Stępnik Jolanta, Stępnik Konrad, de Pourbaix Renata, Maj-Gnat Katarzyna, Wołoszynek Eliza, Bujak-Krzemińska Agata. The role of food and nutrition in the prevention and pathogenesis of atherosclerosis development. Journal of Education, Health and Sport. 2019;9(3):445-454. eISNN 2391-8306. DOI http://dx.doi.org/zenodo.2604435
http://ojs.ukw.edu.pl/index.php/johs/article/view/6722
https://pbn.nauka.gov.pl/sedno-webapp/works/908504

The journal has had 7 points in Ministry of Science and Higher Education parametric evaluation. Part B item 1223 (26/01/2017).
1223 Journal of Education, Health and Sport eISSN 2391-8306 7

The authors declare that there is no conflict of interests regarding the publication of this paper.

Received: 01.03.2019. Revised: 15.03.2019. Accepted: 24.03.2019.

THE ROLE OF FOOD AND NUTRITION IN THE PREVENTION AND PATHOGENESIS OF ATHEROSCLEROSIS DEVELOPMENT

ROLA ŻYWNOŚCI I ŻYWIENIA W PROFILAKTYCE ORAZ PATOGENEZIE ROZWOJU MIAŻDŻYCY

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Abstract

Nowadays it is known that atherosclerotic changes in the arteries occur very early. Occur in practically the entire population of western civilization countries and show rapid progression over the years. As a result of chronic inflammatory process, which lasts even several dozen years, the developing atherosclerosis gradually destroys all layers of the arterials walls. Studies indicate that two diets recommended for atherosclerosis prevention and treatment are the DASCH diet (Dietary Approaches to Stop Hypertension), especially in relation to blood pressure control, and the Mediterranean diet. In the treatment of atherosclerosis, it is extremely important to exclude factors that increase the risk of this disease. It is important to emphasize that the conversion of energy consumed from fats to that from simple carbohydrates results in reduction of HDL C *(high density lipoproteins cholesterol)* concentration.

Streszczenie

Wiadomo obecnie, że zmiany miażdżycowe w tętnicach powstają bardzo wcześnie. Występują praktycznie w całej populacji krajów cywilizacji zachodniej i wykazują szybką progresję w miarę upływu lat. W wyniku przewlekłego, trwającego nawet kilkadziesiąt lat procesu zapalnego rozwijająca się miażdżyca stopniowo niszczy wszystkie warstwy ścian tętnic. Badania wskazują, że dwoma dietami zalecanymi w prewencji i leczeniu miażdżycy są dieta z badania DASCH *(Dietary Approaches to Stop Hypertension)*, zwłaszcza w odniesieniu do kontroli ciśnienia tętniczego, oraz dieta śródziemnomorska. W leczeniu miażdżycy ogromnie istotne jest wykluczenie czynników zwiększających ryzyko tej choroby. Należy podkreślić, iż zamiana energii spożywanej z tłuszczów na tę pochodzącą z węglowodanów prostych, powoduje redukcję stężeń HDL-C.

Key words: *Atherosclerosis, plant-based diets*
Słowa kluczowe: *miażdżyca, diety roślinne*

Introduction

Atherosclerosis is a chronic inflammatory process affecting the aorta and medium sized arteries. This process involves the accumulation of deposits consisting of macrophages, LDL-lipoproteins with low-density lipoproteins, foam cells (macrophages loaded with oxidized LDL) and extracellular clusters of cholesterol in the space between endothelium and the muscle layer of vessel. Over time, fibrous connective tissue elements are added to the fatty tissue elements, which by overgrowing and surrounding the primary inflammatory focus, separate them from the rest of vessel, thus creating atherosclerotic plaque. As a result of chronic inflammatory process, which lasts even several dozen years, the developing atherosclerosis gradually destroys all layers of the arterials walls. As it grows into the vessel, it can close the vessel's light and limit or even inhibit blood flow. Sometimes atherosclerotic plaque breaks down, resulting in a change called atherosclerotic ulceration [1].

