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**Joint WHO/UNICEF/ICCIDD
Consultation**

**Review of Findings from
7-country Study in Africa on Levels of Salt Iodization
in Relation to Iodine Deficiency Disorders,
Including Iodine-induced Hyperthyroidism**

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Geneva**



**World Health
Organization**



**United Nations
Children's Fund**



**International Council for
Control of Iodine
Deficiency Disorders**

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Acronyms

ICCIDD	International Council for Control of Iodine Deficiency Disorders
IDD	Iodine deficiency disorders
IHH	Iodine-induced hyperthyroidism
USI	Universal salt iodization
TGR	Total goitre rate
TSH	Thyro-stimulin hormone
UNICEF	United Nations Children's Fund
VGR	Visible goitre rate
WHO	World Health Organization

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry should be supported by a valid receipt or invoice. This not only helps in tracking expenses but also ensures compliance with tax regulations.

In the second section, the author outlines the various methods used for data collection and analysis. These include surveys, interviews, and focus groups. Each method has its own strengths and limitations, and the choice depends on the specific research objectives.

The third section provides a detailed overview of the results obtained from the study. It includes several tables and graphs that illustrate the key findings. The data shows a clear trend towards digital adoption among small businesses, which is a significant shift in the market.

The findings of the study have several implications for business owners and policymakers. First, it highlights the need for better digital infrastructure to support small enterprises. Second, it suggests that training programs should be developed to help these businesses navigate the digital landscape.

Finally, the document concludes with a series of recommendations for future research. It suggests that further studies should be conducted to explore the long-term effects of digitalization on business performance and employment.

Executive Summary

A consultation on salt iodization as a means to control iodine deficiency disorders was held at WHO headquarters in Geneva from 8 to 9 July 1996. The main objectives were (i) to review the information available from the multicentre study in Africa on levels of salt iodization and their biological impact on iodine status, including iodine-induced hyperthyroidism; (ii) to examine, in the light of the African multicentre study, the current recommendations concerning levels of salt iodization under varied conditions of temperature, humidity and packaging; and (iii) to recommend a procedure for monitoring the level of salt iodization so as to achieve desired levels of intake and prevent iodine deficiency diseases.

Three working documents were submitted to the participants for discussion: the report of the seven-country African study, the report of a study on the stability of iodized salt and the report of a case study on iodine-induced hyperthyroidism in Zimbabwe.

The findings of the African multicentre study show that universal salt iodization was introduced within the past five years, although iodized salt has been on the market for 15 years in Kenya and 25 in Zambia. The marked decrease in the prevalence of goitre in most surveyed areas is a striking confirmation of the effectiveness of universal salt iodization in Africa. The increase in urinary iodine concentrations gives an objective confirmation of this, although in five countries the median concentrations of urinary iodine were as high as 30 µg/dl. Nevertheless iodine-induced hyperthyroidism was documented in only two countries and was clearly linked to iodine overload at the household level. This was due to excess during production and lower losses than expected between production and consumption.

The study on stability of iodine in salt in eight countries indicates that moisture plays a critical role, especially at high temperatures and when the salt contains hygroscopic impurities. However, at conditions prevailing in tropical countries, properly sealed packaging in low-density polyethylene bags would keep losses below 20% for at least six months. It is advisable to determine iodine losses locally in each country to ensure programme effectiveness and safety.

The Zimbabwe case study is an example of a longitudinal study that should be replicated in other countries. The data indicate that the high iodine content of salt is the most likely factor behind iodine-induced hyperthyroidism. These high levels of iodine in salt are in part due to inefficient monitoring of salt iodization during production. The benefits of salt iodization in households in Zimbabwe are clearly demonstrated by the improvement of the two main indicators of iodine deficiency disorders: prevalence of goitre and urinary concentration of iodine. The data indicate a need to decrease the requirement for iodine fortification of salt in Zimbabwe.

The major conclusions of the consultation are that urinary iodine is the best indicator of iodine intake and thus of fortification programmes. To meet the desirable intake of 150 µg iodine intake per day by iodized salt, taking into account a maximum loss of 40% iodine between production and consumption, the requirements for salt fortification are 20–40 ppm iodine. These levels would ensure a median urinary

iodine range within 10-20 µg/dl. If this level is not met, reassessment should focus on salt quality and iodization procedures, and on factors affecting losses (packaging, storage, cooking) and salt consumption habits.

To minimize iodine-induced hyperthyroidism, the iodine level should be set at the lowest level which prevents all manifestations of iodine deficiency diseases. A basic monitoring programme includes:

- a qualified IDD committee, supported by a network of field-testing with reliable kits;
 - independent laboratories able to carry out iodine titration in salt and urinary iodine analysis;
 - data from sentinel sites which will permit readjustment of the salt iodization programme;
 - surveillance of the incidence of hyperthyroidism by a thyroid hormone laboratory (for goitre prevalence, ultrasound could complete palpation).
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1 Background

1.1 Introduction

The first recognition of iodine deficiency disorders (IDD)¹ as a public health problem in many African countries (1) took place in 1987 during the meeting jointly convened by WHO, UNICEF and the International Council for the Control of Iodine Deficiency Disorders (ICCIDD) in Yaoundé, Cameroon. As a consequence, an African IDD Task Force was established under the aegis of WHO, UNICEF and ICCIDD to promote, strengthen and evaluate national programmes for the control of IDD. Its priorities were to build capacity for assessment at country and regional levels, and to help countries establish national control programmes in conformity with the global goal of elimination of IDD by the year 2000 adopted by the World Summit for Children (New York, 1990) and by the World Health Assembly, and the mid-decade goal for universal salt iodization (USI) endorsed by WHO, UNICEF and ICCIDD.

To fulfil these goals several workshops and seminars were organized to train programmes managers and sensitise the salt production and distribution sectors. Thus, in the African Region a master plan for salt iodization was drafted and advocated during two meetings held in Francistown, Botswana and in Saly Portudal, Senegal in 1992. Both countries are major salt producers and contribute substantially to the supply of salt in the African Region.

There is a global consensus on USI. To date this has been adopted by 83 governments. All countries in Asia and Latin America have legislation requiring 30–100 ppm at production level. Recently the Conference on Sustainable Elimination of IDD in Africa by Year 2000 (Harare, 1996), held under the sponsorship of WHO, UNICEF, ICCIDD and the Government of Zimbabwe, confirmed the major progress achieved in USI in the African Region. No fewer than 33 of the 45 African countries that participated have legislation on USI at the stage of implementation. Most of the others have it planned for the current year. Thus salt iodization is becoming more common, replacing iodized oil which has been largely used in Central and East Africa (mainly Burundi, Democratic Republic of Congo, Rwanda and Tanzania) and also in Ghana and Nigeria. As a result of recent efforts, the proportion of the population in developing countries regularly consuming iodized salt has increased from 5% to 50% since 1990 (2).

The recommendations of WHO, UNICEF and ICCIDD on salt iodization levels have been formulated on the basis of assumptions about requirements for iodine, people's average salt intake, and the average losses of iodine content from iodized salt during transportation and storage (3). WHO, UNICEF and ICCIDD have emphasized the importance of adequate monitoring of salt iodization programmes to maximize their effectiveness (3). A monograph that gives practical advice on salt monitoring has recently been published (4).

It has been documented that, in neonates and young children, IDD (including subclinical hypothyroidism, goitre and brain damage resulting in irreversible mental deficiency) are prevented only when the iodine supply to pregnant and lactating women is about 200 µg iodine per day (5–8). It is also clear that brain damage in neonates occurs only in conditions of severe iodine deficiency (9).

WHO, UNICEF and ICCIDD have recognized that when populations who have previously been chronically deficient in iodine increase their intake above normal or even up to normal (i.e. 100–200 µg per day) but within a short period of time, there is a risk that a small number of individuals, particularly people over 40 years of age with long-standing, nodular and potentially autonomous goitres, will suffer from a condition

¹ IDD cover a spectrum of pathological conditions resulting from a deficiency of iodine. They include goitre, hypothyroidism, cretinism, deaf-mutism, squint, spastic, diplegia, mental retardation, dwarfism, stillbirth, congenital anomalies and increased perinatal mortality.

known as "Jod Basedow" or iodine-induced hyperthyroidism² (IIH). In these susceptible individuals, the increased iodine intake precipitates hyperthyroidism — an excess secretion of thyroid hormones by the thyroid gland (10).

IIH was first well documented when the iodine content of bread was increased in the 1960s in Tasmania (11,12). The sharp rise in the incidence of hyperthyroidism observed between 1964 and 1967 subsided completely by 1975. It affected only people above 40 years of age. However, it was not documented to be an important problem in other countries in which iodine deficiency was common and where iodized salt was introduced in the fairly recent past (such as the countries of Central America, and Bolivia, Ecuador, Kenya and Yugoslavia. In Guatemala, there was a report of a small increase in the prevalence of hyperthyroidism in older people in the late 1950s following salt iodization, but it was transitory and self-limiting (Scrimshaw, personal communication). A similar observation was made in Brazil (13). It is generally accepted that independently of the source of iodine, IIH could occur even at a level necessary for physiological thyroid function (which ranges from 50 µg/day for the newborn to 200 µg/day for the pregnant woman).

A recent report from Zimbabwe (14) indicates that, during the past four years, and rapidly after the introduction of iodized salt in the country, there has been an increase in the number of adults affected by hyperthyroidism attending health care facilities. This observation may reflect an increase in the incidence of IIH. Similarly, a pilot study (15) was conducted in the north-eastern part of the Democratic Republic of Congo (formerly Zaire), in an area formerly severely deficient in iodine, where there has been a sudden and uncontrolled introduction of incorrectly iodized salt. A fairly high frequency of the biochemical signs of hyperthyroidism indicating IIH was observed in a selected high-risk group of adults with large goitres. The condition was asymptomatic. It is possible that north-eastern Democratic Republic of Congo and Zimbabwe were supplied with the same source iodized salt as that produced in Botswana. Iodized salt is also available in five other countries in the African Region (Cameroon, Kenya, Nigeria, Tanzania and Zambia).

The question arises as to whether the apparent increases in the number of persons with hyperthyroidism in Democratic Republic of Congo and Zimbabwe represent particular local situations or correspond to a more general phenomenon. In an attempt to respond to this question WHO, UNICEF and ICCIDD launched a multicentre study in Africa to investigate the situation. It consisted of a rapid survey in seven African countries, undertaken between October 1995 and March 1996, to determine whether recommendations on salt iodine levels should be modified generally or should be changed in specific countries. In parallel, the Micronutrient Initiative has conducted a laboratory study in Ottawa on the stability of iodized salt from IDD control programmes.

