Public Health Nutrition: 6(5), 463–469 DOI: 10.1079/PHN2003461

Salt iodisation and public health campaigns to eradicate iodine deficiency disorders in Armenia

Laura Rossi and Francesco Branca*
Human Nutrition Unit, National Institute for Research on Food and Nutrition, via Ardeatina 546, 00178 Rome, Italy

Submitted 14 October 2002: Accepted 29 January 2003

Abstract

Background: Iodine deficiency disorders (IDD) are endemic in the mountain regions of Armenia. Universal salt iodisation has been chosen as the control measure.
Objectives: (1) To measure the prevalence of iodine deficiency in the Armenian population; (2) to evaluate household use of iodised salt; and (3) to monitor iodised salt promotion strategies.
Design: Cross-sectional study on a nationally representative sample of 2627 households, including 3390 children under five and 2649 women of fertile age. Cluster sampling design on four population strata: residents, refugees, rural and urban.
Results: Thyroid was palpable in one-third of the women, 6% of them having a visible goitre. Median of urinary iodine excretion in children was 139.5 $\mu g\,l^{-1}$. One-third of the children showed low urinary iodine concentration. Iodised salt was consumed in 66% of the households. The national IDD control programme included modernisation of the Yerevan Salt Factory, legislative regulation of the iodine content of the salt, and public information by the media.
Conclusions: Armenia was still an endemic zone for goitre in 1997. The iodine status of children under five in 1997 was not considered alarming even though 33% of them had low values of urinary iodine. After four years of intervention strategies, the use of iodised salt has increased by 17%. Further efforts should be made to control salt imports and to monitor IDD indicators in vulnerable groups.

Keywords
Iodine deficiency disorders
Children
Women
Dietary prophylaxis
Public health strategies
Armenia

Iodine deficiency is the world's single most significant cause of preventable brain damage and mental retardation. Mild to moderate growth retardation is often present in healthy subjects residing in areas of iodine deficiency[1].

Endemic goitre is the most common consequence of iodine deficiency. The natural history of goitre may be complicated by multi-nodular evolution, thyrotoxicosis and neoplastic degeneration. Severe iodine deficiency leads to major neuropsychological defects such as endemic cretinism.

The iodine content of foods depends on the iodine content of the soil on which they are grown. The low iodine content of the soil is the initial, necessary but not sufficient, cause of iodine deficiency disorders (IDD). Socio-economic conditions are a potent co-factor for the development of goitre and other IDD. IDD cannot be eliminated by changing dietary habits or by eating specific kinds of foods, but must be corrected by supplying iodine from external sources. While a variety of methods exist for the correction of iodine deficiency, in practice the most commonly applied is universal salt iodisation for human and livestock consumption. Other methods such as iodised oil (in capsules and injections), iodised bread, etc. are temporary remedies with high cost-effectiveness but poor sustainability[2].

The Republic of Armenia shows the typical contradictions of a transition country, with low population density, a high literacy rate, a high employment rate but low average monthly income[3]. In addition to that, the breakdown of the centrally planned sanitary system following independence from the Soviet Union, the 1988 earthquake and the armed conflict with Azerbaijan exacerbated the general situation, causing marginal health and nutritional status in high-risk population groups such as young children and women.

Since 1974 Armenia had been supplied with iodised salt made in Ukraine, but economic collapse stopped this in the 1990s. As a result, the prevalence of IDD increased and the situation of goitre prevalence in endemic areas worsened.

In 1995 a survey proved the extent of IDD in the mountainous regions of Armenia. The groups examined were 3211 schoolchildren (6–12 years old) and 633 pregnant women. Half of the pregnant women surveyed

**Corresponding author:* Email f.branca@agora.it

had goitre. Goitre was also found in 40% of the 6–12-year-old children[4].

Considering the lack of information regarding iodine status in Armenia, in the framework of a national nutritional survey promoted by the United Nations Children's Fund (UNICEF) a specific component of IDD assessment was included. Evaluation of the magnitude of a problem of public health is the first step for developing a nutritional intervention strategy[5].

