



IDD NEWSLETTER

ICCID GLOBAL NETWORK

VOLUME 42 NUMBER 3 AUGUST 2014



Brazil's iodized salt program builds on its success

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Brazil is the largest country in Latin America by both size and population, with over 200 million people. Iodized salt has been available in Brazil for more than 60 years and has eliminated IDD from most of the country: the Ministry of Health has promoted iodization of all salt for human consumption by establishing the legal, administrative, and operational conditions for USI. However, the IDD program faces new challenges, including possible mild iodine deficiency in pregnant women and harmonization with salt intake reduction efforts.

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To discuss these issues, the Brazilian ICCIDD Global Network Office convened a roundtable meeting entitled “The Control of Iodine Deficiency Disorders in Brazil” on May 10, 2014, in São Paulo. It was attended by representatives from academia, government, PAHO, and the salt industry. Topics for discussion included the processes of salt iodization in Brazil and control by the National Health Surveillance Agency, iodine nutrition of vulnerable population subgroups, and strategies to decrease the intake of sodium in Brazil and harmonization with salt iodization efforts.

Since colonial times, iodine deficiency has been a major cause of goiter in Brazil, having been described by several scientific expeditions that ventured deep into Brazil’s hinterland (1). In 1953, the first steps were taken in Brazil to introduce iodized salt, albeit restricted to areas recognized as iodine deficient (Table 1). But this law posed an almost impossible task for the health authorities and the salt industry: how could the distribution of iodized salt be organized only to areas defined as „endemic,” while other areas of the country were to continue using non-iodized salt? Thus, in 1956, iodized salt was made widely available to the entire population. The Ministry of Health was charged with the task of importing potassium iodate for distribution to the salt mills. But many small salt mills did not iodize their salt. Successive national surveys of schoolchildren were conducted in 1955 (25% of the Brazilian children were goitrous), and again in 1975 (when 15% of the children had palpable goiters). This latter figure indicated that in 1975 approximately 10 million Brazilians were likely suffering from iodine deficiency (out of a population of 60 million at that time).

TABLE 2 Legislation on iodine fortification of salt for human use in Brazil

In **1953** iodization of salt for human use is made mandatory, but only in areas with endemic goiter.

An amendment in **1956** extends iodization to include all salt for human use. The Ministry of Health is tasked with importing and distributing potassium iodate.

In **1974** salt iodization is set at 10 mg iodine (I)/kg, and the salt industry is responsible for the purchase and fortification of salt at their own expense. Surveillance is to be performed by the individual States and districts.

In **1975**, Quality Standards are established for salt for human use.

In **1984**, the Ministry of Health mandates the addition of 10–30 mg I/kg of salt.

In **1994**, the amount of iodine in salt is changed to 40–60 mg I/kg of salt.

In **1995**, the amount of iodine for fortification of salt for human use is established by the Ministry of Health, which is to import and distribute potassium iodate to the salt industry without charge.

In **1999**, the Ministry of Health increases the amount of iodine in salt for human use to 40–100 mg I/kg salt.

In **1999**, the Government creates a coalition Committee for the Prevention and Control of IDD.

In **2003**, the Ministry of Health reduces the amount of iodine in salt for human use to 20–60 mg I/kg salt.

In **2013**, the Ministry of Health reduces the amount of iodine in salt for human use to 15–45 mg I/kg salt.

Iodized salt legislation

In response, another law was enacted by the government establishing that the amount of iodine in salt for human consumption was to be 10 mg iodine/kg salt. Moreover, this new law transferred the onus of purchasing potassium iodate to the salt industry. Each State of the Republic of Brazil was then responsible for the surveillance of salt iodization by checking samples of salt on the market and also at salt mills, although this was seldom done.

In 1982 the National Institute for Food and Nutrition (INAN) of the Ministry of Health decided to create a Working Task Force to address IDD. It included members of the Salt Industry, Health Authorities, and expert consultants from academia. The Committee decided that the solution would be to provide potassium iodate free of charge to the salt mills, but the industry would have to agree to a system of close surveillance whereby samples of salt would be periodically tested both on the market and on the production line. Therefore, between 1982 and 1992, the Brazilian population received iodine through an effective salt iodization program coordinated by the INAN Committee, with full cooperation of the salt industry. About seven thousand samples of salt were analyzed each year, and INAN published the results annually in an internal bulletin. By 1984 the prevalence of goiter had dropped to 1.3% and has remained stable since.

Iodine excess

In 1994–95, a Third National Survey in schoolchildren was conducted that assessed goiter prevalence and urinary iodine excretion. Four deficient areas and 116 moderately deficient villages were detected, mostly in the impoverished area of Northeast Brazil.



Eduardo Nilson presented the Brazilian government strategy to sustain salt iodization while reducing salt intakes.

In 1995, a new law stated that all salt for human use should be iodized at 40–60 mg iodine/kg of salt, and that surveillance and monitoring should be conducted by the National Agency for Sanitary Surveillance (ANVISA). In 1998, ANVISA decided to increase the concentration of iodine in the salt for human use to 40–100 mg iodine/kg of salt. For the ensuing five years (1998–2003), the Brazilian population had high iodine intakes due to the relatively high content of iodine in the salt. In 2001, 86% of all children examined had a UIC greater than 300 $\mu\text{g/L}$, and 50% of all salt samples (collected at homes) contained more than 60 mg iodine/kg of salt (2). Therefore, in 2003, the ANVISA agency decided to lower the iodine concentration of salt for human use to 20–60 mg/kg of salt. A subsequent study of 828 schoolchildren aged 4–13 years from eight schools in the interior of the state of São Paulo reported a median UIC of ca. 335 $\mu\text{g/L}$, and 67.1% had values above >300 $\mu\text{g/L}$ (3). A study of schoolchildren ($n=300$) in 2010 in Ribeirão Preto, São Paulo State, reported that 58% of 8–10 year-old children had a UIC >300 $\mu\text{g/L}$. Household salt samples had a median of about 27 mg of iodine/kg salt, with 13% of samples <20 mg/kg and 2.9% >60 mg/kg (4).

In 2005 the Ministry of Health established a National Program for the Prevention and Control of Iodine Deficiency Disorders (PRO IODO) to maintain the exemplary progress and prevent IDD recurrence. A Committee for the Prevention and Control of IDD was created, comprising members from the Ministry of Health, the ANVISA, UNICEF, the salt industry, PAHO, and academia. This Committee suggested that a national survey of school children for urinary iodine excretion were conducted in 2008–2009. This survey is called PNAISAL (Pesquisa Nacional da Avaliação de Impacto da Iodação do Sal)

and will constitute a broad and informative study in children of each State, proportional to the respective population. In addition to urinary iodine, it will measure iodine concentration in household salt. This study is currently underway, with full results expected in early 2015.

Current situation

In April 2013, the Ministry of Health reduced the amount of iodine in salt for human use to 15–45 mg I/kg salt, based on observations that the salt intake of Brazilians was high, about 12 grams daily (www.ibge.gov.br). Recently, in 230 salt samples analyzed by the ANVISA, 93% of the results showed iodine content in the range of 15 to 45 mg/kg. The most recent data from small studies in southern Brazil suggest that iodine intakes have been reduced and are in the optimal ranges in schoolchildren ($n=206$; mean UIC of 165 $\mu\text{g/L}$) and adults ($n=65$; median UIC of 166 $\mu\text{g/L}$) (5). Preliminary results of the



Salt production, Rio Grande do Norte State, Brazil



Iodized salt means Brazilian children can learn better at school.



Nearly all of Brazilian salt production is iodized.

PNAISAL survey appear to support this latest reduction of iodine in salt to 15–45 mg/kg.

However, a study in pregnant women ($n=191$) in the first trimester in São Paulo State reported a median UIC of 138 $\mu\text{g/L}$. Although 57% of women had a UIC <150 $\mu\text{g/L}$, their mean TSH, TT4, and FT4 values were within the range expected for pregnant women and were similar to those of pregnant women with adequate UIC values (≥ 150 $\mu\text{g/L}$). However, a high percentage of them had mild goiter at palpation. Non-pregnant women ($n=58$) age-matched controls in the study had a median UIC of 190 $\mu\text{g/L}$, with only 16% having a UIC <100 $\mu\text{g/L}$ (6).

Future plans

In collaboration with the Ministry of Health and PAHO, ICCIDD GN in Brazil is planning a cross-sectional, observational study involving 1600 pregnant women in their first, second, and third trimester of pregnancy, from areas of Brazil with different iodine intake. Subjects will provide a spot urine sample for the measurement of iodine concentration. The objective of this study is to evaluate the status of iodine nutrition among pregnant women in Brazil, as determined by the median urine concentration of this population.

By the end of 2014, the results of the 2013 National Health Survey will be officially released. Conducted on a sample of 20 thousand adults, this survey is the first to combine the analysis of urinary excretion of iodine and sodium, which is a key step in the process of harmonizing iodine deficiency elimination with sodium reduction initiatives in Brazil.