1.2 Objectives of the consultation

In order to make recommendations on levels of salt iodization under varied conditions and in various countries, it was necessary to evaluate the information from these studies. Subsequently, a consultation was convened by WHO, UNICEF and ICCIDD on 8–9 July 1996 in Geneva. Its objectives were:

- to review the information available from the seven-country African study of salt iodization levels and their biological impact, including evidence of IIH;
- to review, in light of the African study, current recommendations concerning levels of iodization of salt under varied conditions of temperature, humidity and packaging;

² Hyperthyroidism is a condition marked by increased functional activity of the thyroid gland with excessive biosynthesis and secretion of thyroid hormones triiodothyronine (T₃) and thyroxine (T₄), leading to thyrotoxicosis, whose characteristic manifestations include profuse sweating, weight loss, increased appetite, ocular changes (especially upper eyelid retraction), cardiovascular effects (especially tachycardia and arrhythmias), dyspnoea, nervousness, weakness and fatigability.

- to recommend a procedure for monitoring the level of salt iodization to achieve desired levels of intake to prevent IDD while avoiding unnecessarily high levels which carry a needless economic burden for a public health programme and have some risk of adverse consequences.

1.3 Proceedings

The consultation was opened by Dr B. Hetzel who gave a welcoming address on behalf of ICCIDD, followed by Mr D. Alnwick, on behalf of UNICEF and Dr B. de Benoist on behalf of WHO. The participants elected Dr L. Braverman as chairman. After an introduction on climatic and ecological variations in Africa relative to potential effects on the stability of iodine in salt by Dr M. Benmiloud, three studies were reported: the African multicentre study presented by Dr F. Delange, the study on the stability of iodine in salt presented by Mr T. Stone, and the Zimbabwe case study presented by Dr C. Todd. Each presentation was discussed by the participants. Participants then split into three drafting groups (Annex 3) to develop a consensus statement to include:

- recommended levels of iodization at factory, community and household levels, taking into account factors affecting the stability of iodine;
- the risk of IIH and iodine levels in salt;
- minimum requirements for monitoring the adequacy of levels of iodine in salt and in human beings.

Reports of the drafting groups were discussed in plenary session and resulted in the recommendations of the consultation.

The present document is a report of the presentations, discussions and recommendations made by the consultation.

2 The African Multicentre Study

2.1 Objectives

The overall objectives were to obtain information on:

- the present iodine intake of populations in areas known to be at risk of severe iodine deficiency in the past and where salt iodization has recently been introduced;
- the possibility of IIH in these areas.

This information would allow WHO, UNICEF and ICCIDD to decide whether to recommend that governments change the amounts of iodine added to salt in order to minimize the risk of IIH.

The specific objectives were:

- In areas which were previously severely iodine deficient but are now receiving iodized salt:
 - to identify the actual iodine content of salt consumed and to obtain measures of salt and iodine intake;

- to determine whether salt iodization levels could be reduced without lessening impact of the programme in combating iodine deficiency.
- To visit factory or site, or point of importation, where the salt consumed in the above areas is iodized, in order:
 - to examine the adequacy of iodization and quality control procedures;
 - to recommend specific practical changes which could be introduced to minimize undesirable fluctuations in the iodine content of salt.
- To visit health facilities and, through discussions with health workers in both peripheral and referral health facilities and through a review of available records:
 - to determine whether there is evidence of an increase of hyperthyroidism associated with the introduction of iodized salt;
 - to review current procedures for recognizing, referring and treating people with hyperthyroidism.

2.2 Methodology

Field surveys

Selection of countries

Seven countries were selected: Cameroon, Democratic Republic of Congo, Kenya, Nigeria, Tanzania, Zambia and Zimbabwe. Two of these were under scrutiny because of recent reports of an increased rate of IIH. In addition Botswana, as a major exporter of salt in southern Africa, was also included.

All countries had identified areas of severe endemic goitre due to iodine deficiency, often aggravated by intake of goitrogens from staple foods such as cassava. Consumption of seafood is generally limited to coastal areas.

While Kenya and Tanzania iodize locally produced salt, Cameroon, Nigeria and Zimbabwe have refineries or packaging companies with iodization capacity for imported salt. The Democratic Republic of Congo and Zambia are fully dependent on imports. Each of the selected countries presents variations in salt iodine requirements and also in the pattern of introduction of iodized salt. Introduction of iodized salt was progressive in Kenya: from 1970 to 1990 the required levels of iodine were increased from 20 to 100 ppm. In Nigeria the first introduction of iodized salt was at a level of 20 ppm in 1984, and in 1993 the USI requirement increased to 30-50 ppm. In Zambia the legislation enacted in 1978 was not fully implemented. In the other countries, exposure to salt with an iodine content of between 30 and 100 ppm – at producer and consumer level – was more rapid between 1990 and 1995.

Collection of information

Before the countries were visited, information was collected from various sources, particularly national authorities, country and regional offices of WHO and UNICEF, and from a review of the literature.

The information collected related to:

- the characteristics of the climate;

- the characteristics of endemic goitre before the introduction of iodized salt (severity, extension, complications, duration);
- the characteristics of the programme of salt iodization (date of initiation, iodization of table salt only or USI, level of iodization, origin of iodized salt, quality control of iodized salt).

Sampling method

The areas visited were not chosen according to a representative national sample. The study team deliberately set out to visit areas most likely to have a problem, i.e. areas known to have a high prevalence of IDD and likely to have many older adults with nodular goitre. Two or three areas were surveyed in each selected country.

Two or three primary schools were selected at random in each area. Casual urine samples were collected from 50-100 primary school children of both sexes aged 6-14 years at each school. Although the risk of thyrotoxicosis is mainly a problem in older people, urinary iodine concentrations of primary school children can provide adequate indication of the recent iodine intake of the whole population. This approach, therefore, was much more convenient than collecting urine samples from older people at home. Age, sex and goitre stage by palpation were recorded for each child.

Schoolchildren were requested to bring approximately 20 g of salt from home to school in special containers provided for this purpose. A sample of 5-10 salt samples were selected at random in each school for analysis. In addition, questionnaire surveys on salt consumption were carried out in 5-10 households in each area. Finally, 10-20 samples of the most common types of salt consumed in the area were collected from shops and markets.

Sample analysis

All urine and salt samples collected during the multicentre study were analysed by one external reference laboratory (Laboratory of Endocrinology, St Pierre Hospital, Brussels, Belgium). This approach aimed to ensure reliability in comparing the results from the seven countries under study. In addition, three of the countries studied (Cameroon, Tanzania, Zimbabwe) carried out parallel measurements of the iodine content of salt and urine samples in their own laboratories. Comparison of their results with those of the external reference laboratory allowed for intercalibration and subsequently validated the quality of the measurements made in the laboratories of those countries.

Visits to salt factories

Salt factories operating in the surveyed areas, or other salt factories producing salt consumed in the surveyed areas, were visited. The objective was to examine iodization and quality control procedures and to check current records of the amount of iodate obtained, utilized and in store. In addition, 10 samples of salt were collected for independent assessment of iodine content.

Visits to health facilities

Health facilities – primary and tertiary – covering the areas surveyed were visited to examine recent changes in the prevalence of hyperthyroidism and to observe the procedures for referring and treating hyperthyroidism. A visit was paid to the main referral hospital in the country to discuss preliminary findings with thyroidologists, endocrinologists and biochemists in charge of hormone laboratories. Meetings were held with public health officials, IDD committee members and WHO and UNICEF representatives.

Analysis of the results and conclusions

Once the survey in the seven countries was complete, data were analysed: the iodine content of urine and salt samples was measured in the external reference laboratory and statistical analysis of the results was performed. Results were compared with those obtained on the same samples by national laboratories. The results of the clinical and epidemiological surveys on hyperthyroidism were analysed. A national report was prepared for each country in collaboration with the national team.

When all country reports were available, an overall report was prepared with the agreement of all participating groups. As a follow-up to the multicentre study, WHO, UNICEF and ICCIDD had committed themselves:

- to hold an expert consultation in order to critically review the results of the multicentre study and make recommendations on the levels of salt iodization (16);
- to decide whether follow-up visits are required for blood-testing in the framework of a case-finding study in individuals at high risk of IIH (The results of the present survey will indicate the level of risk of IIH depending on the past severity of iodine deficiency and the rapidity of the overcorrection of the deficiency. It will not provide an adequate estimate of the prevalence and still less of the incidence of IIH because the condition is often pauci-symptomatic or even asymptomatic. The symptoms, including asthenia, weight loss and tachycardia are nonspecific and are also found in a number of infectious disorders that may be endemic in the areas under investigation);
- to inform countries and revisit them if necessary;
- to report the results of the multicentre study at international fora such as the Conference on the Sustainable Elimination of IDD in Africa by the Year 2000 (Harare, 1996), the ICCIDD Board Meeting and the World Health Assembly.

Organizational arrangements

The global design of the study and the protocol were carefully reviewed by a high-level epidemiologist.

Teams of international experts were set up, each with three members – a qualified practising thyroidologist of international repute, a specialist in salt iodization procedures and a statistician-epidemiologist with experience of programmes for the control of IDD. In each country, the external team was joined by national experts designated by the Ministry of Health in collaboration with the national IDD committee. These included the national programme manager, an epidemiologist and the head of the national laboratory with several technicians to obtain the necessary samples (Annex 4).

Before the visits to countries, the detailed protocol of the study was circulated to all team members, both external and national. In addition, WHO held a meeting for all external experts before the survey took place to ensure the same approach in the different countries.

2.3 Results

Climatic conditions

The countries selected for the multicentre study all lie within the tropics. Most of Botswana is subtropical. Botswana and the northern parts of Cameroon and Nigeria have a hot and dry climate with a short rainy season (3 months) with rainfall of 20–40 cm. The remaining parts of Cameroon and Nigeria as well as the Democratic Republic of Congo have tropical, hot and humid weather, with rainfall of 100–400 cm. Humidity

reaches 80-90% in Cameroon and Nigeria, and 60% the Democratic Republic of Congo. Variation in altitude leads to variation in weather in Kenya, Tanzania, Zambia and Zimbabwe and parts of Cameroon, Democratic Republic of Congo and Nigeria. In these areas, weather is more temperate with a longer dry season, very often divided into two periods. In all the countries selected, temperatures remain between 15°C and 35°C, except in desert areas and very high locations where the temperature may occasionally drop to 0°C.

