IDD NEWSLETTER

VOLUME 44 **NUMBER 3 AUGUST 2016**

IN THIS ISSUE

IODINE GLOBAL NETWORK (formerly ICCIDD Global Network) is a nongovernmental organization dedicated to sustained optimal iodine nutrition and the elimination of iodine deficiency throughout the world.

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Background

The Republic of Haiti is located on the second largest island, after Cuba, of the Great Antilles archipelago and, with 10.7 million inhabitants, is the second most populous country in the Caribbean. Haiti's geography is marked by large contrasts between elevations, with fertile valleys interspersed between tall mountain ranges. The presence of iodine deficiency in Haiti was first confirmed in the 1990s. A national iodine deficiency survey, which followed in 2004–2005, reported a median urinary iodine concentration of 84 µg/L (optimal range: 100–299 µg/L), putting Haiti on the list of priority countries for IDD control *(see IDD Newsletter 4/2012)*. Several smaller studies over the course of the past two decades have verified that the problem of iodine deficiency in Haiti is widespread, also noting considerable geographical variation in iodine status partly attributable to the differences in elevation.

IDD prevention through salt iodization

Haiti's economy has been rocked by numerous natural disasters, some in recent past. Most notably, the 2010 earthquake undermined agricultural production, infrastructure, and the public health system and prompted a national recovery plan supported by the international community. In this challenging context, efforts to improve iodine nutrition through salt iodization have been slow. An important constraint has been the structure of the local salt industry, with many small-scale artisanal salt farmers producing low-quality raw salt. Steps taken to improve the salt industry, establish national mandatory legislation, and stoke consumer demand have had only limited impact on household coverage of iodized salt: only 18% in 2012, almost twice as high in urban as in rural areas (26.1% vs 12.6%) and almost three times higher in the wealthiest than in the poorest households (29.9% vs 11.0% in the top vs bottom wealth quintile) *(1)*.

Yet, there has been important progress in nutrition programs. A new national nutrition policy was adopted in January 2011, and draft legislation for food fortification, which includes iodized salt, is in the final stages of approval. Once adopted, it will provide a legal and regulatory framework for more robust monitoring of iodized salt imports and production. A critical consideration will be how to leverage the legislation to ensure that all salt used in the production of processed foods and condiments is iodized in accordance with national standards.

New data suggests that Haitian pre-school children may have adequate iodine intakes, but a national survey is needed to confirm this finding.

An inter-agency meeting on 26–29 July, with (L-R) Roland Kupka (UNICEF), Jonathan Gorstein (IGN), Elizabeth Pearce (IGN), Joseline Marhone (MSPP Haiti), Leslie Koo (USAID), Omar Dary (USAID)

Partnership with the University of Notre Dame

Collaborative efforts between the University of Notre Dame's Haiti Program (UNDHP) and the Ministry of Public Health and Population (Ministère de la Santé Publique et de la Population–MSPP), have led to the production of fortified salt (single and double fortified; the latter includes a drug against lymphatic filariasis), which began in 2006 at the MSPP facility in Cite Militaire, using imported bagged solar salt. Following gradual expansion, production of washed salt began in January 2015 with the addition of a facility at Delmas, which installed a brine-washing system to use Haitian salt as a raw material. The current capacity of the two facilities is a nominal 3,600–4,800 MT per year, about half of which is iodized salt for retail and the other half is produced for non-edible industrial applications. Plans are underway to double the operating capacity in the first half of 2017, which would meet 24–32% of the estimated national demand. If iodized at 40 mg I/kg as prescribed by the law, the salt would contribute 100–200 µg iodine/day (assuming consumption of 2.5 to 5.0 g/day of salt from this source). The construction of a second salt processing facility with a similar capacity is being considered in the north of the country near the sea-salt harvesting region, and training on how to improve the quality and yield of sea-salt harvesting is scheduled to take place in September.

Iodine status is improving

Despite the slow progress in scaling up salt iodization, a recent small-scale survey suggests that iodine status may be improving. Conducted by Boston University and Boston Children's Hospital in 2015 (March–June), a cross-sectional study of 299 Haitian pre-school children aged 9 months to 6 years across three different geographical regions has reported an overall median UIC of 128 µg/L, with regional variation: highest in the urban site (187 µg/L) and coastal region (145 µg/L), and lowest in the mountains (89 µg/L) *(3)*. Although these findings are not statistically representative of the country as a whole and should not be generalized to the entire population, they do suggest that the iodine intake may be optimal in some areas.

Some of the most popular bouillon brands available in Haiti include Don Poyo, El Criollito, and Nina, and they contain various amounts of iodine as iodized salt.

Iodized salt in processed foods

In spite of the current low household coverage of adequately iodized salt, there may be other sources of iodine in the diet, albeit which still rely on iodized salt. The use of bouillon cubes, a staple condiment in Haiti used in the preparation of principal meals, has increased in recent years. Bouillon does contain salt as a major ingredient, and if the salt used in its manufacture is adequately iodized, it may be an additional source of iodine to the diet. Sufficient iodine in the diet has been observed in other countries where the coverage of iodized salt in households is low, but where iodized salt is present in widely consumed processed foods, such as instant noodles or bread, as well as condiments, including bouillon and tomato ketchup. A 2005 assessment conducted by the World Food Program and the Micronutrient Initiative indicated that per capita consumption of bouillon cubes in Haiti was, on average, around 2.25 g/day, equaling approximately 1.2 g/day of salt *(4)*. Given this level of intake, bouillon could be a major source of iodine, although it is important to manage communications and not to promote increased consumption of this product as the sodium intake is already feared as high. Preliminary analyses of two out of several common bouillon brands on the Haitian market indicate that the El Criollito brand (manufactured in the Dominican Republic) contains 153 μg iodine/cube, while the local Nina brand contains <10 μg iodine/cube. While it is believed that other brands may contain similar or higher quantities, they are yet to be tested.

Joint visit to review the IDD program in Haiti

A joint mission was undertaken by USAID, UNICEF, and the Iodine Global Network to review the current universal salt iodization (USI) program in Haiti. Over four days (26–29 July), an inter-agency team, working under the leadership and guidance of Dr. Joseline Pierre Marhone, Director of Nutrition in the MSPP, held a series of discussions and meetings with key stakeholders (including government staff, development partners, as well as salt processing and trade industry representatives). The following are some of the key recommendations arising from the meeting:

1. Ratify and publish the national legislation on staple foods fortification (salt, flour, and cooking oil), and enable and strengthen enforcement.
2. Conduct a national survey of iodine status (including measurement of urinary sodium and determination of major dietary sources of sodium). The survey should help to provide additional evidence on the iodine status of women of reproductive age and the consumption patterns of salt and of iodine. The sodium content of the Haitian diet has historically been difficult to measure but is generally considered to be high, and the country has a high rate of morbidity and mortality linked to hypertension *(5)*. To achieve and sustain optimal iodine nutrition among all population groups, iodine should be added to all salt available for human consumption (including all salt used in bread baking, as well as in the production of condiments and processed foods), and the iodine levels should be adjusted if salt intakes fall.
3. Measure the iodine content in branded bouillon cubes and in discretionary salt to estimate their contribution to the iodine intake in Haiti.
4. Undertake a comprehensive study to review the salt situation and generate reliable data. The goal of this study will be to characterize the overall salt supply, including salt trade (import vs domestic production), building on existing reviews.
5. Schedule a national meeting following the iodine nutrition survey to validate survey results and refine a national action plan to optimize population iodine status based on outcomes of steps 2–4.
6. Explore the feasibility of using the iodized salt produced by the UNDHP/MoH to meet the national needs of the baking industry and food services (i.e. mostly school feeding programs).
7. Provide political support to UNDHP/MoH in its search for additional funds to consolidate the salt processing program in Haiti, not only to increase the availability of discretionary iodized salt but also as a source of income for the Haitian salt producers.

As the program continues to develop and there is a greater focus on the use of adequately iodized salt by the processed food industry, with particular attention on bouillon and bread, it will be imperative to strengthen regulatory monitoring activities. These can be significantly enhanced by the reduced number of actors, but they are important to have in place to ensure compliance and sufficient enforcement of the legislation. This will require a review of existing regulatory monitoring guidelines and protocols, as well as the capacity in place for their effective implementation. Where gaps are identified, efforts should be taken to build and further strengthen these systems.

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Putting East Asia back on track towards sustainable USI

Karen Codling IGN Regional Coordinator for South-East Asia and Pacific and **Christiane Rudert** Regional Nutrition Adviser for UNICEF East Asia and Pacific

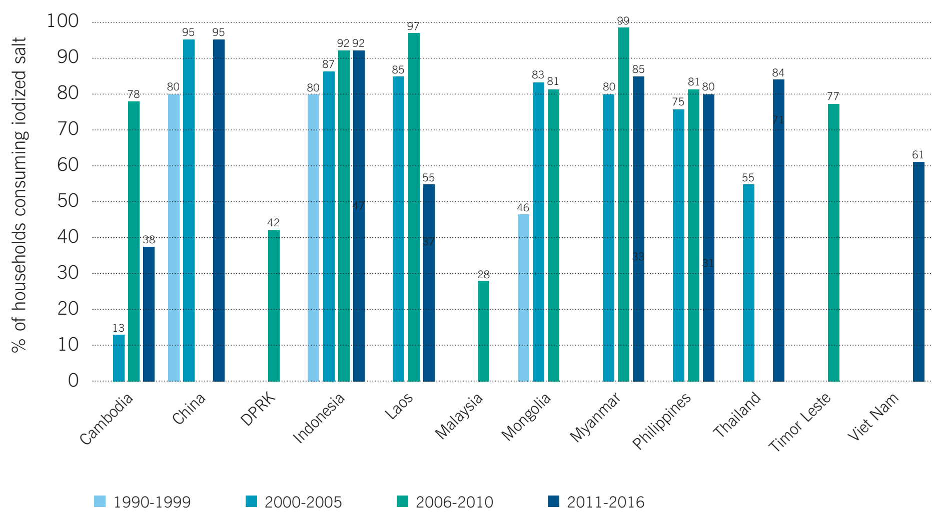
A meeting of eleven countries of the East Asia region in October 2015 recognized that backsliding in household coverage of adequately iodized salt has occurred in the region. Actions that should be implemented to improve the sustainability of iodization programs in East Asia have been identified in the meeting report: *http://www.ign.org/cm_data/unicef_USI_250416web_1.pdf*

In the mid-1990s, there were in excess of 2.2 billion people in 130 countries at risk of iodine deficiency. In 2015, only 26 countries, home to 665 million people, were classified as iodine deficient. This significant reduction in iodine deficiency has been achieved primarily through universal salt iodization (USI). The East Asia region has been at the forefront of these achievements; for many years it has boasted the highest household coverage of adequately iodized salt (91% in 2014) alongside Latin America, which compares favourably against South Asia (71%), Southern Africa (61%), and West and Central Africa (53%). Even so, the proportion of households that use iodized salt has fallen in recent years, particularly in Cambodia, Lao PDR, and Myanmar. In some countries (i.e., China, Indonesia, Mongolia, and the Philippines) this proportion has stagnated, although the coverage remains high *(Figure 1)*.

