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The challenges of iodine supplementation: a public health programme perspective☆

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An adequate iodine intake during pregnancy, lactation and early childhood is particularly critical for optimal brain development of the foetus and of children 7–24 months of age. While the primary strategy for sustainable elimination of iodine deficiency remains universal salt iodisation, the World Health Organization and the United Nations Children's Fund recommend a complementary strategy of iodine supplements as a temporary measure when salt iodisation could not be implemented. This article aims to review current evidence on efficacy and implications of implementing iodine supplementation as a public health measure to address iodine deficiency. Iodine supplementation seems unlikely to reach high coverage in a rapid, equitable and sustained way. Implementing the programme requires political commitment, effective and efficient supply, distribution and targeting, continuous education and communication and a robust monitoring system. Thus, universal salt iodisation should remain the primary strategy to eliminate iodine deficiency.

A diet low in iodine is the main cause of iodine deficiency and is especially damaging during the early stages of pregnancy and in early childhood because it retards foetal development, especially the brain, causing a range of intellectual, motor and hearing deficits, which are mostly irreversible.[1,2] Even mild deficiency can cause a significant loss of learning ability – about 13.5 intelligence quotient points

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at population level. In their most severe form, iodine deficiency disorders (IDDs) include cretinism, stillbirth and miscarriage, and increase infant mortality[1,3] as well as other symptoms such as goitre, an abnormal enlargement of the thyroid gland.[2]

The good news is that it is easily preventable and inexpensive by iodising all salt for human and animal consumption, also called the Universal Salt Iodisation (USI). USI guarantees an adequate and regular intake of iodine since dietary salt intake has been shown to be remarkable constant and within narrow ranges across populations.[1,4,5] This approach has been shown to be successful in countries such as Switzerland and United States of America since the early 1900s. Today, at least 120 countries have salt iodisation programmes, and so far, 34 developing countries have achieved elimination of iodine deficiency through USI.[5]

In 1994, a special session of the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) Joint Committee on Health Policy recommended USI as a safe, cost-effective and sustainable strategy to ensure sufficient intake of iodine by all individuals.[4] It was also suggested where full salt iodisation is not possible in areas where iodine deficiency disorders (IDDs) are a severe public health problem, supplementation with oral or injected iodised oil be provided as a temporary measure.[4] Based on new evidence and lessons learned within the past decade, it appears that in some countries/areas the iodine requirements of the most susceptible groups – pregnant and lactating women, and children 6–24 months of age – might not always be adequately met by iodised salt.[6,7] This situation may jeopardise the optimal brain development of the foetus and young child.[7,8] There was also some concern in studies using iodised salt that small children's salt consumption would not be high enough to achieve adequate iodine status.[7,9–11] In the case that the implementation of salt iodisation programmes is not feasible, this may result in insufficient iodine intake for some groups within the population or in certain geographic areas.

To address the above situation, WHO/UNICEF issued a joint statement in 2007 on "Reaching Optimal Iodine Nutrition in Pregnant and Lactating Women and Young Children."[7] It recommends that besides strengthening the USI programmes, additional complementary strategies such as iodine supplements should be considered to ensure optimal iodine nutrition for pregnant and lactating women and supplement or complementary food fortified with iodine for children 7–24 months of age for a short-term measure.[7] Prior to deciding whether additional/alternative, interventions such as iodine supplementation is required to meet the iodine requirement of the population, countries need to assess the level of implementation of salt iodisation programmes and, based on this analysis, should revisit the strategy for elimination of IDDs, as necessary. Guidance for the categorisation and the planning process is presented in the WHO/UNICEF joint statement.[7]

This article aims to review the efficacy of iodine supplementation, and the implications of implementing iodine supplementation as a public health measure for addressing iodine deficiency in pregnant and lactating women and in children 7–24 months of age. In addition, challenges in implementing the supplementation programme are discussed. The methodology applied for this review includes searches of literatures through a MEDLINE/PubMed and Internet and compilation of all published studies and reports related to iodine supplementation and its programmatic aspects.

Efficacy, dose and safety of iodine supplementation

Various studies on the efficacy and dosages of iodine supplementation to prevent and control iodine deficiency suggested that giving iodine increased the iodine status of the subjects as indicated by decreased thyroid size and increased iodine in the urine.[6,12–17] Although the effect of supplementation on cognitive and psychomotor function were mixed, generally a positive effect or correlation between the iodine deficiency and impaired intellectual function was found.[2,18–24] Adverse effects of supplementation were generally minor and transient.