Table 1: Climate and temperature in the 8 African countries included in the multicentre study

Country	Climate	Temperature (average)	Rainfall cm/year	Humidity (%)
Botswana	Sub-desertic in west and centre, more humid in north	National range: 0.5-34°C - Gaborone: 13-26°C	National range: 23-46 cm - Gaborone: 54 cm	
Cameroon	Sub-equatorial in south, tropical in north and centre	National range: 10-47°C - Yaoundé: 24-25°C - Douala: 26-24°C	National range: 60-600 cm - Yaoundé: 156 cm - Douala: 403 cm	Up to 80-90%
Democratic Republic of Congo	Equatorial in centre, subtropical in north-west, tropical in north and south, tropical and temperate by altitude in east	National range: 16-38°C except in Kivu and Shaba mountains where temperature drops to 0°C - Kinshasa: 22-26°C	National range: 102-203 cm - Kinshasa: 113 cm	65% (25% in Kivu)
Kenya	Tropical in coastal area, cooler and temperate by altitude on western plateaux, sub-desertic in north-east	National range: 10-43°C - Nairobi: 17-21°C	National range: 18-278 cm - Nairobi: 96 cm	Coastal humidity up to 60%
Nigeria	Sub-equatorial in south, sahelian in north	National range: 21-32°C - Lagos: 26-29°C - Kano: 21-25°C	- Lagos: 183 cm - Kano: 87 cm	Up to 80-90%
Tanzania	Tropical and humid in east and north-east, temperate by altitude and less humid on plateaux	National range: 15-32°C, higher in islands and coast - Dar es Salaam: 23-27°C - Dodoma: 19-24°C	National range: 7-234 cm, highest in islands - Dar es Salaam: 106 cm - Dodoma: 57 cm	
Zambia	Tropical temperate by altitude	National range: 16-38°C - Lusaka: 16-21°C	National range: 125-63 cm with dry cold season half year - Lusaka: 84 cm	Decreasing humidity from north to south
Zimbabwe	Tropical with variations due to altitude and latitude, dry season during 6 months	National range: 6-33°C - Harare: 14-22°C	National range: 40-102 cm (5 cm in the dry region)	

Cameroon

Background

In 1991-1992, before USI was implemented, the mean total goitre rate (TGR) was 29.4% (range: 0.2-75.4%) with a mean urinary concentration of iodine at national level of 6.3 µg/dl and a median urinary concentration of iodine in sentinel sites of 3.2-10.2 µg/dl. The frequency of biochemical hypothyroidism based on measurements of serum concentration of thyro-stimulin hormone (TSH) and T4 was about 40%. Moreover, the level of serum thiocyanate was as high as 1.55-2.05 mg/dl.

Legislation was adopted in 1991 requiring 100 ppm iodine in salt. Potassium iodate was designated the sole source of iodine in 1995. Salt is mostly imported through Egypt, Namibia, Senegal and Tunisia (Table 2).

Table 2: Main brands of salt found in Cameroon

Brand	Origin of salt	Annual quantity(tons)	Iodization level (ppm)
Selcam Cameroon	Egypt, Namibia, Tunisia, etc.	45 000	100
SSS	Senegal	14 000	100
Pardis Commodities/SA	Switzerland	3500	100
La Baleine (IK)	France	30	10-15
Total		62 530	

A small amount of salt is imported from Gabon and Nigeria. In Selcam Cameroon, the major salt company in the country, salt is iodized by continuous spraying after drying/cooling and before packaging. Salt may be stored either in 18 kg polypropylene bags either with polyethylene lining (Pardis Commodities/SA) or without polyethylene lining (Selcam Cameroon). At retail level, salt is sold in 50, 200 and 250 g plastic bags. The Ministry of Health, the Ministry of Development and the salt companies such as Selcam Cameroon use test kits to control the iodine content of salt. Titration is carried out by the laboratory of the Faculty of Medicine and the Centre Pasteur. Per capita salt consumption, extrapolated from national salt consumption, is estimated at 8 g/day.

IDD situation after introduction of iodized salt

Two areas were selected for the study, one in the East Province at Betare-Oya 600 km north-east of Yaoundé and another in the North-Western Province at Oshie 600 km north-west of Yaoundé. Local referral hospitals of Garoua-Boulay and Acha-Tugi were visited. In addition, a salt factory, Selcam Cameroon, was visited to examine salt iodization and quality control procedures. The university hospital and public referral hospitals in Yaoundé were visited, as were the hormone laboratories.

The study showed that the introduction of iodized salt had a very positive impact on goitre prevalence which decreased in the areas surveyed from around 60% to around 20%. There was also a positive impact on urinary iodine excretion: the median urinary iodine ranges from 10.4 to 12.2 µg/dl with a mean at 14.3 ± 8.79 µg/dl. In the local hospitals visited, as well as in Yaoundé, no increase in hyperthyroidism was noted (Table 3).

Table 3: Current IDD situation in Cameroon

Area	Goitre		Urinary iodine	
	Prevalence (%)	Number of samples	Concentration (µg/dl)	Number of samples
Betare-Oya	22.7	353	12.2	98
Oshie	21.1	394	10.4	153

Iodine concentration in salt decreased as expected from production levels to household levels when tested with kits (Table 4). Titration, on the other hand, showed a decrease in iodine concentration from retail levels to household levels, while at production levels iodine concentration was paradoxically lower than at retail levels. This discrepancy may be linked to the small number of samples tested. During the survey, it was observed that plastic bags have entirely replaced banana leaves or open containers and that the turnover of salt in households was fast (1-2 weeks).

Table 4: Frequency distribution of salt iodization levels in Cameroon

Level of sampling	Frequency distribution of samples expressed as % according to salt iodization level (ppm)				Number of samples
	0 ppm	7-15 ppm	15-30 ppm	> 50 ppm	
Household	9.6%	18.7%	11.0%	60.8%	209
Retail	3.8%	7.7%	9.6%	76.8%	52
Production	0%	0%	0%	100.0%	47
Total	7.1%	14.0%	9.1%	69.8%	308

Democratic Republic of Congo

Background

In the 1960s and 1970s, a TGR above 50% with severe endemic cretinism described in northern and eastern parts of the Democratic Republic of Congo. From 1965 to 1995, iodized oil was administered in hyperendemic areas. The National Programme for IDD Control (Programme national pour le contrôle des troubles dus à la carence iodée) started in 1988 and more recent surveys carried out in 1994 by the IDD National Office (Bureau National des Troubles dus à la carence iodée) have shown a TGR varying between 9.6% and 66.4% with 0-3.2% prevalence of endemic cretinism. Surveys conducted between 1990 and 1993 found a mean excretion of urinary iodine of 13.2 µg/l.

Legislation on salt iodization was enacted in 1993. This required 100 ppm iodine at factory level and 30-50 ppm at retail and household levels. An overall amount of 145 000 tons of salt is imported, mainly from Botswana, Kenya, Namibia, South Africa and Tanzania. It follows three major routes: the western route from Namibia and South Africa, the eastern route from Kenya and Tanzania and, the south-eastern route from Botswana, Namibia and South Africa (Table 5).

Table 5: Main sources of salt in the Democratic Republic of Congo

Access routes	Amount of salt (tons)	Origin
1. West	75 000	South Africa and Namibia (Sokin, ICCI, Sopex, Eco, Kivu, Quo Vadis etc.)
2. East	35 000	Kenya (Hababi, Rafiki, Mzuri, Malindi etc...) and Tanzania (Coastal, Bagamoya etc.)
3. South-East	35 000	South Africa (Saltcor, Got); Namibia (Société Mukap) and Botswana (Botsart)
Total	145 000	

About 20 importers in the west import from South Africa white medium crystals of sea salt, mostly iodized at 60 ppm iodine. Imported Kenyan salt is iodized at 165 ppm potassium iodate. Salt from Botswana and Namibia are iodized. Small quantities of iodized or non-iodized salt come from the United Kingdom. Packaging is in 20 kg bags for salt coming by the western route, and in 50 kg bags for the salt coming by the eastern and southern routes. The bags are made of polypropylene without polyethylene lining. Quality control of iodized salt is ensured by a public institution, OZAC. Test kits are used to monitor the iodine content of salt. Titration can be performed by the OZAC laboratory in Kinshasa. Per capita salt intake, measured by dietary survey, is estimated at 5 g/day.

IDD situation after introduction of iodized salt

The study was conducted in four areas: the Rutshuru and Uvira zones in Kivu Region (2000 km east of Kinshasa) and the Kalemie and Likasi zones in Shaba Region (2000 km south-east of Kinshasa). Three primary schools were surveyed in each zone. The reference hospitals in health zones of Likasi, Kalemie, Uvira and Rutshuru and the regional hospital in Bukavu were visited. Salt samples were collected in households, and at retailers and markets, in Kivu Region (Goma, Rutshuru, Uvira), in east Kasai Region (Mbuji Mayi), in Shaba Region (Lubumbashi, Likasi, Sakania Kasumbalesa) and Matadi.

As a result of USI, the previous goitre prevalence of around 50% has decreased to a range of 16.2-35% in the areas of investigation. While normal in Shaba, concentrations of urinary iodine were equal or greater than 30 µg/dl in Kivu. This correlates with values of the iodine content of salt being higher in Kivu than in Shaba (Table 6). It is worth noting that in Kivu salt is mostly imported from Kenya and Tanzania, while in Shaba it comes from Botswana and Namibia. In Kasai, where the largest part of salt comes from South Africa, salt is uniodized.

Table 6: Current IDD situation in the Democratic Republic of Congo

Areas	Goitre		Urinary iodine	
	Prevalence (%)	Number of samples	Concentration (µg/dl)	Number of samples
Rutshuru	32	83	36.8	80
Uvira	16.2	80	30.3	75
Kalemie	34.7	75	16.0 ³	150
Likasi	31.3	75		

In the areas surveyed, salt comes mainly from Tanzania, but also from Kenya or even South Africa. The level of iodine in salt was measured by test kits. Iodized salt was found in 80-100% of households and markets in Kivu and Shaba, except in Likasi where only 10% of household samples and 15% of samples collected in the markets contained iodine (Table 7).

Table 7: Frequency distribution according to the level of salt iodization levels in the Democratic Republic of Congo

Level of sampling	Frequency distribution of samples expressed as % according to salt iodization level				Number of samples
	0 ppm	25-50 ppm	50-75 ppm	>75 (ppm)	
Household level					
- Kivu	24%	4.8%	69.0%	23.8%	84
- Kasai	90.0%	10.0%	0%	0%	31
- Shaba	48.9%	4.4%	44.4%	2.2%	45
Retail level	4.3%	95.7%	0%	0%	47
Import level	7.4%	18.9%	67.5%	6.1%	148
Total	17.7%	11.0%	62.8%	8.5%	355

Titration shows that samples collected in most areas have an acceptable level of iodine except in Mbuji Mayi, Kasai Region (Table 8).

