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Iodine prophylaxis in Poland – new, old challanges

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INTRODUCTION

For years, the societies of various countries and international organizations have been taking action to eliminate iodine deficiency in iodine-deficient areas. Poland is one of those countries and – similarily to other European countries – it is located within areas with natural goitre endemicity.

Since 1997, Poland has a new model of iodine prophylaxis, based on obligatory consumption of iodized salt. The results of numerous studies have proved that these actions contributed to such an increase in iodine intake that Poland has been qualified for the group of countries with sufficient iodine supply [1].

Therefore, is there anything else we should worry about? Iodine prophylaxis is not an event, but a process that changes over time; thus the key to the permanent elimination of iodine deficiency is the monitoring of this process and its modification, depending on the changing conditions. Although currently indicators evaluating iodine intake are correct, they oscillate around the borderline values of the standards, and in the situation of reduced iodine consumption they can again become too low, which could translate to the re-occurrence of endemic goitre. Recently, a wide-action has been undertaken to implement a more healthy way of eating, including restrictions on sodium intake, which consequently can lead to reduction of iodine intake.

The supply of iodine in the population is also affected by the processes of integration between countries and increasingly growing free trade and movement of people. Food (especially imported by individuals) do not need to meet the standards of iodine content set by a country, because in different countries models of iodine prophylaxis usually differ.

Appreciating the tremendous effort undertaken so far to eliminate iodine deficiency in Poland and – at the same time – being aware of the fact that the upcoming changes in diet may jeopardize these achievements, we should summarize our current knowledge about iodine prophylaxis, identify the most important controversies and uncertainties, which should be explained, and analyze the actions being made in Poland in terms of alignment of iodine deficiency.

IODINE SUPPLY

Iodized salt. The current model of iodine prophylaxis was introduced in Poland in early 1997. It assumes that only iodized salt is available in retail for the individual client. Initially, potassium iodide (KI) was added to the salt. Since 2002, potassium iodate may also be added which, as a less soluble compound, is more stable than KI. This, however, does not have so much significance in a moderate climate. Polish current law assumes that potassium iodide or potassium iodate is added to the salt designed for human consumption in such an amount that 100 g of kitchen salt contains 2.3 ± 0.77 mg of iodine, which corresponds to 30 ± 10 mg of potassium iodide or 39 ± 13 mg of potassium iodate in 1 kg of kitchen salt [2,3]. Since the consumption of iodized kitchen salt in the Poland is mandatory, the household use of iodized salt (HHIS) is > 90% [1]. This value proves a broad intake of iodized salt in Poland. The consumption of iodized salt constitutes <50–60% of the total daily consumption of the salt [4]. The remaining part is the salt added in food processing. Determination of the concentration of KI added to the salt was aimed at maintaining a daily salt consumption of 55–111 µg/day [5]. This dose can be provided by consuming 2.5–5 g of iodized salt/day [1 tsp of salt (10 pinches) weighs 6 g].

The total daily intake of salt in Poland is much higher – 11.5–15 g/day [6,7]. This places Poland in the group of countries with a high salt consumption.

Sodium is a predisposing factor for the development of hypertension. Limitation of salt intake to 5 g/day reduces systolic blood pressure in healthy subjects, depending on the race, by 1 mmHg (Caucasians and Asians) to 4 mmHg (Africans) and in patients with hypertension by 5 mmHg (Caucasians), 6 mmHg (Africans) and 10 mmHg (Asians) [8]. The effect of decreased salt intake on diastolic blood pressure is less pronounced.

Reducing the amount of sodium in a diet is one of the main recommendations for lifestyle modification in patients with hypertension. According to the recommendations of the Polish Society of Hypertension, patients with hypertension should limit salt intake to 5 g/day [9]. This is consistent with the guidelines of other organizations (European Society of Hypertension and the European Society of Cardiology), whose recommendations go further and recommend a salt intake of 5–6 g/day in the general population [10].

The arguments for limiting salt intake in the diet are so numerous and consistent that the European Union became involved and pledged before the United Nations High Level Meeting on non-communicable diseases prevention and their control, to take wide-actions aimed at promoting healthy eating, including reducing salt intake [11]. In the coming years we should expect, therefore, a significant (reaching as high as 70%) decrease in salt intake in the Polish population. To achieve such a goal comprehensive action must be taken in which there must be involved: the food industry, offices and agencies controlling food, the media, schools and universities that train, among others, dieticians and doctors.

The reduced salt intake will result in the limitation of iodine intake. In this situation, one can consider increasing the concentration of iodine added to salt, although potentially

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this increases the risk of excessive iodine intake in people who consume high amounts of salt. The US Food and Drug Administration recommendations – which assume adding 60–100 mg of KI/kg of salt, equivalent of 46–76 mg of I/kg of salt – speak in favour of this proposition [12]. Apart from this, iodized salt can also be used in the processing industry. Moreover, one should look for new carriers for iodine.