The objectives of the present study were to quantify the prevalence of iodine deficiency and goitre in vulnerable groups of the Armenian population, to evaluate the use of iodised salt in households and to compare different regions and ethnic groups with the aim to tailor intervention strategies adequately. This paper also describes and comments about the public health strategies adopted and their impact.

Subjects and methods

Study area and study population

A cross-sectional study was carried out in May–June 1997 on four population strata: residents and refugees living in rural and urban areas. The most recent census was used to select the sample for a cluster sampling design[6]. The sample size was calculated to provide an estimate of the prevalence of IDD within the 95% confidence interval (CI) and an error margin of 0.05 for each age and sex category. The total number of subjects to be covered by the survey was then calculated to be 437 children and 282 women per stratum.

The location of the clusters was decided with a two-stage procedure with a Probability Proportional to Size methodology.

The study protocol was reviewed and approved by the Ministry of Health of Armenia and by the UNICEF office in Yerevan. People in the households were informed of the purpose of the survey and an official letter from the Armenian Ministry of Health was shown in order to introduce the fieldworkers.

Assessment of iodine status and exposure

Thyroid size

Thyroid size was assessed in all women, including those who were pregnant, by using the traditional method of inspection and palpation. Physicians evaluated the presence of a palpable and visible thyroid, recording their findings with simplified international criteria[7] as: stage 0 (no palpable or visible goitre), stage 1 (a mass in the neck that is consistent with an enlarged thyroid that is palpable but not visible when the neck is in the neutral position; it also moves upwards in the neck as the subject swallows) or stage 2 (a swelling in the neck that is visible when the neck is in a neutral position and is consistent with an enlarged thyroid when the neck is palpated). According to the World Health Organization (WHO)/UNICEF/International Council for Control of Iodine Deficiency Disorders, the total goitre rate (TGR: the number with goitres of grades 1 and 2 divided by the total number examined, expressed as a percentage) should not exceed 5% to justify iodine supplementation[2].

Urinary iodine concentration

Urinary iodine was used for the assessment of iodine status in children under five. This is a widely used biochemical marker of iodine status since most dietary iodine is excreted in urine (usually over 90% of the daily intake) and only a minor fraction in faeces[8,9].

A 10 ml urine sample from the first-void morning urine was collected in all children aged 6–59 months for urinary iodine measurements. Urine iodine concentration was measured by using a commercial colorimetric kit (Elvi, Milan, Italy) based on the method reviewed by Dunn and co-workers[9].

Urinary iodine concentration greater than $100\,\mu g\,l^{-1}$ is considered normal. A range of excretion of $50–99\,\mu g\,l^{-1}$ indicates mild deficiency, while $20–49\,\mu g\,l^{-1}$ indicates moderate deficiency. Severe iodine urinary excretion is defined for concentration lower than $20\,\mu g\,l^{-1}$. In a population with no iodine deficiency, 50% of the people should have iodine urinary concentration of $100\,\mu g\,l^{-1}$ and above and no more than 20% of the sample should be below $50\,\mu g\,l^{-1}$ (WHO[10]).

Iodised salt in the household

The iodine content of salt can be determined qualitatively using rapid test kits. Rapid test kits can be used in the field to give an immediate result and are particularly suitable for household surveys[11,12]. The iodine content of salt used in the households was evaluated by testing the content of potassium iodate or potassium iodide and using a semi-quantitative test giving an approximate concentration of the iodine in salt. A drop of each one of two indicator solutions, one for concentration lower than 15 ppm (UNICEF Stock No. 05-860-01, Copenhagen, Denmark) and one for concentration higher than 15 ppm (UNICEF Stock No. 05-860-02, Copenhagen, Denmark), was applied to one spoon of salt, flattened on a dish. The colour that developed immediately from the reaction was interpreted with a coloured scale on the back of the packet of the test solution.

Monitoring of intervention strategies

Production and packaging equipment and techniques, and the quality of raw materials were checked in the salt factory. Reports on the legislation and on the information campaigns carried out by the Ministry of Health were reviewed. Structured interviews were carried out with local health authorities for an evaluation of the awareness of IDD problems.

