GUIDELINE: Fortification of food-grade salt with iodine for the prevention and control of iodine deficiency disorders

World Health Organization

GUIDELINE: Fortification of food-grade **salt with iodine** for the prevention and control of iodine deficiency disorders

WHO Library Cataloguing-in-Publication Data

Guideline: fortification of food-grade salt with iodine for the prevention and control of iodine deficiency disorders.

1.Sodium Chloride, Dietary. 2.Iodine. 3.Deficiency Diseases – prevention and control. 4.Food, Fortified. 5.Guideline. I.World Health Organization.

ISBN 978 92 4 150792 9 (NLM classification: QV 283)

Design and layout: Alberto March

Printed by the WHO Document Production Services, Geneva, Switzerland

Suggested citation

WHO. *Guideline: fortification of food-grade salt with iodine for the prevention and control of iodine deficiency disorders*. Geneva: World Health Organization; 2014.

Contents

Acknowledgements

This guideline was coordinated by the World Health Organization (WHO) Evidence and Programme Guidance Unit, Department of Nutrition for Health and Development. Dr Maria Nieves Garcia-Casal and Dr Juan Pablo Peña-Rosas oversaw the preparation of this document. WHO acknowledges the technical contributions of the following individuals (in alphabetical order): Dr Lisa Rogers, Dr Godfrey Xuereb and Mr Gerardo Zamora. We thank Dr Maria Andersson, Dr Omar Dary, Dr Laurence Grummer-Strawn, Mr Lorenzo Locatelli-Rossi, Mr Arnold Timmer and Dr Michael Zimmermann for peer-reviewing this guideline.

We would like to express our gratitude to Dr Susan L Norris from the WHO Guidelines Review Committee Secretariat and the members of the Guidelines Review Committee for their technical support throughout the process. Thanks are also due to Mr Issa T Matta and Ms Chantal Streijffert Garon from the WHO Office of the Legal Counsel, and to Ms Alma Alic from the Department of Compliance and Risk Management and Ethics, for their support in the management of the conflicts of interest procedures. Ms Jennifer Volonnino, from the Evidence and Programme Guidance Unit, Department of Nutrition for Health and Development, provided logistic support.

WHO gratefully acknowledges the technical input of the members of the WHO Steering Committee for Nutrition Guidelines Development and the WHO guidelines development groups, especially the co-chairs of the meeting concerning this guideline, Ms Deena Alaasfor and Dr Maria Elena del Socorro Jefferds.

Financial support

WHO thanks the Government of Luxembourg and the Bill & Melinda Gates Foundation for providing financial support for this work. The Micronutrient Initiative provides financial support to the Evidence and Programme Guidance Unit for the commissioning of systematic reviews of nutrition interventions. Donors do not fund specific guidelines and do not participate in any decision related to the guideline development process, including the composition of research questions, membership of the guideline groups, conduct and interpretation of systematic reviews, or formulation of recommendations.

Executive summary

Iodine is a trace element that is essential for the synthesis of thyroid hormones by the thyroid gland. These hormones are involved in growth, development and control of metabolic processes in the body. Not only does iodine deficiency cause goitre, but it may also result in irreversible brain damage in the fetus and infant and retarded psychomotor development in children. Iodine deficiency disorders are usually the most common cause of preventable impaired cognitive development. They also affect reproductive functions and impede children's learning ability.

The most susceptible group for iodine deficiency disorders is women of reproductive age, whose neonates, if iodine deficient in utero, are at high risk of irreversible mental impairment. Moreover, the other susceptible group is women providing breast milk to their children, as this may be the only source of iodine during the first 6 months of life. It is estimated that about 1.88 billion people worldwide remain at risk of insufficient iodine intake, if iodine interventions are not kept in place. Approximately one third of the world's population lives in areas where natural sources of iodine are low, and therefore they require the permanent presence of iodine-supplying interventions. This population at risk of iodine deficiency is unevenly distributed across the world and within countries.

Salt iodization is the preferred strategy for control of iodine deficiency disorders and is implemented in more than 120 countries around the world. Many countries worldwide have successfully eliminated iodine deficiency disorders or made substantial progress in their control, largely as a result of salt iodization.

Salt is considered an appropriate vehicle for fortification with iodine, for the following reasons: (i) it is widely consumed by virtually all population groups in all countries, with little seasonal variation in consumption patterns, and salt intake is proportional to energy intake/requirements; (ii) in many countries, salt production is limited to a few centres, facilitating quality control; (iii) the technology needed for salt iodization is well established, inexpensive and relatively easy to transfer to countries around the world; (iv) addition of iodate or iodide to salt does not affect the taste or smell of the salt or foods containing iodized salt, and therefore consumer acceptability is high; (v) iodine (mainly from iodate) remains in processed foods that contain salt as a main ingredient, such as bouillon cubes, condiments and powder soups, and hence these products become sources of iodine; and (vi) iodization is inexpensive (the cost of salt iodization per year is estimated at US$ 0.02–0.05 per individual covered, and even less for established salt-iodization programmes). Additionally, the concentration of iodine in salt can easily be adjusted to meet policies aimed at reducing the consumption of salt in order to prevent cardiovascular disease.

Considering the existing World Health Organization (WHO) policies about reducing the intake of salt and delivering adequate dietary iodine to populations, it is important to establish the amount of iodine in salt that would provide sufficient iodine for salt intakes of <5 g/day. Iodization methods can provide the recommended concentrations of iodine for this amount of salt intake, so these two policies are compatible. However, careful monitoring of fortification procedures and salt iodine levels is therefore of paramount importance.

Purpose of the guideline

The proposed guideline[1] aims to help Member States and their partners in their efforts to make informed decisions on the appropriate nutrition actions to achieve the Millennium Development Goals (MDGs), in particular, reduction of child mortality (MDG 4) and improvement of maternal health (MDG 5). It will also support Member States in their efforts to achieve global targets on the *Comprehensive implementation plan on maternal, infant and young child nutrition* and in the *Global action plan for the prevention and control of noncommunicable diseases 2013–2020*, as approved in resolution WHA66.10 in 2013, including the voluntary global targets on salt reduction.

This guideline is intended for a wide audience, including policy-makers; their expert advisers; and technical and programme staff at organizations involved in the design, implementation and scaling-up of salt-iodization programmes, and in nutrition actions for public health. Engagement and commitment of the private sector can benefit fortification efforts and the implementation process.

Guideline development methodology

WHO developed the present evidence-informed recommendations using the procedures outlined in the *WHO handbook for guideline development*. The steps in this process included: (i) identification of priority questions and outcomes; (ii) retrieval of the evidence; (iii) assessment and synthesis of the evidence; (iv) formulation of recommendations, including research priorities; and (v) planning for dissemination, implementation, impact evaluation and updating of the guideline. The *Grading of Recommendations Assessment, Development and Evaluation* (GRADE) methodology was followed, to prepare evidence profiles related to preselected topics, based on up-to-date systematic reviews.

The guideline development group – nutrition actions 2013–2014 consisted of content experts, methodologists, and representatives of potential stakeholders and consumers. One expert group participated in the WHO technical consultations concerning this guideline, held in Geneva, Switzerland on 20–25 February 2010, where the guideline was scoped. A second meeting was convened with the guideline development group – nutrition actions 2013–2014 in Geneva, Switzerland on June 23–26 2014. A consultation in Sydney, Australia, in March 2013 about strategies to reduce salt/sodium intake at the population level, while ensuring adequate iodine nutrition, was also assessed.

---

[1] This publication is a WHO guideline. A WHO guideline is any document, whatever its title, containing WHO recommendations about health interventions, whether they be clinical, public health or policy interventions. A standard guideline is produced in response to a request for guidance in relation to a change in practice, or controversy in a single clinical or policy area, and is not expected to cover the full scope of the condition or public health problem. A recommendation provides information about what policy-makers, health-care providers or patients should do. It implies a choice between different interventions that have an impact on health and that have ramifications for the use of resources. All publications containing WHO recommendations are approved by the WHO Guidelines Review Committee.

Members of the external review group were identified through a public call for comments, and this panel was involved throughout the guideline development process. The document was peer-reviewed by six experts, who provided technical feedback on the document.

Available evidence

The available evidence comprised a systematic review that followed the procedures of the *Cochrane handbook for systematic reviews of interventions* and assessed the effects and safety of fortification of food-grade salt with iodine. The review included randomized controlled trials, non-randomized controlled trials and quasi-experimental, cohort and multiple cross-sectional studies. All studies compared a group of individuals with exposure to iodized salt to a group without exposure to iodized salt. The review included two randomized controlled trials, six non-randomized controlled trials and 20 quasi-experimental, 16 cohort and 42 multiple cross-sectional studies, as well as three studies with mixed designs. Another review assessed whether there were alternative food vehicles fortified with iodine to prevent iodine deficiency disorders. The overall quality of the available evidence for salt fortification with iodine ranged from moderate to low for the critical outcomes of goitre (moderate), cretinism (moderate), low cognitive function (low) and urinary iodine concentration (moderate).

Recommendation

All food-grade salt, used in household and food processing, should be fortified with iodine as a safe and effective strategy for the prevention and control of iodine deficiency disorders in populations living in stable and emergency settings (*strong recommendation*).

Suggested concentrations for fortification are shown in Table 1.

Remarks

- This recommendation recognize that salt reduction and salt iodization are compatible. Monitoring of sodium (salt) intake and iodine intake at country level is needed to adjust salt iodization over time as necessary, depending on observed salt intake in the population, to ensure that individuals consume sufficient iodine despite reduction of salt intake).

- The concentrations of iodine may need to be adjusted by national authorities responsible for the implementation and monitoring of universal salt iodization, in light of their own data regarding dietary salt intake.

- The national distribution of salt consumption must provide key guidance for the concentration of iodine in salt ; sufficient iodine should be supplied to most members of the population, even those with the lowest salt intake, while at the same time preventing excessive iodine supply to those individuals whose salt intake remains high.

- Iodized salt should reach, and be used by, all members of the population after 1 year of age. Infants and young children are assumed to be covered via breast milk or iodine-enriched infant formula milk when this is prescribed. Addition of salt to products consumed by young children may need regulation, to avoid insufficient or excessive consumption of either sodium (salt) or iodine.

- Since pregnant women have a daily iodine requirement of 250 µg/day, other interventions such as iodine supplementation could be considered if iodine inadequacy is found. Intake of salt correlates with caloric intake, and pregnant women usually increase their energy intake during this physiological stage.

- Policies for salt iodization and reduction of salt to <5 g/day are compatible, cost effective and of great public health benefit. Although salt is an appropriate vehicle for iodine fortification, iodization of salt should not justify promotion of salt intake to the public.

- Monitoring of food-grade salt quality is essential to ensure both efficacy and safety of the process of iodine fortification. Monitoring of urinary iodine excretion (UIE) and urinary iodine concentration (UIC) is useful not only to detect deficiency but also to detect excessive intakes and therefore prevent the health risks of iodine excess, by adjusting the level of iodine fortification accordingly, as part of a monitoring system. Countries should determine iodine losses from iodized salt under local conditions of production, climate, packaging and storage. For these reasons, iodine losses may be extremely variable and influence the additional amount of iodine that should be added at factory level.

- Fortification of salt with iodine should be appropriately regulated by governments and harmonized with other local or country programmes, to ensure that fortified food-grade salt is delivered safely within the acceptable dosage range. Particular attention should be given to identifying potential barriers to equitable access for all population groups needing iodine-fortified salt.

- Country programmes should be culturally appropriate to the target populations, so the intervention is accepted, adopted and sustained.

- Clear legislation should also be established for food producers and distributors, especially where the main source of dietary salt is processed foods and meals consumed outside households. Legislation should cover not only proper iodization of salt, but also the salt content of industrialized food products.

- Establishment of an efficient system for the ongoing and routine collection of relevant data, including measures of quality assurance and household use of iodized salt and measures of programme performance, is critical to ensure programmes for iodized salt are effective and sustained.

- Regular monitoring and evaluation can identify barriers that may be limiting equal access to fortified salt and thus preserving health inequities. Sustained implementation and scale-up derive great benefit from appropriate monitoring mechanisms.

Table 1. Suggested concentrations for the fortification of food-grade salt with iodine.

Estimated salt consumption[a], g/day	Average amount of iodine to add, mg/kg salt (RNI + losses[b])
3	65
4	49
5	39
6	33
7	28
8	24
9	22
10	20
11	18
12	16
13	15
14	14

[a] This includes consumption as table salt as well as salt from processed foods.

[b] This fortification concentration was calculated based on the mean recommended nutrient intake of 150 μg iodine/day + 30% losses from production to household level before consumption, and a 92% iodine bioavailability. Losses depend on the iodization process, the quality of salt and packaging materials and the climatic conditions. Losses could vary widely[1] and this table presents the value considering 30% losses. The monitoring of urinary iodine concentrations will allow adjustment of the selected fortification concentrations.

