

Nutrition of children and adolescents with type 1 diabetes in the recommendations of the Mediterranean diet

Odżywianie dzieci i młodzieży z cukrzycą typu 1 w rekomendacjach diety śródziemnomorskiej

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Abstract

Introduction: The nutrition of children and adolescents significantly affects the physical and mental development of those suffering from type 1 diabetes and their healthy peers. Nutrition rules for children and adolescents with type 1 diabetes do not differ from the principles of feeding their healthy peers. Hence, the demand for individual nutrients in type 1 diabetes and healthy people is the same. The nutrition of children and adolescents should meet the recommendations of the Institute of Food and Nutrition and the Polish Diabetes Association.

Aim of the study is to present a pattern of nutrition for children and adolescents with type 1 diabetes, treated with intensive insulin therapy using the Mediterranean diet, which was recognised by the World Health Organization as a model of a healthy diet for both children and adults. Through the participation of a large number of natural products, it has antioxidant, chemopreventive, and anti-inflammatory effects, it reduces the level of triglycerides and cholesterol, as well as postprandial glycaemia.

Conclusions: Preparing meals according to the principles of rational nutrition and the guidelines of the Mediterranean diet allows maintenance of daily normal glycaemia and prevention of later metabolic disorders. Observance of diet principles ensures proper physical and mental development of the child and protects them against overweight and obesity.

Key words:

type 1 diabetes, nutrition for children and adolescents, the Mediterranean diet, a plate of healthy eating.

Streszczenie

Wprowadzenie: Żywność dzieci i młodzieży istotnie wpływa na rozwój fizyczny i psychiczny dziecka – zarówno chorego na cukrzycę typu 1, jak i zdrowego. Zasady odżywiania dzieci i młodzieży z cukrzycą typu 1 nie różnią się od zasad żywienia ich zdrowych rówieśników. Dlatego też zapotrzebowanie na poszczególne składniki pokarmowe u dzieci chorych na cukrzycę typu 1 oraz dla zdrowych jest takie samo. Sposób odżywiania dzieci i młodzieży powinien spełniać zalecenia Instytutu Żywności i Żywienia oraz Polskiego Towarzystwa Diabetologicznego.

Cel pracy: Przedstawienie schematu żywienia dzieci i młodzieży z cukrzycą typu 1 leczonych intensywną insulinoterapią z wykorzystaniem diety śródziemnomorskiej, która została uznana przez Światową Organizację Zdrowia za wzór zdrowego sposobu odżywiania się zarówno dzieci, jak i dorosłych. Poprzez udział dużej ilości produktów naturalnych ma działanie antyoksydacyjne, chemopreventyjne oraz przeciwzapalne, zmniejsza stężenie trójglicerydów i cholesterolu, a także glikemię poposiłkową.

Wnioski: Przygotowanie posiłków zgodnie z zasadami racjonalnego żywienia i wytycznymi diety śródziemnomorskiej pozwala na utrzymanie codziennej prawidłowej glikemii oraz zapobiegnie późniejszym zaburzeniom metabolicznym. Przestrzeganie zasad tej diety zapewnia prawidłowy rozwój fizyczny i psychiczny dziecka, a także chroni je przed nadwagą i otyłością.

Słowa kluczowe:

cukrzyca typu 1, żywienie dzieci i młodzieży, dieta śródziemnomorska, talerz zdrowego odżywiania.

Introduction

Nutrition rules for children and adolescents with type 1 diabetes do not differ from the principles of feeding their healthy peers. Hence, the demand for individual nutrients in type 1 diabetes and in healthy children is the same [1, 2].

Fat should be 30–40% for children up to three years old and 30–35% for children over three years of age, protein 15–20%, and carbohydrates (sugars) should not exceed 45–50% of the daily energy requirement, and both in healthy people and in those with type 1 diabetes they must be under control in the daily food ration. Due to the intense physical and mental development of children and adolescents, the appropriate amounts of nutrients, vitamins, and minerals in each meal should be taken into account [1, 2].