Statistical analysis

Data analysis was done by using the software package STATISTICA for Windows 4.5 (StatSoft, Tulsa, OK, USA, 1995). The results are presented either as means and standard deviation (SD) or as proportions (%). In order to examine the results for each population stratum, cross-tabulations were produced and the chi-square test was used. The same technique was followed for examining results by regions (Marzes), by urban areas and by sex. Statistical significance was defined as a P-value of 0.05 or less. In addition, continuous variables were transformed into categorical variables by using the cut-off points mentioned and cross-tabulations were then produced. To assess the magnitude of association between age or nutritional status indicators and iodine deficiency exposure, the relative risk was calculated. The relative risk is defined as the ratio of the prevalence of iodine deficiency in the exposed group to the corresponding prevalence of iodine deficiency in the unexposed group. Calculation of the risk difference parameter permitted an evaluation of the risk percentage attributable to the risk factor. In order to calculate national prevalence figures, a different weighting factor was applied to each of the four strata. This population weight was obtained by dividing the total population in each stratum by the number of subjects in the study sample.

Results

Characteristics of the study population

Complete interview data were gathered on 2627 households and included 3390 children under 5 (6–59 months) and 2649 women of fertile age (15–45 years). The total sample of children and women was examined in four strata of population. Variable proportions of households either refused to be surveyed or were not available. Among residents, basically all of the target families were interviewed in the rural areas and only 5% were unavailable in the urban zone. A larger number of refugee households (11% in rural and 26% in urban areas) could not be interviewed, largely because the households originally present in the census of the United Nations High Commissioner for Refugees had moved.

Iodine status and prevalence of goitre

Women

Figure 1 shows the prevalence of goitre in women aged 15–45 years in the different population strata. Thyroid was palpable in one-third of the women surveyed, 6% of whom had a visible goitre. A higher TGR was observed among rural residents (35%) while the lowest prevalence (28%) was found in resident women living in urban areas ($P < 0.05$). Southern regions and one northern region had the highest TGR, with positive thyroid palpation in more than 40% of the cases.

Children

The median level of urinary iodine concentration was above the 100 $\mu g\, l^{-1}$ cut-off point and the 20th percentile was above 50 $\mu g\, l^{-1}$, indicating that iodine status in the children was not severely deficient (Table 1). One-third of the children under five showed low levels of urinary iodine concentration. Children living in rural areas, both residents (39%) and refugees (32%), showed lower levels of urinary iodine concentration than those living in the urban zone (residents, 27% and refugees, 26%). Severe forms of iodine deficiency were uncommon (less than 1%) in Armenian children (Fig. 2). The prevalence of low iodine excretion was significantly higher in children under two (36%) than in older children (29%) (Table 2). Young children were more likely to become iodine-deficient, and

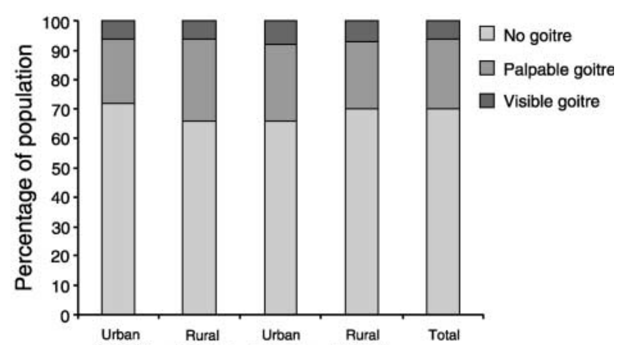

Fig. 1 Prevalence of goitre in women aged 15–45 years by population stratum ($n = 2569$, missing values = 58; prevalence between population strata significantly different with $P < 0.05$ and Pearson's $\chi^2 = 13.19$)

Table 1 Urinary iodine concentration by population stratum in children under five: summary of results*

	Urban residents	Rural residents	Urban refugees	Rural refugees	Total†
Number of children	632	764	501	662	2559
Median ($\mu g\, l^{-1}$)	151.0	120.0	148.3	135.0	139.5
20th percentile ($\mu g\, l^{-1}$)	80.0	64.5	83.5	75.0	73.2
80th percentile ($\mu g\, l^{-1}$)	282.5	217.0	249.6	250.0	250.0

* Distribution by stratum (Kruskal–Wallis test) significantly different with $P < 0.0001$ and Pearson's $\chi^2 = 27.04$.
† Missing values = 831.

