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Review Article

Towards universal salt iodisation in India: achievements, challenges and future actions

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Abstract

India is one of the first countries to introduce salt iodisation, but the national programme has experienced major setbacks. The purpose of this paper is to review the national efforts towards universal salt iodisation (USI) in India and highlight key challenges in programme implementation. A brief historical overview of the salt iodisation programme is provided and the current status of the household usage of iodised salt and population iodine status is described. The present status of the USI programme together with the challenges being faced towards achieving USI are classified in five categories, which represent the five guiding principles crucial to sustained USI programme success: ensuring political commitment, forming partnerships and coalition, ensuring availability of adequately iodised salt, strengthening the monitoring system and maintaining continuous advocacy, education and communication. A future agenda towards the achievement of USI is also proposed.

Keywords: universal salt iodisation (USI), iodine deficiency disorders (IDD), India.

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Introduction

Iodine is an essential micronutrient required for normal thyroid function, growth and development (WHO/FAO 2004). Suboptimal intake of iodine causes inadequate thyroid hormone production, which leads to a spectrum of adverse outcomes, collectively termed iodine deficiency disorders (IDD) (Zimmermann *et al*. 2008). The most damaging consequences of IDD are in the first 1000 days of life, from conception until the age of two (Cao *et al*. 1994; Zoeller & Rovet 2004). Severe iodine deficiency during this period increases the risk of stillbirth, congenital abnormalities, perinatal and infant mortality and impairs physical growth, motor function and cognitive development (Zimmermann *et al*. 2008; Zimmermann 2009). Fetal and early childhood brain damage is often irreversible, causing mental retardation and reduced school performance (Zimmermann *et al*. 2008; Zimmermann 2009). In adults, iodine deficiency also reduces work productivity (Zimmermann *et al*. 2008). Therefore, widespread iodine deficiency in the population poses a significant threat to national economic growth and development and slows down progress towards health for all, education for all, and millennium development goals, particularly in developing countries (Engle *et al*. 2007).

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 (Andersson *et al*. 2012).

Over half the children with insufficient iodine intake live in South/South-East Asia (76 million) and Africa (58 million) (Andersson *et al*. 2012). Thus, a sustainable strategy tackling iodine deficiency is required.

Universal salt iodisation (USI) is recognised as the most promising, sustainable and cost-effective solution to address iodine deficiency at the country level (The Micronutrient Initiative 2009). A country is said to have achieved USI when at least 90% of households consumed adequately iodised salt (≥15 ppm). In the past 20 years, a massive international effort has been made towards USI; as a result, 34 countries have eliminated IDD through USI and an estimated 70% of households worldwide are currently consuming adequately iodised salt (UNICEF 2008). However, access to and use of adequately iodised salt varies sharply within regions and countries and IDD continues to be a public health problem in 32 countries (UNICEF 2008; Andersson *et al*. 2012).

In 2006, United Nations Children's Fund (UNICEF) identified 16 'make-or-break' countries that required additional support to accelerate their efforts towards USI (UNICEF 2008). These are major salt-producing countries with a low coverage of salt iodisation and high numbers of unprotected newborns (UNICEF 2008). UNICEF estimated that if these 16 countries achieved USI, the global household coverage of adequately iodised salt would reach 85% (UNICEF 2008). With only 51% of households consuming adequately iodised 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.

The purpose of the present paper is to review the national efforts towards USI in India, document achievements and progress, identify challenges in policy formulation and programme implementation and propose a future agenda towards the achievement of USI.

A brief history of the USI programme in India

India recognised iodine deficiency as a national public health concern immediately after it earned its independence and began supplying iodised salt to its endemic population as early as the 1960's (Pandav *et al*. 2003). A seminal study conducted in 1956 in the Kangra Valley, Himachal Pradesh in North India established iodine deficiency as a major cause of endemic goitre and demonstrated a significant decline in goitre prevalence in the areas receiving iodised salt (Sooch & Ramalingaswami 1965; Sooch *et al*. 1973). This led the Government of India to launch the National Goitre Control Programme (NGCP) in 1962, in an attempt to provide iodised salt to identified goitre endemic districts (Pandav *et al*. 2003). Since its inception, however, the NGCP was considered a low priority due to the perception of goitre being primarily a cosmetic concern (Pandav *et al*. 2003). Moreover, the production of iodised salt, which was limited at ~0.15 million metric tons (MMT) per year, was largely insufficient to meet the requirements of all endemic areas (Pandav *et al*. 2003). At the start of the NGCP, only the public sector was allowed to produce iodised salt (Vir 2002; Pandav *et al*. 2003). Thus, the Government set up 12 salt iodisation plants, with a total annual installed capacity of ~0.39 MMT, and subsidised the entire cost of iodisation (Vir 2002; Pandav *et al*. 2003).

