Review Article

Past, present, and future of iodine deficiency disorders in India: Need to look outside the blinkers

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Abstract

Iodine deficiency disorders (IDDs) have been recognized as one of the major nutritional disorders throughout the world affecting 200 million people who are at risk and another 71 million suffering from goiter and other IDDs. These groups of disorders can affect every stage of life, but most vulnerable age group is between 6 and 12 years and these disorders together constitute the single largest preventable cause of brain damage leading to learning disabilities and psychomotor impairment. The existence of endemic goiter in an extensive belt along the southern slopes of the Himalayas, Alps, and Andes has long been described, but consistently high prevalence of IDDs outside the endemic zones and failure to attain goals set by the National Iodine Deficiency Disorder Control Program questions the strategy and achievements till date. Therefore, the present article is an attempt to critically examine the program since inception in India.

Keywords: Goiter, India, iodine deficiency

Introduction

Iodine is an essential micronutrient required for normal thyroid function, growth, and development.[1] Suboptimal intake of iodine causes inadequate thyroid hormone production, which leads to a spectrum of adverse outcomes, collectively termed iodine deficiency disorders (IDDs).[2] The most damaging consequences of IDD are in the first 1000 days of life, from conception until the age of 2 years.[3] Severe iodine deficiency during this period increases the risk of stillbirth, congenital abnormalities, and perinatal and infant mortality and impairs physical growth, motor function, and cognitive development.[2] Fetal and early childhood brain damage is often irreversible, causing mental retardation and reduced school performance.[1] In adults, iodine deficiency also reduces work productivity.[2] Therefore, widespread iodine deficiency in the population poses a significant threat to national economic growth and development and slows down progress toward health for all, education for all, and millennium development goals, particularly in developing countries.[4] Iodine deficiency is a major global public health challenge.

According to the most recent global estimate, 1.88 billion people are at risk of iodine deficiency and 241 million children (~30%) have an inadequate iodine intake.[5] Over half the children with insufficient iodine intake live in South/South-East Asia (76 million) and Africa (58 million).[5] Thus, a sustainable strategy tackling iodine deficiency is required.

Universal salt iodization (USI) is recognized as the most promising, sustainable, and cost-effective solution to address iodine deficiency at the country level.[6] A country is said to have achieved USI when at least 90% of households consumed

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adequately iodized salt (15 ppm). In the past 20 years, a massive international effort has been made toward USI; as a result, 34 countries have eliminated IDD through USI and an estimated 70% of households worldwide are currently consuming adequately iodized salt.[7] However, access to and use of adequately iodized salt varies sharply within regions and countries, and IDD continues to be a public health problem in 32 countries.[5,7] In 2006, the United Nations International Children's Emergency Fund (UNICEF) identified 16 "make-or-break" countries that required additional support to accelerate their efforts toward USI.[7] These are major salt-producing countries with a low coverage of salt iodization and high numbers of unprotected newborns.[7] UNICEF estimated that if these 16 countries achieved USI, the global household coverage of adequately iodized salt would reach 85%.[7] With only 51% of households consuming adequately iodized salt in 2006 and an estimated 13 million newborns unprotected again IDD, India was at the top of the list of "make-or-break" countries.

In 2013, in India, about 200 million people were at risk of IDDs and another 71 million were suffering from goiter and other IDDs. Sample surveys conducted all over the country found that of 324 districts included in the study, 263 districts were IDD endemic, that is, where the prevalence of IDD is >10% but there was a significant reduction in visible goiter.[8] Visible goiter was just the tip of the iceberg. IDDs constitute a wide spectrum of diseases and effect persons of all age groups. Hence, does that mean that the survey conducted by the ICMR in 2006 represents just the 10% of the total problem? The purpose of the present paper is to review the national efforts toward USI in India, document achievements and progress, identify challenges in policy formulation and program implementation, and propose a future agenda toward the achievement of USI.

