.

Modern history: the Rockefeller Foundation's study

The first systematic attempt to investigate dietary intake in the Mediterranean region took place shortly after the end of World War II. In 1948, the government of Greece, concerned about the need to improve postwar economic, social, and health

conditions, invited the Rockefeller Foundation to undertake a major epidemiologic study on the island of Crete to determine how best to raise the population's standard of living. In response to this request, the Foundation appointed an epidemiologist, Leland Allbaugh, to direct what turned out to be an unusually enlightened investigation to discover how "... the knowledge and skills of industrialized countries might best serve and least injure an underdeveloped area such as Crete." Allbaugh and his colleagues responded to their charge by designing and conducting a comprehensive survey of the demographic, economic, social, health, and dietary characteristics of the members of 1 out of every 150 households on the island, a sample chosen through a carefully designed randomization process. The Foundation published the results of these investigations as a monograph in 1953 (15).

The report of the survey was remarkably thorough. It included, for example, a 75-page appendix describing and critically evaluating the statistical methods, as well as a 50-page section containing copies of each of the many questionnaires. The survey's numerous dietary components included a review of food balance (food supply) data for Greece; the administration to 128 households of several distinct questionnaires probing cooking practices, daily menus, food expenditures, household food production, and food handling and consumption practices; a 2-d dietary intake survey of pregnant and lactating women and another of children aged 7–19 y; and a survey of the dietary intake of children aged 1–6 y, obtained from their parents. These, however, were only peripheral components of the overall dietary probe.

The core of the survey's dietary sections consisted of 7-d weighed food inventories collected from the 128 households, 7-d dietary intake records obtained from >500 individuals in those households, and food-frequency questionnaires administered to 765 households. All of these dietary investigations were conducted in the early fall by volunteer nurses from the Greek Red Cross who, after 5 full days of training, went to live in the survey communities for periods of 7–10 d and made daily visits to the sample households. The work of these nurses was closely supervised and their data cross-checked in several ways. It is difficult to imagine a survey of this magnitude and complexity being initiated—or funded—today.

Table 2 compares selected data on Cretan dietary practices obtained through the various dietary survey methods. The methods were in substantial agreement about per capita intake of energy [10.5 MJ/d (2500 kcal/d)] and the consumption or supply of foods from animal sources. Food balance data, which represented the amounts of food available throughout the entire country of Greece, were higher for cereals and sugar but lower for potatoes, pulses, nuts, oils, and fats than found by the dietary intake surveys in Crete. As will be discussed later, these differences can be attributed to sources of random and systematic error inherent in methods of dietary intake measurement. As just one example, Allbaugh attributed the small quantities of alcoholic beverages reported in the dietary intake records relative to the much larger amounts identified by food balance or household inventory data to systematic underreporting. This source of error was confirmed by his own observations as well as "... an expressed feeling by the respondents that the visiting Americans might be expected to frown on heavy wine consumption where food was short" (15, p 106).

TABLE 2
Dietary intake in Crete in 1948 as estimated by three methods¹

	Greece: food balance 1948-1949	Crete: 7-d diet record	Household inventory ²
Energy (MJ/d)	10.2	10.6	10.7
(kcal/d)	2443	2547	2554
Foods (kg · person ⁻¹ · y ⁻¹)			
Cereals	158.2	127.7	128.2
Potatoes	30.9	59.1	38.6
Sugar and honey	9.1	5.5	5.5
Pulses and nuts	15.0	20.0	23.2
Vegetables, fruits, and olives	120.5	175.9	132.3
Meat, fish, and eggs	23.2	28.6	27.7
Milk and cheese	35.0	25.5	34.5
Oils and fats	15.0	30.9	30.9
Wine, beer, and spirits	37.7	10.0	38.6

¹ Adapted from reference 15.

² Adjusted for information obtained from food-frequency questionnaires.

Table 3 compares the food sources of energy in the diets of Crete, Greece, and the United States, as reported in the Rockefeller Foundation's study. This Table displays dietary intake data from Crete, but reports food balance data for Greece and the United States, even though these methods are not truly comparable. Therefore, the results can only be interpreted as indicating that plant foods (eg, cereals, pulses, nuts, potatoes, vegetables, and fruits) made up 61% of total energy in the diet of Crete, compared with 74% of energy in the Greek food supply (but not the Greek diet) and 37% of energy in the US food supply (not necessarily diet). Similarly, foods of animal origin (eg, meat, fish, eggs, and dairy products) made up only 7% of energy in the Cretan diet, but they constituted 19% of the energy in the Greek food supply and 29% of the energy in the US food supply. Table oils and fats contributed 29% of energy to the Cretan diet, but only 15% to the Greek and US food supplies. In Crete, however, 78% of the table fats derived from

TABLE 3
Percent of total energy contributed by major food groups in the diet of Crete compared with their availability in the food supplies of Greece and the United States in 1948-1949¹

Food group	Crete: 7-d record	Greece: food balance	US: food balance
Energy (MJ/d)	10.6	10.4	13.1
(kcal/d)	2547	2477	3129
Foods (%)			
Cereals	39	61	25
Pulses, nuts, and potatoes	11	8	6
Vegetables and fruits	11	5	6
Meat, fish, and eggs	4	3	19
Dairy products	3	4	14
Table oils and fats	29	15	15
Sugar and honey	2	4	15
Wine, beer, and spirits	1	— ²	—

¹ Adapted from reference 15.