A turning point came in 1983 when, as a result of high-level advocacy, the Prime Minister accepted the

Key messages

- The salt iodization programme in India boasts half a century of history and has made significant progress towards the achievement of USI.
- However, the USI programme in India has faced numerous challenges in implementation, obstructing progress towards achieving the goal of USI.
- Currently, ~71% of households are consuming salt with adequate levels of iodine. A well-defined and cogent strategy is required in order to reach the last 30% of households that are likely to be least accessible and most socioeconomically disadvantaged.

importance of IDD elimination, and the eradication of goitre was included as 'Point Eight' in the Prime Minister's 20-point National Development Programme (Pandav *et al*. 2003). The Central Council of Health, the highest health policymaking body in India, also made a recommendation in 1983 that as all states were IDD prone, iodised salt should be made available to the entire population (The Government of India 1994; Pandav *et al*. 2003). Consequently, in 1983, the government made a historic policy decision to strive for USI and permitted the commercial production of iodised salt by the private sector (The Government of India 1994; Pandav *et al*. 2003).

Efforts were made in a phased manner starting in April 1986, to increase the production, demand and supply of iodised salt (The Government of India 1994; Pandav *et al*. 2003). In 1986, the USI policy was announced and the 'smiling sun' logo, a voluntary certification of iodised salt, was developed (The Salt Department 1994). The subsidisation of potassium iodate continued until 1992 (Pandav *et al*. 2003).

In 1992, the NGCP was renamed the National Iodine Deficiency Disorders Control Programme (NIDDCP), reflecting the government's commitment to eliminating the whole spectrum of IDD (Tiwari *et al*. 1995; Pandav *et al*. 2003; Ministry of Health and Family Welfare 2006). Universal iodisation of edible salt was the intervention strategy recommended to prevent and control IDD. The objectives of the programme were expanded to include five main initiatives: (1) assessing the magnitude of IDD; (2) supplying iodised salt to the entire population; (3) assessing the impact of USI every 5 years; (4) laboratory monitoring of iodised salt and urinary iodine concentration; and (5) health education (Pandav *et al*. 2003; Ministry of Health and Family Welfare 2006).

The continued efforts in implementing the policy initiatives and the cooperation of the salt industry have led to substantial progress in salt iodisation status in India. In the past two decades, the national production of iodised salt has seen an eightfold increase – from 0.7 MMT in 1985–1986 to currently ~6.2 MMT (Pandav *et al*. 2003; The Salt Department 2012). Also, 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 (The Government of India 2008).

Yet, the implementation of the programme has experienced some major challenges in the past two decades. The iodine level of the salt that moves by rail is monitored prior to shipment, while there is no monitoring of the quality of salt transported by road (Kapil *et al*. 2001; Sankar *et al*. 2006). The transportation of iodised salt by rail has been subsidised and designated a priority second only to that of defence since 1973 (Pandav *et al*. 2003; Sankar *et al*. 2006). However, the freight costs for iodised salt increased substantially from April 2002, thus reducing the cost advantage of rail shipment (Sankar *et al*. 2006). Consequently, the unchecked movement of inadequately iodised salt by road has increased dramatically (Sankar *et al*. 2006). In an effort to restore the transportation of adequately iodised salt by rail, at the instance of the Salt Department, the Ministry of Railways has provided for graded concessions in the freight costs of edible salt since 2003 depending on the distance of salt transportation (Ministry of Railways 2003).

In 1996, the salt industry was de-licensed, making it difficult for the Salt Department to regulate (Pandav *et al*. 2003). In 1997, the Central Government enacted a national ban on the sale of non-iodised salt for edible purposes, under the Prevention of Food Adulteration (PFA) Act, 1954 (The Salt Department 2007). The PFA Act stipulates the minimum iodine content of salt at the production and consumption levels at 30 and 15 ppm, respectively (The Salt Department 2007). Prior to the issue of this notification, all states except Kerala, Andhra Pradesh and Maharashtra imposed a state-level ban on the sale of non-iodised salt for human consumption. However, due to the dissenting voices raised against USI, the central ban was lifted in 2000 (Ministry of Health and Family Welfare 2000). While the majority of the states maintained the ban, Gujarat and Orissa revoked it (Kotwal 2010). It took 5 years of intensive advocacy with the central government to reinstate a nationwide ban on the sale of non-iodised salt in 2005 (Ministry of Health and Family Welfare 2005). At present, all states have also imposed a complete ban (Sundaresan 2009).

