

## **The importance of the Mediterranean diet in cardiovascular disease**

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### **ABSTRACT**

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The Mediterranean diet is characterized by abundance of plant foods, such as vegetables, fruit, bread and cereal products, legumes, nuts and seeds, as well as olive oil, herbs and spices. Moreover, moderate intakes of dairy products, fish, poultry and wine, and low consumption of red meat are recommended. This diet is low in saturated fat (<7% of energy) with total fat within the range of 25-35% of energy. To assess dietary compliance with the recommendations of the Mediterranean

diet a variety of indicators are used, of which the most common are: 9-point scale of alternate Mediterranean Diet Score (aMED) and 14-item Questionnaire of Mediterranean diet adherence (MDA). The results of the epidemiological research indicate that the nutrition model based on the assumptions of the Mediterranean diet is a crucial component of primary and secondary prevention of cardiovascular diseases.

**Keywords:** Mediterranean diet, cardiovascular disease

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## INTRODUCTION

The concept of the Mediterranean diet is derived from the dietary habits of the population inhabiting the Mediterranean region from ancient times, characterized by the lowest incidence of cardiovascular disease. The concept was introduced to the medical literature in the 1950s by an American epidemiologist Ancel Keys, dealing with issues of coronary heart disease. The epidemiological study (*Seven Countries Study*) initiated by Keys in the years 1958-1964 [1] and continued in 1985-1987 [2,3,4] in Japan, Greece, the former Yugoslavia, Italy, the Netherlands, the United States and Finland showed an association between mortality from coronary heart disease and diet. Higher consumption of butter, pastries, meat, milk, hard margarine and sugar directly correlated with death from coronary heart disease, while the consumption of legumes, fish and vegetables were found to correlate inversely. Morbidity and mortality due to coronary heart disease were strongly positively associated with serum cholesterol and the consumption of saturated fatty acids, while negatively with the intake of monounsaturated fatty acids. In Italy and Greece (especially on the island of Crete), where the inhabitants instead of animal fats consumed olive oil, the incidence rate of ischemic heart disease was very low. This study showed that the dietary habits of the Mediterranean region inhabitants greatly deviated from the typical diet in the United States and Northern Europe. Currently, international societies of cardiology recommend the Mediterranean diet for the prevention of cardiovascular diseases, being the major cause of death in the world.

## REVIEW

### Characteristics of the Mediterranean diet

In the 1960s, the traditional Mediterranean diet varied among the respective Mediterranean countries due to different cultural, ethnic, religious, economic and agricultural aspects specific to the respective population. However, the Greek diet was considered as the standard of the Mediterranean diet due to the lowest mortality from cardiovascular diseases reported from Crete. The characteristic features of the traditional Mediterranean diet included [5,6]:

- high intake of olive oil, vegetables, fruit, pulses, nuts and wholegrain cereals;
- moderate consumption of fish, poultry, eggs, dairy products and alcohol (mainly red wine with meals);

- low consumption of red meat and red meat products, and animal fats.

The traditional Mediterranean diet was characterized by low intake of saturated fatty acids (<7% energy), with the total fat content within the range of 25-35% of energy, depending on the region.

