The impact of salt iodisation in Zimbabwe

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In 1991 the Zimbabwe Ministry of Health and Child Welfare established a monitoring system to determine the changes in the iodine status of the population following the implementation of the universal salt iodisation. Regular collections of urine for measurement of iodine concentration were made in primary schools in each of 11 sentinel districts, which were selected with an emphasis on those areas formerly affected by severe iodine deficiency. Salt samples for titration were collected independently in retail stores nationwide. In 1992, the overall median urine iodine level was 51 μg/l (n=5 districts); in 1993 it was 296 μg/l (n=4); in 1995 it was 453 μg/l (n=8), and in 1997 it was 434 μg/l (n=10). The median iodine level in salt was 30 mg/kg in 1994 (n=250 salt samples), 38 mg/kg in 1996 (n=335), and 60 mg/kg in 1997 (n=100). The available evidence indicates that iodine deficiency has been eliminated in Zimbabwe. Median urine iodine levels are now well in excess of the target range recommended by WHO, UNICEF and ICCIDD (100-200 μg/l).

1. INTRODUCTION

In 1988, the Zimbabwe Ministry of Health and Child Welfare (MoHCW) performed a national goitre survey in primary school children. The survey was initiated in response to reports of a high prevalence of goitre in several districts throughout the Zimbabwe, and the growing body of evidence linking iodine deficiency to mental impairment. The results of the survey confirmed that iodine deficiency was a widespread and severe problem in Zimbabwe. Total goitre rates were found to be above 10% in all 53 districts surveyed, and the weighted national total goitre rate was 38.3%. In 20 districts, goitre rates were above 50%. At the same time the first reliable estimates of urinary iodine levels became available. In Hwedza and Mazowe districts, median urine iodine values were 10 μg/l and 16.5 μg/l respectively, levels consistent with severe iodine deficiency[1]. In Murewa district, where total goitre prevalence was 79% in the 1988 survey, median urine iodine was 25 μg/l (J Mutamba – unpublished data).

Urgent action to correct iodine deficiency in Zimbabwe was clearly needed. As a first step, the MoHCW organised a national consultative meeting in 1989, with the aim of sensitising policy makers on the extent and severity of the iodine deficiency disorders (IDD) in Zimbabwe and formulating strategies to control them. The meeting set goals for the IDD control programme, and sanctioned the establishment of a national intersectoral committee on IDD control under the chairmanship of the MoHCW, with representation from all relevant ministries, the salt industry, the Universities, UNICEF and other key stakeholders. The intersectoral committee adopted a national plan of action on IDD in 1991, with the overall goal of eliminating the iodine deficiency disorders in Zimbabwe by ensuring normal iodine nutrition of the entire population by the year 2000. The main strategy recommended was universal salt iodisation, with iodised oil capsule distribution as an interim measure in severely affected areas.

Three subcommittees were established: (i) monitoring and research, (ii) salt iodisation, and (iii) social marketing. The subcommittee on monitoring and research is the only one of these subcommittees which is still active, and has met regularly since 1990. In the recent past it has *de facto* adopted the role of overall co-ordinating committee for all IDD matters. The subcommittee was tasked with developing and maintaining a sustainable mechanism to monitor the effects of salt iodisation on the population of Zimbabwe. This paper relates the development and results of the monitoring system established by this subcommittee.

1.1 Salt iodisation in Zimbabwe

Universal salt iodisation was the principle strategy adopted to eliminate IDD in Zimbabwe, as elsewhere in the world. However, in 1990, the goal seemed more readily achievable in Zimbabwe than in other parts of Africa. Virtually all of Zimbabwe's salt requirements were imported, with no significant small-scale production. Only four companies handled 80% of all salt imports. Salt was sold pre-packed in 0.5, 1 or 2 kg bags. There was an efficient and well-developed transport sector, which ensured distribution to even the remotest parts of the country. Studies on the availability of sugar and salt for the production of home-based oral rehydration solutions for diarrhoea had shown that salt was available in 99% of households.

