Eliminating Iodine Deficiency: Obstacles and Their Removal

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Abstract

Iodine deficiency remains a global concern for developing countries and some industrialised countries. Iodine deficiency is the most common cause of preventable mental retardation, posing a threat to the social and economic development of countries. Initiatives were developed and instituted to accelerate progress to achieve the goal of universal salt iodisation (USI). However, these efforts were not successful in eliminating iodine deficiency disorders (IDD) in some countries. Every year, 50 million children are born without the protection that iodine offers to the growing brain and body and about 18 million suffer some significant degree of mental impairment. The World Health Organization (WHO), United Nations Children's Fund (UNICEF) and non-governmental organisations assist to ensure that populations at risk have access to iodised salt. This paper will review the highlights of iodine deficiency and present the experiences in the various countries in Asia, i.e. assessments of the situation, action plans, and obstacles to implementation.

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Introduction

Iodine is an essential nutrient for normal body function and the thyroid gland, which is essential for normal growth and development. Deficiency of this nutrient leads to development of thyroid gland enlargement (goitre) and iodine deficiency disorders (IDD). The most serious effect is mental retardation with a loss of 13.5 IQ points. The primary cause of iodine deficiency is a low dietary supply of iodine aggravated by intake of natural goitrogens in staple foods like cassava, and exacerbated by deficiencies of selenium, iron, and vitamin A.[1]

Urinary iodine excretion (UIE) is the most appropriate outcome indicator for iodine deficiency under field conditions at the district level.[2] Severity of iodine deficiency can be assessed using mean UIE (μg/L) based on the set criteria by the WHO/UNICEF/ International Council for the Control of Iodine Deficiency Disorders (ICCIDD): mean UIE >100 (no IDD), 50 to 99 (mild IDD), 20 to 49 (moderate IDD), <20 (severe IDD).[3]

Strategies

The following strategies have been used to prevent and control iodine deficiency:

(i) USI and (ii) supplementation with iodised oil.

Universal Salt Iodisation (USI). USI is the iodisation of all salt for human (food industry and household) and livestock consumption. It is safe, effective, and cost beneficial. Other fortification vehicles that can be used are bread, water, milk, and complementary food. In some regions where iodisation of salt may not be feasible, particularly in remote areas, supplementation with iodised oil is a good alternative. Another way is by giving potassium iodide (KI) or potassium iodate (KI03) as drops or tablets in drinking water.[1] Global progress towards USI, which was rapid during the 1990s, has slowed down over the past decade. The latest survey showed that only 70% of households worldwide, only 54% in South Asia, and 85% in the East Asia and the Pacific have access to iodised salt. These findings argue for renewed efforts to reach the remaining one-third of the global population not covered by iodised salt. [4]

Supplementation. A single dose of iodised vegetable oil delivers 200 to 480 mg of iodine that provides sufficient coverage for 6 to 12 months (orally) or longer (intramuscular administration).[1] Table 1 shows the recommendation of the WHO for the daily and annual

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Table 1. WHO-recommended Dosages of Daily and Annual Iodine Supplementation[5]

Population group	Daily dose of iodine supplement (μg/day)	Single annual dose of iodised oil supplement (mg/year)
Pregnant women	250	400
Lactating women	250	400
Women of reproductive age (15-49 years)	150	400
Children< 2 years [a,b]	90	200

[a] For children 0 to 6 months of age, iodine supplementation should be given through breast milk. This implies that the child is exclusively breastfed and that the lactating mother received iodine supplementation as indicated above.

[b] These figures for iodine supplements are given in situations where complementary food fortified with iodine is not available, in which case iodine supplementation is required for children 7 to 24 months of age.

dosages for iodine supplementation for different age groups.[5]

WHO, in collaboration with UNICEF and the ICCIDD, helps raise awareness of the importance of IDD; ensures scientific consensus and information on standards for levels of salt iodisation, the safety of iodised salt in pregnancy, and indicators for monitoring and evaluation; and provides technical and financial support for many steps of the process. Other international agencies involved are the World Food Program (WFP), Micronutrient Initiative (MI), Kiwanis International, United States Agency for International Development (USAID), Canadian International Development Agency (CIDA), Australian Government Overseas Aid Program (AUSAID), and the Gates Foundation.[1]