² Data not available.

olives and olive oil. The total amount of fat from all sources in the Cretan diet, including that "hidden" in animal foods, was 107 g/d, or an estimated 38% of total energy, a percentage similar to that in the US food supply in the late 1940s (16) and considerably higher than that recommended today for reducing chronic disease risk factors (17-19).

The data in Tables 2 and 3 constitute the basis of the report's conclusion that "olives, cereal grains, pulses, wild greens and herbs, and fruits, together with limited quantities of goat meat and milk, game, and fish have remained the basic Cretan foods for forty centuries . . . no meal was complete without bread . . . Olives and olive oil contributed heavily to the energy intake . . . food seemed literally to be 'swimming' in oil" (15, p 100). The Rockefeller survey data also indicated that wine was consumed frequently, with the midmorning, noon, and evening meals.

In attempting to correlate dietary data with the health of the population, Allbaugh noted certain limitations of his study: the lack of composition data for Cretan foods and the lack of clinical and biochemical studies of the Cretan population. Nevertheless, the study found few serious nutritional problems in Crete, and these ". . . were limited to a relatively small number of households, living under conditions of very low income and little home production of food" (15, p 124). Diets generally were nutritionally adequate as measured against the US recommended dietary allowances of that time (20). The investigators concluded that the diets and food consumption levels observed in most individuals ". . . were surprisingly good. On the whole, their food pattern and food habits were extremely well adapted to their natural and economic resources as well as their needs" (15, p 31).

This optimistic view, however, was not necessarily shared by the study subjects. Allbaugh reported that only one out of six of the interviewed families judged the typical diet to be satisfactory. He quoted one family as stating: "We are hungry most of the time" (15, p 105). Survey respondents listed the following foods, in priority order, as those most desired to improve their diets: meat, rice, fish, pasta, butter, and cheese. A large majority of respondents (72%) listed meat as their favorite food. On the basis of such views, Allbaugh concluded that the diet of Crete could best be improved by providing more foods of animal origin.

Ancel Keys: the Seven Countries Study

Despite the wealth of information provided by the Rockefeller Foundation's study, current interest in the health implications of Mediterranean diets more commonly begins with the work of Ancel Keys. In 1952, impressed by the low rates of heart disease in the region, he initiated a series of investigations of dietary and other coronary risk factors with colleagues in seven countries (21). Keys and his wife Margaret reported the genesis of these investigations in vivid detail:

Snowflakes were beginning to fly as we left Strasbourg on the fourth of February. All the way to Switzerland we drove in a snowstorm. . . . On the Italian side the air was mild, flowers were gay, birds were singing, and we basked at an outdoor table drinking our first espresso coffee at Domodosola. We felt warm all over. . . . (22, p 2)

The diet that the Keyeses and the people they met ordinarily were eating also created a strong impression. It typically included:

homemade minestrone... pasta in endless variety... served with tomato sauce and a sprinkle of cheese, only occasionally enriched with some bits of meat, or served with a little local sea food... a hearty dish of beans and short lengths of macaroni... lots of bread never more than a few hours from the oven and never served with any kind of spread; great quantities of fresh vegetables; a modest portion of meat or fish perhaps twice a week; wine of the type we used to call "Dago red"... always fresh fruit for dessert. Years later, when called on to devise diets for the possible prevention of coronary heart disease we looked back and concluded it would be hard to do better than imitate the diet of the common folk of Naples in the early 1950s (22, p 4). Keys and his colleagues published the results of their Neapolitan observations in the early 1950s. These investigations found Italian diets to be remarkably low in fat (20% of energy), or just half the proportion observed in the diets of comparable American groups (23). By that time, long before such ideas became commonplace, Keys had associated the typical American diet, rich in meat and dairy fats, with higher concentrations of blood cholesterol and, therefore, with increased risk of coronary heart disease.

In 1959, the Keyeses reviewed the principal lines of evidence for these associations in a cookbook designed to help the general public reduce risks for coronary heart disease (24). In a foreword to this volume, the eminent cardiologist Paul Dudley White, who had made several expeditions with the Keyeses "... to study the health and the ways of life of native populations..." in southern Italy and Crete, extolled both the health benefits and the taste of the low-fat foods—and the wine—that they had routinely consumed during their Mediterranean travels.