³ These figures include all the samples collected in both zones investigated in Shaba Region: Kalemie and Likasi.

Table 8: Iodine content of salt samples measured by titration in the Democratic Republic of Congo

Areas	Regions	Salt iodine content (ppm \pm sd)	Number of samples	Range
Rutshuru	North Kivu	60.4 \pm 38.4	20	1-115
Goma	North Kivu	50.2 \pm 37.3	22	1-116
Mbuji Mayi	East Kasai	1.8 \pm 1.9	12	1-5.8
Likasi	Shaba	52.2 \pm 47.8	12	1-139.2
Lumumbashi	Shaba (warehouse)	48.3 \pm 29.5	6	14-82
Kasumbalesa	Shaba (import)	47.8 \pm 19.2	10	1-60
Matadi	Bas Zaire (import)	42.0 \pm 52.6	12	1-138

In Kivu, there has been a previous report indicating IIH but no further evidence was reported during this survey.

Kenya

Background

In surveys conducted between 1962 and 1964, TGR ranged from 15% to 74% with the highest prevalence in the west of the Rift Valley, in central Nyanza and in Western Province. In spite of the voluntary introduction of iodized salt in the 1970s, limited surveys still showed a goitre prevalence of about 20% (1994). In 1994 the national survey found a TGR of 16.3% and a level of urinary iodine excretion of 26-95 μ g/g creatinine in children aged between 8 and 10 years.

The legislation on salt iodization was enacted in 1970 and modified in 1973, 1978 and 1990. The required level of 20 ppm of iodine was raised to 30 ppm and finally to 100 ppm. Salt comes mainly from the sea (25 000 tons) and the lakes (30 000 tons). Most of it is processed in Malindi and Mombasa by four major salt companies (Table 9), one of which is a refiner. One company provides 70% of the salt consumed in the country. Packaging is done by 20 small companies that operate independently. Salt iodization is carried out by spraying manually or is continuous. Mixing after iodization is not done by the small packaging companies.

Per capita salt intake is estimated at 8 g/day by extrapolation from the national salt consumption figures.

Table 9: Amount of salt produced by salt manufacturers in Kenya

Factory name	Amount of salt produced per year (tons)	Amount of salt exported per year (tons)	Trade name of salt companies
Salt Manufacturers Kenya Ltd	50 000	Uncertain	Kensalt
Krystalline Salt Ltd	40 000	20 000	Kensalt
Victoria Salt Works Ltd	9 000	None	Chumvi table salt Kado table salt
Kurawa Industries Ltd	25 000	15 000	Kurawa Ltd Industries Malindi
Magadi S.P. Industries	12 000	1 000	Magadi Salt Works
Mombasa Salt Works Ltd	60 000	30 000	Habari Mzuri Silver

IDD situation after introduction of iodized salt

The study was conducted in Kericho district 200 km northwest of Nairobi, in Kiambu district 50 km north of Nairobi, and in the Nairobi area. District hospitals were visited, as was the Kenyatta National Hospital which is the national referral hospital and the National Public Health Laboratory. All major salt manufacturing companies in Kenya, mainly located in Mombasa and the Rift Valley, were visited along with three salt packaging companies. Information on quality assurance and monitoring was obtained from the Kenya Bureau of Standards in Nairobi and its Mombasa branch.

The results of the study show that the introduction of iodized salt resulted in a fall in goitre prevalence from 20% in 1984 to 10% in 1995. However, the median concentration of urinary iodine ranges from 12.5 to 58.0 µg/dl, thus shifting to higher values. This was mostly linked to similarly scattered values of concentrations of salt iodine in salt. In the hospitals visited in the districts surveyed and in Nairobi, no increase in hyperthyroidism was reported by the medical personnel.

Table 10: Current IDD situation in Kenya

Areas	Goitre		Urinary iodine	
	Prevalence (%)	Number of samples	Concentration (µg/dl)	Number of samples
Kericho District	14	283	12.5	109
Kiambu District	11	233	37.8	110
Nairobi Area	9.5	350	58.0	108

Salt samples for measurement of iodine content were collected at household and retail levels, and also at the sites of production and packaging. At household level, concentrations of iodine in salt were higher than at retail level. It is probable that these inconsistencies are due to excessive iodization by small packaging companies which do not monitor the iodine level. Rapid tests were carried out during the study but were ineffective: no iodine was found in about one-third of the salt samples analysed by test kits. At the sites of production and packaging, it was impossible to make a reliable estimate of the iodine content of salt using a test kit due to very poor mixing: iodine was found in about 70% of the samples with a concentration below 15 ppm (?), and 30% did not contain iodine at all.

Measurement by titration found a concentration of iodine in analysed salt samples of about 60 ppm at household level, 39 ppm at retail level and 51 ppm at production level. Correlation between salt and urine was nonsignificant (Table 10).

Table 11: Iodine content of salt samples measured by titration in Kenya

Areas	Iodine content of salt at various levels (ppm)		
	Household	Retail	Production
Kericho District	63 ± 35 (n= 40)	39 ± 32 (n=10)	51 ± 34 (n=39)
Kiambu District	47 ± 33 (n= 40)		
Nairobi	68 ± 31 (n= 10)		

Nigeria

Background

Small-scale surveys conducted between 1960 and 1987 in various parts of Nigeria showed a TGR between 7.7% and 24.2% in 10 states and a visible goitre rate (VGR) between 26 and 36% in three states. In 1993, a national survey among schoolchildren showed an average TGR of 20% (12-37%). In 1988, urinary iodine

excretion was reported in Plateau State to be 3.5-15.3 µg/24h. It is worth noting that cassava is a staple food in many states. In order to combat IDD, the government adopted a national plan of action for the elimination of IDD in 1992, covering the period 1993-1995, and established a National IDD Committee in 1994.

In October 1993, legislation on salt iodization was enacted requiring a concentration of 50 ppm of iodine in salt at the point of entry or at the packaging site, and 30 ppm at retail level. Salt iodized at 20 ppm has been distributed in the country since 1984. Salt is mostly imported through Lagos and Port Harcourt. There is, however, some limited local salt production by evaporating or boiling in the Eastern and Central Regions. In addition, some table salt is imported in limited amounts and sold in supermarkets. It comes from Germany and the United Kingdom and may or may not be iodized. When it is so, the level of iodization ranges between 15 and 30 ppm.

One of the major salt companies, Union Dicon Salt PLC, imports salt already iodized from Australia. Other salt companies such as the New Nigeria Salt Company and the National Salt Company of Nigeria Ltd refine and iodize the salt they import, the latter by continuous spraying (Table 12). They all package salt in 25 kg polypropylene bags without polyethylene lining or in 1 kg polypropylene bags with polyethylene lining, according to demand. At retail level, smaller bags of 100 and 250 g are used. Quality control is performed by titration by the three major companies Dicon, Nascon and Ethiope Salt. The Standards Organization of Nigeria uses both the titration method and the rapid test kits. Titration is also available at the Federal Ministry of Health and Ibadan University Teaching Hospital. In addition, since December 1994 salt iodization has been monitored by UNICEF through its zonal representation.

Table 12: Major salt companies and sources of salt in Nigeria

Brand	Source of salt	Amount of salt produced per year (tons)	Iodine content of salt (ppm)
Union Dicon Salt PLC	Australia	350,000	30-50
New Nigeria Salt Co, Ltd	Namibia	120,000	Not with KIO ₃ (probably with KI) "Ethiope Salt"
National Salt Company of Nigeria Ltd "Nascon"	Brazil	50,000	30-50
Total		520,000	

IDD situation after introduction of iodized salt

The study was conducted in areas located in two areas north-east of Lagos – Igarra, Edo State, and Uzo-Uwani in Enugu State at 600 km and 900 km respectively from Lagos. The three major reference hospitals were visited: Eguru Teaching Hospital, Benin Teaching Hospital and Ibadan University Teaching Hospital. Measurement of thyroid hormones could be carried out only in the chemical pathology laboratory of Ibadan University Teaching Hospital. This laboratory could not measure urinary iodine. A salt company, Union Dicon Salt PLC, was visited to examine salt iodization and quality control procedures. Salt samples were collected in the markets of Igarra and Uzo-Uwani-Omolokpa.

The results of the study show that the impact of USI on goitre prevalence is not apparent. In the absence of previous accurate data on goitre prevalence in the two surveyed areas, comparisons are difficult. However, goitre prevalence varies between 26% and 39% and the median concentration of iodine in urine is around 30 µg/dl (Table 13).

Table 13: Current IDD situation in Nigeria

Area	Goitre		Urinary iodine	
	Prevalence (%)	Number of samples	Concentration ($\mu\text{g/dl}$)	Number of samples
Edo State	25.7	443	26.0	159
Enugu State	39.511	147	36.9	134

The rapid test kit shows a shift to higher values at household level compared to production level (Table 14).

Table 14 Frequency distribution of salt iodization levels in Nigeria

Level of sampling	Frequency distribution of samples expressed as % according to salt iodization level (ppm)				Number of samples
	0 ppm	7-15 ppm	15-30 ppm	> 50 ppm	
	Household	7.4%	3.7%	14.8%	
Retail	11.2 %	5.0 %	15.0%	68.8%	80
Production	1.9%	9.4%	41.5%	47.2%	53
Total	7.4%	5.9%	22.5%	64.2 %	187

Titration carried out on a smaller number of samples gives values of around 20 ppm at all levels (Table 15).

Table 15: Iodine content of salt samples measured by titration in Kenya

Areas	Iodine content of salt at various levels (ppm)		
	Household	Retail	Production
Igara	25.2 (n= 3)	6.5 (n=10)	
Uzo	21.6 (n= 7)	22.5 (n=7)	20.7(n=6)
Berini		20.7 (n=4)	
Lagos	14.3 (n= 3)	27.6 (n=4)	

A questionable increase in incidence of hyperthyroidism was reported among patients attending the Department of Surgery at the hospital in Enugu City.

Tanzania

Background

Nationwide surveys conducted between 1980 and 1990 demonstrated that 41 % of the population (10 million) were at risk of IDD. Mean TGR was 37% with rates less than 60% in many areas. The number of cretins was estimated at 160 000, and cretinoids at 450 000. It was also estimated that 30 per 1000 perinatal deaths and 10 000 late reproductive losses were due to IDD. Under an extensive programme of supplementation with iodized oil capsules, TGR decreased by half in some districts. An iodized salt programme has been progressively introduced so far.