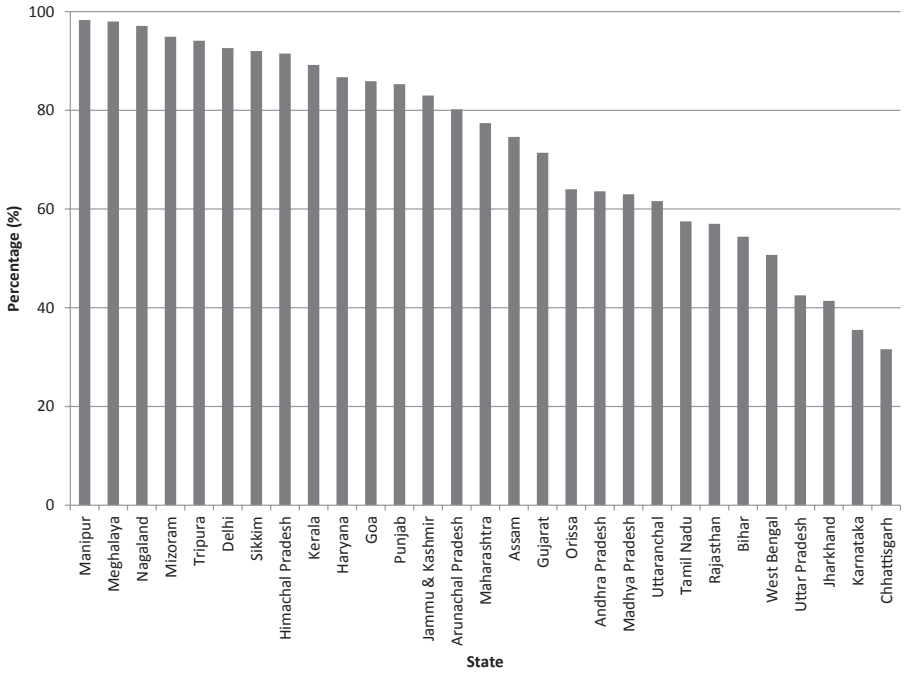

Fig. 1. Percentage of households using adequately iodised salt* by state in 2009.
*Adequately iodised salt contains ≥15 ppm iodine.

Household usage of iodised salt and population iodine status

Despite the impressive progress with regards to the provision of iodised salt, salt quality warrants further improvement. The household coverage of adequately iodised salt[1] 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 less than 30% in 2002–2004, reflecting the major setbacks in programme implementation (International Institute for Population Sciences (IIPS) & Macro International 2000; Ministry of Health and Family Welfare 2004). Notably, the 1998 cyclone in Gujarat followed by a devastating earthquake in the same area seriously damaged salt iodisation 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 iodised salt, with the national coverage reaching 51% in 2005–2006 and 71% in 2009[2] (International Institute for Population Sciences (IIPS) & Macro International 2007; UNICEF 2011). Still, in 2009, nearly 20% of households were found to be consuming inadequately iodised salt and 9% using salt that was not iodised (UNICEF 2011).

The proportion of households using adequately iodised salt varied widely by state in 2009, ranging from ~98% in Manipur to ~30% in Chhattisgarh (Fig. 1) (UNICEF 2011). Interestingly, the states

[1]Adequately iodised salt contains ≥15 ppm iodine. Salt iodine content is measured using either a titration method or a Salt Testing Kit.

[2]The coverage estimate in 2009 was obtained from the 2009 Coverage Evaluation Survey, a nationwide survey carried out to assess the impact of the National Rural Health Mission strategies on coverage levels of maternal, newborn, and child-health services. A nationally representative sample of 45 058 households were sampled using a two-stage sampling method in both rural and urban areas.