In the treatment of atherosclerosis, it is extremely important to exclude factors that increase the risk of atherosclerosis. An important element of conservative management in atherosclerosis is the treatment of coexisting diseases, especially hyperlipidemia, obesity, diabetes, coronary disease and arterial hypertension. Studies prove that there is a close, independent relation between cholesterol levels (especially LDL cholesterol) and the development of atherosclerosis and a risk of serious cardiovascular events [2].

Over the last few years there has been a significant increase in the prevalence of hypercholesterolemia, one of the main modified factors conducive to the occurrence and

development of atherosclerosis. Hypercholesterolemia is diagnosed in about 2/3 of Poles and hypertension in about 1/3 [3]. Coexistence of these factors may lead to serious complications, such as heart attack – one of the main causes of death in Poland. Physical activity, nicotine abstinence and the use of a healthy diet are conducive to prevention and improve the effectiveness of treatment of these disorders.

Many studies aimed to deepen the knowledge of prophylaxis and pathogenesis of atherosclerotic changes prove that dietary management has an important role in reducing the risk factors of atherosclerosis [4]. More data confirm the association of numerous risk factors of atherosclerosis with obesity, hyperinsulinemia and insulin resistance of peripheral tissues. This, in turn, promotes development of many metabolic and haemodynamic pathologies. Obesity, especially abdominal type, leads to anomalies of carbohydrate metabolism, hypercoagulability, hyperuricaemia and hypertension, and significantly accelerates the formation of changes in the vascular wall of arteries. Then it is too late to take preventive measures, although similar dietary recommendations apply to both prevention and treatment of particular clinical symptoms. Although the occurrence of atherosclerotic symptoms usually favors older age, it is now suggested that the first preventive measures should be implemented already in the prenatal period [5].

How to modify the diet in order to contribute to the prevention and treatment of atherosclerosis?

The main aim in this fight is to reduce the concentration of the most atherogenic cholesterol fraction, which is LDL C. The guidelines of the European Association for Cardiovascular Prevention and Rehabilitation (EACPR) of June 2016, in all patients with diagnosed arteriosclerosis, it is recommended to modify the diet and change the lifestyle. The use of hypolipemic drugs in selected clinical situations [6, 7]. Studies indicate that two diets recommended for atherosclerosis prevention and treatment are the DASCH diet (Dietary Approaches to Stop Hypertension), especially in relation to blood pressure control, and the Mediterranean diet. Both diets have been shown to be effective in the reduction of risk factors and contribute to the prevention of atherosclerosis [6, 8]. They are characterized by high consumption of vegetables, fruits and whole grain cereal products (pasta, flakes), frequent consumption of legumes, nuts, fish, poultry and low-fat dairy products, as well as reduction of sweets consumption, sweetened drinks and red meat. In DASH and Mediterranean diets, much of the fat comes from non-tropical vegetable fats instead of animal sources. Great emphasis is placed on the consumption of fish and oils: rapeseed, sunflower, soybean and olive oil. The program proposed by Ornish et al. [9, 10], more than 20 years ago, including, among others, a low-fat (up to 10% of energy coming from fat),

high-carbohydrate (70-75% of energy coming from carbohydrates) diet based on low-processed plant products, is so far considered to be one of the non-operational regression methods of atherosclerotic changes [6].

Effect of diet on serum levels of TC (total cholesterol) and LDL C (low-density lipoprotein cholesterol)

The greatest influence on the reduction of TC and LDL C has a decrease in consumption of saturated fatty acids (SFA) and trans fats [11]. In case of converting 1% of energy from SFA into energy from monounsaturated fatty acids (MUFA), plasma LDL concentrations can be reduced by 1.6 mg/dl. The conversion to energy from polyunsaturated fatty acids (PUFA) results in a reduction of LDL C by 2 mg/dl. The conversion of SFA into carbohydrates translates into the smallest reduction of LDL C concentration by 1.2 mg/dL [12].

When changing foods rich in SFA to foods rich in carbohydrates, it is worth choosing products rich in fiber, which makes it easier to maintain the calorie balance. Weight reduction, similarly to physical activity, does not result in a significant reduction of LDL C concentration [6, 7, 13] (each 10 kg lost reduces LDL C by 8 mg/dl).