During the 1980s, the bulk of Zimbabwe's salt imports originated from South Africa. Some iodised fine salt was imported, but this only contained 10-20 mg/kg of iodine, in accordance with the South African requirements at the time. However, in 1990 it was anticipated that the salt situation would change rapidly, with the immanent commissioning of the Sua Pan plant in Botswana. This project was developed to exploit the vast deposits of soda ash (sodium carbonate) that lie in the Makgadikgadi Pan complex of northern Botswana, with sodium chloride as a by-product. Projections anticipated that at full capacity the plant could produce as much as 650,000 tonnes of salt per year: this would clearly have a huge impact on the regional salt trade. The Africa IDD Task Force realised the potential role that this project could play in eliminating IDD from Southern Africa, and in early 1991 it passed a resolution urging the managing company to produce iodised salt. This was followed by a workshop for salt producers, which was held in Botswana in 1992. This recommended that potassium iodate is added to salt at a level of 50-100 mg/kg iodine at all producers in Southern Africa.

While salt iodisation commenced from 1992 onwards on a voluntary basis, the regulations governing salt in Zimbabwe were only amended in February 1995. The new regulations require: *all salt that is manufactured or sold for human consumption, whether as crude salt, table salt, flavoured salt or otherwise shall be iodated with potassium or sodium iodate and contain the equivalent of not less than thirty milligrams or more than ninety milligrams of iodine per kilogram of salt.*

Salt monitoring in Zimbabwe is carried out in all districts. Environmental health staff use rapid test kits (supplied by UNICEF) to check salt at wholesale, retail and household levels. These staff have the power to confiscate suspect salt samples and send them for testing at the Government Analyst Laboratory.

2. METHODS

In 1991, the sub-committee on monitoring and research for the control of IDD in Zimbabwe selected 12 sentinel districts for monitoring the impact of salt iodisation on the population of Zimbabwe. The districts were chosen purposively to represent the country as a whole, but with an emphasis on rural areas that were found affected by severe IDD in the 1988 survey. (See Table 1). In each district three schools were chosen at random for regular surveys, and in each of these schools about 50 pupils were chosen by systematic random sampling for collection of spot urine specimens for subsequent iodine estimation. Goitre surveys were carried out at the same time. Urine collections for iodine estimation were also periodically carried out in other districts.

Urine iodine estimation was originally carried out in the Department of Biochemistry in the University of Zimbabwe, but was subsequently transferred to the Government Analyst Laboratory. Both laboratories are located in Harare. One of the authors (TM), a

Table 1
Sentinel Districts and their total goitre rates (TGR) and general characteristics

District	*Province*	*TGR% (1988)*	*Characteristics*
Bikita	Masvingo	63%	Poor, communal area in south-east. Mountainous.
Binga	Matebeleland North	54%	Remote, very poor communal area in north-west.
Centenary	Mashonaland Central	53%	Commercial farming area in north.
Chegutu	Mashonaland West	54%	Mixed farming, communal areas and small towns. Central.
Chikomba	Mashonaland East	75%	Underdeveloped communal area. Central.
Chimanimani	Manicaland	54%	Remote, district in Eastern Highlands.
Harare	Harare	11%	Large urban area – capital city.
Hurungwe	Mashonaland West	49%	Underdeveloped communal and farming area in north.
Matobo	Matebeleland South	12%	Poor communal area in south-west.
Murewa	Mashonaland East	79%	Communal area. Mountainous. East of Harare.
Nyanga	Manicaland	52%	Mixed communal areas and farming in Eastern Highlands.
Shurugwi	Midlands	48%	Communal and farming area. South central.

senior analytical chemist at the Government Analyst Laboratory, attended a training course at the Program against Micronutrient Malnutrition (PAMM) in 1991, and the laboratory regularly participated in the PAMM quality control scheme until the latter ceased to operate. A recognised method was used for urine iodine estimations, based on the Sandell-Kolthoff reaction. Urine is digested using chloric acid under mild conditions, and iodine detected manually in a colorimeter by ceric sulphate reduction[2].

In 1993, the sub-committee on monitoring and research, with the help of UNICEF, initiated collection of salt samples at households for formal analysis. This proved difficult to sustain, and subsequently salt sample collection was incorporated into the programme to monitor the social dimensions of the economic structural adjustment programme. Both coarse and fine salt samples were collected from retail stores in sentinel sites in all of the country's ten provinces. Analysis of these salt samples by thiosulphate titration was carried out at the Government Analyst Laboratory and the Standards' Association of Zimbabwe using a standard method[3].

