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International Journal of Food Sciences and Nutrition (1999) **50**, 7–12

Impact after 1 year of compulsory iodisation on the iodine content of table salt at retailer level in South Africa

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The short-term effectiveness of introducing compulsory iodisation through revised health legislation, evaluated in terms of the iodine content of iodised table salt, was investigated in three of the nine provinces in South Africa. Shortly before the introduction of compulsory iodisation of table salt in December 1995, iodised at a higher level than before, 187 iodised salt samples were purchased at retailers in 48 magisterial districts situated in the three provinces of Western and Eastern Cape and Mpumalanga for analysis of the iodine content using the titration method. In a follow-up 1 year later 287 iodised salt samples were obtained from the same retailers for iodine determination. The mean iodine content of iodised salt increased significantly from 14 to 33 ppm. However, large variation in the iodine content of iodised table salt among and within salt brands existed at follow-up, and the mean iodine content was lower than the legal specification of 40 to 60 ppm. Only 24% of the samples were found within the range required by the law at follow-up compared to 42% before revising the salt legislation. Despite the introduction of compulsory salt iodisation, the mean retail price of iodised salt remained the same between 1995 and 1996 for a 500 g package of salt. Further refinement of the iodisation process is necessary to improve the accuracy of iodisation and decrease the variation in iodine content. This study nevertheless showed that the introduction of compulsory iodisation and elevating the legally specified iodine level of table salt resulted in a significantly elevated mean iodine level of iodised salt within 1 year, without any additional cost to the consumer.

Introduction

Endemic goitre was identified in some parts of South Africa before 1955 (Steyn *et al.*, 1955). This resulted in the introduction of optional iodisation of table salt in December 1954, iodised at a level of between 10 and 20 parts iodine per million parts of salt (ppm). However, an investigation 40 years later showed that only about 30% of table salt in the country was iodised (Jooste *et al.*, 1995b). Furthermore, several factors such as a low level of awareness of the benefits of iodised salt, small producers not iodising locally distributed salt, low consumer demand, and variation in levels of salt consumption, resulted in unequal access to iodised salt (Jooste *et al.*, 1995b).

To control and prevent the global health problem of iodine deficiency disorders (IDD), e.g. retarded physical and mental development

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0963-7486/99/010007-06

(Lamberg, 1993; Delange, 1994; Hetzel & Pandav, 1996), the commitment to virtually eliminate IDD by the year 2000 was endorsed at several high-level conferences, e.g. World Summit for Children in 1990, Ending Hidden Hunger: Policy Conference on Micronutrient Malnutrition in 1991, and the International Conference on Nutrition in 1992. The following year, at their meeting in February 1993, a UNICEF–WHO Joint Committee on Health Policy adopted the intermediate goal to achieve universal salt iodisation by 1995. Although the epidemiology of endemic goitre in South Africa was not known at that time, compulsory iodisation of food-grade salt was introduced in December 1995 based on historic evidence of endemic goitre in the country and the fact that endemic goitre prevails in all of South Africa's neighbouring countries (Jooste *et al.*, 1995a).

The regulation related to salt of the South African Foodstuffs, Cosmetics and Disinfectants Act 54 of 1972 (a subsequent version of the earlier legislation) was revised to introduce compulsory iodisation of table salt to come into effect on 1 December 1995. This revision not only introduced compulsory iodisation of salt but also increased the previous level of iodisation of 10 to 20 ppm to a level of between 40 and 60 ppm.

Large variation in iodine levels of salt has been observed in other African countries in spite of specific legal requirements that have been in place for a number of years. For example, more than 80% of salt obtained from wholesalers, retail shops, factories and consumers in Kenya did not contain the iodine level required by the law (Alnwick, 1988; Muture *et al.*, 1994). However, the time required for implementing compulsory iodisation in a country and inducing a measurable change in iodine content of salt, only as a result of revising the salt legislation, is not known. Therefore this study focused on the short-term effectiveness of revising salt legislation as a public health measure to prevent and control iodine deficiency, evaluated in terms of the change in iodine content of table salt at retailer level. Thus the aim of this follow-up study was to assess the impact of introducing compulsory iodisation on the iodine levels, and the price, of salt in food shops in three of the nine provinces in South Africa 1 year after the introduction of compulsory iodisation.