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Thyroglobulin: a promising biomarker of iodine status

Excerpted from: **Ma, ZF and Skeaff, SA. Thyroglobulin as a biomarker of iodine deficiency: a review.**
Thyroid. 2014; 24(8):1195–1209

Background

Iodine deficiency is assessed by measuring urinary iodine concentration (UIC). But due to large intra- and inter-individual variation, UIC is only appropriate for groups. Thyroglobulin (Tg) is a thyroid storage protein and is a precursor for the synthesis of T3 and T4. In iodine deficiency, an increased amount of Tg is released into the blood, which is positively correlated with thyroid volume. In their paper, Ma and Skeaff reviewed the evidence on the usefulness of Tg to assess iodine status.

Measuring Tg concentration

Tg can be measured using either radioimmunoassay (RIA) or a variety of immunometric assays (IMA). Tg measurements are method dependent, which means that it may be difficult to compare studies. But the considerable interassay variation (43–65% in healthy adults) can be reduced by 14–27% by standardizing the assays against a certified reference material (CRM-457) (1). Yet, not many studies have performed standardization, and the authors encourage greater use of CRM-457.

The results of Tg assays may be altered by Tg antibodies (TgAb), present in 3–13% of adults. The authors recommend that adults are screened for TgAb prior to measuring Tg. In children, the prevalence of TgAb is lower, and so screening for TgAb in this age group is likely not necessary.

The reference range for Tg in adults (3–40 µg/L) has been determined using both RIA and IMA methods. For healthy children aged 5–14 years, a similar reference range of 4–40 µg/L was established by a dried blood-spot fluorimmunoassay (FIA) (2). There appears to be no consistent effect of age or sex on Tg. An international study of children (n=2512) with varying iodine status suggested that a median Tg <13 µg/L and/or a prevalence below 3% of Tg values >40 µg/L should be used as a biomarker of adequate iodine status in children (3).

Pregnant women

Pregnant women who are iodine deficient typically have a median Tg ≥ 13 µg/L. Interestingly, iodine supplementation does not consistently decrease Tg below this cutoff either during pregnancy or postpartum, but this may be due to inadequate supplementation. More large trials are needed, measuring both Tg and UIC, before conclusions can be drawn about the usefulness of Tg as a biomarker in pregnancy. It is also unclear whether Tg needs to be trimester specific.

Newborns and children

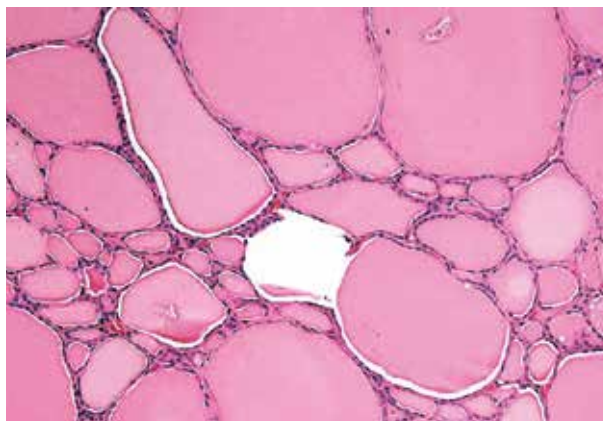
Measuring Tg may be useful in addition to neonatal TSH, a common biomarker of iodine status in newborns. Newborns whose mothers did not take iodine during pregnancy had Tg concentrations of 62–113 µg/L, while those born to mothers who took iodine supplements had Tg concentrations of 31–65 µg/L. The majority of studies in

Adults

Based only on observational studies, it is difficult to conclude whether the Tg cutoff of 13 µg/L can also be used in adults. Importantly, there are no randomized placebo-controlled trials in adults showing an improvement in iodine status (indicated by an increase in UIC from <100 to ≥ 100 µg/L) with a simultaneous fall in Tg concentration from ≥ 13 to <13 µg/L.

Summary

The authors conclude that Tg does hold promise as a biomarker of iodine deficiency. The studies included in this review support the use of Tg as a biomarker of iodine status in school children, using the <13 µg/L cutoff. However, it is not possible to draw conclusions regarding the efficacy of Tg in adults because the data are equivocal. Well-designed randomized placebo-controlled trials are required to investigate further the effect of iodine supplementation on Tg.



Microscopic view of a goiter:
thyroid follicles distended with thyroglobulin

school-age children appear to support the 13 µg/L cutoff. However, the relationship between UIC and Tg is not always consistent, suggesting that Tg alone should not be used in this age group.

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More iodine recommended for U.S. pregnant and lactating women

A policy statement developed by the American Academy of Pediatrics (AAP) appeared in the journal *Pediatrics* on May 26. It recommends iodine supplementation for breastfeeding mothers and recommends that young infants not be exposed to tobacco smoke or drinking water with excess nitrate. The AAP calls for better labeling of supplements to reflect their actual iodide content. It also calls on the federal government to adopt a national primary drinking water regulation for perchlorate and encourages state and local governments to enact clean-air and smoke-free legislation. This is the first time that the AAP has issued a statement on iodine. The document is available to download at:

<http://pediatrics.aappublications.org/content/133/6/1163.full.html>

By iodizing table salt in 1924, the U.S. had largely eliminated the endemic “goiter belt.” But since the 1970s, median iodine levels have decreased, and today around one-third of U.S. pregnant women are marginally iodine deficient (1). This status is often attributed to an increase in the consumption of processed foods, which use non-iodized salt. Although the American Salt Institute supports the goal of universal salt iodization, processed food manufacturers have been reluctant to switch to iodized salt, quoting their concern that the taste or other characteristics of the food would be altered.

The American Thyroid Association (2) and the National Academy of Sciences (3) recommend that breastfeeding women should consume 290 µg of iodide per day, which generally requires a supplement containing 150 µg of iodide (combined iodide intake should be between 290 and 1100 µg per day). It is thought that only 15–20% of American pregnant and breastfeeding women take supplements that contain any iodide (4), and many of these supplements may be inadequately formulated and labeled.

In addition to causing harm to the developing nervous system, iodine deficiency may also make the mother and child more vulnerable to some environmental pollutants. Iodide is transported into the thyroid gland and into breast milk via the sodium-iodide symporter (NIS), a protein in the cellular membrane. Although the NIS has a high affinity for iodide, other anions such as thiocyanate, nitrate, and perchlorate can compete with iodide for uptake. This may decrease iodide concentration in the thyroid or breast milk and augment the effects of iodine deficiency.



Breastfeeding sharply increases iodine requirements

Exposure to thiocyanate comes mainly from cruciferous vegetables and tobacco smoke. Nitrate can be found in some leafy and root vegetables, but the main source of excess exposure is drinking water. Although municipal water supplies are regulated in the U.S., nitrate is a common pollutant of private wells. Perchlorate (ClO_4^-) is used industrially as an oxidizer and has become a widespread environmental contaminant. The Environmental Protection Agency (EPA) detected it in about 4% of U.S. drinking water systems (5). It has also been found in cow's milk and several varieties of food. NHANES (2001–2002) samples revealed widespread human exposure to perchlorate, and a median urine perchlorate concentration of 3.6 µg per g of creatinine (6).

Perchlorate exposure and excretion were also found to be significantly higher in breastfed infants (7).

To limit exposure to thiocyanate and nitrate, young infants should not be exposed to tobacco smoke or drinking water with excess nitrate. Clinicians should advise pregnant women not to smoke and to avoid all exposures to second-hand tobacco. On the other hand, dietary nitrate and thiocyanate do not appear to increase a child's exposure during breastfeeding. And because few infants consume large quantities of cruciferous, leafy, or root vegetables, these sources are not of concern.

The current state of discordance between the label and the actual content of iodide in supplements is unacceptable. The FDA is aware of this situation and was investigating it in the fall of 2013. The statement recommends that the FDA corrects this situation and, if voluntary action on the part of the suppliers is insufficient, do what is necessary to allow consumers to identify and use iodide supplements with confidence.

The statement also recommends that clinicians advise women who are pregnant or planning to become pregnant to take a daily supplement with at least 150 μg of iodide. If the mother is vegan or does not consume dairy or fish, testing urine to check for iodine deficiency may be indicated.

The AAP policy statement has been widely recognized as timely and commended for acknowledging the importance of iodine in early neurodevelopment.

In June, the journal *Pediatrics* published a letter by Leung et al., in which the authors expressed two concerns about the policy. Firstly, they suggest that the recommendation to take a supplement with “at least” 150 μg of iodide should be hedged with a clear warning about the potential toxicity of excess iodine (above 1100 μg daily). Secondly, they draw attention to the limitations of measuring UIC to determine iodine status in women at risk of deficiency. Due to the substantial day-to-day and hour-to-hour variation in urinary iodine excretion, this method does not accurately determine iodine status in individuals (9).

The U.S. Council for Responsible Nutrition (CRN), a leading trade association representing the dietary supplement industry, urged supplement manufacturers to review the policy’s recommendations particularly about the dose and form of iodine. CRN has compared the current situation to that of folic acid several decades ago, when scientific and policy communities, and the industry came together to establish the recommendations for intake, which resulted in significant reductions in neural tube birth defects. CRN hopes to see similar support develop for iodine supplementation.