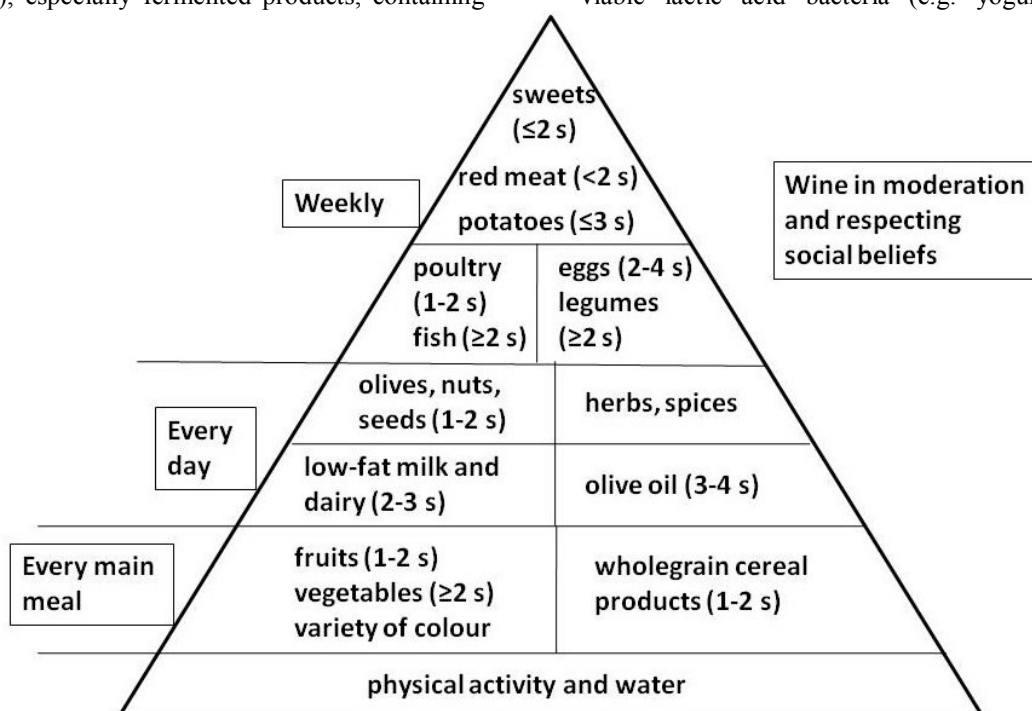
Apart from diet, regular physical activity was a crucial component of healthy lifestyle in the Mediterranean regions in the 1960s, contributing to rare incidence of obesity. Research conducted in Spain confirmed that the dietary model based on the Mediterranean diet was inversely correlated with body mass index (BMI) [7].

Figure 1 present the modern Mediterranean Food Pyramid for adult population (18-65 years old). The pyramid establishes dietary daily, weekly and occasional guidelines in order to follow a healthy and balanced diet [8,9,10].

Physical activity for at least 30 min daily and water as the main drink are the basis of the Mediterranean Diet Pyramid. The daily food components include wholegrain cereal products, such as whole-wheat bread, thick groats, brown rice and pasta. These foods have a lower glycaemic index as compared to white flour cereal products, and contain mineral components, such as magnesium, iron, zinc, copper, potassium and phosphorus. Since cereal products belong to high-calorie food, the modern diet pyramid assumes the intake of 1-2 servings of these products per main meal. One serving stands for one slice of bread or one small bun or ½ glass of cooked rice, groats and pasta. One or two servings of fruit and ≥2 servings of vegetables should be consumed per main meal. Fruit and vegetables are low-calorie food, rich in fibre, vitamins, mineral components and polyphenols. Since fruits contain simple sugars, their intake should be lower than that of vegetables. One serving of fruit implies one medium fruit (e.g. apple, pear, banana, orange) or 2-3 small fruits (e.g. plum, apricot) or a glass of tiny fruits (e.g. raspberries, blueberries) or a glass of juice or ¼ glass of dry fruit (e.g. raisins). One serving of vegetables means one medium item (e.g. paprika, tomato, potato) or 4-5 small items (e.g. radish, olives, cocktail tomatoes) or 4-5 leaves (e.g. salad) or ½ glass of cooked vegetables or one glass of raw shredded vegetables (e.g. mixed salad) or one glass of juice. Fruit and vegetables should be consumed raw due to a substantial loss of vitamins, especially vitamin C and folic acid during heat treating and increased glycaemic index of the products [11].

Another level of the pyramid is made up of low-fat milk and dairy products, which should be consumed in 2-3 servings daily and 3-4 servings of olive oil daily. Milk and dairy products are a good source of complete protein, light fat and easy to absorb calcium. However, low-fat dairy products are recommended (e.g. milk and low fat curd

cheese), especially fermented products, containing viable lactic acid bacteria (e.g. yogurt, kefir).



**Figure 1.** The modern Mediterranean Food Pyramid for adult population – own work based on [8,9,10].

The intake of hard and processed cheese should be limited due to high calorificity, high fat content, mainly saturated fatty acids and cholesterol. One serving of dairy products implies one glass of milk, drinking kefir and yogurt or ¾ glass of thick yogurt or a thick slice of curd cheese or 2 slices of hard cheese. Olive oil contains approximately 70% of monounsaturated omega-9 fatty acids (oleic acid), 10% of polyunsaturated fatty acids: omega-6 linoleic acid - 9% and omega-3  $\alpha$ -linolenic acid - 1%, as well as 14% of saturated acids. Moreover, extra virgin olive oil contains polyphenols and vitamins soluble in fats: A, E, D, K. One serving of olive oil occupies one spoon of oil [11,12].