Methodology

This is a narrative literature review with an iterative approach in extracting relevant literature on the National Iodine Deficiency Disorders Control Programme (NIDDCP) operational in India. Search was restricted to literature sources in English published till July 2014. Search engines such as PubMed, IndMed, Directory of Open Access Journals, and Google Scholar were used to identify published and unpublished/in-progress studies, references, and citations of articles of interest. Search terms that were used in the process were "iodine deficiency disorders," "iodine deficiency control program," "national iodine deficiency disease control program," "goiter," "cretinism," "urinary iodine excretion," "iodine content in salt," "iodine deficiency among school going children," and "environmental goitrogens." In addition, manual search of literature was also performed in the institute library to collect relevant information. A systematic search of pertinent journals was also undertaken. Unpublished literature (using authors' knowledge of the field) was included in the review along with inputs from experts using the snowballing technique to identify additional studies. Articles related to the prevalence of IDD in different districts of India and salt iodization before and after the publication of revised policy guidelines for NIDDCP were included in the study. Only articles published in last 25 years (1990–2015) were included. Total of 100 articles were identified, of which 75 were read fully. Articles with low sample size (<100) and overlapping data regarding salt iodization strategies were excluded from the review. Thus, a total of 37 articles were included in the final review process of manuscript. The aim was to capture the efficiency of revised NIDDCP, to identify any lacunae that have been overlooked while forming the policy, and to propose suggestions for filling those voids.

A Brief History of the Universal Salt Iodization Program in India

Background (The story so far: The Indian Experience)

The earlier studies conducted by McCarrison[9] and Stott *et al.*[10] along the southern slopes of Himalayas demonstrated moderate rates of goiter in coastal and hilly areas. There is numerous evidence of goiter being attributed to drinking water. Antithyroid activity has been shown in cultures of *Escherichia coli* isolated from polluted streams of highly endemic areas.[11] Several endemics of goiter have also been attributed to environmental goitrogens with water, air, and milk being their vehicles.[12]

However, later studies focused only on one causal factor: low environmental iodine levels.[13] India recognized iodine deficiency as a national public health concern and began supplying iodized salt to its endemic population as early as 1960s.[14] A seminal study conducted in 1956 in the Kangra Valley, Himachal Pradesh in North India established iodine deficiency as a major cause of endemic goiter and demonstrated a significant decline in goiter prevalence in the areas receiving iodized salt.[15,16]

Based on these studies, the government of India formed the National Goiter Control Program (NGCP) in 1962 with the objectives to identify the goiter endemic regions in the country and supplement the intake of iodine to the entire population in these regions. NGCP primarily focused on the so-called goiter belt which comprises the Himalayas and Terai regions in the north and the northeastern parts of India.[17] Subsequent studies after the implementation of NGCP showed that the problem was not focal but was present in almost all geographical regions of the country.[18,19] This leads to the expansion of NGCP, and it was decided that all edible salts in India to be iodized by 1992 and iodized salt was brought under the revised Prevention of Food Adulteration (PFA) Act of 1988.[20]

Since its inception, the NGCP was considered a low priority due to the perception of goiter being primarily a cosmetic concern.[14] Moreover, the production of iodized salt, which was limited at ~0.15 million metric tons (MMT) per year, was largely insufficient to meet the requirements of all endemic areas.[14] At the start of the NGCP, only the public sector was allowed to produce iodized salt.[14,18] Thus, the government set

up 12 salt iodization plants, with a total annual installed capacity of ~0.39 MMT, and subsidized the entire cost of iodization.[14,18]

In 1983, the government made a historic policy decision to strive for USI and permitted the commercial production of iodized salt by the private sector.[14,21] In 1986, the USI policy was announced and the "smiling sun" logo, a voluntary certification of iodized salt, was developed.[22] The subsidization of potassium iodate continued until 1992.[14]

In 1992, NGCP was renamed to NIDDCP when it was recognized that IDD was not a single disease but rather a large spectrum of disease. NIDDCP came up with the objectives to assess the burden of IDDs in the country, to supply iodized salt in place of common salt, survey every 5 years to assess the extent of IDDs and the impact of iodized salt, laboratory monitoring of iodized salt and urinary iodine excretion and health education.

In 1996, the salt industry was de-licensed, making it difficult for the Salt Department to regulate.[14]

In 1997, the central government enacted a national ban on the sale of noniodized salt for edible purposes, under the PFA Act, 1954.[23] The PFA Act stipulates the minimum iodine content of salt at the production and consumption levels at 30 and 15 ppm, respectively.[23] Prior to the issue of this notification, all states except Kerala, Andhra Pradesh, and Maharashtra imposed a state-level ban on the sale of noniodized salt for human consumption.