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Why are iodine supplements recommended? A pediatrician's view

Excerpted from an interview by the Medscape's Stephanie Cajjal with Heather L. Brumberg, MD, MPH.
Full interview is available here: <http://www.medscape.com/viewarticle/829448#1>

Why do clinicians need to be aware of [iodine deficiency]?

We know that iodine deficiency in the United States is occurring at least marginally in about one third of pregnant women (1). Also, this deficiency may be compounded by environmental exposures that are ubiquitous: for example, perchlorate, which may take the place of iodide and thus make iodide less available for the thyroid and for breastmilk (2).

Which health providers are you targeting with this message?

The message is targeted to pediatricians and any caregivers of pregnant women, women who intend to become pregnant, and breastfeeding moms—and in theory, even internal medicine doctors. Many different providers come in contact with breastfeeding moms, pregnant women, or women who intend to become pregnant. It's important in preconception health counseling, too.

How do you envision providers responding to these recommendations?

Caregivers of pregnant women, women of reproductive age who are intending to become pregnant, and breastfeeding moms should encourage the use of supplements with adequate amounts of iodine. Also, when patients are using salt, caregivers should encourage them to use iodized salt.

Breastfeeding moms should avoid excess nitrates, which can occur in well water, because it could interfere with the body's handling of iodine. As a corollary, the American Academy of Pediatrics recommend that all well water should be tested for nitrate levels annually to help prevent too high an exposure to nitrate.

Furthermore, tobacco smoke is a source of thiocyanate, which can compete with iodine. So, it's another reason not to smoke and to avoid secondhand smoke. Caregivers

and interested providers should support and advocate for the Environmental Protection Agency's regulation of perchlorate levels in water. And they can support and advocate for the US Food and Drug Administration's (FDA's) correction of the inconsistent and inadequate content of iodine in supplements and inaccurate labeling of such.

How common is it for supplements to not be labeled accurately?

A 2009 study in the *New England Journal of Medicine* (3) looked at the iodine content of prenatal multivitamins and found a lower content than what is actually needed by a pregnant woman or a lactating woman in many of the vitamins tested, as well as a discordance between what was labeled as the amount of iodine vs. what was actually in the vitamin. In addition, 13 of the brands studied had levels of iodine that were discordant by 50% or more, and 10 of those brands had values that were lower by 50% or more.

Are physicians not having these conversations with women?

I think a lot of the recommendations are not being done. Providers should be making the recommendations to avoid the environmental exposures—the nitrates in well water and thiocyanate in smoke. In addition to being aware of the environmental exposures that may affect the uptake of iodine, it is important for providers to counsel women to be aware that supplements need adequate iodine content.

Should these recommendations be a part of every consultation?

Absolutely, because they involve behaviors that could be easily changed. These aren't hard things to incorporate into your life: taking supplements, using iodized salt, making sure your well water is tested, and avoiding tobacco smoke.

Could dietary modifications negate the need for supplements?

It would be difficult to get all of the necessary iodine through diet alone, especially because intake of seafood is encouraged, but in limited amounts during pregnancy. Dairy food, such as cow's milk or yogurt, could help, as well as iodized salt. However, iodine content is not always noted in all foods, making it even more challenging to accurately assess.

Therefore, it's probably safest to have a daily supplement containing adequate amounts of iodine. This would obviously not be an additional supplement besides the prenatal vitamin, but instead should be solely the prenatal vitamin, as long as it contains enough iodine. Even this is difficult, because few supplements contain adequate amounts of iodine and labeling issues persist. But the FDA is moving to correct this.



Heather L. Brumberg, MD, MPH, is Associate Professor of Pediatrics and Clinical Public Health at New York Medical College, and a member of the AAP Council on Environmental Health.

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Salt iodization in Bangladesh: leaving no household behind

The Bangladesh Small and Cottage Industries Corporation (BSCIC), with the financial and technical support of GAIN, convened a day-long national workshop on 21 May 2014 in Dhaka, Bangladesh, on improving access to quality iodized salt for Bangladeshis.

Led by key government and industry partners, the workshop aimed to build a shared understanding and consensus on Quality Assurance and Quality Control (QA/QC) measures, identify better delivery models, and create an enabling environment for salt mill owners and consumers. Ultimately, the day helped to facilitate decisions on how to achieve universal access to high-quality iodized salt for the most marginalized people, with a special focus on children and women.



All Bangladeshi families need to have ready access to iodized salt

The Government of Bangladesh first committed to eliminating IDD in 1989, when the Ministry of Industries established the Control of Iodine Deficiency Disorder (CIDD) Project through universal salt iodization (USI) within BSCIC. Since then, the project has focused on the quality of iodized salt from production to consumption, and the Ministry has committed to supplying adequate iodized salt for 90% of households by 2016. The Ministry receives ongoing support from GAIN and its partner on the



USI Partnership Project, UNICEF, as well as the Micronutrient Initiative. GAIN and the Ministry have committed to working together to strengthen QA/QC of USI in the country.

By including salt-related businesses (producers, wholesalers, and retailers) and other key stakeholders, the workshop built a consensus on better monitoring and law enforcement in the production, procurement, and sale of adequately iodized salt.

Mr. Amir Hossain Amu, MP, Honorable Minister, Ministry of Industries, said: “I congratulate the BSCIC and GAIN for organizing such a timely workshop to work out a strategy to increase the coverage of adequately iodized salt from the present 58% to 90% by 2016. I would like business enterprises to supply iodized salt at an affordable price to the most vulnerable people. I also reiterate that the government will support the millers to improve their facilities so they can produce adequately iodized salt. I look forward to GAIN’s technical support for both the salt iodization and edible oil fortification programs.”

Mr. M. M. Neazuddin, Secretary, Ministry of Health and Family Welfare, said: “The government of Bangladesh is com-

mitted to supporting the cause to combat iodine deficiency through Universal Salt Iodization in the country.” He reiterated that the Ministry of Health will provide leadership to disseminate the message, ensure enforcement, and provide strategic guidance and support to make it a successful program.

Mr. Shyam Sunder Sikder, Chairman BSCIC, said: “BSCIC will develop a sustainable model so that the activity of the present project can be transformed into a regular program to support the government in monitoring the USI program, so that 90% of Bangladeshis can consume adequately iodized salt.”

About CIDD Project/Ministry of Industries

Bangladesh Small and Cottage Industries Corporation (BSCIC) initiated the Control of Iodine Deficiency Disorders (CIDD) Project through the Universal Iodization of Salt Project in 1989. The Global Alliance for Improved Nutrition (GAIN), UNICEF, and the Micronutrient Initiative (MI) are official partners of the project. The program is in its third phase and targeted to reduce iodine deficiency by increasing production and consumption of adequately iodized salt to 90% of the population, including newborns, by 2016.

Teaching students about iodine: an eye-catching article in ‘Science in School’

Frithjof C Küpper, Martin C Feiters, Berit Olofsson, Tatsuo Kaiho, Shozo Yanagida, Michael B Zimmermann, Lucy J Carpenter, George W Luther III, Zunli Lu, Mats Jonsson and Lars Kloo

Excerpted from an article published in *Science in School*, Issue 27: Autumn 2013; 45–53 www.scienceinschool.org

Iodine, with its characteristic purple vapors, has myriad applications—from the familiar disinfectant to innovative solar cells.

Iodine discovery

The discovery of iodine can be traced back to the 19th century and the Napoleonic wars. With the British imposing a blockade on European ports, the French were faced with shortages of saltpeter (KNO_3) for manufacturing gunpowder. Chemist Bernard Courtois investigated the potential of seaweed (brown algae, *Laminaria* sp.) as the potassium source for this crucial substance. He added concentrated sulfuric acid to seaweed ash and was surprised by the beautiful purple fumes that were produced.

Although Courtois suspected that his purple vapor was a new element, he did not have the financial means to follow up his research. It was left to his colleagues, including Joseph Gay-Lussac, to confirm his results and name the element iodine, from the Greek word *iodēs*, which means purple or violet.

Gay-Lussac went on to investigate the chemistry of iodine, and despite the war, the French chemists found ways to correspond with British chemists, notably Sir Humphry Davy. Initially, Davy believed the vapor to be a chlorine compound, but soon concluded that it was indeed a new element.

With the help of X-ray absorption spectroscopy, we now know that seaweeds accumulate iodine as iodide (I^-), which acts as an antioxidant to protect them against oxidative damage caused by atmospheric ozone (O_3). This goes some way to explaining why trace amounts of molecular iodine (I_2) can be detected in the atmosphere of



Iodine produces characteristic purple fumes
(Photo credit: Jurii/Wikimedia Commons; CC BY 3.0)

coastal regions and why iodine intake in these regions is dependent on seaweed abundance rather than proximity to the sea.

For much of the next century, iodine continued to be extracted from seaweed. Today, however, it is removed from natural iodine-containing brines in gas and oil fields in Japan and the USA, or from Chilean caliches (nitrate ores), which contain calcium iodate ($\text{Ca}(\text{IO}_3)_2$). The iodine is supplied to the market as a purplish-black solid.

Iodine chemistry

Iodine belongs to the halogens, and thus shares many of the typical characteristics of the elements in this group. Because of its high electronegativity, iodine forms iodides with most elements in its formal oxidation state, -1 . Many iodine-containing compounds are frequently used as reagents in organic synthesis—mainly for iodination, oxidation, and C-C bond formation.

