

## Iodine deficiency disorders

Z. Paknahad (Ph.D)\*

\* Hezar Jarib Street-Isfahan University of Medical Sciences- Faculty of Health-Isfahan

paknahad@hlth.mui.ac.ir

### Abstract

*Iodine deficiency is a major public health problem for populations throughout the world, particularly for pregnant women and young children. They are a threat to the social and economic development of countries. Goitre is the most visible manifestation of IDD. Endemic goitre results from increased thyroid stimulation by thyroid stimulating hormone (TSH) to maximize the utilization of available iodine and thus represents maladaptation to iodine deficiency. However, the most damaging disorders induced by iodine deficiency are irreversible mental retardation and cretinism. If iodine deficiency occurs during the most critical period of brain development (from the fetal stage up to the third month after birth), the resulting thyroid failure will lead to irreversible alterations in brain function. In severely endemic areas, cretinism may affect up to 5–15% of the population. While cretinism is the most extreme manifestation, of considerably greater significance are the more subtle degrees of mental impairment leading to poor school performance, reduced intellectual ability and impaired work capacity.*

### Introduction

Iodine deficiency is a major public health problem for populations throughout the world, particularly for pregnant women and young children. They are a threat to the social and economic development of countries (1). The geographical distribution of severe endemic areas has been progressively reduced, and at present, approximately 200 million people living in remote places are still at risk of severe iodine deficiency (2).

### Functions

Iodine is stored in the thyroid gland, where it is used in the synthesis of triiodothyronine (T4) and thyroxine (T3). Thyroid hormone is degraded in target cells and the liver, and the iodine is highly conserved under normal conditions. Selenium is important in iodine metabolism because of its presence in one enzyme responsible for forming active T3 from thyroglobulin. Stored in the thyroid gland.

### Dietary Reference Intakes

An iodine intake of 150 µg/day has been suggested as sufficient for all adults and adolescents. The RDA for pregnant and lactating women increases to 220 microgram and 290 microgram, respectively. The RDA is 110 µg for infants up to 6 months of age and 130 µg for older infants. The RDA for children is between 90 and 120µg and increase with age (or body size)(3).

### Food Sources and intakes

Iodine and iodine-rich foods have long been used as a treatment for hypertension and cardiovascular disease (4). The native iodine content of most foods and beverages is low, and most commonly consumed foods provide 3 to 80 µg per serving. Iodine content in foods is also influenced by iodine-containing compounds used in irrigation, fertilizers, and livestock

feed. Iodophors, used for cleaning milk cans and teats in the dairy industry, can increase the native iodine content of dairy products through contamination of iodine containing residues(5).

Iodine exists in variable amounts in food and drinking water. Seafood such as clams, lobsters, oysters, sardine and other saltwater fish is the richest source of iodine. Saltwater fish contain 300 to 3000 µg/kg of flesh; freshwater fish contain 20 to 40 mcg/kg, but they are still good sources. The iodine content of cow's milk and eggs is determined by the iodides available in the diet of the animal; the iodide content of vegetables varies according to the iodine content of the soil in which they grow. Iodine also enters the food chain through iodophors, which are used as disinfectants in dairy processing, coloring agents, and dough conditioners...

The use of iodized salt should still be advocated in certain areas to prevent goiter. The best way to obtain an adequate intake of iodine is to use iodized salt (which has about 60 µg of iodine per gram of salt. (3).

### **Deficiency**

An estimated 2 billion people worldwide living in less Developed nations remains at risk for iodine deficiency. These individuals may have a moderate iodine deficiency, even when obvious goiter a severe condition, is not evident. In school children iodine deficiency is associated with poor cognition. Iodine deficiency is the most common preventable cause of mental retardation in the world. Iodized salt or the oral administration of a single dose of iodized oil, and weekly iodine supplements are effective. Use of iodized salt should be encouraged during pregnancy, especially through the end of the second trimester.

Very low iodine intakes are associated with the development of endemic or simple goiter, which is an enlargement of the thyroid gland (fig 1). The deficiency may be nearly total, especially in mountainous areas and regions of high goitrogen intakes, or relative, subsequent to an increased need for thyroid hormones.

#### **Goitrogenic factors**

Goitrogens, which exist naturally in foods, can also cause goiter by blocking uptake of iodine from the blood by thyroid cells. Foods containing goitrogens include cabbage, turnips, rapeseeds (from rape plants), peanuts, cassava, sweet potatoes, kelp, and soybeans. Goitrogens are inactivated by heating or cooking. Severe iodine deficiency during gestation and early postnatal growth results in cretinism in infants, a syndrome characterized by mental deficiency, spastic disoplegia or quadriplegia, deaf mutism, dysarthria, a characteristic shuffling gait, shortened stature, and hypothyroidism. Less severe variations of this syndrome also exist, manifesting as moderate retardation in intellectual or neuromotor maturation (3, 5).