Universal iodization of edible salt was the intervention strategy recommended to prevent and control IDD. The objectives of the program were expanded to include five main initiatives: (1) assessing the magnitude of IDD; (2) supplying iodized salt to the entire population; (3) assessing the impact of USI every 5 years; (4) laboratory monitoring of iodized salt and urinary iodine concentration (UIC); and (5) health education.[14,24]

The continued efforts in implementing the policy initiatives and the cooperation of the salt industry have led to substantial progress in salt iodization status in India. In the past two decades, the national production of iodized salt has seen an eightfold increase – from 0.7 MMT in 1985–1986 to currently ~6.2 MMT.[14,25]

However, due to the dissenting voices raised against USI, the central ban was lifted in 2000.[26] While the majority of the states maintained the ban, Gujarat and Odisha revoked it.[11] It took 5 years of intensive advocacy with the central government to reinstate a nationwide ban on the sale of noniodized salt in 2005.[27] At present, all states have also imposed a complete ban.[28]

In addition, the Government of India's 11th Five Years Plan (2008–2012) reiterates the need to eliminate IDD and recommends USI as the best means to achieve this goal.[29] So far, the implementation of the program has experienced some major challenges in the past two decades. The iodine level of the salt that moves by rail is monitored before shipment while there is no monitoring of the quality of salt transported by road.[30-32] The transportation of iodized salt by rail has been subsidized and designated a priority second only to that of defense since 1973.[14,29]

Household Usage of Iodized Salt and Population Iodine Status

The household coverage of adequately iodized salt (adequately iodized salt contains 15 ppm iodine; salt iodine content is measured using either a titration method or a salt testing kit) in India has undergone major ups and downs in the past two decades. Coverage increased up to ~70% in 1997, declined to 49% in 1998–1999, and dropped to <30% in 2002–2004, reflecting the major setbacks in program implementation.[33,34] Notably, the 1998 cyclone in Gujarat followed by a devastating earthquake in the same area seriously damaged salt iodization facilities in the major salt-producing districts of India, which took years for restoration. Nevertheless, efforts to intensify USI activities, especially in the past few years, have led to a remarkable improvement in the consumption of adequately iodized salt, with the national coverage reaching 51% in 2005–2006 and 71% in 2009.[35,36] Still, in 2009, nearly 20% of households were found to be consuming inadequately iodized salt and 9% using salt that was not iodized.[36] The proportion of households using adequately iodized salt varied widely by state in 2009, ranging from ~98% in Manipur to ~30% in Chhattisgarh [Figure 1].[36]

Thus, the states performing poorly are likely to continue to show the least improvement or even worsening of coverage in coming years unless urgent actions are taken [Figure 2].[36] Moreover, data indicate that a clear urban-rural [Figure 3][36] and rich-poor differential [Figure 4][36] in salt iodization still persists with better coverage of adequately iodized salt in urban areas and richer wealth quintile, leaving the most disadvantaged population vulnerable to IDDs. Rural-urban differential in salt iodization was

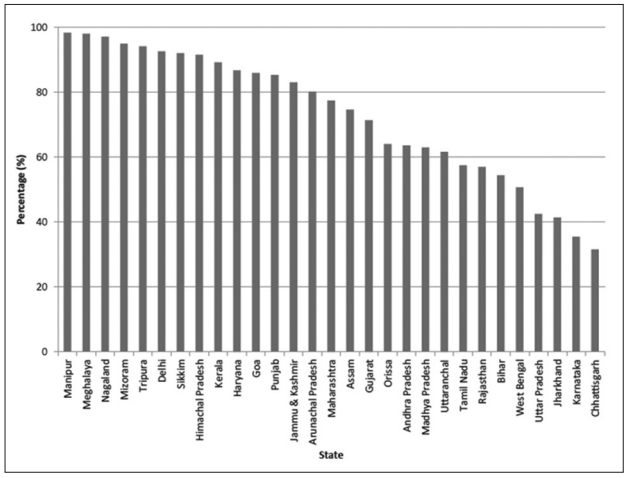

Figure 1: Percentage of households using adequately iodized salt by state in 2009. Adequately iodized salt contains ≥15 ppm iodine