RNI: recommended nutrient intake, is the daily intake, set at the estimated average requirement plus 2 standard deviations, which meets the nutrient requirements of almost all apparently healthy individuals in an age- and sex-specific population group.

Although iodate is more stable, either potassium iodate (KIO_3) or iodide (KI) can be used. Iodide may be used for dry, low crystal size and washed or refined salts. While iodate can be used alone and in any type of salt quality, iodide is used in very good quality salt and cannot be added alone. Therefore, some salt producers add sodium carbonate or sodium bicarbonate when they iodize salt, to increase alkalinity, and sodium thiosulfate or dextrose to stabilize potassium iodide. Without a stabilizer, potassium iodide may be oxidized to iodine and lost by volatilization from the product.[2]

An estimated additional variability of ±10% during iodization procedures could be considered at the production site for use in quality control and assurance procedures. This variability depends on the iodization methods used and quality assurance system in place.

Shaded areas correspond to the WHO salt reduction guideline.

---

[1] Aburto NJ, Abudou M, Candeias V, Wu T. Effect and safety of salt iodisation to prevent iodine deficiency disorders: a systematic review with meta-analyses. 2014; (in press).

[2] The Salt Institute. Iodized salt (http://www.saltinstitute.org/news-articles/iodized-salt/, accessed 10 September 2014).

Implications for future research

Discussions with members of the WHO guideline development group and the external review group highlighted the limited evidence available in some areas, meriting further research on the fortification of food-grade salt with iodine, in particular in the following areas:

1. determination of the relationships between iodine excretion (24-h collection) and UIC in different ages, sexes, and physiological stages (mainly pregnancy and lactation), and under different climatic conditions and levels of physical activity, in order to adjust the criteria for UIC for population assessments;
2. determination of the relative contribution to iodine intake from table salt and from processed foods;
3. investigation of the usefulness of thyroglobulin as a functional indicator of iodine status, to complement the use of UIC as an indicator of iodine intake;
4. investigation of whether iodine deficiency (mild or moderate) is occurring in pregnant and lactating women worldwide, and the potential negative impact in their health, as well as on development of their offspring;
5. alignment of national salt-iodization and dietary salt-reduction programmes, including optimization of policy implementation and ensuring effective monitoring and coordination of monitoring;
6. understanding the potential impact of salt-containing processed foods, such as bouillon cubes, condiments and powder soups, and other edible vehicles;
7. identification of the optimal indicators to assess iodine nutrition during pregnancy, lactation and infancy. The use of neonatal serum concentration of thyroid-stimulating hormone as an indicator of iodine status in pregnancy needs further validation;
8. better prevalence data on the iodine status of pregnant and lactating women, and infants;
9. more data from large studies of the impact of iodine-intervention programmes on iodine-induced thyroiditis and iodine-induced hyperthyroidism;
10. further studies to correct misperceptions that link iodized salt to certain diseases, as well as the barriers that might be encountered during implementation and scale-up, such as consumer demand for non-iodized salt, religious concerns relating to iodized salt, and the perception of extra costs of purchasing iodized salt. Findings arising from these studies can help identify bottlenecks and barriers to access to iodine-fortified food-grade salt;
11. studies to identify the knowledge and awareness of the general population about the use of iodized salt are important to address barriers such as religious concerns and existing demand for non-iodized salt;
12. studies to search and evaluate the use of different vehicles for iodine fortification.

Scope and purpose

This guideline provides global, evidence-informed recommendations on fortification of food-grade salt with iodine, for the prevention and control of iodine deficiency disorders, with the purpose of improving iodine nutrition and preventing iodine deficiency disorders in populations.

The guideline will help Member States and their partners in their efforts to make informed decisions on the appropriate nutrition actions to achieve the Millennium Development Goals (MDGs), in particular reduction of child mortality (MDG 4) and improvement of maternal health (MDG 5). It will also support Member States in their efforts to achieve global targets of the *Comprehensive implementation plan on maternal, infant and young child nutrition*, as endorsed by the Sixty-fifth World Health Assembly in 2012, in resolution WHA65.6 *(1)*, and in the *Global action plan for the prevention and control of noncommunicable diseases 2013–2020* *(2)*, as approved in resolution WHA66.10 in 2013, including the voluntary global targets on salt reduction *(3)*.

The guideline is intended for a wide audience, including policy-makers; their expert advisers; and technical and programme staff at organizations involved in the design, implementation and scaling-up of salt-iodization programmes, and in nutrition actions for public health.

This document presents the key recommendations and a summary of the supporting evidence. Further details of the evidence base are provided in Annex 1 and other documents listed in the references.

Background

Iodine is a trace element that is essential for the synthesis of thyroid hormones by the thyroid gland. These hormones are involved in growth, development and control of metabolic processes in the body. The iodine content of foods depends on the iodine content in the soil. Thus, low iodine concentrations in soil and water result in iodine-deficient plants and animals *(4)*. As populations depend on food sources grown in areas where iodine may be deficient, iodine can only enter the food supply through the addition of this nutrient to nutrient-delivery interventions, and the most common has been a common staple: edible food-grade salt, a crystalline product consisting predominantly of sodium chloride *(5)*.

The most susceptible group for iodine deficiency disorder is women of reproductive age, whose neonates, if iodine deficient in utero, are at high risk of irreversible mental impairment. Moreover, the other susceptible group is women providing breast milk to their children, as this may be the only source of iodine for an infant during the first 6 months of life *(4)*. It is estimated that about 1.88 billion people worldwide are at risk of insufficient iodine intake if iodine-delivered interventions are not kept in place *(4)*. Approximately one third of the world's population lives in areas where natural sources of iodine are low, and therefore they require the permanent presence of iodine-supplying interventions. Approximately 29.8% (241 million) school-age children globally are estimated to have insufficient intake of iodine.

Many of these 241 million children live in the World Health Organization (WHO) South-East Asia Region (76 million) and African Region (58 million) *(6)*.

Salt iodization is the preferred strategy for control of iodine deficiency disorders and is implemented in more than 120 countries around the world *(7)*. Many countries worldwide have successfully eliminated iodine deficiency disorders or made substantial progress in their control, largely as a result of salt iodization and dietary diversification. Dairy products are also a good source of iodine if cattle are fed with iodine-enriched feed, and therefore including milk and other dairy products as part of promotion of dietary diversification is important to prevent iodine deficiency disorders.

The most visible sign of iodine deficiency is goitre, an enlargement of the thyroid gland. Individuals living in areas affected by severe iodine deficiency may have an intelligence quotient (IQ) of up to 13.5 points below that of those from comparable communities in areas where there is no iodine deficiency *(8–10)*.

When iodine intake is inadequate, the thyroid gland may no longer be able to synthesize sufficient amounts of thyroid hormones. Low levels of thyroid hormones in the blood, referred to as hypothyroidism, are responsible for damage to the developing brain and for the whole spectrum of iodine deficiency disorders. The spectrum of iodine deficiency disorders includes goitre; hypothyroidism; increased susceptibility to nuclear radiation; spontaneous abortion; stillbirths; congenital anomalies; perinatal mortality; endemic cretinism, including mental deficiency with a mixture of mutism, spastic dysplegia, squint, hypothyroidism and short stature; infant mortality; impaired mental function; delayed physical development; and iodine-induced hyperthyroidism *(11, 12)*. These can be prevented by ensuring that the population has an adequate intake of iodine.

Both insufficient and excess iodine can have negative effects on thyroid functioning. Excessive intake of iodine may be associated with complications such as iodine-induced hyperthyroidism in some cases *(13)* or hypothyroidism in others *(14)*. Data indicate a small increase in the risk for iodine-induced hyperthyroidism with increasing iodine intakes in older adults, mainly those with pre-existing nodular goitre *(14, 15)*.

On a population basis, iodine-induced hyperthyroidism represents a transient increase in the incidence of hyperthyroidism that occurs when there is an increase in iodine intake in severely iodine-deficient populations. The number of people at risk of iodine-induced hyperthyroidism is directly proportional to the number of individuals with nodular goitre. This condition will disappear with the correction of iodine deficiency *(16, 17)*.

Based on studies of balance and excretion, an adult iodine intake is in the range of 100–300 μg/day. The recommended daily intake of iodine is 90 μg/day for infants and children aged less than 6 years, 120 μg/day for children aged 6–12 years, and 150 μg/day for adolescents and adults from 13 years of age through to adulthood. It is recommended that pregnant and lactating women consume 250 μg of iodine per day *(11)*. Sea fish and some seaweeds are good sources of dietary iodine. Iodine can also be found in vegetables and cereals if they are produced in iodine-sufficient soils, poultry or meat and milk, if the animals consume foods grown in iodine-sufficient soils or are given iodine-containing feed supplements.

At all intake levels, a proportionate amount of iodine is excreted in the urine, so the urinary iodine excretion (UIE) using 24-h urine collections is the ideal biochemical indicator for assessing iodine status. However, owing to the difficulties associated with using this indicator for assessing populations and monitoring programmes, the simple urinary iodine concentration (UIC) has been used *(18)*, although this may not reflect the intake distribution of individuals and populations as well as measurement of 24-h UIE.

Both UIC and UIE correlate with recent iodine intakes and, therefore, they are useful for estimating iodine intake. Currently, the median value of ≥100 µg/L for UIC is being used to identify when an adult population has sufficient intake of iodine *(19)*, but it has mainly been applied to school-age children, from whom is easier to collect urine samples *(4)*. However, because of the lower urinary volume in children, the UIC may be higher in that age group than in adults. As of 2013, there were 57 million school-age children who were not attending school *(20)*, which may affect the interpretation of the results. For pregnant women, however, a median UIC of <150 µg/L has been proposed to indicate insufficient iodine intake *(21)*.

In the past, the prevalence of goitre was also a commonly used indicator for the assessment of iodine deficiency in a population, although it has little practical usefulness now because goitre has nearly disappeared in many countries. Goitre is also not recommended for assessing the response to an intervention, as it can take months or years for goitre to regress after the normalization of iodine intake *(11, 22)*. However, it remains useful in countries or regions that have not yet introduced iodised salt programmes.

The concentrations of thyroid-stimulating hormone (TSH) and thyroid hormone (T_3 and T_4) in serum/plasma are additional indicators of iodine status. However, these indicators are usually not recommended for monitoring iodine nutrition, because they are more expensive and less sensitive *(11)*. Measurement of serum or dried blood spot thyroglobulin (Tg) in school-age children appears to be a sensitive indicator of iodine status in a population and it may be used to monitor improving thyroid function after iodine repletion *(11)*. However, further validation is required for standardization of collection and measurement techniques for Tg, and for establishment and interpretation of cut-off values *(21)*.

Recognizing the importance of preventing iodine deficiency disorders, in 1991 the World Health Assembly adopted the goal of eliminating iodine deficiency as a public health problem. In 1990, world leaders endorsed this goal when they met at the World Summit for Children at the United Nations, and it was reaffirmed by the International Conference on Nutrition in 1992 *(23)*. In 1993, WHO and the United Nations Children's Fund (UNICEF) recommended universal salt iodization as the main strategy to achieve elimination of iodine deficiency disorders *(24)*. In 2005, the importance of eliminating iodine deficiency disorders was again recognized when the World Health Assembly adopted a resolution committing to reporting on the global situation of iodine deficiency disorders every 3 years *(25)*. In 2013, the World Health Assembly further recognized that the fight against iodine deficiency disorders contributes directly to many of the MDGs, including anti-poverty, reduction of infant mortality, maternal health, education for all, gender equity and private–public partnership *(26)*.

Universal salt iodization

Since 1993, when WHO and UNICEF recommended universal salt iodization, many countries worldwide have made substantial progress in the control and prevention of iodine deficiency disorders, largely as a result of salt iodization. Salt iodization has been implemented in more than 120 countries around the world *(27)* and 71% of households worldwide are estimated to have access to adequately iodized salt *(28)*. However, iodine deficiency disorders still constitute a public health problem in many countries where the salt iodization programmes are weakly implemented. On the other hand, it is important to avoid excess iodine fortification levels. Eleven countries have populations with apparent excessive iodine intakes based on UIC *(6)*; however, the true iodine intake has not been assessed in most of them. Such excess intakes, if they exist, may be mainly due to excess fortification levels rather than excess salt intake.

Salt is considered an appropriate vehicle for fortification with iodine, for the following reasons: (i) it is widely consumed by virtually all population groups in all countries, with little seasonal variation in consumption patterns, and salt intake is proportional to energy intake/requirements; (ii) in many countries, salt production is limited to a few centres, facilitating quality control; (iii) the technology needed for salt iodization is well established, inexpensive and relatively easy to transfer to countries around the world; (iv) addition of iodate or iodide to salt does not affect the taste or smell of the salt or foods containing iodized salt, and therefore consumer acceptability is high; (v) iodine (mainly from iodate) remains in processed foods that contain salt as a main ingredient, such as bouillon cubes, condiments and powder soups, and hence these products become sources of iodine; and (vi) iodization is inexpensive (the cost of salt iodization per year is estimated at US$ 0.02–0.05 per individual covered, and even less for established salt-iodization programmes) *(12)*. Additionally, the concentration of iodine in salt can easily be adjusted to meet policies aimed at reducing the consumption of salt in order to prevent cardiovascular disease *(29, 30)*.