Sub-optimal iodization levels are a cause for concern despite adequate iodine status

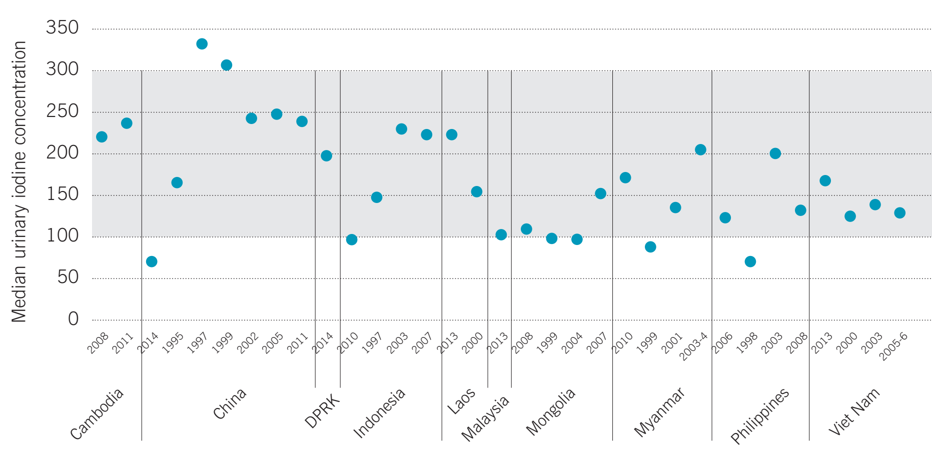
Despite clear progress in achieving optimal iodine status thanks to high coverage of iodized salt, several countries have recently reported a decline in urinary iodine concentration (UIC) among school-age children (SAC) that is not due to intentional adjustments of the iodine levels in salt (as has been done e.g., in China). In Cambodia, urinary iodine levels have fallen precipitously, in line with falls in coverage, such that pre-school children are now deficient. In DPRK, where iodized salt reaches only 42% of households, a 2010 survey indicated that children were borderline deficient *(Figure 2)*.

FIGURE 1 Household coverage with iodized salt in East Asian countries*



* Data from nationally-representative surveys. Iodine content measured by either quantitative or qualitative methods.

FIGURE 2 Median urinary iodine of school-age children in East Asian countries

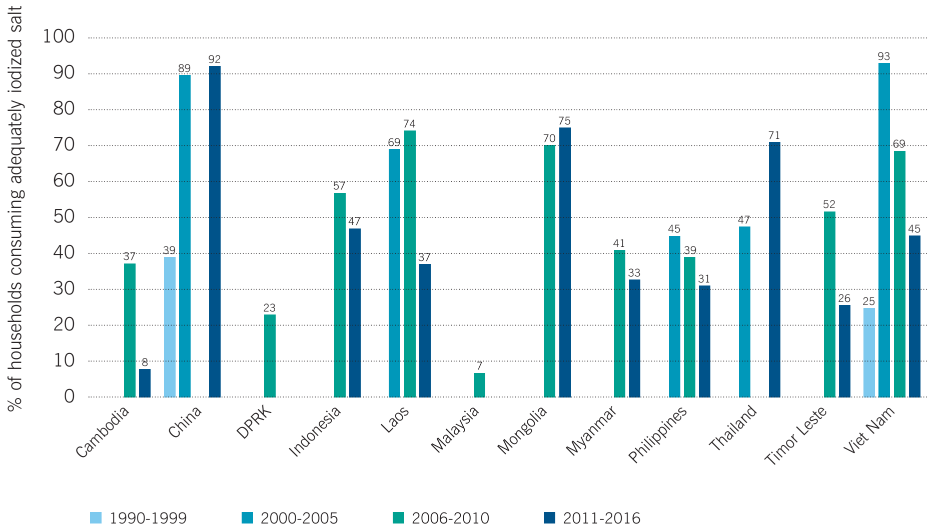


Shaded area indicates range of optimal urinary iodine in school age children. Ref: Zimmerman et al. J Clin Endocrin Metab 2013

Also of concern is the fact that the iodine status among pregnant women (in some provinces of China, Thailand, and the Philippines), and women of reproductive age (Cambodia and Vietnam) appears to be sub-optimal, even when it is adequate in children.

While the majority of salt in the region is iodized, it is of concern that significant proportions do not contain levels of iodine that meet national standards. This likely results from a combination of poor iodization and quality assurance procedures in salt processing facilities, and inadequate external regulatory monitoring and enforcement by authorities at the factory level and at points of importation. As a result, the proportion of households consuming adequately iodized salt is significantly lower than the proportion consuming salt with any iodine *(Figure 3)*. Moreover, the situation appears to be worsening in many countries. Access to adequately iodized salt is lower in 2011–2016 than it was in 2006–2010 in Cambodia, Indonesia, Lao PDR, Myanmar, the Philippines, Timor Leste, and Vietnam.

FIGURE 3 **Household coverage with adequately* iodized salt across East Asia**



*Adequately iodized salt is salt that has iodine content meeting or more than national standards, i.e. it includes over-iodized salt. All data from national surveys such as DHS, MICS, Living Standards, National Nutrition or IDD Surveys assessing iodine in salt by a quantitative method e.g.. titration, WYD or iReader, with the exception of Mongolia where RTK was used. Cambodia 2011-2016 data based on market rather than household survey.

Why has coverage with adequately iodized salt declined in East Asia?

A key reason for the deterioration of USI appears to be a decline in political commitment. Although political prioritization of nutrition has improved globally and within the region, IDD elimination appears to have been "crowded out" by other nutrition priorities such as stunting and emergency nutrition. Additionally, many governments feel that "the job is done" as urinary iodine levels indicate optimal iodine status at a national level. The problem is that IDD quickly returns if salt iodization is not sustained and, in most countries, the waning of political commitment had occurred before sustainable USI programs were fully established. National-level data may also sometimes mask variation in iodine status at the sub-national level. Another crucial consideration is that many countries have not assessed the iodine status of pregnant women, an important target group of iodine interventions. Finally, for some countries, achieving universal salt iodization may be harder than initially anticipated. Although, in principle, salt iodization is a simple intervention, to put it into practice successfully requires multisectoral knowledge, partnership, and commitment.

Adverse consequences of waning political commitment

The decline in political commitment throughout East Asia has meant that the functioning of national coordination and oversight structures for USI has deteriorated. They no longer have sufficient data to understand program weaknesses to develop corrective actions, or sufficient political clout or the necessary capacity to bring about changes. As a result, few national programs have adequate strategic direction and coordination of implementation. In the Philippines, a good coordination structure exists in the form of the Technical Working Group (TWG) for IDD Control, but a lack of political support at the highest level has limited what the group can achieve. The decline in commitment has also resulted in insufficient regulatory monitoring and enforcement of legislation, which are probably the two weakest components of food fortification programs in most countries.

It is widely recognized that a necessary, although by itself insufficient, key step toward sustainable fortification, is the adoption of mandatory legislation. All except three countries in East Asia have national legislation which makes salt iodization mandatory (in DPRK, Malaysia, and Timor discussions to implement such legislation are ongoing). Vietnam re-established its mandatory law in January 2016, after it had become clear that downgrading it to voluntary had led to a considerable decline in iodized salt coverage and urinary iodine levels. But even mandatory legislation may be problematic to enforce if there are loopholes, or if the law is overly complicated or open to interpretation (e.g., in Indonesia and Myanmar). Across the region, the context of weak political commitment, inadequate strategic direction, and poorly resourced regulatory monitoring systems have exacerbated difficulties in implementing poorly designed salt iodization legislation.

The sustainability of programs has also been affected by the supply systems for potassium iodate (KIO_3). Several programs were started on the basis of a free supply of KIO_3 provided by external donors (in Cambodia, DPRK, Mongolia, Myanmar, Timor Leste, and Vietnam) or government (China). In Cambodia and Myanmar, the free supply has since ended, and the industry has not fully taken over the purchase of KIO_3, with a subsequent decline in the quality of iodization. In Vietnam, the free supply of KIO_3 was stopped when the program became voluntary, contributing to a decline in iodized salt production. Inadequate transition strategies, perception within both industry and government that KIO_3 needs to be provided free of charge, price increases of KIO_3 following the Fukushima incident in 2011, and weak regulatory monitoring and enforcement systems have led to poor industry uptake of the responsibility for KIO_3. While free provision of KIO_3 facilitates programs in the start-up phase, in reality this strategy has adversely affected sustainability.