Studies on the dosage of iodised oil supplementation suggested that 200–480 mg iodine per millilitre might provide protection against iodine deficiency for about 1 year.[6,12,17,25–31] A review on the requirements for iodine suggested that the iodine requirement during pregnancy is 250–300 $\mu g\, d^{-1}$; during lactation is 225–350 $\mu g\, d^{-1}$; and during the neonatal period the requirement of the infant is 90 $\mu g\, d^{-1}$.[8] WHO and UNICEF[7] recommend two main approaches for administering iodine supplements, either as a daily supplement or on annual iodised oil preparation. Based on various technical

consultations and reviews, the WHO/UNICEF/ICCIDD recently increased the recommended nutrient intake for iodine during pregnancy from 200 to 250 $\mu g\,d^{-1}$ to ensure maternal and newborn euthyroidism.[7,32]

A recent study on the administration of supplementary iodine to an unselected population, residing in an area of mild iodine deficiency, in the postpartum period indicated that a dose up to 250 $\mu g\,d^{-1}$ is safe.[33] Even the amount of 50 $\mu g\,d^{-1}$ of iodine supplementation seems to be very efficient in reducing pregnancy-associated increments in thyroid volume. WHO confirmed that an annual dose of supplementation of 400 mg is safe during pregnancy and lactation and 200 mg for children 7–24 months of age.[7,34] Results of a randomised, placebo-controlled clinical trial on the effect of oral iodised oil in infants suggested that oral iodine may safely be delivered to infants at the same time as oral poliovirus vaccine according to the current EPI immunisation schedules. A summary of recommended daily and annual dose of supplementation is presented in the Table 1.[7]

Considerations for iodine supplementation as a public health programme

Micronutrient supplementation has many potential advantages for improving micronutrient intake in comparison with fortification. Population groups with a higher biological requirement (pregnant and lactating women) and/or who consume insufficient quantities of fortified food to have their requirement met (children aged 7–24 months) benefit directly from supplementation if they are reached with the intervention. Experience with vitamin A supplementation in young children over the past decade has proved to be remarkably successful. UNICEF estimated that in 2004, approximately 190 million children aged 6–59 months received at least one high-dose vitamin A supplement, representing global coverage of 68% and for high-mortality countries in sub-Saharan Africa the coverage was even over 70%.[35] Demonstrated efficacy of vitamin A supplements for improved child survival in many settings, technical consensus and extensive programme experience on how to implement interventions were major factors in achieving this success.[36]

Supplementation may appear to be a feasible intervention that can be scaled up easily and fast when salt iodisation is unsuccessful. In fact, however, supplementation also has to go through a similar programme design cycle of policy and strategy development for which political commitment and support need to be sought, securing a quality and reliable supply, identifying an effective and inclusive distribution and delivery system, designing a communication strategy for sensitising the target population and demand creation, training and capacity development of staff responsible for providing the supplements and counselling, developing a monitoring and evaluation system and securing the required funding. A lesson from micronutrient programmes suggests that the main constraints to supplementation are related to supply and awareness of health staff and communities.[37]

Supply and distribution

The goals of supply management are to obtain a product of good and stable quality procured from suppliers with sufficient capacity and with a guaranteed continuous supply. Its management needs to

Table 1
Recommended dosages of daily and annual iodine supplementations.

Population group	Daily dose of iodine supplementation (μg/d)	Single annual dose of iodized oil supplementation (mg/y)
Pregnant women	250	400
Lactating women	250	400
Women at reproductive age (15–49 y)	150	400
Children 7–24 mo[a,b]	90	200

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

[b] These figures for iodine supplement are given for situation where complementary food fortified with iodine is not available in which case iodine supplementation is required for children of 7–24 mo of age.

be transparent and accountable. The supplement should have accurate labelling in local languages with adequate information and understandable instructions. A study in distribution micronutrient supplementation targeted to children and women of childbearing age in Peru suggested that effective, sustainable, large-scale programmes require secured supply and distribution of the supplements.[38]

With few countries producing the iodine mineral,[39] the production/supply of iodine supplementation is limited. The delivery system of supplies to the distribution centres and target groups should be well planned and decentralised. Distribution channels are needed, which are able to deliver supplements to a large proportion of the target groups, have distributors with the capacity and the willingness to provide the supplement, accompanied with right amount and accurate information to the target group so that the beneficiary understands the reason for the supplement, accepts it and actively seeks such service.

