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Short communication
Schoolchildren in the Principality of Liechtenstein are mildly iodine deficient

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Abstract

Objective: To investigate the iodine status of schoolchildren in the Principality of Liechtenstein.
Design: A representative, cross-sectional principality-wide screening of iodine level in household salt and urinary iodine concentrations (UIC) in primary-school children. Data were compared with the WHO criteria and with 2009 iodine survey data from Switzerland, a neighbouring country that supplies most of the salt used in Liechtenstein.
Settings: Principality of Liechtenstein.
Subjects: Schoolchildren (n 228) aged 6–12 years from five different primary schools representing 11·4 % of the children at this age.
Results: The median UIC was 96 (range: 10–446) μg/l; 11 %, 56 % and 1 % of children had a UIC <50, <100 and >300 μg/l, respectively. In all, 79 % of households were using adequately iodised salt (≥15 ppm). The median UIC was 20 % lower than that in children at comparable age in Switzerland (120 μg/l; $P < 0·05$).
Conclusions: According to the WHO criteria, schoolchildren in Liechtenstein are mildly iodine deficient and household iodised salt coverage is inadequate. Public health measures to increase iodine intakes in the Principality should be considered.

Keywords
Iodine
Principality of Liechtenstein
Children
Urinary iodine

Iodine deficiency is a problem not only in developing regions but also in many industrialised countries[1]. Globally, two billion individuals have an insufficient iodine intake, and approximately 50 % of continental Europe remains mildly iodine deficient[2]. Iodine intakes in several industrialised countries, including the USA, Australia and New Zealand, have fallen in recent years[3]. In most countries, the best strategy to control iodine deficiency is salt iodisation. However, because approximately 90 % of salt consumption in industrialised countries is from purchased processed foods, to complement iodisation of household salt it is critical that the food industry uses iodised salt[3]. However, many European processed food producers are reluctant to use iodised salt because of differences in legislation in different countries. In addition, the current push to reduce salt consumption to prevent chronic diseases may be reducing iodised salt intake. In this context, it is becoming increasingly important to periodically monitor iodine status in populations; WHO recommends assessment every 5 years and reporting at 3-year intervals[4].

The mountainous regions of central Europe are historically an area of endemic goitre and iodine deficiency[5,6]. Despite this, the iodine status of Liechtenstein, a small independent principality (population: 35 356 in 2007)[7] located between Switzerland and Austria in central Europe, has not been assessed. As in Switzerland, iodisation of salt is not compulsory in Liechtenstein, as the Swiss food law is also effective in Liechtenstein since the customs union with Switzerland was formed in 1923. Therefore, 20–30 ppm iodine can be added to salt[8]. Most salt imported to the Principality is produced by the Swiss Salt Works in Basel, Switzerland, and hence fortified with 20 ppm iodine. Thus, the aim of the present study was to assess iodine status in Liechtenstein by determining urinary iodine concentrations (UIC) in schoolchildren and the iodine content of household salt[4].

Subject and methods

Subjects and design

Ethical approval for the study was obtained from the Swiss Federal Institute of Technology (ETH) Zurich and from the Ministry of Health of the Principality of Liechtenstein. Written informed consent was obtained from the parents of the children and oral consent from the children. Five of

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the fourteen primary schools in the Principality of Liechtenstein were selected for sampling, three from the southern region (Oberland) and two from the northern region (Unterland). The schools were in Balzers, Triesenberg, Schaan, Mauren and Eschen. Classes of each school were selected to obtain a balanced number of children from each age group. All children whose parents provided consent were enrolled from these classes. The age of the children was obtained from the consent forms and weight and height were measured[9]. A morning spot urine sample was collected from each child and stored at −25°C until analysis. In each class, children were randomly selected and given plastic bags for collection of a household salt sample. The salt samples were collected at the schools 1 week later and stored at the Human Nutrition Laboratory at ETH Zurich at −25°C until analysis.

Laboratory analysis

UIC and salt iodine concentration were measured in duplicate at the Human Nutrition Laboratory at ETH Zurich by using a modification of the Sandell–Kolthoff reaction[10]. By this method, the CV for UIC in our laboratory is 11·5 % at 31 (SD 4) μg/l and 3·6 % at 212 (SD 8) μg/l. The ETH iodine laboratory participates successfully in EQUIP (Program to Ensure the Quality of Urinary Iodine Procedures)[11].

Statistical analysis

EXCEL (XP 2003; Microsoft, Seattle, WA, USA) and the Statistical Package for the Social Sciences statistical software package version 18·0 (SPSS Inc., Chicago, IL, USA) were used for data processing and statistics. Normally distributed data were expressed as mean and SD; non-normally distributed data (UIC) were expressed as median and range. Non-normally distributed data were compared using the Mann–Whitney *U* test. *P* values <0·05 were considered significant.

