# Iodine nutrition in Brazil: where do we stand?

## Iodo nutricional no Brasil: como estamos?

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## ABSTRACT

Brazilian legislation, since 1955, failed to achieve its objectives because the issue was not properly addressed: iodized salt was only available in endemic areas, at a low amount of 10 mg Iodine/kg salt. Lack of surveillance and cooperation were common errors. From 1982 to 1992, the INAN distributed potassium iodate to the industry free of charge, but it was abolished in 1991. Only four years later (1995) was a new law enacted effective in determining that all salt for human use should be iodized at levels established by the Health Authorities. During the period comprising 1998 to 2004, excessive iodination of salt (40 to 100 mg/kg) could lead to an increased prevalence of chronic autoimmune thyroiditis and iodine-induced hyperthyroidism. In 2003, the content of iodine/kg of salt was lowered to 20 to 60 mg I/kg salt. A national survey of schoolchildren is currently underway and will indicate the changes required for adequate iodine in salt for human use. Arq Bras Endocrinol Metab. 2009;53(4):470-4.

**Keywords**

Iodine nutrition; excess iodine; hyperthyroidism; hypothyroidism; autoimmune thyroid disease

## RESUMO

A legislação para corrigir deficiência crônica de iodo no Brasil iniciou-se em 1955. O sal iodado seria distribuído somente em áreas endêmicas de bócio, com dose fixa de 10 mg Iodo/kg de sal. Na década de 1982 a 1992, o Instituto Nacional de Alimentação e Nutrição assumiu o Programa Nacional para a Deficiência Crônica de Iodo e forneceu o iodato de potássio a todos os produtores de sal. Em 1992, o INAN foi dissolvido. Nova legislação foi promulgada em 1995. A Anvisa ficou encarregada de supervisionar o teor de iodo em amostras de sal. No período de 1998 a 2004, o teor de iodo no sal foi elevado para 40 a 100 mg I/kg de sal. O excesso nutricional de iodo na população possivelmente aumentou a prevalência de tireoidite de Hashimoto e hipertireoidismo. Inquérito epidemiológico nacional (PNAISAL) em escolares, em execução, indicará as futuras determinações para a adição de iodo no sal. Arq Bras Endocrinol Metab. 2009;53(4):470-4.

**Descritores**

Iodo nutricional; excesso de iodo; hipertireoidismo; hipotireoidismo; moléstias autoimunes tireoideas

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## INTRODUCTION

Since colonial times, iodine deficiency disorders have been a major cause of goiter in the Brazilian population, having been described by several scientific expeditions that ventured deep into Brazil's hinterland (1). But although goiter is a visible and easily detectable anomaly, the most serious sequelae of iodine deficiency disorders is brain damage to fetus and infants. Indeed, several reports confirm that mild to severe iodine deficiency induces some degree of brain defects, with post-natal sequelae such as mental deficiency, abnormal neurological signs and deaf mutism (2). Thus, several countries in Europe introduced iodized salt in order to prevent the consequences of iodine deficiency. Only in 1953 were the first steps taken in Brazil following the introduction of iodized salt, albeit restricted to areas recognized as iodine deficient (Table 1). This legal ruling posed an almost impossible task for the health authorities and the salt industry. How could possibly the distribution of iodized salt only to areas defined as "endemic" be organized, while other areas of the country were to continue using non-iodized salt?

**Table 1.** Legislation on iodine fortification of salt for human use in Brazil

| |
|---|
| **Law 1944, August 14, 1953:** iodination of salt for human use is made mandatory, but only in areas with endemic goiter |
| **Amendment in 1956:** iodized salt is extended for all salt for human use. The Ministry of Health is to import and distribute potassium iodate |
| **Law 6150, Dec. 3, 1974:** salt iodination is set at 10 mg/kg and the salt industry is responsible for the purchase and fortification of salt at their own expense. Surveillance is to be performed by the individual States and districts |
| **Law 9005, March 16, 1995:** * the amount of iodine for fortification of salt for human use is established by the Ministry of Health which is to import and distribute potassium iodate to the salt industry without charge. Surveillance of the content of iodine/kg of salt to be conducted by Anvisa** |

* In 1998, Anvisa increased the amount of iodine in salt for human use to 40-100 mg Iodine/kg salt.
** In 2003, the amount of iodine in salt for human use was reduced to 20 to 60 mg I/kg salt.