Current Situation

Table 2 shows the current situation in countries in Asia. In Australia, there has been a reduction in the mean UIE due to replacement of iodine-containing sanitizers with chlorine-containing sanitizers in the dairy industry and non-use of iodised salt in the preparation and manufacture of food by manufacturers.[6]

In Bangladesh, legislation contributed to the reduction in the total goitre prevalence (TGP); however, the following problems continue to exist: (i) illegal smuggling of relatively cheap non-iodised salt from India and Myanmar; (ii) poor quality salt production with substantial amount of mud and other insolvable compounds; (iii) lack of microcredit / loans for farmers to purchase polyethylene sheets used to separate crude salt from mud and other impurities; (iv) small domestic salt factories are not registered/licensed and have not complied with salt iodisation; (v) handicapped law enforcement; and (vi) significant portion of households do not perceive importance of iodised salt.[7]

The reduction in iodised salt coverage in India is due to (i) insufficient availability of adequately iodised salt, especially in the rural areas; (ii) low awareness; and (iii) poor enforcement of legislation against the sale of non-iodised salt.[7]

The problems in Indonesia are due to (i) a diverse cultural pattern that dictates various preferences for types of food and salt; (ii) inadequate public awareness; (iii) existence of local salt of differing quality produced by poor farmers; (iv) inadequate and high cost of iodised salt; (v) limited or absent supply of potassium iodate (KIO3); (vi) inadequate monitoring of iodine content in salt; and (vii) poor enforcement of regulations mandating iodisation of salt.[7]

The increase of goitre cases in New Zealand is attributed to (i) the decline in the use of table salt in response to public health recommendation to decrease sodium intake; (ii) replacement of iodophors by less expensive detergent-based sanitizers in the dairy industry; (iii) little awareness among the public; and (iv) absence of legislation.[8]

In Pakistan, the high incidence of goitre is due to (i) absence of legislation; (ii) low enforcement of provincial regulations; (iii) negative propaganda; (iv) availability of non-iodised salt in the market; (v) poor monitoring of consumption of iodised salt; (vi) lack of interest and motivation among salt producers due to low demand and cost implications; (vii) USI programme and IDD control not integrated within the health service delivery; and (viii) lack of awareness and demand for iodised salt.[7]

The increase in goitre cases in the Philippines has been attributed to (i) inadequate capacity of the Department of Health programme managers in monitoring and quality controls; (ii) poor monitoring and enforcement of the law; (iii) limited financial resources for small scale salt producers; and (iv) lack of awareness of households on the health benefits of iodised salt.[7]

Despite complaints of the lack of political will, China was successful in reducing the incidence of goitre and increasing the UIE.[9]

Challenges

Countries can achieve and maintain optimal iodine

Table 2. Current Situation in the Asia Pacific Region in Terms of Total Goitre Prevalence (TGP), Mean Urinary Iodine Excretion (UIE), Iodised Salt Coverage and Policies

Country	TGP (%)	Mean UIE (μg/L)	Iodised Salt Coverage (%)	Legislation
Australia	–	>200 (1992)[10] 104 (2003-2004)[6]	10 (2001)[11]	–
Bangladesh	47.1 (1993)[7] 17.8 (1999)[7]	123 (1999)[7]	70 (2003)[7]	1989 – Mandatory iodisation of edible salt[7] 1994 – Salt Bi-Law[7]
China	20.4 (1995)[9] 5 (2005)[9]	164 (1995)[9] 246 (2005)[9]	39.9 (1995)[99] 94.9 (2005)	–
India	17.9 (1960-1990)[7]	85.5-123.3 (2001-2002)[7]	50 (1998-1999) 36.7 (2002-2003)[7]	1997 – Nationwide ban on storage and sale of common salt for human consumption[7] 2000 – lift of ban except in 2 districts[7] 2005 – re-instatement of ban[7]
Indonesia	29 (1982)[7] 11 (2003)[7]	229 (2003)[7]	58 (1996)[7] 73.2 (2003)[7]	Kepres 69/1994 (Presidential Decree)[7]
New Zealand	1 (1953)[12] 30 (2003)[12]	60-76 (1992-1993)[12] 67 (2002)[12]	83 (2000-2006)[13]	–
Pakistan	84.9 (1993)[7]	16 (1993)[7]	17 (1995)[7]	–
Philippines	3.5 (1987)[14] 6.7 (1993)[14]	71 (1998)[14] 201 (2003)[7]	9.7 (1998)[14] 56.4 (2003)[7]	1987 - RA 3720 (Cosmetics Act)[7] 1995 - RA 8172 (Asin Law)[7] 2000 – RA 8976 (Philippine Food Fortification Law)[7]