In many low-income countries, several child-survival interventions including supplementation are being implemented. Combining interventions in convenient and effective distribution channel or delivery mechanisms require thorough reflection on suitable contact points with the target population through routine events (e.g., health centres, school visits, workplace programmes and nutritional safety net programmes) or through specially organised events such as child health days. A review of Vitamin A suggested that until routine health services can reach all targeted children on a regular basis, outreach and campaign-style events will be critical to protect children from the life-threatening effects of deficiency.[35]

Victora et al.[40] assessed how these interventions are clustered at the level of the individual child based on data gathered from Bangladesh, Benin, Brazil, Cambodia, Eritrea, Haiti, Malawi, Nepal and Nicaragua. The review suggested that countries with higher coverage rates tended to show bottom inequity patterns, with the poorest lagging behind all other groups, whereas low-coverage countries showed top inequities with the rich substantially above the rest. The inequitable clustering of interventions at the level of the child raises the possibility that the supplement might primarily benefit children who are already covered by existing interventions. Packaging several interventions through a single delivery strategy, while making economic sense, could contribute to increased inequities unless population coverage is very high.[40]

Communications, public education and role of health-care workers

An effective social marketing campaign, combined with the effective counselling of consumers by health-care workers, has a two-way benefit, that is, increase acceptability and create a demand. The compliance of supplement use by the target groups depends on effective communication by trained, motivated health-care workers who can increase awareness, help to overcome fears and clarify misinformation and misconceptions. A review of an iodine supplementation programme in Tanzania indicated that motivating health workers and community leaders to carry out effective social mobilisation remains crucial even if logistics are vertically well organised.[41] A study in Cambodia showed that maternal formal education appears to be an important determinant for receipt of a vitamin A capsule by preschool children.[42] Taking capsules may require behaviour change through seeking supplements actively from the health-care services. The neediest populations often have limited knowledge on the importance of the supplement.[42] The perception about supplements – whether it is true or false – also play an important part, for example, a common fear among women that an iodine supplement is a contraceptive. Communication efforts should therefore articulate concrete accountabilities and should include specific messages tailored to the entire range of audiences, including national and community leaders, technical and professional groups, health-care providers and families. Messages must be delivered through all types of media, ranging from television to person-to-person communication and must be regular and ongoing.[43]

In supplementation, therefore, much rides on the abilities of health-care providers to explain the nature and importance, dosage and target groups and the supplement's possible side effects. A study in Peru suggested that a thoroughly planned and implemented nutrition communication programme could secure high compliance of the beneficiaries of micronutrient supplementation.[38,43] Adequate training for the health-care providers to anticipate and accommodate increased demand for supplements from newly informed consumers and to direct scarce supplies of supplements to the neediest is an important component of the programme.[38,43]

Targeting supplementation

Targeting is a critical step and requires a carefully crafted strategy in the design of an iodine supplementation programme because some groups are more susceptible to iodine deficiency than are others, taking into consideration also the functioning of the salt iodisation programme. Supplementation targeted to pregnant women needs a strong implementation of preconception programmes and other public health strategies since a start of pregnancy is often only detected at a later stage. In cases where it is difficult to reach pregnant women, supplementation to all women of reproductive age is advised.[9]

A review of the available published studies on administration of iodised oil during pregnancy confirms that the administration of iodised oil before or during pregnancy prevents endemic cretinism and brain damage by correcting iodine deficiency and thyroid function in pregnant women, foetuses, neonates, infants and children. The potential benefits derived from using iodised oil immediately before or during pregnancy greatly outweigh the potential risks in areas of moderate and severe prevalence of iodine-deficiency disorders, where iodised salt is not yet available.[14]