Iodination of drinking water. Water may be the carrier for iodine. For the first time water was iodinated in years 1917–1922 in Ohio (USA) [13]. The fact that iodine, like the chlorine compounds added to the water, has a strong oxidizing action might be its additional advantage, as it could also be used for tap water disinfection. Although iodination of tap water on a national scale is theoretically possible, it is difficult to control such a process. On the other hand, only about 1% of tap water is ingested by humans, while the rest is used for other purposes. Thus, the small amount of water used for consumption significantly increases the potential cost of such an operation.

Currently, attention is focused on the iodination of drinking water. Many spring waters of various spa ('Wysowianka', 'Kujawianka', 'Muszynianka', 'Piwniczanka', 'Szczawniczanka', 'Celestynka') contain iodine compounds at a concentration corresponding to 0.1–0.2 mg/L [7].

However, water from some healing springs available for purchase naturally contains iodine in a very high concentration (e.g. 'Franciszek' water deriving from the spa town of Wysowa-Zdroj contains 2.9 mg I/L), and 'Henryk' water from the same spa town contains 0.9 mg/L [14]. For prevention, on the manufacturer leaflet, it is recommended to consume 200 mL of this water 2–3 times a day, which corresponds to 1,160–1,740(!!!) µg of iodine. In the case of medical recommendations, water consumption can be even greater. 'Franciszek' water is an exception. Many natural healing spring water, especially in Gorlice County, contains large amounts of iodine (0.2–2.9 mg I/L). In cases of regular consumption of such water, the body exposure to the iodine is huge and can be hazardous to one's health. Mineral waters containing so large quantities of iodine cannot be used in the prevention of iodine deficiency since they contain iodine in an amount much larger than considered desirable ('Franciszek' water contains approx. 20 times more iodine than recommended, and 'Henryk' water – approx. 5 times more). The content of other minerals in spring healing water, including sodium, is an additional issue to be taken into account as a high sodium concentration also limits its use. The ideal water, which could be applied in the prevention of iodine deficiency, should be low-sodium with an iodine concentration of 0.1–0.2 mg I/L. This applies particularly to pregnant women who should avoid large amounts of sodium. Therefore, although iodine-containing water consumption is very important in the prevention of deficiency of this element, its consumption must be very carefully considered.

Iodination of bread and other food products. In baking, one can use iodized salt [15] or add potassium iodate instead of potassium bromate as a bread improver in a dose of 20 mg/kg of bread [16, 17]. One can also add iodine to sugar (Guatemala and the Sudan) and iodize tea (China) [18].

Iodination of animal feed. Iodine intake among animals depends on the natural iodine content in animal feed and water, iodine content in vitamin supplements and iodine contained in the substances used for disinfection.

In years 2007–2008, the actions of iodizing dairy cows' salt licks was undertaken, which increased the concentration of iodine in cows'milk from 20–40 mg/L (1970) to 86.6–142.6 mg/L (2009) [7]. The concentration of iodine in milk is also affected by the season (mean is 142.2 mg/L in winter vs. 100.4 mg/L in summer), but also the consolidation of farms (small farms do not use feed additives that enrich the diet of animals) [19]. Iodine consumed by animals does not only penetrate into milk, but it is also present in the meat of animals.

Indicators of iodine intake. The two simplest tools to assess iodine intake in the population is HHIS and urinary iodine concentrations (UICs).

Although the obligatory model of iodine prophylaxis in Poland should guarantee that HHIS is above 90% [1], it is worth noting that these data cannot be confirmed in ICCIDD (International Council for the Control of Iodine Deficiency Disorders) statements for the end of 2012 [20]. This document also does not contain any comment. One can only speculate that the lack of data is random, or that HHIS has actually declined in recent years because, for example, households increasingly use table salt intended for pickling food, which is sold in stores (large packages of not-iodized salt).

The range of iodine content in different food products is so great that it is virtually impossible to assess iodine intake based on diet, hence a more useful tool for iodine supply assessment is to analyze urine iodine concentration.

Urine Iodine Concentration (UIC). Urine Iodine Concentration is an accepted indicator of recent iodine intake because the majority (>90%) of dietary iodine is excreted by the kidneys.

Assessment of iodine concentration in spot urine samples in the population is the most useful way to determine the iodine intake for the purposes of epidemiological studies. According to the World Helth Organization (WHO) recommendations, for national, school-based surveys of iodine nutrition, the median UIC from a representative sample of spot urine collections from approximately 1,200 children (30 sampling clusters x 40 children per cluster) could be used to derive the median UIC used to clssify a country's idoine status [21].

It is noteworthy that the last such tests were held in years 1994 (n = 952) and 1999 (n = 884) [22]. Later reports describe significantly smaller groups of studied children and/or living only in a peculiar area, thus these data cannot be considered as representative for the whole country [23, 24, 25].

