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Dietary recommendations for iodine intake — in search of a consensus between cardiologists and endocrinologists

Zalecenia dietetyczne dotyczące spożywania jodu — w poszukiwaniu konsensusu między kardiologami a endokrynologami

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Abstract

Iodine is one of the essential bioactive components of the diet which has an effect on the synthesis of the thyroid hormones, and the latter affect proper development and functioning of the organism. If iodide intake is below 50 μg/day, the thyroid gland cannot maintain adequate synthesis of thyroid hormones. The 1992/1993 Polish Council for Control of Iodine Deficiency Disorders study results were a direct reason for resumption of compulsory table salt iodination. Table salt is the commonly used iodine carrier. According to the World Health Organization recommendations, daily salt intake should not exceed 5 g of sodium chloride (2 g of sodium) per person. Reduction of dietary sodium intake may thus prevent cardiovascular disease. Actions are also being taken to increase the intake of other natural iodine carriers (milk, mineral water). Alternative iodine sources in the diet include codfish, Alaska pollock, salmon, eggs, wheat bran, broccoli, dried pea seeds, and hazelnuts. Iodination of mineral water and milk, as well as biofortification of the selected vegetables and feeding flock and cattle by food rich in iodine should be concerned according to salt restriction diet. It is also justified to introduce iodination of mineral water and milk, as well as biofortification of selected vegetables and feeding flock and cattle with food rich in iodine to provide adequate iodine intake in the setting of coexisting recommendations to reduce salt intake.

Key words: iodine, diet, arterial hypertension, salt iodination, amiodarone

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Introduction

Iodine is one of the essential bioactive components of the diet which has an effect on the synthesis of the thyroid hormones, and the latter affect proper development and functioning of the organism. Iodine is one of the most potent antioxidants and has a protective effect in inflammatory and malignant processes [1].

Iodine is a dietary constituent that cannot be stored in the human body and thus must be consumed in a diet. Inadequate iodine intake leads to iodine deficiency, and excess intake may result in hyperthyroidism [1, 2].

Dietary recommendations regarding iodine intake

The World Health Organization (WHO) recommends the following optimal daily iodide intake: 150 μg/day in adult subjects, 250 μg/day in pregnant and lactating women, 50 μg/day in children under 1 year of age, 90 μg/day in children at 1–5 years of age, and 120 μg/day in children at 6–12 years of age [3]. If iodide intake is below 50 μg/day, the thyroid gland cannot maintain adequate synthesis of thyroid hormones. This results in a functional hypertrophy and structural changes that ultimately lead to the development of hypothyroidism. Thyroid hypertrophy is potentiated by the lack of thyroid-stimulating hormone (TSH) inhibition by the pituitary gland, as TSH is also a growth hormone [1].

Thus, it is necessary to maintain adequate iodine intake, as its deficiency (and also relatively rarely occurring excess iodine intake) has a negative effect on the population health. Prophylactic iodine supplementation should be constantly monitored, so its effectiveness can be evaluated, and the optimal level of iodine supplementation determined [1, 4].

The Polish Council for Control of Iodine Deficiency Disorders (PCCIDD) decided to undertake an epidemiological study in 1992–1993 that included schoolchildren, neonates, and pregnant women. Results of these studies prompted resumption of universal, compulsory salt fortification with iodine (20–40 mgKJ/kg) since 1997 [1, 2, 4]. The council also determined other indications for prophylactic iodine supplementation: additional fortification of infant formulas with iodine (10 μg/100 mL of milk) and additional iodine supplementation of 150–200 μg/day in pregnant and lactating women [1].

This model proved very effective. The prevalence of goitre in schoolchildren decreased by 30–80% compared to 1992–1993, and in the youngest children (6–8 years of age), the prevalence was only 2.6%, *i.e.*, below the endemic level [1]. The prevalence of neonatal TSH levels above 20 μIU/mL decreased from 2.0% to 0.16%, the prevalence of goitre in pregnant women decreased from 80% to 19%, and a reduction in the prevalence of differentiated thyroid cancer in women was observed [1].