Another challenge to sustainably is that, in most countries of the region (including China, Cambodia, DPRK, Indonesia, Laos, Mongolia, Myanmar, the Philippines, Thailand, and Vietnam), iodization was first established as a vertical, stand-alone program, not integrated into food fortification or general nutrition efforts, nor into existing national systems and budgets. This has particularly affected coordination, regulatory monitoring, and the monitoring and evaluation components, exacerbated in the context of reduced political commitment. In Indonesia plans are underway to establish one coordinating committee for food fortification, including salt iodization, under the Scaling Up Nutrition (SUN) Framework.

How can East Asia get back on track towards USI?

1. Political commitment

In most countries, the first step must be re-advocacy for action and resources to ensure optimal iodine nutrition, positioned as one objective of national nutrition efforts. In countries such as Indonesia, Laos, Malaysia, Mongolia, Myanmar, the Philippines and Vietnam, advocates will need to reinforce the message that the risk of iodine deficiency is still present even if school-age children have currently adequate iodine intake. Advocacy will be needed to assess and monitor the iodine status of reproductive age or pregnant women. Without sufficient political commitment to optimal iodine nutrition, it is unlikely that the other goals listed below can be achieved.

2. Mandatory legislation

Mandatory iodization is generally a pre-requisite of sustainable national USI programs. There are few examples where countries have achieved high coverage of adequately iodized salt without it. Countries in which all salt is imported or supplied by a small number of large producers may be an exception. A number of lessons are emerging from the global experience of salt iodization legislation:

- Salt iodization requirements should be established under the Food Act or within food regulations rather than as stand-alone legislation
- Iodization standards should be specified within food regulations or separate directives, not within higher-level legislation

A workshop attended by 11 countries in the East Asia region in October 2015 recognized that backsliding in USI has occurred and proposed remedial actions.

- The scope of the legislation should include domestically produced and imported salt for consumption, including salt for food processing and condiments
- The legislation should require the iodization of all salt or ban non-iodized salt for consumption rather than set conditions for iodization of salt.

All countries would benefit from reviewing their iodization standards to align them with WHO recommendations and take into account the estimated salt consumption, including from processed foods and condiments.

Adjusting salt iodization levels will only enable the fine-tuning of urinary iodine levels when the majority of salt is adequately iodized. For example, the Philippines increased iodization levels in 2013 in an effort to improve iodine status. As household coverage with adequately iodized salt is only about 25%, this change ended up providing excess iodine to the minority of the population who consume adequately iodized salt, while a large proportion of the population continue to have inadequate iodine intakes.

3. Appropriate coordination structures

Successful USI requires the collaboration of multiple sectors including ministries of health, industry, trade and customs, food administration, the salt industry, the food processing industry, and academia. It also requires implementation at several levels and on several fronts. Programs, therefore, need multi-sectoral coordination, at least in the initial phase, when systems and norms need to be established. Coordination structures require strong leadership with authority over multiple sectors, representation from all relevant sectors, and a strategic plan or national strategy based on a thorough understanding of the national landscape and emerging challenges. Further, such structures should be integrated into national food fortification coordination structures, which themselves should be integrated into national nutrition coordination structures. Such integration allows, for example, cross-cutting issues for all fortification programs to be addressed, such as a common regulatory monitoring system for all fortified foods. Another example is the integration of iodine indicators into national monitoring and evaluation systems, such as nutrition surveys.

4. Integration of salt iodization with salt reduction programs

The two are entirely compatible; salt iodization does not encourage or lead to higher salt intakes, and as salt intake is reduced, iodine levels can be increased to continue adequate iodine intakes. Iodization levels should be based on salt intake amounts; communication messages of the two programs should be aligned, and monitoring systems for compliance and assessment of impact should be merged. As iodine and sodium are both assessed through urine, accurate data on sodium intake, the key indicator of salt reduction programs, can be used by salt iodization programs to set iodization levels. The key for all stakeholders is to ensure that the population consumes enough iodine, while sodium intake is limited to less than 2 g/day (5 g of salt/day).

5. Strategic plan or national strategy

Globally, it has been recognized that the previously popular "wide consumer-oriented mass-media campaigns to raise consumer awareness and demand to 'pull' producers towards quality iodization" have not worked. It is more appropriate to engage with the stakeholders in the supply chain—a process which must be based on a proper understanding of the salt industry and national supply and demand, including the size, capacity, and market share of salt facilities, what proportions of salt are used for food processing, and which foods use the majority of salt. In Indonesia, the national strategy includes different approaches for salt producing and salt importing provinces and has evolved with an improved under-standing of what proportions of salt are processed by large-, medium- and small-scale facilities and their capacities and constraints in adequate iodization. Information has also recently been collected on the use of salt by food processors, including whether that salt is iodized.

6. Building salt iodization into existing systems

It is important to understand which government ministries provide support and oversight to salt and food processing industries, how regulatory monitoring for iodized salt and ensuring use of iodized salt in processed foods can be incorporated into routine food control systems, who is responsible for monitoring salt factories at different levels of the government, and what opportunities exist for assessing iodine status. Further questions include how iodization can be incorporated into national policies and plans related to the domestic salt industry, and how salt iodization is best implemented in a decentralized context, as is the case in many countries in the region.

7. Enabling environment

The chief actors in salt iodization are the salt processors, as distinct from the producers of raw salt, as it is during processing that the iodization occurs. While iodization is technically easy, it is an additional step in the processing, and there are cost implications. An enabling environment is needed, in which salt processors can and do iodize their salt. Past strategies of providing inputs, such as KIO_3 and mixing machines, to enable salt processors to iodize, have proven unsustainable. Even when such inputs are provided, salt processors will avoid iodization if they can get away with it. Rather, incentives are needed in the form of legislation and effective regulatory monitoring to ensure compliance and enforcement. While this appears as a punitive approach, in reality it creates a "safe environment" and a level playing field in which to iodize, as compliant processors can be confident that all their competitors are also iodizing and incurring the same costs. As monitoring and enforcement systems are institutionalized, iodization becomes the norm for both industry and consumer, and the regulatory monitoring and enforcement becomes a routine component of food control systems. Within such an environment, support to industry is only needed in genuine areas of low capacity, such as the smallest of processors.

8. Small-scale salt processors

Much attention and resources have been devoted to supporting small processors to produce quality iodized salt. Lessons learnt, however, are that the proportion of total salt supply from the small-scale processors is often minor relative to that produced by large and medium processors, even when small processors are numerous. As nations develop, industry consolidation is further reducing their numbers and market share. Meanwhile, the costs of efforts to build their capacity and monitor their compliance are prohibitive and inefficient compared to the amount of salt produced. More effective programs should focus on ensuring adequate iodization of salt produced by large and medium producers, including salt used in food processing.

> **"Salt iodization is the optimal way to address the hidden problem of iodine deficiency. But backsliding has occurred in the region because initial achievements were made in an unsustainable way."**

9. Regulatory monitoring systems

Effective regulatory monitoring, encompassing internal (by salt processors in salt processing facilities), and external (by government authorities in salt processing facilities and points of import) monitoring, are the key limiting factors in the majority of national programs. Constraints include political commitment, inadequate legislation, and inadequate routine resources. The problem has been exacerbated by the fact that programs have often tried to monitor and enforce salt iodization through vertical systems, which lack authority and resources. The primary necessary action is to integrate salt regulatory monitoring into routine food control systems in order to tap into its routine resources and authority for enforcement. Unfortunately, food control systems are often weak, lacking human, financial, and laboratory resources. Salt iodization monitoring, therefore, needs to add as little burden as possible to the food control system and to focus on the most effective and cost-effective monitoring actions, such as unannounced factory visits, auditing of factory records, and physical inspection. While collection and testing of salt samples has a role in regulatory monitoring, it should not be the primary focus of regulatory monitoring activities. Likewise, it is important to recognize that the role of external regulatory monitoring is to verify that the salt processing facility is operating an adequate internal monitoring system, not to verify that salt is adequately iodized on the day of inspection.

10. Surveillance and monitoring systems

Improved surveillance and monitoring are needed for assessing coverage and impact, identifying unreached populations, and generating data for fine-tuning of programs. Household surveys remain the optimal way to assess the proportion of the population consuming adequately iodized salt and iodine status, but such surveys can be improved by using only quantitative methodologies, such as titration, iCheck Iodine or WYD machines to measure iodine content of salt; collecting qualitative information about the source and type of salt; assessing iodine status of pregnant or reproductive-age women; and presenting median urinary iodine levels for different sub-populations and by iodine levels in salt. The consumption of processed foods that contribute significantly to salt intake and the use of iodized salt in their production should be monitored as well. Survey data should also be triangulated with industry and external monitoring data.

Building better programs – the next steps for East Asia

Backsliding of salt iodization has occurred in the region because initial achievements were made in an unsustainable way. Most countries have proven that reaching high coverage of adequately iodized salt is possible. They now need to rebuild these achievements, but this time, salt iodization needs to be based on strong legislation, integrated into existing systems, and funded by domestic resources and not external funding. Salt iodization is the optimal way to address iodine deficiency; the long term objective is that the problem of iodine deficiency is eliminated by the unseen, but ever present intervention of salt iodization.

An extensive bibliography for this article is available at http://www.ign.org/idd-newsletter-dashboard.htm

Iodine production and industrial applications

Katja Hora World Iodine Association (WIA)

Leading manufacturers, formulators, and distributors of iodine recently established the World Iodine Association (WIA), whose role is to promote the use of iodine and provide relevant and accurate information about its applications and benefits. The WIA members involved in the production of iodine and its derivatives (Iofina, Calibre Chemicals, SQM, and Ajay-SQM Group) explain where iodine comes from and where it is used.

1. How common is iodine in nature?

No less than 99.6% of the earth's mass can be accounted for by only thirty-two chemical elements, and the remaining 0.4% is apportioned among sixty-four elements in trace quantities. Iodine is number 61 on this list, making it one of the least abundant non-metallic elements in earth's composition. Although not abundant in quantity, iodine is distributed almost everywhere. It is present in rocks, soils, waters, plants, animal tissues, and our daily food. Seawater contains the world's largest iodine reserve (approx. 34.5 million tons), but its direct extraction is not economically feasible because of its extremely low concentration: less than 0.05 ppm. Organisms that naturally accumulate iodine include seaweeds, sponges, and corals. Arable soils vary in iodine content, but it is generally low, with a global average of 3 ppm.