A higher level of the Mediterranean pyramid is occupied by olives, nuts and seeds, which should be consumed in 1-2 servings daily, as well as herbs and spices added to dishes instead of salt. Nuts belong to high-calorie products due to high fat content. Monounsaturated fatty acids (oleic acid 50-80%) prevail in most types of nuts, such as hazelnuts, groundnuts, pistachio nuts and almonds, whereas polyunsaturated fatty acids, including omega-6 linoleic acid (58%) and omega-3  $\alpha$ -linolenic acid (12%) are mainly found in walnuts, which have the highest content of omega-3 fatty acids of all the nuts. Moreover, nuts are a rich source of dietary fibre, vitamins (mainly vitamin E and folic acid), polyphenols and microelements (magnesium, iron, calcium, potassium). One

serving of nuts means 1/3 glass of husked nuts or 2 spoons of seeds or 1 spoon of peanut butter [11].

According to the Mediterranean Pyramid, weekly consumption should include 1-2 servings of low-fat poultry, 2-4 eggs and  $\geq 2$  servings of fish and pulses. Low-fat poultry meat, e.g. chicken or turkey breasts, is a good source of complete protein and has low fat content. Fish is a source of complete protein and fat rich in indispensable unsaturated fatty acids, mainly omega-3, such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Moreover, poultry and fish meat provides group B vitamins, A and D vitamins, microelements, such as iron and zinc, whereas saltwater fish also ensures iodine. One serving of poultry and fish means approximately 100-150 g of a dish. The egg white exhibits a standard amino acid composition; however, a single egg yolk contains as much as 250-300 mg of cholesterol. Pulses belong to high-calorie products with a high content of vegetable protein and complex carbohydrates, and a low content of fat. Moreover, they are a rich source of dietary fibre, group B vitamins, microelements (iron, calcium, magnesium, zinc) and polyphenols [11].

At the very top of the Mediterranean Diet Pyramid there are red meat (<2 servings per week) and potatoes ( $\leq 3$  servings per week, preferably fresh potatoes). Red meat and offal are a source of saturated fat and cholesterol. Sweets should be consumed in small amounts and set aside for special occasions. These foods are the source of

empty calories and simple sugars and are likely to contribute to weight gain. Of sweets, bitter chocolate and sweets produced on the basis of nuts and seeds have the highest nutritional value [11].

Moderate consumption of red wine at a meal-time, which enriches the diet with polyphenols, mainly resveratrol, is also typical of the Mediterranean diet [13].

### **The Mediterranean diet in the prevention of cardiovascular diseases**

Nowadays, cardiovascular diseases are the most common cause of death worldwide. Meta-analysis of cohort studies showed that mortality due to cardiovascular disorders was lower in vegetarian by 16% as compared to non-vegetarian [14]. The consumption of the Mediterranean diet is an approach to prevent circulatory disorders [15]. A large body of research data suggests that traditional dietary habits and lifestyle unique to the Mediterranean diet lower the incidence of chronic diseases and improve longevity [16].

It was found in a PREDIMED study that people with a high risk of morbidity due to cardiovascular diseases (smokers, obese, with type 2 diabetes, dyslipidaemia and hypertension, with a positive family history of cardiovascular diseases), who consumed the Mediterranean diet (olive oil and nuts) exhibited lower risk of mortality due to these disorders as compared to those who did not consume the diet. The findings confirm a beneficial effect of the Mediterranean diet in the primary prevention of cardiovascular diseases [17,18]. The intake of olive oil reduces the level of total cholesterol and LDL cholesterol in blood serum, and increases HDL cholesterol. Due to antioxidant content, LDL cholesterol is protected against oxidation and thus atherosclerosis is prevented [19]. Regular consumption of nuts limits cardiovascular incidents [20].

