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Addressing Widespread Iodine Deficiency Disorders: A Serious Health Problem in Thailand and Beyond

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Worldwide, millions of people both young and old suffer unnecessarily from iodine deficiency disorders, or IDDs. This problem is not directly related to poverty per se but rather to inadequate implementation of public health measures, along with food habits and ignorance of iodine's importance to human health *(1)*. Although in this article we draw on our in-depth knowledge of IDD issues in Thailand (ranked 91st out of 170 countries in terms of GDP per capita, according to ref *2*), we will also discuss IDD problems in other countries and some strategies for mitigating iodine insufficiency within human populations.

The Individual and Social Effects of IDDs

Thai people commonly associate iodine deficiency with goiters, which are enlarged thyroid glands. However, even in Thailand, a country whose people are at risk of iodine deficiency, obvious goiter cases are now rare. The perception, though, can distract people from less obvious and more insidious IDDs *(3, 4)*.

Iodine deficiency can cause lifelong and serious mental and physical defects in humans because the thyroid hormone, which uses iodine atoms as an essential constituent, acts on most body systems *(5)*. When pregnant women have an iodine deficiency, it can lead to severe consequences for their newborns and infants. It is thus imperative that fecund females of all ages have sufficient iodine. To this end, the Thai government encourages pregnant women to receive iodine supplements at local health centers or clinics. Intervention by health providers may be especially necessary in the case of unwanted or unprepared pregnancies *(4, 6)* as the mothers-to-be may be reluctant to seek help.

Sufficient iodine intake is crucial at all stages of life. Iodine deprivation during fetal development and early infancy can lead to permanent mental defects, lethargy, physical and sexual underdevelopment, eye−hand incoordination, and other conditions. In other words, it can lead to cretinism. In older children and adolescents, temporary iodine insufficiency can result in reduced physical and academic performance. People of working age who have not reached their mental potential because of iodine deficiency may be unable to find or keep jobs, even menial ones. One study that examined the deformed and stunted bone remains of Neanderthals claims that these humanoid relatives of ours went extinct because iodine deficiency diminished their competitiveness *(7)*.

Iodine Deficiency as a Global Problem

Many people in Asia, Africa, Eastern Europe, and Central America are at risk of iodine deficiency because of insufficient iodine in their foods and their animal feeds *(1)*. Indeed, even some Americans living in the land of plenty may be at risk for iodine deficiency *(1, 8)*. Female livestock suffering from low iodine intake are a low-iodine food source and produce fewer surviving offspring—if, indeed, they are fertile at all *(1)*. People in mountainous areas and hinterlands, such as Tibet *(9)*, are more likely than other people to be at risk of iodine deficiency. However, even people near the sea may suffer from iodine deficiency if they do not consume enough seafood or seaweed. Such cases can be found in the island states of The Philippines *(9)*, Indonesia *(9)*, Fiji *(10)*, and Greenland *(11)*, and also in coastal areas of southern Thailand *(12)*. If the government agencies responsible for assuring that the public receives a sufficient intake of micronutrients do not monitor the iodine status of their people, then their citizens may suffer from IDDs.

The Role of Cultural Beliefs and Practices Concerning Iodine Deficiency

One misconception held by both the general populace and even some trained health workers is that sea salt, by itself, can provide sufficient iodine because sea foods (especially seaweeds) have a high iodine content *(13)*. However, sea salt is made from the natural drying of seawater in a salt farm over several weeks. During this process, oxygen in the air causes the iodide in the seawater to oxidize, and the resulting I_2 sublimates. Some factories purify the salt even further, leading to the loss of more iodine *(13)*.

Ingrained but misguided beliefs are also to blame for iodine deficiency among people who have a choice in what salts they can use. For example, some people in Romania, India, Pakistan, and Thailand think that iodized salt renders their food less savory or appealing to the eye *(14)*. However, the authors of this essay have disproven this gustatory aspect in Thailand. In a double-blind experiment (unpublished results), we gave unlabeled samples of iodized and uniodized salt to villagers. The villagers used the samples in the preparation of food and we put each preparation into an unlabeled jar. We then asked the villagers to taste the contents in these unlabeled jars and record their preferences. No significant difference in preferences was found. This can be explained simply: a concentration of 20−30 ppm of iodine in salt means that one teaspoon of solid potassium iodate or potassium iodide is uniformly dispersed in 1000 kg of salt. This is an extreme case of dilution, even for such a potent chemical as potassium iodate.

In addition to local beliefs, some cultural practices affect the iodine intake of various peoples. For example, in Nepal, the

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practice of washing salt grains prior to consumption can lead to low iodine content *(15)*. Some Greenland Inuits suffer from iodine deficiency because they have begun consuming more imported food and less of their traditional foods that come from the sea *(11)*. The Japanese, in contrast, consume enough seaweed to provide their iodine needs; as long as this practice does not change, they do not need iodine supplementation *(13)*. We have heard an anecdote, backed up by a short report *(16)*, that some minority groups in Pakistan suspect that iodine supplementation may be a means used by ill-intentioned authorities for birth control. Because of this suspicion, those minority groups oppose the use of iodine supplementation.

Law Enforcement as a Means of Combating Iodine Insufficiency

In most countries with citizens at risk for iodine deficiency, standardized iodine-supplemented table salt (iodized salt) is deemed the most pragmatic public health countermeasure to combat such insufficiency *(13, 17)*. Iodized bread and fish sauce have also been discussed as means of counteracting iodine insufficiency *(17)*. In Thailand, iodine-supplemented salt costs the same or nearly the same as unsupplemented salt *(12)*; this means that both types of salt are affordable by all. Public awareness of the importance of sufficient iodine intake, along with the availability and accessibility of low-cost iodine supplements, are important factors that must be addressed when developing any solutions to the problems of widespread iodine insufficiency.