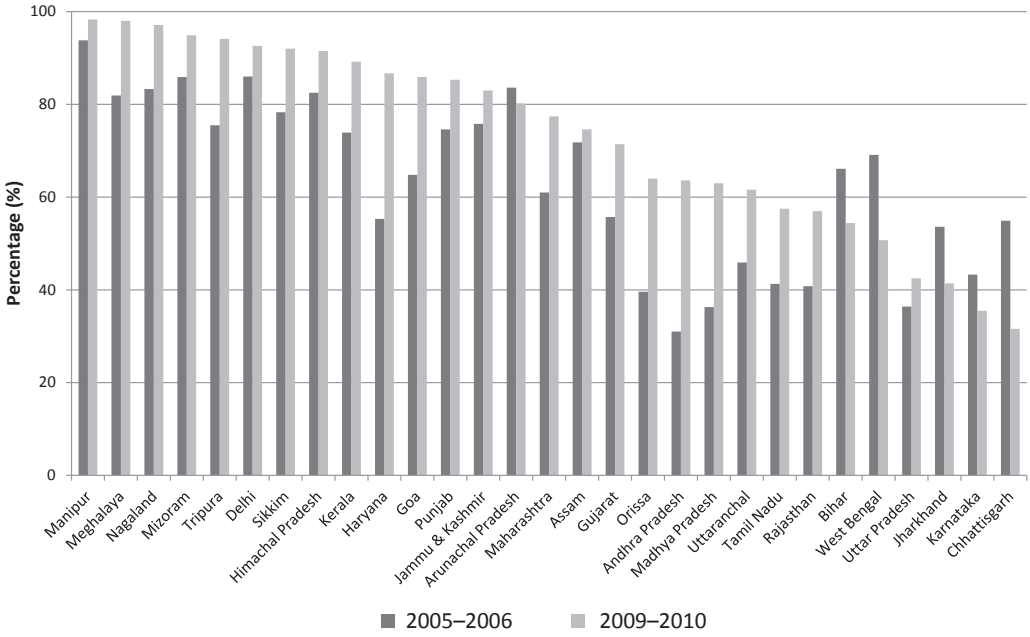

Fig. 2. Percentage of households using adequately iodised salt* by state in 2005–2006 vs. 2009.
*Adequately iodised salt contains ≥15 ppm iodine.

with the lowest coverage were the ones that showed a substantial reduction in coverage compared to the previous estimate in 2005–2006 (Fig. 2). 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. Moreover, data indicate a clear urban-rural (Fig. 3) and rich-poor differential (Fig. 4) in salt iodisation still persists with better coverage of adequately iodised salt in urban areas and richer wealth quintile, leaving the most disadvantage population vulnerable to IDD.

Currently, there are no national data on the iodine status of the population based on urinary iodine concentration (UIC), although a number of small-scale surveys have been carried out in the past (Andersson *et al*. 2012). The most recent weighted estimate pooled from subnational surveys indicated that the median UIC of the population was 154 μg L^{-1} and that 34% of Indians had UIC <100 μg L^{-1}, indicating insufficient iodine intake (Andersson *et al*. 2012). Although India is classified as a country with adequate iodine intake based on the median UIC

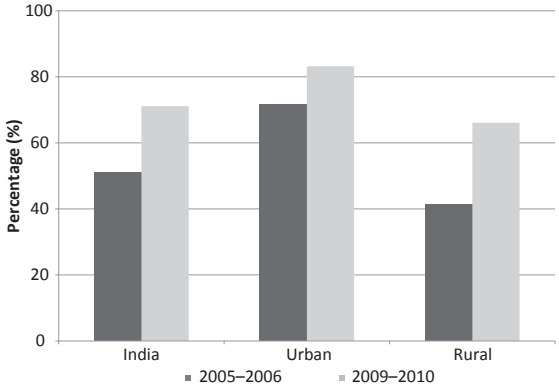

Fig. 3. Percentage of households using adequately iodised salt* in urban and rural areas in 2005–2006 and 2009.
*Adequately iodised salt contains ≥15 ppm iodine.

(Andersson *et al*. 2012), 249 million people including 8 million newborns annually are still unprotected from the lifelong consequences of IDD. In addition, the current estimate should be interpreted with caution because the median UIC was extrapolated from small subnational surveys.