This paper presents the principles of nutrition for children and adolescents with type 1 diabetes based on the latest recommendations of the Polish Diabetes Association and the principles of the Mediterranean diet, which can be used by patients to prepare a healthy meal based on the “healthy eating plate” model.

Aim of the study

The aim of the work is to present the principles of nutrition for children and adolescents with type 1 diabetes, treated with intensive insulin therapy using the Mediterranean diet.

The principles of nutrition for children and adolescents with type 1 diabetes and their healthy peers

Proper nutrition is responsible for the proper physical and mental development of children and helps to protect them from overweight and obesity. According to Bremer and Nelson, overweight is one of the main risk factors for developing diet-related diseases [3–5]. Parents/guardians of the child play a major role in shaping the principles of rational nutrition. Among other things, they should: provide appropriate conditions during preparation and meal intake, present the right attitude by maintaining proper body weight, and engage in physical activity with the child [6]. Scaglioni *et al.* showed that parents' eating habits significantly influence the dietary choices of their children [7]. An indispensable element in the treatment of type 1 diabetes, apart from intensive insulin therapy, is the diet [8]. The nutritional strategy of children and adolescents is based on balanced, healthy meals, in which an appropriate ratio of carbohydrates to proteins and fats should be maintained. According to experts' recommendations, both a diabetic child and his/her healthy peer should eat 4–5 meals every 3–4 hours, including three main meals: breakfast, lunch, dinner and two snacks. Breakfast, which should be eaten up to 30 minutes after waking up, should account for 30% of daily energy, lunch 30–35%, supper eaten 2–3 hours before bedtime 25–30%, and snacks only

5–10% of daily energy demand [1, 2, 9]. All of the assumptions above are met by the Mediterranean diet [10–12].

Water

The importance of water is crucial in the context of human health and the proper functioning of human body. Systematic consumption of too little water in relation to the demand is visible and perceptible in a short time. It contributes to the weakening of the mechanism of removing toxins, disturbances of metabolic processes, and decrease of physical efficiency. Water should be supplied throughout the day in an amount consistent with the recommendations developed by the Institute of Food and Nutrition in Warsaw, which include both drinking water in its pure form and water from all types of beverages and water consumed with food. The quantities included in the standards apply to the average person in a given age group, staying in a room of moderate temperature [13, 14]. Flavoured waters and other colourful drinks are not recommended. In addition to the large amount of sugar, they contain numerous preservatives and colourants that may cause hyperactivity and concentration disorders in children, repeatedly confirmed by numerous studies [15]. McMann *et al.* showed a negative impact of six common drink colourants on the child's nervous system [16]. According to the guidelines of the Mediterranean diet, water should be consumed with every meal, in an amount of about two litres a day, and juices and other coloured drinks should be very limited – which fully meets the aforementioned recommendations [12].

Carbohydrates

Carbohydrates – colloquially called “sugars” – should constitute 45–50% of the daily energy demand [2]. One gram of carbohydrates provides four kilocalories. Due to their structure, sugars are divided into simple and complex ones, and because of their digestibility they are classified as digestible and non-digestible (dietary fibre). The basic source of sugars should be complex carbohydrates (slowly absorbing), which, as American researchers have proven, should be obtained from minimally processed products with low or moderate glycaemic load¹, and thus a low glycaemic index², e.g. thick groats, rice, pasta, or cooked jacket potatoes [17, 18]. Particular attention should be paid to simple sugars, a fast but short-lasting injection of energy that cannot exceed 8–10% of the daily energy requirement. They can be found not only in sweets, but also in drinks, bread, boiled vegetables, and fruits [17–19].

Fruits supplement the daily diet with vitamins and minerals necessary for the proper functioning of the body. They also

¹ A way of assessing the carbohydrate content in 100 g of product, where 10 and less is a low glycaemic load, 11–19 is average, and 20 and more is a high glycaemic load.