Legislation on salt iodization was enacted in January 1995. It requires a concentration of 75-100 ppm of iodine in salt at production level, 37.5 ppm at retail level and a minimum concentration of 18.7 $\mu\text{g/kg}$ at household level. Apart from occasional imports from India, Kenya and Yemen, all edible salt (106 000 tons) is locally produced: 25% is produced by about 150 small-scale producers who iodize a very small part of their production. The rest comes from about 40 medium and large-scale producers. Between 1992 and 1995, 41 iodization plants of varying capacity were established with the support of various donors, including UNICEF (Table 16).

Table 16: Location and type of iodization plants in Tanzania by December 1995

Regions	Type of iodization plant		Area for big plants
	Small	Large	
Kigoma, Uvinza	-	2	Nyanza Salt Works
Tanga	5	1	Kibo Match Corporation
Coast	6	4	2 coastal Salt Works Stanley (Bagamoyo)
Dar Es Salaam	-	1	Mbagala (Abbas Manji)
Mtwara	8	1	Sinani Salt Producer - Mtwara
Lindi	6	1	Lirema - Lindi
Kilwa	-	1	Kilwa Town
Dodoma	5	1	Women's economic groups in Dodoma Foothills salt sources
Total	30	11	

Iodization is done by continuous spraying, batch mixing or hand-operated mixers for salt coming from the sea (45%), underground brine (15%) and the foothills (40%). It is sold in 50 kg and 500 g bags. With regard to quality control, monitoring is carried out by iodine titration in the 11 satellite laboratories and by rapid test kits by the ward health officers. Per capita salt intake measured by dietary survey is estimated at 8 g/day (range: 6.6-9.4 g/day).

IDD situation after introduction of iodized salt

The study was conducted in two districts: Iringa Rural in Iringa Region 800 km south-west of Dar es Salaam and Mbeya Rural in Mbeya Region 1200 km south-west of Dar es Salaam. Regional and referral hospitals were visited: in Iringa Region, the regional hospital in Iringa and Tosamaganga Hospital in Tosamaganga; in Mbeya Region, the referral hospital in Mbeya and the mission hospital in Chimala. The regional/satellite iodine monitoring laboratory in Iringa Region was also visited. This is one of the 11 satellite laboratories which have been established for estimating iodine content by titration of salt samples from wholesale and retail traders. Moreover, four salt works were visited (two parastatal and two private at Sadani, Bagamoyo, Manji and Mbagala). Salt samples were collected from households, wholesalers and retailers in Iringa Municipality, Iringa Rural, in Mbeya Municipality and Mbeya Rural.

In spite of universal salt iodization, goitre prevalence remains high between 31.3 in Iringa Region and 60% in Mbeya Region but is much lower than in 1980. The median concentration of urinary iodine of 16 µg/dl is within a physiological range (Table 17).

Table 17: Current IDD situation in Tanzania

Districts	Goitre		Urinary iodine	
	Prevalence (%)	Number of samples	Concentration (µg/dl)	Number of samples
Iringa	60.9	305	16.1	304
Mbeya	31.31	408	16.0	404

The levels of iodine in salt are in keeping with the required values by test kits (Table 18).

Table 18: Frequency distribution of salt iodization levels in Tanzania

Districts	Frequency distribution of samples expressed as % according to salt iodization level			Number of samples
	0 ppm	25 ppm	50-75 ppm	
Iringa	23%	28%	48%	196
Mbeya	4%	9%	87%	261

Titration showed that an important number of salt samples collected at household level were below the lower limit of 18 ppm (Table 19). The results provided by the external reference laboratory⁴ were similar to those obtained from the micronutrient laboratory of the Tanzanian Food and Nutrition Centre.

Table 19: Frequency distribution according to the level of titration in Tanzania

Level of sampling	Frequency distribution of samples expressed as % according to iodization level (n = 75)			
	<18 ppm	18-36 ppm	37-74 ppm	>75
Wholesale	25	55	20	0
Retail	13	63	6	19
Household	49	36	19	0

In both Iringa and Mbeya Regions, no cases of IHH were reported. However, in hospitals in Dar es Salaam, a rate of hyperthyroidism of 13-30% is indicated on the basis of biological measurements. This rate of frequency was unchanged after universal salt iodization.

Zambia

Background

In 1971, a national survey was carried out in the general population with an unclear sampling method. It found a mean TGR of 50.5%, ranging from 44% to 76%, and a VGR of 13%. In 1993, another survey was carried out in primary schools: the mean TGR measured by palpation gave a figure of 31.6%, ranging from 9% to 59%, while the figure obtained by ultrasound was higher. The mean excretion of urinary iodine was 60 µg/l, with a median ranging from 9 to 200 µg/l. The National IDD Task Force was established in 1990 and an iodized oil programme was carried out in 1995.

Legislation on salt iodization was enacted in 1978 and revised in July 1994. It has not been fully enforced. The iodine level required is 80-100 ppm at factory level, 50-80 ppm at point of entry into the country and 30-50 ppm at retail level. Most of the salt is imported from either Botswana or Namibia, smaller quantities arrive from South Africa and a little comes from Zimbabwe. The salt arrives primarily in 90 kg or 50 kg woven polypropylene bags. The 90 kg bags are repacked into 1, 2.5, 5 or 10 kg bags, while the 50 kg bags are sold to wholesalers and retailers who repack it themselves. Two types of salt arrive from Botswana - fine and coarse. Namibia seems to supply only coarse salt. There are four main importers. The National Milling Company is the largest, importing 10 000 to 15 000 metric tonnes out of the total annual requirement of 30 000 metric tonnes for human consumption. Salt imported by the National Milling Company was previously iodized at 40 ppm and is now iodized at 80 ppm. Since 1980, there has been an attempt by this company to iodize salt. Local production of salt takes place in parts of the Northern and North-Western Provinces. It is believed to provide less than 10% of the total requirement. Salt is produced from a special grass that grows in the salt pans and from soil scraped from the pans. Per capita salt intake averages 10 g/day (range: 9-13 g/day).

⁴ Laboratory of endocrinology, Saint Pierre Hospital, Brussels, Belgium.

Quality control of the iodine level in salt is carried out by test kits at all levels. All districts were provided with rapid test kits in 1995. A monitoring system was established using test kits at retail and household levels. In the areas surveyed, it appears that the monitoring of iodine content by test kits is working but that reporting is rather weak. The Food and Drug Control Laboratory in Lusaka functions as a reference laboratory. It can measure iodine content by titration.

IDD situation after introduction of iodized salt

The study was conducted in Choma and Livingstone Districts in Southern Province, 400 km south-west of Lusaka, and in Katete District in Eastern Province, 600 km north-east of Lusaka. The University Teaching Hospital and the Maina Soko Military Hospital in Lusaka were visited. The largest importer of salt, the National Milling Company, is parastatal. Salt samples were collected at household level and in marketplaces.

With USI, the previous goitre prevalence of around 50% has decreased to 3.6-16%. Median concentrations of urinary iodine vary between 18 and 26 µg/dl (Table 20).

Table 20: Current IDD situation in Zambia

Provinces	Goitre		Urinary iodine	
	Prevalence (%)	Number of samples	Concentration (µg/dl)	Number of samples
Southern	4.3-16	634	18.4-26.4	202
Eastern	3.62	231	17.5	110

The use of test kits showed that 94% of the salt samples collected at household level contained more than 25 ppm iodine, while 100% of samples collected at retail level or in marketplaces were iodized.

In provincial hospitals, no cases of IH were reported. At the University Hospital in Lusaka, 8-12% of the tests indicated (possible) hyperthyroidism. The number of cases of hyperthyroidism seen between 1985 and 1995 remained stable (\pm 50-60 cases per year), which means that the implementation of USI was not associated with an increase in hyperthyroidism.

Zimbabwe

Background

Goitre surveys conducted in Zimbabwe between 1966 and 1988 showed that IDD was a public health problem. The goitre prevalence range was 25-75%. In 1988, a national survey was carried out among schoolchildren. It found a TGR varying from 17% in Mash South Province to 52% in Mash Central Province. The VGR was 0.7% in Mash South Province and 7% in Mash East Province. The overall national rate was 44% for TGR and 4% for VGR, the highest prevalence being in Murewa with a TGR of 78% and VGR of 24%. A more careful study in 1990 found in the latter region lower rates: TGR was 65% and VGR was 5.6%.

Biochemical studies in 1991 showed a good correlation between high goitre rates and low median urinary iodine levels (1.0-1.65 µg/dl) in selected areas. Likewise TSH levels were elevated in as much as 30% of children in areas with high TGR and VGR rates, indicating biochemical hypothyroidism. Despite these findings, myxoedematous cretinism has been rarely documented (at an incidence less than 1%) and neurological cretinism has never been reported.

A national programme steered by an intersectoral committee was launched in 1989 and iodized oil capsules were provided to target populations in severely deficient districts in 1992. This short-term measure was to be replaced by an iodized salt programme. Between 1991 and 1995, the median urinary iodine concentration increased more than 10-fold (Table 21).

Table 21: Changes in median urinary iodine concentration as iodine salt was introduced

Year	Median urinary iodine concentration (µg/dl)
1991-92	2-8 µg/dl
1993-94	20-50 µg/dl.
1995	29-56 µg/dl

The 1973 Food and Food Standard Act was amended in 1994 to include USI. The regulation enacted in 1995 raised the required level of iodine in salt from 10-30 ppm to 30-90 ppm. With the exception of a small local production of salt at Chipinge Mines, practically all edible salt is imported. The bulk of it comes from Botswana, while some also comes from South Africa. A salt refinery was established in 1989. However, it was not able to compete with iodized salt imported from Botswana.

IDD situation after introduction of iodized salt

Since 1992, salt has been increasingly imported from Botswana. This salt is iodized locally before packaging. In early 1993, 47% of salt samples had at least 30 ppm but some had well in excess of 100 ppm. In late 1994, 58% had less than 30 ppm and 89% had less than 10 ppm.

After USI, goitre prevalence fell from 38% to 9%. The median urinary iodine values increased to 45.0 µg/dl.

As measured by titration in the external reference laboratory and in Harare, salt iodine concentration averaged 50 ppm.

Cases of IIH have been reported between 1993 and 1995 (Table 22). Out of the 15 deaths that occurred among the thyrotoxic patients reported in Parienyatwa Central Hospital, thyrotoxicosis was found to be the sole factor of death identified in 12 cases (Todd et al., 1995).

