ПРОБЛЕМНАЯ СТАТЬЯ

IODINE DEFICIENCY: EPIDEMIOLOGY AND NUTRITIONAL PREVENTION

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ABSTRACT. Iodine deficiency disorders (IDD) are present in all the continents; developing nations are most severely affected. There are 14 European countries affected by iodine deficiency, we can cite France, Belgium, Norway, Portugal and Russia whose population have a median iodine urinary excretion (IUE) under 100μg/l. Iodine deficiency is the first cause in the world of mental retardation, but this consequence occurs with severe deficiency. The sensitivity is higher in pregnant women and young children. Median rate of iodized salt consumption in countries of Central and Eastern Europe and CIS is 50% and stay the lowest rate of all world areas. Russia reduces because it's the most populated country and only 35% of couples use iodized salt. In 2006, UNICEF counted 16 "decisive" countries which needed a supplemented help to increase their effort. These countries are important salt producers, the number of newborn babies which risk iodine deficiency is high, rate of salt iodization is small, so it's necessary to conduct a particular action to mobilize population and government and, moreover bring a technical support to renew national programs of elimination of iodine deficiency. If these 16 countries manage to universal salt iodization, world average of households which take correctly iodized salt will be about 85%. Russia takes part among these 16 "decisive" countries in fighting against IDD (the other are India, Pakistan, China, Ethiopia, Indonesia, Ukraine, Philippines, Soudan, Bangladesh, Egypt, Afghanistan, Ghana, Angola, Niger, Senegal). That's why, it's important that health sector, medias, consumers associations and salt producers work in concomitance in order to household understand the necessity of suitable daily iodine intake and in order to increase the accessibility of iodized salt..

KEYWORDS: iodine, deficiency, epidemiology, prevention, nutritional.

EPIDEMIOLOGY OF IODINE DEFICIENCY

Nowadays, epidemiological indicator usually used to measure iodine deficiency is iodine urinary excretion. This parameter is used to evaluate iodine status in populations and not for individual diagnosis. In recent publications (Gorbachev et al., 2007; Momcilovic et al., 2014) there were demonstrated the perspectiveness of hair iodine determination in assessment of individual iodine status in human. Moreover, the aim of the epidemiological studies and the struggle for reducing iodine deficiency is not really the increase of urinary excretion but the decrease of goiter prevalence in endemic areas.

Iodine deficiency disorders (IDD) are present in all the continents; developing nations are most severely affected. Iodine deficiency is a scourge which persists all around the world and its world distribution changes. Indeed, a WHO report of 1994, evaluated at about 1,6 billion the number of persons in the world, which risked to be affected by IDD. This number has increasing during the last 15 years with about 2 billion persons in 2011. Their geographic distribution reflects the economic development. (WHO, 2011)

Only few countries like Switzerland, USA, Canada, Australia and Scandinavia had a sufficient iodine intake before the 1990s.

We can notice that in some countries of eastern and western Europe, there is a persistence of iodine deficiency in a subclinical form (WHO, 1997; 2011). According to the report of ICCIDD president (International Council for the Control of Iodine Deficiency Disorders), concerning the International Days HP Klotz which took place in Paris in 2011, there are 14 European countries affected by iodine deficiency, we can cite France, Belgium, Norway, Portugal and Russia whose population have a median iodine urinary excretion (IUE) under 100 μg/l.

About France, recent data ranked it in an optimal iodine status but the way how the trials are made is not completely known so there are some doubts concerning the results.

Russia is in mild deficiency with a median IUE between 50 and 99 μg/l in its population; 31 countries corrected their deficiency with UIE between 100 and 300 μg/l. Concerning 6 countries like United-Kingdom, data were insufficient. Armenia and Georgia were in excess (> 300 μg/l).

About Russia, iodine deficiency is an older health problem, indeed, 20 years ago, IDD already present

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caused an higher sensitivity to the Chernobyl radioactive fallout; but the matter is not finished now, it affects millions children. Iodine deficiency is the first cause in the world of mental retardation, but this consequence occurs with severe deficiency. The sensitivity is higher in pregnant women and young children. In endemic areas and those affected by Chernobyl disaster, IQ of children is about 13 points under the average, school results are bad and when they become adults, these persons have a lot of problems (Veneman, 2006).

However, it's necessarly to notice that, in some Russin regions, lots of parameters are also responsible, like social level, poverty.