3. RESULTS

Collection of urine samples commenced in 1992. Urine samples were never collected in Chikomba District because of the lack of a nutritionist in that province, and it is therefore omitted from the results tables. For logistical and other reasons, it was not always possible to collect samples in all of the other sentinel districts. The results are summarised in Table 2; the "overall median" is the median of the various district medians for that year. An additional 194 samples collected in Nkayi district (Matebeleland North) in 1995 had a mean iodine level of 615 μg/l.

In the first national salt survey, which took place in April 1993, 36 household salt samples were collected. The median salt iodine was 25.9 mg/kg (minimum 0.5, maximum 204.7 mg/kg). 53% of samples had iodine content below 30 mg/kg. Collection of salt samples under the programme to monitor the social dimensions of structural adjustment commenced in September 1994, followed by further collections in 1996 and 1997. A summary of the results of analysis of these samples is shown in Table 3.

Table 2:
Changes in median urinary iodine levels in the sentinel districts, 1992-7

District	*Median urinary iodine (μg/l)*			
	1992	*1993*	*1995*	*1997*
Bikita	31 (n=148)		500 (n=174)	290 (n=151)
Binga	51 (n=145)		290 (n=126)	517 (n=150)
Centenary		228 (n=174)	450 (n=141)	338 (n=153)
Chegutu			560 (n=146)	475 (n=149)
Chimanimani		283 (n=148)		330 (n=150)
Harare	51 (n=136)			288 (n=149)
Hurungwe			456 (n=76)	450 (n=143)
Matobo	37 (n=147)		370 (n=267)	417 (n=165)
Murewa*	56 (n=188)	315 (n=281)	430 (n=177)	
Nyanga		310 (n=155)		460 (n=151)
Shurugwi			560 (n=130)	625 (n=149)
Overall median	**51**	**296**	**453**	**434**

* Iodised oil capsules were distributed in Murewa district during 1991.

Table 3
Iodine levels in salt samples collected at retail stores countrywide: 1994-7

Year	*Number*	*Median (mg/kg)*	*Min-max (mg/kg)*	*Percentage of samples:*		
				<30 mg/kg	*30-90 mg/kg*	*>90 mg/kg*
1994	250	30	1-96	56%	42%	1%
1996	335	38	1-127	32%	65%	3%
1997	100	60	4-115	16%	69%	15%

4. DISCUSSION

Prior to 1990, the entire population of Zimbabwe was at risk of iodine deficiency. In some areas, particularly in the more mountainous and wetter north and east, iodine deficiency was severe, but the 1988 national goitre survey revealed that IDD was a problem throughout the whole country, including the major cities. The change in iodine status during the 1990s has been dramatic. In 1992, iodine status was similar to that in 1988, although perhaps had improved marginally. All median urinary iodine values were well below 100 μg/l, and were generally consistent with moderate iodine deficiency. By the following year urinary iodine levels had increased by several hundred percent, and the overall median was around 300 μg/l. After 1993 urinary iodine levels continued to rise overall, but with wide variation between districts, and even in the same district over time. Since 1993 median values in all districts have been well in excess of 100 μg/l, indicating that there is no longer any iodine deficiency in Zimbabwe. There are no obvious discrepancies between urban and rural areas, nor between remote areas and elsewhere.

The elimination of iodine deficiency has undoubtedly been due to the introduction of iodised salt. There have been no other major dietary changes in Zimbabwe in the current decade. While large quantities of frozen sea-fish were imported from Namibia in the early 1990s, this has not been sustained. Moreover, the fish was largely consumed in urban and not remote rural areas.

Before 1993 little iodised salt was available in Zimbabwe. Following the sensitisation of salt traders in the early 1990s, and in particular following the opening of the plant at Sua Pan in Botswana, increasing quantities of iodised salt were imported. Data from 1993, although limited, clearly indicate that significant quantities of iodised salt were then available in the country. By late 1994 the median salt iodine level was just below 30 mg/kg. Since then the iodine level has continued to rise, and by 1998 the median had reached 60 mg/kg, the target level for iodisation at Sua Pan at that time. These changes have been closely mirrored by the changes in urinary iodine excretion. At the present time virtually all of Zimbabwe's salt requirements are imported from Sua Pan.