Iodine in the atmosphere originates mostly from biological and chemical processes in the ocean—such as the iodide antioxidant system in seaweeds. Most iodine is ultimately removed from the atmosphere by cloud formation. In the ocean, iodine is mainly dissolved and exists as iodate (IO_3^- , oxidized form) and iodide (I^- , reduced form). In the Earth’s outer layer (the lithosphere), most iodine is in marine and terrestrial sediments; iodine levels are low in igneous rocks.

Industrial uses of iodine

Iodine and its compounds are used in myriad products, from food and pharmaceuticals, through to animal feed and industrial catalysts (Figure 1). For instance, iodine is a potent antimicrobial. For more than a century, iodine tincture—a mixture of ethanol, water, iodine, and potassium iodide—was used as an antiseptic for wounds. This has now largely been replaced by water-soluble ionophores (iodine complexed with surfactants), which are less irritating to the skin. For example, povidone iodine, a mixture of polyvinylpyrrolidone and iodine, is used widely as a surgical scrub.

In the industrial production of acetic acid, iodine compounds such as rhodium iodide (the Monsanto process) or iridium iodide (BP's Cativa process) are used to catalyze the carbonylation of methanol.

Silver iodide (AgI), used in early photographic plates, is used today in cloud seeding to initiate rain and to control climate. Because AgI has a similar crystal structure to ice, it can induce freezing by providing nucleation sites. This was done at the 2008 Beijing Olympics to prevent rainfall during the opening and closing ceremonies.

With its high atomic weight (126.9) and large number of electrons, iodine is also an excellent X-ray absorber and is used in

X-ray contrast media. These substances are generally safe to administer to humans and enable the visualization of soft tissues in X-ray examinations.

A more everyday application of iodine is in liquid-crystal displays for TVs, computers, and mobile phones, which use polarizing films to filter light. These films are commonly made of polyvinyl alcohol layers doped with iodine. Here, iodine acts as a cross-linker and ensures that the structure is polarizing.

Iodine in the energy industry

Iodine is used in one of the most promising solar cells on the market for the production of low-cost “green energy”: the dye-sensitized titanium oxide solar cell. Also known as the Grätzel cell after one of its inventors, it consists of polyiodide electrolytes as the charge transport layer between the cathode and the anode (1).

Of the 37 known isotopes of iodine, all but one, ^{127}I , are radioactive. Most of these radioisotopes, which are produced via fission reactions in nuclear power plants and weapons, are short-lived, which makes them useful as tracers and therapeutic agents in medicine. For example, iodine isotopes can be used to image the thyroid gland, which absorbs radioactive iodine when it is

injected into the bloodstream.

Unfortunately, radioactive ^{131}I , released from nuclear accidents—such as the disaster in Fukushima, Japan, in 2011—is also taken up by the thyroid. Because it is a high-energy β -particle emitter, it damages cells and induces cancer. To counteract this effect, nonradioactive potassium iodide (KI) tablets are ingested to saturate the thyroid's ability to take up radioactive iodine.

These are just a small sample of the many applications of iodine. Clearly, although the element has been known for only two hundred years, it is well established in modern chemistry, physics and medicine.

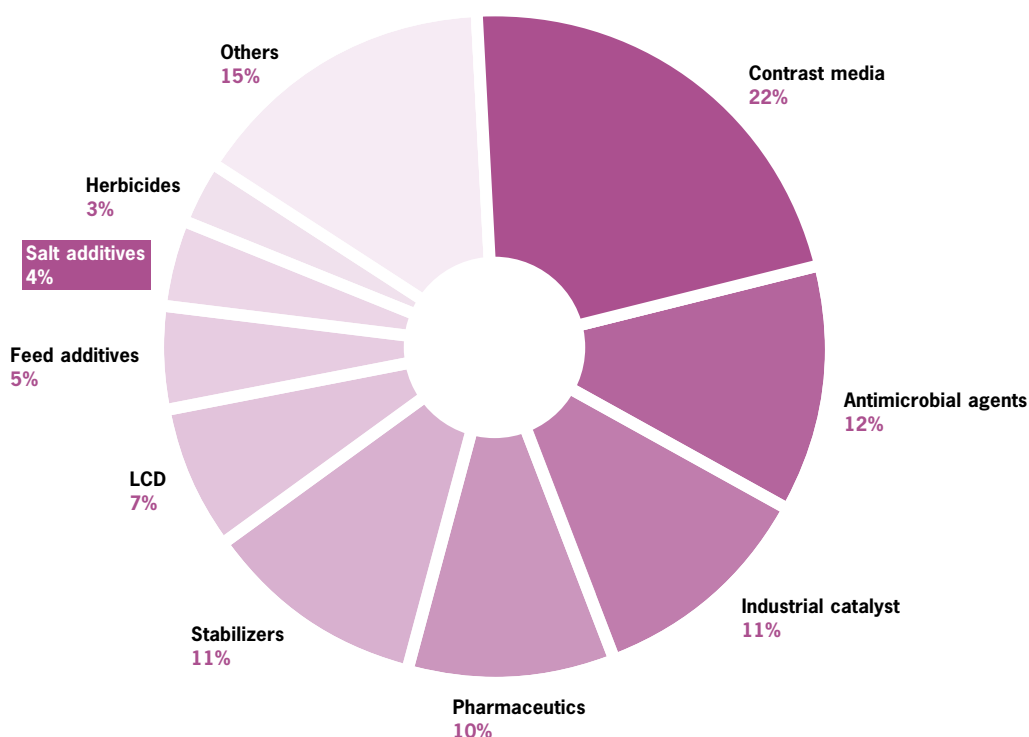
Acknowledgement

This article was adapted from a much longer publication in *Angewandte Chemie International Edition* (2).

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FIGURE 1 The major industrial uses of iodine



Iodine biomarkers: a new interactive web interface

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Background

The role of food and nutrition in health promotion and disease prevention is irrefutable, and the ability to assess this relationship is contingent upon having accurate and reliable nutritional biomarkers. The need for better data on the prevalence of health conditions and micronutrient deficiencies to guide intervention programs nationally and set priorities globally has been codified in the Lancet series on maternal and child undernutrition (1). To address this need, the Biomarkers of Nutrition for Development (BOND) project was initiated in 2010 led by the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD)/National Institutes of Health (NIH) and supported by a consortium of public (NIH, CDC, USDA, USAID) and private (Bill and Melinda Gates Foundation, PepsiCo) entities. The BOND project has two separate but complementary tracks:

- The **Translational Track** is focused on a process to i) harmonize the approach to decisions about what biomarkers are valid and reliable across a range of uses at clinical and population levels, and ii) develop materials based on a review of the available evidence to inform various user groups (i.e., researchers, clinicians, programmers, policymakers) about appropriate biomarker selection, and their use and interpretation.
- The **Research Track** is focused on the development of a targeted research agenda to address knowledge gaps along with new approaches to discovery, development and implementation of new biomarkers.



The BOND web interface provides clear guidance to choose from the different iodine biomarkers

The BOND process

The initial phase of BOND project focused on six “case study” nutrients: iodine, vitamin A, iron, folate, vitamin B12 and zinc, chosen by the BOND Steering Committee for their public health importance and because they represent the range of challenges confronting the user communities. For each nutrient, an expert panel was constituted and charged with the development of comprehensive reviews covering key issues pertaining to their respective nutrients, the available biomarkers (relative strengths, weaknesses, technological requirements), research needs, and potential new biomarkers and related technologies. To support their deliberations, each expert panel had an opportunity to convene a 2-day nutrient-specific consultation to bring in additional expertise. After the consultation, the panels assessed the existing literature and completed their reviews. The completed draft reviews are undergoing a process of review and preparation to be posted as part of the BOND website. In addition, each review is also being published in a peer-reviewed journal.

Iodine was the first nutrient considered under BOND, and the iodine review has very recently been published in the *Journal of Nutrition* (2). The Expert Panel members include Dr. Michael Zimmermann (Chair, ICCIDD GN Executive Director), Dr. Fabian Rohner (GroundWork, LLC), Dr. Pieter Jooste (ICCIDD GN Regional Coordinator for Southern Africa), Dr. Chandrakant Pandav (ICCIDD GN Regional Coordinator for South Asia), and Dr. Kathleen Caldwell (Centers for Disease Control and Prevention).

BOND Query Based System (QBS) for iodine

One of the important objectives of the BOND project is to translate the existing evidence made available through the expert panel reviews to the wider audience through the BOND website. The website presents an overview of BOND, including links to all participating organizations and key resources. Of importance to the readers of the IDD Newsletter is the launch of the Iodine Query Based System (QBS) on the BOND website (3).

Recommended Biomarker
Based on your response, the best biomarker for assessing Iodine Status in your study sample 14-18 years, 19-30 years is:

- Urinary Iodine
 - Cut-off Value
 - Factors To Consider
 - Technical Consideration

Select this [Back to Start](#) link to return to the Query Based System.
You can also review the [guidance](#) of all the biomarkers available for Iodine.

Urinary Iodine
Cut-off value:

Cut-offs: Urinary iodine cut-off for non-pregnant women is not well established.