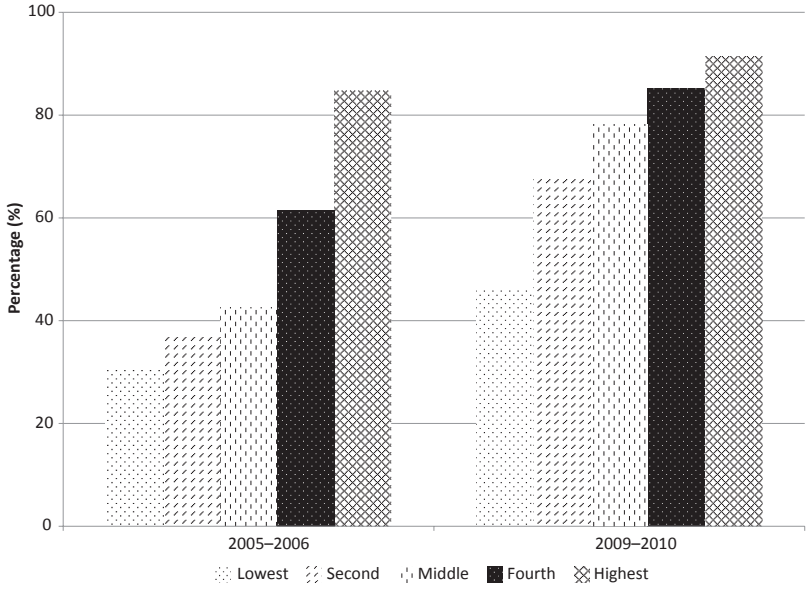

Fig. 4. Percentage of households using adequately iodised salt* by household wealth index in 2005–2006 and 2009. *Adequately iodised salt contains ≥15 ppm iodine.

Current status of the USI programme and challenges to overcome

The USI programme has matured over the past two decades within the context of India's NIDDCP – making unsteady but remarkable progress despite many setbacks and on-going problems. A brief overview of the present status of the USI programme is described below together with the challenges being faced towards achieving USI, classified in five categories, which represent the five guiding principles[3] crucial to sustained USI programme success.

Ensuring political commitment

The NIDDCP has a complex governance structure with multiple sectors involved in its implementation (Pandav *et al*. 2003). The Ministry of Health and Family Welfare (MOHFW) is the core body responsible for making policy decisions pertaining to the NIDDCP (Pandav *et al*. 2003; Ministry of Health and Family Welfare 2006). Specifically, the Central Nutrition and IDD Cell at the Directorate for General Health Services (DGHS) of MOHFW is responsible for designing and implementing the programme, providing funds for the state programme implementation and monitoring compliance with salt iodisation regulation (Pandav *et al*. 2003; Ministry of Health and Family Welfare 2006). The Nutrition Advisor in the DGHS is the nodal officer of the programme (Pandav *et al*. 2003; Ministry of Health and Family Welfare 2006). Simultaneously, the Salt Department under the Ministry of Commerce and Industry is responsible for monitoring the quantity and quality of iodised salt at the production level and ensuring the equitable distribution of iodised salt across the country (Pandav *et al*. 2003; Ministry of Health and Family Welfare 2006). A key partner is the Ministry of Railways which jointly organises the transportation of iodised salt to all parts of the country (Pandav *et al*. 2003; Ministry of Health and Family Welfare 2006).

Also assisting the MOHFW in implementing the NIDDCP are the Ministry of Information and Broadcasting which aids in communication

[3]The five guiding principles crucial to sustained success of the USI programme were identified by UNICEF (2008) based on a review of global efforts towards USI.

campaigns; the Ministry of Women and Child Development which mobilises its extensive network of village level Anganwadi centres and workers for raising awareness and monitoring iodine status; and the Ministry of Food and Civil Supplies which distributes iodised salt to the 'below-poverty-line' households through the Public Distribution System (PDS) (Pandav *et al*. 2003; Ministry of Health and Family Welfare 2006).

This network of partners is mirrored at the state level. In 31 of the 34 States and Union Territories, an independent IDD Cell was established for the effective execution of NIDDCP, which is responsible for the policy implementation at the state level (Ministry of Health and Family Welfare 2006).

The Government's commitment to eradicate IDD as an important public health issue has been confirmed at many national and international events (Pandav & Anand 1995). It is also reflected in the '20-point National Development Programme' and the '11th Five Years Plan' (Pandav *et al*. 2003; The Government of India 2008). Yet, despite such political will, IDD is not recognised as a priority in the health sector, resulting in a weak strategy formulation and poor programme implementation (Pandav & Anand 1995).

In addition, weak enforcement of the legal ban on the sale of non-iodised salt for human consumption is an on-going challenge together with the ban only applying to salt for human consumption (Sundaresan 2009). This is problematic, as animals and livestock are also affected by IDD, and so indirectly influence the iodine status of the population (WHO 2007). Also, the Food Safety and Standard Act 2006 prescribes that iodine content in salt should not be less than 30 ppm at the point of production and not less than 15 ppm along the supply chain and 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 iodisation makes the enforcement at the production a real challenge. Finally, the NIDDCP policy guidelines were first published in 1998 and although revised in 2006, are in need updating, particularly with regards to the survey guidelines to assess the iodine status of the population (Ministry of Health and Family Welfare 2006). The current revised policy guidelines lack epidemiological rationale both in terms of sampling method and sample size, and thus will not be able to generate reliable and valid state level or national level data on the iodine status of the population. In addition, adequate resource needs to be allocated to enable the implementation of such surveys.