Another review on the effect of iodine deficiency in brain development in the first half of pregnancy suggested that an inadequate supply of iodine during gestation results in damage to the foetal brain that is irreversible by mid-gestation unless timely interventions can correct the accompanying maternal hypothyroxinaemia.[44] Even mild-to-moderate maternal hypothyroxinaemia may result in suboptimal neurodevelopment. De Escobar et al.[45] suggested that women who are unable to increase their production of thyroxine (T4) in the first half of pregnancy constitute a population at risk for having children with neurological disabilities. As mild-to-moderate iodine deficiency is still the most widespread cause of maternal hypothyroxinaemia, the birth of many children with learning disabilities may be prevented by advising women to take iodine supplements as soon as pregnancy starts, or earlier if possible, to ensure that their requirements for iodine are met.[45]

However, a systematic literature review on factors affecting the use of antenatal care in developing countries suggested that millions of women in developing countries do not adequately receive it.[46,47] The most commonly identified factors affecting antenatal care uptake are maternal education, husband's education, marital status, availability, cost, household income, women's employment, media exposure and having a history of obstetric complications. Whilst women of higher parity tend to use antenatal care less, there is a correlation with women's age and religion.[46]. In the case where it is difficult to reach pregnant women, supplementation to all women of reproductive age is advised.[7] However, finding a suitable distribution channel and the higher cost because of the larger number of beneficiaries also pose serious challenges.

A review on breastfeeding and maternal and infant iodine nutrition indicated that iodine content of breast milk varies with dietary iodine intake, being lowest in areas of iodine deficiency with high prevalence of goitre.[48] Milk iodine levels are correspondingly higher when programmes of iodine prophylaxis such as salt iodisation or administration of iodised oil has been introduced.[48,49] The small iodine pool of the neonatal thyroid turns over very rapidly and is highly sensitive to variations in dietary iodine intake. In areas of iodine sufficiency, breast milk iodine concentration should be in the range of 100–150 $\mu g\,l^{-1}$.[48] Studies from France, Germany, Belgium, Sweden, Spain, Italy, Denmark, Thailand and Zaire have shown breast milk concentrations of $<100\ \mu g\,l^{-1}$ while adequate levels of iodine in breast milk have been reported from Iran, China, USA and some parts of Europe.[48] Adequate concentration of iodine in breast milk is essential to provide for optimal neonatal thyroid hormone stores and to prevent impaired neurological development in breast-fed neonates.[8,48,49] In many countries of the world, low iodine content of the breast milk indicates less than optimum maternal and infant iodine nutrition.[48]

Children aged 7–24 months can be reached through iodine supplementation annually, or daily through multi-micronutrient-fortified complementary food or through home fortification, such as multiple micronutrient powders. A study in Indonesia suggested the benefit of iodised oil supplementation in infant survival, as indicated by a 72% reduction in the risk of death during the first 2 months of follow-up after the supplementation and a delay in the mean time to death among infants who died in the iodised oil group compared with infants who died in the placebo group. This study concluded that an annual dose of oral iodised oil supplementation of infants might reduce infant mortality in populations at risk for iodine deficiency.[24]

A review on Nutrient Composition for Fortified Complementary Foods suggested that iodine should be routinely added to complementary foods.[50] A small amount of additional iodine (daily recommendation) is unlikely to have significant adverse effects in children or their mothers if they are already iodine sufficient. Even when the salt in a country contains adequate iodine, salt intake is frequently restricted during pregnancy and the median national urinary iodine concentration may not reflect the true status for this condition.[50] Another study on the efficacy of a multiple-micronutrient food LET indicated that providing daily dose of iodine (1 RNI) during infancy might be one strategy to improve iodine status.[51]

Where iodine deficiencies are geographically concentrated, targeted rather than national programmes may be preferable (although emerging evidence on the effects of sub-clinical deficiencies suggests that broader rather than narrow targeting may be warranted). High-risk areas are fairly easy to delineate on the basis of low iodine content in soils and water or iodine nutrition status. These high-risk areas often coincide with high altitude or flood plains because the iodine has been leached away over millennia.

Cost of supplementation

An expert panel of eight world's leading economists, including five Nobel laureates, through the 'Copenhagen Consensus' meeting provided a prioritised list highlighting the potential of 30 specific solutions to combat some of the biggest challenges facing the world.[52] Combating malnutrition in the 140 million children who are undernourished through provision of vitamin A capsules and zinc supplements reached the number one spot. Each dollar spent for this programme creates benefits (in the form of better health, fewer deaths, increased future earnings, etc) worth more than $17.[53] The third top priority is micronutrient fortification involving the iodisation of salt and fortification of basic food items with iron, and each dollar spent would result in benefits of more than $9.[53] These results confirm that both supplementation and fortification are highly cost-effective programmes.