Salt-water fish, rich in omega-3 fatty acids, make up a significant component of the Mediterranean diet. As revealed by a population study, moderate consumption of fat fish (1-2 portions a week) is associated with the reduced risk of heart failure [21]. Omega-3 fatty acids exhibit a multidirectional effect, reducing serum triglycerides by decreasing accessibility of free fatty acids, substrates for the production of triglycerides, and inhibiting the activity of the key enzymes for triglyceride biosynthesis. The hypotensive effect of omega-3 fatty acids was also observed in hypertensive patients due to more effective production of nitric oxide and improved endothelial function [22]. Moreover, EPA and DHA attenuate the inflammatory response of the body through a decrease in the activity of the NF-kappa B transcription factor and reduced synthesis of proinflammatory cytokines in patients with heart failure [23].

Vegetables and fruit, which are the source of antioxidant vitamins and polyphenols, are the basis of the Mediterranean diet. High consumption of vegetables and fruit reduces the risk of cardiovascular diseases. As shown by meta-analysis of prospective research, individuals eating more than 5 portions of fruit and vegetables (approximately 400g) daily exhibit lower incidence of cardiac diseases by 17% [24].

Red wine, which is a crucial component of the Mediterranean diet, contains polyphenols, mainly resveratrol. Its cardioprotective effect is associated with e.g. inhibition of oxidation of polyunsaturated fatty acids, reduction in the synthesis of fats in the liver, a decrease in the level of cholesterol and triglycerides in blood serum, prevention of atherosclerotic lesions, oxidative stress reduction and nitric oxide synthesis enhancement [25].

### **Assessment of dietary compliance with recommendations of the Mediterranean diet.**

To assess the compliance of the diet with the recommendations of the Mediterranean diet a variety of indicators are used, of which the most common are: 9-point scale of alternate Mediterranean Diet Score (aMED) and 14-item Questionnaire of Mediterranean diet adherence (MDA). The 9-point aMED scale is based on 9 prerequisites:

1. consumption of vegetables (without potatoes),
2. consumption of legume seeds,
3. consumption of fruit,
4. consumption of nuts and seeds,
5. consumption of wholemeal cereal products,
6. consumption of red meat and meat products,
7. consumption of fish,
8. consumption of alcohol,
9. monounsaturated to saturated fatty acid ratio.

One point is awarded when:

- the intakes of vegetables, pulses, fruit, nuts and seeds, wholemeal cereal products and fish are above the median value (quantitative value in grams) in the group analysed;
- the consumption of red meat and meat products is below the median value (in grams);
- alcohol intake range is 5-25g/day (women) and 10-50g/day (men).

The likely score range of the aMED scale ranges from 0 to 9 points. The higher the score, the more nutrition model refers to the Mediterranean diet [26-28]. The MDA scale consists of 14 questions concerning the consumption of the respective food products that are typical for the Mediterranean diet (table 1). This scale ranges from 0 to 14 points and can be divided into the following three categories of adherence to the Mediterranean diet: low  $\leq 5$ , middle 6-9 and high  $\geq 10$  points [29].

**Table 1.** 14-item Questionnaire of Mediterranean diet adherence [29].

Questions	Criteria for 1 point
1. Do you use olive oil as main culinary fat?	Yes
2. How much olive oil do you consume in a given day?	≥4 tablespoon
3. How many vegetable servings do you consume per day? (1 serving – 200 g)	≥2 (≥1 portion raw)
4. How many fruit units (or natural fruit juices) do you consume per day?	≥3
5. How many servings of red meat or red meat products do you consume per day (1 serving – 100-150g)	<1
6. How many servings of butter, margarine or cream do you consume per day (1 serving – 12g)	<1
7. How many sweet or carbonated beverages do you drink per day?	<1
8. How many wine do you drink per week?	≥7 glasses
9. How many servings of legumes do you consume per week? (1 serving – 150g)	≥3
10. How many servings of fish or shellfish do you consume per week? (1 serving – 100-150g of fish or 200 g of shellfish)	≥3
11. How many times per week do you consume commercial sweets, cakes, cookies?	<3
12. How many servings of nuts do you consume per week (1 serving – 30g)	≥3
13. Do you preferentially consume chicken, turkey or rabbit meat instead of pork, beef, hamburger or sausage?	Yes
14. How many times per week do you consume vegetables, pasta, rice, or other dishes seasoned with sofrito (sauce made with tomato, onion, leek, garlic and olive oil)?	≥2

## CONCLUSIONS

The nutrition model based on the assumptions of the Mediterranean diet is a crucial component of primary and secondary prevention of cardiovascular diseases.

## Conflicts of interest

The authors declare that they have no conflict of interest.

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