Table for School Children

Median UI (µg/L)	Iodine Intake	Iodine Nutrition	
Age group: 4-8, 9-13, 14-18			
<20	Insufficient	Severe iodine deficiency	WHO 2007, ¶ (PDF - 726 KB)
20-49	Insufficient	Moderate iodine deficiency	
50-99	Insufficient	Mild iodine deficiency	Zimmermann MB, 2013, ¶
100-199	Adequate	Optimal	
200-299	Above Requirement	Likely to provide adequate intake for pregnant/lactating women but may pose a slight risk in the overall population.	
>300	Excessive	Risk of adverse health consequences (iodine-induced hyperthyroidism, autoimmune thyroid disease)	

References:
World Health Organization UNICEF, International Council for Control of Iodine Deficiency Disorders. Assessment of iodine deficiency disorders and monitoring their elimination: a guide for programme managers. Geneva: World Health Organization; 2007.
Zimmermann MB, Iqbal SK, Anderson M, Assary J, Fong JH, Joseph P, Jialit T, Kafaru D, Kusic Z, Pretell E, et al. Thyroglobulin is a sensitive measure of both deficient and excess iodine intakes in children and indicates no adverse effects on thyroid function in the IUC range of 100-299 µg/L: a UNICEF/ICDD study group report. *J Clin Endocrinol Metab*. 2013; 96(2): 1271-80.

A snapshot of the iodine Query Based System (QBS) output on the BOND website

The QBS is an interactive tool that provides users with customized advice derived from the work of the nutrient expert panels about appropriate biomarker(s) to meet their specific needs and conditions of use. For example, if a program manager from sub-Saharan Africa wants to know which iodine biomarker to use for measuring iodine status in their study population (e.g. school-age children), they can access QBS and receive a recommendation on the biomarker by answering a series of questions. The uniqueness of the tool lies in that it is inclusive and provides biomarker information to different user groups (researcher/clinician/program manager/policymaker) in both developing and developed countries, irrespective of their expertise. All the information provided in QBS is backed by scientific evidence and linked to relevant publications in the PubMed whenever possible.

In addition to recommending a biomarker, the QBS informs the user about the caveats to consider (when using a given biomarker), lab methods and cut-off values for the biomarker. The BOND Secretariat encourages the readers of the IDD newsletter to visit the BOND website/QBS and provide input. That input will be used to determine new directions for BOND and related activities. In the upcoming months the BOND Secretariat is planning to launch QBS for folate, zinc, iron, vita-

min A, and vitamin B12. For any feedback regarding the use of the website and the QBS in particular, please e-mail us on NICHDGlobalNutrition@mail.nih.gov.

Next phase of BOND

Based on the inputs received during the first wave of nutrients, the next phase of BOND will adopt a systems biology approach to consider nutrients as they interact within systems. Using a nutrient cluster approach, BOND phase II will potentially address i) Biomarkers in Growth (BIG), intended to focus on biomarkers of linear growth and body composition which could include

e.g. vitamin D, calcium, magnesium and phosphorus; and, ii) Micronutrients in Neurological Development (MIND), to address the role and assessment of micronutrients in neurological development and those biomarkers/tools that may further the understanding of these relationships, and to evaluate the impact of interventions to improve cognitive/behavioral outcomes. BOND will incorporate the recommendations of the expert panel addressed in the initial phase into the appropriate nutrient cluster.

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Other relevant BOND publications:

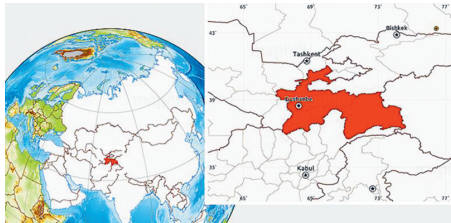
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At the BOND Iodine Consultation: Expert Panel members, invited speakers, and BOND Secretariat

IDD continues to threaten health and development in South Tajikistan

Abridged from: **Matthys et al. Iodine nutritional status and risk factors for goiter among schoolchildren in South Tajikistan. BMC Endocrine Disorders. 2013; 13: 50** <http://www.biomedcentral.com/1472-6823/13/50>



The independence of the Central Asian region from the Soviet Union in 1991 and the subsequent civil unrest in Tajikistan led to discontinuation of salt iodization programs in the country, resulting in an increase in IDD. The government of the Republic of Tajikistan designed legislation on salt iodization and launched the National Program for Elimination of IDD in 1997. The law “On salt iodization,” regulating the production, distribution and consumption of iodized salt, was adopted in 2002 (1).

The National Program was implemented by specified institutions such as the Republican Clinical Endocrinology Centre, the State Sanitary Epidemiological Surveillance Service (SSESS), and the Healthy Lifestyle Centre, and supported by international partners, including UNICEF, ICCIDD, and the Aga Khan Foundation. At district level, school canteens are provided with iodized salt, schoolchildren are screened annually for goiter, and family doctors using rapid test kits monitor iodine content

in cooking salt samples at selling points and households.

A Tajik-Swiss team, led by Barbara Matthys from the Swiss Tropical and Public Health Institute in Basel, Switzerland, studied ten primary schools in four districts in South Tajikistan (Figure 1). In schoolchildren aged 7 to 11 years, a spot urine sample was collected for measurement of urinary iodine, dried blood spots were collected for measurement of thyroglobulin, and goiter was assessed by palpation. Iodine content of salt samples and local selling points was determined by coloration using rapid test kits and titration method.



The results are of major concern: among the over 600 schoolchildren enrolled, the overall median urinary iodine concentration was 51.2 µg/L indicating mild-to-moderate iodine deficiency.

Among all children, 46.6% were found to have goiter of which 16.0% was visible goiter. Median thyroglobulin concentration was modestly elevated in the overall sample, and strongly elevated in schools with the most severe iodine deficiency. One third of the salt samples were not iodized, one third insufficiently, and only one third adequately. These findings suggest little or no improvement of iodine status in this region over the past decade (2).

The study shows that IDD remains a serious health issue among schoolchildren in South Tajikistan, despite control interventions by the government of Tajikistan and international partners. Considering that IDD impairs intellectual function in children and salt iodization is an effective low-cost intervention, concerted advocacy to increase consumer and household demand for iodized salt are needed along with better monitoring of the quality of salt iodization.

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Representatives from 12 salt companies and other stakeholders attended the USAID-sponsored workshop

A workshop on quality control of USI in Tajikistan

USAID's Universal Salt Iodization (USI) project, implemented by GAIN with collaboration from UNICEF, convened a workshop on the Quality Assurance and Quality Control of USI on August 4–5, 2014. The workshop was facilitated by Dr. Azonov, Director of the Nutrition Institution under the Ministry of Industry and New Technologies, and Mr. Makhsum Saidov, Deputy Head of the State Unitary Enterprise Korporatsiya Khurikvori corporation. Representatives from 12 salt companies and other stakeholders including Tojikstandards and Kulob local government attended the two-day intensive workshop. The training was led by GAIN experts, and it included theory and practical demonstrations at the Khoja Mumin Salt Factory. Adequate iodine in the diet is particularly important in landlocked, mountainous countries, such as Tajikistan, with few other sources of iodine in the soil. Provided that all salt for animal and human consumption is consistently iodized at appropriate levels, salt iodization is a very effective strategy to eliminate iodine deficiency and protect the population against it. The quality assurance and control of salt iodization are, therefore, crucial components of any national salt iodization program.

New Iodine Nutrition Survey Toolkit

A Survey Toolkit for Nutritional Assessment has been developed by the U.S. Centers for Disease Control and Prevention (CDC)'s International Micronutrient Malnutrition Prevention and Control Program (IMMPaCt) to provide epidemiological support to countries that want to assess and monitor the elimination of micronutrient malnutrition. The toolkit can be accessed at: <http://www.micronutrient.org/nutritiontoolkit/index.htm>

The kit provides a set of tools collected from many sources, including public health specialists from the CDC and other agencies. New tools have been created where gaps existed. The toolkit provides:

- Public online access
- A search function that enables the user to identify the tools needed for a specific task or to work through the stages of survey planning and implementation step by step
- Examples of how the tools have been used in the field
- A collection of resources that will be updated as research and best practices evolve

Purpose

The Survey Toolkit for Nutritional Assessment obviates the need for survey planners to create various tools anew for each survey. It offers many specific benefits:

- Standardized tools that will enhance the likelihood of more reliable data collection, as well as a better comparison of results across different surveys
- Free software and macros that can assist in the entry and analysis of survey data
- Tools to inform planning, implementation of surveys, and dissemination of results
- Tools which have been utilized in multiple sites, in all regions of the world

- Potential capacity building of survey managers and people involved in planning and implementing surveys, and for using the data for program planning
- Potential cost reduction of surveys, as the need for external assistance during some phases of the survey may not be necessary
- Standardized tools and best practice guidelines, so data can be compared across countries and populations

Toolkit structure

The aim of the toolkit is to provide a set of resources that people can utilize as needed. It is structured in the sequence through which survey planning and implementation generally progress, but a menu system and search function can easily enable the user to select a particular phase of a survey or to identify a particular tool or resource.