When IDD occurs in child, the common form is a goiter, which is less and less reversible with the increase of the age.

IODINE INTAKES. RECOMMENDED DAILY INTAKES

Iodine recommended daily intakes depending on âge and physiological status (ANSES, 2009):

Age/Status	Intake µg/day
0–3 years old	80
4–6 years old	90
7–10 years old	120
Adolescents et adults	150
Pregnancy	200
Breastfeeding	200

It is shows that iodine recommended intakes are higher for pregnant and for breastfeeding, indeed, iodine deficiency in fetus can cause severe impairments in child development.

IODINE SOURCES

Main food sources of iodine:

Cheese	30 µg/100 g
Cow milk	9 µg/100 ml
Eggs:	
white:	59 µg/100 g
yolk:	192 µg/100 g
Sea fish	110 µg/100 g
Shelfish	180 µg/100 g
Seaweed	320 µg/100 g
Yogourt	20 µg/100 g
Chocolate	17 µg/100 g
Breakfast cereals	13 µg/100 g
Bread, pastries	14 µg/100 g
Pastas	14 µg/100 g
Iodinated salt	15–20 µg/g
Meat	6 µg/100 g
Pork meat products	14 µg/100 g
Fruits and vegetable	2 µg/100 g
Fats	2,9 µg/100 g
Drinking water	2 µg/100 g

In Russia, food is relatively diversified; it's composed of meat, vegetables and starchy food. Vegetables usually eaten are cabbages, cucumbers, beetroot, which accompany some dishes or are served with different soups. Potatoes are often found in meals and pastas like ravioli.

Bread is a basis of Russian food above all blackbread or rye bread. Pork meat products are regularly eaten and most at breakfast or as sausages at lunch or dinner. Fish is one of foodstuffs which is liked a lot, but Russians prefer fresh-water fishes like carp.

Still water isn't generally on tables; they drink more often cooked fruits juices.

Russian population eats lots of milk products with bread or in fermented milk form. (Bichet et al., 2006; Small, 2007)

It's necessary to notice that the difference between rural and urban habits is very important in Russia, in towns and not far from touristic sites, the consumption of ready-meal have been increased a lot in households (Berry, 2011).

We can see that traditional Russian food is much diversified but some foodstuffs appear in various meals like bread which is a basis food. Usually eaten food, except milk products, contains naturally little quantity of iodine.

However, in other areas, food habits change to become about western habits. We have to consider all these parameters and make the difference between the several areas in order to introduce a new iodine carrier for the food supplementation.

INFLUENCING FACTORS CONCERNING THE IODINE ABSORPTION

(Duron, 2001)

The bioavailability of potassium iodine or sodium iodine which is found in food or in supplemented salt is about 100%. However, some factors influence the absorption of these iodine forms. Indeed, there are some parameters which influence iodine deficiency; they are named strumagenic or goitrogenic factors. They have several origins:

1. In foodstuffs, there are substances which inhibit iodine penetration in the thyroid, its organification, iodothyrosines synthesis. Among these foodstuffs, we find vegetables like brassicacea family with cabbages (eaten a lot in Russia), turnips and crucifers used to feed cows. We can cite manioc, soya, millet and sorghum (which feed population exposed to a higher level of iodine deficiency, in Asia and in Africa). There are also lentils, onions, garlic. Concerning drinking water, it can contain toxic substances against thyroid gland: resorcinol, phthalates, and organic disulfide.

2. Drugs for treating thyroid disorders, lithium can act on goiter formation.

3. Pathologic factors acting on iodine absorption like troubles of hormone synthesis by enzymatic deficiency or genetic factors caused by genomic mutations (thyroglobulin).

4. We can notice also, the influence of physiological status: a goiter often occurs when there are periods for which hormonal synthesis needs are increased, for example, during puberty, pregnancy or breastfeeding.

REAL INTAKES

Median rate of iodized salt consumption in countries of Central and Eastern Europe and independent States is 50% and stay the lowest rate of all world areas. Russia reduces because it's the most populated country and only 35% of couples use iodized salt.

In 2006, UNICEF counted 16 « decisive » countries which needed a supplemented help to increase their effort. These countries are important salt producers, the number of newborn babies which risk iodine deficiency is high, rate of salt iodization is small, so it's necessary to conduct a particular action to mobilize population and government and, moreover bring a technical support to renew national programs of elimination of iodine deficiency.