TABLE 1 **Iodine sources and concentrations**

Origin	Chemical form	Typical concentration
Underground brines	Sodium iodide: NaI	30–150 ppm
Caliche ore	Calcium iodate: $(CaIO_3)_2$	400 ppm

TABLE 2 **Estimated iodine reserves per region**

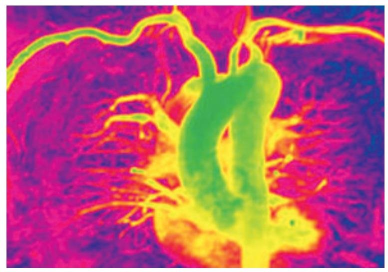
Origin	Region	Reserves x 1000 ton
Underground brines	Japan	5,000
	USA	250
	Indonesia	100
	Turkmenistan, Azerbaijan, Russia	360
Caliche ore	Chile	1,800
Seaweed	China	4
Total estimated reserves		7,514

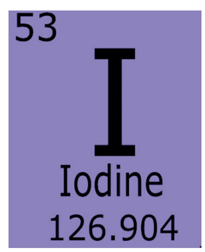
Source: 2016 USGS Mineral Commodity Summary

2. Where does most iodine come from?

Due to unique events in geological history, iodine is found in higher concentrations in mineral deposits in underground brines and in caliche ore *(Table 1)*. It is from these deposits that iodine is extracted for production. The global demand for iodine is on the rise and currently exceeds 33 thousand metric tons per year. The bulk of iodine for production (>95% of the demand) is derived from brines in Japan, USA, Turkmenistan, Azerbaijan, Indonesia, and from caliche ore in Chile.

In Chile, iodine is produced from caliche ore found in the Atacama Desert in northern Chile and west of the Andes Mountains. Most current commercial production of iodine in the United States comes from deep well brines in northern Oklahoma. Japan's iodine is found in brines associated with gas wells. Production in Azerbaijan and Turkmenistan is not associated with oil extraction; their wells have been drilled specifically for brine to produce iodine. Iran is also reported to produce iodine from brine. In Indonesia, iodine brine deposits are located in Mojokerto, East Java, but production is limited and mainly consumed domestically *(Table 2)*.





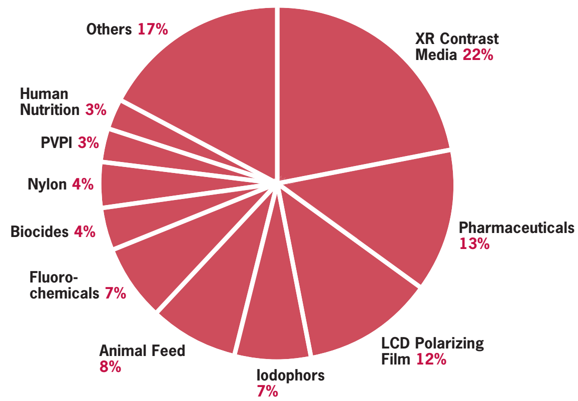
A scan made with the help of x-ray contrast media and potassium iodide tablets (100 mg I) to protect the thyroid during nuclear accidents.

3. Will we ever run out of iodine?

It is estimated that the existing global reserves of iodine will support iodine production for at least the next two centuries. Their lifespan is likely to be further extended by developments in production efficiency and iodine recycling from industrial uses. Japanese iodine producers play a major role

Transport of caliche ore from its mining site

FIGURE 1 Global estimated demand for iodine in 2016 according to its application



in iodine recycling, leading in iodine recovery worldwide. Other producers of iodine and iodine derivatives in Europe, India, and America are active recyclers as well. Around 6 thousand metric tons of iodine are being recycled annually and sold back to the merchant market as fresh product, mostly to the same companies which originated the recyclable iodine stream. This amount corresponds to approximately 18% of the total world iodine demand and is additional to the iodine recovered and recycled internally by many industrial users. The main drivers of recycling include savings in costs as well as environmental and regulatory considerations.

4. What are the most common uses of iodine?

Only around 3% of the global iodine production is destined for human consumption. As an animal feed additive, iodine is only slightly more in demand, at 8%. In addition to nutrition products, iodine and iodine derivatives are used in a wide range of medical, agricultural, and industrial applications. The leading application is in the production of X-ray contrast media (22%) *(Figure 1)*. Iodine's high atomic number and density make it ideally suited for this application, as its presence in the body can help to increase contrast between tissues, organs, and blood vessels with similar X-ray densities. Another application driving the demand for iodine is in polarizing film in liquid-crystal display (LCD) screens, where iodine is incorporated as polyiodide (I_3- or I_5-). Potassium iodide is used in iodine tablets to be taken during nuclear accidents to protect the thyroid against exposure to radioactive iodine. Iodine based biocides are often used in paints as an in-can preservative as well as to prevent mold growth after application. Other applications include pharmaceuticals, disinfectant iodophors and povidone-iodine, fluoride derivatives, heat stabilization of nylon, or as process enabler in polymerization of plastics or other processes requiring chemical synthesis.

5. What are the different types of iodine derivatives?

Most iodine producers deliver their product on the market as solid, prilled, elemental iodine (I_2), which is then used to produce a wide range of organic and inorganic derivatives.

Inorganic derivatives

Typically iodine is introduced into the human food chain as an inorganic compound: iodide or iodate of potassium, calcium or sodium. Iodides range from completely ionic structures, like potassium iodide, to covalent structures such as titanium tetraiodide. They are produced by reduction of iodine.

Iodates are stable at room temperature, but they lose oxygen on heating. Iodates can be prepared by strong oxidation of iodine to iodic acid, followed by neutra lization with an oxide or hydroxide or by electrolytic oxidation of an iodide solution.

Organic derivatives

Iodine-containing organic compounds include a wide range of aliphatic or aromatic iodine derivatives. Compounds such as ethyl- or methyl iodide and hydriodic acid are used in organic chemistry or for pharmaceutical purposes. Ethylenediamine dihydroiodide (EDDI) is used as an additive in pet food and cattle feed with high bioavailability.

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WIA
WORLD IODINE ASSOCIATION

Thyroglobulin is a useful biomarker of adequate iodine status in adults

Excerpted from: Angela M. Leung, a summary of Feei Ma Z, Venn BJ, Manning PJ, Cameron CM, Skeaff SA. Iodine supplementation of mildly iodine deficient adults lowers thyroglobulin: a randomized controlled trial. J Clin Endocrinol Metab. February 18, 2016 [Epub ahead of print]

Because there is significant day-to-day variation in iodine intake, iodine status cannot be accurately determined in individuals and can only be assessed in aggregate at the population level, using median urinary iodine concentration (UIC). Thyroglobulin (Tg), secreted from the thyroid follicular cells, has been used as a validated biomarker of iodine status in children, inverse to the median UIC (1). A new study examined the efficacy of using serum Tg concentration as an inverse biomarker of iodine status in adults, as compared with the reference of median UIC.

Study method and results

This was a double-blind, randomized, placebo-controlled clinical trial of mildly iodine-deficient adults aged 18 to 40 years in New Zealand, where pockets of mild iodine deficiency persists despite national measures to mandate iodized salt in bread products starting in 2009 (4). Study participants (112 adults with a baseline median UIC of 65 μg/L, consistent with mild iodine insufficiency, and a median serum Tg of 16.6 μg/L) received either 150 μg of potassium iodate or placebo daily for 24 weeks. For paired analyses, they provided spot urine samples at baseline and at 24 weeks for the measurement of urine iodine, and blood serum throughout the study for the measurement of Tg. By the end of the study, the median UIC had increased to 79 μg/L in the placebo group and to 178 μg/L in the iodine-supplemented group. As compared with the placebo group, serum Tg levels among the supplemented group decreased by 12%, 20%, and 27% at 8, 16, and 24 weeks, respec-tively. These decreases resulted in a median serum Tg concentration of 13 μg/L at 24 weeks, and only 1.8% of the population with a serum Tg >40 μg/L.

Discussion

The study adds significantly to the current understanding of monitoring iodine status as an important global public health measure, given the challenges of urine collection, the inability to measure urinary iodine in some laboratories, and that UIC is a reflection of short-term (i.e. days or weeks) iodine status. The use of serum thyroglobulin, which can be obtained from a fingerprick and spotted onto filter paper, may be particularly attractive in overcoming the difficulties of the collection, storage, and the shipping of urine samples in the field. The findings of this study confirm those of two other studies in adults, which were limited by their short duration, use of too little iodine supplementation to improve iodine status, and a cohort of only iodine-suf ficient subjects (5, 6). The study also confirmed that serum Tg is a more sensitive biomarker of iodine status than TSH and thyroid hormone. Further studies are needed to expand on the findings among adults of other age ranges and to be adequately powered to assess potential sex-based differences that is common to many thyroid disorders.

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Mild iodine deficiency among elderly in residential care

Excerpted from: Miller JC et al. Iodine Status of New Zealand Elderly Residents in Long-Term Residential Care. Nutrients 2016, 8, 445; doi:10.3390/nu8080445

In response to the re-emergence of iodine deficiency in New Zealand, in 2009 the government mandated that all commercially made breads be fortified with iodized salt. This study evaluates the impact of the program on iodine intake and status of elderly New Zealanders in residential care homes.

Although the detrimental health effects of iodine deficiency are most pronounced in the fetus and during infancy, adverse effects are observed at all life stages. Thyroid dysfunction in adults is associated with many important adverse health outcomes, including hypertension, dyslipidemia, cognitive impairment, osteoporosis, muscle wasting, and frailty. Older adults are more susceptible to iodine deficiency or excess due to age-related changes in thyroid function. For example, thyroid autonomous nodules are increased in older adults who reside in areas of mild to moderate iodine deficiency, and are associated with subclinical hyperthyroidism when iodine intake is low, or after increases in intake following implementation of iodine fortification programs (1). The elderly are a rapidly growing segment of the population, and it is, a high public health priority to ensure they have sufficient iodine intake to maintain optimal thyroid function and reduce the burden on health care resources.