One might think it would be sufficient to pass a law stipulating that all commercial table salts have a minimum amount of, say, 20−30 ppm of iodine weight per dry weight of salt *(4)*. The reality, however, is that in certain countries or parts thereof, the authorities do not properly enforce such laws. For example, some salt manufacturers get away with placing unsupplemented or unevenly supplemented salt into plastic bags that bear labels of official approval. Small salt factories usually have primitive procedures for mixing salt with potassium iodide or potassium iodate; this results in packages that contain nonstandard iodized salt *(17)*. A person cannot get enough iodine from unsupplemented salt that has only 2−3 ppm iodine, regardless of whether it is rock salt or sea salt.

Some might ask, "Why not consume more sea salt to obtain enough iodine?" This is a poor solution, because human beings can safely consume only an equivalent of 0.5 g of table salt per day; higher intake may lead to cardiac and circulatory problems *(18)*. People in difficult terrains may not have access to good salt and therefore obtain it by bartering with traders of uniodized salt coming into their village *(8)*. Additionally, some health workers may not realize the importance of regular iodine intake, not knowing that the body constantly secretes iodine and requires constant replenishment *(19)*.

In Thailand, small salt producers with no proper knowledge abound *(12)*, and we are told that local politicians in this system of government are reluctant to offend these voters and their relatives by closing down their factories. One might expect that the problem could be solved by having a small number of licensed salt manufacturers supply good salt to all people *(2)*. Without implying too much in terms of preference for a political system, a country with a strong central government that has a long arm of the law should be able to do better in its efforts to impose standardized salt on the population *(8)*. Certainly, with more dedicated health workers, village leaders, teachers, monks, and a better road system, the situation should improve, even if slowly.

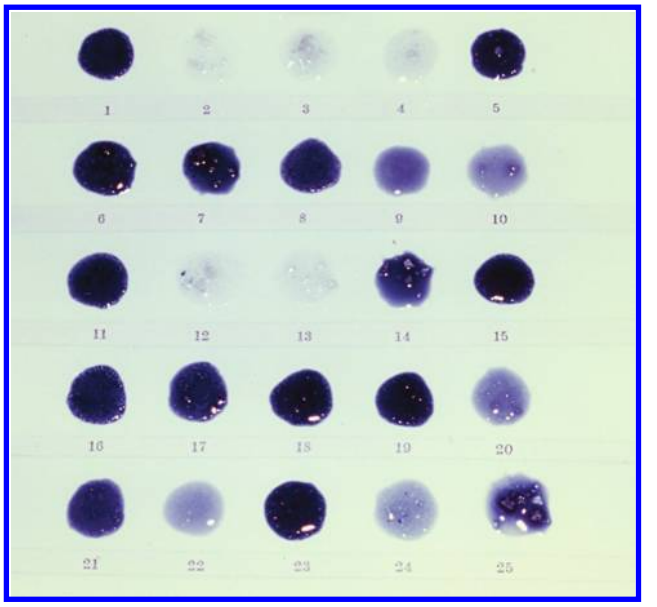

Figure 1. Colors of different intensities developed by using the I-Kit reagent on different salt samples labeled as containing the same concentration of potassium iodate. The intensity of the blue reflects the concentration of iodate; no color indicates the absence of iodate.

Assessing the Success of Education Efforts

Our group has successfully disseminated iodine test kits for monitoring iodate in salt to villagers in Thailand (Figure 1). However, we have found that for the kit to be useful, the villagers, salt manufacturers, and health workers must be continually trained and encouraged to use it. Many people have helped us in the implementation of this test kit. To increase awareness of the problem and encourage activities to ensure consumption of fortified salt, we have had to educate high school students and their teachers as well. Without such efforts, one simply does not know the extent to which supplemented salt is being used. The results so far, we are told, include an increased percentage of household salt being supplemented in areas where we have carried out our campaign. In addition to reports from local partners in these efforts to reduce iodine deficiency by supplementing salt with iodine, determination of iodine in urine can also be performed. However, although this test is of immediate individual relevance and immediacy for timely remedies, conducting the test is time-consuming and expensive.

Online resources are available that offer educational information about the importance of appropriate iodine intake to support human health (4, 9, 19) and references therein). This *Journal* has published a classroom activity for students to learn about the health aspects and chemistry of iodine by testing samples of table salt to determine whether they contain iodine *(20)*. A laboratory experiment *(21)* and a historical survey of human uses of iodine *(22)* also serve as useful resources for teaching about iodine in relation to human health and sources of dietary iodine.

Conclusion

In this article, we have cited instances in Thailand as providing a useful example of both the problems of and the

political solutions to IDDs. We hope readers have learned that to overcome iodine deficiency and IDDs in the populations of the least-developed and developing nations, consistent and effective law enforcement is required. In all countries, the public must be constantly educated about and reminded of the dire effects of iodine insufficiency. Even developed countries can be at risk of iodine deficiency unless the relevant authorities keep a watchful eye on the iodine status of the population. Proper food practices are essential, and iodized salt that is the same price as uniodized salt should be made easily available. Local authorities should monitor both iodine intake and secretion to ensure that the iodine status of the general populace is not at an unacceptable risk level.

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