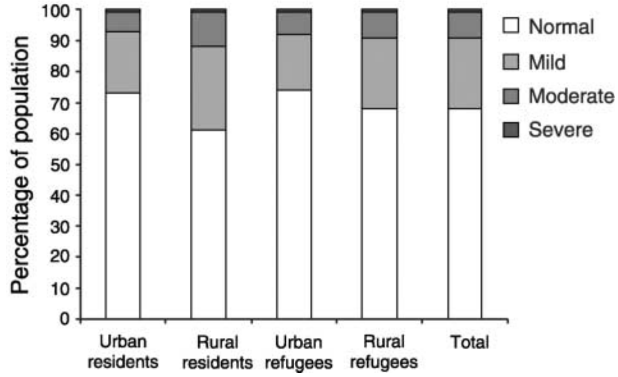

Fig. 2 Prevalence of different classes of urinary iodine concentration (normal iodine concentration: $>100\,\mu g\,l^{-1}$; mild degree of deficiency: iodine concentration between 99 and $50\,\mu g\,l^{-1}$; moderate degree of deficiency: iodine concentration between 49 and $20\,\mu g\,l^{-1}$; severe degree of deficiency: iodine concentration $<20\,\mu g\,l^{-1}$) in children aged 6–59 months by population stratum ($n = 2559$, missing values = 831; prevalence between population strata significantly different with $P < 0.0001$ and Pearson's $\chi^2 = 35.45$)

their relative risk was 0.77 (95% CI 0.68–0.86) compared with older ones. Low levels of urinary iodine concentration were found especially in north-eastern regions, in which the prevalence was higher than 40%, while south-western areas were less affected.

Use of iodised salt in households

In urban areas, mainly packaged salt was available, while in rural areas loose or coarse unpacked granular salt was the most common type. Tests of domestic salt showed that the majority of salt used by the population was iodised (66%). Residents were more likely to consume iodised salt than were refugees, and the use of iodised salt was more common in rural than in urban areas (Fig. 3). In southern regions iodised salt consumption was particularly low, with more than 60% of the households not using it.

Table 2 Urinary iodine concentration by age class in children under five*

Age class	Urinary iodine concentration† Low	Normal	Total
6–24 months			
n	324	539	863
%	37.5	62.5	100.0
95% CI	33.1–41.9	58.0–66.9	
25–59 months			
n	488	1208	1696
%	28.8	71.2	100.0
95% CI	25.1–32.5	67.5–74.9	
Total			
n	812	1747	2559‡
%	31.7	68.3	100.0
95% CI	28.2–35.2	64.8–71.8	

*Prevalence by age class significantly different with $P < 0.001$ and Pearson's $\chi^2 = 20.30$.
†Low: urinary iodine concentration $\leq 99\,\mu g\,l^{-1}$; normal: urinary iodine concentration $\geq 100\,\mu g\,l^{-1}$.
‡Missing values = 831.

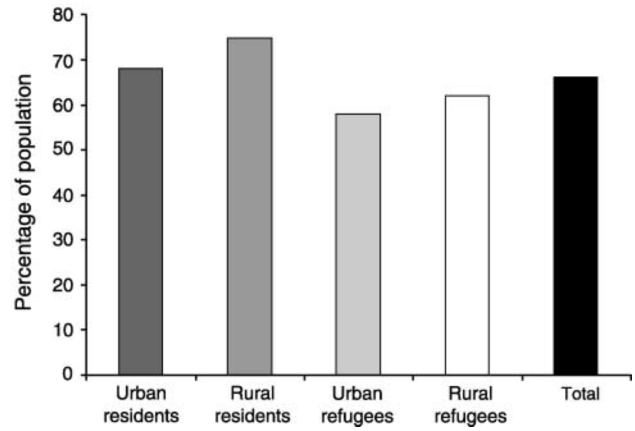

Fig. 3 Iodised salt use in households by population stratum ($n = 2431$, missing values = 196; prevalence between population strata significantly different with $P < 0.0001$ and Pearson's $\chi^2 = 45.34$)

Iodine intake in the households was not related to iodine excretion in children and goitre in women (data not shown).