If these 16 countries manage to universal salt iodization, world average of households which take correctly iodized salt will be about 85%.

Russia takes part among these 16 "decisive" countries in fighting against IDD (the other are India, Pakistan, China, Ethiopia, Indonesia, Ukraine, Philippines, Soudan, Bangladesh, Egypt, Afghanistan, Ghana, Angola, Niger, Senegal) (UNICEF, 2008).

According to a 2003–2004 survey in Russia (UNICEF, 2008):

number of inhabitants: 143 221 000;
number of yearly births: 1 506 000;
households taking iodized salt : 35%;
children exposed to IDD: 979 000;
population exposed to IDD: 93 094 000.

NECESSITY OF IODINE FORTIFICATION

Iodized salt exists since 1952, but for pregnant women there isn't particular fortification. However, during pregnancy state, needs are increased because of several reasons:

oestrogens cause the increase of circulating rate of TBG, that causes the decrease of free T4;
HCG has a TSH-like action;
there is a placental transfer of iodides.

Iodine deficiency in pregnant women leads to different troubles like:

gestational goiter in mother;
backwardness in intrauterine development;
an increase of thyroid volume in newborn child;
a backwardness of psycho-intellectual development at 3 years, a decrease of QI score, attention deficiency, hyperactivity.

WHO wants a iodine supplementation about 250 μg/day in pregnant women, or breast-feeding, or in procreation age.

General Medicine Department of University of Lyon realized a research in literature thanks to many scientific databases and synthesis of several trials about the interest of iodine supplementation in pregnant women and young children, its advantages, and its potential toxic risk.

Method: a key-word research limited by dates between 1991 and 2001, in about 10 databases was realized. Several criterions to include or exclude trials was retained to have a good pertinence in conclusions.

Results: It emerge from this research that in general, a supplemention between 100 and 300 μg/day brings lots of advantages:

goiter prevention in mother;
prevention in fetal thyroid volume;
prevention in psychomotor and behavioral development in 12–18 months;
correction of hypothyroxemia and maternal TSH stabilization.

Some side effects which are paradoxical effects were found in some studies:

psychomotor backwardness at 1 year;
increase in maternal and fetal TSH.

Discussion: Benefit of iodine supplementation seems real, in particular potassium iodide which have a positive effect on neurological development of children, according to recent studies only however the link between iodine deficiency and intellectual backwardness is known since some decades. However, we can notice the small size of samples and a different in size of control group and supplemented group. More recent studies evidence supplementation effects on thyroid volume in mother and child with a good level of proof. Despite of few limits, these studies are in favor of benefit of iodine supplémentation in pregnant women, for mother and child. This supplementation would be ideal if it begins before pregnancy.

Some studies, but it's not majority, show some side effects, paradoxical effects of fortification which are hypothyroidism with TSH increase but with no clinical signs. Systematic supplementation has to be discussed and it necessary to study more particularly these paradoxical effects.

How does supplémentation must be realized: It's very difficult to target women really in iodine deficiency, the ideal way would be to lead general population to an optimal iodine status. That's why, supplementation in pregnant women must be short term measure, and in the long run, the objective wood be generalize and optimize salt fortification.

WHO thinks necessary to supplement systematically pregnant women in countries where iodized salt id used by less 90% of households.

UNIVERSAL IODINE SUPPLEMENTATION OF SALT

The problem of iodine deficiency affects all the world with several levels of severity and causes lots of health troubles as we can see previously, for example goiter, cretinism, however we can easily suppress or reduce this problem with a simple and very little expensive method which is universal salt iodization.

For a country, the level of supplementation can be reduced because of several factors: the time, the modification of daily consumption of salt, the iodine dispersal when it's stocked. We can see in table, the Iodine recommended contents by WHO-UNICEF-ICCIDD according to the different intakess, and various environmental conditions and packaging.

Table. ***Iodine recommended contents by WHO-UNICEF-ICCIDD (mg of iodine/ kg of salt) (mg/kg) (Venkatesh Mannar, 1995)***

Climate and daily intakes of iodized salt	Packaging			
	At factory		At wholesaler	
	Big sacks in bulk	Retail plastic Sacks	Big sacks in bulk	Sac plastique détail
Warm and humid: 5 g	100	80	80	60
10 g	50	40	40	30
Cold and dry: 5 g	80	60	60	40
10 g	40	30	30	20

Each State Authority will have to define suitable levels of salt, working with salt industries.