In this cookbook, perhaps the first of the "healthy heart" genre, the Keyeses summarized their best advice for lifestyle practices to reduce coronary risk (24, p 40). Table 4 lists their precepts compared with the 1990 US dietary guidelines for health promotion and disease prevention (17). As is evident from this Table, the US guidelines closely follow the 1959 advice that the Keyeses derived from their observations of diet and coronary risk in southern Italy and Crete. This comparison demonstrates that the Mediterranean diet of the 1950s constituted the original prototype for the development of current dietary guidance policy in the United States.

Beginning in the early 1950s, and for >20 y thereafter, Keys and his colleagues identified dietary and other risk factors for coronary heart disease through a large-scale study of nearly 13 000 middle-aged men from seven countries distributed among 16 cohorts (2, 25). The overall results of this Seven Countries Study provided strong epidemiologic evidence for the effects of fat and various fatty acids on serum cholesterol concentrations and on coronary heart disease risk (26).

Dietary intake data for foods and food components other than fat, however, were published in English for all cohorts only in 1989 (27). That report compared the 16 cohorts with respect to their intake of bread, cereals, various vegetables, fruit, meat, fish, eggs, dairy foods, table fats, pastries, and alcoholic beverages. These data confirmed that Mediterranean diets in the early 1960s were based primarily on foods from plant sources, but that some versions were higher in fat (mainly olive oil) than might be expected in a population with such good health. The Seven Countries' data, as confirmed by

TABLE 4

The Keys' 1959 dietary advice for prevention of coronary heart disease compared with the 1990 US dietary guidelines

The Keys' best advice (24)

- 1) Do not get fat; if you are fat, reduce.
- 2) Restrict saturated fats; the fats in beef, pork, lamb, sausages, margarine, and solid shortenings; and the fats in dairy products.
- 3) Prefer vegetable oils to solid fats, but keep total fats under 30% of your diet calories.
- 4) Favor fresh vegetables, fruits, and nonfat milk products.
- 5) Avoid heavy use of salt and refined sugar.
- 6) Good diets do not depend on drugs and fancy preparations.
- 7) Get plenty of exercise and outdoor recreation.
- 8) Be sensible about cigarettes, alcohol, excitement, and business strain.
- 9) See your doctor regularly and do not worry.

1990 dietary guidelines (17)

- 1) Eat a variety of foods.
 - 2) Maintain healthy weight.
 - 3) Choose a diet low in fat, saturated fat, and cholesterol.
 - 4) Choose a diet with plenty of vegetables, fruits, and grain products.
 - 5) Use salt and sodium only in moderation.
 - 6) Use sugars only in moderation.
 - 7) If you drink alcoholic beverages, do so in moderation.
-

subsequent investigations (5, 28, 29), constitute the principal research basis for the proportions of foods from plant and animal sources proposed recently as a Mediterranean diet pyramid (30).

The study by EURATOM

One additional study provided comparative information about dietary intake in the Mediterranean and other regions of Europe. From 1963 to 1965, the European Atomic Energy Commission (EURATOM) examined household food consumption in 3725 families in 11 regions of 6 European countries in an effort to identify commonly consumed foods that were most likely to be sources of radioactive contaminants (28). In these households, investigators conducted dietary interviews on each of 7 consecutive days, and weighed all foods present in the households on those days. After applying several correction factors, the investigators converted the data on household food consumption to average amounts of food consumed per person per day.

Of the regions selected for the study, nine were in northern Europe and two in southern Europe. One of the northern regions was in Italy (Friuli). Because both of the southern regions also were in Italy (Campania and Basilicata), the data could be used to compare the typical dietary intake of the Italian north—which was quite similar to dietary patterns throughout the rest of northern Europe—with that of its Mediterranean regions. A detailed comparative analysis of these data is now available (31).

The study by EURATOM describes distinct differences in dietary intake patterns among the Italian regions. Diets in the Mediterranean areas were characterized by a much greater intake of cereals, vegetables, fruit, and fish, but a much smaller intake of potatoes, meat and dairy foods, eggs, and sweets. Although no consistent north-south differences were observed

in overall consumption of table fats, the foods contributing to total fat intake were quite different. Consumption of butter and margarine was much higher in northern regions. In the southern regions, in contrast, the principal fat was olive oil and margarine was not consumed at all. Taken together, the results of this study provide further evidence that the Mediterranean diet of the mid-1960s was based predominantly on plant foods and included olive oil as the principal fat.

Recent observations

In the years following Keys' investigations, his description of the role of diet in coronary risk has become increasingly accepted (32-34). Along with this acceptance has come increasing recognition that the traditional dietary patterns of many cultures meet current dietary guidelines, and that the cuisines of these cultures, especially those of Mediterranean and Asian countries, could serve as models for dietary improvement (7). In recent years, reports of investigations of the scientific basis and health implications of Mediterranean diets have been published in at least four edited collections of papers (35-38); others were presented at an international symposium in 1993 (39). Public interest in Mediterranean diets has been stimulated by numerous articles in the popular press (40, 41) and by their palatability as celebrated in cookbooks emphasizing the dual themes of good taste and good health (42-45).