Effect of diet on TG level (triglyceride)

In case of intervention aimed to reduce TG, the greatest role is played by weight loss, minimization of alcohol consumption and reduction of simple sugars consumption, as well as regular physical activity [14]. Weight reduction improves insulin sensitivity of tissues, which directly translates into plasma concentrations of TG. TG concentration is also closely related to disturbed carbohydrate metabolism. Excessive supply of simple sugars significantly translates into increased TG concentrations. The best effects in the reduction of this fraction are achieved with food products with a low glycemic index (e.g. raw fruits, vegetables, coarse groats, oat bran, cottage cheese, fish) [8, 15]. The glycemic index enables identification and differentiation of foods with a fast glucose absorption profile into plasma from those products which absorb carbohydrates slowly. Dietary fiber in plant products reduces the glycemic index of food products by absorbing glucose and gradually releasing it during the intestinal passage.

Influence of nutrition on HDL C level (high density lipoproteins cholesterol)

High-density lipoproteins with normal functionality have protective properties in terms of atherogenesis. The strongest increase in HDL C can be observed after the reduction of trans-fat content in the diet. An increase in HDL C is observed after an increase in the intake of SFA.

Unfortunately, this increase is combined with an increase in LDL C. It is important to emphasize that the conversion of energy consumed from fats to that from simple carbohydrates results in reduction of HDL C concentration [17, 18]. One of the elements of eating habits that induce HDL C concentration is alcohol consumption. However, it is necessary to remember that this applies only to moderate alcohol consumption (up to 30 g/d in men and up to 20 g/d in women), and its abuse is one of the risk factors for many diseases [13]. Alcohol can affect the metabolism of lipoproteins. In most people it increases the triglyceride concentration and may increase the HDL concentration. LDL cholesterol levels are generally not affected, although the risk of disease is lower in moderate alcohol consumption than in non-smokers. Weight reduction is also beneficial for the HDL C concentration. Each 1 kg of weight loss translates into an increase in HDL C concentrations of about 0.4 mg/dl. This effect was also observed with aerobic physical activity. Each 1000 kcal burned translates into an increase in HDL C concentrations of about 3 mg/dl [7, 17, 19].

The importance of nutraceuticals and modified foods

Functional food has potentially important functional effects to support the achievement of therapeutic objectives in terms of TC (total cholesterol) concentrations and individual fractions. Currently, food products are the best tested and most effective. The main phytosterols are sitosterol, campesterol and stigmasterol. They are naturally found in vegetable fats, vegetables, fresh fruit, wholegrain products and legumes. They are added to some margarines and yoghurts. Currently, products with sterols are not recommended for primary prevention. Sterols may be appropriate for statin-resistant patients with hypolipemic therapy. They can reduce cholesterol uptake by 50%. Acids from the n-3 group deserve special attention. Their consumption in the amount of about 2-3 g/d translates into a reduction in TG by about 25-30% [20]. Results indicate that these acids influence cardiovascular risk by lowering heart rate and blood pressure, reducing inflammation, improving endothelial function, stability of atherosclerotic plaque and insulin sensitivity. Some studies suggest that docosahexaenoic acid (DHA, docosahexaenoic acid) has a special role and its lower serum concentration may correlate with a higher risk of cardiovascular diseases [21, 22].

Vitamin D and development of atherosclerosis

Vitamin D is considered to be one of the most important vitamins necessary for the proper functioning of body. Receptors for vitamin D have been found in many target tissues, including smooth muscles of blood vessels, cardiomyocytes, monocytes and macrophages. The results suggest a beneficial effect of vitamin D on the cardiovascular system, prove its participation in prevention of atherosclerotic plaque formation and prevention of vascular calculation [23]. Vitamin D

influences the modulation of systemic inflammation, processes of tissue calcification, oxidation or regulation of RAA (renin-angiotensin-aldosterone) system. The inflammatory process participates in development of atherosclerotic plaque and contributes to its instability. Disorder of balance by increasing the amount of free radicals and/or reducing the antioxidant capacity causes the occurrence of so-called oxidative stress. It is generally accepted that the occurrence of oxidative stress and imbalances between free radicals and antioxidants has progressive and atherogenic effects, which promotes the occurrence of coronary disease and increases the risk of cardiovascular events [22, 23].

