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THE USE OF GLYCAEMIC INDEX IN THE PREVENTION OF CARDIOVASCULAR DISEASES

ZASTOSOWANIE INDEKSU GLIKEMICZNEGO W PROFILAKTYCE CHORÓB UKŁADU KRĄŻENIA

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The simple and complex carbohydrates have a varying influence on human metabolism. There has been much interest recently in the potential benefits resulting from the slow absorption of low glycaemic index (GI) carbohydrates. The attention of nutrition specialists has been increasingly concentrating on the glycaemic index in diet planning. Research done in the last few years shows that both the quantity and the type of the carbohydrates in the diet are closely related to the health status of the population and the incidence of such diseases as obesity, diabetes, cardiovascular diseases, some neoplasms, etc. The data resulting from epidemiological and clinical investigations show that a low GI diet facilitates body mass reduction and an improved lipid profile. However, we still need further research to learn more about the factors which influence carbohydrate and lipid metabolism and the determination of the role of various genetic and environmental factors. This paper presents a review of the published research results and the possibilities of the appliccation of the glycaemic index in the prevention and dietetic treatment of circulatory system diseases.

Key words: glycaemic index, cardiovascular system diseases, diet
Słowa kluczowe: indeks glikemiczny, choroby układu krążenia, dieta

INTRODUCTION

Perhaps no other single scientific problem has caused so much confusion and controversy in recent years as the question of the ideal diet. It is currently believed that the optimum diet should combine moderate amounts of protein and beneficial fats, as well as carbohydrates ob-

tained only from low glycaemic index foods. It seems that when combined with daily physical activity, such a diet is the best way to keep the body weight at an appropriate level and prevent circulatory system diseases. The appropriate diet lowers the risk through several mechanisms, such as the reduction in the body weight, decrease in arterial blood pressure, impact on the concentration of lipids in plasma, glycaemia control and a limitation of the susceptibility to thrombosis.

In Poland, cardiovascular diseases are the leading single cause of death and one of the most frequent causes of disability, as well as a considerable cause of premature mortality. The relation between a high concentration of the total cholesterol and the LDL-cholesterol, and the increased risk of the ischemic heart disease has been known for years. However, the role and composition of lipids (rather than carbohydrates) in the diet was until recently the key question on which researchers focused when doing research into the prevention of obesity, ischemic heart disease and diabetes.

Recently, the attention of nutrition specialists has been increasingly concentrating on the usefulness of the glycaemic index and the glycaemic load in diet planning. Attempts at the classification of products of carbohydrates based on their impact on the level of glucose in the blood, carried out with the help of the glycaemic index, made it possible to discover that both simple and complex carbohydrates have a varying influence on human metabolism. The concept of glycaemic load takes into account the quantity of carbohydrates marked by a specific glycaemic index [6, 17].

Research done in the last few years shows that both the quantity and the type of the carbohydrates in the diet are closely related to the health status of the population and the incidence of such diseases as diabetes, obesity, some neoplasms, dental caries, cardiovascular diseases, etc.[3–5, 11, 14, 19, 24, 31]. This paper presents a review of the published research results and the possibilities of the application of the glycaemic index in the prevention and dietetic treatment of circulatory system diseases.

The consumption of products marked by the same energy value and the contents of nutrients, but different glycaemic index values, has a different impact on the rate and intensity of physiological reactions in the organism. In the case of high glycaemic index foods, the changes are more rapid. The consumption of such products also involves the risk of noticeable hypoglycaemia. As a result of hypoglycaemia, persons with type 2 diabetes and healthy persons experience a prolonged period of increased appetite and excessive consumption of food, which continues despite the restoration of the correct blood glucose level. Additionally, hypoglycaemia may stimulate the consumption of high glycaemic index foods, leading to subsequent repetitive episodes of hypoglycaemia and excessive appetite. The consumption of low glycaemic index foods does not cause such rapid reactions in the organism. The process of digestion and absorption is much more slowly than after the consumption of high glycaemic index foods; simultaneously the risk of hypoglycaemia is reduced and the feeling of satiety is maintained [25, 28].

There are a growing number of reports in the literature that postprandial hyperglycaemia increases the risk of circulatory system diseases through the induction of oxidative stress. It was shown that glucose causes the oxidation of lipids, proteins and lipoproteins of cell membranes and DNA, and stimulates the inflammatory process [7, 30].