Table 22: New cases of iodine-induced hyperthyroidism reported at Parienyatwa Central Hospital, Harare, Zimbabwe, between 1991 and mid-1995

Year	Number of cases of IIH reported
1991	89
1992	95
1993	139
1994	189
1995 (until June)	92

Source: Todd et al., *Lancet*, 1995, 346:1563.

Botswana

In Botswana, the study was limited to an evaluation of salt iodization procedures in the Botswana Soda Ash Plant, the main salt producer in Botswana, which is located in Sua, 650 km north-west of Gaborone. Its annual production capacity may reach 600 000 tons. However, in 1995, 200 000 tons of salt were produced. The company produces refined salt and two grades of coarse salt for distribution in Botswana, the Democratic Republic of Congo, Malawi, South Africa and Zambia. Its primary activity is the production of soda ash. Potassium iodate is added continuously by dry-mixing before bagging in 50 kg woven polypropylene bags with inner lining. The blending of iodine in salt is not adequate.

With regard to quality control, a handful of salt is randomly taken after every 20 bags. A sample from the mixing of 40 handfuls is analysed in the laboratory, where iodine titration is carried out. The level varies from 30 to 120 ppm and the company identifies the destination of the batch according to the requirements of the client. There is a log recording all information on each sample analysis that is used by the quality control manager when dispatching the salt. Kit testing requires a re-check solution to acidify the soda salt because of its alkalinity. However, the sampling plan is not always respected, packages have no date or batch marking and quality control monitoring is limited to the main Soda Ash Plant: there is no quality control at other levels.

Titration was tested on 22 samples at the production site. It gave values of 0-200 ppm with a mean of 90 ppm. Test kit sampling on 22 other samples gave values between 25 and 75 ppm, and two samples were uniodized. In addition, several samples collected from imported salt were uniodized.

2.4 Overall summary of the study

An overall review of the results of the multicentre study is given in Table 23.

Table 23: Summary of results of the multicentre study

Countries	Duration of USI (years)	Number of years for introduction of iodized salt	Concentration of iodine in salt (ppm)			Goitre rate (%)	Urinary iodine ($\mu\text{g}/\text{dl}$)	Comments
			Theoretical	Actual				
				Production	Household			
Botswana				90				
Cameroon	5	4	100	20	20	20	12	OK
Democratic Republic of Congo	3		100				16 (Shaba) 30 (Kivu)	- Iodine level in salt need to be decreased ++
Kenya	5	25	100	50	50	9-14	12-58	- OK? (25 years) - Iodine level in salt need to be decreased?
Nigeria	2	12	50	20	20	26-39	26-37	- Salt intake ++ - OK? (12 years) - Iodine level in salt need to be decreased?
Tanzania	1	6	75-100		20	30-60	16	- OK
Zambia	2	18	80-100		47	3-16	17	- OK
Zimbabwe	1	4	30-90		50	9	45	- Iodine level in salt need to be decreased ++

2.5 Conclusion

The surveys conducted in Cameroon, Democratic Republic of Congo, Kenya, Nigeria, Tanzania, Zambia and Zimbabwe included the evaluation of the past history of IDD, the iodized salt network, the possible occurrence of IIH, the prevalence of goitre in subsamples of schoolchildren, and the iodine content of urine and salt samples. The survey in Botswana focused only on the production of iodized salt.

During these surveys, 4110 school children were examined clinically for the presence of goitre, 2261 urine samples and 2397 salt samples (1618 for test kits and 779 for titration) were collected for the determination of their iodine content. Test kits were used in the field and titration in the external reference laboratory in

Brussels and the national laboratories in Dar es Salaam, Harare and Yaoundé. The same laboratories carried out urinary iodine measurements.

All areas investigated used to be moderately to severely iodine deficient and all have USI programmes implemented for periods varying from 1 to 5 years, but iodized salt was introduced 25 years ago in Kenya and 15 years ago in Zambia.

In all areas investigated, the prevalence of goitre has drastically decreased since the implementation of USI. In some areas, the prevalence is currently almost normal.

These results document a spectacular success in the elimination of IDD by USI in Africa. This constitutes a major public health achievement which should be emphasized.

The median urinary iodine levels were equal to or above the cut-off point of 10 µg/dl in all sites investigated, indicating the disappearance of iodine deficiency. This is one of the indications of success.

However, in some areas in five out of the seven countries, the median urinary iodine was quite elevated, varying from 30 to 58 µg/dl. These values are unquestionably too elevated and are accompanied by a potential risk of IIH, especially in that they were reached rapidly in areas previously severely iodine deficient, as in Zambia and Zimbabwe.

In spite of this risk, the situation of high and rapidly increasing incidence of clinically detectable IIH as reported in Zimbabwe has not been observed in other regions. This difference can be explained partly by the fact that in some countries, such as Kenya, iodized salt at the household level had been used for more than 20 years. However, in the absence of biochemical screening for IIH in the multicentre study, the possibility of biochemical IIH without clinical manifestations, as reported in the Democratic Republic of Congo, cannot be excluded.

The cause of iodine overload in the population is clearly excessively iodized salt. It is most likely that this situation is due to a combination of several factors: a major iodine excess in the salt at the level of production, a lower loss of iodine from the salt between the producer and the consumer, and a higher salt intake than expected.

2.6 Discussion

A longitudinal study such as has been carried out in Zimbabwe for several years could obtain information and make comparison easier between the different countries.

A clear distinction should be made between USI implementation, date of enactment of legislation and the introduction of iodized salt. In the Democratic Republic of Congo, Nigeria and Zimbabwe, introduction of iodized salt preceded legislation. Full USI was implemented in Kenya and Zambia only recently while legislation on salt iodization preceded this by several years.

The role of goitrogens in IDD is negligible when there is a physiological intake of iodine. This was illustrated in Cameroon where significant decrease in the prevalence of goitre was observed while thiocyanate levels remained elevated.

The case of USI in Switzerland could be used as a model of a careful step-by-step increase in iodine fortification over several decades. It went up from 3.5 ppm to 30 ppm recently with the objective of reaching and maintaining mean urinary iodine of about 150 µg/day. During this period there was no striking increase in IIH. However, under careful monitoring a transient 25% increase was observed when the iodine level went up from 7.5 to 15 ppm. Thereafter, the incidence of thyrotoxicosis, mostly due to toxic nodular goitre, decreased.

It is debatable whether urinary iodine concentration equates to the iodine intake through salt. In Switzerland and Tuscany, Italy 30 ppm of iodine in salt are accompanied by median urinary iodine of 150 µg/day. In Zimbabwe 40–50 ppm iodine fortification of salt resulted in urinary iodine concentrations above 40 µg/dl. The same amount used homogeneously in all the salt of Ecuador was accompanied by urinary iodine concentration between 10–20 µg/dl with jumps as high as 48–70 µg/dl in some areas. In contrast with Zimbabwe, no IIH was noted. Therefore, cultural habits may affect salt intake and thus iodine urinary excretion.

A rapid increase in iodine intake may have been an important factor in both the Democratic Republic of Congo and Zimbabwe where the change was dramatic over a period of 2–3 years (1991–1993).

Since there is a higher incidence of IIH in the older age groups, about 30% of the population in Africa would be at risk.

3 Stability of Iodine in Iodized Salt

3.1 Objectives and background

The study assessed the effects of humidity and packaging on iodine stability in salt samples from eight countries with tropical and subtropical climates under controlled climatic conditions and with typical packaging. The aim was to determine the range and timing of iodine losses and define effective means of control and compensation that would ensure appropriate iodine supplementation to the target population. These matters are of crucial importance to national planners and salt producers involved in IDD control.

Consumer intake of iodine from iodized salt can vary widely because of:

- variability in the amount of iodine added during the mixing process, which results in an uneven distribution of iodine within salt batches and individual bags;
- losses of iodine during storage and distribution, resulting from reactions with impurities, packaging and environmental conditions;
- losses due to food processing, washing and cooking practices in the household (potassium iodate can be reduced and volatile elemental iodine rapidly lost in the atmosphere).

3.2 Methodology

Samples of uniodized salt were obtained from production runs of local producers in eight countries and air-shipped to Canada, in airtight containers. Two kg of each sample were fortified to contain 50 ppm of iodine with potassium iodate (30 g/l solution). Next, 500 g samples were packaged in three different ways:

- low-density polyethylene (LDP);
- open plastic container;
- woven high-density polypropylene (HDP) bags.

The samples were stored for six months at 40°C, at high humidity (100%) and at medium humidity (60%), in an oven at controlled temperature with air saturated with vapour by exposure to a water tray. Iodine content was measured by neutron activation analysis at 0, 3 and 6 months of storage.

3.3 Results

Samples included sea salt from Ghana, Indonesia, Philippines, Senegal and Tanzania, lake salt from Bolivia, and rock salt from country A.

There was great variability in size (15–100 mm) and homogeneity of salt particles, as well as in colour (bright white, dark grey, rusty brown). Over the six-month period all salt samples lost iodine (0–100% of the original content).

With regard to relative humidity, at six months relative humidity losses were 0–20% at 60% humidity and 98.5% at 100% humidity.

With regard to packaging material, the best results were obtained with low-density polyethylene bags. Open containers allowed free contact between air and salt; absorbed or condensed moisture would remain in the sample and contribute to the instability of the iodine. Woven high-density polypropylene bags behaved similarly to open containers but retained significantly less iodine than the containers in all but two cases because the bags allowed iodine to drip out in the form of saturated salt solution.

With regard to the origin of the salt solution, impurities and levels of processing had a dramatic effect on stability. Country A samples were well controlled in terms of colour and size yet showed a very rapid loss of iodine (95% after one month). At medium humidity, salt from Ghana lost very little iodine; at high humidity its iodine content remained high for three months and dropped sharply thereafter. Samples from Canada, India, Philippines and Senegal lost less than 15% added iodine even at 100% relative humidity when kept in low-density polyethylene bags. Canadian salt, which was of high purity and contained very little moisture or hygroscopic impurities, was relatively stable.

3.4 Conclusion

The moisture level plays a critical role in the stability of iodine, particularly at high temperatures.

Increased refinement of salt would improve the stability of the iodine in it. However, this may not be feasible in many developing countries.

Properly sealed packaging and intact low-density polyethylene bags keep losses below 10% for at least six months. Woven high-density polypropylene (for bulk packaging) should be fitted with a liner (low-density polyethylene) or laminated.

For programme effectiveness and safety, countries with salt iodization programmes should determine iodine losses from local iodized salt under local climatic conditions and with local packaging (using the titrimetric method).

3.5 Discussion

With regard to the salt stability study, it was felt that the same experiment should be carried out in the field since the level of humidity (100%) used experimentally is never experienced in Africa or elsewhere.