RESEARCH ISSUES

As noted earlier, studies of Mediterranean dietary patterns raise research issues that are also applicable to a more general understanding of the role of diet in health.

Definition

At least 16 countries border the Mediterranean Sea. Their populations vary greatly in culture, ethnicity, religion, economic and political status, and other factors that might influence dietary intake, and their food supplies vary widely in every item examined. Identification of the common dietary elements within the region has proved a challenging task (46-49). Because Keys' studies found the typical dietary pattern of the Greek island of Crete in the 1950s and 1960s to be associated with especially good health, this pattern has come to be viewed as the model Mediterranean diet. Because olive oil was a principal source of fat in the Cretan diet, the model has been extended to include diets consumed in olive-producing Mediterranean regions. In this manner, the generic term "Mediterranean diet" is used in practice to refer to dietary patterns similar to those of Crete in the early 1960s and other regions in the Mediterranean where olive oil is a major fat source (30).

Methods

Knowledge of the content of Mediterranean diets in the early 1960s or at present necessarily depends on the reliability of methods used to determine the typical food intake of the population. National diet surveys, such as those conducted in the United States, were not generally available in Mediterranean countries. The Rockefeller Foundation's study of Crete was a notable exception, remarkable by any standard of epidemiologic investigation in its use of multiple methods to define dietary intake (see Table 2), lengthy personal interviews,

and critical analysis of results (15). Multiple methods were also used in the Seven Countries Study. For most of the 16 cohorts, Keys and his colleagues obtained 7-d diet records from small subsamples of each group, and corroborated these records by analyzing the energy and nutrient composition of weighed duplicate meals. For a few cohorts, they collected dietary data from 24-h recalls as verified through food-frequency questionnaires (2). Finally, the study by EURATOM corroborated daily reports of household food intake by weighing all foods present in the house on each of the 7 consecutive interview days (28).

These investigations were designed to overcome fundamental flaws in each of the methods commonly used to evaluate the dietary intake of individuals and populations; all provide opportunities for random and systematic errors in reporting food intake, estimating serving sizes, and determining nutrient content (50, 51). Such problems are compounded in studies that attempt to compare dietary intake data from one country to another, or within one country over time. If the methods for determination of dietary intake differ, their results are not strictly comparable (see Tables 2 and 3).

For purposes of international comparison, investigators must often rely on food balance data: agricultural data on specific commodities present in the food supply from one year to the next. These data are distinctly different from those that describe dietary intake. They reflect the amounts of specific foods produced in a country during a given year, plus imports, less exports, and expressed per capita. Such data are also known by other names: supply, availability, disappearance, and consumption. Among these terms, "consumption" is a misnomer; food balance data are only an indirect estimate of dietary intake. A food that is produced, but is then wasted, fed to animals, or used for nonfood purposes is not actually consumed; for many foods, therefore, food balance data overestimate dietary intake. For foods produced at home, however, food balance data underestimate consumption. The average annual per capita availability of a food commodity only rarely—and accidentally—is an accurate measure of actual consumption by an individual man, woman, or child. These limitations may explain observed discrepancies in study results, and they suggest the need for caution in interpreting comparative data (see Tables 2 and 3).

Despite such limitations, food balance data often are the best, or only, data available to estimate time trends in dietary practices, and they are used frequently in comparative descriptions of Mediterranean diets (46, 52). Three agencies of the United Nations (UN) produce such data. The Organization of Economic Cooperation and Development (OECD) has published data for the supply and use in 23 countries of specific food items such as pork, cheese, or olive oil from 1979 to 1988 (53). The Food and Agriculture Organization (FAO) publishes individual food balance sheets for 145 countries that include data for per capita supply of major food groups (eg, meat, legumes, and alcohol); the most recent edition provides data in 3-y averages from 1961-1963 through 1986-1988 (54). The WHO Regional Office for Europe has established a comprehensive computerized database that incorporates FAO food balance data as well as the WHO annual health statistics since 1961 for each of the countries tracked by the UN (4); this program makes it possible to generate an immediate display of the relation between the availability of any food and a disease rate in any country of interest (4, 52).

Health effects

By the definition used here, the Mediterranean diet can be considered to be a near-vegetarian diet. As such, it should be expected to produce the well-established health benefits of vegetarian diets, as well as to solve any deficiencies of energy or micronutrients (especially vitamin B-12) that are occasionally associated with such diets (55). It is also exceptionally palatable (42-45). Vegetarian or near-vegetarian diets also contain specific nutrient and nonnutrient components, antioxidant vitamins, fiber, and a variety of phenolic compounds, for example, that have been identified as being protective against major chronic diseases (56-58). The relative importance of the single nutrient components, the foods that contain them, or Mediterranean physical activity and lifestyle patterns—alone or in combination—in the favorable health indexes observed in these regions has yet to be determined.

