Mandatory iodisation of table salt at an elevated iodine concentration was introduced in South Africa in 1995 as a public health measure to avoid the grave consequences of iodine deficiency, particularly the effect on brain functioning.\(^1\),\(^2\) Because mild iodine deficiency was found in children attending a primary school near Worcester in the Western Cape in 1998,\(^3\) this study assessed the iodine, goitre, and anthropometric indices of nutritional status of Grade 5 and 6 children at the same school 2 years later.

**Subjects and methods**

All the Grade 5 and 6 children, from labourer families, attending the primary school near Worcester in the Western Cape, were included in this study. Written consent was obtained from the parents of the children, the headmaster of the school and the Director of the Boland/Overberg Regional Office of the Department of Health. The Ethics Committee of the Medical Research Council (MRC) approved all the measurements applied in this assessment.

Demographic information regarding birth date and gender was provided by the teaching staff.
For the ultrasonographic determination of thyroid size, a Toshiba Just Vision 200 ultrasonograph was used with a 7.5 MHz transducer. Transverse and longitudinal scans were performed of each lobe of the thyroid gland, and the volume of each lobe was calculated using the formula: volume = 0.479 × w × d × l, where w represents the width, d represents the depth, and l represents the long axis of each lobe. The thyroid volume was the sum of the volumes of the two lobes. Because undernutrition and retarded growth appeared prevalent among these children, the thyroid size was also assessed in relation to the body surface area (BSA) of the children. The BSA of children, the thyroid size was also assessed in relation to retarded growth appeared prevalent among these children. The thyroid size of each child, measured by palpation and the ultrasound measurements on all the palpation and the ultrasound measurements on all the children. The thyroid size of each child, measured by ultrasonography, was then evaluated against the 97th percentile revised cut-off values of the WHO, UNICEF and the ICCIDD for age as well as for body surface area.7 Children with thyroid sizes exceeding these cut-off levels were considered goitrous. When the prevalence of goitres, determined either by palpation or by ultrasonography, exceeds 5%, it is said that a public health problem of endemic goitre exists in such a population.

Urine samples were obtained from all the children during school hours, and four drinking water samples were taken from the water tap at the school. The iodine concentration in the urine and water samples was analysed by means of a mild perchloric acid digestion, followed by the spectrophotometric analysis for iodine concentration using the Sandell-Kalthoff method. The median urinary iodine concentration is used to assess the iodine status. A median urinary iodine concentration below 20 µg/l indicates severe iodine deficiency, 20 - 49 µg/l indicates moderate iodine deficiency, 50 - 99 µg/l mild iodine deficiency, 100 - 199 µg/l an adequate iodine intake, 200 - 299 µg/l more than adequate iodine intake, and more than 300 µg/l an excessive iodine intake.6

Each child was asked to bring three teaspoons (approximately 15 g) of salt used in the preparation of food at home, to school in a plastic zip-seal bag provided. In addition, three packets of retailer salt were purchased at each of the five small shops selling groceries in this area. These 15 retail salt samples, as well as the salt brought from home, were analysed for iodine concentration using the Sandell-Kalthoff method.8 The concentration of iodine in 15 retailer salt samples purchased from five small grocer shops in the area, where people from the study area usually buy their food, ranged from 5 to 116 parts per million (ppm), with a mean value of 42 ppm. However, 5 of the 15 samples had iodine concentrations of less than 15 ppm. The mean iodine concentration of household salt samples was also 42 ppm (Table II), ranging from 0 to 184 ppm. However, only 67% of these salt samples were adequately iodised, containing more than 15 ppm of iodine. Four water samples obtained from the water source at the school generally contained little iodine, ranging from 0 to 16 µg/l.

### Results

All 66 children in Grades 5 and 6, 42 boys and 24 girls, participated in the study. Their demographic and anthropometric characteristics are summarised, by sex and for the total group, in Table I. This table shows that a substantial percentage of the children were growth retarded as is evident from the high percentage of stunted children (33.3%). Approximately 20% of the children were also underweight. The boys, whose mean age of 13.2 years was higher than the 11.8 years of the girls, had higher stunting and underweight rates than the girls.

The results of the median urinary iodine, prevalence of goitre by palpation, thyroid volume and the iodine concentration in the salt samples brought from home are summarised in Table II. The goitre prevalence (by palpation) in the whole group was 7.6%, accompanied by a median urinary iodine concentration of 177.5 µg/l. The median thyroid volume of 2.8 ml was also low, but 2 children were goitrous, representing a goitre rate of 3% based on the ultrasonographic measurement.

The concentration of iodine in 15 retailer salt samples based on the ultrasonographic measurement.

### Discussion

Based on the mean iodine concentration of 42 ppm in both the retail and household salt samples, which was higher than in other South African studies,10 it was reasonable to expect an adequate iodine status in the schoolchildren who participated in this study. Their median urinary iodine value of 177 µg/l indeed indicated a sufficient iodine intake, and was markedly higher than the median value of 97 µg/l obtained in the same school during the national survey more than 2 years earlier.1 Although we were concerned about the variability of the iodine concentration in the retail and household salt, and in particular about the third of these salt samples that