Each module of the toolkit is divided into the following four sections:

1. **Overview** – provides a brief description of the purpose of the module and the variety of information it contains.
2. **Tools** – contains the generic tools and templates available in the module.
3. **Examples** – contains examples of tools used in other countries (i.e., different examples illustrate how tools can be adapted to fit different contexts).

4. **Resources** – contains useful resources related to the topics in the module.

Examples related to iodine are shown in *Table 1*.



Slide on goiter palpation from the Powerpoint presentation: "Clinical signs of micronutrient disorders" available in the toolkit

Target users

The toolkit is intended for use by governments, non-governmental organizations, independent research consultants, and United Nations agencies that conduct surveys. Ideally users will have some expertise in conducting surveys, as many of the materials contained in the toolkit will need to be adapted depending on the complexity of the survey and the specific context. Although most of the materials contained in the toolkit are nutrition related, there are some tools (specifically in the sampling module) that may be useful for other survey workers.

Technical assistance

Remote technical assistance for any aspect of the survey toolkit is available if needed via phone or e-mail:

Attn: IMMPaCt Program, Division of Nutrition, Physical Activity, and Obesity Centers for Disease Control and Prevention
Email: cdcinfo@cdc.gov

Telephone: +1 800-CDC-INFO (800-232-4636)

TABLE 1 Iodized salt

Criteria for assessing adequacy of salt iodization at the household level*		
Variable	Indicator	Household
Household use of iodized salt	Iodine content of household salt	Non-iodized salt 0 ppm (titration) No color change (field test)
		Iodized salt ≥ 0 ppm (titration) Color change (field test)
		Adequately iodized salt >15 ppm (titration)

* WHO/ICCIDD/UNICEF. Assessment of iodine deficiency disorders and monitoring their elimination: a guide for programme managers. 3rd edition. Geneva: WHO; 2007

International standards: improving the quality of iodized salt supplies

Frits van der Haar Global Public Nutrition Services, LLC and Visiting Associate Professor, Emory University School of Public Health, Atlanta, USA

Background

Since Universal Salt Iodization (USI) was first recommended as a key strategy for eliminating iodine deficiency in the 1990s, regulations on salt iodization have been enacted around the world. In 2008, UNICEF counted ongoing salt iodization strategies in around 120 countries (1). Salt iodization efforts straddle different interests across sectors of society, and effective follow-through of such regulations requires a collaborative partnership among public, private, and civic organizations, each with unique roles and responsibilities (2). Once salt iodization has been mandated, the salt industry has the duty to supply only salt with adequate iodine content as defined by a national standard. Setting iodization standards involves a number of considerations, including the habitual dietary iodine intake in the population and the intake shortfall to be made up. And in case the habitual consumption of sodium changes, there may be need to revise the prescribed salt iodine levels.

Although the IDD-related guidelines stress the importance of monitoring by health authorities (3), the production and quality performance of salt enterprises falls typically under the authority of a Ministry of Trade, Commerce and/or Industry. The ongoing consolidation of the industry, the rapid extension of new technologies into remote areas, and the proliferation of bi- and multi-lateral trade agreements make international standards increasingly important. And as these arrangements become adopted ever more widely, they can assist in promoting more permanent elimination of IDD by aligning the international standards with national USI strategies.

The World Trade Organization (WTO)

The WTO (4) deals with global agreements on the rules of trade between nations. Its main function is to ensure that trade flows as smoothly, predictably, and freely as possible. Based in Geneva, Switzerland, WTO came into being in 1995 as the successor to the General Agreement on Tariffs and Trade (GATT). In June 2014, the WTO website listed 160 member countries. Decisions in the WTO are taken by consensus and are then ratified by the member countries.

As a result of the WTO work, consumers and producers know they can expect more secure supplies and a greater choice of products, raw materials, and services. Producers and exporters know that foreign export markets will remain open to them. Any trade friction is channeled into WTO's dispute settlement procedures. The WTO agreements cover goods, services, and intellectual property and spell out the principles of trade liberalization and the permitted exceptions. They include individual countries' commitments to lower trade barriers and settle disputes; they prescribe special treatment for developing countries, and they require governments to make their trade policies more transparent. The WTO encourages its members to use international standards where they exist. For example on foods, an annex in WTO agreements specifically cites the FAO/WHO Codex Alimentarius Commission. If a country does apply international standards, it is less likely to be challenged legally in WTO than if it sets its own standards.

GATT remains the WTO's principal rule-book for cross-border trade. Through the GATT agreement, each WTO member receives guarantees that its exports will be

treated fairly and consistently in other countries' markets, and each promises to do the same for imports. Nevertheless, WTO has recognized human health as being highly important, and each WTO member retains the right to determine the level of health protection it deems appropriate. GATT permits member governments to restrict the import of products, including fortified foods (5), to protect the life or health of humans, animals, and plants in their own country, provided they do not use this as disguised protectionism.

There are two subordinate agreements relevant to these rights, namely on Technical Barriers to Trade (TBT) and on Sanitary and Phytosanitary Measures (SPS). The TBT aims to ensure that the regulations, standards, and certification procedures adopted by members do not create unnecessary obstacles for trade. TBT recognizes that each member has the right to adopt product standards it considers appropriate. Importantly, to uphold this right, the TBT only requires that state members *take available scientific information into account*, whereas the SPS requires that the member state should *demonstrate the scientific basis to justify a trade measure* aimed at a health risk (6). If the currently available scientific evidence is not sufficient, the SPS permits adoption of provisional measures, but ultimately the member state must produce scientific evidence.

The International Organization for Standardization (ISO)

The ISO is a non-governmental network of national standards institutes from 163 countries with a secretariat in Geneva. The organization develops and promotes international standards of desirable characteristics of products and services such as quality, environmental friendliness, safety, reliability, efficiency, and interchangeability at an economical cost. The widespread adoption of ISO standards means that suppliers can offer products that meet specifications with wide international acceptance. As a result, businesses that adhere to ISO standards can compete on more markets around the world. ISO standards are the technical means by which international trade agreements—such as the GATT, TBT, and SPS—help to overcome trade barriers by creating “a level-playing field” for competition. For governments, the ISO standards provide a technological and scientific basis for improved health, safety, and environmental legislation. And for consumers, conformity to ISO standards increases the confidence in the quality, safety, and reliability of products and services.

ISO initiates new standards in response to the needs of businesses, governments, or civic society. The ISO 9000 (7) family of „quality management“ standards define what an organization should do to fulfill the customer’s quality requirements and adhere to regulatory requirements, while aiming at customer satisfaction and improving its performance. Due to their wide adoption, the ISO 9000 standards have become an international reference for quality management in business-to-business dealings. Many large salt companies in the world show the ISO 9000 logo on their corporate website to demonstrate that their quality management systems have been certified in an external, ISO-affiliated assessment.

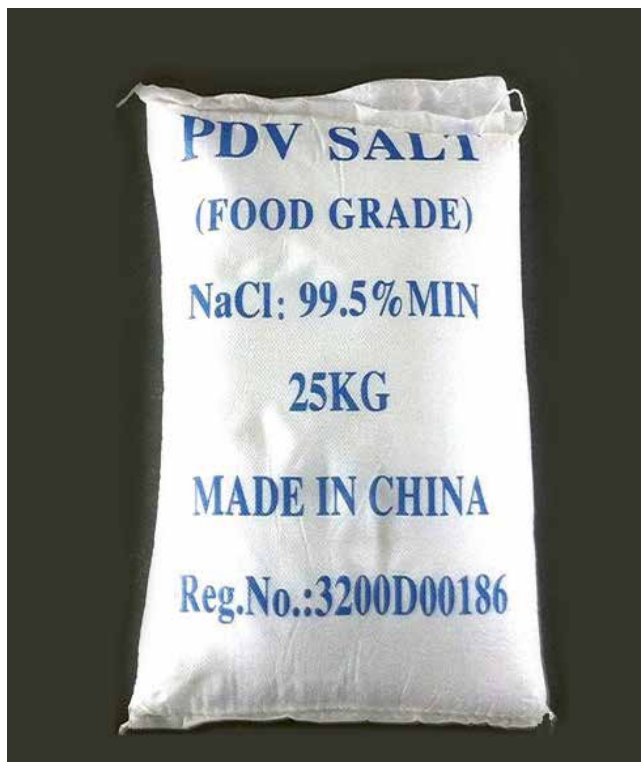
The Codex Alimentarius Commission

Codex Alimentarius (Latin for “food law” or “code”) was initiated in 1963 by FAO and WHO to provide an international reference of food standards that aim to protect the health of consumers, support fair practices in the food trade, and help coordinate the food standards work undertaken by international organizations (8). The part of the Codex Alimentarius most relevant to salt iodization is the *General Principles for*

the Addition of Essential Nutrients to Foods (CAC/GL 07-1987, amended 1989, 1991), which offers a set of over-arching principles and provides guidance in developing legal texts for the addition of essential nutrients to foods. Another important section of the Codex Alimentarius is named *Codex Alimentarius—Food labeling—Complete texts* and deals with labeling and claims issues.