Changing dietary patterns

If it is indeed true that Mediterranean diets of the 1960s protected adult populations against premature death, it would seem highly desirable to preserve the protective elements of those diets. Evidence from dietary intake surveys and from food balance data indicates, however, that dietary patterns throughout the region are changing rapidly, and generally in an undesirable direction. For example, one dietary intake study of an urban population in Crete (obtained by 24-h diet recalls corroborated by food models, photographs, and clinical and biochemical measurements) reported an increase in intake of meat, fish, and cheese, but a decrease in intake of bread, fruit, potatoes, and olive oil (5), compared with data collected by Keys and his colleagues in the early 1960s (27). Similar changes have been observed in Italy (31). Food balance data also document large increases in the availability of meat, dairy foods (54), and animal fats (38) throughout the region since the early 1960s. Given this situation, Mediterranean diets may well be considered to be endangered species.

Increasing evidence suggests that dietary changes have been accompanied by increases in the following chronic disease risk factors among Mediterranean populations: less physical activity, higher concentrations of serum cholesterol (5), hypertension, and obesity (36). In turn, investigators have observed rising rates of coronary heart disease, diabetes (36), and several types of diet-related cancers (59) in various Mediterranean countries. These trends confirm well-established relations between diet and chronic disease risk (32-34) and suggest the need to reverse current practices through widespread efforts to preserve and promote traditional diets within the region.

Preservation and adaptation

Overall dietary patterns in a country are the result of an ongoing interaction between culturally determined food traditions and the assimilation of new foods through economic improvement, foreign contact, or international food marketing. Education also has a role in influencing personal food preferences and dietary change (60). Until recently, Mediterranean dietary patterns were quite resistant to change. Allbaugh and Keys both remarked on the similarity of the foods commonly eaten in Italy and Crete to those produced in those areas in the ancient past. Despite suggestions that traditional dietary patterns are beginning to be abandoned (61), such foods continue

to be consumed routinely by at least some older population groups (62).

Issues related to the assimilation of Mediterranean dietary patterns within other countries are best illustrated by the adaptation of southern Italian foods to American tastes (63). Italian immigrants of the late 19th and early 20th centuries retained their food traditions despite American views of their diets as insufficiently nutritious, indigestible, unsanitary, and inadequate in amounts of milk and meat. Such views began to change during the economic restrictions of World War I when Italian pastas became popular as inexpensive, well-balanced alternatives to meat. By the 1920s, Italian food products were widely marketed in the United States, and they have been ever since (64). Today, however, many Italian-style foods have been "Americanized" to the point where they are far higher in energy, fat, cholesterol, and sodium than the traditional foods from which they were derived (65).

Policy implications

Policies designed to encourage consumption of traditional diets within their country of origin, or to promote the adoption of traditional models to new locations, will need to address

TABLE 5
Mediterranean diets: areas of opportunity for basic and applied research

Basic research opportunities

- 1) The roles of plant foods characteristic of Mediterranean diets—fruits, vegetables, legumes, cereals, nuts, oils, and wine—in protection against chronic diseases.
- 2) The roles of specific nutrient and nonnutrient components of characteristic plant foods—vitamins, minerals, monounsaturated fatty acids, linolenic acid, fiber, alcohol, and phytochemicals—in the low rates of chronic diseases observed in Mediterranean countries.
- 3) The proportions of plant and animal foods most associated with disease prevention in Mediterranean diets.
- 4) The proportion of energy from fat and specific fatty acids most associated with disease prevention in Mediterranean diets.

Applied research opportunities

- 1) Methods to determine the typical dietary intake of individuals and populations in Mediterranean countries in the past, present, and future.
- 2) Methods to determine time trends in Mediterranean dietary patterns.
- 3) Determination of the effect of dietary changes on nutritional status and health risks in Mediterranean countries.
- 4) Identification of cultural, behavioral, economic, and environmental determinants of dietary change in Mediterranean countries.
- 5) Development of dietary recommendations and food guides that best reflect current scientific knowledge of the health benefits of Mediterranean diets.
- 6) Identification of effective methods to educate the public in Mediterranean countries about traditional dietary practices that best promote health.
- 7) Determination of the effects of dietary changes on the agriculture, food industry, economy, and environment of Mediterranean countries.
- 8) Determination of the effect of adoption of Mediterranean foods or dietary patterns on the agriculture, food industry, economy, and environment of countries outside the Mediterranean region.

many cultural, economic, and institutional barriers to dietary improvement (6, 7). They will also need to recognize that diet is only one of a great many behavioral factors that influence health, and that other determinants may command higher national priorities for action (66). Moreover, the transfer of traditional Mediterranean dietary patterns to a country such as the United States would be likely to affect agriculture, the food industry, the overall economy, and the environment in highly complex ways, some of which may be beneficial, but others undesirable (67-69).