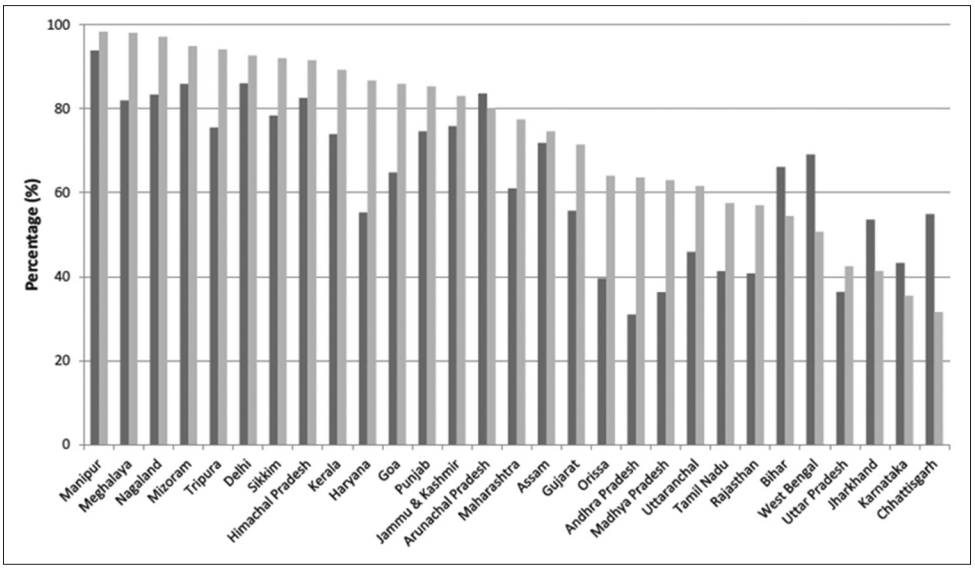

Figure 2: Percentage of households using adequately iodized salt by state in 2005–2006 versus 2009. Adequately iodized salt contains ≥15 ppm iodine

pronounced. Around 83.2% of households in urban areas used salt with 15 ppm or more iodine content compared to 66.1% of households in rural areas. The proportion of households using noniodized salt was more in rural areas (11.0%) as compared to their urban counterparts (5.1%). The use of iodized salt was high in northeastern States and in States of New Delhi, Goa, Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab, and all union territories (UTs) ranging from 80% to 94% [Figure 1]. In the States of Karnataka, Andhra Pradesh, Tamil Nadu, Madhya Pradesh, Uttar Pradesh, Odisha, and Jharkhand, the use of noniodized salt seemed more common compared to other states.[36]

Currently, there are no national data on the iodine status of the population based on UIC although a number of small-scale surveys have been carried out in the past.[3] The most recent weighted estimate pooled from subnational surveys indicated that the median UIC of the population was 154 mg L-1 and that 34% of Indians had UIC <100 mg L-1, indicating insufficient iodine intake.[3] Although India is classified as a country with adequate iodine intake based on the median UIC,[3] 249 million people including 8 million newborns annually are still unprotected from the lifelong consequences of IDDs. In addition, the current estimate should be interpreted with caution because the median UIC was extrapolated from small subnational surveys.

To understand whether program policy would lead to elimination of the problem and whether the program will sustain to maintain the goals, it is imperative that certain factors/criteria should be defined clearly in the policy. For assessing whether the IDDs control program has achieved sustainable elimination IDDs, the WHO has given the three criteria [Table 1].[37] The WHO has also given 10 program indicators for the assessment of progress toward attaining sustainable elimination of IDDs as part of these criteria [Table 2].[38] At present, according to a recent study, India has achieved only five, with another four being partially attained.[38]

Table 1: Current status of progress toward sustainable elimination of iodine deficiency disorder in India[37]

Indicators	Goals	Status in India
Salt Iodization		
Proportion of households using adequately iodized salt (%)	>90	71
Urinary iodine excretion (μg/L)		
Median in general population	100-199	No national level representative data
Median in pregnant females	150-249	No national level representative data
Programmatic indicators	Attainment of 8 out of 10 indicators	Yes - 5 Partial - 4 No - 1

Current Status of the Universal Salt Iodization Program and Challenges to Overcome

The present status of the USI program is described below under five categories which represent the five guiding principles crucial to sustained USI program success.