The amount of iodine added to salt should be based on the estimated daily consumption of salt. Salt is the main dietary source of sodium and a high intake of sodium has been associated with hypertension, cardiovascular disease and stroke; and decreasing sodium intake may reduce blood pressure and the risk of associated noncommunicable diseases. Salt consumption varies widely in different countries and sometimes within a country. For instance, some indigenous populations of Brazil have salt intakes of less than 1 g/day, while some countries like Korea or Japan have reported consumptions close to 20 g/day *(31, 32)*.

Since decreased sodium intake in the population is a cost-effective public health intervention that could potentially reduce morbidity and mortality associated with noncommunicable diseases, and because of the increasing importance of noncommunicable diseases for health-care costs and burden of disease, WHO recently updated guidance on sodium intake for adults and children *(33)*. WHO currently recommends a reduction to <2 g/day sodium (5 g/day salt) in adults, and in children the recommended maximum level of intake should be adjusted downward based on the energy requirements of children relative to those of adults. This applies to all individuals, with or without hypertension, and should be complemented with the WHO guideline on potassium intake and other nutrient guidelines and recommendations, to guide the development of public health nutrition programmes and policies *(34–36)*.

It has been recognized that polices on salt reduction and salt iodization are compatible *(29, 30)*. Monitoring of salt intake and salt iodization at country level is needed to adjust salt iodization over time as necessary, depending on observed salt intake in the population, to ensure that individuals consuming the recommended amount of sodium continue to consume sufficient iodine. Resolution WHA57.17 on the *Global strategy on diet, physical activity and health* *(37)* confirmed that the policy on salt iodization for preventing iodine deficiency should be compatible with the recommendation to limit salt (sodium) consumption from all sources.

Although WHO recommends a reduction in the intake of salt to less than 5 g/day, on average, it is estimated that individuals still consume around 10 g of salt per day in countries where most of the salt in the diet comes from household salt, used for home cooking and at the table *(36)*. Previous estimations assumed an average salt intake of 10 g per capita per day, and recommended that salt be iodized at a concentration of 20 mg iodine per kg of salt. The minimum and maximum levels used for the iodization of food-grade salt (expressed as mg iodine/kg salt) needed to be established by the national health authorities in the light of the local iodine deficiency situation, local consumption of salt and quality systems in place.

Although universal salt iodization calls for fortification with iodine of all food-grade salt for human and animal consumption, including salt for food processing, in practice, focus on implementation had only been on table salt and not on all salt destined for the food industry or animal consumption. Food-grade salt can obtained from the sea, from underground rock salt deposits or from natural brine *(5)*. Washed and refined salt is the most widely used form. The main bulk of salt is sold for industrial use, where it has great commercial value as a necessary ingredient in many manufacturing processes.

Recent trends, particularly in high-income and middle-income countries, but also urban populations in low and middle income countries, show that individuals are consuming the majority of their salt through processed foods, in which iodized salt is generally not used, rather than through iodized salt. Nevertheless, in many low- and middle-income countries, discretionary salt (cooking and table) continues to be the main source of salt *(29)*. Thus, countries that focus on iodization of table salt alone may not achieve optimal iodine nutrition of their population *(38)* and it is necessary to include iodized salt in processed foods.

There have been some concerns about technical difficulties, retention, losses and changes in organoleptic properties of final products, with the inclusion of iodized salt in industrialized processed foods *(39, 40)*. However, studies in more than 20 food products containing salt fortified with potassium iodide or potassium iodate found no adverse effects on food quality *(39, 41)*. Concerns still remain regarding the stability of iodine during food processing *(42)* and supply of iodine through these sources remain uncertain, although products with high content of salt, such as bouillon cubes, condiments and powder soups made with iodized salt, retain the iodine after production. It has been reported that considerable losses, up to 100%, are possible during food processing, depending on the product and the procedure, moisture, heating and storage *(43–48)*.

Successful and sustainable implementation of the use of iodized salt in processed foods requires awareness of the risks of iodine deficiency, adequate legislation in line with a country's dietary customs and "legislation culture", regular monitoring of iodine nutrition status and dietary intake, and a cooperative role of the salt industry and food processors *(39)*.

Summary of evidence

A systematic review that followed the procedures of the *Cochrane handbook for systematic reviews of interventions* *(49)* was prepared, on the use of iodized salt for preventing iodine deficiency disorders *(50)*. This updated review considers the recent efforts to reduce the overall consumption of salt in populations. Comparisons were made between the consumption of iodized salt and a placebo, non-iodized salt or no intervention. The search included the Cochrane Controlled Trials Register; China National Knowledge Infrastructure; the Global Health Library WHO regional databases; MEDLINE (PubMed 1966 to 31 May, 2011); the Virtual Health Library of the Pan American Health Organization, May 2011); and the WHO International Clinical Trials Registry Platform (18 June 2011). The International Council for the Control of Iodine Deficiency Disorders Global Network and other international organizations were also contacted on 15 February 2013 for recently published, ongoing or unpublished trials. The WHO Secretariat conducted an additional search on PubMed (20 June 2014) prior to the guideline development group meeting and identified only one additional randomized controlled trial comparing the effects in women of food-grade salt fortified with iron and iodine versus salt fortified with iodine alone *(51)*, thus not meeting the criteria of interest. The systematic review included two randomized controlled trials (of poor methodological quality), six non-randomized controlled trials, 20 quasi-experimental studies, 16 cohort observational studies, 42 multiple cross-sectional studies, and three studies with mixed designs. The participants included members of the general population of any age and sex, with comparisons between iodized salt using iodide or iodate coming from any source (e.g. local village industry).

The results of this review showed that iodized salt has a large effect on reducing the risk of goitre (non-randomized controlled trials risk ratio [RR] = 0.59 [95% confidence interval {CI} = 0.36 to 0.95; cohort RR = 0.30 [95% CI = 0.23 to 0.41]; multiple cross-sectional RR = 0.18 [95% CI = 0.14 to 0.22]); cretinism (multiple cross-sectional Peto odds ratio [OR] = 0.13 [95% CI = 0.08 to 0.20]), low cognitive function (quasi experimental RR = 0.28 [95% CI = 0.21 to 0.36]; multiple cross-sectional RR = 0.24 [95% CI = 0.07 to 0.82]); and iodine inadequacy, as indicated by low UIE, (multiple cross-sectional RR = 0.45 [95% CI = 0.33 to 0.60]). The results also indicate that, in some contexts, iodization of salt at the population level may cause a transient increase in the population incidence of hyperthyroidism, but not hypothyroidism. However, the beneficial effects of iodization of salt far outweigh the potential adverse effects. The quality of evidence for salt fortification with iodine ranged from moderate to low for the critical outcomes of goitre (moderate), cretinism (moderate), low cognitive function (low) and urinary iodine concentration (moderate), using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology *(52)*.

Recommendation

This guideline supersedes previous WHO recommendations on salt iodization *(11, 16, 18)*.

All food-grade salt, used in household and food processing should be fortified with iodine as a safe and effective strategy for the prevention and control of iodine deficiency disorders in populations living in stable and emergency settings (*strong recommendation*).[1]

Suggested concentrations for the fortification of food-grade salt with iodine are shown in Table 1.

Table 1. Suggested concentrations for the fortification of food-grade salt with iodine.

Estimated salt consumption[a], g/day	Average amount of iodine to add, mg/kg salt (RNI + losses[b])
3	65
4	49
5	39
6	33
7	28
8	24
9	22
10	20
11	18
12	16
13	15
14	14

[a] This includes consumption as table salt as well as salt from processed foods.

[b] This fortification concentration was calculated based on the mean recommended nutrient intake of 150 µg iodine/day + 30% losses from production to household level before consumption, and a 92% iodine bioavailability. Losses depend on the iodization process, the quality of salt and packaging materials and the climatic conditions. Losses could vary widely *(50)* and this table presents the value considering 30% losses. The monitoring of urinary iodine concentrations will allow adjustment of the selected fortification concentrations.

RNI: recommended nutrient intake, is the daily intake, set at the estimated average requirement plus 2 standard deviations, which meets the nutrient requirements of almost all apparently healthy individuals in an age- and sex-specific population group.

Although iodate is more stable, either potassium iodate (KIO_3) or iodide (KI) can be used. Iodide may be used for dry, low crystal size and washed or refined salts. While iodate can be used alone and in any type of salt quality, iodide is used in very good quality salt and cannot be added alone. Therefore, some salt producers add sodium carbonate or sodium bicarbonate when they iodize salt, to increase alkalinity, and sodium thiosulfate or dextrose to stabilize potassium iodide. Without a stabilizer, potassium iodide may be oxidized to iodine and lost by volatilization from the product *(53)*.

An estimated additional variability of ±10% during iodization procedures could be considered at the production site for use in quality control and assurance procedures. This variability depends on the iodization methods used and quality assurance system in place.

Shaded areas correspond to the WHO salt reduction guideline *(33)*.

---

[1] A *strong recommendation* is one for which the guideline development group is confident that the desirable effects of adherence outweigh the undesirable effects. Implications of a strong recommendation for patients are that most people in their situation would desire the recommended course of action and only a small proportion would not. Implications for clinicians are that most patients should receive the recommended course of action, and adherence to this recommendation is a reasonable measure of good-quality care. With regard to policy-makers, a strong recommendation means that it can be adapted as a policy in most situations, and for funding agencies it means the intervention probably represents an appropriate allocation of resources (i.e. large net benefits relative to alternative allocation of resources).

Remarks

- These recommendations recognize that salt reduction and salt iodization are compatible. Monitoring of sodium (salt) intake and iodine intake at country level is needed to adjust salt iodization over time as necessary, depending on observed salt intake in the population, to ensure that individuals consume sufficient iodine despite reduction of salt intake *(33)*.

- The concentrations of iodine may need to be adjusted by national authorities responsible for the implementation and monitoring of universal salt iodization, in light of their own data regarding dietary salt intake *(30)*.

- The national distribution of salt consumption must provide key guidance for the concentration of iodine in salt *(29, 31)*; sufficient iodine should be supplied to most members of the population, even those with the lowest salt intake, while at the same time preventing excessive iodine supply to those individuals whose salt intake remains high.

- Iodized salt should reach, and be used by, all members of the population after 1 year of age. Infants and young children are assumed to be covered via breast milk *(4)* or iodine-enriched infant formula milk when this is prescribed *(54)*. Addition of salt to products consumed by young children may need regulation, to avoid insufficient or excessive consumption of either sodium (salt) or iodine.

- Since pregnant women have a daily iodine requirement of 250 µg/day, other interventions such as iodine supplementation could be considered if iodine inadequacy is found *(55, 56)*. Intake of salt correlates with caloric intake, and pregnant women usually increase their energy intake during this physiological stage.

- Policies for salt iodization and reduction of salt to <5 g/day are compatible, cost effective and of great public health benefit. Although salt is an appropriate vehicle for iodine fortification, iodization of salt should not justify promotion of salt intake to the public *(30)*.

- Monitoring of food-grade salt quality is essential to ensure both efficacy and safety of the process of iodine fortification. Monitoring of UIE and UIC is useful not only to detect deficiency but also to detect excessive intakes and therefore prevent the health risks of iodine excess, by adjusting the level of iodine fortification accordingly, as part of a monitoring system. Countries should determine iodine losses from iodized salt under local conditions of production, climate, packaging and storage. For these reasons, iodine losses may be extremely variable and influence the additional amount of iodine that should be added at factory level.

- Fortification of salt with iodine should be appropriately regulated by governments and harmonized with other local or country programmes, to ensure that fortified food-grade salt is delivered safely within the acceptable dosage range. Particular attention should be given to identifying potential barriers to equitable access for all population groups needing iodine-fortified salt.

- Country programmes should be culturally appropriate to the target populations, so the intervention is accepted, adopted and sustained.

- Clear legislation should also be established for food producers and distributors, especially where the main source of dietary salt is processed foods and meals consumed outside households. Legislation should cover not only proper iodization of salt, but also the salt content of industrialized food products.

- Establishment of an efficient system for the ongoing and routine collection of relevant data, including measures of quality assurance and household use of iodized salt, and measures of programme performance, is critical to ensure programmes for iodized salt are effective and sustained.

- Regular monitoring and evaluation can identify barriers that may be limiting equal access to fortified salt and thus preserving health inequities. Sustained implementation and scale-up derive great benefit from appropriate monitoring mechanisms *(4)*.