## FURTHER LEGISLATION ON SALT IODINATION

After three years, this situation was recognized as logistically unworkable and in 1956, iodized salt was made widely available to Brazil's population as a whole (Table 1). The Ministry of Health was charged with the task of importing potassium iodate for distribution to the salt mills. Again, the whole strategy of adding iodine to salt was hampered because, in brief, small salt mills never added potassium iodate to the salt they produced, in spite of receiving this iodine source from the health authorities. Successive national surveys of schoolchildren were conducted in 1955 (24.6% of the Brazilian children were goitrous), and again in 1975 (when 14.7% of the children had palpable goiters). This latter figure indicated that approximately 10 million Brazilians were likely suffering from iodine deficiency (out of a population of 60 million).

Thus, another law was enacted by the House of Representatives (Table 1), determining that the amount of iodine in salt for human consumption was to be set at 10 mg iodine/kg salt. Moreover, this new law transferred the onus of purchasing potassium iodate to the salt industry. Obviously, this was ineffective because each State of the Republic of Brazil was then responsible for the surveillance of salt supplied for human use by checking samples of salt on the market and also at salt mills, although this was seldom done.

## CREATION OF TASK FORM TO SAVE THE IODINATION PROGRAMME

The situation was so badly conducted that in 1982 the National Institute for Food and Nutrition (INAN) of the Ministry of Health decided to create a Working Task Force to solve the problem. This new task force included members of the Salt Industry, Health Authorities, and expert consultant from the Universities of Pernambuco and São Paulo (GMN). The Committee decided that the solution would be to provide Potassium Iodate free of charge to the salt mills, but the industry would have to agree a system of close surveillance whereby samples of salt would be periodically tested both on the market and on the production line. If below or above legal concentrations of iodine/kg were detected, the salt mills would be fined and possibly closed down.

Therefore, between 1982 and 1992, it can be assured that the Brazilian population had received iodine through an effective salt iodination program coordinated by the INAN Committee, with full cooperation of the salt industry. About seven thousand samples of salt were analyzed each year, and INAN published the results annually in an internal bulletin.

## SALT IODINATION PROGRAMME INTERRUPTED IN 1992

In 1992, there was a legal dispute based on the fact that supplying the salt industry with free potassium iodate was illegal according to the 1974 law (Table 1). Therefore, during the proceeding three years most of the salt consumed by the Brazilian population was not iodized. The largest salt mills, however, continued to add iodine to their salt at their own expense. In 1994 and 1995, a Third National Survey in schoolchildren was conducted and aside from goiter prevalence iodine urinary excretion was assayed. Four deficient areas and 116 moderately deficient villages were detected. This work indicates that iodine deficient is still present mostly in the impoverished area of Northeast Brazil (3). Finally, in 1995, a new law was approved by the House of Representatives and the Senate, and signed by the President of the Republic of Brazil (Table 1). The law simply stated that all salt for human use should be iodinated according to the limits and rules set forth by the Ministry of Health. During the same period, it was agreed that surveillance and monitoring should be conducted by the National Agency for Sanitary Surveillance (Anvisa). The limits for salt iodination were set at 40 to 60 mg iodine/kg of salt.

## NEW LIMITS FOR SALT IODINATION

In 1998, Anvisa decided to increase the concentration of iodine in the salt for human use to 40 to 100 mg iodine/kg of salt. The rationale was to provide a broader range so as to avoid salt producers from introducing less (< 40 µg) or more (> 100 µg/L) iodine to salt. In either circumstance, the salt industry would be fined accordingly.

For the ensuing five years (1998-2003), the Brazilian population was subjected to excessive iodine nutrition due to the relatively high content of iodine in the salt. This was confirmed by the studies linked to the Thyromobil Project in 2001 (4). In this field work, it was confirmed that schoolchildren were receiving excessive iodine nutrition. Indeed, almost 86% of all children examined excreted more than 300 µg iodine/L of urine (Table 2). Moreover, close to 50% of all salt samples (collected at homes) contained more than 60 mg iodine/kg of salt. Therefore, in 2003, the Anvisa agency decided to lower the iodine concentration of salt for human use to 20-60 mg iodine/kg of salt (Table 3).