Supplementation requires personal contact, is more expensive when targeting those living in physically remote and culturally isolated regions, which is often the case for endemic iodine-deficient areas in mountainous regions. A review of Tanzania programme revealed that the cost of iodine supplementation itself might account for more than 90% of total costs at the levels of coverage achieved.[41] Consider the case of salt, which is consumed by practically everyone, the World Bank estimated that adding iodine to refined salt would cost less than $0.10 per person per year while cost of iodine supplementation is about $0.50 per person per year or 5 times higher than that of iodised salt.[54]

Fiedler et al.[55] recently reviewed various literatures on the cost of micronutrients interventions and found enormous variation in the estimated costs of the programmes due to differences in programme structure, delivery systems and a host of country-specific factors, differences in the studies' objectives, designs and costing methodologies. As the magnitude of these variations suggests, the bulk of these studies are idiosyncratic, and their results are not directly comparable. The review highlights the need for greater specificity in discourse about these programmes and for greater transparency about cost-estimation methods.

Monitoring

Monitoring is essential to ensure that the programme is functioning as planned and whether targeted groups are effectively reached by iodine supplementation and to provide information for corrective action. In addition, periodic impact evaluation of health programmes is necessary to ensure that overall goals and objectives are met, that is, whether iodine deficiency has been eliminated as a public health problem.[56,57] WHO/UNICEF/ICCIDD recommend various approaches for monitoring and assess progress of the programmes and iodine status of the population.[32] To achieve these goals, local community's participation and ownership is key. This requires committed leaders, capable managers, motivated and well-trained workers and acceptance among the target group that demands the supplements.

In addition to evaluate the programme achievements, monitoring iodine nutritional status is also important to assess whether any occasional adverse effects occurs. The principal effect is iodine-induced

hyperthyroidism, which occurs essentially in older people with autonomous nodular goitre, especially following iodine intake that is too rapid and of too massive an increment. The incidence of the disorder is usually low and reverts spontaneously to the background rate of hyperthyroidism or even below this rate after 1–10 years of iodine supplementation.[58] Iodine-induced hyperthyroidism and other adverse effects can be almost entirely avoided by adequate and sustained quality control and monitoring of iodine supplementation, which should also confirm adequate iodine intake. Available evidence clearly confirms that the benefits of correcting iodine deficiency far outweigh the risks of iodine supplementation.[58] However, a review on the impact of micronutrients programmes suggested that national monitoring data on iodine nutrition status are still limited.[59] Another review indicated that nationally representative surveys depict only 60% of the worldwide population included in the global database maintained by WHO and subnational data might underestimate or overestimate the extent of iodine deficiency.[60] In addition, data from nearly all countries are insufficient to estimate the prevalence of iodine deficiency in pregnant women.[60] WHO/UNICEF/ICCIDD also recently emphasised the need for more data on the level of iodine intake and the corresponding urinary iodine concentration that ensures maternal and newborn euthyroidism.[32]

Political commitment and sustainability

Planning for programme sustainability is a key contributor to health and development, especially in low-income and middle-income countries.[61] Political commitment is essential for adopting new programmes and obtaining the necessary support. Yet, political support alone is unlikely to sustain a programme long enough to outlive the micronutrient problem, and popular support must be generated. A review of the vitamin A supplementation programme in Bangladesh suggested that an integrated approach, which brings together appropriate actions at every level, within and across the many sectors of society, is required to achieve the goal of the programme.[62] In the case of iodine supplementation, the programme should be implemented and scaled up in a short period and as part of the national strategy, it should not have negative impact on the long-term commitment for USI as the primary strategy for sustainable elimination of iodine deficiency and an exit/transition strategy should be developed.

Low cost and high effectiveness of the programme enhances sustainability. If a government cannot afford to carry on the supplementation programme after donors withdraw, it is not viable. Cost and cost-effectiveness should be priority considerations in setting national strategies. Packaging several interventions through a single delivery strategy, while making economic sense, could contribute to increased inequities unless population coverage is very high.[40]

A key requirement is to provide iodine supplementation to the target group in a sustainable manner. Government commitment, clear policy and programme direction, advocacy and communication combined with a strong public–private partnership is essential for successful programmes.[63] However, this may risk that the focus on supplementation will divert attention from USI as the main sustainable strategy to eliminate iodine deficiency.