Lack of political commitment

The NIDDCP has a complex governance structure with multiple sectors involved in its implementation.[14] The Ministry of Health and Family Welfare (MOHFW) is the central body responsible for planning policy decisions regarding NIDDCP.[14] Precisely, the Central Nutrition and IDD Cell at the Directorate for General Health Services (DGHS) of MOHFW is advocated for design and implementation of the program, allocating funds to the state program for adequate implementation and monitoring the

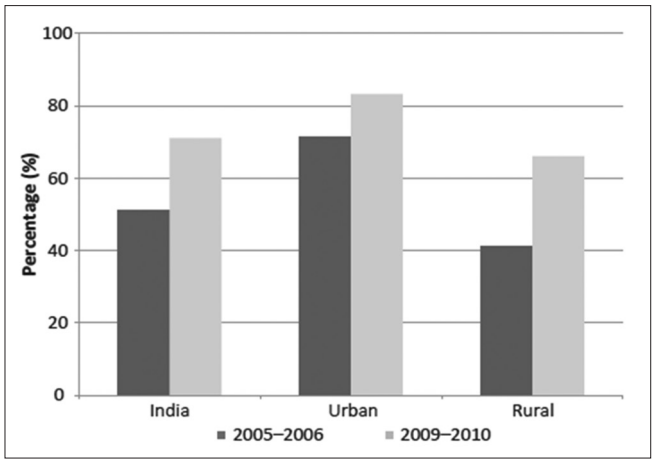

Figure 3: Percentage of households using adequately iodized salt in urban and rural areas in 2005–2006 and 2009. Adequately iodized salt contains ≥15 ppm iodine

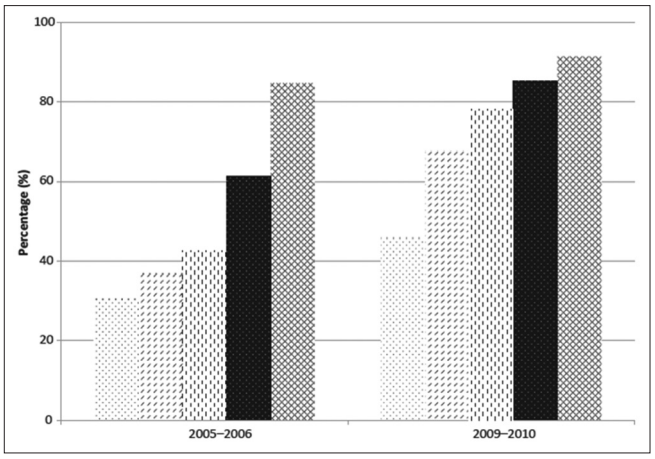

Figure 4: Percentage of households using adequately iodized salt by household wealth index in 2005-2006 and 2009. Adequately iodized salt contains ≥15 ppm iodine

Table 2: Programmatic indicators for tracking progress toward sustainable elimination of iodine deficiency disorder in India[38]

Indicators	Current status
Presence of national multisectoral coalition	Partial
Demonstration of political commitment	Yes
Enactment of legislation and supportive regulations on universal salt iodization	Yes
Establishment of methods for assessment of progress in the elimination of IDD	Partial
Access to laboratories to provide accurate data on salt and urinary iodine levels and thyroid function	Yes
Establishment of a program of education and social mobilization	Partial Need for more focus on social mobilization and BCC
Routine availability of data on salt iodine content, at the factory level at least monthly, and at the household level at least every 5 years	Yes
Routine availability of population-based data on urinary iodine every 5 years	Partial
Demonstration of ongoing cooperation from the salt industry	Yes
Presence of a national database for recording of results of regular monitoring procedures which include population-based household coverage and urinary iodine	No

BCC: Behavior Change Communication; IDD: Iodine deficiency disorder

compliance through salt iodization regulation. The Nutrition Advisor of DGHS is the nodal officer of the program. The quantity and quality of iodized salt at the production level and the equitable distribution of iodized salt across the country is monitored by the Salt Department under the Ministry of Commerce and Industry. The Ministry of Railways holds an important role as it jointly organizes the transportation of iodized salt to all parts of the country. Along with MOHFW, the NIDDCP implementation is assisted by the Ministry of Information and Broadcasting which aids in campaigns of communication; the Ministry of Women and Child Development mobilizes its anganwadi centers and workers for raising awareness and monitoring iodine status; and the Ministry of Food and Civil Supplies distributes iodized salt to the "below-poverty-line" households through the public distribution system (PDS).[14,39] This network of partners are simulated at the state level too. An independent IDD cell was established for the effective execution of NIDDCP, which is responsible for the policy implementation at the state level in 31 of 34 states and UTs.[40] The government's commitment to eradicate IDD has been confirmed at many national and international events.[39] It is also reflected in the "20-point National Development Programme" and the "11th Five Years Plan."[14,31] Despite the political will, commitment is not enough as still IDDs are not recognized as a prerogative issue in the health sector, resulting in a weak policy formulation and poor program operation.[39] In addition, weak execution of the legal ban on the sale of noniodized salt for human consumption is an ongoing challenge.[28] Moreover, it is problematic, as animals and livestock are also affected by IDD, and so indirect influence is applied on iodine status of the population as a whole.[2] In addition, the Food Safety and Standard Act 2006 prescribes that iodine content in salt should not be <30 ppm at the point of production and not <15 ppm at the supply level and also at the point of consumption at the household level. However, as the "supply chain" starts from the warehouse of the salt processors immediately after production, the dual standard for levels of salt iodization makes the execution at the production a big obstacle.