National regulations will have to impose minimal content of salt for the production and another, lower, concerning the intake in order to consider the losses during the storage and the transport. For example, 40 mg/kg (production); and 20 mg/kg (intake).

Iodine rate in salt depends on two parameters:

1. Recommended daily intake for one person necessary to prevent IDD which must be added to the median salt quantity consumed per person. It appears that in endemic areas, each inhabitant should receive 150μg of iodine per day.

2. The median intake of salt per day and per person in community at stake which depends on two factors, racial, climatic; indeed, consumption of salt is higher under tropical climates than under moderate climates.

Moreover, it's necessary to consider the totality of consumable salt: salt for cooking, salt on table, salt used by industry to make bread, cheese and other foods.

At different periods, various ways of iodine supplementation had been tested. Concerning Russia, it was the iodization of drinking water or iodine added in bread which is a basis foodstuff in this country.

Today, we have chosen salt iodization because of several reasons (WHO, 2011):

consumption in all the planet;

stable intakes during the year;

limited production in few geographic areas;

easy way to make use of this iodization and affordable in all developing nations. The cost is about only 0.02 to 0.05 dollars per child per year; and it permits to earn 1000 dollars per year concerning the death and 35 dollars concerning the life adaptation of affected children;

addition of iodine doesn't change color, neither smell, neither taste;

the quality is supervised at the level of production, sale, and household.

However, some negative points have to be emphasized:

1. Iodized salt isn't present in transformed products, ready-meals, canteens, intake of iodized salt requires cooking was made by the family; it's not always easy according to different ways of life.

2. Campaigns against hypertension in developed countries caused a reduction of salt intakes so of iodine intakes in populations;

3. Russia and new independent republics, Bulgaria, Rumania, have a low production of solar salt at the seaside of Black Sea and Azov Sea. Most of their needs are satisfied by gem salt (Venkatesh Mannar, 1995).

4. Only 55% of Belarus households consume iodized salt and only 30% in Russia and Ukraine. It means that, about 41000 Belarus children, 274000 Ukrainian children, and 1 billion Russian children are born with iodine deficiency each year. It's necessary that governments of these 3 countries act rapidly with the help of international community. That's why, it's important that health sector, medias, consumers associations and salt producers work in concomitance in order to household understand the necessity of suitable daily iodine intake and in order to increase the accessibility of iodized salt (Veneman, 2006).

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ДЕФИЦИТ ЙОДА: ЭПИДЕМИОЛОГИЯ И ПИЩЕВАЯ ПРОФИЛАКТИКА

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РЕЗЮМЕ. Йододефицитные заболевания (ЙДЗ) широко распространены в мире, особенно от них страдают развивающиеся страны. Дефицит йода является первой причиной умственной отсталости в мире, правда в случае резко выраженного дефицита. Наиболее чувствительны к дефициту йода беременные женщины и маленькие дети. К пострадавшим от йододефицита можно отнести 14 европейских стран, в том числе Францию, Бельгию, Норвегию, Португалию и Россию, население которых демонстрирует низкий уровень экскреции йода с мочой (ИЭГ) (ниже 100 мкг/л). Средний показатель потребления йодированной соли в странах Центральной и Восточной Европы и СНГ составляет 50% и остается самым низким на фоне всех регионов мира. В России только 35% используют йодированную соль. В 2006 г. ЮНИСЕФ насчитал 16 «решающих» стран, в которых необходимо дополнительно способствовать увеличению их усилий по ликвидации дефицита йода. Несмотря на то, что эти страны являются важными производителями соли, количество новорожденных, которым грозит дефицит йода, является высоким, степень потребления соли низкая, поэтому необходимо проведение конкретных мер в целях мобилизации населения и правительств и, более того, оказать техническую поддержку возобновлению национальных программ устранения дефицита йода. Если эти 16 стран удается приобщить к употреблению йодированной соли, то среднемировая доля домохозяйств, которые употребляют правильно йодированную соль, достигнет 85%. Важно, чтобы здравоохранение, СМИ, ассоциации потребителей и производителей соли в этих странах работали совместно для того, чтобы семьи понимали необходимость потребления суточной дозы йода, а также для повышения доступности йодированной соли.

КЛЮЧЕВЫЕ СЛОВА: йод, дефицит, эпидемиология, профилактика, питание.