**Table 2.** Urinary iodine excretion (µg I/L) in schoolchildren during the Thyromobil project (May to June, 2000)*

| State | Samples (n) | Median (µg/L) | Urinary Iodine excretion (µg/L) | | |
|---|---|---|---|---|---|
| | | | 101-200 | 201-300 | > 300 |
| Maranhão | 205 | 220 | 33.5 | 66.6 | - |
| Tocantins | 188 | 315 | - | 25.0 | 75.0 |
| Goiás | 187 | 360 | - | 33.3 | 66.6 |
| Mato Grosso | 95 | 520 | - | 2.0 | 98.0 |
| Mato Grosso do Sul | 239 | 480 | - | 3.0 | 97.0 |
| Minas Gerais | 99 | 501 | - | 4.0 | 96.0 |
| Total | 1.013 | 360 | - | 22.3 | 86.1 |

*Assays of urinary iodine were conducted at the Universidad Peruana Cayetano Heredia, Lima, Peru (Prof. Eduardo Pretell).

## EFFECTS OF EXCESSIVE IODINE INTAKE ON THE POPULATION

Excessive iodine intake for a prolonged period of time may be harmful. The WHO states that iodine excess may increase the prevalence of chronic autoimmune thyroiditis (in individuals with a genetic trait linked to autoimmunity) and also lead to iodine-induced hyperthyroidism (5) mainly in the elderly (who frequently present thyroid nodules). Thus, Camargo and cols. (6,7) confirmed that the prevalence of chronic autoimmune thyroid disease (Hashimoto's thyroiditis) was elevated in an urban population in São Paulo, after five years of excessive iodine nutrition (from 1998 to 2004). A total of 16.5% of women (all ages) had clinical signs, ultrasonographic hypoechogenicity and positive anti-TPO antibodies, which, taken together, are considered to strongly indicate chronic autoimmune thyroiditis. Men were also affected (4% of all men) by Hashimoto's thyroiditis. Another study by Duarte and cols. (8) indicated that 8% of 868 children studied in São Paulo had echographical evidence of marked hypoechogenicity suggestive of chronic thyroiditis. More recently, Duarte and cols. (9) studied 400 elderly patients in São Paulo. One third of the patients had urinary iodine excretion of more than 300 µg I/L urine. Echographic studies confirmed that 20.9% of the woman and 8.4% of the men had marked hypoechogenicity indicative of chronic autoimmune thyroiditis. Moreover, overt hypothyroidism (4.3%) and subclinical hypothyroidism

**Table 3.** Salt for human use in Brazil (t = tons)

| Year | Total (salt consumed) (t) | Other Uses *1 (t) | Ingested (t) | Population (*2, x 10³) | Daily consumption (*3) g/person/day | | Total (g/day) |
|---|---|---|---|---|---|---|---|
| | | | | | Direct | Indirect | |
| 1998 | 793,300 | 87,260 | 706,040 | 161,790 | 8.96 | 2.99 | 11.95 |
| 1999 | 793,900 | 87,330 | 706,570 | 163,947 | 8.85 | 2.96 | 11.81 |
| 2000 | 764,700 | 84,120 | 680,580 | 166,112 | 8.89 | 2.30 | 11.19 |
| 2001 | 759,900 | 83,590 | 676,310 | 172,385 | 8.05 | 2.69 | 10.74 |
| 2002 | 788,500 | 86,730 | 701,770 | 174,632 | 7.77 | 3.24 | 11.01 |
| 2003 | 798,900 | 87,880 | 711,020 | 181,581 | 7.57 | 3.44 | 11.01 |
| 2004 | 856,700 | 94,240 | 762,460 | 184,184 | 8.01 | 3.46 | 11.47 |
| 2005 | 875,800 | 96,340 | 779,460 | 184,784 | 8.14 | 3.45 | 11.59 |
| 2006 | 895,200 | 98,470 | 796,730 | 186,770 | 8.26 | 3.43 | 11.69 |
| 2007 | 931,400 | 102,450 | 828,950 | 183,987 | 8.62 | 3.72 | 12.34 |

Source: ABERSAL, 2008.
* 1 Salt used in preservation of food.
* 2 Source: IBGE (Brazilian Institute for Geography and Statistics).
* 3 Salt used domestically (direct) and ingested in industrialized food (indirect).