In 1998, the NIDDCP policy guidelines were first published and in 2006 although revised, there is a need of update, particularly with respect to the survey guidelines to assess the iodine status of the population.[40] The epidemiological rationale both in terms of sampling method and sample size are lacking in the current revised guidelines, and thus will not generate reliable and valid state level or national level data on the iodine status of the population. In addition,

adequate resources are needed to be allocated to enable the implementation of such surveys.

Poor coalitions and partnerships

NIDDCP being a multisectoral program requires a coordination of various stakeholders for effective implementation. The two national coordination bodies were established by the government, namely, a Central Steering Committee and a Program Implementation Committee.[14,28] However, neither of the two committees has been effective, resulting in poor action and lack of leadership for the USI program.[14,28]

Multisectoral workshops on NIDDCP at both the national and state level have reviewed the progress made, identified bottlenecks in program implementation, and discussed the way forward. In April 2006, the National Coalition for Sustained Iodine Intake was officially launched with the objective of bringing key partners together for regular dialogue and monitoring progress toward the acceleration of USI.[41] The coalition is made up of representatives of the relevant governmental departments, national institutions, and partner agencies, together with salt producers, civil society stakeholders, and media advocacy groups. The coalition has held regular meetings and served as a platform for dialogue and exchange; however, its overall structure for coordination needs to be strengthened if the coalition is to fulfill its role fully. An increasing number of states are establishing state-level coalitions for inter-departmental coordination and implementation oversight. Interestingly, the states with more ineffective USI programs have either poorly functioning coalitions or do not have any coordination and partnership mechanisms in place.

Lack of availability of adequately iodized salt

India is the third largest salt-producing country in the world after China and the USA.[25] The majority (~90%) of the 13,000 salt producers currently operating in India belong to the private sector; 90% of them are small producers, 4.5% are medium, and 5.5% are large.[25] India has become self-sufficient in the production of iodized salt.[25] There are a total of 843 registered iodization units in the country with a capacity to produce 17.5 MMT of iodized salt annually.[25] The actual production was 6.2 MMT during the year 2010–2011, against the total requirement of 5.5 MMT.[25] Ironically as can be seen, although India has the capacity to produce sufficient iodized salt to meet its needs, a sizeable proportion of the Indian population still consumes either inadequately iodized or noniodized salt. A significant barrier toward improving the distribution of affordable, adequately iodized salt is the lack of capacity and/or commitment of the medium and small producers and traders.[28,42] Iodization is often viewed as an additional burden as they operate within narrow profit margins and commonly use less effective, poorly maintained equipment.[28,42]

The consolidation of the salt industry and use of improve production process by many of the large producers are the most significant reasons behind the recent improvement in the household coverage of adequately iodized salt in India. In contrast, the nonrefined iodized salt produced by medium and small producers and the traders is often inadequately iodized; it is sold at a lower price than the refined iodized salt in packages with similar design, brands, and logos to those of the refined iodized salt.[28,42] The end-user is thus unable to tell the difference other than the price and is attracted to the lower priced product. The small producers are often not registered with the Salt Department, have limited resources, use low-cost techniques for iodization, and tend to falsely label their noniodized salt as "iodized."[28,42] In both salt-producing and non-producing states, iodized salt is procured by wholesalers who often purchase the salt in bulk, and subsequently repackage it.[43-45]

Salt procured in bulk is often noniodized, but the wholesalers and retailers are not able to recognize it.[43,45] Although potassium iodate for salt iodization is produced in India, the iodine – the basic raw ingredient required – has to be imported.[28] Due to the increasing global price of iodine, the cost of potassium iodate has fluctuated and escalated in the past few years.[28] This has adversely affected the small producers and traders, and so has negatively affected the quality of iodized salt produced by them.[28] There is currently no mechanism in place to ensure stable pricing for potassium iodate or to ensure its quality. Moreover, iodized salt is perceived to be relatively expensive compared to common salt by consumers, especially the poorest.[44] To make the prices of common salt and iodized salt more comparable, efforts have been made to provide iodized salt at prices comparable to common salt to consumers below the poverty line through the PDS network in several states.

