Iodine nutrition in Italy – past, present, and future

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Italy has been dealing with iodine deficiency since ancient times. Incredibly, goiter and cretinism were first reported in Northern Italy in the first century AD. The relationship between endemic goiter and cretinism was recognized only in 1848, by a special committee appointed to investigate their widespread prevalence in Piedmont, Liguria and Sardinia. With the identification in the early 20th century of iodine deficiency as the cause of endemic goiter, many epidemiological studies showed that iodine deficiency was common in both mountainous and coastal areas. Short-term prevention programs were implemented mainly at a local level in the 1970s–1990s.

Iodine nutrition before the nationwide program

A review of studies carried out between 1978 and 1991 collated data from a total of 71,112 school-age children (aged 6–14 years) mostly from extraurban, hilly or mountainous districts which were known or suspected to be endemic at the time of the survey. Low or very low mean UIC values were found across the country (50-75 μg/g creatinine or lower compared with 85–175 μg/g creatinine in control areas), and were accompanied by a generally high prevalence of goiter (14–73% compared with 2.2–15% in control areas). Goiter was more prevalent in Central and Southern districts than in the mountainous North, possibly due to scarce local consumption of fish and seafood in the coastal urban areas and high rates of migration from the neighboring rural areas. Surveys since the late 1980s have shown a lower prevalence of goiter and higher UIC values, which could be explained by "silent prophylaxis": iodine intakes improving thanks to diet diversification due to improved distribution of foods, inclusion of seafoods and iodine-enriched dairy products.

In 1972, iodization of salt at 15 mg/kg was permitted by law, so that it could be readily available for distribution to affected areas upon request. Five years later the distribution of iodized salt was extended to the whole country, but because the sale of iodized salt was not mandatory, only a very small fraction of Italians adopted it. In 2005 the iodine deficiency prevention program became nationwide, but iodization of salt continues on a voluntary basis.

Mental defects and cretinism continued to be reported in some of the moderate-to-severe deficiency areas. Squatrito et al. (1) identified 19 subjects with mental retardation in an endemic area of North-East Sicily characterized by a mean urinary iodine excretion (UIE) <43 μg/day and a prevalence of goiter in schoolchildren of 42–68%. Less serious neuropsychological impairments were detected in schoolchildren living in moderately iodine deficient areas of Tuscany and Sicily, including defective visual perceptual integrative motor ability and poorer vocabulary scores (2,3).

Iodine deficiency was also confirmed by the presence of congenital hypothyroidism (CH). In the 1990s a nationwide screening program documented an incidence of CH of about 1:3000 babies, which was comparable to that observed in Europe, but higher than in iodine sufficient countries at the time (4,5).

Epidemiological surveys carried out in 1992–2004 continued to show a progressive increase in population UIC. The lowest values were in the Central-Southern regions (median UIC of 72 μg/L vs. 90 μg/L in the Northern regions), and almost 5 million Italians (12% of the population) were still affected by goiter in that period. However, in some areas that remained iodine deficient, the prevalence of thyroid disease had increased. A survey in 1994 in Pescopagano (6), a village in the South of Italy found that

thyroid nodularity progressed from 0.5% in children to 28.5% in the 56–65 yr age group. In subjects older than 15-years the prevalence of diffuse and nodular goiter was 41.8% and 17%, respectively. The occurrence of thyroid functional autonomy increased from 0.7% in children up to 15.4% in older subjects. Hyperthyroidism was twice as high as that reported in iodine-sufficient areas and was mainly due to an increased frequency of toxic nodular goiter. An IDD prevention program implemented in Pescopagano following this survey led to a significant improvement of iodine nutrition: in 2010, median UIC reached 98 µg/L and was associated with a decreased prevalence of goiter and thyroid autonomy.

Small-scale projects provide iodine to local populations

A successful voluntary salt iodization program was introduced in the Autonomous Province of Bolzano (Alto Adige) in 1981 (7). A 1982 survey in 3'109 local schoolchildren found a prevalence of goiter grades 1B–3 of 23.6% and a mean UIC of 10.2 µg/L. Thanks to an extensive mass-media campaign, more than 50% of the Bolzano population adopted iodized salt. In a follow-up study in 1990, goiter prevalence was 1.6% and a mean UIC was 137 µg/L (optimal iodine nutrition). Smaller-scale but equally successful local iodization programs were introduced in the Tuscan Apennines and Emilia Romagna. In both cases, goiter prevalence was significantly reduced while the UIC increased as a result of the program.