Implications for future research

Discussions with members of the WHO guideline development group and the external review group highlighted the limited evidence available in some areas, meriting further research on the fortification of food-grade salt with iodine, in particular in the following areas:

1. determination of the relationships between iodine excretion (24-h collection) and urinary (UIC in different ages, sexes, and physiological stages (mainly pregnancy and lactation), and under different climatic conditions and levels of physical activity, in order to adjust the criteria for UIC for population assessments;

2. determination of the relative contribution to iodine intake from table salt and from processed foods;

3. investigation of the usefulness of Tg as a functional indicator of iodine status, to complement the use of UIC as an indicator of iodine intake;

4. investigation of whether iodine deficiency (mild or moderate) is occurring in pregnant and lactating women worldwide, and the potential negative impact in their health, as well as on development of their offspring;

5. alignment of national salt-iodization and dietary salt-reduction programmes, including optimization of policy implementation and ensuring effective monitoring and coordination of monitoring;

6. understanding the potential impact of salt-containing processed foods, such as bouillon cubes, condiments and powder soups, and other edible vehicles;

7. identification of the optimal indicators to assess iodine nutrition during pregnancy, lactation and infancy. The use of neonatal serum concentration of TSH as an indicator of iodine status in pregnancy needs further validation;

8. better prevalence data on the iodine status of pregnant and lactating women, and infants;

9. more data from large studies of the impact of iodine-intervention programmes on iodine-induced thyroiditis and iodine-induced hyperthyroidism;

10. further studies to correct misperceptions that link iodized salt to certain diseases, as well as the barriers that might be encountered during implementation and scale-up, such as consumer demand for non-iodized salt, religious concerns relating to iodized salt, and the perception of extra costs of purchasing iodized salt. Findings arising from these studies can help identify bottlenecks and barriers to access to iodine-fortified food-grade salt;

11. studies to identify the knowledge and awareness of the general population about the use of iodized salt are important to address barriers such as religious concerns and existing demand for non-iodized salt;

12. studies to search and evaluate the use of different vehicles for iodine fortification.

Dissemination, adaptation and implementation

Dissemination

The current guideline will be disseminated through electronic media such as slide presentations and the World Wide Web, through either the WHO Nutrition *(57)* and United Nations Standing Committee on Nutrition (SCN) *(58)* mailing lists, social media, the WHO nutrition website *(57)* or the WHO e-Library of Evidence for Nutrition Actions (eLENA) *(59)*. eLENA compiles and displays WHO guidelines related to nutrition, along with complementary documents such as systematic reviews and other evidence that informed the guidelines; biological and behavioural rationales; and additional resources produced by Member States and global partners. In addition, the guideline will be disseminated through a broad network of international partners, including WHO country and regional offices, ministries of health, WHO collaborating centres, the International Council for the Control of Iodine Deficiency Disorders Global Network, universities, other United Nations agencies and nongovernmental organizations.

Particular attention will be given to improving access to these guidelines for stakeholders that face more, or specific, barriers in access to information, or that play a crucial role in the implementation of the guideline recommendations, for example, policy-makers and decision-makers at subnational level that disseminate the contents of the guideline, especially information on the benefits of consuming fortified food-grade salt in populations or regions presenting an important risk of iodine deficiency. This is remarkably important in rural communities or highly isolated communities, where seeking health care is less frequent, and obtaining health care is more difficult, because of distance or transport barriers (e.g. women before and during pregnancy; infants and young children).

Accessing hard-to-reach population groups is extremely important during implementation stages, as it contributes to preventing or tackling health inequities. Fortified foods, such as corn–soya blend, biscuits, vegetable oil enriched with vitamin A and iodized salt, are usually provided as part of food rations during emergencies *(60)*. In the United Nations system, the World Food Programme is responsible for mobilizing the iodized salt for selective feeding programmes *(61)*. Moreover, dissemination of the guidelines and information on the benefits of consuming fortified food-grade salt in iodine-deficient contexts helps to empower consumers, and thus contributes to creating consumer demand.

Adaptation and implementation

As this is a global guideline, it should be adapted to the context of each Member State. Prior to implementation, a public health programme that includes the fortification of food-grade salt with iodine should have well-defined objectives that take into account available resources, existing policies, suitable delivery platforms and suppliers, communication channels, and potential stakeholders. Ideally, all food-grade salt should be fortified at a concentration based on the average salt consumption and in line with the country's policy on the reduction of salt intake.

To ensure that WHO global guidelines and other evidence-informed recommendations for nutrition interventions are better implemented in low- and middle-income countries, the Department of Nutrition for Health and Development works with the WHO Evidence-Informed Policy Network (EVIPNet) programme *(62)*. EVIPNet promotes partnerships at country level between policy-makers, researchers and civil society, to facilitate policy development and implementation through use of the best available evidence.

In some countries, implementation of salt-iodization programmes may not be feasible, and increased iodine intake through iodine fortification of foods other than salt may be necessary, to ensure optimal iodine nutrition in relevant groups.

Although fortification of food-grade salt is a relatively inexpensive intervention that is likely to be well received by the different stakeholders, it is likely to face difficulties in terms of implementation. Initial resistance from some stakeholders, well-established practices, changes in consumption habits, or potential misbeliefs in certain populations are some of the implementation barriers that could arise. Therefore, any adoption and adaptation of these recommendations at country level and within-country level should bear in mind the following series of key aspects that enhance implementation and scale-up.

Particular attention should be given to the *acceptability* of the recommendation by the different stakeholders, including the salt companies, food inspection officers and final consumers. For instance, a large share of salt consumption in the population is obtained from industrialized processed foods *(63)*; therefore, commitment from the industry is necessary to implement and scale up this intervention. This is also imperative when food-grade salt is imported. For instance, table salt is sometimes labelled as iodine fortified, but in some cases the content does not match the label; hence the work of food inspection officers is needed *(64, 65)*. Likewise, although the taste of fortified food-grade salt is not different from that of non-fortified salt, there may be certain consumers that prefer non-iodized salt for reasons of perceived taste, religious concerns or alleged medical properties *(66)*, or simply for a perceived violation of consumers' right to choose between a fortified and non-fortified product. Other perceptions may sometimes be based on misunderstandings or misinformation. Consumer demand for non-iodized salt can push local stores and food shops to supply such a product; this circumstance must be taken into account when developing programmes or deploying implementation and should be addressed through information and communication efforts targeting specific audiences. Long-standing experiences and best practices in many countries around the world can inform those countries initiating or enhancing their fortification efforts, to ensure *adoption* of this intervention.

Acceptability and adoption are better achieved if they are accompanied by simple and easy-to-access information that can be understood by different population groups. Dissemination of information must be carried out in a manner that aims to ensure that these recommendations are perceived as appropriate. In this sense, the *appropriateness* of consuming iodine-fortified food-grade salt must be fully explained to the target population (including final consumers) in a way that is culturally appropriate and understandable, taking into account consumption habits and religious beliefs, for example. Sometimes, evidence-based and proven interventions fail to be adopted by the population because issues of acceptability and appropriateness are not taken into account during implementation.

Better-informed consumers are more likely to become *empowered* consumers that demand fortified salt for health reasons. Besides dissemination of appropriate and adapted information on the benefits of iodine fortified-salt in areas or populations presenting risk of iodine deficiency, consumers must be informed about the fact that consuming iodine-fortified salt does not imply additional costs to the household economy – a residual but sometimes prevalent misbelief found in research *(66–68)*.

In many high-income and middle-income countries, there are some social groups and individuals that promote the consumption of so-called "all-natural foods", especially those that have not undergone the addition of any other "element" to the food itself. Qualitative research on perceptions of fortified foods suggests that, for certain groups, fortification may be viewed as a form of artificial processing, which could be perceived as reducing the health benefits of natural foods *(69)*. Public health programmes should be aware of this misinterpretation of fortified foods, in order to better implement scale-up and respond to potential setbacks in terms of acceptability and adoption by consumers in high- and middle-income countries.

Moreover, linking the implementation of these recommendations with other intersectoral interventions will benefit the *sustainability* and scale-up of iodine fortification of food-grade salt. For instance, given that the most important iodine intake for any individual is the one that occurs before the mother is pregnant and during pregnancy, the empowerment of women in terms of health literacy and self-care for their health will benefit both women themselves and neonates. Information and advice about how women can take better care of their health before and during pregnancy is essential to encourage consumption of iodized salt in a context where the availability of non-iodized salt is a reality. The unequal sexual division of labour worldwide puts women in the position of making decisions about the food intake of the household; therefore, it is important to improve their access to information and health advice. This is particularly important in low- and middle-income settings, where those who are better off are usually more likely to receive early benefit from health innovations that take time to scale up and become widespread. A second example of the importance of intersectoral action is collaboration with the education sector. Often, children who are in school are provided either a snack or lunch at a school cafeteria. Making sure that processed foods and prepared foods served by these canteens include iodized salt in their preparation is a strategy worth exploring.

Monitoring and evaluation of guideline implementation

A plan for monitoring and evaluation with appropriate indicators is encouraged at all stages. The impact of this guideline can be evaluated within countries (i.e. monitoring and evaluation of the programmes implemented at national or regional scale) and across countries (i.e. adoption and adaptation of the guideline globally). The WHO Department of Nutrition for Health and Development, Evidence and Programme Guidance Unit, jointly with the United States Centers for Disease Control and Prevention (CDC) International Micronutrient Malnutrition Prevention and Control (IMMPaCt) programme, and with input from international partners, has developed a generic logic model for micronutrient interventions in public health *(70)*, to depict the plausible relationships between inputs and expected MDGs by applying the micronutrient programme evaluation theory. Member States can adjust the model and use it in combination with appropriate indicators, for designing, implementing, monitoring and evaluating the successful escalation of nutrition actions in public health programmes. The WHO/CDC eCatalogue of indicators for micronutrient programmes *(71)* intends to be a dynamic, user-friendly and non-comprehensive web resource for those actively engaged in providing technical assistance in monitoring, evaluation, and surveillance of public health programmes implementing micronutrient interventions. It provides potential indicators with standard definitions that can be selected, downloaded and adapted to a local programme context. An electronic WHO/CDC eCatalogue of indicators for micronutrient programmes is a repository of indicators to monitor and evaluate micronutrient interventions. The eCatalogue initially includes key programme indicators (inputs, activities, outputs and outcomes) related to salt iodization. While it does not provide guidance for designing or implementing a monitoring or evaluation system in public health, some key indicators may include useful references for that purpose.

Key indicators used in the implementation of universal salt-iodization programmes are:

1. government commitment to salt iodization;
2. active multisectoral coalition on salt iodization;
3. legislation on iodization of salt consumed by humans;
4. regulation for iodized salt includes definitions of national standards;
5. internal quality control by domestic producers of iodized salt;
6. imported iodized salt is adequately fortified;
7. subsidies for production of iodized salt are phased out;
8. monitoring and enforcement by food control agency;
9. household coverage with iodized salt;
10. UICs in children, non-pregnant and pregnant women.

Median UIC has been proposed for monitoring established salt-iodization programmes and adjusting the iodine content of salt, if needed. The use of data on urinary iodine can serve to adjust fortification levels in food-grade salt throughout implementation of the programme. The levels will serve to inform decisions on whether to review salt consumption, salt quality and iodization procedures, and consider increasing iodization concentrations, continue an actual fortification programme as it stands, or consider reducing iodization levels. The median UIC is a rough estimation, and it depends on the hydration status of the person and the climate where he or she lives. When sampling urinary iodine in iodine-sufficient school-age children, the median UIC may be between 100 and 300 ug/L, at or above the recommended value for pregnant women *(72)*. In countries or regions with a notable rate of school-age children not attending school, iodine sampling may be biased; therefore, sampling could be adjusted if considered appropriate and feasible. As of 2013, there were 57 million school-age children not attending school: 29.8 million in sub-Saharan Africa, 12.4 million in South and West Asia, and 14.9 million in the rest of the WHO regions *(20)*. School attendance may also have an impact on food intake (provision of foods at canteens).

Since 1991, WHO has hosted the Vitamin and Mineral Nutrition Information System (VMNIS) Micronutrients Database *(73)*. Part of WHO's mandate is to assess the micronutrient status of populations, monitor and evaluate the impact of strategies for the prevention and control of micronutrient malnutrition, and track related trends over time. The Evidence and Programme Guidance Unit of the Department of Nutrition for Health and Development manages the VMNIS Micronutrient Database through a network of regional and country offices, and in close collaboration with national health authorities.

UNICEF's global databases monitor coverage of salt iodization in countries and incorporate statistically sound and nationally representative data from household surveys, including multiple indicator cluster surveys and demographic and health surveys. These databases are updated annually through a process that draws on data maintained by UNICEF's network of field offices. The databases are publicly available at http://data.unicef.org/nutrition/malnutrition *(74)*.