Forming partnerships and coalitions

As the NIDDCP is a multi-sectoral programme, effective implementation requires coordination of various stakeholders. Two high-level national coordination bodies were established by the government; namely a Central Steering Committee and a Program Implementation Committee (Pandav *et al*. 2003; Sundaresan 2009). However, neither committee has been effective, resulting in poor coordination and a lack of leadership for the USI programme (Pandav *et al*. 2003; Sundaresan 2009).

Multi-sectoral workshops on NIDDCP at both the national and state level have reviewed the progress made, identified bottlenecks in programme 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 towards acceleration of USI (Pandav *et al*. 2008). The coalition is also expected to serve as a platform for high-level advocacy, streamlined communication and to act as a pressure group to ensure timely action (Pandav *et al*. 2008). 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 fulfil 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 programmes have

either poorly functioning coalitions or do not have any coordination and partnership mechanisms in place.

Ensuing availability of adequately iodised salt

India is the third largest salt-producing country in the world after China and the USA, with an average annual production of ~18.6 MMT in 2010–2011 (The Salt Department 2012). The majority of the raw salt comes from three states, namely Gujarat, Tamil Nadu and Rajasthan, which produce 80%, 11%, and 5.5% of the salt, respectively (The Salt Department 2012). 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] 4.5% are medium and 5.5% are large (The Salt Department 2012).

India has become self-sufficient in the production of iodised salt (The Salt Department 2012). There are a total of 843 registered iodisation units in the country with a capacity to produce 17.5 MMT of iodised salt annually (The Salt Department 2012). The actual production was 6.2 MMT during the year 2010–2011, against the total requirement of 5.5 MMT (The Salt Department 2012). Notably, ~56% of all edible iodised salt is produced by 86 refineries and an additional 24% by a network of ~341 traders. The remaining ~9% is produced by large and medium producers, and 11% by small ones.

Ironically as can be seen, although India has the capacity to produce sufficient iodised salt to meet its needs, a sizeable proportion of the Indian population still consumes either inadequately iodised or non-iodised salt. A significant barrier towards improving the distribution of affordable, adequately iodised salt is the lack of capacity and/or commitment of the medium and small producers and traders (Vir 2008; Sundaresan 2009). Iodisation is often viewed as an additional burden as they operate within narrow profit margins and commonly use less effective, poorly maintained equipment (Vir 2008; Sundaresan 2009).

[4]Small-scale producers operate with <10 acres of land; Medium-sized units operate with 10–100 acres of land; Large-scale producers operate with >100 acres of land.

In general, the refined iodised salt supplied by the refineries and large producers is adequately iodised, as in their case the profit margin is high and there is no economic benefit to compromising the quality (Sundaresan 2009). In 2011, ~2.7 MMT of refined iodised salt were produced (The Salt Department 2012). In fact, 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 iodised salt in India. In contrast, the non-refined iodised salt produced by medium and small producers and the traders is often inadequately iodised; it is sold at a lower price than the refined iodised salt in packages with similar design, brands and logos to those of the refined iodised salt (Vir 2008; Sundaresan 2009). 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 iodisation and tend to falsely label their non-iodised salt as 'iodized' (Vir 2008; Sundaresan 2009).

In both salt-producing and non-producing states, iodised salt is procured by wholesalers who often purchase the salt in bulk, and subsequently repackage it (Vir *et al*. 2007; The Micronutrient Initiative 2011). Salt procured in bulk is often non-iodised, but the wholesalers and retailers are not able to recognise it (Vir *et al*. 2007; The Micronutrient Initiative 2011).

Although potassium iodate for salt iodisation is produced in India, the iodine – the basic raw ingredient required – has to be imported (Sundaresan 2009). Due to the increasing global price of iodine, the cost of potassium iodate has fluctuated and escalated in the past few years (Sundaresan 2009). This has adversely affected the small producers and traders, and so has negatively affected the quality of iodised salt produced by them (Sundaresan 2009). There is currently no mechanism in place to ensure stable pricing for potassium iodate or to ensure its quality.