The New Zealand Nutrition and Ageing Project was a cross-sectional study to assess the health and nutritional status of care home residents.

Older adults in long-term residential care are at particularly high risk of nutrient deficiencies because they have small appetites and are often unable to consume enough food to meet their nutrient requirements. Furthermore, they often have both acute and chronic diseases, and use medications or oral nutritional supplements that may increase the risk of suboptimal or excessive nutrient status due to varying nutrient intake, absorption, metabolism and/or excretion.

Study setting and design

The New Zealand Nutrition and Ageing Project was a cross-sectional survey conducted in 2014, which recruited 309 long-term residents aged 60 years and older from 16 residential-care homes (rest homes) throughout New Zealand (Auckland, Hamilton, Hawkes Bay, Wellington, Christchurch, Dunedin and Invercargill) to investigate their nutritional status and health. As part of a full nutritional assessment, dietary iodine intake (pre- and post-fortification) and iodine status were measured. Malnutrition risk was determined using the Malnutrition Universal Screening Tool (MUST) (2) with information collected from medical records. This tool uses current BMI, weight loss over the previous 3–6 months and acute illness with no nutritional intake over the previous five days to calculate a risk score. Frailty scores were determined using the Survey of Health, Ageing and Retirement in Europe Frailty Instrument (SHARE-FI) (3).

About study participants

The median age was 85 years (range: 65-107 y), with 68% women. Almost all participants (98%) were of New Zealand European ethnicity. The average duration of residence was 31 months (range: 2 months to 13 years). 60 participants were diagnosed with a thyroid disorder (9 with hyperthyroidism, 46 with hypothyroidism, and 5 had undergone a partial thyroidectomy). Fifty participants (16%) were prescribed levothyroxine and four prescribed anti-thyroid medications. 112 participants were prescribed loop diuretics (mostly furosemide), and two were prescribed amiodarone (antiarrhythmic agent), providing 75 mg of iodine per day. Oral nutritional supplements were prescribed for 22 (7%) participants, contributing an average 14 µg of iodine per day, and 29 (9%) were taking supplements containing iodine. Participants at high risk of malnutrition were more likely to be prescribed oral nutritional supplements (24% for high risk, 4% for moderate risk, and 1% for low risk). The majority of participants (83%) were identified as being either pre-frail or frail.

Low urinary iodine and high Tg levels point to improved but still insufficient iodine intakes

The median urinary iodine concentration (MUIC) was 72 µg/L, indicating mild iodine deficiency among the elderly adults. Urinary iodine levels were lower in summer/autumn, in the oldest age group, and in participants with stage 3 and 4 chronic kidney disease. Participants treated with levothyroxine had significantly higher MUIC, and a higher proportion with UIC >300 µg/L, compared with participants not on this medication. After excluding participants with elevated TgAb (n = 35, 13%), the median thyroglobulin concentration was 18 ng/mL and 26% had an elevated thyroglobulin concentration (>40 ng/mL). Both of these values were above the assay-specific recommendations to indicate population iodine sufficiency (median serum thyroglobulin <13 ng/mL, and/or no more than 4% with thyroglobulin concentration >40 ng/mL), further indicating that the iodine status was insufficient. The prevalence of elevated thyroglobulin concentrations was highest in women and pre-frail participants. In participants treated with levothyroxine, the median serum thyroglobulin concentration of 7 ng/mL was within recent guidelines, but the proportion with elevated thyroglobulin (16%) was higher than recommended.

In the adjusted analyses, the MUIC was higher during summer/autumn than during winter/spring, participants on loop diuretics had lower MUIC, and median thyroglobulin concentration increased with age and with BMI.

Iodine intake has improved after mandatory iodization of bread

The mean intake of bread per day was 66 g/day, or approximately 2 slices of bread (~30 g per slice). Bread intake was significantly higher in men than in women, and it was inversely associated with age, malnutrition risk and frailty, and positively associated with BMI. Mandatory fortification of commercially baked bread with iodized salt increased the mean intake of iodine from bread by 31 μg/day, and comparison of studies conducted pre- and post-fortification in other sectors of the population suggest iodine status has improved. The MUIC in the present study (72 μg/L) was slightly higher than the pre-fortification MUIC of 61 μg/L reported for community-dwelling older participants in the nationally representative 2008/2009 Adult Nutrition Survey (4).

While the finding of iodine insufficiency in this elderly population is strengthened by the use of two objective biochemical indices of iodine status, the results should be interpreted with caution because each index individually has limitations that hinder interpretation in older adults. Further exacerbating the difficulties in assessing iodine status in institutionalized adults is the high prevalence of diseases or use of medications that may alter nutrient metabolism and nutrient requirements, and influence the validity of nutrient biomarkers. Renal insufficiency decreases urinary iodine excretion through reduced renal filtration of iodine from plasma and increased tubular resorption of the filtered iodine, leading to high levels of iodine in plasma. Therefore, in patients with renal insufficiency low urinary iodine concentration does not necessarily indicate poor iodine status. In the present study, while the authors observed lower MUIC in participants with chronic kidney disease, serum thyroglobulin concentrations were not statistically associated with renal function.

Frailty may lead to higher odds of having elevated serum thyroglobulin concentration, indicating poorer iodine status.

Important implications

This study provides important information on predictors of low iodine status in institutionalized elderly. That frail participants were at higher risk of elevated thyroglobulin concentration is of particular interest. Frailty is an important geriatric syndrome that substantially increases morbidity, health care costs, and reduces quality of life. The criteria for frailty (weakness, exhaustion, slowness, poor exercise tolerance and/or unintentional weight loss) overlap with the symptoms of thyroid dysfunction (fatigue, reduced muscle strength, and weight change). Recent cross-sectional studies have found positive associations between high-normal thyroxine hormone concentration and frailty, or reduced physical function, in older men. Alternatively, TgAb positivity–which is a risk factor for hypothyroidism–was associated with lower risk of frailty in older women (5).

When developing the mandatory bread fortification policy in New Zealand, strategies such as mandating universal salt iodization, or replacing all salt with iodized salt in processed foods, or in breakfast cereals, biscuits and crackers in addition to bread, were considered. These options were rejected after public consultation, because of perceived logistical difficulties, and a risk of excessively high intakes for children in the case of universal salt iodization. However, extending mandatory use of iodized salt in other food items would be a good strategy to improve iodine intakes of older adults because it would increase iodine intake without the need for an increase in food intake. Supplementation, however, is problematic because taste fatigue limits adherence, and polypharmacy increases the risk of nutrient-drug interactions. With an increased risk of hyperthyroidism with even a modest increase in iodine intake in the elderly with a history of iodine deficiency, any intervention should include close monitoring of adverse health effects. Worldwide, assessment of nutritional status in this age group is limited. The importance of such is particularly relevant in the context of global population ageing, with numbers of older adults escalating in regions with a history of iodine deficiency, including New Zealand, the UK, and some regions in Europe, Africa and Asia.

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An innovative new portable salt refinery

Lorenzo Locatelli-Rossi International Salt Consultant

A salt washing machine improves productivity, quality and lowers the cost. Here is why.

Solar salt crystallizes in a pond, and once it reaches appropriate density, it can be harvested and washed in brine to remove impurities.

Over the past 30–40 years, the salt industry has undergone a dramatic change. Taking Europe as an example, four decades ago there were far more small salt producers than there are today. As the market demand changed, only those who understood the changes and invested in new technology, survived. Another factor that led to the gradual demise of small producers was urban and industrial expansion. As the value of the land increased, many producers gave up land for financial gain. The universal salt iodization programs that began in the 1990s revolutionized the salt industry, with a profound impact on the small-scale, artisan salt farmers. In 2016, small-scale salt farmers continue to contribute a sizeable proportion of iodized salt in a number of countries to help sustain a high household coverage. In many cases, their enterprises support large families and entire communities.

As salt technology evolved in leaps and bounds, its application became more widespread and accessible. But as with any technology, its adoption depends largely on the economics: the initial financial cost and return on investment. Time equals money, and nowhere is this more apparent than in solar salt production, where the harvest is dependent on the season (not unlike agricultural crops), and achieving a high-quality product requires a lengthy process of scraping up salt crystals, piling the salt in heaps, and washing out the impurities using brine, before the salt can be moved out of the crystallizing pond onto dry land to drain. The more time-consuming this process is, the lower the overall return on investment. Therefore, shortening it could improve both yield over time and the profit, and this can be achieved using salt washing machinery.

An early patented salt washing system (U.S. patent 25th June 1963) can be seen in the black and white photos (following page), being used in a salt pond in South Africa. The hopper was on wheels, which means the device could be moved from one brine pond to another. The salt from the crystallizer pond would be shoveled into the hopper where it would be sieved, and brine would be pumped in to wash it. Thus, the action of the mixture of salt and brine would achieve two goals: transport and wash the salt, landing clean salt on dry land on a stockpile, where it would drain. This washing system was built from common steel, which meant it required thorough and regular (after every season) maintenance and service.

In 1976, a salt engineering company Saltec (Rome, Italy) designed and built a salt refinery which could be transported in small containers. The system, aptly called "The Compact", consisted of three containers: the first, a washing and refining system; the second, for salt drying; and the third, a screening and packing machine. The benefit of this ingenious device was that it offered a turn-key solution for refining salt. The client would build the foundations, supply electricity, water, and brine, and the Compact could be plugged in upon delivery, ready for production. Saltec's Compact washing and refining system (1st container) with a production capacity of 3 tons per hour, was custom built and delivered to a salt production enterprise in Mozambique. Unfortunately, as chance would have it, the container was washed away in the devastating floods that hit Mozambique in the 1990s, and any photographic evidence disappeared along with it.