In recent years there have been many studies of iodine deficiency in pregnant women. Although this is a group of subjects who are particularly at risk of iodine deficiency (increased demand for iodine) and particularly sensitive to its deficit (thyroid hormones are essential for the proper development of the foetus), the assessment of school-children, still remains a key study evaluating the supply of iodine in the general population (because of general compulsory schooling, children from different backgrounds can be studied, children usually do not take drugs, the incidence of thyroid disease is lower than in adults).

In analyzing UICs, one should keep in mind that due to the high daily variability, long-term assessment of iodine supply cannot be the based on a single evaluation of ioduria in a single person. A urine iodine concentration of <100 µg/L in a spot urine sample proves only a smaller iodine intake within the last day. Unfortunately, such results are too often erroneously interpreted as a long-term iodine deficiency occurring in a given person. In order to reliably assess the individual iodine intake, UIC should be estimated in about 10 repeat spot urine collections [26].

The matter of limit values indicative of iodine deficiency is an additional issue in the reliable assessment of iodine intake. This value, from one side is a result of the organism's demand for iodine (the higher the demand, the greater the ioduria), and – from the other side – of the daily urine volume (the bigger the urine excretion, the smaller the iodine concentration in spot urine sample). Therefore, the correct value of the median of UIC >100 µg/L, found in the population of school-aged children, is not a universal value. In pregnant women it should be >150 µg/L [21], and it is postulated that in adults this value should be 60–70 µg/L [27].

The fact that the material is obtained without any invasive procedures is a huge advantage in evaluating UIC over other tests assessing iodine intake. It should be remembered, however, that the WHO/UNICEF/ICCIDD now also recommend dried whole-blood spots (DBS) thyroglobulin for the monitoring of iodine status in school-age children [21]. Thyroglobulin concentration is significantly higher in the case of iodine deficiency (median UIC <100 µg/L), as well as in the case of its excess (median UIC ≥300 µg/L) [27].

INCIDENCE OF GOITRE

Ultrasound reference ranges for the thyroid gland. It has always been difficult to precisely define a goitre. This problem is particularly relevant in borderline cases, that is in setting the border between healthy and sick thyroid. The use of thyroid ultrasound significantly reduced the variability of the data received, but it did not resolve the issue of reference ranges.

For years, the borderline values, which could be universally used in such evaluations have been searched for. However, presented reference values were very often disappointing as they proved to be either too restrictive or too liberal.

This is one of the reasons why assessment of goiter incidence based even upon ultrasound examination has been losing its significance, giving way to assessment of UIC, which seems to be more a objective evaluation of iodine intake in the examined population. However, although analysis of UIC distribution is a very reliable test, it reflects only the current situation of iodine intake. Analysis of thyroid volume indirectly assesses the influence of iodine intake over the course of several years.

Therefore, in no way can these two examination be treated interchangeably – on the other hand, they logically complement each other.

In the authors'opinion, the comparison of thyroid size measured by ultrasound to the BSA (body surface area) is a good index of evaluating the thyroid gland free of errors due to rounding. Analysis of the comparison of the thyroid gland volume to BSA (V/BSA), in the opinion of the authors, is the best estimation of the thyroid size in the study population [28]. Potential error is only burdened with the error resulting from the measurements (intra- and inter-observer variability), as in UIC level determination.

Analysis of the thyroid size, however, should not be neglected as this information supplements UICs data. Relating the size of the thyroid gland to BSA is a good, sensitive tool for such analysis, and can be used for comparisons of different populations as well as surveys conducted at different time points.

Actions aimed at eliminating iodine deficiency in Poland. A programme for the Elimination of Iodine Deficiency in Poland is being currently carried out as part of the III module of the National Programme for Preventing Civilization Diseases under the auspices of the Ministry of Health (2012–2016) [29].

The main elements of the programme are:

1) undertaking educational activities in the community on the optimal supply of iodine and health consequences of iodine deficiency, especially among pregnant women, nursing women, women of childbearing age and school-age children;
2) education and promotion of knowledge, especially among gynecologists-obstetricians and endocrinologists in such areas as the importance of iodine for proper functioning of the body, the effects of iodine deficiency, the current state of iodine deficiency, thyroid disease during pregnancy, with particular emphasis on disorders associated with iodine deficiency, iodine prophylaxis in pregnancy;
3) monitoring and evaluating the effectiveness of undertaken activities in the field of education on the optimal supply of iodine.

Educational activities are of enormous importance, as greater knowledge and awareness of health behaviour is the foundation of any prevention. It should be noted that these measures may not be sufficient in the nearest future.

There is a need for periodic examination of children in various regions of Poland for monitoring the iodine situation in the country, skillful analysis of the data received, and undertaking comprehensive measures for the introduction of other carriers for iodine. Otherwise, the success of iodine prophylaxis introduced in 1997 may prove to be out-of-date.

Let us remember that we are still living in areas naturally low in iodine, and only its skillful supplementation (this is a continuous process and not an event), guarantees the benefits of the elimination of iodine deficiency.

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