Moreover, iodised salt is perceived to be relatively expensive compared to common salt by consumers, especially the poorest (Yadav *et al*. 2011). In order to make the prices of common salt and iodised salt more comparable, efforts have been made to provide

iodised salt at prices comparable to common salt to consumers below the poverty line through the PDS network in several states.

Strengthening the monitoring system

To ensure the supply of adequately iodised salt, sustained monitoring of the iodine level is required at different stages, namely at the production stage, prior to dispatch by rail or road, at the wholesale and retail level, and at the consumer household level. Monitoring at the production level is a crucial component of the salt iodisation programme. Efforts have been made to develop guidelines for internal monitoring and to train manufacturers in the three main salt-producing states. Yet, limited internal monitoring is carried out by the medium and small producers (Vir 2008; Sundaresan 2009). 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 (Sundaresan 2009).

External monitoring at the production level is done by the Salt Department. Field officials visit the iodisation plants on a regular basis to collect samples of iodised salt, which are analysed in 26 salt-testing laboratories at the production centres and eight mobile laboratories (Pandav *et al*. 2003; Ministry of Health and Family Welfare 2006). However, the monitoring process is not being carried out in a systematic manner; moreover, due to a lack of trained staff, funds and laboratories is restricted to major salt producers (Sundaresan 2009). 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 (Sundaresan 2009).

A second quality check of the iodised salt which is transported by rail (i.e. ~58% of salt) is carried out by the Salt Department prior to shipment (The Salt Department 2012). Whereas only the adequately iodised salt is given permission for rail transportation, there is currently no mechanism in place for testing the quality of salt transported by road (Kapil *et al*. 2001; Sankar *et al*. 2006). Small producers often choose to transport their salt by road not only for cost saving, but because the current railway system favours large salt producers (Sundaresan 2009).

In terms of the regulatory monitoring, the Food Safety Officers collect samples of iodised 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 (Pandav *et al*. 2003; Sundaresan 2009). 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 (Sundaresan 2009). Furthermore, the food inspectors are reluctant to file a case under PFA for inadequately iodised 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 (Sundaresan 2009). The wholesale and retail level monitoring is also expected to be done by the state IDD Cell, but no regular actions are taken (Sundaresan 2009).

With regards to tracking progress towards 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 goitre prevalence are rarely included in national health surveys (WHO/UNICEF/ICCIDD 2007). Moreover, most of the district level IDD prevalence data use goitre as an indicator which is prone to subjective bias and errors. While national data on the household coverage of iodised 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 (The Micronutrient Initiative 2011).

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 iodised salt in India. Specifically, the system connects the Salt Department office to the salt production plants to enable real-time information flow. Information is organised and displayed clearly through a simple user interface including dashboards depicting quality, production and distribution, along with custom search functions. Through access to real-time information, the Salt Department will be able to improve supply management of one of the largest salt industries and delivery networks in the world.

Maintaining continuous advocacy, education and communication

Communication and advocacy efforts have mainly targeted three audience segments; influencers of the USI policy, producers and suppliers of iodised salt and consumers. Advocacy has focused on generating political commitment for the programme by informing the politicians and policymakers about the serious implications of IDD on mental health and the benefits of iodised salt. In order to mobilise the entire salt-trade chain, education and communication activities were carried out to create awareness of IDD among the salt producers and suppliers. Salt producers were encouraged to adequately iodise the salt they produce, while wholesalers and retailers were trained on the necessary skills required for procuring adequately iodised salt.

Public education and intensive social mobilisation activities have been conducted through various channels including print media, television and radio and inter-personal communication to create consumer demand for adequately iodised salt. School-based sensitisation programmes are on-going, through which students are oriented on the benefits of consuming iodised salt, and participate in the testing of salt to determine if it is adequately iodised. The school-based initiative aims to help equip consumers with adequate information to guide them to purchase the right product at an affordable cost.

However, the public awareness of IDD and its serious consequences remains low and there is a lack of consumer demand for adequately iodised salt (The Micronutrient Initiative 2011). 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 iodised salt.

Future agenda

In the present review, we have examined the current status of the salt iodisation programme in India and have identified a number of challenges obstructing progress towards achieving the goal of USI. Lack of strong political leadership, inadequate capacity and commitment of salt producers and traders to supply adequately iodised 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 programme, 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 programme success. Strong commitment and ownership of the programme by each stakeholder is also essential.