² Classification of products based on their effects on blood glucose levels approximately two hours after consuming a meal.

have healing properties. It is not without reason that fruits in accordance with the principles of the Mediterranean diet should belong to the basic products of this diet [10]. For example, studies by Zikri *et al.* show that anthocyanins contained in fruits provoke the process of cancer cell death in the oesophageal epithelium [20]. Similar conclusions were drawn by Wang, who pointed out the inhibition of oesophageal cancer development by black raspberries rich in anthocyanins [21, 22]. However, fruits represent a group of products belonging to rapidly absorbed carbohydrates; therefore, despite many advantages, they should not be eaten without control. According to the World Health Organization (WHO) and the Institute of Food and Nutrition, the daily portion of fruit should not exceed 300 g. The absorption of simple sugar can be slowed down by combining fruit with a standard-fat milk product, e.g. cottage cheese with raspberries. Recommended fruits (especially for diabetics), due to the small amount of sugar and high content of water and dietary fibre are berries, i.e. blueberries, raspberries, blackberries, and gooseberries [18, 23].

An extremely important carbohydrate is dietary fibre, which, regardless of the fraction (soluble or insoluble), contains 2 kcal in one gram [24]. Fibre plays an important role in the prevention of many diseases. Schoenaker *et al.* analysed the effect of dietary fibre intake on the occurrence of cardiovascular diseases in people with type 1 diabetes. In a seven-year study, there were 2100 participants between 15 and 60 years of age. It was noticed that an increase in fibre intake by only 5 g/day resulted in a decrease in mortality and morbidity among the respondents [25]. The sources of dietary fibre include raw or cooked al dente vegetables (which absolutely should be added to every meal), cereal products, fruits, and legume seeds. The Mediterranean diet is a diet rich in fibre, because the products mentioned above form the basis of this diet [10]. Fibre has many functions in the body, including: binding water and bile acids, increasing the mass of faeces, absorbing metals, lowering glucose, affecting the flow of nutrients through the intestines, and lowering cholesterol in blood [24]. Both the Polish and American Diabetes Society recommend increasing the amount of complex carbohydrates taken, including fibre. Increasing the content of dietary fibre contributes to the reduction of blood glucose fluctuations, consequently limiting the glycaemic response, which has been confirmed by numerous studies. Anderson *et al.* clearly proved in a systematic review that this thesis is true, analysing the results of 34 previous, randomised trials [26].

Proteins

The next nutrients are proteins that have building functions. Protein is used only to a small extent for the production of energy; however, in poorly treated diabetes, it can be used excessively, which is detrimental to health. The daily requirement for protein ranges between 15 and 20%, and its calorific value is the same as for carbohydrates and amounts to 4 kcal/g. We distinguish complete protein (found in animal products), which contains all the essential amino acids, and low-value protein (found in

plants), which is deficient in at least one amino acid in the composition. In every main meal there should be a product containing a complete protein e.g. egg, cottage cheese, poultry, or fish (when prepared without batter, they meet one of the principles of healthy nutrition). It is also recommended to include legumes (lentils, beans, peas) in a weekly menu, which contain a comparatively similar quality protein as animal products. The Mediterranean diet meets these recommendations and promotes the consumption of fish, legumes, and white meat [10, 18, 27].