The role of the Mediterranean diet in US dietary guidance policy is of particular interest. As is demonstrated in Table 4, Ancel and Margaret Keys' observations of Mediterranean diets led directly to the formulation of dietary guidelines for prevention of coronary heart disease. In turn, these guidelines were adapted to encompass more general advice for health promotion and disease prevention in US statements of dietary guidance policy as expressed in the *Dietary Guidelines for Americans* (17). Because animal foods are principal sources of fat, saturated fat, and cholesterol in American diets (70), the dietary guidelines necessarily should promote predominantly plant-based diets similar to those traditionally consumed in the Mediterranean or in Asia. That this point may not be evident from US food guides (18) is at least in part a result of pressures from meat and dairy food producers to ensure that their products retain a dominant position in American diets (71).

RESEARCH DIRECTIONS

As much as can be determined, and as defined here, traditional Mediterranean diets were based mainly on plant foods, contained small amounts of animal foods, used olive oil as the principal fat, used alcohol in moderation, and balanced energy intake with energy expenditure. Substantial research—in quantity and in quality—supports the very great health benefits of such dietary patterns (57, 58, 72).

Because the Mediterranean diet more than meets current US Department of Agriculture food guide recommendations (18), also meets recommendations for nutritionally adequate vegetarian diets (73), and is particularly appreciated for its gastronomic qualities (42-45), it is well worth further study as a cultural model for dietary improvement (7) as well as for the identification and understanding of its characteristics that best promote health. Several areas of basic and applied research related to Mediterranean diets seem especially demanding of additional investigation; these are listed in Table 5.

While waiting for the results of further research, immediate efforts should be instituted to preserve the ancient and healthful dietary traditions within the Mediterranean region, and to encourage greater consumption of plant foods in industrialized populations, consistent with virtually all current dietary recommendations for health promotion and disease prevention. ■

REFERENCES

- World Health Organization. World health statistics annual, 1993. Geneva: WHO, 1994.
- Keys A, ed. Coronary heart disease in seven countries. *Circulation* 1970;41(suppl 1):1-211.
- World Bank. World development report: investment in health. Washington, DC: World Bank, 1993.
- WHO, FAO. Food and health indicators in Europe: nutrition and health, 1961-1990 (computer program). Copenhagen: World Health Organization Regional Office for Europe, 1993.
- Kafatos A, Kouroumalis I, Vlachonikolis I, Theodorou C, Labadarios D. Coronary-heart-disease risk-factor status of the Cretan urban population in the 1980s. *Am J Clin Nutr* 1991;54:591-8.
- Gussow JD, Akabas S. Are we really fixing up the food supply? *J Am Diet Assoc* 1993;93:1300-4.
- Nestle M. Traditional models of healthy eating: alternatives to "techno-food." *J Nutr Educ* 1994;26:241-5.
- Fidanza F. Diets and dietary recommendations in ancient Greece and Rome and the school of Salerno. *Prog Food Nutr Sci* 1979;3:79-99.
- Darby WJ, Ghalioungui P, Grivetti L. Food: the gift of Osiris. Vols 1,2. London: Academic Press, 1977.
- Vermeule E. Greece in the bronze age. Chicago: University of Chicago Press, 1964.
- Vickery KF. Food in early Greece. *Illinois Studies Social Sciences* 1936;20:1-97.
- Seymour TD. Life in the Homeric age. New York: The Macmillan Co, 1907:208-34.
- Yonge CD, trans. The Deipnosophists or banquet of the learned of Athenaeus. Vols 1-3. London: George Bell & Sons, 1909.
- Wells C. Prehistoric and historical changes in nutritional diseases and associated conditions. *Prog Food Nutr Sci* 1975;1:729-79.
- Allbaugh LG. Crete: a case study of an underdeveloped area. Princeton, NJ: Princeton University Press, 1953.
- US Department of Agriculture. Food consumption, prices, and expenditures. *Agric Econ Rep* 138. Washington, DC: US Government Printing Office, 1968.
- US Department of Agriculture, US Department of Health and Human Services. Nutrition and your health: dietary guidelines for Americans. 3rd ed. Washington, DC: US Government Printing Office, 1990. (Home and garden bulletin no. 232.)
- US Department of Agriculture. The food guide pyramid. Hyattsville, MD: Human Nutrition Information Service, 1992. (Home and garden bulletin no. 252.)
- Cannon G. Food and health: the experts agree. London: Consumers' Association, 1992.
- National Research Council. Recommended dietary allowances, revised 1948. Washington, DC: National Research Council, 1948.
- Keys A. The Mediterranean diet and public health: personal reflections. *Am J Clin Nutr* 1995;61(suppl):1321S-3S.
- Keys A, Keys M. How to eat well and stay well the Mediterranean way. New York: Doubleday & Company, 1975.
- Keys A, Fidanza F, Scardi V, et al. Studies on serum cholesterol and other characteristics on clinically healthy men in Naples. *Arch Intern Med* 1954;93:328-35.
- Keys A, Keys M. Eat well and stay well. New York: Doubleday & Company, 1959.
- Keys A, Aravanis C, Blackburn H, et al. Seven countries: a multivariate analysis of death and coronary heart disease. Cambridge, MA: Harvard University Press, 1980.
- Kromhout D, Menotti A, Blackburn H, eds. The seven countries study: a scientific adventure in cardiovascular disease epidemiology. Utrecht, Netherlands: Brouwer Offset, 1994.
- Kromhout D, Keys A, Aravanis C, et al. Food consumption patterns in the 1960s in seven countries. *Am J Clin Nutr* 1989;49:889-94.
- Cresta M, Ledermann S, Garnier A, Lombardo E, Lacourly G. Study of the food consumption of the population of eleven regions of the European Community in view of the determination of levels of radioactive contamination: report of the Center for Nuclear Study of Fontenay-aux-Roses, France. (Etude des consommations alimentaires des populations de onze régions de la Communauté Européenne en vue de la détermination des niveaux de contamination radioactive. Rapport établi au Centre d'Etude Nucleaire de Fontenay-aux-Roses, France.) EUR 4218f. Brussels: Communauté Européenne de l'Energie Atomique (EURATOM), 1969 (in French).