In 2002, the Polish model of prophylaxis of iodine deficiency was judged effective and safe. It was found that there was no population risk of both hypothyroidism due to iodine deficiency and hyperthyroidism due to increased iodine intake [1, 3].

It should be noted, however, that this success was not absolute. In older children (particularly those in the puberty period), goitre is still present in 7–8% depending on the region, and the rate of urinary iodine excretion above 100 μg/L did not achieve the desired level of 50%. No more than 70% of pregnant women receive the recommended iodine dose and although the prevalence of thyroid cancer in women has decreased, it is progress rate of thyroid carcinoma in women is slower its incidence is still 3–4 times higher than in 1990. Finally, the quality of salt fortification with iodine was estimated at 96% of the recommended norm [1, 5].

The National Program to Eliminate Iodine Deficiency-related Abnormalities (Narodowy Program Eliminacji Zaburzeń w Przebiegu Niedoboru Jodu) was interrupted in 2003–2005, reintroduced in 2006 and has been continued until present [1].

Reduction of dietary salt intake for cardiovascular disease prevention and iodine intake

A separate issue is prophylactic iodine supplementation in the setting of the recommended reduction of salt intake to 5 g/day, as salt is the commonly used carrier for iodine.

The WHO recommendations (Paris 2006, Luxembourg 2007) are based on the established role of salt in increasing the risk of cardiovascular disease including arterial hypertension, atherosclerosis, stroke and myocardial infarction, as well as some malignancies. According to the WHO recommendation, daily salt intake should not exceed 5 g of sodium chloride (2 g of sodium) per person [6]. The mean daily salt intake in Poland is 13.5 g per person, including 8.8 g of table salt, reaching as much as 15.0 g per person in some regions of the country [4].

According to the Standards of Dietary Management in Cardiology (Standardy Postępowania Dietetycznego w Kardiologii), the 2016 Polish Society of Dietetics statement, more than 1 million of deaths annually in the past years might be attributed to sodium chloride intake exceeding 5 g/day, the level recommended by WHO (1.65 million of deaths in 2010) [7].

The World Heart Federation (WHF), European Society of Hypertension (ESH), and European Public Health Association (EUPHA) report on the effect of sodium intake on the incidence of cardiovascular disease in low-to-moderate income countries indicates that a reduction of sodium intake by 1.76 g/day per person results in blood pressure lowering by 3.39/1.54 mm Hg [7, 8]. Reduction of dietary sodium intake may thus prevent cardiovascular disease, in particular hypertension, and it may significantly lower elevated blood pressure in hypertensive subjects [9].

According to the 2015 Polish Society of Hypertension (PTNT, *Polskie Towarzystwo Nadciśnienia Tętniczego*) guidelines, a diet rich in sodium chloride may reduce the effectiveness of antihypertensive treatment and thus much attention should be paid to reducing salt intake below 5.0 g per day in patients with hypertension [8]. It is believed that the blood pressure lowering effect of a reduced dietary sodium intake is much higher in the elderly patients, salt-sensitive subjects, and those with diabetes, metabolic syndrome or chronic kidney disease, and thus it may lead to a reduction in the number of drugs and their doses in such patients [8]

Kypridemos et al. [10] used a microsimulation model to evaluate the effect of efforts to reduce sodium chloride intake in the United Kingdom on the prevention of cardiovascular disease. Introduction of a policy to reduce sodium chloride intake in 2003–2015 prevented or delayed cardiovascular disease in 52,000 persons, and prevented 10,000 cardiovascular deaths [10].

In view of the above opinions and data, it is important to find the right balance between adequate iodine intake to allow normal thyroid function and a reduction in salt intake recommended by cardiac societies. Of note, salt is the main source of iodine in the diet [10].