Social and public health activities for national IDD control programme

The three major components required to consolidate the elimination of IDD and to sustain it permanently are political support, financial support and the establishment of an assessment and monitoring system[5]. Between 1998 and 2000, different activities aimed at increasing the consumption of iodised salt were carried out. The local salt factory went through extensive renovations of the technical and structural aspects. New equipment, such as a pump, spraying nozzles and a modern iodisation machine, were provided to produce high-quality iodised salt. Since iodine loss occurs as a result of improper packaging, several versions of salt packages were elaborated and provided by the salt factory in order to avoid humidity, moisture and sunlight exposure of the product. Investments were made to grant job security and to cut production costs. Quality control on the production site and at market level is now carried out. The local salt factory was designed for a maximum capacity of 45 000 tons per annum. In 1999, the production of vacuum iodised fine salt was 14 903 tons of which 12 903 tons was distributed in 1 kg packs and 2000 tons in 50 kg bags. Since the table salt requirement in Armenia is about 14 tons per annum, the production capacity of the salt factory is adequate.

As a result of activities directed towards advocacy and the promotion of iodised salt, the standard level for salt iodisation in Armenia was officially increased from 35 to $50\,mg\,kg^{-1}$. International recommendations indicate that, at the point of production, iodine concentration in salt should be in the range of 20–40 mg iodine per kg of salt[5]. Like most countries, Armenia has established a level of 50 mg per kg of salt in order to compensate for losses due to transit, storage and cooking, estimated at about 20 mg per kg[5].

A further challenge for Armenia was the production of iodised salt for animal consumption. In 2000, a law was also established that made the sale of non-iodised salt illegal.

Information and educational campaigns were also carried out all over the country. Public information was promoted through the distribution of 5000 colour posters on iodised salt and 300 000 colour leaflets on the prevention of IDD. Posters and leaflets were appealing and included recent information and messages on IDD and universal salt iodisation directed towards different groups of the population.

Multi-channel information dissemination was used to ensure a high coverage rate and a high access to information. With this purpose, two TV companies were involved in the project. In total, eight IDD-focused TV programmes and six TV spots were produced. All programmes were broadcast by different national channels, providing a country-wide coverage rate. Four TV programmes and spots were incorporated into a special national health-related programme. TV spots were periodically broadcast during the whole year. To ensure coverage at the regional level, the TV companies provided 12 copies of videotapes with all materials produced for distribution to all Marzes and for broadcasting by local Marz TV channels. Information and education campaigns were undertaken in Syunik (South) and Shirak (North) regions. Endocrinologists and paediatricians visited villages and organised community meetings with local authorities, health providers and the village population to disseminate information on IDD and its prevention, emphasising and promoting the use of iodised salt.

Discussion

The Republic of Armenia was still classified as an endemic zone for goitre in 1997, and the present work confirms that IDD was a major public health problem at least in women of childbearing age. In fact goitre was common in women, particularly in the southern regions, where more than 40% of them were positive at thyroid palpation. The iodine status of children under five was not considered alarming in 1997. The level of public health concern about the iodine status of children was evaluated on the basis of the recent international recommendation that did not indicate a specific cut-off point for children under five[5]. Recent work by Delange and co-workers[13] suggested a median normal range of iodine excretion in children under three of 180–220 $\mu g\, l^{-1}$. This range would completely change the interpretation of our results, but in our opinion its application should be done cautiously and after a large international consensus. At any rate, one-third of the children under five showed low levels of urinary iodine concentration with a higher prevalence in rural than in urban areas. In the majority of the population studied, only mild iodine deficiency was observed. Less than 1% had severe iodine deficiency. The higher prevalence of low iodine excretion in children under two (36%) than in older children (29%) can be explained by considering that the latter are more likely to consume iodised salt, as part of the family diet. Residents and refugees did not show a different pattern of IDD prevalence, possibly because the displaced people are now well integrated in the Armenian social structure.