Methods

Iodised salt samples were purchased in three provinces during the month before the revised salt legislation came into effect on 1 December 1995, and again 1 year later. Salt samples were obtained from ten towns situated in ten different magisterial districts, representing both larger and smaller towns, in the provinces of Western Cape, Eastern Cape and Mpumalanga. Due to available infrastructure salt samples were obtained in both years from 21 additional towns in the Western Cape.

One food shop, frequented by a large proportion of the local population, was selected in each town as a sentinel site. Three 500 g iodised salt samples per brand name, packed in sealed plastic bags and available to the public, were randomly chosen from the shelf. Where 500 g samples were not available, 1 kg samples were purchased. The name of the shop, the brand name and the price of the salt were recorded during the baseline study to enable, as far as practically possible, an exact repeat of the sampling procedure during the follow-up study. At baseline the price of similarly named non-iodised salt was also recorded to compare the price of iodised and non-iodised salt. Several new brand names had appeared on the market at the time of the follow-up study, and samples of these were also purchased.

The salt samples were kept unopened in the sealed plastic bags in a dark thermoneutral environment until analysed. An iodometric titration method was used for analysing the iodine content of these samples (Mannar & Dunn, 1995). In our laboratory the coefficient of variation for this method is 0.68 at 20 ppm and 1.05 at 60 ppm.

To study the variation in iodine levels of iodised salt, the percentage of samples complying and not complying with the legal requirement before and after revision of the salt regulation were calculated. The impact of introducing compulsory iodisation was assessed after 1 year by means of determining the actual change in level of iodine in the salt samples. The Wilcoxon Two Sample Test was used for comparing 1995 and 1996 iodine values and the Spearman correlation to determine if a relation existed between price and iodine content.

Table 1. Sampling data, price and iodine content of iodised salt samples

	No. of districts		*No. of samples*		*Mean iodine content (SD)*	
Province	*1995*	*1996*	*1995*	*1996*	*1995 ppm*	*1996 ppm*
Western Cape	30	31	103	121	13 (7)	35 (15)
Eastern Cape	9	9	38	106	10 (11)	35 (21)
Mpumalanga	9	7	46	60	18 (13)	27 (18)
Total	48	47	187	287	14 (10)	33 (18)

SD = standard deviation.
ppm = parts per million.

Results

In 1995, during the month before the revised salt legislation came into effect, 187 iodised salt samples were purchased from retail food shops in 48 magisterial districts. One year later, 287 iodised salt samples were obtained from 47 of the 48 magisterial districts. The mean iodine content of these salt samples varied in the different provinces from 10 to 18 ppm in 1995 and from 27 to 35 ppm in 1996 (Table 1). When the iodine values of the three provinces were combined, the overall mean iodine content increased significantly (Wilcoxon Two Sample Test, $P < 0.0001$) from 14 to 33 ppm.

Information on the price of salt was available for 159 samples in 1995 and for 273 samples in 1996, but the comparison of price between these two years was done on 64 pairs of baseline and follow-up data of the same brands of 500 g packages of salt. This calculation showed that the mean price of 500 g salt packets remained unchanged at R1.11 (1US$ = R4.50) from November 1995 to November 1996. In 1995, when non-iodised salt was still available in food shops, the price of iodised and non-iodised salt for the same brands did not differ (data not shown).

Figure 1 illustrates the change in salt iodine content upon revising the salt legislation. There is a clear shift towards higher iodine levels in the entire distribution as a result of introducing higher, legally specified, iodisation levels than before. The figure also shows the percentage of iodised salt samples complying and not complying with the legal requirements applicable in the respective two years. In 1995 42% of the salt samples complied with the legal specification,

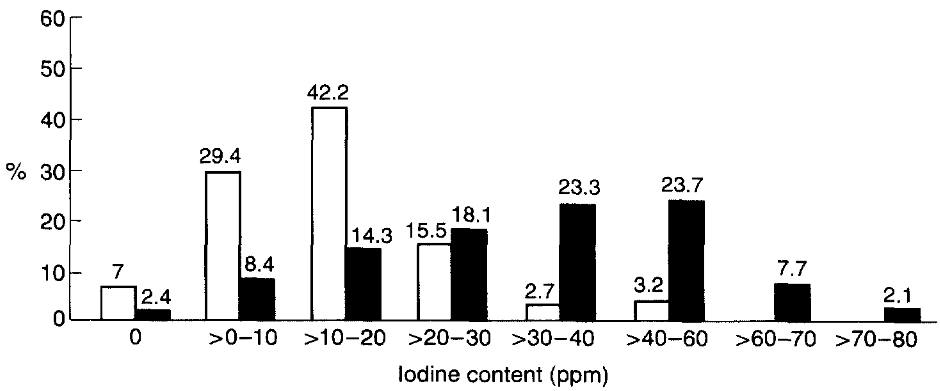

Figure 1. Relative distribution of the iodine content of iodised salt samples collected in three provinces of South Africa in 1995 and in 1996. □ 1995 iodine values, $n = 187$; ■ 1996 iodine values, $n = 287$.