The striking conclusion is that packaging is a more important factor in the stability of iodized salt than either salt quality or environmental conditions.

The 10–20% losses found were smaller than the expected 50%. This was similar to some field data reported from Ecuador and Guatemala.

Although less crucial, salt quality should be improved since artisanal salt could be of much poorer quality than the samples tested in Canada. Salt should be properly washed and dried.

Large open containers should be avoided because iodine may be drawn to the bottom by gravity.

4 Iodine-induced Hyperthyroidism in Zimbabwe

This section of the document consists of a report commissioned as part of the WHO/UNICEF/ICCIDD multicentre study to assess the impact of USI on iodine status of the population in different countries in Africa. The main purpose of this report is to review available data on past and present iodine status in Zimbabwe and any changes that have occurred in the incidence of thyrotoxicosis since USI was implemented.

4.1 Background

The extent and severity of endemic goitre in Zimbabwe was well documented in the 1980s and earlier, culminating in the 1988 national goitre survey. The whole country was affected by varying degrees of endemic goitre: the most severely affected areas were in the north and east. In such areas, median urine iodine was in the range 10–25 µg/l which is consistent with moderate to severe iodine deficiency. Cretinism has been documented in the severely endemic areas but at an incidence below 1%. However, biochemical hypothyroidism was a common finding. Cognitive function and work performance would have suffered as a result.

A National IDD Control Committee was established in 1989 and a national intersectoral committee established. One of the major objectives was to achieve USI by 1995. Zimbabwe was well suited to USI. All salt is imported and virtually all households have salt. A formal survey has never been performed but salt consumption is probably around 10 g per person per day. Following sensitization of local suppliers and manufacturers in neighbouring countries, increasing amounts of iodized salt were probably imported from 1992 onwards, although precise data are lacking.

Zimbabwean food regulations were amended in late 1995 to require all salt for human consumption to be iodized to a level of between 30 and 90 ppm iodine as iodate. In early 1993, 47% of samples had at least 30 ppm iodine (n = 36) but some samples had well in excess of 100 ppm. In late 1994, mean salt iodine was 29 ppm (n = 227) and, while 42% of samples had less than 30 ppm, 89% of samples had at least 10 ppm iodine. Since 1992, consumption of sea fish has increased with an average per capita consumption in 1995 of 6.35 kg.

4.2 Changes in IDD situation after introduction of iodized salt

Available data on iodine status from Zimbabwe's monitoring programme suggest that change started to occur in 1992. By 1993, median urine iodine levels of at least 200 µg/l were found in most districts where samples were collected. The most recent data on urinary iodine monitoring, from late 1995, show median levels of 33–62.5 µg/dl in the six districts for which results are so far available. Of 966 samples collected, median urinary iodine was 43 µg/dl. Only 5% had levels below 10 µg/dl, while 7% had levels above 100 µg/dl. Iodine intake has increased by 100% since 1991. Few results are available for goitre surveys that have been carried out since 1990. One small survey in early 1996 revealed a total goitre rate of 9.1%, where previously it had been 44%.

Thyrotoxicosis appears to have been uncommon among the African population of Zimbabwe until fairly recently. In 1994, physicians reported a sudden increase in the number of cases being seen. Investigations showed that the incidence of thyrotoxicosis increased about three-fold in all ages between 1991 and 1995,

with overall incidence rising from around 2.8 per 100 000 in 1991 to 7.4 per 100 000 in 1994–1995. Over 90% of cases were in females, with a mean age of 41 years. Hospital record data suggest that toxic nodular goitre is the most common presentation (as opposed to Graves' disease). Fifteen deaths in thyrotoxic patients have been recorded at the central hospital in Harare: in 12 of these this was the sole factor identified. All but two of the deaths occurred after 1992.

Good facilities exist in Zimbabwe for investigation and treatment of patients with thyroid disease, at least in the major centres. Radio-iodine treatment is available, and there has been a steep increase in use since 1991.

A monitoring system for the control of IDD has been established. It involves a system of sentinel districts for the surveillance of biological indicators. Salt is monitored by environmental health staff, and formal salt surveys are carried out.

Laboratory facilities are available. Facilities for performing urine iodine assays are well established at the Government Analyst Laboratory, and for thyroid function testing at the two central hospitals in Harare and Bulawayo. Facilities also exist at the University of Zimbabwe.

4.3 Conclusion

USI has been achieved in Zimbabwe and the most recent data suggest that iodine deficiency has been eliminated.

IIH has occurred in Zimbabwe due to the rapid improvement of iodine status which has followed the implementation of USI. It is of particular concern at present that iodine intake is more than sufficient and that this may result in a continued increase in thyrotoxicosis and possibly an increase in thyroiditis.

4.4 Discussion

The increase in thyrotoxicosis was probably inevitable in view of the severity of iodine deficiency which increased the population at risk, and the steep change in iodine intake.

There is a discrepancy between the classical pattern of IIH and the urinary levels within a normal range found in the hyperthyroid subjects (200 µg/day). Likewise the radioactive iodine uptake remained high in contrast with the low uptake of sporadic IIH patients.

Although a more sensitive assay of serum TSH was introduced in 1993, the increased incidence of hyperthyroidism is not spurious since it was also established by measurement of serum FT3 and FT4 with unchanged methods.

The true prevalence of thyrotoxicosis among the goitrous population needs to be assessed.

Specifications for iodine requirements of salt fortification should be lowered in Zimbabwe.

In view of the erratic concentrations of iodine content in the salt samples, the quality of iodization in Botswana should be improved at the production level.

USI needs to be strictly monitored.

5 General Discussion

Participants in the consultation also discussed a number of issues related to the positive impact of USI, the occurrence of IIH and the level of iodine in salt iodization with regard to iodine requirements, production, distribution and monitoring.

Some general statements by the consultation were related to the stability of iodine in salt:

- Iodate in salt is more stable than iodide.
- Continuous spraying of salt with iodine is better than dry mixing but in both methods the critical point is that mixing must be thorough.
- Salt quality at production level plays a role since dry and pure fine-grain salt is more readily iodized. The salt must be low in components other than NaCl and especially low in magnesium which increases the hygroscopic properties of salt.
- From production to consumption, salt should not be mixed with dirt or dust.
- Packaging is very important for good conservation. The smaller bags containing 0.5-25 kg should be preferred to the larger ones (50-75 kg). They should not be porous. Polyethylene is to be preferred to jute, woven polypropylene or open containers.
- Speed of transport and distribution influences conservation of iodine in salt. Thus the price of truck or rail transport could be an important issue.
- There is a need to establish good monitoring at all levels. A simplified procedure of monitoring, easy to implement by all producers, would help.
- Community habits could influence losses of iodine from salt: i.e. washing or boiling of salt, or addition during or after cooking. In an Indian study the average losses during cooking were about 20%.

The fact that benefits of IDD prevention far outweigh the danger of IIH is demonstrated by the very positive findings of the multicentre study:

- All of these previously iodine deficient countries have had USI programmes for the past 1-5 years.
- Some of the countries had iodized salt in use for periods as long as 25 years (Kenya).
- In most of the areas surveyed for goitre, there has been a clear-cut decrease of prevalence.
- In some areas the prevalence is within the normal range.

- The median urinary iodine levels are equal to or above the cut-off point of 10 µg/dl in all the sites visited. These results are evidence of a spectacular elimination of iodine deficiency and therefore of a major step in the elimination of IDD as a public health problem.

More specifically it could be concluded from the data obtained in the seven countries that:

- Median physiological levels of urinary iodine were found only in Cameroon and Tanzania. There were wide variations above 10 µg/dl in the Democratic Republic of Congo, Kenya, Nigeria, Zambia and Zimbabwe.
- In Zimbabwe, median urinary iodine concentration increased from 2 to 43 µg/dl between 1991 and 1995, while iodine intake multiplied by 100%. Between 1991 and 1994 the incidence of thyrotoxicosis, as detected by the main endocrine laboratory in Zimbabwe, increased three-fold in a similar number of tested subjects (about 5000). There was a tendency to reach a plateau in 1995.
- Only in Kivu, Democratic Republic of Congo, was there another documented increase in hyperthyroidism and therefore a strong suspicion of IIH as in Zimbabwe. Although in Kenya, Nigeria and Zambia similar urinary iodine levels were found in some areas, there has been no documented evidence of IIH.

The above findings could be explained in several ways:

- Higher iodine concentrations were found in salt at consumer level because losses were smaller than expected.
- Better packaging in polypropylene bags gives good protection, as indicated by the experimental data reported from the study on the stability of iodine in salt. The transport is speedier and the turnover of salt faster. The weather conditions in most African countries are less harmful to iodine conservation than previously thought.
- Inadequate iodization methods in Botswana and Kenya, the two main producers/exporters, account for intercountry and intracountry variations. Zimbabwe receives its salt from Botswana, and in the Kivu Region of the Democratic Republic of Congo most salt comes from Kenya. The different legislative requirements in the importing countries are a compounding factor.
- More difficult to ascertain, but certainly an important factor, is the variation in salt intake from one country to the other and within the same country. Although considered to be generally around 10 g/day per capita, there are significant individual variations.
- No strict correlation could be found between iodine levels in the urine and the incidence of IIH. This is most likely explained by the rapidity of change of intake from very low level that has followed the rapid introduction of iodine fortification of salt in the Democratic Republic of Congo and Zimbabwe. In Kenya and Zambia the changes have been more progressive. However, detection of hyperthyroidism by biochemical screening should complement this study.

On the basis of the data presented and the discussions, and using the Swiss programme of salt iodization as a model, it was concluded that for cost-effectiveness of the programmes as well as to minimize the

incidence of IIH, it is desirable to revise the previous recommendations of WHO, UNICEF and ICCIDD. The level of salt iodization should provide a physiological intake of 150 µg/day, which should bring median urinary iodine within a range of 10–20 µg/dl. To achieve this, 30 ± 10 ppm iodine are needed.

6 Recommendations

6.1 Introduction

Universal salt iodization is the recommended intervention for preventing and correcting iodine deficiency.

In the past, recommendations for iodine levels in salt were made on the assumption that, from producer to consumer, iodine losses from iodized salt were commonly between 25% and 50%, and that average salt intakes were commonly between 5 and 10 g/person/day.

Substantial experience has been gained in the past decade in implementing USI and assessing its impact on IDD.

A major achievement is the spectacular reduction of IDD in countries that have implemented USI.

However, it appears that some people in some countries now have iodine intakes that are unnecessarily high and that may occasionally be associated with IIH.