For evaluation at the global level, the WHO Department of Nutrition for Health and Development has developed a centralized platform for sharing information on nutrition actions in public health practice implemented around the world. By sharing programmatic details, specific country adaptations and lessons learnt, this platform will provide examples of how guidelines are being translated into actions. The Global database on the Implementation of Nutrition Action (GINA) *(75)* provides valuable information on the implementation of numerous nutrition policies and interventions. The use of GINA has grown steadily since its launch in November 2012.

Another element that enhances implementation and scale-up is making sure that monitoring and data collection are sensitive to health inequities. For instance, monitoring both industry efforts in fortification and consumer behaviour related to consumption of food-grade salt and industrialized processed foods containing non-iodized salt is key to identifying gaps for effective scale-up and sustainability. Identifying the barriers to an effective supply of iodized salt, and the barriers to strengthening consumer demand for iodized salt, prevents widening of unequal distributions of the benefits of health innovations. No actions tackling health inequities can be further sustained without robust, valuable data.

Guideline development process

This guideline was developed in accordance with the WHO evidence-informed guideline development procedures, as outlined in the *WHO handbook for guideline development (76)*.

Advisory groups

The WHO Steering Committee for Nutrition Guidelines Development (see Annex 3), led by the Department of Nutrition for Health and Development, was established in 2009 with representatives from all WHO departments with an interest in the provision of scientific nutrition advice, including the Department of Maternal, Neonatal, Child and Adolescent Health and Development and the Department of Reproductive Health and Research. The WHO Steering Committee for Nutrition Guidelines Development meets twice yearly and both guided and provided overall supervision of the guideline development process. Two additional groups were formed: an advisory guideline group and an external review group.

The guideline development group – nutrition actions, was established for the biennium 2013–2014. Participants of the meetings relevant to this guideline are listed in Annex 4. Its role was to advise WHO on the choice of important outcomes for decision-making and on interpretation of the evidence. The WHO guideline development group – nutrition actions includes experts from various WHO expert advisory panels *(77)* and those identified through open calls for specialists, taking into consideration a balanced gender mix, multiple disciplinary areas of expertise, and representation from all WHO regions. Efforts were made to include content experts, methodologists, representatives of potential stakeholders (such as managers and other health professionals involved in the health-care process), and technical staff from WHO and ministries of health from Member States. Representatives of commercial organizations may not be members of a WHO guideline group.

An external review group peer-reviewed the draft guideline. The WHO Nutrition *(57)* and SCN *(58)* mailing lists, which together include over 5500 subscribers, and the WHO nutrition website *(57)* were used to identify members of the external review group. Additionally, six content experts peer-reviewed the draft guideline and provided technical input.

The Appraisal of Guidelines, Research and Evaluation II (AGREE II) Instrument can be used to assess the methodological rigour for developing this global guideline *(78)*.

Scope of the guideline, evidence appraisal and decision-making

An initial set of questions (and the components of the questions) to be addressed in the guideline was the critical starting point for formulating the recommendation. The questions were drafted by technical staff at the Evidence and Programme Guidance Unit, Department of Nutrition for Health and Development, based on the policy and programme guidance needs of Member States and their partners. The population, intervention, control, outcomes (PICO) format was used (see Annex 6). The questions were discussed and reviewed by the WHO Steering Committee for Nutrition Guidelines Development and the guideline development group – nutrition actions, and were modified as needed.

A meeting of the guideline development group – nutrition actions was held on 14–16 March 2010, in Geneva, Switzerland, to finalize the scope of the questions and rank the outcomes and populations of interest for the recommendation on the fortification of food-grade salt with iodine for the prevention and control of iodine deficiency disorders. The guideline development group discussed the relevance of the questions and modified them as needed. The group scored the relative importance of each outcome from 1 to 9 (where 7–9 indicated that the outcome was critical for a decision, 4–6 indicated that it was important and 1–3 indicated that it was not important). The final key questions on this intervention, along with the outcomes that were identified as critical for decision-making, are listed in PICO format in Annex 6.

A systematic review *(50)* was used to summarize and appraise the evidence using the Cochrane methodology for randomized controlled trials and observational studies *(49)*. Evidence summaries were prepared according to the *Grading of Recommendations Assessment, Development and Evaluation* (GRADE) approach to assess the overall quality of the evidence *(79)*. GRADE considers: the study design; the limitations of the studies in terms of their conduct and analysis; the consistency of the results across the available studies; the directness (or applicability and external validity) of the evidence with respect to the populations, interventions and settings where the proposed intervention may be used; and the precision of the summary estimate of the effect.

Both the systematic review and the GRADE evidence profiles for each of the critical outcomes were used for drafting this guideline. The draft recommendation was discussed by the WHO Steering Committee for Nutrition Guidelines Development and at a second consultation with the WHO guideline development group – nutrition actions, held on 23–26 June 2014 in Geneva, Switzerland. The procedures for decision-making are established at the beginning of the meetings, including a minimal set of rules for agreement and decision-making documentation. The guideline development group members secretly noted the direction and strength of the recommendation, using a form designed for this purpose, which also included a section for documenting their views on (i) the desirable and undesirable effects of the intervention; (ii) the quality of the available evidence; (iii) values and preferences related to the intervention in different settings; and (iv) the cost of options available to health-care workers in different settings (see Annex 2). Each member used one form, if not advised otherwise after managing any potential conflict of interests. Abstentions were not allowed. The process was improved with the availability of a predefined link to an online form prepared using survey software. Subsequent deliberations among the members of the guideline development group were of private character. The WHO Secretariat collected the forms and disclosed a summary of the results to the guideline development group. If there was no unanimous consensus (primary decision rule), more time was given for deliberations and a second round of online voting took place. If no unanimous agreement was reached, a two thirds vote of the guideline development group members present was required for the approval of the proposed recommendation (secondary decision rule). Divergent opinions could be recorded in the guideline. The results from voting forms are kept on file by WHO for up to 5 years. Although there was no unanimous consensus, more than 80% of the guideline development group members decided it was a strong recommendation.

WHO staff present at the meeting, as well as other external technical experts involved in the collection and grading of the evidence, were not allowed to participate in the decision-making process.

Two co-chairs with expertise in managing group processes and interpreting evidence were nominated at the opening of the consultation, and the nomination was approved by the guideline development group. Members of the WHO Secretariat were available at all times to help guide the overall meeting process, but did not vote and did not have veto power.

Six content experts peer-reviewed the draft guideline. Additionally, a public call for comments on the final draft guideline was released in August 2014. All interested stakeholders were included as part of an external review group and were allowed to comment on the draft guideline only after submitting a signed declaration of interests form. Feedback was received from several stakeholders. WHO staff then finalized the guideline and submitted it for clearance by WHO before publication.

Management of competing interests

According to the rules in the WHO *Basic documents* *(80),* all experts participating in WHO meetings must declare any interest relevant to the meeting, prior to their participation. The declarations of interest statements for all guideline development group members were reviewed by the responsible technical officer and the relevant departments, before finalization of the group composition and invitation to attend a guideline development group meeting.

All guideline development group members, and participants of the guideline development meetings, submitted a declaration of interests form, along with their curriculum vitae, before each meeting. Participants of the guideline development group meetings participated in their individual capacity and not as institutional representatives. In addition, they verbally declared potential conflicts of interest at the beginning of each meeting. The procedures for management of competing interests strictly followed the *WHO Guidelines for declaration of interests (WHO experts) (81)*. The management of the perceived or real conflicts of interest declared by the members of the guideline group is summarized below.[1]

Dr Luz Maria De-Regil declared that her present employer is an international non-governmental organization devoted to the improvement of micronutrient status among infants, children and women. These activities are primarily financed by the government of Canada. The Micronutrient Initiative (MI) is a leading organization working exclusively to eliminate vitamin and mineral deficiencies in the world's most vulnerable populations. MI is leading efforts to reach the last 30% of households still not using iodized salt, by working with small, local salt processors to provide simple and easy iodization techniques. It was decided that Dr De-Regil could be a member of the guideline development group and would disclose her interests and the interests of her organization in the relevant guidelines related to micronutrient interventions, specifically salt iodization. It was required that she disclosed her employer partnership on the International Council for the Control of Iodine Deficiency Disorders Global Network. She participated in the deliberations related to recommendations on fortification of food-grade salt but recused herself from voting on this guideline.

Dr Maria Elena del Socorro Jefferds is employed by CDC. She declared CDC's partnership on the International Council for the Control of Iodine Deficiency Disorders Global Network. It was agreed that she could participate fully in the deliberations and decision-making on this guideline.

Dr Lynette Neufeld declared that her current employer has received funding in the past 4 years for research and programming related to salt iodization. At the moment she is not leading any of these initiatives. In a prior position she held with MI, she commissioned research related to iodine. It was decided that Dr Neufeld could be a member of the guideline development group and had to disclose her and her organization's interests in the relevant guidelines related to micronutrient interventions, specifically salt iodization. It was required that she disclosed her employer partnership on the International Council for the Control of Iodine Deficiency Disorders Global Network. She could participate in the deliberations but she recused herself from the decision-making (voting) on recommendations related to salt iodization.

[1] A conflict of interest analysis must be performed whenever WHO relies on the independent advice of an expert in order to take a decision or to provide recommendations to Member States or other stakeholders. The term "conflict of interest" means any interest declared by an expert that may affect or be reasonably perceived to affect the expert's objectivity and independence in providing advice to WHO. WHO's conflict of interest rules are designed to avoid potentially compromising situations that could undermine or otherwise affect the work of the expert, the committee or the activity in which the expert is involved, or WHO as a whole. Consequently, the scope of the inquiry is any interest that could reasonably be perceived to affect the functions that the expert is performing.

Ms Rusidah Selamat declared herself to be a member of a National Technical Food Fortification Committee in Malaysia. She has also published articles on iodine deficiency status and iodized salt consumption in Malaysia and the need for wider coverage with iodized salt in Malaysia. It was agreed that Ms Selamat could be a member of the guideline development group and that she declared her membership in the above-mentioned national committees at the beginning of the guideline development group meeting.

All other members made a verbal declaration of their interest and it was considered that they were not relevant for this guideline on fortification of food-grade salt with iodine. External experts also declared their interest but did not participate in the deliberations or decision-making process.

Plans for updating the guideline

This guideline is planned to be reviewed in 2024. The Department of Nutrition for Health and Development at the WHO headquarters in Geneva, Switzerland, along with its internal partners, will be responsible for coordinating the guideline update, following the formal procedures of the *WHO handbook for guideline development* *(76)*. WHO welcomes suggestions regarding additional questions for evaluation in the guideline when it is due for review.

References

1. Resolution WHA65.6. Comprehensive implementation plan on maternal, infant and young child nutrition. In: Sixty-fifth World Health Assembly, Geneva, 21–26 May 2012. Resolutions and decisions, annexes. Geneva, World Health Organization, 2012:55–68 (WHA65/2012/REC/1; http://apps.who.int/gb/DGNP/pdf_files/A65_REC1-en.pdf, accessed 19 June 2014).

2. Global action plan for the prevention and control of noncommunicable diseases 2013–2020. Geneva: World Health Organization; 2013 (http://apps.who.int/iris/bitstream/10665/94384/1/9789241506236_eng.pdf, accessed 15 August 2014)

3. Follow-up to the Political Declaration of the High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases. In: Sixth-sixth World Health Assembly, Geneva, 21 May 2013. Geneva: World Health Organization; 2013 (http://apps.who.int/gb/ebwha/pdf_files/WHA66/A66_R10-en.pdf, accessed 18 June 2014).

4. Rohner F, Zimmermann M, Jooste P, Pandav C, Caldwell K, Raghavan et al. Biomarkers of nutrition for development-iodine review. J Nutr. 2014;144(8):1322S–42S. doi:10.3945/jn.113.181974.

5. Codex Alimentarius. Codex Standard for food grade salt. CODEX STAN 150–1985. Adopted in 1985; revised in 1997; 2012; amended in 1999; 2001; 2006 (www.codexalimentarius.org/input/download/standards/3/CXS_150e.pdf, accessed 19 June 2014).

6. Andersson M, Karumbunathan V, Zimmerman MB. Global iodine status in 2011 and trends over the past decade. J Nutr. 2012;142(4):744–50. doi:10.3945/jn.111.149393.

7. Sustainable elimination of iodine deficiency. New York: United Nations Children's Fund; 2008.

8. Bleichrodt N, Born MP. A metaanalysis of research on iodine and its relationship to cognitive development. In: Stanbury JB, editor. The damaged brain of iodine deficiency. New York: Cognizant Communication; 1994:195–200.

9. Kapil U, Singh P. Current status of urinary iodine excretion levels in 116 districts of India. J Trop Pediatr. 2004;50:245–7.

10. Kapil U. Successful efforts toward elimination iodine deficiency disorders in India. Indian J Community Med. 2010; 35(4):455–68. doi:10.4103/0970-0218.74339.