The traditional method for determining thyroid size is inspection and palpation. Ultrasonography provides a more precise and objective method. However, there is no agreement on reference values. Palpation has been used in most epidemiological studies of endemic goitre and is still recommended. In fact, this method is particularly useful in assessing goitre prevalence although its validity is weak in determining impact[5]. The main advantages in using the palpation methodology are related to the low costs of assessment, the short training of the personnel required and the simplicity of the fieldwork. The cut-off point (TRG of 5%) for assessing the severity of IDD takes into account that some goitre assessment by palpation could be inaccurate.

IDD surveys are usually carried out in schools. School-age children are a useful target group for IDD surveillance because of the combination of their high vulnerability and easy access for a variety of surveillance activities. For cost and logistic reasons, the present work was conducted within a household micronutrient survey in which women and children under five were targeted. The advantage of this design is that the women's assessment, salt analysis and urine sample collection were performed at the same time, giving a full picture of the household situation.

In 2000, in the framework of a Demographic and Health Survey (DHS), a representative sample of 5976 households (3630 in urban areas and 2346 in rural zones) was tested for iodised salt use. These datasets are in the public domain and are available from the DHS website[14]. No stratification for residents and refugees was performed in this assessment. Figure 4 shows that iodised salt use in the households had increased by 17%. Improvements appeared in both urban and rural areas, although it was most relevant in the former. In the 2000 survey, 83% of households were effectively consuming iodised salt while in 1997 this prevalence was 66%. In central areas of the country, iodised salt was used in 95% of the households, as opposed to 59% in the northern regions. Compared with the data collected in 1997, iodised salt consumption was increased in all regions except in the North-East (Fig. 5). Despite the efforts and the encouraging results, there are still some regions in which approximately a quarter of salt samples did not contain iodine. A possible explanation for

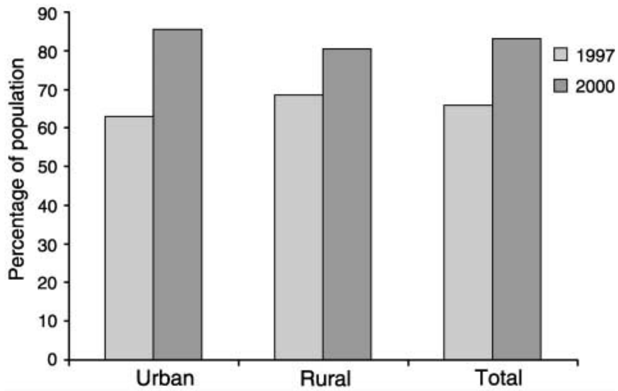

Fig. 4 Comparison between iodised salt use in households in 1997 and 2000 by area (urban and rural)

Fig. 5 Attitude towards iodised salt use in households between 1997 and 2000 by Marz

this finding could be related to the presence on the market of packages of salt imported from other countries, such as Ukraine and Iran. It is possible that salt produced outside Armenia (which is cheaper) is more widely available in certain regions.

WHO indicates that coverage is adequate when 90% or more of households consume iodised salt[5]. Therefore, despite the good results, Armenia should better control the salt market by preventing external imports. Enforcement of the Government Decree banning the import of non-iodised salt for human consumption is poor, and more than 2000 tons of non-iodised salt are imported annually[15]. With respect to regional differences, the highest prevalence of low urinary iodine excretion in children under five was observed in the northern regions. The low prevalence of iodine deficiency in southern mountainous regions (less than 30%) perhaps reflects recent trends of increased levels of iodised salt consumption in these areas.

An evaluation of the effect of the intervention strategies has not yet been performed. Urinary iodine concentration should thus be reassessed in children.

Until the 1980s, the presence of IDD was underestimated in Eastern Europe[16]. Since then, iodine prophylaxis programmes have been started in several countries. While iodine deficiency has been recorded in nearly all of the 51 countries in the European region, IDD have been eliminated in only 12 of them by salt iodisation programmes (e.g. Slovakia, Switzerland).

The lesson learned by the Armenian IDD control strategies indicates a general recommendation about IDD assessment, and one about IDD eradication strategies.