The role of antioxidants in atherosclerosis treatment

Recently, more often an important role not only in prevention, but also in treatment, is attributed to flavonoids, i.e. ingredients that occur in plants as plant dyes and play a protective role in these plants against harmful factors. They are important in reducing the harmful effects of free radicals, the excess of which in the body contributes to development of atherosclerosis. The presence of antioxidants in food inhibits LDL susceptibility to oxidative modification, which is tantamount to antiatherosclerotic effect [14, 16].

Flavonoids with antiatherosclerotic effect:

- Grapefruit – reduces cholesterol levels, contains a lot of vitamin C and beta-carotene, as well as galacturonic acid dissolving deposits in the arteries, which withdraws atherosclerosis changes.
- Onions contain quercetin and garlic allicin. These are anticoagulants that reduce blood pressure and cholesterol levels.
- Artichokes (edible, soft flower bottom) – positively influence fat metabolism.
- Red grapes – contain a substance that prevents platelets from clumping.
- Black tea – also contains quercetin to prevent cholesterol build-up.
- Green tea – reduces blood pressure, has antioxidant properties.
- Willow bark – tea from half a teaspoon of such bark contains about 100 mg of salicylates, which are the herbal precursor of acetylsalicylic acid. It can therefore replace the daily prophylaxis of blood clots, which are a frequent cause of heart attacks, strokes and blockages in other organs.
- Tomatoes, especially the yellow, gelatinous substance surrounding the seeds, as well as the

famous acetylsalicylic acid, reduce the activity of platelets that are already involved.

- in the initial phase of blood clotting process. Quantity of this substance contained
- in four tomatoes causes as much as 70% decrease in this activity, without increasing – in contrast to acetylsalicylic acid – the risk of haemorrhages.
- Cocoa and chocolate – polyphenols contained in them reduce LDL-C activity, and among them, present in cocoa, relax blood vessels, facilitating their flow. The activity of blood compounds involved in formation of blood clots decreases and the antioxidant capacity of blood increases, having a beneficial effect on the heart and its vessels.
- Hawthorn – its products improve blood supply to the heart.

Of course, all these products should be consumed in moderate, nutritious amounts and should not be exaggerated at all [14, 16, 24].

Atherosclerosis – a low-fat diet with the limitation of energy, simple sugars and fats

Recommendations of the Aleksander Szczygła Institute of Food and Nutrition:

1. Reducing the proportion of fat in a diet below 30% of the energy provided by food per day. At the same time, the proportion of saturated fatty acids in the diet should be reduced to 10%. In case of no effects, it is necessary to limit even to 7%.
2. Instead of excess fat, the supply of complex carbohydrates should be increased – they should provide 50-60% of total energy in the daily ration.
3. The amount of fiber-rich products should be increased so that the amount of fiber in the daily ration is 30 g.
4. The supply of monounsaturated and polyunsaturated fatty acids should be increased to 10-15% and 7% of total energy respectively. Cholesterol intake along with diet must be limited to 300 mg per day and even 200 mg in case of no effects.
5. In case of overweight or obesity, weight-reducing diets should be used. [25]

Nowadays it is known that atherosclerotic changes in the arteries occur very early, often even during fetal life, occur in practically the entire population of western civilization countries and show rapid progression over the years. Epidemiological and clinical studies of recent decades have led to identification of numerous risk factors for clinical manifestations of atherosclerosis. It is known that the risk of atherosclerosis can be reduced by reducing risk factors, even if preventive

measures are implemented relatively late, even after the clinical onset of these diseases. A properly composed plant-based diet should be considered both as a tool to prevent and support the treatment of atherosclerosis and its accompanying symptoms. It is also important to remember that physical exercise should also be included in preventive measures. The best results of this therapy can be achieved by applying both measures at the same time.

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