Fats

The most energetic component of the diet is fat, which in the daily energy demand should be 30–40%. Fat has the highest calorific value of nutrients and provides 9 kcal/g, but contrary to popular opinion it is not only a source of calories, but also essential vitamins such as: A, E, D, and K and essential fatty acids (EFA). Fats are also a source of ingredients for the construction of organs and tissues and for the synthesis of numerous biologically active substances, e.g. tissue hormones. There are saturated and unsaturated fats. Saturated fats are found in animal products such as eggs, meat, or dairy products, whereas unsaturated fats are found in plant products such as nuts, seeds, and vegetable oils. Oily fish are an exception because, despite the fact that they are not vegetable products, they contain omega 3 polyunsaturated fats. Unsaturated fats, depending on the number of double bonds, are divided into: monounsaturated fatty acids (MUFA), which should constitute 10–15% of the estimated energy requirement (EER)³ and polyunsaturated fatty acids (PUFA), which should be 6–10% of EER (including 1–2% omega 3 and 5–8% omega 6). Saturated fatty acids (SFA), not containing double bonds, should not constitute more than 10% of EER [27–29]. The Mediterranean diet is characterised by a high share of unsaturated fats, fulfilling another important assumption propagated in feeding children with type 1 diabetes, as well as their healthy peers [10]. Jakobsen *et al.* analysed 11 cohort studies and showed that replacing saturated fat (SFA) with polyunsaturated fats (PUFA) allows the maintenance of normal cholesterol levels in blood, which significantly reduces the risk of diabetes, atherosclerosis, or ischaemic heart disease. This was not observed when saturated fatty acids were replaced with monounsaturated fatty acids (MUFA) and carbohydrates [30]. Prophylaxis of cardiovascular diseases should be carried out from an early age; therefore, vegetable fats, i.e. rapeseed oil (which should account for 2/3 of the amount of fat delivered), are recommended in the children's diet. From among animal fats 82% butter is recommended (in the amount advised for food rations), because, apart from the fact that it does not contain chemical components, it is easily digestible and is a very well absorbed animal fat [31].

³ Estimated Energy Requirement (EER) is the average dietary energy intake that is predicted to maintain energy balance in healthy, normal weight individuals of a defined age, gender, weight, height, and level of physical activity consistent with good health.

Dairy

Dairy is a group of animal products the ingredients of which are easily absorbed. Dairy products contain complete protein and fat. Dairy is rich, among others, in calcium, mineral salts, and vitamins such as A, B₂, B₁₂, and D. This group includes fermented products, such as buttermilk, kefir, yoghurts, all kinds of cottage cheese, and cream. The dairy representative is milk, which is the basis for the production of other dairy products. Milk is a very good source of calcium (300 mg of calcium in the glass), fat-soluble vitamins (A, D, E, K), as well as water-soluble vitamins, i.e. B₁, B₂, B₆, B₁₂, PP, biotin, pantothenic acid, or vitamin C [18, 32]. However, despite these advantages, attention should be paid to the fact that cow's milk contains lactose (disaccharide), which, without the presence of dietary fibre, absorbs very quickly and affects glycaemia as a simple sugar, e.g. glucose [18]. Cow's milk is also one of the most common allergens [33]. In a cohort study by Wood and *et al.* of 512 children aged 3–15 months, allergy to milk protein was confirmed in up to 293 children [34]. In the Mediterranean diet, milk is replaced with yogurt, buttermilk, kefir, and cottage cheese [10].

Highly processed products

Highly processed products are products that are impossible to produce at home; they are processed in food industry factories to extend freshness and speed up the process of their preparation. Such products usually contain health-unfavourable food additives, e.g. salt, sugar, fat, flavour enhancers, and preservatives. Food that has been properly processed is safer, free of microbes, and easier to digest [35, 36].

Taking care of the proper development of the child, meal preparation should be based on using good quality products, of standard fat, and without the addition of preservatives. Originally, the Mediterranean diet was based on such products [11]. Low-processed products have a low or medium glycaemic index, which for both diabetics and healthy people will contribute to reducing the 24-hour insulin requirement, decreasing appetite and achieving or maintaining normal body mass [18]. Snacks are a significant problem because for children they are usually sweet and highly processed. Children often consume them in large quantities, often replacing meals or shortening the recommended breaks between meals. According to Kolarzyk *et al.*, among 250 surveyed children a large majority showed a high level of preference for sweets and fast food. Fruits and dairy products were much less preferred by children and were usually found in small amounts as an addition to processed food; however, fruit together with a standard fat milk product (e.g. natural yoghurt with an apple) is a good and healthy snack [37].