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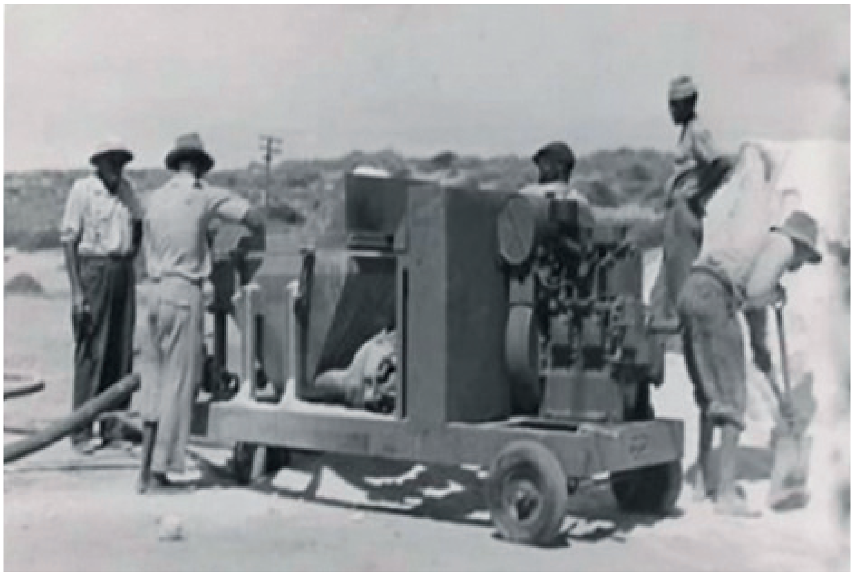
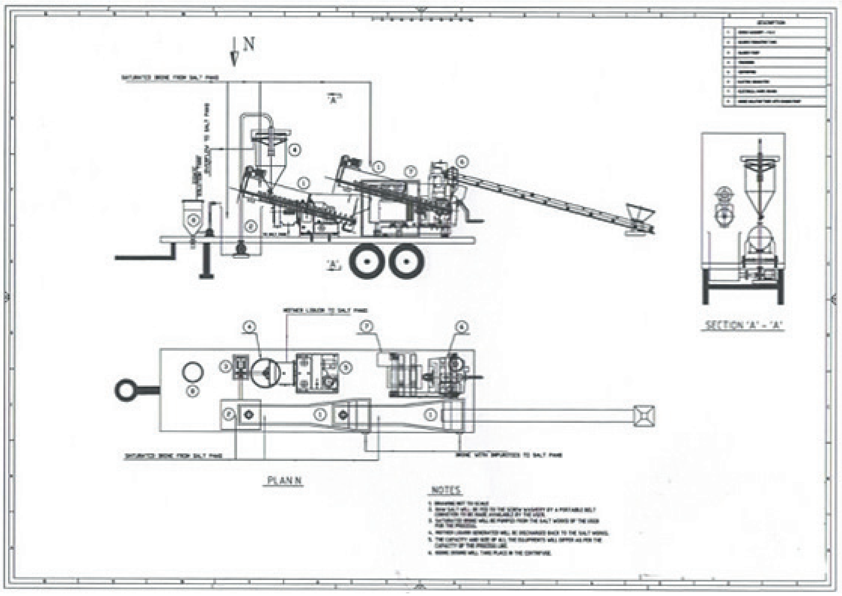
Fast forward to 2010, and the concept of "The Washinery" was born, a solution designed to meet the needs of small-to-medium salt farmers. The requirements have not changed since the days of the Compact: adequate technology must go hand in hand with affordability, low upfront investment and running cost, and mobility, so that farmers could share the benefits of a joint investment. As seen in the schematic, the Washinery consists of washing components that feed a centrifuge to reduce water content in the final stage of iodization. Thus, the salt exits at ca. 5% maximum moisture content. Salt loss during washing depends on the quality of the dirty salt and can vary from 12% to 18%. The brine used for washing can be recycled, so all losses are mostly recuperable. As the project develops and the Washinery becomes a reality, updates on this exciting development will be shared.



An early salt washing system patented in the U.S. in 1963, here being used in a salt pond in South Africa. The apparatus is mobile thanks to wheels, and the hopper can be moved from pond to pond. Salt is loaded and washed with brine, and it lands on stockpiles to dry.

In 1976, a salt engineering company Saltec (Rome, Italy) designed and built an ingenious compact salt refinery in a container.



This schematic depicts "The Washinery" developed by Shriraam Engineering (India): a series of salt washing devices that feed into a centrifuge to reduce water content the final stage of iodization.

Children and pregnant women in Abkhazia are iodine deficient

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Abkhazia is a partially recognized state at the crossroads of Western Asia and Eastern Europe, on the eastern coast of the Black Sea, south of Russia and northwest of Georgia. It covers 8,660 sq. km and has a population of around 240,000. Its capital is Sukhumi. While Georgia exerts no control over its former Autonomous Republic, the Georgian government, the United Nations and the majority of the world's governments (with the exception of Russia and few other countries) consider Abkhazia part of Georgia. Like in other parts of the former USSR, iodine deficiency in the Caucasus Republics (Georgia, Armenia, and Azerbaijan) was virtually eliminated in the 1950s to 1980s, which helped to significantly reduce the prevalence of endemic goiter and eliminate the most severe manifestations of IDD, such as cretinism.

While many of the other newly independent states managed to successfully revive their IDD prevention programs in the mid 1990s, and went on to achieve significant improvements in iodine nutrition status by 2010, Abkhazia lagged significantly behind. It was only recently (in May 2016) that the Ministry of Health, with technical support from the IGN and UNICEF, conducted the first ever survey of iodine nutrition and use of iodized salt in Abkhazia. The survey recruited 212 participants from three administrative districts: Gagra, Sukhumi and Gali (see map). Among them were 151 school-age children (SAC, 8–12 year-old), recruited from schools, and 61 pregnant women aged 18–39 years mostly in the 2nd and 3rd trimester of pregnancy, recruited from prenatal clinics. Of the 151 SAC 67 were living in urban and 84 in rural areas. The two urban sites (Sukhumi and Gagra) are located on the Black Sea coast, while the rural schools are all inland. The women attending the prenatal clinic in Gali were mainly from rural inland villages; those from Sukhumi and Gagra were from coastal towns. Spot urine samples as well as samples of household kitchen salt were collected at each survey site. All salt samples were tested for iodine content using qualitative rapid test kits (RTKs: MBI Kits, India). Quantitative testing of the salt was not carried out, as only very few salt samples were found to contain any iodine. The urinary iodine concentration (UIC) was measured at the laboratory of A.D. Sakharov Environmental Institute of the Belarus State University in Minsk.

The survey findings are concerning: the median urinary UIC in school-age children is only 29 μg/L (optimal range: 100–299 μg/L), while the median UIC in pregnant women is 27 μg/L (optimal range: 150–499 μg/L), which suggests that both population groups may be iodine deficient (see Table 1). In SAC, the median UIC was higher in urban compared to rural areas (36.3 μg/L vs 24.1 μg/L). No such difference was observed in pregnant women.

Main street in Abkhazia's capital and largest city, Sukhumi.

Map of Abkhazia. The numbers represent the three Districts (Gagra, Sukumi, and Gali) selected for the assessment of iodine nutrition and use of iodized salt in Abkhazia.

The proportion of SAC with urinary iodine levels below 100 μg/L was very high at 97%, with 30.5% of values below 20 μg/L. In pregnant women, the median UIC was alarmingly low at all three surveyed sites, but it was particularly low (below 20 μg/L, indicating severe iodine deficiency) in the capital city of Sukhumi. Only 3.4% of pregnant women had UICs within the optimal range of 150–499 μg/L, while 37.9% UICs were below 20 μg/L.

TABLE 1 **Median urinary iodine concentrations (μg/L) in school-age children (SAC) and pregnant women by place of residence, in Abkhazia.**

Place of Residence (District)	**Urban SAC** (n=67)	**Rural SAC** (n=84)	**Pregnant women** (n=61)
Sukhumi	42.3 (n=33)	22.5 (n=30)	18.0 (n=23)
Gagra	31.4 (n=34)	30.0 (n=30)	33.0 (n=19)
Gali	-	19.5 (n=24)	32.5 (n=19)
Total for Abkhazia	**29.1 (n=151)**		**26.5 (n=61)**

Why are children and pregnant women iodine deficient?

Although Abkhazia is on the Black Sea, fish and seafood are mostly imported and quite expensive; for this reason they are not widely consumed by the population. Despite local beliefs, that persimmon, feijoa *(Acca sellowiana)*, and walnuts are rich sources of iodine, in fact, there are almost no local natural, rich sources of dietary iodine in Abkhazia. At the same time, household coverage of iodized salt appears to be very low: only five out of the 150 tested salt samples were iodized (3.3%). While iodized salt (premium brands only) was available in urban supermarkets, it was not commonly sold in the rural shops or markets. In addition, a considerable price difference between the premium (iodized) salt and non-iodized salt in economy packaging prevents most customers from buying it. In the survey, only a few participants reported buying iodized salt to season food. There is no currently no legislation in Abkhazia to limit the import or use of non-iodized salt.

A questionnaire on the use of iodized salt suggests that the vast majority of pregnant women (88%) are aware of the existence of iodized salt, but only 5% declare a strong preference for purchasing iodized salt. The reported purchasing habits (preference given to salt in its original packaging with a label, buying salt in smaller volumes, and buying from preferred shops) suggest that it might be possible to increase the sales of iodized salt if a reasonably priced variety would become available on the market. When asked about the benefits of iodized salt, only a relatively small proportion of respondents (17%) knew that it prevents goiter. Recent experience of similar questionnaires in Georgia (in 2016) and Tajikistan (in 2015) shows that this is rather low: in the other two surveys, more than 90% of respondents recognized goiter prevention as the main beneficial effect of iodized salt. On the other hand, a relatively high proportion of respondents recognized that iodized salt plays a beneficial role in children's mental development (15%) and in fetal development (27%). At the same time, it is troubling is that over 40% of pregnant women in Abkazia could not list a single benefit of iodized salt.