It was discovered on the basis of many research results that the increased content of carbohydrates in the diet causes an increase in the concentration of triglycerides in the blood

serum. The phenomenon was called carbohydrate-induced hypertriglycaeridemia (HPTG). The consumption of a considerable amount of carbohydrates results in a significant increase in FFA (free fatty acids) in the blood serum in the late postprandial period [16]. The process of the *de novo* lipogenesis which occurs in liver is also a source of fatty acids. The process may be an excess amount of the substrate used in the chemical reaction, i.e. glucose (indirectly) and acetyl-CoA (directly). It was proved that the lowering of the total glycaemic index of the diet without the change of the contents of carbohydrates reduces the concentration of free fatty acids [26, 32].

Until recently fructose was considered a beneficial food ingredient. The belief was mainly based on the relatively small increase in glycaemia after the consumption of fructose in comparison with other carbohydrates. The latest research presents the physiological influence of fructose in a new light. It was discovered that fructose may contribute to the development of insulin resistance, disturbances in the lipid metabolism, obesity and arterial hypertension. Fructose does not activate the excretion of two hormones – insuline and leptin – which are of the key importance for the metabolism. It is for this reason that a long-term use of a diet supplying large amounts of fructose may contribute to the worsening of the insulin response and a decreased production of leptin, which consequently leads to disturbances in the control of energy homeostasis and an increase in the amount of fatty tissue [9]. Fructose also contributes to a decreased production of adiponectin – a hormone produced in the fatty tissue. Research shows a positive impact of adiponectin on the metabolism of carbohydrates and lipids. The lowered levels of adiponectin are connected with obesity, a development of atherosclerosis and cardiovascular diseases [34]. Some research results suggest that the production of triglycerides depends on the considerable supply of monosaccharides - fructose and sucrose containing fructose. It was proved that despite its low glycaemic index, fructose stimulates the synthesis of triglycerides and the production of VLDL much more than other carbohydrates [9].

C-reactive protein (CRP) is a marker of an inflammatory reaction playing an important role in the pathogenesis of atherosclerosis-based diseases. It participates indirectly in all the stages of the development, rebuilding and destruction of atherosclerotic plaque. Researchers carried out several tests assessing the impact of various diets on the behaviour of CRP. It was discovered that high glycaemic index foods caused an increase in the concentration of the protein. Opposite results were obtained for foods marked by high fibre content (tantamount to low glycaemic index). However, it was also discovered that the reduction in the body mass achieved through a diet, rather than the type of food consumed, has a beneficial impact on the behaviour of CRP in the blood serum, which may be related to a decreased risk of the development and progress of atherosclerosis and the related cardiovascular diseases, as the production of CRP decreases along with the reduction in the quantity of the fatty tissue [15].

EVIDENCE RESULTING FROM EXPERIMENTS

Ford et al., [12] showed the existence of a positive correlation between the value of glycaemic index in the diet and the risk of the development of the ischemic heart disease, regardless of sex and the BMI value. Tests were carried out on a group of approximately 14000 Americans above 20 years of age on the basis of an analysis of data from food consumption survey and blood test results. Similar conclusions were drawn up by *Willet et al.* [31] who

indicated a necessity to replace high glycaemic index carbohydrates with low glycaemic index carbohydrates in order to reduce the risk of development of cardiovascular diseases. As a practical application of the conclusions, a proposal of a new food pyramid was developed.

Bouche et al. [5] compared the impact of high and low glycaemic index diet on the change of metabolism of lipids. After 5 weeks of the use of a diet marked by a low glycaemic index it was discovered that it considerably contributed to the reduction of triglycerides in the blood serum. Additionally, a decreased concentration of leptin, lipoprotein lipase and hormone-sensitive lipase mRNA in the subcutaneous abdominal fatty tissue was also discovered.