For this reason, WHO, UNICEF and the ICCIDD carried out a study in seven African countries to examine the relationship between salt iodization and population iodine status.

Previous recommendations for iodine levels in salt have been reconsidered as a result of this study and in the light of other technical and scientific developments.

6.2 Iodine requirements

To meet iodine requirements, the current recommended daily iodine intakes are:

- 50 µg for infants (first 12 months of age);
- 90 µg for children (2–6 years of age);
- 120 µg for schoolchildren (7–12 years of age);
- 150 µg for adults (beyond 12 years of age);
- 200 µg for pregnant and lactating women.

6.3 Risk of iodine-induced hyperthyroidism

IIH is an IDD which may occur primarily in older people when severely iodine-deficient populations increase their iodine intake, even when the total amount is within the usually accepted range of 100–200 µg/day.

On a population basis, IIH represents a transient increase in the incidence of hyperthyroidism, which will disappear in due course with the correction of iodine deficiency.

IIH occurs in some subjects who have pre-existing autonomous nodular goitre. It appears likely that some patients with latent Graves' disease are also at risk.

The number of people at risk of IIH is directly proportional to the number of subjects with nodular goitre.

The occurrence of IIH is probably related to the relative increase, and rapidity of increase, of iodine intake which occurs when iodized salt is introduced in populations that are severely iodine deficient.

An increase in the incidence of hyperthyroidism may follow relatively small increments in iodine intake, but the risk is most likely to be greatest following ingestion of larger increments.

There is no level of iodine in salt that offers complete protection against some increase in the incidence of hyperthyroidism in a previously iodine-deficient population.

On a population basis, the benefits of correcting iodine deficiency through USI vastly outweigh the risks of IIH.

6.4 Required iodine levels in salt

Taking into account the following revised assumptions, which are based on new information:

- 20% of iodine is lost from salt between the production site and the household;
- another 20% is lost during cooking before consumption;
- average salt intake per capita is 10 g/day.

In order to provide 150 µg/day of iodine via iodized salt, iodine concentration in salt at the point of production should be within the range of 20–40 mg of iodine (or 34–66 mg potassium iodate) per kg of salt. When all salt used in processed food is iodized, the lower limit (20 mg) is recommended. Under these circumstances, median urinary iodine levels will vary from 100 to 200 µg/l.

In many situations in developing countries, however, despite improvements in salt production and marketing technology, the quality of available salt is poor, or salt is incorrectly iodized, or salt that has been correctly iodized deteriorates due to excessive or long-term exposure to moisture, light, heat and contaminants. Under these circumstances, iodine losses can be 50% or more from the moment salt is produced until it is actually consumed, and median urinary iodine levels could thus fall below the recommended range (100–200 µg/l). In addition, salt consumption is sometimes considerably less than 10 g/person/day. All these factors should be carefully take into account, particularly when establishing the initial level of iodine in salt.

If median urinary iodine levels from a representative sample of the population at risk are not within the recommended range, salt iodization levels and factors affecting its utilization should be reassessed, focusing on:

- salt quality and iodization procedures;
- factors affecting iodine losses in salt (e.g. packaging, transport, storage, cooking);
- food habits in relation to salt intake and cooking practices.

6.5 Risk of iodine-induced hyperthyroidism associated with iodine levels in salt

Where severe iodine deficiency has been a long-term problem, in the light of the risk factors for IIH noted in section 3, especially points 3.5–3.7, iodine levels in salt should be set at the lowest level that will prevent all manifestations of IDD while minimizing the risks of IIH.

Periodic surveys of urinary iodine are necessary to monitor actual iodine intake. Iodine levels in salt should be adjusted accordingly to progressively ensure a median of 100–200 µg/l.

6.6 Requirements for monitoring iodine status and adequacy of iodine levels in salt

A national monitoring programme should include:

- Establishing an IDD committee of qualified individuals who are responsible for programme monitoring and evaluation.
- Ensuring regular quality control of iodine concentration in salt at the point of production by using titration methods or, in the case of imported salt, at the point of entry by using reliable test kits. Consignments with suspect iodine levels should be rechecked by titration.
- Setting up independent laboratories capable of carrying out salt iodine titration and urine iodine analysis to ensure external quality control.
- Designating sentinel sites to carry out the following activities:
 - monitoring periodically salt iodine levels in retail shops and households using reliable test kits;
 - conducting occasional goitre prevalence surveys;
 - measuring regularly urinary iodine.
- Adjusting salt iodine levels on the basis of the results of monitoring, especially of iodine in urine.
- Alerting health workers to the possible occurrence of hyperthyroidism, and ensuring access to appropriate treatment when necessary.
- Establishing a health notification system for cases of hyperthyroidism at selected hospitals in areas of former severe/moderate iodine deficiency.
- The following equipment and procedures may also be required:
 - a laboratory capable of investigating thyroid function, particularly TSH and thyroid hormones;
 - ultrasound equipment to complement palpation;
 - semi-quantitative test kits for measuring urinary iodine, as soon as such kits are available.

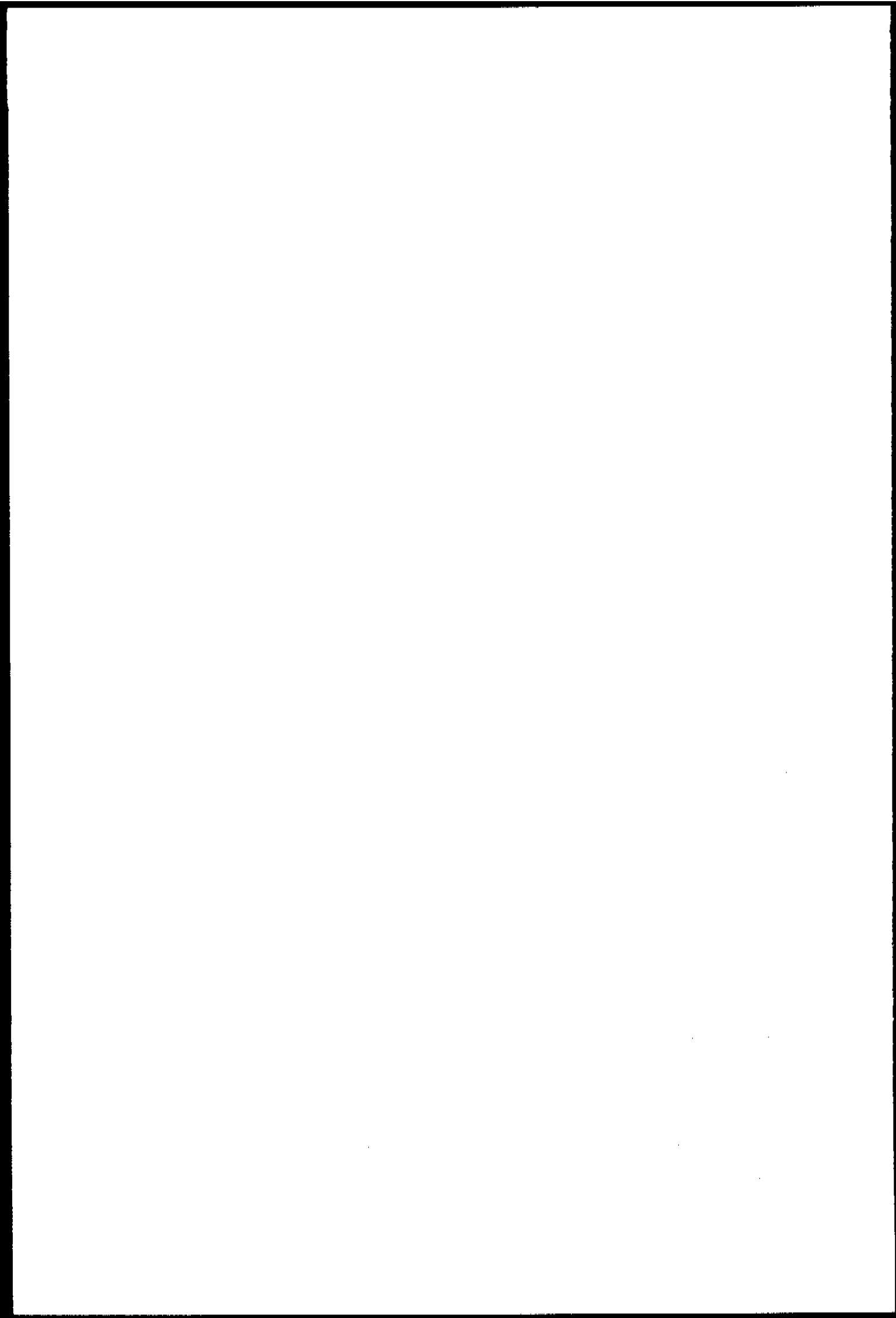


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Agenda

Monday, 8 July 1996

Session 1: Opening ceremony

- | | | |
|------|---|--|
| 8.30 | Welcome address | B.S. Hetzel,
Chairman ICCIDD |
| | Welcome address | D. Alnwick,
Senior Advisor,
Micronutrients, UNICEF |
| | Welcome address | B. de Benoist,
Regional Adviser
in Nutrition, WHO |
| 8.45 | Administrative matters and overview of objectives and expected outcomes, election of chairman | B. Underwood |

Session 2: Review and country-by-country discussions of the draft of the African 7-country summary report

- | | | |
|-------|---|--|
| 9.00 | Summary of climatic and ecological variations in Africa relative to potential effect on stability of iodine in salt | M. Benmiloud |
| 9.15 | Presentation of the findings and discussion of the 7-country study in Africa | F. Delange with
participation of
country investigators |
| 10.30 | <i>Break</i> | |
| 11.00 | General discussion | Chairman |
| 12.30 | <i>Break</i> | |

Session 3: Stability of iodine in salt

- | | | |
|-------|---|----------|
| 14.00 | Results from the study of factors affecting the stability of iodine in salt | T. Stone |
| 15.30 | <i>Break</i> | |

Drafting Groups

Topic 1: Recommended levels of iodization at factory, community and household levels according to factors affecting stability of iodine

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B. de Benoist
H. Burgi
B. Hetzel
L. Locatelli-Rossi
C. Pandav
T. Stone

Topic 2: Risk of iodine-induced hyperthyroidism and iodine levels in salt

M. Benmiloud
L. Braverman
M. Rivadeneiro
C. Todd

Topic 3: Minimum requirements for monitoring adequacy of levels of iodine in salt and in humans

F. Delange
N. Kibambe
L. Meftah
D. Lantum
P. Vitti

Composition Of The Teams Involved In The African Multicentre Study

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