What is next for Abkhazia?

The survey results are alarming, as they point to the presence of moderate-to-severe iodine deficiency in the Abkhaz population, including pregnant women, which puts their babies at risk of cretinism, impaired cognitive development and intelligence, as well as goiter. To eliminate the risk of iodine deficiency disorders and achieve optimal iodine nutrition, Abkhazia should urgently implement appropriate legislative/regulatory measures to restrict the import, sale, and use of non-iodized salt. There is no local salt production in Abkhazia that would require time and resources in order to start iodization. Fortunately, all salt in Abkhazia is imported from Russia by a very limited number of wholesale companies and, in theory, switching from import of mainly non-iodized to exclusively iodized salt should not pose a problem.

The survey report submitted to the Government of Abkhazia calls for the adoption of legislation that would ban all import, wholesale and retail trade of common salt, as well as the use of non-iodized salt in the catering and food processing (baking) industry. Similar laws completely banning non-iodized salt were adopted 10–15 years ago in Armenia, Azerbaijan, Georgia, Turkmenistan, Uzbekistan, Kazakhstan and other post-Soviet states, which have subsequently achieved optimal iodine nutrition at the national level.

Technical and logistical support for this study in Abkhazia was provided by UNICEF and the IGN thanks to a generous grant from GiveWell.

Salt and urine samples are being collected for analysis of iodine content

China announces reforms to salt monopoly

By **Grace Zhu** for The Wall Street Journal, May 5, 2016 *http://www.wsj.com/articles/china-announces-reforms-to-salt-monopoly-1462451878*

State Council chips away at millennia-old monopoly, scrapping controls on price and distribution

China's government is chipping away at the country's millennia-old salt monopoly, scrapping controls on the price and distribution of edible salt as part of the broader overhaul of the state sector.

The State Council, or cabinet, announced that, while the government will continue to license salt producers and require them to add iodine to most salt, the companies will be free to set prices and distribution channels starting next year.

Workers harvest dried salt in Yanchi Village of Gaotai County, northwest China's Gansu Province in August, 2015.

Though the reform plan doesn't do away with the monopoly—as some have called for—it does attempt to give market forces greater sway to bring greater efficiency and lower prices to a system that critics say has provided fat profits for what has been a powerful industry.

"It's a milestone for China's salt reform. The removal of state controls over price and distribution is big progress for the industry," said Zou Jialai, a Shanghai-based lawyer who has represented private salt firms against the state monopoly for over a decade.

A government fixture for 2,600 years, the salt monopoly was once a key source of revenue, helping emperors pay for stretches of the Great Wall. Though its role in government income has waned, Beijing has relied on licensed salt companies in recent decades to ensure iodine is added to table salt and distributed to all corners of China. That has helped radically reduce iodine deficiency, which can cause goiter and stunted growth.

Under the monopoly's recent iteration, Beijing has licensed around 100 companies to produce table salt, requiring them to sell to state distribution companies, which in turn are solely permitted to sell edible salt to the public. Government-set prices at each step of the distribution chain have ensured hefty profit margins.

Given its power, the salt monopoly has resisted previous reforms, with several plans having been released since 2000 but without great effect. This time around, the reforms are being introduced as part of a wider effort to improve the performance of state companies, which dominate sectors from banking to telecommunications.

Under the new reform plan, the licensed producers are allowed to set prices and decide how to distribute the salt, whether selling it themselves or to other distributors, either inside or outside the current government system.

In a nod to greater competition, the reforms allow larger provincial-level salt wholesalers to sell their products to provinces and cities outside their current remit, while smaller ones may sell salt in different markets within the province.

In making these changes, however, the State Council said regulators must ensure good quality iodine salt reaches more than 90% the market. The government also said a salt-reserve system will be set up to hold a month's supply of edible salt.

No new licenses will be issued for edible salt producers, effectively shielding them from new competition, according to the plan, while private capital will be encouraged to invest in the sector.

Mr. Zou, the lawyer, said he hoped that the government would allow more private investors into the salt sector in its next reform plan.

Iodine Global Network continues to support USI in China

In recent years, the IGN has been working with UNICEF and the Chinese Government to ensure that, when the salt industry reform comes into effect, universal salt iodization and optimal iodine nutrition of the population will remain a priority for the government. The IGN has been advocating strongly for salt iodization to remain mandatory and in favour of strengthening regulatory monitoring and ongoing vigilance with respect to iodine status and salt surveillance. China's own history and recent examples from other countries clearly show that, in the absence of mandatory regulations and ongoing adequate supply of iodized salt, progress could reverse and iodine deficiency could re-emerge in China with all its sequelae, including goiter and severe cognitive impairment in the newborns. A conference on iodine and thyroid disease will be held in China on 19–20 October, bringing an opportunity to review the latest evidence on iodine nutrition and salt iodization, and consider what programmatic revisions may be required to accommodate the opening of the Chinese salt industry to greater competition.

MEETINGS AND ANNOUNCEMENTS

IGN Board welcomes new Directors

Mr. Rishi Kansagra

Where are you based?
I am based in London and Lagos.

What is your current position?
I am a Director of Royal Salt Limited in Nigeria and of Seven Seas Salt Limited in Ghana. I also sit on the Advisory Board for Kensalt Ltd in Kenya.

What is your background?
I graduated from Oxford University and focus on the commercial side of business.

How did you come to be nominated to the IGN Board?
I have engaged with IGN at a high level for some time, whilst some of the companies I work with have engaged at ground level. We felt by joining the Board we could co-ordinate to ensure we all work together.

How do you hope to contribute to the Iodine Global Network as a newly elected Director?
I hope to bring a sense of the reality of the iodine situation in parts of Africa where I or my connections can assist and advise as to the courses of action I believe can lead to meaningful movement towards improving iodization in the African populace in a sustainable manner to ensure these improvements are not eroded.

Dr. Napaphan Viriyautsahakul

Where are you based?
In Bangkok, Thailand.

What is your current position?
I have been the Director of Bureau of Nutrition, at the Department of Health, Ministry of Public Health in Thailand since March 2012. I am also the program manager of Thailand's nutrition programs including obesity control, iodine and iron deficiency control and an advisory member of the Nutrition Association of Thailand Committee and Thai Breastfeeding Center Committee.

What is your background?
I graduated from Medical School, Faculty of Medicine, Ramathibodi Hospital, Mahidol University in 1989. I started my career with the Ministry of Public Health with an internship at Maternal and Child Hospital in Khon Kaen Province and in Bangkok after graduation. I completed a Pediatrics residency in Bangkok then served as a pediatrician in Health Promotion Center, Bangkok during 1995-2008. In 2008, I became the chief of Nutrition Prevention and Control Group in the Bureau of Nutrition, Department of Health before receiving a government grant to study for a master's degree in Clinical and Public Health Nutrition at University College London.

What are you professional interests and goals?
Throughout my time with the Department of Health, I've worked in Thailand and abroad with ASEAN, SEAMEO RECFON, UNICEF, WHO and now also the IGN to help improve mother and child nutrition, with particular focus on iodine status and breastfeeding.

Prof. Srinivasan Krishnamachari

Where are you based?
In Bangalore, India

What is your current position?
I am a Professor in the Department of Psychiatry, St John's Medical College Hospital and Head, Division of Mental Health & Neurosciences, St John's Research Institute, Bangalore, India.

What is your background?
I have special interest in the area of Maternal and Child Health, in particular, examining the role of nutrition, antenatal and postnatal factors on child health outcomes. The emphasis in several of my studies has been measuring the impact of nutritional and psychological factors on brain development and cognitive and behavioral outcomes in children from disadvantaged background.

How did you come to be nominated to the IGN Board?
Professor Michael Zimmermann (IGN Board Director and Chair) and I are collaborators in a longitudinal study examining the impact of oral iodine supplementation in pregnancy on cognitive outcomes in children. Prof. Zimmermann introduced me to IGN and through the IDD Newsletter I got to know the excellent work the organization is doing in highlighting the role of nutrition, particularly iodine, in improving health outcomes of women and children.

How do you hope to contribute to the Iodine Global Network as a newly elected Director?
As a member of Board of the Directors of IGN, I intend to play an active role in spreading the awareness of health benefits of optimal iodine intake especially among women in the reproductive age group and its impact on child cognitive outcomes.

IGN/EUthyroid Satellite meeting

EUthyroid investigators (L-R) Prof. Margaret Rayman (University of Surrey, UK), Prof. Robin Peeters (Erasmus Medical Centre, Netherlands), and Dr. Sarah Bath (University of Surrey, UK)

On Saturday, 3rd September, the Iodine Global Network Western & Central Europe and EUthyroid held a joint satellite meeting at the European Thyroid Association conference in Copenhagen (*www.eta2016.com*). The purpose of the meeting was to take stock of EUthyroid Project's activities and progress to date in harmonizing iodine nutrition in Europe. A number of presentations were devoted to tackling the challenges associated with iodine status and program assessment (including coping with bias in existing iodine and thyroid research, evaluating the effectiveness of IDD prevention strategies, using thyroglobulin as a biomarker of iodine deficiency in pregnancy, and learning from birth cohorts in iodine research), while others focused on ways of achieving optimal iodine nutrition (including ensuring an iodine supply in milk, iodine supplements).

Launch of the Global Nutrition Report 2016

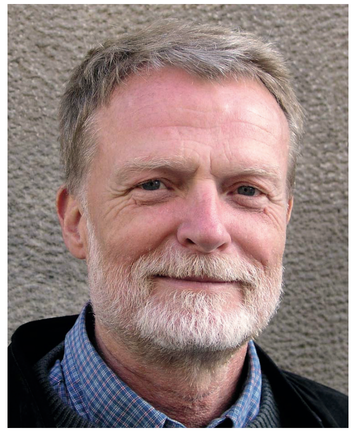
Dr. Vincent Assey (IGN Regional Coordinator for Eastern Africa) at the GNR launch in Dar es Salaam, Tanzania

The Global Nutrition Report 2016 launched on 14 June, 2016 through a special live broadcast in seven cities around the globe Beijing, Johannesburg, Nairobi, New Delhi, New York, Stockholm, and Washington D.C. The report, which is now in its third year, takes stock of the state of the world's nutrition and emphasizes the need to ramp up efforts to end all forms of malnutrition by 2030.