Table 2. Brand-related variation in iodine content of iodised salt in 1996

Brandname code	*Number of samples*	*Iodine content in ppm*	
		Mean (SD)	*Range*
1	6	40 (9)	35–56
2	123	38 (17)	5–78
3	11	37 (20)	0–72
4	55	36 (13)	0–63
5	8	34 (18)	13–56
6	28	32 (20)	0–80
7	10	31 (13)	6–44
8	6	29 (21)	12–61
9	2	21 (2)	19–22
10	18	19 (12)	0–47
11	14	18 (4)	12–23
12	3	10 (2)	9–12
13	3	7 (5)	2–13

ppm = parts per million
SD = standard deviation

but 36% of the salt samples were lower, and 21% of the samples exceeded the legal specifications. In 1996 24% of the samples were within the revised range while 67% were lower than required and 10% exceeded the specified range.

The mean iodine content as well as the range of iodine values are given in Table 2 for the different brands collected in this study. Some of the sample sizes in this analysis were rather small because sampling was not brand-specific and some brands occurred only in localised areas. The information nevertheless indicated a marked variation in mean iodine content between brands (ranging from a mean iodine content of 7 to 40 ppm) as well as within brands, where the largest variation found was from 0 to 80 ppm.

Across brands the price for a 500 g packet of salt varied more than five-fold from R0.35 to R1.79. Within brands, the price varied up to 2.8 times the lowest price of the same product purchased elsewhere. When the price was correlated with the iodine content of salt, a positive and significant Spearman correlation of $r = 0.25$ ($P = 0.002$) was found for the 1995, as well as for the 1996, data ($r = 0.16$; $P = 0.007$).

Discussion

South Africa has joined several other African countries such as Namibia, Zimbabwe, Kenya, Tanzania, Zambia, Cameroon, Burundi and Nigeria in introducing compulsory iodisation, while a number of other African countries are in the process of preparing legislation for compulsory iodisation (Jooste & Blaauw, 1995). Iodisation of salt is compulsory in at least six European countries (Austria, Bulgaria, Czechoslovakia, Hungary, Yugoslavia and in endemic goitre regions of Portugal) while it is voluntary in the majority of other European countries (Bürgi, 1992). In South Africa the introduction of compulsory iodisation at the end of 1995 impacted favourably within 1 year on both the availability and the iodine content of iodised salt at the retail level. Although we did not quantify the availability of iodised salt in this study, it was obvious that only iodised salt was available in virtually all the grocer shops and non-iodised salt in very few shops. Theoretically this means that virtually all people in the country should have access to iodised salt because iodised salt was also available in the few shops that stocked non-iodised salt at the time of the follow-up study. Factors previously responsible for unequal access to iodised salt, such as small producers producing only non-iodised salt, low consumer demand and low levels of awareness of the benefits of iodised salt (Jooste *et al.*, 1995b), therefore no longer restrict the availability of, and accessibility to, iodised salt.

Individual countries had to decide on realistic iodisation levels based on local factors such as the per capita consumption of salt, the climate and the iodine losses during storage and transport. The revised South African legislation not only resulted in greatly improved availability of iodised salt, but also in higher iodine levels in salt than before. While the mean iodine levels in iodised salt increased significantly as a result of the revised legislation, these levels had not increased to the level required by the revised legislation. In the provinces of Western and Eastern Cape the mean level of 35 ppm was just below the minimum legal level of 40 ppm, but in Mpumalanga province the mean level of 27 ppm was off the mark. This was probably due to more brands containing insufficient amounts of iodine being distributed in Mpumalanga.