11. World Health Organization, United Nations Children's Fund, International Council for the Control of Iodine Deficiency Disorders. Assessment of iodine deficiency disorders and monitoring their elimination: a guide for programme managers, 3rd edition. Geneva: World Health Organization; 2007 (http://whqlibdoc.who.int/publications/2007/9789241595827_eng.pdf, accessed 19 June 2014).

12. Zimmerman M, Jooste P, Pandav C. Iodine-deficiency disorders. Lancet. 2008;372(9645):1251–62. doi:10.1016/S0140-6736(08)61005-3.

13. Roti E, Uberti E. Iodine excess and hyperthyroidism. Thyroid. 2001;11(5):493–500.

14. Lauberg P, Cerqueira C, Ovensen L, Rasmussen L, Perrild H, Andersen S et al. Iodine intake as a determinant of thyroid disorders in populations. Best Pract Res Clin Endocrinol Metab. 2010;24(1):3–27. doi:10.1016/j.beem.2009.08.013.

15. Carlé A, Krejbjerg A, Laurberg P. Epidemiology of nodular goitre. Influence of iodine intake. Best Pract Res Clin Endocrinol Metab. 2014;28 (4):465–79. doi:10.1016/j.beem.2014.01.001.

16. World Health Organization, United Nations Children's Fund, International Council for the Control of Iodine Deficiency Disorders. Recommended iodine levels in salt and guidelines for monitoring their adequacy and effectiveness. Geneva: World Health Organization; 1996 (WHO/NUT/96.13; http://whqlibdoc.who.int/hq/1996/WHO_NUT_96.13.pdf, accessed 19 June 2014).

17. Bürgi H, Kohler M, Morselli B. Thyrotoxicosis incidence in Switzerland and benefit of improved iodine supply. Lancet. 1998;352(9133):1034.

18. Iodine and health. Eliminating iodine deficiency disorders safely through salt iodization: a statement by the World Health Organization. Geneva: World Health Organization; 1994 (WHO/NUT/94.4; http://whqlibdoc.who.int/hq/1994/WHO_NUT_94.4.pdf?ua=1, accessed 19 June 2014).

19. Indicators for assessing iodine deficiency disorders and their control programmes. Report of a joint WHO/UNICEF/ICCIDD consultation, 3–5 November 1992. Review version September 1993. Geneva: World Health Organization; 1993 (WHO/NUT 93.1; http://whqlibdoc.who.int/hq/1993/WHO_NUT_93.1.pdf?ua=1, accessed 19 June 2014).

20. United Nations Educational, Scientific and Cultural Organization Institute for Statistics. Schooling for millions of children jeopardised by reductions in aid. UIS Fact Sheet June 2013;25 (UIS/FS/2013/25; http://www.uis.unesco.org/Education/Documents/fs-25-out-of-school-children-en.pdf, accessed 19 June 2014).

21. WHO Secretariat, Andersson M, de Benoist B, Delange F, Zupan J. Prevention and control of iodine deficiency in pregnant and lactating women and in children less than 2-years-old: conclusions and recommendations of the technical consultation. Public Health Nutr. 2007;10(12A):1606–11. doi:10.1017/S1368980007361004.

22. Zimmermann M, Hess S, Adou P, Toresanni T, Wegmüller R, Hurrell RF. Thyroid size and goiter prevalence after introduction of iodized salt: a 5-y prospective study in schoolchildren in Côte d'Ivoire. Am J Clin Nutr. 2003;77(3):663–7.

23. Food and Agriculture Organization of the United Nations, World Health Organization. International Conference on Nutrition. Nutrition and development – a global assessment. Geneva: World Health Organization; 1992 (ICN/92/INF/5; http://www.fao.org/docrep/017/z9550e/z9550e.pdf, accessed 19 June 2014).

24. United Nations Children's Fund–World Health Organization Joint Committee on Health Policy. World Summit for Children mid-decade goal: iodine deficiency disorders (IDD). UNICEF–WHO Joint Committee on Health Policy Special Session, 27–28 January 1994. Geneva: World Health Organization; 1994 (JCHPSS/94/2.7; http://www.ceecis.org/iodine/01_global/01_pl/01_01_1994_summit.pdf, accessed 19 June 2014).

25. Resolution WHA58/2005/REC/1. Sustaining the elimination of iodine deficiency disorders. Resolutions and decisions. In: Fifty-eighth World Health assembly, Geneva, 16–25 May 2005. Geneva: World Health Organization; 2005. (http://www.who.int/nutrition/topics/WHA58.24_idd_en.pdf?ua=1), accessed 3 July 2014).

26. Resolution WHA65.11. Nutrition. Maternal, infant and young child nutrition: draft comprehensive implementation plan. Report by the Secretariat. In: Sixth-fifth World Health Assembly, Geneva, 21–26 May 2012. Resolutions and decisions, list of participants. Geneva: World Health Organization; 2012:5–23 (A65/11; http://apps.who.int/gb/ebwha/pdf_files/WHA65/A65_11-en.pdf, accessed 19 June 2014).

27. Sustainable elimination of iodine deficiency: progress since the 1990 World Summit for Children. New York: United Nations Children's Fund; 2008 (http://www.childinfo.org/files/idd_sustainable_elimination.pdf, accessed 19 June 2014).

28. The state of the world's children 2012: children in an urban world. New York: United Nations Children's Fund; 2012 (http://www.unicef.org/sowc2012/pdfs/SOWC%202012-Main%20Report_EN_13Mar2012.pdf, accessed 19 June 2014).

29. Salt as a vehicle for fortification. Report of a WHO expert consultation on salt as a vehicle for fortification. Luxembourg 21–22 March 2007. Geneva: World Health Organization;2008 (http://www.who.int/nutrition/publications/micronutrients/978924159678/en/, accessed 19 June 2014).

30. World Health Organization and International Council for the Control of Iodine Deficiency Disorders Global Network. Salt reduction and iodine fortification strategies in public health. Report of a joint technical meeting convened by World Health Organization (WHO) and The George Institute for Global Health in collaboration with the International Council for the Control of Iodine Deficiency Disorders Global Network, Sydney, Australia, March 2013. Geneva: World Health Organization; 2013 (http://www.who.int/nutrition/events/2013_technicalconsultation_salt_iodine_strategies_25to27Mar2013/en/, accessed 19 June 2014).

31. Strategies to monitor and evaluate population sodium consumption and sources of sodium in the diet: report of a joint technical meeting convened by WHO and the Government of Canada, November 2010. Geneva: World Health Organization; 2011 (http://whqlibdoc.who.int/publications/2011/9789241501699_eng.pdf, accessed 19 June 2014).

32. Elliott P, Brown I. Sodium intakes around the world. Background document prepared for the Forum and Technical meeting on Reducing Salt Intake in Populations (Paris 5–7th October 2006). Geneva: World Health Organization; 2007 (http://www.who.int/dietphysicalactivity/Elliot-brown-2007.pdf, accessed 19 June 2014).

33. Guideline: Sodium intake for adults and children. Geneva: World Health Organization; 2012 (http://www.who.int/nutrition/publications/guidelines/sodium_intake_printversion.pdf, accessed 19 June 2014).

34. Guideline: Potassium intake for adults and children. Geneva: World Health Organization; 2012. (http://apps.who.int/iris/bitstream/10665/77986/1/9789241504829_eng.pdf?ua=1, accessed 15 August 2014).

35. WHO Forum on Reducing Salt Intake in Populations. Reducing salt intake in populations: report of a WHO forum and technical meeting, 5–7 October 2006, Paris, France. Geneva: World Health Organization; 2007 (http://www.who.int/dietphysicalactivity/Salt_Report_VC_april07.pdf, accessed 19 June 2014).

36. Prevention of cardiovascular disease: guidelines for assessment and management of cardiovascular risk. Geneva: World Health Organization; 2007 (http://whqlibdoc.who.int/publications/2007/9789241547178_eng.pdf, accessed 19 June 2014).

37. Resolution WHA57.17. Global strategy on diet, physical activity and health. In: Fifty-seventh World Health Assembly, Geneva, 17–22 May 2004. Resolutions and decisions, annexes. Geneva: World Health Organization; 2004:38–55 (http://apps.who.int/gb/ebwha/pdf_files/WHA57/A57_R17-en.pdf, accessed 18 June 2014).

38. Ohlhorst S, Slavin M, Bhide J,Bugusu B. Use of iodized salt in processed foods in select countries around the world and the role of food processors. Compr Rev Food Sci Food Saf. 2012;11:233–84.

39. De Jong JM. Review of use of iodized salt in processed foods. Ottawa: The Network for the Sustained Elimination of Iodine Deficiency; 2007 (http://www.iccidd.org/cm_data/Salt_in_processed_foods.pdf, accessed 20 June 2014).

40. West C, Merx R. Effect of iodized salt on the colour and taste of food. New York: United Nations Children's Fund; 1995 (http://www.micronutrient.org/resources/Salt_CD/4.0_useful/4.1_fulltext/pdfs/4.1.4.pdf, accessed 19 June 2014).

41. Kojima N, Brown H. The effects of iodized salt in processed fruits and vegetables. Food Technology. 1955;9:103–7.

42. Kuhajek E, Fiedelman H. Nutritional iodine in processed foods. Food Technology. 1973;27:52–3.

43. Wang G, Zhou R, Wang Z, Shi L, Sun M. Effect of storage and cooking on the iodine content in iodized salt and study on monitoring iodine content in iodized salt. Biomed Environ Sci. 1999;12:1–9.

44. Diosady L, Alberti J, Mannar VM, Fitzgerald S. Stability of iodine in iodized salt used for correction of iodine-deficiency disorders. Food Nutr Bull. 1998;19(3):240–50.

45. Goindi G, Karmarkar M, Kapil U, Jagannathan J. Estimation of losses of iodine during different cooking procedures. Asia Pac J Clin Nutr. 1995;4:225–7.

46. Maramag C, Tengco L, Rayco-Solon P, Solon J, Maglalang H, Solon F. Stability of iodine in iodized fresh and aged salt exposed to simulated market conditions. Food Nutr Bull. 2007;28(4):412–18.

47. Shawel D, Hagos S, Lachat C, Kimanya M, Kolsteren P. Post-production losses in iodine concentration of salt hamper the control of iodine deficiency disorders: a case study in Northern Ethiopia. J Health Popul Nutr. 2010;28(3):238–44.

48. Winger R, Koenig J, Lee S, Wham C, House D. Technological issues with iodine fortification of foods. Final report for New Zealand Food Safety Authority. Ministry for Primary Industries. Wellington, May 2005. (http://www.foodsafety.govt.nz/elibrary/industry/Technological_Issues-Science_Research.pdf, accessed 19 June 2014).

49. Higgins PT, Green S, editors. Cochrane handbook for systematic reviews of interventions. Version 5.1.0 [updated March 2011] (http://handbook.cochrane.org/, accessed 18 June 2014).

50. Aburto N, Abudou M, Candeias V, Wu T. Effect and safety of salt iodization to prevent iodine deficiency disorders: a systematic review with meta-analyses. WHO eLibrary of Evidence for Nutrition Actions (eLENA). Geneva: World Health Organization; 2014. (http://www.who.int/nutrition/publications/micronutrients/effect_safety_saltiodization/en/. Accessed 19 January 2015).

51. Haas JD, Rahn M, Venkatramanan S, Marquis GS, Wenger MJ, Murray-Kolb LE et al. Double-fortified salt is efficacious in improving indicators of iron deficiency in female Indian tea pickers. J Nutr. 2014; 144(6):957–64. doi:10.3945/jn.113.183228.

52. GRADE Working Group (http://www.gradeworkinggroup.org/, accessed 18 June 2014).

53. The Salt Institute. Iodized salt (http://www.saltinstitute.org/news-articles/iodized-salt/, accessed 10 September 2014).

54. WHO/UNICEF. Acceptable medical reasons for use of breast-milk substitutes. WHO/NMH/NHD/09.01. Geneva: World Health Organization; 2009. (http://whqlibdoc.who.int/hq/2009/WHO_FCH_CAH_09.01_eng.pdf?ua=1, accessed 15 August 2014)

55. World Health Organization and United Nations Children's Fund. Reaching optimal iodine nutrition in pregnant and lactating women and young children. Joint statement by the World Health Organization and the United Nations Children's Fund. Geneva: World Health Organization; 2007 (http://www.who.int/nutrition/publications/WHOStatement__IDD_pregnancy.pdf, accessed 19 June 2014).

56. Angermayr L, Clar C. Iodine supplementation for preventing iodine deficiency disorders in children. Cochrane Database Syst. Rev. 2009;(2):CD003819.

57. World Health Organization. Nutrition (http://www.who.int/nutrition/en/, accessed 18 June 2014).

58. United Nations Standing Committee on Nutrition (http://www.unscn.org/, accessed 18 June 2014).

59. World Health Organization. e-Library of Evidence for Nutrition Actions (eLENA) (http://www.who.int/elena/en/, accessed 18 June 2014).