29. Trichopoulou A, Toupadaki N, Tzonou A, et al. The macronutrient composition of the Greek diet: estimates derived from six case-control studies. *Eur J Clin Nutr* 1992;47:549-58.
30. Willett WC, Sacks F, Trichopoulou, et al. The Mediterranean diet pyramid: a cultural model for healthy eating. *Am J Clin Nutr* 1995; 61(suppl):1402S-6S.
31. Ferro-Luzzi A, Branca F. The Mediterranean diet, Italian style: prototype of a healthy diet. *Am J Clin Nutr* 1995;61(suppl):1338S-45S.
32. US Department of Health and Human Services. The Surgeon General's report on nutrition and health. Washington, DC: Public Health Service, 1988. [DHHS (PHS) publication no. 88-50210.]
33. National Research Council. Diet and health: implications for reducing chronic disease risk. Washington, DC: National Academy Press, 1989.
34. James WPT. Healthy nutrition: preventing nutrition-related diseases in Europe. Copenhagen: World Health Organization Regional Office for Europe, 1988.
35. Helsing E, Trichopoulou A, eds. The Mediterranean diet and food culture—a symposium. *Eur J Clin Nutr* 1989;43(suppl 2):1-92.
36. Spiller GA, ed. The Mediterranean diets in health and disease. New York: AVI, Van Nostrand Reinhold, 1991.
37. Giacosa A, Hill MJ, eds. The Mediterranean diet and cancer prevention: proceedings of a workshop organized by European Cancer Prevention Organization (ECP) and the Italian League Against Cancer, Cosenza, Italy, 28-30 June 1991. Andover, UK: ECP Press, 1993.
38. Serra-Majem L, Helsing E, eds. Changing patterns of fat in Mediterranean countries. *Eur J Clin Nutr* 1993;47(suppl 1).
39. Gifford KD, Drescher G, Jenkins NH, eds. Diets of the Mediterranean: a summary report of the 1993 international conference on the diets of the Mediterranean, Cambridge, MA, Jan 20-23, 1993. Boston: Oldways Preservation & Exchange Trust and Harvard School of Public Health, 1993.
40. Hamlin S. Mediterranean madness. *Washington Post* 1994 June 8:E1,E10.
41. Kummer C. The Mediterranean diet. *Self* 1993 129(July):75-9.
42. Shulman MR. Mediterranean light: delicious recipes from the world's healthiest cuisines. New York: Bantam, 1989.
43. Goldstein J. Mediterranean the beautiful: authentic recipes from the Mediterranean lands. New York: Collins, 1994.
44. Jenkins NH. The Mediterranean diet cookbook: a delicious alternative for lifelong health. New York: Bantam, 1994.
45. Wolfert P. The cooking of the Eastern Mediterranean: 215 healthy, vibrant, and inspired recipes. New York: Harper Collins, 1994.
46. Ferro-Luzzi A, Sette S. The Mediterranean diet: an attempt to define its present and past composition. *Eur J Clin Nutr* 1989;43(suppl 2):13-30.
47. Giacco R, Riccardi G. Comparison of current eating habits in various Mediterranean countries. In: Spiller GA, ed. The Mediterranean diets in health and disease. New York: AVI, Van Nostrand Reinhold, 1991:3-9.
48. Varela G, Moreiras O. Mediterranean diet. *Cardiovasc Risk Factors* 1991;1:313-21.
49. Giacosa A, Merlo F, Visconti P, Tixi P, Filiberti R. Mediterranean diet: an attempt at a clear definition. In: Giacosa A, Hill MJ, eds. The Mediterranean diet and cancer prevention: proceedings of a workshop organized by European Cancer Prevention Organization (ECP) and the Italian League Against Cancer, Cosenza, Italy, 28-30 June 1991. Andover, UK: ECP Press, 1993:1-14.
50. Mertz W. Food intake measurements: is there a "gold standard?" *J Am Diet Assoc* 1992;92:1463-5.
51. Buzzard IM, Willett WC, eds. First international conference on dietary assessment methods: assessing diets to improve world health. *Am J Clin Nutr* 1994;59(suppl):143S-306S.