Inadequate monitoring system

To ensure the supply of adequately iodized salt, sustained monitoring of the iodine level is required at different stages, namely, at the production stage, before dispatch by rail or road, the wholesale and retail level, and the consumer household level. Monitoring at the production level is a crucial component of the salt iodization program. Efforts have been made to develop guidelines for internal monitoring and to train manufacturers in the three main salt-producing states. So far, limited internal monitoring is carried out by the medium and small producers.[28,42] In addition, internal monitoring relies only on the use of rapid salt test kits, with no quantitative assessment of the actual iodine levels, and the internal monitoring guidelines developed by the salt department are often not properly disseminated to salt producers.[28] External monitoring at the production level is done by the salt department. Field officials visit the iodization plants on a regular basis to collect samples of iodized salt, which are analyzed in 26 salt-testing laboratories at the production centers and eight mobile laboratories.[14,24] However, the monitoring process is not being carried out in a systematic manner; moreover, due to a lack of trained staff, funds, and laboratories, monitoring is restricted to major salt producers.[28] In addition, many small producers and traders are not registered with the salt department

and therefore they are not subject to being monitored at the production level.[28] A second quality check of the iodized salt which is transported by rail (i.e., ~58% of salt) is carried out by the Salt Department before shipment.[25] Whereas only the adequately iodized salt is given permission for rail transportation, there is currently no mechanism in place for testing the quality of salt transported by road.[29,32] Small producers often choose to transport their salt by road not only for cost saving but also the current railway system favors large salt producers.[28]

In terms of the regulatory monitoring, the food safety officers collect samples of iodized salt from the production plants, as well as at the wholesale and retail levels, and send them to designated Food Safety and Standards Authority Laboratories for Testing.[28,14] The procedures for sample collection and testing are described in existing protocols and guidelines. Nevertheless, the guidelines are relatively weak and not properly implemented. In many states, the food inspector posts are vacant and the number of salt samples collected each month is negligible.[28] Furthermore, the food inspectors are reluctant to file a case under PFA for inadequately iodized salt samples, because it requires them to attend court even after being transferred to remote areas or after retirement, as it takes years for the courts to take action.[28] The wholesale and retail level monitoring is also expected to be done by the state IDD Cell, but no regular actions are taken.[28]

With regard to tracking progress toward the elimination of IDD, India is one of the few countries with no national or subnational data on the iodine status of the population available on a regular basis. Iodine deficiency indicators such as UIC and goiter prevalence are rarely included in national health surveys.[2] Moreover, most of the district level IDD prevalence data use goiter as an indicator which is prone to subjective bias and errors. While national data on the household coverage of iodized salt are being collected, its frequency and methodology need to be revisited – specifically, the iodine level in salt is being assessed only using rapid salt test kits, while it needs to be complemented with iodometric titration method.[45]

Recently, a management information system was launched by the salt department, which deploys state-of-the-art web technologies to ensure real-time flow of information related to salt production and quality. Prior to its development, data on salt production, distribution, price, and quality used to be manually collected and integrated, which often resulted in data duplication, redundancy, and errors, as well as time lag in updating information. The system is expected to help the salt department improve its efficiency in performing all of its functions related to monitoring and controlling the flow of iodized salt in India.

Lack of continuous propagation, education, and communication

Communication and propagation have mainly targeted at three audience segments; influencers of the USI policy, producers and suppliers of iodized salt, and consumers. Propagation initiated political commitment for the program by generating awareness among the politicians and policymakers about the serious issues of IDD on mental health and the benefits of iodized salt. To direct the entire salt-trade chain, education and communication activities are carried out to create awareness of IDD among the salt producers and suppliers. Mass education and continuous social mobilization activities have been conducted through print media, television, radio, and inter-personal communication to generate consumer demand for adequately iodized salt. School awareness programs are running, through which students are educated on the advantages of consuming iodized salt, and conduct the testing of salt to estimate if it is adequately iodized.[45,46]

However, the public awareness of IDD and its serious consequences remains low, and there is a lack of consumer demand for adequately iodized salt. Most importantly, consumers are not equipped with the tools and skills necessary to assess the quality of the salt they purchase, making them unable to demand only adequately iodized salt.