Chocolate is considered controversial among sweets. According to KPMG (2016), the average Pole eats about 4.5 kg a year. Milk chocolate belongs to the group of highly processed products; it contains saturated fatty acids, a large amount of white sugar, and often preservatives and colourants. The positive impact of milk chocolate on health is doubtful, in contrast

to the impact of plain chocolate. Chocolate with a large amount of cocoa fat (over 70%), consumed in small amounts, has a positive effect on human health. It is rich in iron, calcium, magnesium, phosphorus, potassium, and vitamins A, E, and D, and the most desirable ingredient of chocolate found in cocoa beans – flavonoids. Flavonoids have antioxidant properties, improve brain function, stop the development of cancer cells, reduce appetite, and protect against solar radiation [38, 39]. Numerous studies confirm their impact on a significant reduction in the risk of developing civilisation diseases [40–42].

Mediterranean diet

Among experts in the field of dietetics, the Mediterranean diet, which in 2003 was recognised by the WHO as a model of a healthy diet for both children and adults, is highly appreciated. The diet, owing to the inclusion of a large number of natural products, has antioxidant, chemopreventive, and anti-inflammatory effects, and it decreases the level of triglycerides and cholesterol, as well as postprandial glycaemia. Thus, it prevents many diseases including atherosclerosis and some cancers [43–48]. In 2008, a systematic review by Sofi *et al.* considering the impact of the Mediterranean diet on broadly understood human health was published. Twelve studies were conducted for the analysis, carried out on a group of 1,574,299 people. Observations have shown that the use of the Mediterranean diet plays an important role in the prevention of civilisation diseases and reduces the risk of death [49]. Spanish scientists, as part of the PREDIMED study, also checked the influence of the Mediterranean diet on the human body. They proved that even in people at high risk of cardiovascular disease, the Mediterranean diet contributes to reducing the risk of coronary events by as much as 30% [50]. However, Zhong *et al.* and Cadario *et al.* proved that in children suffering from type 1 diabetes, the Mediterranean diet has a beneficial effect not only on the cardiovascular system and LDL and HDL cholesterol levels, but also on interprandial glycaemia [51, 52].

The basis of this diet is constituted by products with a low glycaemic index, which come from a full milling. The vegetables – especially green and raw, as well as legume seeds, which are the source of folic acid, zinc, magnesium, iron, and dietary fibre – also play an important role. Popular in the diet are berries: blueberries, blackberries, dried apricots. The diet assumes about 15 g of dietary fibre for every 1000 kcal, which has a significant impact in the prevention of overweight, obesity, diabetes, and cardiovascular diseases. It is characterised by a high content of marine fish, i.e. salmon, mackerel, tuna, sole, pollock, and hake, which provide valuable docosahexaenoic acids (DHA) and eicosapentaenoic acids (EPA). The recommended amount of DHA and EPA is 1–2 g per day, while ALA (α -Linolenic acid) is 3 grams per day. Fish are recommended at least twice a week. Milk in this diet has been replaced by yogurt, kefir, buttermilk, and cottage cheese. Feta cheese, produced with 70% sheep's milk and 30% goat's milk, which can be used to prepare salads or as an addition to cream soup, is especially recommended. The diet recommends white meat (e.g. chicken, turkey, rabbit).

In addition, the characteristic feature of the diet is a small intake of animal fat (lard, butter, margarine), and a large share of vegetable fats. Olive oil contains essential fatty acids, antioxidants, and vitamin E; hence the Greeks consume for good reason about 50 millilitres a day, or about 26 litres of olive oil annually. García González *et al.* showed a significant relationship between the consumption of olive oil and the low incidence of civilisation diseases [10]. Other extremely important components of the diet are nuts and oilseeds, which are also a valuable source of essential fatty acids, vitamin E, and selenium, magnesium, and phosphorus. Studies show that regular consumption of nuts reduces the level of total cholesterol and LDL-cholesterol fraction; it also reduces the risk of heart attack, stroke, and death from cardiovascular causes [11]. The Mediterranean diet assumes a glass of water for each meal (around two litres daily), while both vegetable and fruit juices are very limited. Meals should be prepared with the use of the non-fat method. Salt should be limited to 5–6 g per day. Dishes should be prepared without the addition of salt (replaced with natural spices). Depending on the region, various natural spices are used to prepare dishes, e.g. rosemary, oregano, thyme, basil, or turmeric [12, 32, 43].