60. World Health Organization, World Food Programme, United Nations Children's Fund. Preventing and controlling micronutrient deficiencies in populations affected by an emergency. Joint statement by the World Health Organization, the World Food Programme and the United Nations Children's Fund. Geneva: World Health Organization; 2007 (http://www.who.int/nutrition/publications/WHO_WFP_UNICEFstatement.pdf, accessed 10 September 2014).

61. World Food Programme. WFP's food basket (http://www.wfp.org/nutrition/wfp-foodbasket, accessed 10 September 2014).

62. World Health Organization. Evidence-Informed Policy Network (http://global.evipnet.org/, accessed 18 June 2014).

63. Speeckaert M, Speeckaert R, Wierckx K, Delanghe JR, Kaufman JM. Value and pitfalls in iodine fortification and supplementation in the 21st century. Br J Nutr. 2011;106(7):964–73. doi:10.1017/S000711451100273X.

64. Rapid assessment of the iodine content in table salt in Port-au-Prince. Port-au-Prince: United Nations Children's Fund; 2011 (http://www.nutritionenhaiti.org/sites/default/files/faits/files/unicefhaiti_table-salt-paup.pdf, accessed 19 June 2014).

65. Ngnie-Teta I, Ayoya MA, Favre R, Mamadoultaibou A, Saint-Fleur JE, Pierre JM et al. Iodine content in imported table salt in Haiti on the eve of a mandatory salt iodization bill. IDD Newsletter, November 2012 (http://www.iccidd.org/newsletter/idd_nov12_haiti.pdf, accessed 19 June 2014).

66. Kalra S, Kalra B, Sawhney K. Usage of non-iodized salt in North West India. Thyroid Res Pract. 2013;10:12–14.

67. Jooste PL, Weight MJ, Locatelli-Rossi L, Lombard CJ. Impact after 1 year of compulsory iodisation on the iodine content of table salt at retailer level in South Africa. Int J Food Sci Nutr. 1999;50(1):7–12.

68. United Nations Children's Fund, Flour Fortification Initiative, International Council for Control of Iodine Deficiency Disorders (ICCIDD) Global Network, Alive&Thrive. Iodising salt and fortifying flour: the best investment for Viet Nam's National Economic Development. Ha Noi: United Nations Children's Fund; 2013 (http://www.unicef.org/vietnam/UNICEF_Food_Fortification_Salt_Flour.pdf, accessed 19 June 2014).

69. Ipsos-Eureka Social Research Institute. Consumer awareness, attitudes and behaviours to fortified foods. Ipsos Eureka Project 09-003975-01. Report prepared for Food Standards Australia New Zealand. Melbourne: Food Standards Australia New Zealand; 2010 (http://www.foodstandards.gov.au/publications/Documents/Fortification%20report%20-%20qualitative.pdf, accessed 10 September 2014).

70. Logic model for micronutrient interventions in public health. Vitamin and Mineral Nutrition Information System. Geneva: World Health Organization; 2011 (WHO/NMH/NHD/MNM/11.5; http://www.who.int/vmnis/toolkit/WHO-CDC_Logic_Model_en.pdf, accessed 19 June 2014).

71. World Health Organization. eCatalogue of indicators for micronutrient programmes (https://extranet.who.int/indcat/, accessed 10 September 2014).

72. Ghassabian A, Steenweg-de Graaff J, Peeters RP, Ross HA, Jaddoe VW, Hofman A, Verhulst FC, White T, Tiemeier H. Maternal urinary iodine concentration in pregnancy and children's cognition: results from a population-based birth cohort in an iodine-sufficient area. BMJ Open. 2014; 4(6):e005520.

73. World Health Organization. Vitamin and Mineral Nutrition Information System (VMNIS). Micronutrients database (http://www.who.int/vmnis/database/en/, accessed 18 June 2014).

74. UNICEF data: monitoring the situation of children and women (http://data.unicef.org/nutrition/malnutrition, accessed 18 June 2014).

75. World Health Organization. Global database on the Implementation of Nutrition Action (GINA) (http://www.who.int/nutrition/gina/en/, accessed 18 June 2014).

76. WHO handbook for guideline development. Geneva: World Health Organization; 2012 (http://apps.who.int/iris/bitstream/10665/75146/1/9789241548441_eng.pdf, accessed 19 June 2014).

77. Expert advisory panels and committees. Geneva: World health Organization; 2010 (http://www.who.int/rpc/expert_panels/Factsheet_EAP2010.pdf, accessed 18 June 2014).

78. National Collaborating Centre for Methods and Tools. Critically appraising practice guidelines: the AGREE II instrument. Hamilton, Ontario: McMaster University; 2011 (updated 2013) (http://www.nccmt.ca/registry/view/eng/100.html, accessed 19 June 2014).

79. Guyatt G, Oxman A, Vist G, Kunz R, Falck-Ytter Y, Alonso-Coello P et al. Rating quality of evidence and strength of recommendations GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. BMJ. 2008;336:924–6. doi:10.1136/bmj.39489.470347.AD.

80. Basic documents, 47th ed. Geneva: World Health Organization; 2009 (http://apps.who.int/gb/bd/, accessed 18 June 2014).

81. Guidelines for declaration of interests (WHO experts). Geneva: World Health Organization; 2010.

Annex 1 GRADE "Summary of findings" tables

Iodized salt for goitre

Patient or population: general population
Settings: all settings (low-, middle-, high-income countries)
Intervention: iodized salt

Outcomes	Relative effect (95 % CI)	Number of participants (studies)	Quality of the evidence (GRADE)	Comments
Cognitive function – RCT	**RR 1.06** (0.69 to 1.62)	286 (1 study)	⊕⊕⊖⊖ **low**[1,2]	
Goitre – non RCTs	**RR 0.59** (0.36 to 0.95)	32 219 (3 studies)	⊕⊕⊕⊖ **moderate**[3,4]	
Goitre – quasi	**Peto OR 0.1** (0.08 to 0.13)	42 367 (1 study)	⊕⊕⊖⊖ **moderate**[3,5]	
Goitre – cohort	**RR 0.3** (0.23 to 0.41)	754 387 (11 studies)	⊕⊕⊕⊖ **moderate**[5]	
Goitre – multiple cross sectional palpation	**RR 0.18** (0.14 to 0.22)	1 963 247 (34 studies)	⊕⊕⊖⊖ **low**[5,6]	

*The basis for the assumed risk (e.g. the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CI: confidence interval; RCT: randomized controlled trial; OR: odds ratio; RR: risk ratio.

GRADE Working Group grades of evidence

High quality: further research is very unlikely to change our confidence in the estimate of effect.

Moderate quality: further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low quality: further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low quality: we are very uncertain about the estimate.

[1] Unclear randomization and allocation of concealment.

[2] 95% CI crosses null.

[3] Non-randomized.

[4] Though the results of one study suggested an opposite result from the others, there were too few events to generate a meaningful result (5 in intervention and 4 in control).

[5] Very large protective effect of iodized salt.

[6] Many studies did not provide sufficient detail to assess the risk of bias.

Iodized salt for cognitive function

Patient or population: general population
Settings: all settings (low-, middle-, high-income countries)
Intervention: iodized salt

Outcomes	Relative effect (95 % CI)	Number of participants (studies)	Quality of the evidence (GRADE)	Comments
Goitre – RCTs				No studies
Cognitive function – non-RCT				No studies
Cognitive function – cohort				No studies
Cognitive function – quasi mean intelligence quotient (IQ)	The mean cognitive function in the intervention group (IQ) was 8.18 higher (6.71 to 9.65 higher)	12 995 (18 studies)	⊕⊕⊖⊖ **low**[1-3]	
Cognitive function – multi cross-sectional mean IQ	The mean cognitive function in the intervention group (IQ) was 10.45 higher (4.79 to 16.11 higher)	2262 (2 studies)	⊕⊕⊖⊖ **low**[1, 3]	
Cognitive function – quasi IQ <70	**RR 0.28** (0.21 to 0.36)	12 761 (16 studies)	⊕⊕⊖⊖ **low**[1-3]	
Cognitive function – multi cross-sectional IQ <70	**RR 0.24** (0.07 to 0.82)	509 (1 study)	⊕⊕⊖⊖ **low**[1-3]	

*The basis for the assumed risk (e.g. the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CI: confidence interval; RCT: randomized controlled trial; RR: risk ratio.

GRADE Working Group grades of evidence

High quality: further research is very unlikely to change our confidence in the estimate of effect.

Moderate quality: further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low quality: further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low quality: we are very uncertain about the estimate.

[1] Many studies did not provide sufficient detail to assess the risk of bias.

[2] Quasi-experimental studies.

[3] Large protective effect with iodized salt.

Iodized salt for urinary iodine excretion

Patient or population: general population
Settings: all settings (low-, middle-, high-income countries)
Intervention: iodized salt

Outcomes	Relative effect (95 % CI)	Number of participants (studies)	Quality of the evidence (GRADE)	Comments
Urinary iodine excretion – cohort μg/L iodine in urine	The mean UIE in the intervention group was 19.96 μg/L higher (19.8 to 20.12 μg/L higher)	1307 (3 studies)	⊕⊕⊕⊖ **moderate**[1]	9 comparisons
Urinary iodine excretion – cohort 2 μg iodine/g creatinine in urine[2]	Not estimable[3]	244 (2 studies)	⊕⊕⊕⊖ **moderate**[1]	Studies could not be pooled
Urinary iodine excretion – multiple cross-sectional μg iodine/L urine	The mean UIE – multiple cross-sectional in the intervention groups was 72.35 μg/L higher (44.54 to 100.17 μg/L higher)	6760 (5 studies)	⊕⊕⊕⊖ **moderate**[1]	
Urinary iodine excretion – multiple cross-sectional 2 μg iodine/g creatinine	The mean UIE in the intervention group was 104.11 μg/g creatinine higher (55.28 to 152.94 higher)	1773 (4 studies)	⊕⊕⊕⊖ **moderate**[1]	
Urinary iodine excretion – multiple cross-sectional (low UIE)	RR 0.45 (0.33 to 0.60)	7252 (10 studies)	⊕⊕⊕⊖ **moderate**[1]	

*The basis for the assumed risk (e.g. the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CI: confidence interval; RR: risk ratio; UIE: urinary iodine excretion.

GRADE Working Group grades of evidence

High quality: further research is very unlikely to change our confidence in the estimate of effect.

Moderate quality: further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low quality: further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low quality: we are very uncertain about the estimate.

[1] Large positive effect of iodized salt on UIE.

[2] The standard deviation for one of the two studies was 10-fold less than the other study and these values could not be verified; therefore, the data were not pooled. Both studies showed a significant increase in UIE with iodized salt mean difference [MD] = 66 [95% CI = 45 to 87); MD = 105 (95% CI = 104 to 106).

Annex 2 Summary of the considerations of the members of the guideline development group – nutrition actions for determining the strength of the recommendation

Quality of the evidence:	Depending on the outcome, the quality of the evidence ranged between very low and moderate. Although the evidence from randomized controlled trial is limited, the consistency and the number of all the included studies were noted as going in the same direction. Evidence was very low or missing on some functional consequences.
Values and preferences:	Individuals decreasing their salt intake according to WHO recommendations will still be covering their needs for iodine. Salt iodization is an established effective intervention and mandatory legislation should exist in each country to support it.
Trade-off between benefits and harms:	The benefits are well established. The only harm is a transient increase in hyperthyroidism, which can be easily treated. There are not enough data on harm, especially for the long-term impact of overdose. More research should be performed to give accurate evidence of benefits and harms. Good monitoring of coverage of salt iodization is needed, to ensure that the benefits at population level outweigh any possible harm. Most members considered that benefits clearly outweigh harms.
Costs and feasibility:	Salt iodization has been effectively implemented for decades. Very cost effective. Needs global support and political will in countries, as well as a strong monitoring and reporting mechanism. Annual costs between US$ 0.02 and US$ 0.05 per capita can result in huge benefits.