Introduction of iodine into a public water supply was tested in 1979 in Troina, a small town in the North-East Sicily with a single-source water supply (9). Four years later, the prevalence of goiter in children had dropped from 51% to 6%, and the mean UIE had increased from 41 to 86 µg. Iodinated water was well-tolerated and caused no adverse effects. However, this method can be applied only in specific circumstances, in areas with a single water supply.

Going national with iodized salt

A nationwide salt iodization program was implemented in 2005 with the approval of the law no.55/2005. The law requires that salt is added to coarse and table salt at 30 (24–42) mg/kg as potassium iodate. Yet, while food shops and supermarkets are required to stock iodized salt, non-iodized salt is not prohibited and can be stocked on customers' request. The law also permits the use of iodized salt in the food and catering industries.

In 2009 a nationwide monitoring program of universal salt iodization was implemented, and the Italian National Observatory for Monitoring Iodine Prophylaxis (OSNAMI) was established at the Italian National Institute of Health to evaluate the effectiveness of the program.

Iodine content in salt and the sale of iodized salt

Iodine content in salt available on the market is tested by regional health authorities, and non-compliant results are verified by the National Institute of Health. Salt samples are taken both at the production sites and at the points-of-sale, and data indicate that <5% of all samples are non-compliant. Following the approval of the IDD prevention law in 2005, iodized salt sales have improved, from 34% in 2006 to 55% in 2012 *(Figure 1)*. An increase has also been observed in the use of iodized salt in communal eateries, from 14% in 2006 to 23% in 2012. This increment is particularly relevant because in Italy communal eating, including school canteens, accounts for about 2 billion meals per year. Despite this trend, a substantial proportion of the salt is sold un-iodized, most likely because consumers are unaware of the health benefits of using iodized salt, and also because of the higher price (+20% on average) of iodized salt due to higher production costs.

The percentage of iodized salt in the food industry is still low (at 5.5% in 2012) (8), suggesting that that household iodized salt is still a major contributor to iodine intake in Italy. However, if the trends in other industrialized countries are to be believed, and processed food becomes the primary contributor of dietary salt, it will be critical for the food industry to use iodized salt to successfully maintain optimal iodine intakes.

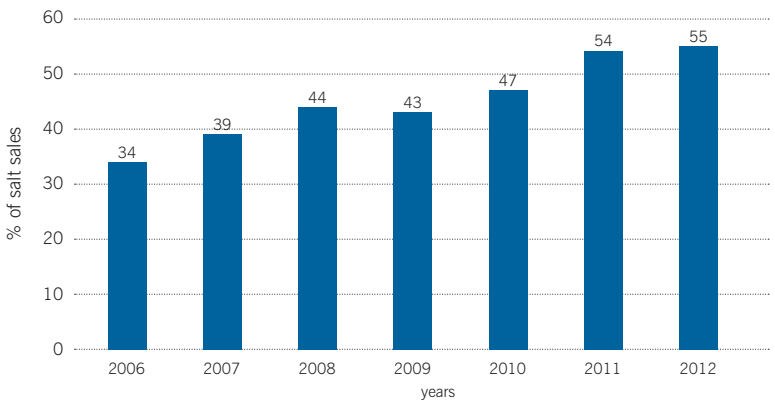
TABLE 1 Median urinary iodine concentration (UIC) and prevalence of goiter in schoolchildren recruited in 12 out of 20 Italian regions between 2007 and 2012.

Italian regions	School-children (n)	Median UIC µg/L	% of goiter assessed by ultrasonography
Piedmont	1228	98	–
Lombardy	1393	84	–
Veneto	1375	81	–
Liguria	1238	145	6.8
Marche	1000	–	6.0
Tuscany	150	119	6.0
Molise	142	48	–
Puglia	599	93	6.0
Calabria	729	87	7.5
Sicily	601	160	9.0

TABLE 2 Median urinary iodine concentration (UIC) in pregnant women recruited in 5 out of 20 Italian regions between 2007 and 2012.