### Table I. Demographic and anthropometric characteristics (mean ± SD) of the children

<table>
<thead>
<tr>
<th>Study subjects</th>
<th>Mean age (years)</th>
<th>Height (m)</th>
<th>Height-for-age (z-score)</th>
<th>Stunting % &lt; −2 SD</th>
<th>Weight (kg)</th>
<th>Weight-for-age (z-score)</th>
<th>Underweight % &lt; −2 SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys (N = 42)</td>
<td>13.2 ± 1.0</td>
<td>146.8 ± 8.8</td>
<td>−1.44 ± 1.02</td>
<td>35.7 ± 7.8</td>
<td>13.6 ± 0.99</td>
<td>37.2 ± 7.8</td>
<td>21.4 ± 16.7</td>
</tr>
<tr>
<td>Girls (N = 24)</td>
<td>11.8 ± 0.9</td>
<td>138.9 ± 8.3</td>
<td>−1.48 ± 0.95</td>
<td>29.2 ± 7.1</td>
<td>1.48 ± 0.95</td>
<td>31.8 ± 7.1</td>
<td>16.7 ± 19.7</td>
</tr>
<tr>
<td>Total (N = 66)</td>
<td>12.7 ± 1.3</td>
<td>143.9 ± 9.4</td>
<td>−1.45 ± 0.98</td>
<td>33.3 ± 7.9</td>
<td>1.33 ± 0.92</td>
<td>35.2 ± 7.9</td>
<td>19.7 ± 9.2</td>
</tr>
</tbody>
</table>

SD = standard deviation.
iodine deficiency. The goitre prevalence of 7.6% in the longer to regress in children with endemic goitre and consequently no need for an iodine intervention indicates an adequate iodine intake in these children and the importance of using iodised salt; the importance of providing sufficient iodine to the children, as well as to be ascribed to the national salt iodisation programme because their current iodine status is normal. Interestingly, the nutritional status of the boys in this group of children was worse than that of the girls. The prevalence of stunting (35.7%) and overweight (21.4%) was higher among the boys than the girls, their median urinary iodine concentration was lower (but within the normal range), and their goitre rate appeared higher.

In conclusion, this investigation showed that the iodine status of the children is currently normal. Although their goitre rate, established by palpation, is marginally above the cut-off level of 5%, the ultrasonographic measurement of thyroid size indicated an acceptably low prevalence of goitre. The improved iodine status of these children can be ascribed to the national salt iodisation programme providing sufficient iodine to the children, as well as to the nutrition education given to the community.

We would like to thank the headmaster, staff and children of the primary school for their wholehearted collaboration in this study.

Table II. The iodine concentration in urine and salt, and the goitre prevalence and thyroid volume of the study participants

<table>
<thead>
<tr>
<th>Study subjects</th>
<th>Median urinary iodine (µg/l)</th>
<th>Goitre prevalence by palpation (%)</th>
<th>Thyroid volume (by ultrasonography)</th>
<th>Mean iodine content in household salt (ppm) (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys (N = 42)</td>
<td>147.3</td>
<td>9.5</td>
<td>2.8</td>
<td>43 (37)</td>
</tr>
<tr>
<td>Girls (N = 24)</td>
<td>239.6</td>
<td>4.2</td>
<td>2.7</td>
<td>41 (44)</td>
</tr>
<tr>
<td>Total (N = 66)</td>
<td>177.5</td>
<td>7.6</td>
<td>2.8</td>
<td>42 (40)</td>
</tr>
</tbody>
</table>

*Percentage of children exceeding the 97th percentile cut-off levels of the WHO/UNICEF/ICCIDD.
SD = standard deviation.

were under-iodised, the median of the urinary iodine concentration nevertheless indicated a sufficient iodine status in this study population.

An improvement of this magnitude is almost certainly due to a higher iodine intake, and the most likely source of the additional iodine is iodised salt. During the National IDD Survey in 1998, the two salt samples obtained from children of this primary school contained 12 and 17 ppm of iodine, indicating a low iodine content in the salt. Although the sample size was very small, it nevertheless appears likely that the iodine content of table salt increased substantially from the time of the national survey to the time of the MRC assessment 2 years later, providing the additional dietary iodine. The improved iodine status of the children could also be ascribed partly to input from the Department of Health, which ensured that after the 1998 study, children, teachers, parents and shopkeepers in the community in which the school was situated were educated about the importance of using iodised salt; the importance of including foods high in iodine content in the daily diet was also emphasised. Therefore, the information on the iodine status of the children, substantiated by the data on the iodine content of retailer and household salt, indicates an adequate iodine intake in these children and consequently no need for an iodine intervention programme.

Effective salt iodisation results in a rapid eradication of iodine deficiency within 1 year, but the goitres take longer to regress in children with endemic goitre and iodine deficiency. The goitre prevalence of 7.6% in the children should therefore not be of concern because the goitre rate appears to decline gradually over a number of years, as seen elsewhere in the country after the correction of iodine deficiency through salt iodisation (P Jooste — unpublished data). It is likely that the goitre rate among the children of this primary school was higher at the time of the national survey than the current rate, and that it is on the decline. Furthermore, the thyroid volume measured by ultrasound was normal, and this method indicated an acceptably low goitre prevalence rate of 3%.

Despite the relatively small sample size, the anthropometric indices of malnutrition in these children indicated a high prevalence of undernutrition. Because undernourished children are usually vulnerable to micronutrient deficiencies, it is gratifying to report that their current iodine status is normal. Interestingly, the nutritional status of the boys in this group of children was worse than that of the girls. The prevalence of stunting (35.7%) and overweight (21.4%) was higher among the boys than the girls, their median urinary iodine concentration was lower (but within the normal range), and their goitre rate appeared higher.

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