nutrition by ensuring adequate availability of iodised salt to meet total consumer requirements, by monitoring iodine content at production and consumer level, by increasing awareness about the effects of iodine deficiency, and by increasing public demand for iodised salt.[1] Where salt iodisation has yet to occur, the main challenges are: (i) political commitment; (ii) salt iodisation legislation; (iii) iodisation of salt licks for animals; (iv) iodisation of processed food; (v) effective enforcement and monitoring; (vi) small scale producers are not supported and organized to ensure that their products are iodised; and (vii) consumer awareness and demand for iodised salt.[15]

Pregnant and lactating women and infants are the most susceptible groups to IDD. However, most of the surveys are done on children or general adult population because monitoring of iodine status of the susceptible groups is difficult since there are no established reference criteria for UIE. Optimal indicators, the mean UIE and the correct timing when to screen, are yet to be identified. Approaches to salt fortification and supplementation using iodised oil are different and bioavailability of iodine in iodised oils and optimum dose are yet to be determined. Iodised salt may not provide enough iodine to meet a child's needs during complementary feeding, therefore, research must be done.[1]

The key to a successful national programme towards USI is constant monitoring of iodine content in household and retail salt. To ensure easy monitoring there is a need to develop rapid test kits (RTK).[1]

The push from WHO for a reduction in population salt intake to reduce the risk for hypertension is another factor that contribute to poor iodised salt intake. It is suggested that other vehicles other than salt must be used. There is also a low consumer demand for iodised salt particularly among lower income consumers. There is a need for effective health promotion to ensure use of iodised salt and need for effective strategies to empower consumer organisations to work with government and industry to ensure quality assurance and monitoring of USI.[1]

The Wheel Model for IDD Elimination Programme

This model represents the continuous "feed back" process involved in the national IDD programme. A continuous series of steps are required to achieve success: (i) assessment of the IDD problem; (ii) communication of the problem to the public and the politicians in terms they can understand; (iii) development of a plan including the salt industry, the education system, the media, the public health professionals, and the consumers; (iv) political decision, which includes the allocation of the necessary funds from the government resources within the country supplemented by external funds from bilateral and/or multilateral sources; (v) implementation, including the organization of the supply of iodised salt, iodised oil (if necessary), appropriate training, and education programmes; and (vi) monitoring and evaluation of the programme which requires process indicators on delivery of iodised salt, checking its iodine content in the factory, on arrival at the destination and in the

home and determination of iodine in the population by measurement of urine iodine.[16]

The final responsibility for the national programme rests on national governments and the role of the international agencies is to work with national governments to assist them with appropriate advice, funding, and training.[16]

There is a need for further research on: (i) iodine nutrition in pregnancy and infancy; (ii) adverse effects on cognitive development; (iii) safe upper limit of iodine intake; (iv) laboratory methods for monitoring salt iodine content; and (v) metabolic interactions of iodine and other micronutrient deficiencies.[1]

Specific issues include: (i) optimal indicators to assess iodine nutrition during pregnancy, lactation, and infancy need to be identified; (ii) use of newborn serum thyroid stimulating hormone (TSH) concentration as an indicator of iodine status in pregnancy needs further validation; (iii) effects of mild to moderate IDD during pregnancy on the cognition of the offspring; (iv) validation of evidence from China's IDD control programme suggesting that a median UI of 240 μg/L is associated with an increased prevalence of subclinical hypothyroidism; (v) large scale trials looking at the correlation between community iodine intake and autoimmune thyroid disease or papillary thyroid cancer are needed; (vi) rapid test kits (RTK) for iodine in salt need to be improved; and (vii) the effects of Vitamin A, iron, zinc and selenium deficiencies in the setting of iodine deficiency should be investigated.[1]

Conclusions

Iodine deficiency is still a problem in the Asia Pacific as shown with the high prevalence in the region. The eradication of iodine deficiency must be a national goal and countries must not remain complacent with decreasing goitre percentage or increasing UIE. There must be continuous evaluation of all problems including iodine supplementation for pregnant women. Other vehicles for iodine besides salt (e.g water and rice) must be seriously studied. Rapid tests that can measure quantitatively the iodine levels are critical particularly for remote areas. Lastly, there must be a single method for detecting iodine levels so that global comparisons can be more accurate.