Future actions required to achieve USI are shown in Table 1. As the political and administrative leadership in the country continues to change, sustained advocacy at the national, stat, and district level is required to ensure higher political commitment and prioritisation of the USI programme. Equally important to continuing the central ban on the sale of non-iodised salt for edible purpose is the 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

Table 1. Future actions required to achieve universal salt iodisation

Guiding principles crucial to salt iodisation programme success	Action plans
Ensuring political commitment	• Continue advocating for ensuring high political priority to USI • Strengthen enforcement of the legal ban on the sale of non-iodised salt for edible purpose • Updating NIDDCP policy guidelines • Strengthen the Central IDD Cell of the Directorate General of Health Services; ensure estimation of urinary iodine as mandated in the policy guidelines and use data for programmatic corrections • Strengthen collaboration and coordination between involved sectors, particularly the central IDD cell and Salt Department • Advocate for the policy development to iodise salt for animal feeds • Advocate for the policy development to use only iodised salt for the mid-day meal programme and the Integrated Child Development Services programme • Continue advocating for the inclusion of iodised salt as one of the food items to be sold through the PDS
Forming partnerships and coalition	• Form state-level coalition in all states • Hold regular multi-sectoral meetings at the state level to review progress made, identify bottlenecks and suggest way forward
Ensuring availability of adequately iodised salt	• Develop robust business case for production and distribution of adequately iodised salt targeted to the marginal population • Sensitise and motivate medium and small salt producers and traders to incorporate correct levels of iodine • Continue mapping of wholesalers and retailers of salt; Sensitise and equip them with information, tools and skills for measuring iodine levels in salt • Technical support to medium-size producers for establishing units for producing refined salt • Technical support to small-scale producers for developing technologies and methodologies which will enable them to do quality iodisation • Control escalation in price of potassium iodate
Strengthening monitoring system	• Strengthen monitoring at the production level particularly for small and medium producers • Strengthen monitoring of the quality of salt before loading into railway rakes • Strengthen the regulatory monitoring at state and district level • Monitor quality of salt transported by road • Check quality of salt at household level through school children and through the Anganwadi centres • Check quality of salt being received at PDS outlets • Ensure sufficient manpower to perform monitoring at different levels • Improve laboratories facilities of the Salt Department and MOHFW and increase the number of laboratories for monitoring • Monitor guidelines, produced by the Salt Department, need to be updated and shared with all iodisation salt unit owners • Monitor population IDD status using urinary iodine concentration regular basis • Provide support to strengthen the monitoring conducted by the State IDD Cells
Maintaining continuous education and communication	• Concerted efforts at all levels and in all sectors for increasing and sustaining demand at the community level • Streamlining USI and IDD messages into the health education messages of the NRHM and integrating IDD/USI messages into formal education system

IDD, iodine deficiency disorders; MOHFW, Ministry of Health and Family Welfare; NIDDCP, National Iodine Deficiency Disorders Control Programme; NRHM, National Rural Health Mission; PDS, Public Distribution System; USI, universal salt iodisation.

organisational 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 inter-ministerial coordination and establishing an effective national level oversight mechanism to coordinate the efforts of the government, non-governmental organisations and salt industry to ensure that USI is achieved by 2015.

Ensuring adequate access and availability of appropriately iodised 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 iodised salt. For small-scale producers, support should focus on developing technologies which will enable them to conduct quality iodisation. Mapping of the wholesalers and retailers of salt should be expanded to cover all states to sensitise, train and equip them with tools and skills to procure and sell only adequately iodised 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) centres. 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. Also, the National Health Survey needs to report systematically on the iodine status of the population and progress of the USI programme at the household level, state by state to increase public accountability.

An updated education, communication and social mobilisation strategy with a well thought out implementation and monitoring plan is required for generating stronger consumer demand for adequately iodised 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.

In order to maximise the effective use of limited resources, a sensible prioritisation of states based on their past and current performance in salt iodisation may be needed. A well-defined and compelling strategy is necessary in order 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 iodised salt in the mid-day meal programme and the ICDS programme may help reach the most vulnerable segments of the population.

Conclusion

In conclusion, although there has been significant progress towards USI in India in the last two decades, it has been limited and beset with challenges. Urgent, targeted and comprehensive intervention is required if IDD is to be eliminated. In addition, on-going actions will be necessary to ensure that the gains are sustained.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Contributions

JHR and VMA jointly conceived the review project and wrote the paper. AMA, AC, RS, and CSP provided critical insights into the historical aspects and implementation of the USI programme in India, and jointly reviewed and analysed the background information. All authors reviewed and approved the manuscript.

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