Future Agenda

In the present review, we have examined the current status of the salt iodization program in India and have identified a number of challenges obstructing progress toward achieving the goal of USI. Lack of strong political leadership, inadequate capacity and commitment of salt producers and traders to supply adequately iodized salt, weak monitoring systems throughout the salt-trade chain, and low consumer demand are the key constraints. Overall, the elimination of IDD through USI needs to be higher on the political agenda, and a clear strategy for the program supported by cogent implementation plans is warranted. Establishing and managing partnerships with a wide network of stakeholders, including salt producers and suppliers, is a critical determinant of program success. Strong commitment and ownership of the program by each stakeholder is also essential.

As the political and administrative leadership in the country continues to change, sustained advocacy at the national, state, and district level is required to ensure higher political commitment and prioritization of the USI program. Equally important is to continue the central ban on the sale of noniodized salt for edible purpose and establishment of an effective mechanism to ensure proper enforcement of both the national and state legal measures. The national bodies playing key roles in NIDDCP need to be strengthened. The central IDD cell needs to be strengthened with additional human resources to provide quality support to state IDD cells and coordinate inter-departmental collaboration. The organizational structure, staffing position, and technical capacity of state IDD cells should also be strengthened.

Critical too is that there should be better coordination and collaboration between all stakeholders. There is a need for strengthening the interministerial coordination and establishing an effective national level oversight mechanism to coordinate the efforts of the government, nongovernmental organizations, and salt industry to ensure that USI.

Ensuring adequate access and availability of appropriately iodized salt, particularly for the vulnerable populations, remains a challenge. The medium and small-scale salt producers and traders need to be motivated to incorporate correct levels of iodine and their technical capacity should be enhanced. Technical support should be provided to medium-size producers to set up units for producing refined iodized salt. For small-scale producers, support should focus on developing technologies which will enable them to conduct quality iodization. Mapping of the wholesalers and retailers of salt should be expanded to cover all states to sensitize, train and equip them with tools and skills to procure and sell only adequately iodized salt. Monitoring needs to be strengthened at all levels.

The monitoring mechanism through food safety officers should be strengthened. In general, adequate manpower should be ensured to carry out monitoring at different levels – vacant posts need to be urgently filled with qualified staff and all personnel engaged in monitoring should receive the required training and supervision. The facilities at the salt testing laboratories should be improved and the number of laboratories should be increased. Medium and small-scale producers need to be encouraged and trained to perform effective internal monitoring. In addition, an effective mechanism for checking the quality of salt transported by road should be urgently established. Iodine levels in salt used at the household level should be checked on a regular basis through school children or the Integrated Child Development Schemes (ICDS) centers. The quality of salt received at the PDS outlets should also be checked. The iodine status of the population should be assessed on a regular basis and should be reported in a timely fashion; the NIDDCP guidelines need to be revised so that IDD cells are required to conduct and report on the IDD situation on a regular basis. In addition, the National Health Survey needs to report systematically on the iodine status of the population and progress of the USI program at the household level, state by state to increase public accountability. An updated education, communication, and social mobilization strategy with a well thought out implementation and monitoring plan is required for generating stronger consumer demand for adequately iodized salt. The communication campaign should be framed around the benefits of USI for children's brain development, school performance, and success in life, linked to global national policy priorities such as Right to Education Act and Food Security Bill and the National Development Plan. Furthermore, it will be essential to incorporate information on iodine deficiency and its consequences into the regular educational curricula. To maximize the effective use of limited resources, a sensible prioritization of states based on their past and current performance in salt iodization may be needed. A well-defined and compelling strategy is necessary to reach the last 30% of households that are likely to be least accessible and most socioeconomically disadvantaged, making it mandatory to use only adequately iodized salt in the mid-day meal program, and the ICDS program may help reach the most vulnerable segments of the population.

To conclude, although there have been significant achievements toward USI in India in the last two decades, many obstacles are to be overcome. Immediate, focused, and operational intervention is required if IDDs are to be eliminated. In addition, ongoing strategies will be necessary to ensure that the gains are sustained and mistakes are not repeated.

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Conflicts of interest

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