REFERENCES

1. Zimmermann, M. Key barriers to global iodine deficiency disorder: a summary. Available at: http://www.a2zproject.org/pdf/Gap-Analysis-Iodine-Final.pdf Accessed on 6 Oct 2008.
2. Pardede LVH, Hardjowasito W, Gross R, Dillon DHS, Totoprajogo OS, Yosoprawoto M, et al. Urinary Iodine Excretion Is the Most Appropriate Outcome Indicator for Iodine Deficiency at Field Conditions at District Level. J Nutr 1998;128:1122–6.
3. WHO/UNICEF/ICCIDD. Indicators for assessing iodine deficiency disorders and their control through salt iodination. WHO/NUT/94.6, Geneva, Switzerland. 1994
4. UNICEF. 2007. The State of the World's Children 2007: Women and Children: The Double Dividend of Gender Equality. Available at: http://www.unicef.org/sowc07/docs/sowc07.pdf Accessed on 6 Oct 2008.
5. WHO/UNICEF. 2007. Reaching optimal iodine nutrition in pregnant and lactating women and young children. World Health Organization and United Nations Children's Fund, 2007. Available at: http://www.who.int/nutrition/publications/WHOStatement_IDD_pregnancy.pdf. Accessed 6 October 2008.
6. Li M, Eastman CJ, Waite KV, Ma G, Zacharin MR, Topliss DJ, et al. Are Australian children iodine deficient? Results of the Australian National Iodine Nutrition Study. Med J Aust 2006;184:165-9.
7. Network for sustained elimination of iodine deficiency. Country Reports. Available at: http://206.191.51.240/Resources_Region.htm Accessed 6 October 2008.
8. Skeaff SA and CD Thomson. IDD re-emerges in New Zealand. IDD Newsletter (ICCIDD) 2006;22(4):8-10.
9. Zupei C. Sustained elimination of IDD in China: an update. IDD Newsletter (ICCIDD). 2006 Aug; 24(3): 14-16. Available at: http://www.iccidd.org/media/IDD%20Newsletter/1991-2006/v22n3_0806.pdf Accessed 6 October 2008.
10. Eastman CJ. Where has all our iodine gone? Med J Aust 1999;171: 455-6.
11. Li M, Ma G, Guttikonda K, Boyages SC, Eastman CJ. Re-Emergence of Iodine Deficiency in Australia. Asia Pacific J Clin Nutr 2001;10:200-3.
12. Parnell W, Scragg R, Wilson N, Schaaf D, Fitzgerald E. Serum zinc, serum cholesterol and urinary iodine. NZ Food NZ Children: Key results of the 2002 Children's Nutrition Survey. Wellington: Ministry of Health, 2003. Available at: http://www.moh.govt.nz/moh.nsf/pagesmh/4330. Accessed 6 October 2008.
13. UNICEF. At a glance: New Zealand. Available at: http://www.unicef.org/infobycountry/newzealand_statistics.html. Accessed 6 October 2008.
14. Perlas LA, Desnacido JA, Marcos JM, Cheong RL, Pedro MRA. Steady progress against IDD in the Philippines. IDD Newsletter (ICCIDD) 2006;22(4):1-4.
15. Micronutrient Initiative. Experts urge complete global access to iodised salt; prevents IQ loss and brain damage in babies. Available at: http://www.physorg.com/news116687532.html. Accessed 6 October 2008.
16. Hetzel BS. Towards the global elimination of brain damage due to iodine deficiency – the role of the International Council for Control of Iodine Deficiency Disorders. Int J Epidemiol 2005;34:762-4.

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