Results

The mean number of children sampled at each of the five schools was forty-six (range: 24–77). A total of 228 children participated, representing 11·4 % of all children enrolled in primary schools in the Principality of Liechtenstein at the time of sampling. The female/male ratio was 119:109. The age of the children was between 6 and 12 years, with a mean age of 9·2 (SD 1·4) years. The median UIC was 96 μg/l (Fig. 1). In all, 56 % of the children had UIC < 100 μg/l, the cut-off for sufficiency, and 1 % had UIC > 300 μg/l, indicating excess[4]. Median UIC (range) in girls was lower than that in boys: 92 (10–446) *v.* 101 (11–483) μg/l ($P < 0·05$). There was no significant difference in median UIC between the two regions or between schools.

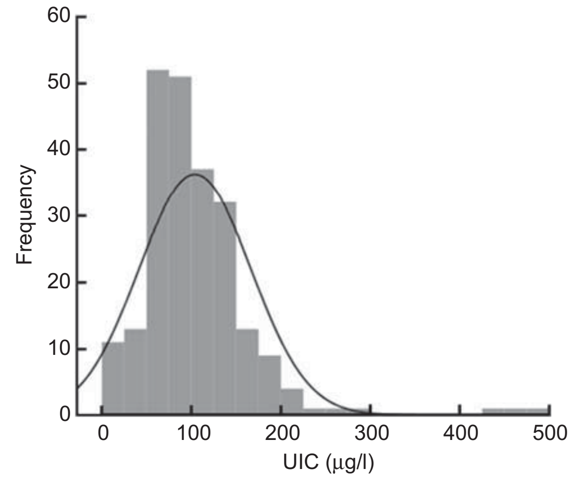

Fig. 1 Histogram of the urinary iodine concentration (UIC) in μg/l of the Liechtenstein schoolchildren

A total of 108 salt samples from households were analysed. Eighty-five (79 %) samples were adequately iodised, i.e. they had iodine concentrations ≥15 ppm[4]. The median iodine concentration of all samples was 19·1 (range: 0–39) ppm; 11 % of samples had no detectable iodine. The median iodine concentration of the samples containing adequate iodine (i.e. ≥15 ppm[4]) was 20·2 (range: 15·2–38·0) ppm.

Discussion

In the present study, the iodine status of the population in the Principality of Liechtenstein was assessed for the first time, using UIC in schoolchildren and household salt iodine content as the two indicators. Schoolchildren are recommended for monitoring iodine nutrition in a population because of their easy availability as subjects and their vulnerability to the adverse effects of iodine deficiency[12]. An indicator of optimal iodine nutrition in a population is a median UIC of 100–199 μg/l in school-aged children[4]. The median UIC of our sample was 96 μg/l, suggesting that the population in the Principality of Liechtenstein is mildly iodine deficient[4]. Even mild-to-moderate iodine deficiency may have adverse effects in schoolchildren: recent controlled studies in Albania and New Zealand found significant improvements on cognitive tests after supplementation with iodine in primary-school children[13,14].

Because dietary habits in Liechtenstein are similar to those in Switzerland, we expected the median UIC in the two populations to be comparable. However, the median UIC in schoolchildren in Liechtenstein is significantly lower than that in Swiss schoolchildren; Swiss national data in 2009 (*n* 916) indicate a median UIC of 120 (range: 10–408) μg/l in schoolchildren[15]. Even if similar demographic profiles are compared, i.e. the median UIC in

Liechtenstein children is compared with that of only Swiss children from towns having <10 000 inhabitants in mountainous regions (median UIC = 126 μg/l), the Liechtenstein median UIC remains significantly lower ($P < 0.05$).

This difference in mean UIC is surprising because Switzerland and the Principality of Liechtenstein are culturally very similar and most of the food is purchased at the same supermarket chains. Moreover, Liechtenstein receives food-grade iodised salt from the Swiss Salt Works in Basel. The food law in Liechtenstein is the same as in Switzerland and therefore salt iodisation is not mandatory. Austria, the other country bordering Liechtenstein, has successfully implemented salt iodisation[16], and food imports from there should not have a negative impact on the iodine status. Mild iodine deficiency in Liechtenstein may be due to lower use of iodised salt by local food producers, such as bakeries, as well as by cheese and sausage makers. Alternatively, it could reflect less use of iodophors and/or iodine supplements in Liechtenstein dairies. Bread, dairy foods and processed meat are the major sources of iodine in Swiss diets[17], but there are no data available on patterns of iodised salt use by local food producers in Liechtenstein.

Conclusions

The median UIC in a representative sample of schoolchildren in the Principality of Liechtenstein is 96 μg/l, suggesting mild iodine deficiency in the population. This places the Principality at risk for the adverse effects of mild iodine deficiency, including possible cognitive impairment in schoolchildren. Future studies should assess iodine status of pregnant women in Liechtenstein. They should also examine patterns of iodised salt use by local food producers; if iodised salt is not widely used, a public health campaign to increase awareness of the benefits of adequate iodine may encourage increased use of iodised salt by producers. Finally, our findings indicate that periodic monitoring of iodine status in Liechtenstein, for example, at 5-year intervals, would be beneficial to inform public policy.

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