In Tanzania, the official launch took place on 20 July in the capital Dar es Salaam, and it was attended by H.E. Samia Suluhu Hassani, Vice President of Tanzania, among other distinguished guests. Dr. Vincent Assey (IGN Regional Coordinator for Eastern Africa) gave an overview of the nutrition situation in Tanzania and discussed salt iodization programs as a successful model to be followed by other food fortification approaches to tackle 'hidden hunger' (micronutrient deficiencies).

Malnutrition affects 1 out of 3 people globally, and every year it reduces gross domestic product (GDP) by 11% across Africa and Asia, whereas preventing malnutrition delivers $16 in returns on investment for every $1 spent. Although the report emphasizes the challenges posed by the multiple forms of malnutrition, it also signals the enormous importance of investing in the critical 1,000-day window so that every child can lead a happy, healthy, and productive life.

In Memory of Peter Laurberg, MD



Peter Laurberg died following a car accident when he was struck while walking with his wife in Tbilisi Georgia on June 20th this year. He was 71 years old and Professor of Endocrinology and Internal Medicine, Aalborg Hospital, Aarhus University Hospital, Denmark. He served ICCIDD with distinction being on the Board as well as contributing to the Scientific Committee before the current structure of IGN was implemented. His careful introduction of iodized salt into Denmark and the detailed studies of this strategy for well over a decade made a major contribution to the debate on mild iodine deficiency. He was a giant in the field of clinical and translational thyroidology. In addition to being a past president of The European Thyroid Association he contributed to the organization of many other meetings and was in high demand as a speaker. More recently he was a valued member of the guidelines committee of The American Thyroid Association on thyroid and pregnancy. During the last few years he and his Danish colleagues have produced many papers employing data from the Danish national registry. This has resulted in a much clearer understanding of the use of antithyroid drugs in pregnancy which is changing practice worldwide. Our deepest sympathy and condolences are extended to his wife Grete and family at the loss of this warm family man and clinical scientist who did so much to contribute to our understanding of iodine deficiency and thyroidology.

ABSTRACTS

Dietary habits, nutrient intake and biomarkers for folate, vitamin D, iodine and iron status among women of childbearing age in Sweden

The aim of this study was to describe food and nutrient intake (folate, vitamin D, iodine, and iron) and nutritional status among women of childbearing age in Sweden in relation to current nutrition recommendations. Dietary intake was assessed using a web-based four-day consecutive food record among adults aged 18–80 years ('Riksmaten 2010–11 adults'). Iodine status was assessed in a subsample. Women of childbearing age had lower intakes of fruit and vegetables, fish, and whole grains, but higher intakes of soft drinks. Macronutrient composition was generally in line with the Nordic Nutrition Recommendations, except for a lower intake of fibre, a higher intake of saturated fatty acids, and added sugars. The overall dietary pattern among women of childbearing age (18–44 years) was less favourable compared to older women, but there were no differences in iodine status between age groups. Median urinary iodine concentration (UIC) was 74 μg/L, and the authors recommend following dietary guidelines to improve iodine status.

Becker W et al. Ups J Med Sci. 2016 Aug 25:1-5. [Epub ahead of print]

Assessing infant cognitive development after prenatal iodine supplementation

Little information is available on infant behavioral development outcomes of prenatal iodine supplementation in regions of mild to moderate iodine deficiency, and the existing findings are inconsistent. To identify cognitive processes that might be sensitive to prenatal iodine supplementation, the authors of this review examined the timing of thyroid hormone action on specific brain systems. The development of visual attention is sensitive to thyroid hormone during early pregnancy, when the fetus depends on maternal thyroid hormone. For this reason, infant visual attention could be a sensitive measure of infant outcomes in prenatal iodine supplementation studies. The review suggests the assessment of infant visual attention, with follow-up examination of childhood executive functions, as a means of capturing the effects of maternal iodine deficiency and prenatal iodine supplementation on specific cognitive processes. In particular, it proposes comparison of infant performance on global developmental tests (which are used at present and may be partly responsible for the inconsistent findings) and specialized tests of visual attention in pilot trials of prenatal iodine supplementation in regions of mild to moderate iodine deficiency. In addition, the authors suggest that urinary iodine concentration be monitored regularly in such trials throughout the prenatal period.

Bell MA et al. Am J Clin Nutr 2016 104: Supplement 3 928S-934S

Iodine Nutritional Status of School Children in Nauru 2015

Little is known about iodine nutritional status in island countries in the Pacific Ocean. This study is the first report on the iodine nutritional status of people in Nauru. In addition, sources of iodine nutrition (i.e., water and salt) were investigated. A school-based cross-sectional survey of children aged 6–12 years was conducted in three primary schools of Nauru. Urine, water and salt samples were collected for the measurement of iodine concentration. A food frequency questionnaire was conducted. The median UIC was 142 μg/L, and 25.2% and 7.4% of the population had median UIC below 100 μg/L and 50 μg/L, respectively. Natural iodine-containing foods such as seaweeds and agar were rare. Iodine was undetectable in Nauruan tank water, filtered tap water, and raindrops. Of the analyzed salt products, five kinds were non-iodized, and three were iodized (iodine content: 15 ppm, 65 ppm, and 68 ppm, respectively). The results indicate that the iodine status in Nauruan school children is adequate. Iodized salt may serve as an important source of iodine nutrition in Nauru.

Huang CJ et al. Nutrients 2016, 8(9), 520; doi:10.3390/nu8090520

Prevalence of iodine deficiency disorders among school children in Saudi Arabia: results of a national iodine nutrition study

This study aimed to provide updated data on iodine nutrition among schoolchildren in Saudi Arabia. A cross-sectional cluster survey among schoolchildren aged 8–10 years was conducted during February–April 2012. Children were clinically examined for goitre, and urine and household salt samples were collected for iodine analysis. The overall goitre prevalence at the national level among 4 016 children was 4.2%. The prevalence was <5% in all regions of the country except the southern region with a prevalence of 12.7%. The median UIC of 2224 samples was 133 μg/L, with 74.3% of the surveyed children with UIC ≥ 100 μg/L. Analysis of salt samples (n = 4242) revealed that 69.8% of households were consuming adequately iodized salt. The findings suggest iodine sufficiency at the national level; however, the southern region still has a goitre prevalence of mild degree severity and the proportion of households consuming adequately iodized salt is below recommendations.

Al-Dakheel MH et al. East Mediterr Health J. 2016 Aug 18;22(5):301-8.

Comparison of 2 methods for estimating the prevalences of inadequate and excessive iodine intakes

Prevalences of iodine inadequacy and excess are usually evaluated by comparing the population distribution of UIC in spot samples with established UIC cutoffs. The objective of this study was to assess these prevalences using dietary intake data in the U.S. population. By using the iodine concentrations of foods measured in the US Food and Drug Administration's Total Diet Study (TDS), dietary intake data from the NHANES 2003–2010, the authors estimated each NHANES participant's iodine intake. They calculated prevalences of iodine inadequacy and excess in each sex and life stage by both the UIC cutoff method and the iodine intake cutoff method. A comparison of the two methods found that the prevalences of iodine inadequacy estimated with the iodine intake cutoff method were lower across all sex- and life stage groups than those estimated with the UIC cutoff method. In pregnant women, the respective prevalences were 5.0% and 37.9%. For children aged ≤8 y, the prevalence of excessive iodine intake was high by either method. The consideration of dietary iodine intake may provide a more complete understanding of population prevalences of iodine inadequacy and excess and lead to better dietary guidance.

Juan WY et al. Am J Clin Nutr 2016;104(Suppl):888S–97S.

Iodisation of Salt in Slovenia: Increased Availability of Non-Iodised Salt in the Food Supply

In Slovenia, the iodization of all salt was made mandatory in 1953, changed in 2003 to rock and evaporated salt only. Import of non-iodized salt became possible when Slovenia joined the European Union's single market in 2004. This study investigated the availability and sale of (non-) iodized salt in the country's food supply. Average iodine levels in salt were calculated using the results from a national salt quality monitoring program. Data for analysis were collected at major food retailers in 2014. Iodized salt represented 59.2% of the samples, and 95.9% of salt sales, with an average 24.2 mg KI per kg of salt, in line with regulatory requirements. The average KI level in non-iodized salts was 3.5 mg KI/kg. Although the sales of non-iodized salt are still low, there appears to be a niche market which could pose a risk of inadequate iodine intake in those who deliberately decide to consume non-iodized salt. Policymakers need to provide an efficient salt iodization intervention to assure sufficient iodine supply in the future.

Žmitek K and Pravst I. Nutrients. 2016 Jul 16;8(7). doi: 10.3390/nu8070434

Design: www.imholzdesign.ch Print: Spälti Druck AG CH-8750 Glarus

THE IDD NEWSLETTER is published quarterly by the Iodine Global Network and distributed free of charge in bulk by international agencies and by individual mailing. The Newsletter is also distributed to email subscribers and appears on the Iodine Global Network's website (**www.ign.org**). The Newsletter welcomes comments, new information, and relevant articles on all aspects of iodine nutrition, as well as human interest stories on IDD elimination in countries.

For further details about the IDD Newsletter, please contact: Michael B. Zimmermann, M.D., the editor of the Newsletter, at the Human Nutrition Laboratory, Swiss Federal Institute of Technology Zürich, idd.newsletter@hest.ethz.ch.

The Iodine Global Network gratefully acknowledges the support of **Kiwanis International**, Indianapolis, USA, and the Swiss Federal Institute of Technology Zürich for the IDD Newsletter.