Regular assessment procedures, particularly for salt iodine, goitre and urinary iodine, are advisable for monitoring progress towards the sustainable elimination of IDD as a public health problem. Household surveys are the most widely used method to obtain data on the health and nutritional status of a population. In Armenia, such a survey was an important advocacy and planning tool for IDD control. In addition, the design of the survey provides breakdown of information by regional, social and ethic groups, which is difficult to obtain from routine data sources. Compared with a standard school survey, a household survey can provide information for targeting actions to specific groups, for developing adequate social marketing strategies and for understanding intra-household differences in risk.

The results of the survey led to a strong commitment by the Government at all levels and to the implementation of a strategy including the establishment of strict regulations, the improvement of the capacity of producers and distributors, and the involvement of the health and educational system.

Strict market control is probably essential to achieve good country coverage. However, educational campaigns should also be promoted to improve the efficacy of the programme and to ensure democracy by achieving full awareness in the whole population.

Acknowledgements

This study was supported by Yerevan UNICEF Office, Armenia and by the US Agency for International Development. The authors are grateful to Professor Vincenzo Pezzino for analysing the urine samples, and to Ruzan Gyurjyan and Liana Hovakimyan for their support and contributions during the fieldwork.

References

1 Azizi F, Kalani H, Kimiagar M, Ghazi A, Sarshar A, Nafarabadi M, *et al*. Physical, neuromotor and intellectual impairment in non-cretinous schoolchildren with iodine deficiency. *International Journal for Vitamin and Nutrition Research* 1995; **65**: 199–205.

2 World Health Organization (WHO). *Iodine and Health: A Statement by WHO*. WHO/NUT/94.4. Geneva: WHO, 1994.

3 Cairella G, Napoletano A, Coclite D, Rossi L, Hofwannshian A, Saribekian K, *et al*. A methodological approach for a nutritional surveillance system in a transition country: the case of Armenia. *Annali di Igiene* 1999; **11**: 199–208.

4 Toromanen EN, Alexanian MA, Gevorkian AA, Narimanian NZ. *Prevalence of Iodine Deficiency Disorders in the Republic of Armenia*. Armenian Monthly Public Health Report, 1996.

5 World Health Organization (WHO). *Assessment of Iodine Deficiency Disorders and Monitoring their Elimination*. Geneva: WHO, 2001.

6 Henderson RH, Sundaresan T. Cluster sampling to assess immunization coverage: a review of experience with a simplified sampling method. *Bulletin of the World Health Organization* 1982; **60**: 253–60.

7 World Health Organization (WHO). *Physical Status: The Use and Interpretation of Anthropometry*. Geneva: WHO, 1995.

8 Lamberg BA. Iodine deficiency disorders and endemic goitre. *European Journal of Clinical Nutrition* 1993; **47**: 1–8.

9 Dunn JT, Crutchfield HE, Gutekunst R, Dunn AD. Two simple methods for measuring iodine in urine. *Thyroid* 1993; **3**: 119–23.

10 World Health Organization (WHO). *Recommended Iodine Levels and Salt and Guidelines for Monitoring their Adequacy and Effectiveness*. Geneva: WHO, 1996.

11 Dustin JP, Ecoffey JP. A field test for detecting iodine-enriched salt. *Bulletin of the World Health Organization* 1978; **56**: 657–8.

12 Narasinga R, Ranganathan SA. A simple field kit for testing iodine in salt. *Food and Nutrition Bulletin* 1985; **7**: 70–2.

13 Delange F, Wolff P, Gnat D, Dramaix M, Pilchen M, Vertongen F. Iodine deficiency during infancy and early childhood in Belgium: does it pose a risk to brain development? *European Journal of Pediatrics* 2001; **160**: 251–4.

14 Measure DHS. *Demographic and Health Surveys. Armenia 2001*. Calverton, MD: Macro International, 2001.

15 United Nations Children's Fund (UNICEF). *Assessment of the Armenian Iodised Salt Factory and Program*. Yerevan: UNICEF, 2000.

16 Vitti P, Rago T, Aghini-Lombardi F, Pinchera A. Iodine deficiency disorders in Europe. *Public Health Nutrition* 2001; **4**: 529–35.