### **-Health consequences**

Iodine is present in the body in minute amounts, mainly in the thyroid gland. Its main role is in the synthesis of thyroid hormones. When iodine requirements are not met, thyroid hormone synthesis is impaired, resulting in hypothyroidism and a series of functional and developmental abnormalities grouped under the heading of "Iodine Deficiency Disorders (IDD)".

Goitre is the most visible manifestation of IDD. Endemic goitre results from increased thyroid stimulation by thyroid stimulating hormone (TSH) to maximize the utilization of available iodine and thus represents maladaptation to iodine deficiency(1) .

If iodine deficiency occurs during the most critical period of brain development (from the fetal stage up to the third month after birth), the resulting thyroid failure will lead to irreversible alterations in brain function (1).

In severely endemic areas, cretinism may affect up to 5–15% of the population. While cretinism is the most extreme manifestation, of considerably greater significance are the more subtle degrees of mental impairment leading to poor school performance, reduced intellectual ability and impaired work capacity.

#### *Severe iodine deficiency in pregnancy*

During pregnancy they are associated with maternal and fetal complications: maternal hypothyroxinemia during the first trimester of gestation can be associated with abnormal cognitive development and intellectual outcomes in the newborn and the children (6) the most serious adverse effect of iodine deficiency is damage to the fetus. Congenital hypothyroidism induced by iodine deficiency is a major problem. Its public health importance comes from the neurological complications that lead to the most severe forms of endemic congenital hypothyroidism (cretinism) (7). Iodine treatment of pregnant women in areas of severe deficiency reduces fetal and prenatal mortality and improves motor and cognitive performance of the offspring (5).

#### *B. The risks of excess iodine intake*

The effect of iodine on the thyroid gland is complex with a “U shaped” relation between iodine intake and risk of thyroid diseases. Both low and high iodine intake are associated with an increased risk of thyroid disorders. Healthy adults can tolerate up to 600-1100 µg iodine/day without any side effects (5).

Adults have a UL of 1100 µg/day, and young children have a UL of 200 to 300µg/d. Excessive iodine in the diet may result in hypothyroidism, goiter formation, or hyperthyroidism (2).

### **Conclusion**

The fortification of salt with iodine has been a global success story, but other micronutrient supplementation schemes have yet to reach vulnerable populations sufficiently. To be effective, all such interventions require accompanying nutrition-education campaigns and health interventions. To achieve the hunger- and malnutrition-related Millennium Development Goals, we need to address poverty, which is clearly associated with the insecure supply of food and nutrition (8).

### **References**

1. Bruno de Benoist ,Maria Andersson,Ines Egli ,Bahi Takkouche ,Henrietta Allen;  
Iodine status worldwide WHO Global Database on Iodine Deficiency, Geneva: World Health Organization, 2004.
2. Vanderpas J.; Nutritional epidemiology and thyroid hormone metabolism. Ann. Rev Nut. 2006; 26:293-322
3. L. Kathleen Mahan, Sylvia Escott-Stump: Krause's food, nutrition & diet therapy: Eds: 12, Saunders publication, pp; 127-129
4. Hopton Cann SA; Hypothesis: dietary iodine intake in the etiology of cardiovascular disease. J Am Coll Nutr. 2006 Feb; 25(1):1-11.
5. Eastman, C., Li, M., Zimmermann M.B.: IODINE DEFICIENCY DISORDERS (IDD) IN THE ASIA PACIFIC REGION. Hot Thyroidology. 2007; 0:0.
6. Caron P. et al;Prevention of thyroid disorders in pregnant women]

J Gynecol Obstet Biol Reprod (Paris). 2009 Nov; 38(7):574-9

7. Sidibé el H.; Reflections on mental retardation and congenital hypothyroidism: effects of trace mineral deficiencies, Sante. 2007 Jan-Mar; 17(1):41-50.
8. Muller O, Krawinkel M.; Malnutrition and health in developing countries. CMAJ. 2005 Aug 2; 173(3):279-86.

**Table1: Iodine content of foods (& RDA)<sup>3</sup>**

Food	Content (mcg)
Salt, iodized, 1 tsp	400
Bread, made with iodate dough conditioner and continuous mix process, 1 slice	142
Haddock, 3 oz	104-145
Bread, made with regular process, 1 slice	35
Cheese, cottage, 2% fat, ½ cup	26-71
Shrimp, 3 oz	21-37
Egg, 1	18-26
Cheese, cheddar, 1 oz	5-23
Ground beef, 3 oz	8
<b>DRIs</b>	
Infants and young children	90-130 mcg/day, depending on age
Older children and adolescents	120-150 mcg/day, depending on age
Adults	150 mcg/day
Pregnant	220 mcg/day
Lactating	290 mcg/day

From U.S. Department of Agriculture: Composition of foods, USDA Handbook No. 8 Series, Washington, DC, 1976-1986, Agricultural Research Service, The Department.



Figure 1 shows a young girl with a soft diffuse goitre and an elderly woman with a huge, longstanding multinodular goiter, both resulting from iodine deficiency (5).