(8.1%) indicated that overall 12.4% of the geriatric population had laboratory evidence for diminished thyroid function. Taking together the echographic studies and the thyroid function tests, we may assume that a relatively large proportion of the elderly will develop hypothyroidism in the coming years (10). Single and multinodular goiters were present in 25.6% and 8.5% of this geriatric population, respectively. Hyperthyroidism (subclinical and clinical) was confirmed in 6.5% of the participants. This figure is considered high compared to other population studies (11).

In conclusion, the excessive nutritional iodine intake (from 1998 to 2004) may be considered an environmental factor conducive to a high prevalence of both Hashimoto's thyroiditis and iodine-induced hyperthyroidism, as recently received by Papanastasiou and cols. (10).

## THE FUTURE OF THE SALT IODINATION PROGRAM

The Ministry of Health recently created a multi-center Committee for the Prevention and Control of Iodine Deficiency Disorders. This Committee, comprising Members of the Ministry of Health, the Anvisa, Unicef, the salt industry, WHO and Universities (including the University of São Paulo, GMN), suggested that a national Survey of schoolchildren for urinary iodine excretion were conducted in 2008-2009. This survey was called PNAISAL (Pesquisa Nacional da Avaliação de Impacto da Iodação do Sal) and would constitute a broad and informative survey in children of each State, proportional to the respective population (based on the 2006 census). The total number of children to be visited and examined was estimated at 40,000 (later reduced to 20,000). Urine specimens were to be collected as well as salt samples from domestic sources. At the end of 2008, around 14,000 children had been surveyed and urine samples collected. Results are still pending but are certain to indicate the need for a change in the Salt Iodination Program. Table 3 depicts the data on consumption of salt for human use, in both domestic use (direct) and industrialized products (indirect). It is noteworthy that Brazilians are consuming an increasing amount of salt through this latter source in the past few years. In the last meeting of the Committee, it was proposed that the iodine concentration in salt for human use should be lowered to 20-40 mg/kg of salt. This was criticized by the salt industry representatives for the range between the upper and lower limits was deemed too narrow. As the analytical method for determining iodine in salt has an intra-assay constant variation, the Committee decided to study a proposal to allow salt samples containing 15 mg I/kg or up to 45 mg/kg to be considered acceptable, with salt producers not being subject to fines within these limits.

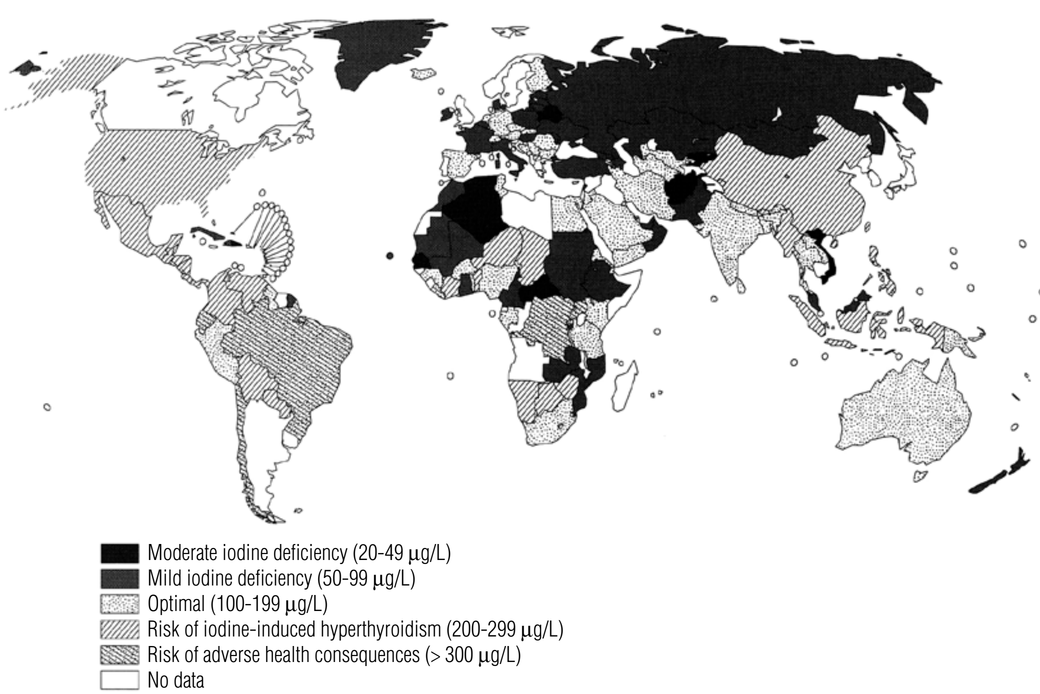


**Figure 1.** Worldwide degree of public health significance of iodine nutrition based on median urinary iodine (data from 2007). Note that Brazil is indicated as at risk of adverse health consequences due to excessive iodine intake. Source: De Benoist and cols. (12).