Conclusions

In the long run, salt iodisation is the more sustainable approach for elimination of iodine deficiency[4,5,7,32,64] and iodine supplementation should be considered as a short-term measure, especially in areas of severe iodine deficiency where salt iodisation cannot be rapidly implemented including emergency situations.[4,5]

The following issues may need to be considered when a country plans an iodine supplementation programme

- **Secure political commitment:** Strong and continuous government commitment is essential to sustain a programme. Such commitment is not a 'one-off' event – it needs to be renewed through regular advocacy. In the long run, salt iodisation is still the most cost-effective strategy for sustainable elimination of iodine deficiency, and iodine supplementation should be adopted only if implementation of salt iodisation programme is not feasible in the short term. Political focus, therefore, should remain on salt iodisation.

- **Supply management should be effective and efficient.** This includes that supplements should be distributed on time and schedule regular month for distribution of iodine supplementation to ease management and marketing problems.
- **Maintain continuous education and communication:** Persuasion is an essential component of national strategies to eliminate iodine deficiency. Health-care providers should be adequately trained and equipped with the necessary knowledge on the programmes.
- **Strengthen monitoring systems:** Monitoring iodine nutrition status should include mechanisms to ensure that the results are reached and are used by the appropriate decision makers. Results should be shared regularly with the general public.
- **Targeting Supplementation**. Rank target groups and try to reach the most vulnerable groups, that is, pregnant and lactating women and children under 2 years. For pregnant women, ensure that the programme reaches them in early pregnancy.

Iodine supplementation should be seen as a temporary complementary measure in addition to salt iodisation rather than as a stand-alone intervention. It is unlikely to scale up supplementation in a short time period because of the stages a new programme has to go through. Reaching a high proportion of pregnant women in the first trimester with iodine supplements in a weak antenatal care programme may not be realistic. Alternatively, all women of childbearing age need to be considered. However, identifying an appropriate delivery channel and the high cost are serious drawbacks to this approach. Children 7–24 months of age can be reached through fortified complementary foods or through home fortification programmes, although scaling up and reaching the unreached population remains a significant challenge till date.

Practice points

- Iodine supplementation targeted to pregnant women needs a strong implementation of preconception programmes and other public health strategies since a start of pregnancy is often only detected at later stage. Alternatively, targeting women pre-pregnancy is considered as well. Situations where unplanned pregnancies are common need to be considered.
- The compliance of supplement use by the targeted groups depends on effective communication by trained, motivated health-care workers who can increase awareness, help to overcome fears and clarify misinformation and misconceptions. Adequate training for the health-care providers is an important component of the programme.
- Low cost and high effectiveness of the programme enhance sustainability. To reduce the cost whenever possible, integrate or extend the programme beyond the iodine supplementation such as vitamin A supplementation and child health days can be cost-effective.

Research agenda

- Effectiveness study on iodine supplementation should be undertaken. It should include the programmatic components, such as supply and distribution management, political commitment, cost, advocacy and communications and monitoring.
- Further study on the efficacy and effectiveness of daily supplementation of iodine among children under 2 years.
- Costing studies of iodine supplementation programmes.

Summary

In summary, the primary strategy for sustainable elimination of iodine deficiency remains USI but in some countries and situation, however, implementation of salt iodisation programmemes may not be

feasible in all areas, thus resulting in insufficient access to iodised salt for some groups within the population. In these cases, besides strengthening the USI programmemes, WHO/UNICEF recommend that additional complementary strategies should be considered by the country to ensure optimal iodine nutrition for these susceptible groups.

The requirements for considering iodine supplementation as a viable alternative to USI include:

- Proven evidence for its efficacy and safety in the target groups and the supplementation is accepted and demanded by the target population and reaches the target group in a timely manner.
- Political commitment exists for the iodine supplementation programme by various stakeholder groups and the cost is covered. The programme should be implemented and scaled up in a short period of time and should not have negative impact on the long-term commitment for sustainable elimination of iodine deficiency through USI. An exit and transition strategy to USI should be developed.
- In addition, an effective supply management, public education and communication as well as monitoring systems should be in place.

Conflict of interest

None of the authors had a financial or personal conflict of interest.

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