The National Institute of Food and Nutrition statement on efforts to reduce salt intake in Poland has defined the directions of these actions, including changes in recipes in food industry and catering facilities, increased supervision by food safety agencies, and continuation of appropriate legislation efforts [7]. These actions should also include educational efforts targeted at various groups: consumers, producers, health care and public health institution workers, and other groups influencing the lifestyle of the population. The PTNT guidelines are also important for these efforts, as they recommend salt intake reduction by appropriate prevention and promotion initiatives [11]. Of note, close cooperation with PCCID is required to introduce necessary modifications to the program of prophylactic iodine supplementation [8].

The authors of the program were criticised by using an undesirable substance as the iodine carrier for prophylaxis, as sodium chloride intake is not recommended in hypertension and other cardiovascular disease. In addition, sodium chloride intake in Poland has been and continues to be excessive; only several years ago, intake levels recommended by WHO were exceeded threefold [2].

As noted above, the current sodium chloride intake in our country much exceeds the recommended daily intake, and thus alternative sources of iodine are needed to provide its adequate daily intake. Endocrinologists agree with cardiologists that nobody should be encouraged to consume salt. They are concerned, however, that a further reduction in the intake of iodine-fortified salt will have an adverse effect on prophylactic iodine supplementation and the epidemiology of thyroid disease. The average iodine content in 100 g of iodine-fortified table salt is 2293 micrograms [12]. To provide the necessary daily iodine intake of 150 μg from salt, it is necessary to consume 6.5 g of iodine-fortified salt, which exceeds the 5.0 g level recommended by WHO [13]. This situation necessitates other solutions that will reconcile recommendations of the cardiologists and the principles of prophylactic iodine supplementation promoted by endocrinologists. One solution may be to additional use of potassium iodate (KIO_3) for food fortification with iodine [2].

Efforts are being made to increase intake of other natural iodine carries (milk, mineral water) [14]. A possibility to increase iodine content in selected vegetables by their biofortification has also been considered [15]. Another possible solution is introducing iodine into the food chain by feeding flock and cattle with iodine-containing foods.

Drugs and iodine intake

When discussing iodine intake, iodine-containing medications and contrast agents also need to be mentioned. Pharmacological iodine doses (which may exceed daily requirement by many times) are present in many substances used for diagnostic or therapeutic purposes. These include radiological contrast agents (containing 140–400 mg of iodine in 1 mL), disinfectants (iodopovidone — 10 mg of iodine in 1 mL), high-potency Lugol's iodine (127 mg of iodine in 1 mL, *i.e.*, approximately 20 drops) [16]. Also some antiarrhythmic agents, otherwise very effective, particularly amiodarone, may induce thyroid dysfunction due to high iodine content (a single 200 mg amiodarone tablet contains about 75 mg of iodine). Cardiac amiodarone dosing may involve administration of even several tablets per day, thus largely exceeding daily iodine requirement [1]. In addition, the drug accumulates in the fat and muscles, and due to a long half-life (about 100 days), iodine is released also after amiodarone is discontinued [16].

Amiodarone has a multidirectional effect on thyroid hormone metabolism. Its moiety is similar to that of T4 and

Table 1. Iodine content in selected food products (based on [12])

Product	Iodine content [μg/100 g of product]
Fish	
Codfish, fresh	110
Alaska pollock, fresh	103
Salmon, fresh	44
Mackerel, smoked	40
Herring, salted/smoked	30
Herring, fresh	24.3
Tuna in oil	25
Flounder, fresh	20
Rainbow trout, fresh	13
Northern pike, fresh	8
Dairy products	
'Rokpol' cheese, full-fat	40
'Edamski' cheese, full-fat	30
Brie cheese, full-fat	11.2
Kefir, 2% fat	7.5
'Edamski' melted cheese	7.1
Buttermilk, 0.5% fat	5.9
Eggs	
Chicken eggs, whole	9.5
Chicken egg white	6.8
Chicken egg yolk	12
Cereals	
Wheat bran	31
Oatmeal	5.9
Rye flakes	5.7
Vegetables	
Broccoli	15
Dried pea seeds	13.9
Spinach	12
Radish	8
Dried soy seeds	6.3
Broad beans	6
Nuts	
Hazelnuts	17
Peanuts	13
Walnuts	9
Other	
White table salt, iodinated	2293
Iodinated mineral water 'Ustronianka'	150 μg/L