52. Helsing E. Traditional diets and disease patterns of the Mediterranean, circa 1960. *Am J Clin Nutr* 1995;61(suppl):1329S-37S.
53. Organization of Economic Cooperation and Development. Food consumption statistics, 1979-88. Paris: OECD, 1991.
54. Food and Agriculture Organization. Food balance sheets, 1984-1986 average. Rome: FAO, 1991.
55. Johnston PK, ed. Second international congress on vegetarian nutrition. *Am J Clin Nutr* 1994;59(suppl):1099S-262S.
56. Dwyer JT. Vegetarian eating patterns: science, values, and food choices—where do we go from here? In: Johnston PK, ed. Second international congress on vegetarian nutrition. *Am J Clin Nutr* 1994; 59(suppl):1255S-62S.
57. Kushi LE, Lenart EB, Willett WC. Health implications of Mediterranean diets in the light of contemporary knowledge. I. Plant foods and dairy products. *Am J Clin Nutr* 1995;61(suppl):1407S-15S.
58. Kushi LE, Lenart EB, Willett WC. Health implications of Mediterranean diets in the light of contemporary knowledge. II. Meat, wine, fats and oils. *Am J Clin Nutr* 1995;61(suppl):1416S-27S.
59. La Vecchia C, Lucchini F, Negri E, Levi R. Patterns and trends in mortality from selected cancers in Mediterranean countries. In: Giacosa A, Hill MJ, eds. The Mediterranean diet and cancer prevention: proceedings of a workshop organized by European Cancer Prevention Organization (ECP) and the Italian League Against Cancer, Cosenza, Italy, 28-30 June 1991. Andover, UK: ECP Press, 1993:81-103.
60. Heimendinger J, Van Duyn MAS. Dietary behavior change: the challenge of recasting the role of fruits and vegetables in the American diet. *Am J Clin Nutr* 1995;61(suppl):1397S-401S.
61. Alberti-Fidanza A, Paolacci CA, Chiuchiu MP, et al. Dietary studies on two rural Italian population groups of the seven countries study. I. Food and nutrient intake at the thirty-first year follow-up in 1991. *Eur J Clin Nutr* 1994;48:85-91.
62. Trichopoulou A, Katsouyanni K, Gnardellis C. The traditional Greek diet. *Eur J Clin Nutr* 1993;47(suppl 1):76S-81S.
63. Levenstein HA, Conlin JR. The food habits of Italian immigrants to America: an examination of the persistence of a food culture and the rise of "fast food" in America. In: Browne RB, Fishwick MW, Browne KO, eds. Dominant symbols in popular culture. Bowling Green, OH: Bowling Green State University Popular Press, 1990:231-46.
64. Levenstein H. The American response to Italian food, 1880-1930. *Food and Foodways* 1985;1:1-24.
65. Hurley J, Liebman B. When in Rome. . . *Nutr Action Health Letter* 1994;21:1,5-7.
66. Jamison DT, Mosley WH. Disease control priorities in developing countries: health policy responses to epidemiological change. *Am J Public Health* 1991;81:15-22.
67. Gussow JD. Ecology and vegetarian considerations: does environmental responsibility demand the elimination of livestock? In: Johnston PK, ed. Second international congress on vegetarian nutrition. *Am J Clin Nutr* 1994;59:1110S-16S.
68. Gussow JD. Mediterranean diets: are they environmentally responsible? *Am J Clin Nutr* 1995;61(suppl):1383S-9S.
69. O'Brien P. Dietary shifts and implications for US agriculture. *Am J Clin Nutr* 1995;61(suppl):1390S-6S.
70. Gerrior SA, Zizza C. Nutrition content of the U.S. food supply, 1909-1990. Hyattsville, MD: US Department of Agriculture, 1994. (Home economic research report 52.)
71. Nestle M. Food lobbies, the food pyramid, and U.S. nutrition policy. *Int J Health Serv* 1993;23:483-96.
72. Willett WC. Diet and health. What should we eat? *Science* 1994;264: 532-7.
73. Haddad EH. Development of a vegetarian food guide. In: Johnston PK, ed. Second international congress on vegetarian nutrition. *Am J Clin Nutr* 1994;59(suppl):1248S-54S.