Italian regions	Pregnant women (n)	Median UIC µg/L
Veneto	300	82
Tuscany	397	62
Sardinia	177	95
Lazio	150	85
Sicily	1432	62

FIGURE 1 The sale of iodized salt as a proportion (%) of all salt sales has been increasing since the adoption of the IDD prevention law in 2005.



In 2017, mild to moderate iodine deficiency still threatens the health of children in some Italian regions.

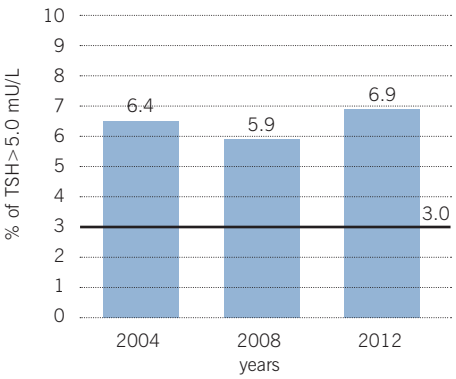
UIC and the prevalence of goiter in schoolchildren

Despite the improvement in iodine status, in the first years of the 21st century, Italy is still thought to have mild-to-moderate iodine deficiency. Between 2007 and 2012, 7,455 schoolchildren residing in 9 Italian regions were recruited to take part in UIC surveys conducted in collaboration with the Regional Observatories for Goiter Prevention. In 6 out of the 9 regions, the median UIC ranged between 48 and 98 μg/L, indicating mild to moderate iodine deficiency. In the remaining three regions (Liguria, Tuscany, Sicily) the medians (ranging from 119 to 160 μg/L) indicated an adequate iodine intake *(Table 1)*. A survey to verify the sustainability of iodine sufficiency in these regions is currently underway. During the same period, goiter rates in schoolchildren in 6 regions ranged from 6 to 9%, which reflects the beneficial effect of iodine prophylaxis *(Table 1)*. Although, overall, these findings are evidence that iodine nutrition has improved significantly, some regions in Italy remain at risk of deficiency.

Pregnant women may be iodine deficient

In 2007–2012, urinary iodine concentration was measured in 2,456 healthy pregnant women in their first trimester recruited in 5 regions: Veneto, Tuscany, Sardinia, Lazio, and Sicily. None of the women were using iodine-containing supplements at the time of recruitment. The median UICs ranged from 62 to 95 μg/L, all below the WHO/UNICEF/IGN range indicating iodine sufficiency (150–249 μg/L) *(Table 2)*. These findings suggest that there may be a need to recommend iodine-containing supplements for pregnant mothers in some regions to avoid impaired cognitive outcomes in babies.

FIGURE 2 Prevalence of TSH>5.0 mU/L in newborns. A prevalence of >3% suggests iodine deficiency. Data collected in three regions (Lombardy, Marche, and Calabria).



Thyroid stimulating hormone (TSH) in neonates is a valuable indicator for iodine deficiency, as it is particularly sensitive to changes in iodine nutrition. A program of neonatal TSH screening has been in place since the 1970s. Screening is performed at 25 regional and inter-regional dedicated health centers. Data collected between 2004 and 2012 in three regions—Lombardy, Marche, Calabria, representative of Northern, Central, and Southern Italy—were used to monitor changes in the iodine status of newborns. About 1 million newborns were screened during this period. The results show that the prevalence of TSH >5.0 mU/L was higher than 3.0% throughout the observation period, ranging from 5.9% to 6.9%, which confirms that pregnant mothers may, indeed, be iodine deficient *(Figure 2)*. However, following successful correction of iodine deficiency, the time needed to observe a decrease in the incidence of CH is about a decade. New analyses are ongoing to estimate the trend in CH incidence in Italy following the introduction of nationwide iodine prophylaxis.

Conclusion

Iodine repletion in quantities used in the iodization of salt and in supplements has few adverse effects. Although iodized salt is produced in sufficient quantities, and its quality is generally satisfactory, further efforts should be made to better inform the population about the importance of using iodized salt and to support and encourage the food industry to use iodized salt in their products.

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