perhaps competes with T4 for receptor binding; the drug inhibits peripheral monodeiodination of T4 to T3 and induces immune processes in the thyroid [16]. It may induce both hypothyroidism (less frequently) and hyperthyroidism (more frequently). While hypothyroidism usually develops during treatment with amiodarone, hyperthyroidism may develop at various times, even several months after the drug is discontinued [17]. Radiological contrast agents and amiodarone may induce thyrotoxicosis caused by destructive thyroiditis [18].

Dietary sources of iodine

There are only few other health prevention interventions that may be considered as effective as the program of iodine deficiency prevention that has been in operation in Poland for many years [1, 13]. As described above, the multiple health benefits of this program are not limited to normal endocrine function of the thyroid gland, prevention of congenital hypothyroidism, and reduction of neonatal mortality in the perinatal period but also include reduction in the development of malignancies [19].

Due to the coexisting recommendations to reduce salt intake in response to an increasing rates of cardiovascular disease, alternative iodine sources are needed to allow adequate daily intake. Table 1 shows dietary sources of iodine [12].

When recommending a reduction of dietary salt intake to the patients, we can also recommend alternative iodine sources from other food products, thus reconciling apparently incompatible recommendations of various societies

Conclusions

Due to the need for adequate iodine intake to prevent thyroid dysfunction, as highlighted by endocrinologists, and a recommendation by cardiologists to reduce intake of iodinated table salt due to an increased cardiovascular disease risk, alternative approaches for providing adequate iodine intake are necessary. Thus, it is justified to introduce iodination of mineral water and milk, as well as biofortification of selected vegetables and feeding flock and cattle with food rich in iodine. We should also remember about food products that are sources of iodine, so as to include them regularly in our menus.

Conflict(s) of interests

The authors declare no conflicts of interest.

Streszczenie

Jod jest pierwiastkiem należącym do niezbędnych bioaktywnych składników diety, który ma udział w syntezie hormonów tarczycy, a te z kolei wpływają na prawidłowy rozwój i funkcjonowanie organizmu. W sytuacji gdy spożycie jodków jest mniejsze niż 50 μg/dobę, gruczoł tarczowy nie jest w stanie utrzymać syntezy hormonów tarczycy na prawidłowym poziomie. Wyniki badań z lat 1992–1993 Polskiej Komisji ds. Kontroli Zaburzeń z Niedoboru Jodu były bezpośrednim powodem powrotu do obowiązkowego jodowania soli kuchennej. Sól kuchenna jest powszechnie stosowanym nośnikiem jodu. Zgodnie z zaleceniami Światowej Organizacji zdrowia dzienne spożycie soli nie powinno przekraczać 5 g NaCl (2 g Na) na osobę. Kontrolowanie zawartości Na w diecie jest metodą prewencji chorób układu sercowo-naczyniowego. Równocześnie są prowadzone działania służące zwiększeniu spożycia innych naturalnych nośników jodu (mleko, woda mineralna). Alternatywne źródło jodu w diecie to między innymi dorsz, mintaj, łosoś, jaja, otręby pszenne, brokuły, suche nasiona grochu i orzechy laskowe. Zasadna jest idea wdrożenia jodowania wody mineralnej i mleka, a także biofortyfikacji wybranych warzyw oraz podawania jodu trzodzie i bydłu w celu zapewnienia jego odpowiedniej podaży w związku z zaleceniami ograniczenia spożycia soli kuchennej.

Słowa kluczowe: jod, dieta, nadciśnienie tętnicze, jodowanie soli, amiodaron

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