The impact of a glycaemic index diet on the concentration of HDL-cholesterol and the concentration of triglycerides in the blood was also studied by [1]. Their tests were carried out on 32 women of approximately 52 years of age, who participated in a body mass reduction programme. The tests showed the existence of a negative correlation between the glycaemic index ($p<0.01$) and the concentration of high density lipoproteins and triglycerides in the blood. Similar tests were carried out by [23], who determined a correlation between the glycaemic index of the diet and the concentration of high density lipoproteins and triglycerides in the blood. After 4 weeks of a diet based on low glycaemic index foods, the level of HDL-cholesterol grew considerably ($p<0.05$), while the concentration of triglycerides in the blood decreased. [29] discovered a significant reduction in the concentration of the total cholesterol in the blood in women remaining on a low-fat diet. However, changes in the body mass were not accompanied by a considerable reduction in the concentration of HDL-cholesterol only in women on a diet rich in low glycaemic index food. Research carried out by [21] did not show any significant changes in the concentration of the total cholesterol and LDL-lipoprotein and triglycerides in the blood of women after 8 weeks of the use of a standard low-energy diet and a low glycaemic index diet. It is also worth quoting a paper by [27] - for the purposes of their research two diets were used: a low-calorie low glycaemic load diet and a low-fat diet. The consumption of cholesterol and saturated fatty acids was low in both diets. The patients on a low glycaemic load diet complained less about hunger. It was also on that diet that a more considerable improvement in insulin resistance, concentration of triglycerides and CRP as well as the mean arterial pressure were recorded.

GLYCAEMIC INDEX OF PRODUCTS AND CIRCULATORY SYSTEM DISEASES

The international GI tables published contain a list of more than 500 products [13]. In their report on the role of carbohydrates in human nutrition, the World Health Organisation and the Organisation for Food and Agriculture recommend that in highly developed countries diet should be based on products marked by a high content of dietary fibre and a low glycaemic index. It would be beneficial if information on the glycaemic index of foodstuffs could be specified on the labels [10]. A lot of evidence supporting the hypothesis that persons following a low glycaemic index diet run a lower risk of many chronic diseases has been collected. Foods with low glycaemic index include pulses, wholegrain products, wholemeal flour and most fruit and vegetables, which apart from carbohydrates are a source of vitamins, minerals, fibre and antioxidants. Refined carbohydrates contained in white bread, white rice, sweetened drinks and sweets (high glycaemic index) provide energy, but not the valuable nutrients. Through their impact on insulin resistance, a high consumption of the products increases the

risk of development of circulatory system diseases, diabetes, obesity and some types of neoplasms. At present among the products the consumption of which is related to a decrease in the risk of ischemic heart disease, more and more attention is focused on crop products and pulses, which are rich in protein [17, 20]. It results from epidemiological observations that in areas where the consumption of legumes is high (Asia, Latin America), the incidence of diseases of the circulatory system is lower [8]. The protein, dietary fibre, vitamins, antioxidant compounds, phytosterols, phospholipids, and the beneficial profile of fatty acids contained in pulses are the recognised food factors recommended in the prevention of heart diseases [2]. Folic acid and thiamine decrease hyperhomocysteinemia, which often accompanies ischemic heart disease. A lower glycaemic index of products from pulses is an additional beneficial element, which helps to limit cardiovascular incidents. They may be considered as foodstuffs used in the primary and secondary prevention of heart diseases [22, 33].

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Summary

The glycaemic index concept has more and more supporters all over the world. Many years will no doubt pass before the beneficial impact of a low glycaemic index diet in the prevention of heart diseases is fully confirmed, but we already know that the risk of heart diseases is lower when we use such a diet. Additionally, the diet is consistent with the other dietary changes necessary in the prevention of heart diseases. The data resulting from epidemiological and clinical investigations show that a low GI diet facilitates body mass reduction and an improved lipid profile. However, we still need further research to learn more about many processes which influence carbohydrate and lipid metabolism and the determination of the role of various genetic and environmental factors.

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Streszczenie

Potencjalne korzyści z powolnego wchłaniania węglowodanów o niskim indeksie glikemicznym są aktualnym przedmiotem zainteresowań. W ostatnim czasie uwaga specjalistów od spraw żywienia koncentruję się coraz wyraźniej na przydatności indeksu glikemicznego (IG) w planowaniu diety. Badania naukowe ostatnich lat wskazują, że zarówno ilość jak i rodzaj spożywanych węglowodanów w diecie ściśle wiążą się ze stanem zdrowia populacji. Dostępne dane z badań epidemiologicznych oraz klinicznych wskazują, że dieta o niskim IG sprzyja redukcji masy ciała oraz poprawie profilu lipidowego. Potrzebne są jednak dalsze badania w celu lepszego poznania czynników mających wpływ na gospodarkę węglowodanową i lipidową oraz określenia roli różnych czynników genetycznych i środowiskowych. W niniejszej pracy przedstawiono przegląd opublikowanych wyników badań i możliwości zastosowania indeksu glikemicznego w profilaktyce i dietoterapii chorób układu krążenia.

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