The healthy eating plate and food pyramid as graphic representations of the general principles of rational nutrition

The healthy eating plate

For easy preparation of Mediterranean diet meals, the model of a healthy eating plate developed by Harvard Medical School can be used. A healthy plate meets the principles of the Mediterranean diet. Taking into account the rules of adjustment of insulin therapy to the number of carbohydrates, proteins, and fats in a meal, regardless of whether it is based on carbohydrate exchange units (CE) and protein-fat exchange units (PFE), or kilocalories, meals are prepared in a similar way. When counting carbohydrate exchange units and protein-fat exchange units,



Fig. 1. Healthy eating plate

Source: <http://bonavita.pl/piramida-zdrowego-zywienia-czyli-recepta-na-aktywne-zycie>

one should remember that one PFE balances with two CE. While counting kilocalories, on the plate 50% of calories should be from protein and fat (maintaining the appropriate ratio of proteins to fat – 2 : 3) and 50% of calories from carbohydrates [53, 54].

The principle of a healthy plate is one of the simple methods of estimating portions and composing balanced meals, which have a positive effect not only on body weight, but also on glycaemia. On a plate of 25–26 cm diameter, half should be covered with raw or cooked al dente vegetables – preferably seasonal. In winter, frozen vegetables can be also used to prepare meals. According to the work of Gębczyński and Fika *et al.*, this process, unlike other methods of food preservation, maintains a high nutritional value [55]. The other part of the plate should be divided in half. A quarter of the plate is the place for complete protein, preferably from poultry (turkey, chicken, eggs, cured meats), dairy products (kefir, buttermilk, cheese, and cottage cheese), or fish, which should be served on the plate 2–3 times a week because they are good source of omega 3 and omega 6. The last part of the plate is covered by complex carbohydrates such as large grain groats, wholegrain pasta, wholegrain bread, and boiled potatoes – preferably jacket potatoes (this method of preparation causes the least loss of valuable minerals and limits starch hydrolysis [56]). In this part there is also fruit (which is good combined with dairy products). The meal should start with raw vegetables, then the protein, and finally the sugars. Such a habit gives time for insulin injected under the skin (or endogenous – in a healthy person) to undergo the appropriate “mixing” of its activity with the absorption of glucose from the meal [18, 23].

Food pyramid

The first food pyramid was published by the United States Department of Agriculture (USDA) in 1992 to raise the awareness of American society about proper nutrition. The pyramid,



Fig. 2. Food pyramid

Source: <http://www.izz.waw.pl/pl/zasady-prawidowego-zywienia>

although modified, functions to this day. It is a simple image of the principles of rational nutrition, which reflects the principles of the Mediterranean diet and implements the WHO recommendation – “less sugar, salt, and fat, and more dietary fibre”. The nutrition pyramid depicts how much of each product should be consumed during the day. On top of it there are those products that should be consumed in very small quantities and not too often. The most important thing is at the base of the pyramid. Scientists unanimously confirm the positive effect of physical activity on human health; hence it was placed at the very bottom of the pyramid, gaining the title of the most important. Sedentary lifestyle is an indirect or direct cause of death [57]. This is confirmed, for example, by research carried out in Canada on a group of over 17,000 people (aged 18–90 years) that has proven a significant increase in the risk of death in reference to the increase in time spent in a sitting position [58]. Immediately after physical activity, the most im-

portant products are vegetables (three servings) and fruit (one serving). Other products are cereal products, followed by dairy products. Higher in the pyramid are meat products and fish, and at the very top – oils [2, 59].

Summary

Preparing meals in accordance with the principles of rational nutrition and the guidelines of the Mediterranean diet allows daily normal glycemia to be maintained and later metabolic disorders to be prevented. Observing the principles of the diet provides the child with physical and mental well-being and protects against overweight and obesity. Daily use of the principles of a healthy plate and a Mediterranean diet by all family members together with a person suffering from diabetes is one of the most important conditions for its long-term success.

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