## CONCLUSIONS

The salt iodination programme has come a long way since the first flawed efforts in 1955. According to the latest WHO report, by De Benoist and cols. (12), the Americas have shown a marked improvement in iodine nutrition since 2003, with less than 10% of the whole population presenting urinary iodine excretion of less than 100 µg iodine/L (13). Nevertheless, Brazil is listed as a country in which iodine intake is more than adequate (or even excessive) with a median urinary iodine intake greater than 200 µg I/L (14), which indicates that susceptible groups within the population might be exposed to the risks of excessive nutritional iodine (Figure 1). It is envisaged that upon completion of the PNAISAL programme, we will have an excellent tool at our disposal to determine the concentration of iodine in salt for human use. Continuous monitoring and surveillance will be necessary to keep our children and the population as a whole on an adequate iodine supply through salt.

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## REFERENCES

1. Medeiros-Neto G. Cento e oitenta anos de bócio endêmico no Brasil. Arq Bras Endocrinol Metab 1982;26(4):120-8.
2. Medeiros-Neto GA, Knobel M. Iodine deficiency disorders. In: DeGroot LJ, Jameson JL, editors. Endocrinology. 6th Ed. New York, Elsevier; 2008.
3. Esteves RZ, Kasamatsu TS, Kunii IS, Furuzawa G, Vieira JGH, Maciel RMB. Desenvolvimento de método para a determinação da iodúria e sua aplicação na excreção urinária de iodo em escolares brasileiros. Arq Bras Endocrinol Metab. 2007;51(9):1977-84.
4. Rossi AC, Tomimori E, Camargo RY, Medeiros-Neto G. Searching for iodine deficiency disorders in schoolchildren from Brazil: the Thyromobil project. Thyroid. 2001;11(7):661-3.
5. Zimmermann MB. Iodine requirements and the risks and benefits of correcting iodine deficiency in populations. J Trace Elem Med Biol. 2008;22(2):81-92.
6. Camargo RYA, Tomimori EK, Neves SC, Knobel M, Medeiros-Neto G. Prevalence of chronic autoimmune thyroiditis in the urban area neighboring a petrochemical complex and a control area in São Paulo. Clinics. 2006;61(4):307-12.
7. Camargo RYA, Tomimori EK, Neves SC, Rubio IGS, Galrão AL, Knobel M, et al. Thyroid and environment: exposure to excessive nutritional iodine increases the prevalence of thyroid disorders in São Pauli, Brazil Eur J Endocrinol. 2008;159(3):292-9.
8. Duarte GC, Tomimori EK, Barcoli RA, Ferreira JE, Catarina RM, Camargo RYA, et al. Avaliação ultra-sonográfica de tireóide e iodúria em escolares de São Paulo. Arq Bras Endocrinol Metab. 2004;49:842-8.
9. Duarte GC, Tomimori EK, Camargo RYA, Rubio IGS, Wajngarten M, Rodrigues AG, et al. The prevalence of thyroid dysfunction in elderly cardiologic patients with mild excessive iodine intake in the urban area of São Paulo. Clinics. 2009;64(2):135-42.
10. Papanastasiou L, Vatalas IA, Koutras DA, Mastorakos G. Thyroid autoimmunity in the current iodine environment. Thyroid. 2007;7:729-39.
11. Canaris GJ, Manovitz NR, Mayor G, Ridgway EC. The Colorado thyroid disease prevalence study. Arch Int Med. 2000;160(4):526-34.
12. De Benoist B, McLean E, Andersson M, Rogers L. Iodine deficiency in 2007: global progress since 2003. Food Nutr Bull. 2008;29(3):195-202.
13. Pontes AAN, Rocha AM, Late DFB, Lessa AF, Adan LF. Iodação do sal no Brasil, um assunto controverso. Arq Bras Endocrinol Metab. 2009:53(1):113-4.
14. Camargo RA, Tomimori E. Risk of iodine excess in Brazil. IDD Newsletter. 2009;13(3):31-7.