Annex 3 WHO Steering Committee for Nutrition Guidelines Development

Emergency Risk Management and Humanitarian Response (ERM)

Dr Richard Brennan
Director
World Health Organization
Avenue Appia 20, 1211 Geneva 27
Switzerland

Food Safety, Zoonoses and Foodborne Diseases (FOS)

Dr Kazuaki Miyagishima
Director
World Health Organization
Avenue Appia 20, 1211 Geneva 27
Switzerland

Global TB Programme

Dr Knut Lonnroth
Medical Officer, Global TB Programme
World Health Organization
Avenue Appia 20, 1211 Geneva 27
Switzerland

Health System Policies and Workforce (HPW)

Dr Ties Boerma
Director
World Health Organization
Avenue Appia 20, 1211 Geneva 27
Switzerland

HIV/AIDS (HIV)

Dr Gottfried Otto Hirnschall
Director
World Health Organization
Avenue Appia 20, 1211 Geneva 27
Switzerland

International Agency for Research on Cancer (IARC)

Dr Isabelle Romieu
Section and Group Head, Nutritional Epidemiology Group
International Agency for Research on Cancer
150, cours Albert Thomas
69372 Lyon Cedex 08
France

Dr Nadia Slimani
Group Head
Dietary Exposure Assessment Group
International Agency for Research on Cancer
150, cours Albert Thomas
69372 Lyon Cedex 08
France

Immunization, Vaccines and Biologicals (IVB)

Dr Jean-Marie Okwo-Bele
Director
World Health Organization
Avenue Appia 20, 1211 Geneva 27
Switzerland

Knowledge Management and Sharing (KMS)

Dr Najeeb Mohamed Al Shorbaji
Director
World Health Organization
Avenue Appia 20, 1211 Geneva 27
Switzerland

Maternal, Newborn, Child and Adolescent Health (MCA)

Dr Elizabeth Mason
Director
World Health Organization
Avenue Appia 20, 1211 Geneva 27
Switzerland

Nutrition for Health and Development (NHD)

Dr Francesco Branca
Director
World Health Organization
Avenue Appia, 20, 1211 Geneva 27
Switzerland

Prevention of Noncommunicable Diseases (PND)

Dr Douglas Bettcher
Director
World Health Organization
Avenue Appia 20, 1211 Geneva 27,
Switzerland

Public Health, Environmental and Social Determinants of Health (PHE)

Dr Maria Purificacion Neira
Director
World Health Organization
Avenue Appia 20, 1211 Geneva 27
Switzerland

Reproductive Health and Research (RHR)

Dr Marleen Temmerman
Director
World Health Organization
Avenue Appia 20, 1211 Geneva 27
Switzerland

The Special Programme for Research and Training in Tropical Diseases

Professor John Charles Reeder
Director
World Health Organization
Avenue Appia 20, 1211 Geneva 27
Switzerland

Annex 4 WHO guideline development group – nutrition actions 2013–2014, WHO Secretariat and external resource experts

WHO guideline development group – nutrition actions 2013–2014
(*Note:* the areas of expertise of each guideline group member are given in italics)

Ms Deena Alasfoor
Ministry of Health
Muscat, Oman
Health programme management, food legislations, surveillance in primary health care

Dr Kalid Asrat Tasew
St Paul Hospital Millennium Medical College
Addis Abba, Ethiopia
Paediatrics, primary health care

Dr Mary Chea
National Nutrition Programme
National Maternal and Child Health Center
Phnom Penh, Cambodia
Programme implementation, midwifery

Dr Luz Maria De-Regil
Research and Evaluation and Technical Services
Micronutrient Initiative
Ottawa, Canada
Epidemiology, systematic reviews, programme implementation

Dr Heba El Laithy
Departments at Faculty of Economics
Cairo University
Cairo, Egypt
Statistics, economics

Dr Davina Ghersi
Executive Knowledge and Development Cluster
National Health and Medical Research Council
Canberra, Australia
Policy-making, systematic reviews, evidence

Dr Maria Elena del Socorro Jefferds
Nutrition Branch
Division of Nutrition, Physical Activity and Obesity
US Centers for Disease Control and Prevention (CDC)
Atlanta, United States of America
Behaviour science, programme evaluation

Dr Rukhsana Haider
Training and Assistance for Health and Nutrition (TAHN) Foundation
Dhaka, Bangladesh
Breastfeeding, capacity-building on counselling and nutrition

Dr Patrick Wilfried Kolsteren
Department of Public Health
Institute of Tropical Medicine
Antwerp, Belgium
Public health, food safety, laboratory methods

Dr Guansheng Ma
National Institute for Nutrition and Food Safety
Chinese Center for Disease Control and Prevention
Beijing, China
Food safety, public health, programme management

Dr Lynnette Neufeld
Monitoring, Learning and Research
Global Alliance for Improved Nutrition (GAIN)
Geneva, Switzerland
Micronutrients, programmes, epidemiology

Dr Orishi Ebere Orisakwe
Toxicology Unit, Faculty of Pharmacy
University of Port Harcourt
Rivers State, Nigeria
Pharmacology, food safety, toxicology

Dr Mical Paul
Infectious Diseases Unit
Rabin Medical Center, Belinson Hospital
Sackler Faculty of Medicine Tel Aviv University
Petah-Tikva, Israel
Infectious diseases, HIV

Professor Dalip Ragoobirsingh
Medical Biochemistry and Diabetology
Diabetes Education Programme
University of the West Indies
Faculty of Medical Sciences Teaching and Research Complex (Level 2),
Mona, Kingston, Jamaica
Diabetes

Professor HPS Sachdev
Sitaram Bhartia Institute of Science and Research
New Delhi, India
Paediatrics, systematic reviews

Ms Rusidah Selamat
Nutrition Division
Department of Public Health
Ministry of Health Malaysia
Putrajaya, Malaysia
Public health nutrition

Dr Rebecca Joyce Stoltzfus
Division of Nutritional Sciences
Cornell University
Ithaca, United States of America
International nutrition and public health, iron and vitamin A nutrition, programme research

Dr Igor Veljkovik
United Nations Children's Fund (UNICEF)
Skopje
Skopje, Former Yugoslav Republic of Macedonia
Programme implementation

Dr Maged Younes
Committee on World Food Security (CFS)
Food and Agriculture Organization (FAO)
Rome, Italy
Food safety, public health, programme management

WHO Secretariat

Ms Sanjhavi Agarwal
Intern, Evidence and Programme Guidance
Department of Nutrition for Health and Development

Ms Maryam Bigdeli
Technical Officer
Alliance for Health Policy and Systems Research

Dr Maria del Carmen Casanovas
Technical Officer, Evidence and Programme Guidance
Department of Nutrition for Health and Development

Dr Maria de las Nieves García-Casal
Senior Consultant, Evidence and Programme Guidance
Department of Nutrition for Health and Development

Dr Laragh Gollogly
Editor, WHO Press

Dr Suzanna McDonald (*rapporteur*)
Consultant, Evidence and Programme Guidance
Department of Nutrition for Health and Development

Ms Daniela Meneses (*rapporteur*)
Intern, Evidence and Programme Guidance
Department of Nutrition for Health and Development

Mr Leendert Maarten Nederveen
Technical Officer, Surveillance and Population-based Prevention
Department of Prevention of Noncommunicable Diseases

Dr Eyerusalem Kebede Negussie
Medical Officer, HIV Treatment and Care
Department of HIV/AIDS

Dr Susan L Norris
Technical Officer, WHO Press
Department of Knowledge Management and Sharing

Dr Juan Pablo Peña-Rosas
Coordinator, Evidence and Programme Guidance
Department of Nutrition for Health and Development

Dr Lisa Rogers
Technical Officer, Evidence and Programme Guidance
Department of Nutrition for Health and Development

Dr Nigel Rollins
Medical Officer, Research and Development
Department of Maternal, Newborn, Child and Adolescent Health (MCA)

Ms Victoria Saint
Technical Officer, Social Determinants of Health
Department of Public Health, Environmental and Social Determinants of Health (PHE)

Dr Eugenio Villar Montesinos
Coordinator, Social Determinants of Health
Department of Public Health, Environmental and Social Determinants of Health

Dr Godfrey Xuereb
Technical Officer, Surveillance and Population-based Prevention
Department of Chronic Diseases and Health Promotion

Mr Gerardo Zamora
Consultant, Equity and Implementation Research
Evidence and Programme Guidance
Department of Nutrition for Health and Development

WHO regional offices

Dr Kunal Bagchi
Regional Adviser
Nutrition and Food Safety
WHO Regional Office for South-East Asia
New Delhi, India

Dr Mercy Chikoko
Regional Advisor for Nutrition (acting)
WHO African Regional Office
Brazzaville, Congo

Dr Chessa Lutter
Regional Adviser
Child and Adolescent Health
WHO Regional Office for the Americas/Pan American Health Organization
Washington, DC, United States of America

External resource experts

Dr Nancy Aburto
United Nations World Food Programme
Rome, Italy

Professor Norm Campbell
Departments of Medicine,
Community Health Sciences and Physiology and Pharmacology
Calgary, Canada

Dr Guillermo Carroli
Centro Rosarino de Estudios Perinatales (CREP)
Santa Fé, Argentina

Ms Nita Dalmiya
Micronutrients United Nations Children's Fund (UNICEF)
New York, United States of America

Dr Maria Cecilia Dedios Sanguinetti
Independent Consultant
Baltimore, United States of America

Dr Kathryn Dewey
Programme in International and Community Nutrition
University of California
Davis, United States of America

Ms Mary-Anne Land
Research Associate
The George Institute for Global Health
Sydney, Australia

Mr Lorenzo Locatelli-Rossi
Senior Technical Specialist Universal Salt Iodization
Global Alliance for Improved Nutrition (GAIN)
Geneva, Switzerland

Dr Sant-Rayn Pasricha
MRC Human Immunology Unit
Weatherall Institute of Molecular Medicine, University of Oxford
John Radcliffe Hospital
Oxford, United Kingdom of Great Britain and Northern Ireland

Dr Rafael Perez-Escamilla
Office of Community Health Yale School of Public Health
New Haven, Connecticut, United States of America

Dr Usha Ramakrishnan
Doctoral Program in Nutrition and Health Sciences
Department of Global Health
Rollins School of Public Health, Emory University
Atlanta, United States of America

Dr Michael Zimmermann
Institute of Food, Nutrition and Health
Swiss Federal Institute of Technology (ETH) Zürich
Zürich, Switzerland

Annex 5 Peer-reviewers

Dr Maria Andersson
Institute of Food, Nutrition and Health
Swiss Federal Institute of Technology (ETH)
Zurich, Switzerland

Dr Omar Dary
Bureau of Global Health
US Agency for International Development
Washington, DC, United States of America

Dr Laurence Grummer-Strawn
Division of Nutrition, Physical Activity and Obesity,
US Center for Chronic Disease Prevention and Health Promotion
Atlanta, United States of America

Mr Lorenzo Locatelli-Rossi
Universal Salt Iodization
Global Alliance for Improved Nutrition (GAIN)
Geneva, Switzerland

Mr Arnold Timmer
United Nations Children's Fund (UNICEF)
New York, United States of America

Dr Michael Zimmerman
Institute of Food, Nutrition and Health
Swiss Federal Institute of Technology (ETH)
Zurich, Switzerland

Annex 6 Questions in population, intervention, control, outcomes (PICO) format

Should salt be fortified with iodine to prevent and control iodine deficiency disorders?

Secondary questions

a. What is the safety of this intervention, considering both high urinary levels and hypertension?

b. Should iodine fortification be targeted for industrial and/or household use?

c. Is the effect different based on the target groups identified below?

d. Is the effect different by population salt-consumption patterns identified below?

e. Is the effect different based on the sources of fortified salt identified below?

f. How can two distinct policies – salt reduction and use of salt as a vehicle for fortification with iodine – be implemented in an efficient and effective manner, protecting the health of the general population?

Population: General population

Subpopulations:

- preschool-age children (6–59 months)
- school-age children (5–11 years)
- women of reproductive age (15–49 years)
- pregnant women

Intervention: Salt (any type) fortified with iodine (mandatory or not)

Subgroup analysis:

a. by dose: 20 ppm or less; 20–40 ppm; 40 ppm or more
b. by salt consumption patterns: 15.0 g/day or more;
10–14.9 g/day or more; 5.0–9.9 g/day; less than 5 g/day
c. by availability of fortified salt source (actual or intended):
- iodized salt for consumption at the household level only
- where iodized salt is used in processed foods;
- all salt being produced in the country or imported is iodized
- unknown

	d. by: - Universal Salt Iodization (USI) certification (defined according to WHO current guidelines) - USI country setting - Non-USI country setting
Control:	No iodized salt (any)
Outcomes:	*All ages* 1. Goitre 2. Hypothyroidism 3. Increased susceptibility to nuclear radiation 4. Intake of dietary iodine *Fetus* 1. Spontaneous abortion 2. Stillbirth 3. Congenital anomalies 4. Perinatal mortality *Neonate* 1. Endemic cretinism, including mental deficiency with a mixture of mutism, spastic diplegia, squint, hypothyroidism and short stature 2. Infant mortality *Children and adolescents* 1. Impaired mental function 2. Delayed physical development 3. Iodine-induced hyperthyroidism *Adults* 1. Impaired mental function 2. Iodine-induced hyperthyroidism 3. Hypertension
Setting:	All countries, stable and emergency settings

World Health Organization

For more information, please contact:

Department of Nutrition for Health and Development

World Health Organization
Avenue Appia 20, CH-1211 Geneva 27, Switzerland
Fax: +41 22 791 4156
Email: nutrition@who.int
www.who.int/nutrition

ISBN 978 92 4 150792 9

9 789241 507929