The Codex Alimentarius Commission is an inter-governmental body, hosted by FAO in Rome, Italy, and constituted of a secretariat plus 29 committees open to all members of FAO and/or WHO. The two committees most directly related to fortification issues are the Codex Committee

prevent iodine-deficiency disorders (IDD) for public health reasons. For the fortification of food grade salt with iodine, use can be made of sodium and potassium iodides or iodates. The maximum and minimum levels used for the iodization of food grade salt are to be calculated as iodine (expressed as mg/kg) and shall be established by the national health authorities in the light of the local iodine situation. The production of iodized food grade salt shall only be performed by reliable manufacturers having the knowledge and the equipment requisite for the adequate production of iodized food grade salt, and specifically for the correct dosage and even intermixing.”



on Nutrition and Foods for Special Dietary Uses, hosted by the German government, and the Codex Committee on Food Labeling, hosted by Canada.

The Codex Alimentarius Commission has developed the *Codex Standard 150-1985 for Food Grade Salt* (9) which applies to salt as an ingredient of food, both for direct sale to consumers and for industrial manufacturing of processed foods. In harmony with the General Principles, Standard 150-1985 includes a special section on the use of salt as a carrier of food additives and/or nutrients, stating that: “In iodine-deficient areas, food grade salt shall be iodized to



Manufacturers of food-grade iodized salt strive to obtain ISO 9000 certification.

Implications

The above-referenced global agreements and international organizations will continue to expand over time. Being aligned, they are already offering an umbrella arrangement that can assist in the quality management of national salt iodization strategies while taking into account the interests of all stakeholders. ISO provides the product management standards and conformity rules to support the interests of salt producers and traders in fair competition and transparent trade. WTO member states are increasingly using the ISO standards in their regulatory oversight of the salt industry and in the mutual recognition of conformity certificates in cross-border trade. The Codex Alimentarius standard for food-grade salt offers a global endorsement to salt iodization in the interest of protecting the health of consumers, and the SPS agreement requires member states to produce scientific evidence in case of a trade measure against iodized salt and/or foods manufactured with the use of iodized salt.

Current international salt trade patterns show that in a large number of countries the national salt supply depends entirely or largely on outside suppliers. For example, in the 16 countries of East and Southern Africa, the salt supplies originate from large-scale producers in only six countries: Eritrea, Kenya, Tanzania, Botswana, Republic of South Africa, and Namibia. In West and Central Africa, the major salt suppliers are located in only two countries: Senegal and Ghana. Almost the entire salt consumption of Nigeria is shipped in from North-Eastern Brazil, while much of the salt consumed in South and South-Eastern Asian countries is

supplied by large salt companies in India, Australia, and China.

Clear, agreed-upon, and transparent international standards on quality management and predictable trade are of keen interest to these producers and their allied traders. Many have strived to obtain ISO 9000 certification, thereby signaling their ability and comfort of operating under global governance rules. The adoption of ISO standards by WTO members implies that the authorization and certification of these enterprises by a parent Ministry of Trade & Industry are typically conducted according to the same global rules. Therefore, when salt iodization is compulsory, the product and its quality assurance management practices, the packaging (labeling, claims etc.), and the certification at sales release are subject to mandatory inspection and review by the relevant Ministry as an integral part of the authorization process. For consumers in importing countries, adherence to this system increases their confidence of being sold a product of good value at an acceptable price. The fact that in WTO history not a single dispute case has been submitted on iodized salt or on foods manufactured with it suggests that the international salt trade proceeds with little risk. Aligning the national oversight function of salt iodization strategies with the system described for international trade would lessen the burden on the food and/or sanitary control authorities related to inspection and enforcement of national USI regulations in the market.

The author is grateful for the contributions by Pieter Jooste and Kimberly Harding.

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9. http://www.codexalimentarius.net/web/more_info.jsp?id_sta=3 (CODEX STAN 150-1985, Rev. 1-1997, Amend. 1-1999, Amend. 2-2001, Amend. 3-2006)

Bridging science and programs: iodine highlights from the 2014 Micronutrient Forum

Source: www.micronutrientforum.org

The 3rd Micronutrient Forum Global Conference was held in Addis Ababa, Ethiopia on 2–6 June 2014 and marked the revival of the Micronutrient Forum. The meeting brought together an estimated 1,000 leading nutrition, food security, global health, and sustainable agriculture experts and practitioners from all over the world.

organizations presenting at the conference included the United Nations World Food Program, the World Bank, UNICEF, the Bill and Melinda Gates Foundation, USAID, MI, GAIN, and WHO.

ICCIDD Global Network (GN) had a strong presence at the Forum, taking the lead in several well-attended sessions.

The first, coordinated by Dr. Roland Kupka, Senior Advisor on Micronutrients at UNICEF and ICCIDD GN Board Director, focused on optimizing iodine status in the context of salt reduction strategies. The second, coordinated by Prof. Michael Zimmermann, Executive Director of the ICCIDD GN, examined recent evidence on iodine interventions from randomized controlled trials. ICCIDD GN, with support from the Micronutrient Initiative, also sponsored a symposium dedicated to two decades of progress against

IDD in Africa, which examined how science and policy have been used to build sustainable nationally-owned programs. Regional progress and challenges across Africa were highlighted in presentations by the three ICCIDD GN Regional Coordinators in Africa, Dr. Vincent Assey, Dr. Roland Kupka and Prof. Pieter Jooste. Greg Garrett, Director of Mass Fortification at the Global Alliance for Improved Nutrition (GAIN) highlighted the importance of private-public partnerships in salt

iodization programs. In other places, nutrition hasn't been given due attention in Ethiopia until recently," he explained. "As of the past few years, both at the governmental and the administrative level, we are working alongside the implementation of the national nutrition programs. We are already noticing a lot of changes in terms of reducing problems related to malnutrition."

Between 2005 and 2010, only 15–20% of households in Ethiopia were using adequately iodized salt, about a third of all school-age children living in endemic regions had goiter, and the national median urinary iodine concentration (MUIC) was 24.5 µg/L (IDD Newsletter, May 2014). Since the introduction of mandatory salt iodization in 2011, the country's salt supply has changed dramatically. Ethiopia has successfully developed new production sites, and salt processors have made great progress in increasing the supply of adequately iodized salt to the population.

Abstracts, presentations, and posters from the Micronutrient Forum Global Conference in Ethiopia will be made available on the organizer's website: www.micronutrientforum.org/events/outcomes. The next Micronutrient Forum will take place in 2016 in Cancun, Mexico.

About the Micronutrient Forum

The Micronutrient Forum is a consultative group, representing a cross-sector approach with stakeholders from nutrition, health, agriculture, social protection, food security, and the private sector. It brings together the most exciting and current research and programming on nutrition, with the focus on micronutrients, to provide an arena for the best evidence-based approach for programming.



An infographic promoting the June 2014 event

The theme of this year's conference, "Bridging Discovery and Delivery" was driven by the need to approach micronutrient malnutrition differently than in the past by strengthening the link between research, policy, and practice. Global agencies and

iodization programs.

Amha Kebede, Director General of the Ethiopian Public Health Institute, believes that choosing Ethiopia to host the forum was apt, since its aim was to raise awareness and advocate for nutrition. "Like in many

MEETINGS AND ANNOUNCEMENTS

The Philippines launches “Exact Iodine in Salt”

Source: Teofilo San Luis, ICCIDD Global Network National Coordinator for the Philippines, and PIA News



Diamond-shaped SIS seal symbolizing adequately iodized salt was revealed during the launch.

On June 20, the Philippine Department of Health in collaboration with partner agencies conducted a soft launch of the “Saktong Iodine sa Asin” program (translated as “Exact Iodine in Salt”) in Cebu City. The main aim of the program is to raise the awareness of adequate iodine nutrition achieved through salt iodization.

Launching it were the Department of Health’s Assistant Secretary Enrique Tayag, the National Nutrition Council’s Executive Director Maria Bernardita Flores, FDA Director-General Kenneth Hartigan Go, and UNICEF’s Deputy Country Representative Abdul Alim. A diamond-shaped SIS Seal was unveiled during the launch, which is to be displayed on all adequately iodized

salt available on the market. The hard launch will be scheduled in Manila later.

Despite the promulgation of the ASIN Law (or “An Act for Salt Iodization Nationwide”) in 1995, a 2008 National Nutrition Survey reported that only 25% of the iodized salt reaching households contained adequate iodine. This contributed to the 25.7% prevalence of IDD among pregnant women and 34.0% among nursing mothers. The same survey showed that the 30 food items commonly consumed by pregnant and lactating women contributed very little to their daily iodine intake. In order to specifically address IDD, the DOH implemented the National Salt Iodization Program (NSIP) 2011–2016 Strategic Plan. The Nutritional Guidelines for Filipinos (NGF) revised in 2012 recommend the use of iodized salt to prevent IDD.

Earlier this year, the National Nutrition Council (NNC) reactivated the Regional Bantay Asin Task Force (RBATF) in an effort to manage and coordinate the NSIP in Central Luzon. RBATF is expected to lead the advocacy for full and effective implementation of the ASIN Law. The group will formulate an annual NSIP operation plan to monitor and evaluate the program, coordinate and provide assistance especially among salt traders and manufacturers, make policy, and formulate strategies to enhance the awareness of the importance of iodization among the general public.