Another reason for concern is the large variation observed in the iodine levels of salt obtained in the three provinces included in this study. Whereas 42.2% of the samples complied with the legal requirement in 1995, this proportion decreased to 23.7% in 1996 while the percentage of samples with insufficient iodine increased from 36.4% to 66.5%. However, in spite of the mean iodine levels which appeared insufficient, the proportion of retailer iodised salt exceeding 20 ppm increased from 21.4% in 1995, when optional iodisation applied, to 74.9% in 1996, 1 year after the introduction of compulsory iodisation.

Problems of a low percentage of samples complying with the legal requirement and a large variation in iodine content need to be cleared in consultation with the salt industry. It needs to be clarified whether the salt industry is still in a transitional phase adapting to the revised legislation or whether this phase is completed. It should also be borne in mind that the specified range of between 40 and 60 ppm applies to the addition of iodate at the production site rather than to the retail level where these samples were obtained. Consensus should therefore be reached about the expected iodine levels at the retail level of salt marketed in the usual plastic bags. It was shown in India that small iodine losses of 9 to 10% occurred within 15 to 20 days after packaging in 5 kg capacity polythene bags where after the iodine level remained constant for 300 days (Chauhan *et al.*, 1992). This initial loss of iodine after 15 to 20 days was ascribed to partial draining of iodised brine, adhered to the surface of salt crystals, and then sticking to the side of the polythene bag. Whether this loss also occurs in South African products has to be investigated. For the purpose of this study we assumed that iodine losses from the impermeable plastic bags used in South Africa were minimal or absent and therefore did not explain the low mean values or the variation observed in this study.

As was mentioned earlier, the sampling was not done to obtain a representative sample of the various brands on the market. The data nevertheless provide some indication of a large variation in iodine levels among and within the different salt brands that existed 1 year after the introduction of compulsory iodisation (Table 2). However, this variation is much smaller than was found in Kenya where only 16% of samples complied with their legal specification and some of the samples had excessively high levels of iodine (Muture & Wainaina, 1994). Although the mean and individual iodine levels varied in our study, the high values did not reach potentially toxic levels and therefore did not pose a public health threat. Further research is, however, necessary to establish whether some brands are consistently and severely under-iodised.

The mean price of iodised salt remained the same over the first year following the introduction of compulsory iodised salt. This could be interpreted as a strong indication that the salt industry has absorbed the cost of iodising all table salt and has not passed the additional cost on to the consumer. It could also be interpreted as an indication of the fierce competition among producers and marketers in the salt industry, and that the additional cost of iodisation is small relative to the other components of the production and distribution process. From the five-fold price difference among different brands of salt it appears that some of these components and perhaps the quality of the salt determines the variation in price to a much greater extent than the iodine content. The 2.8-fold price difference within brands further indicates that factors such as the profit margin, overhead and distribution costs determine the price variation of iodised salt and not a small cost factor such as the iodine content.

The weak but significant correlation between the price and the iodine content of iodised salt found in 1995 and in 1996 indicated slightly higher iodine levels in more expensive salt brands. This could possibly be due to the higher quality salt, or salt with fewer impurities, being slightly better iodised than lower quality salt. From a public health perspective monitoring of iodine levels in table salt at both the production and the retail level is important to ensure the availability of adequately iodised salt, particularly in low socioeconomic areas where often only one of the cheaper salt brands is available in food shops. Furthermore, monitoring and evaluation of the effects of compulsory iodisation at an elevated level of iodine in salt need to go beyond measuring the iodine content of salt. If the latter is viewed as a process indicator, then the effect of the revised salt legislation on impact indicators such as the iodine and goitre status of children also needs to be assessed in future research.

Although only three of the nine provinces were included in this study, it could be assumed that these observations are generalisable to the whole of the country because of the country-wide distribution channels for food commodities such as salt. This study showed that introducing compulsory iodisation and elevating the legally specified iodine level of table salt through revised legislation resulted in an improved availability of iodised salt and a significantly elevated mean iodine level of iodised salt from 14 to 33 ppm within 1 year, without any additional cost to the consumer. Further refinement of the iodisation process is required to reduce the within and between salt brand variation in iodine content and to achieve a greater percentage of salt complying with the legal specification.

Acknowledgement—The authors wish to sincerely thank Mr M. Slabber and E. Bonzet of the Western Cape Department of Health, Mr J.W.L. Nel of the Eastern Cape Department of Health and Mrs L. Viljoen of the Mpumalanga Department of Health for obtaining the salt samples in the various districts.

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