The results of salt monitoring also reveal great variability in iodine levels. Many salt samples have iodine levels that fall outside the limits prescribed by the Zimbabwean regulations – notwithstanding the fact that these regulations permit a generously wide range of 60 mg/kg. While there has been some improvement, the 1997 salt data found that 31% of samples still had iodine levels outside the permitted range. This variability in salt iodine levels explains the wide variability found in urinary iodine levels, with some individual values in excess of 1200 µg/l. This variability is of concern, because of the danger of exposing some individuals to a very high iodine intake.

Sentinel surveillance has proved an effective tool for monitoring the impact salt iodisation. The aim is not to get a precise picture of overall national iodine status, rather it is to ensure that IDD is corrected in the "worst case" areas. If iodine status is adequate in rural schools in remote areas of former high IDD prevalence, then very likely it is eliminated everywhere. A few other areas are also included to ensure that iodine status is adequate there also, but not overcorrected. Staff within the various provinces carry out the surveys, minimising the costs involved, and only the urine samples need be transported to a central point for analysis.

Overall, median urinary iodine levels throughout Zimbabwe are now well in excess of those recommended by ICCIDD, WHO and UNICEF[4]. In Nkayi district, which was not one of the original sentinel sites, and also in Shurugwi, the median urine iodine values are well above 600 µg/l – a very high level. The question must be asked as to how such high levels have been achieved. There are probably two main reasons. First of all, salt intake is high. The few studies on salt consumption that have been carried out suggest that it is around 10 grams per person per day. Anecdotal reports suggest that it may be much higher in certain areas. Second, losses of iodine between producer and consumer are lower than originally anticipated. Recent studies on the stability of iodated salt show that losses of iodine over one year are around 20%, except in conditions of extreme heat and humidity and where the salt is highly impure[5]. Zimbabwe has a warm but dry climate and the salt produced at Sua Pan is very pure. Nearly all the salt sold is prepacked into sealed plastic packets, further reducing losses of iodate. All of these factors are likely to keep losses of iodine between factory and household to a minimum. Losses of iodine during cooking have not been adequately studied, but are probably no more than 20%.

While most people have no difficulty in dealing with a high iodine intake, susceptible individuals may be at risk of developing hyperthyroidism. In Zimbabwe, an increase in cases of hyperthyroidism was recognised in 1994. Review of laboratory records at the major referral hospital in Harare revealed a sharp increase in new cases of the condition[6]. While no further observations on this have yet been published, data available to the authors have shown that the increase in incidence peaked in 1995, and it is now gradually subsiding. However, concern over the reports of hyperthyroidism from Zimbabwe, and from the Kivu Region of the Democratic Republic of Congo[7], led to WHO and UNICEF sponsoring a special study of the current iodine status in seven African countries[8]. This study was followed by a joint

WHO, UNICEF and ICCIDD consultation, which was held in 1996. This recommended that, *in typical circumstances, where iodine lost from salt is 20% from production site to household; another 20% is lost during cooking before consumption, and average salt intake is 10 grams per person per day, iodine concentration in salt at the point of production should be within the range 20-40 mg of iodine per kilogram of salt, in order to provide 150 μg of iodine per day*[9]. In the light of this recommendation, and in an attempt to harmonise salt regulations in the Southern Africa, several countries from the region met in Francistown Botswana in July 1999. At this meeting, representatives from Botswana, Mozambique, Malawi, Zambia and Zimbabwe agreed to a common standard for iodisation of 40 mg/kg of iodine as potassium iodate, with a maximum permitted variability in iodine levels of ±15 mg/kg.

Universal salt iodisation has been a great success in Zimbabwe. There are a number of reasons: all salt is imported, there is just one important salt producer, the salt available is of good quality and is well packaged, and the transport infrastructure is good. All the available data suggest that iodine deficiency has been eliminated as a public health problem, and cluster surveys which are due to be carried out in October 1999 will hopefully confirm that this is the case. However, continued vigilance will be vital in the 21st century. The effect of lowering the iodine levels in salt is to be determined; new suppliers of salt may appear on the scene, and salt intake itself may fall. Sentinel surveillance will continue to provide the necessary information through its ability to provide an inexpensive snapshot of current iodine status in selected districts.

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