In Memoriam

Dr Théophile Ntambwe (1953-2014)



Dr Théophile Ntambwe passed away on August 4, 2014 at the age of 61. With this loss, the ICCIDD Global Network lost one of its Senior Advisors and a champion in the fight against iodine deficiency disorders in Africa. Dr Ntambwe held many senior positions in his native DR Congo, where he directed the National Nutrition Program and led the implementation of the successful national IDD program. In recent years, he supported numerous other country programs in West and Central Africa in the design of national IDD elimination programs. He suddenly passed away while completing an assignment to strengthen the SUN Movement in Cote d’Ivoire. Dr Ntambwe is survived by his wife and six children.

Italy celebrates Thyroid Week

Francesco Vermiglio, Coordinator of the ICCIDD/ World Thyroid Day Commission of the Italian Society of Endocrinology

The 2014 Thyroid Week (19–25 May) was celebrated all over the world. In Italy, many initiatives and joint actions were organized and promoted by the European Thyroid Association (ETA) together with a variety of medical societies and patient groups. The theme of this year’s Thyroid Week: “The thyroid as a social problem: from the body to the mind” was chosen to provide a broad platform from which to share knowledge and understanding of thyroid diseases. Members of the participating scientific bodies responded enthusiastically to the call to organize interactive events involving members of the public. Scientific gatherings for physicians, patients, students, and the media were held in Catania (Sicily) and Rome (Lazio). The ATTA (Associazione dei malati di Tumori della Tiroide e Associati) in Lazio held a series of “Meet the teachers and the school children” events in Anzio and Viterbo which were broadcast on the radio, while ATTA-Palermo (Sicily) organized meetings, charity shows, and free clinical screening for the local population. Systematic screening for thyroid diseases was also offered free of charge in Pisa (Tuscany), and questionnaires and educational brochures were distributed to the local population. A number of information desks were set up in bookstores in Messina (Sicily) to provide information, questionnaires, and educational brochures on thyroid diseases. A permanent program of screening and monitoring of maternal thyroid function, designed specifically to prevent the consequences of iodine deficiency in pregnant women, is now fully operational in Messina (Sicily). In Brindisi (Puglia), a counseling service was offered for pregnant women, thyroid meeting points were set up around town which provided free screening and distributed questionnaires and educational brochures.

ABSTRACTS

Monitoring salt and iodine intakes in Dutch adults between 2006 and 2010 using 24 h urinary sodium and iodine excretions

In a Dutch study, two cross-sectional studies among adults were conducted in 2006 and 2010 (2006: n=317, mean age 48.9 years, 43% men; 2010: n=342, mean age 46.2 years, 45% men), using identical protocols. Participants collected single 24 h urine samples and completed two short questionnaires on food consumption and urine collection procedures. Daily intakes of salt, iodine, K, and Na:K were estimated, based on the analysis of Na, K, and iodine excreted in urine. While median iodine intake was lower in 2010 (179 µg/d) compared with 2006 (257 µg/d; P<0.0001), no difference in median salt intake was observed (8.7 g/d in 2006 v. 8.5 g/d in 2010). Despite initiatives to lower salt in processed foods, dietary salt intake remains well above the recommended intake of 6 g/d. Iodine intake is still adequate, although a decline was observed between 2006 and 2010. This reduction is probably due to changes in iodine policy.

Hendriksen MA, et al. *Public Health Nutr.* 2014;17(7):1431-8

Public health policy to redress iodine insufficiency in pregnant women may widen sociodemographic disparities

The aim of this New Zealand study was to evaluate the impact of a mandatory bread fortification program on estimated iodine intakes of childbearing women (n=723) and to describe the extent to which uptake of a maternal iodine supplement recommendation is associated with sociodemographic characteristics. A postpartum survey was conducted in maternity wards and hospitals using a self-administered questionnaire. Mean iodine intake from fortified bread was 37 µg/d prior to conception. Younger women, women with higher parity, single women, and those with unplanned pregnancies were less likely to meet the pregnancy Estimated Average Requirement (EAR) for iodine. During pregnancy, iodine-containing supplement uptake at the recommended level (150 µg/d) was non-uniform across sociodemographic subgroups, with the most disadvantaged women benefiting the least from this public health policy. The disparities in supplement uptake noted here highlight the need for prioritizing further efforts toward universal salt iodization, such as the mandatory fortification of additional processed foods with iodized salt.

Mallard SR, et al. *Public Health Nutr.* 2014 Jun;17(6):1421-9

Hair iodine for human iodine status assessment

The authors analyzed hair iodine in a prospective, observational, cross-sectional, and exploratory study involving 870 apparently healthy Croatians (270 men and 600 women). Hair iodine was analyzed with inductively coupled plasma mass spectrometry. The hair iodine median was 0.499 µg/g, and was 0.482 and 0.508 µg/g for men and women respectively, suggesting no sex-related difference. Hair iodine uptake was studied by analyzing the logistic sigmoid saturation curve of the median derivatives to assess iodine deficiency, adequacy, and excess. Overt iodine deficiency was thought to occur when hair iodine concentration was below 0.1–0.15 µg/g. Then there was a saturation range interval of about 0.1–2.0 µg/g where the deposition of iodine in the hair was linearly increasing (R²=0.994). Eventually, the sigmoid curve became saturated at about 2.0 µg/g and upward, suggesting excessive iodine exposure. Hair appears to be a valuable and robust biological indicator tissue for assessing long-term iodine status. The authors propose that an adequate iodine status corresponds with hair iodine uptake saturation of 0.565–0.739 µg/g (55–65%).

Momčilović B, et al. *Thyroid.* 2014;24(6):1018-26

Should both iodized and non-iodized salt be made available in Chinese cities? A cross-sectional survey

The authors performed a subnational telephone interview survey to contribute evidence relevant to the policy of supplying iodized salt (IS), non-iodized salt (NIS), or both in Chinese cities. 4833 citizens accepted the telephone interview in 17 capital cities and 6 coastal cities. Among them, 3738 (77.3%) citizens chose IS, 481 (10%) citizens chose NIS, and the others chose both IS and NIS. The citizens' awareness rates of IDD and IDD preventive measures were 68.7% and 62.5%, respectively.

Yu J, et al. *BMJ Open.* 2014;4(7):e005397

Maternal urinary iodine concentration in pregnancy and children's cognition: results from a population-based birth cohort in an iodine-sufficient area

The Dutch study investigated the association between maternal low urinary iodine concentration (UIC) in pregnancy and children's cognition in a population-based sample from a country with an optimal iodine status (the Netherlands, in 1525 mother-child pairs). Non-verbal IQ and language comprehension were assessed during a visit to the

research center using Dutch test batteries when the children were 6 years old. In total, 188 (12.3%) pregnant women had UIC <150 µg/g creatinine, with a median UIC equal to 119.3 µg/g creatinine. The median UIC in the group with UIC >150 µg/g creatinine was 322.9 µg/g, and in the whole sample 296.5 µg/g creatinine. After adjustment for confounders, maternal low UIC was not associated with children's non-verbal IQ (adjusted OR=1.33, 95% CI 0.92–1.93). There was no relation between maternal UIC in early pregnancy and children's language comprehension at 6 years. The lack of a clear association between maternal low UIC and children's cognition probably reflects that low levels of iodine were not frequent and severe enough to affect neurodevelopment. This may result from the Dutch iodine fortification policy, which allows iodized salt to be added to almost all processed food and emphasizes the monitoring of iodine intake in the population.

Ghassabian A, et al. *BMJ Open.* 2014;4(6):e005520

No difference in urinary iodine concentrations between Boston-area breastfed and formula-fed infants

During the first few months of life, infants are reliant on breastmilk and/or infant formula as their sole sources of dietary iodine. The iodine status of U.S. infants has not been well studied. This was a cross-sectional study of 95 breastfed and/or formula-fed infants less than 3 months of age in the Boston area, which measured iodine content from infants' single spot urine samples and assessed associations with infant feeding type as well as maternal demographic data, salt and multivitamin use, smoking status, and diet. The median infant urine iodine concentration (MUIC) was 197.5 µg/L (range 40–897.5 µg/L). MUIC were similar between infants who were exclusively breastfed (n=39, 203.5 µg/L; range 61.5–395.5 µg/L), formula-fed (n=44, 182.5 µg/L; range 40–897.5 µg/L), and mixed (n=10, 197.8 µg/L; range 123–592.5) (p=0.88). There were no significant correlations of infant urinary iodine with maternal salt or multivitamin use (regularly or in the past 24 hours), active or secondhand cigarette smoke exposures, infant weight, infant length, or recent maternal ingestion of common iodine-containing foods. Both breastfed and formula-fed infants less than 3 months of age in the Boston area were generally iodine sufficient. Larger studies are needed to confirm these observations among infants nationwide and elucidate other factors that may contribute to infant iodine nutrition.

Gordon JH, et al. *Thyroid.* 2014;24(8):1309-13

THE IDD NEWSLETTER is published quarterly by the ICCIDD 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 ICCIDD Global Network's website (www.iccidd.org). The Newsletter welcomes comments, new information, and relevant article 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, iccidd.newsletter@hest.ethz.ch.

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