Eur J Nutr (2009) 48:184–186
DOI 10.1007/s00394-009-0780-9

Is iodine intake in Germany almost adequate or even optimal and do nonalcoholic beverages relevantly contribute to iodine status?

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Published online: 12 February 2009

Sirs, in a recent overview of iodine deficiency in Europe published by the World Health Organization (WHO) an optimal level of iodine intake has been reported for several European Countries including Germany [11]. The German data are based on urinary iodine excretion measurements (spot samples) in 3,065 healthy 6–12 years old school children performed in 1999 [1]. In this study a median iodine excretion level of 148 μg/l had been reported. Representative measurements in spot urine samples of 14,078 children and adolescents aged 6–17 years, done 4–6 years later by the Robert Koch Institute as well as longitudinal analyses in 24-h urine samples in children with well documented dietary intakes yielded clearly lower median iodine excretion levels around 117 μg/l [7, 9]. Irrespectively of this discrepancy between the older examination and the two more recent studies, the classification according to the WHO criteria each fell in the assessment category "*optimal iodine nutrition*" (see Table 1). Considering that in the large German survey of the Robert Koch Institute 17% of the samples were below 50 μg/l and of those still 7.1% fell in the category "severe iodine deficiency" (<20 μg/l) [9], it appears not appropriate to classify German children and adolescents as having achieved an *optimal* iodine nutrition. For this classification not more than 3% of a representative sample should be below 20 μg/l. A more appropriate characterization of the current situation in Germany would be that the iodine nutrition is *almost adequate*.

In addition to biomarker measurements, also surveys based on dietary records or dietary recalls allow to evaluate the iodine status, although with an at least modest loss in accuracy and precision. Results and interpretation of dietary data do not only depend on the subjects' compliance and capacity for remembering food intake, but also on the quality and validity of the average analyte measurements as supplied for each food item in the food data bases used. In 2008, the evaluation of the large second German National Nutrition Survey (NVS II) has been completed and a strikingly high median iodine intake of 92 μg in women and 99 μg in men has been calculated solely for the portion of the exclusively intrinsic iodine content of the foods ingested (iodised salt not considered) [4]. These values were about 30–50 μg higher than earlier measurements of urinary 24-h iodine excretion rates in adults on normal diets either without any intake of iodised salt [6] or with only low iodised salt consumption [2]. The authors of the current NVS II report stated that according to the German nutrient data base (BLS) employed, nonalcoholic beverages were one of the food groups contributing most to this overall positive situation and the authors further concluded that particularly the iodine content of the corresponding water is responsible.

However, the question arises whether nonalcoholic beverages do actually have such a relatively high iodine content. In 2004 we measured the iodine content of a selected number of fruit juices commercially available in Germany [5] and found concentrations <5 μg/l (non-measurable) in most of the samples (Table 2). Only three juices had measurable low iodine concentrations of 6.1–7.4 μg/l. Apart from regional variation in the iodine content of German tap water, its mean iodine content is relatively low: 3.8 μg/l [3].

Assuming correspondingly negligible iodine concentration in most of the German beverages and re-evaluating the iodine intakes given in the German National Nutrition Survey (after subtracting the elevated contributions of beverages: approximately 35% for females and 27% for males) results in mean contributions of 60 and 72 μg/d in females and in males, respectively of intrinsic food iodine content (iodised salt not considered) to overall iodine supply. This corresponds roughly to the earlier measurements [2, 6].

Apart from providing estimates of the exclusive contributions of the natural foods' intrinsic iodine content (first scenario), a second scenario was run in the NVS II: the iodine intake was calculated for the theoretical situation that all of the (estimated) ingested salt was completely iodised. The absolute difference between both scenarios then allows estimations of the theoretical maximum contribution of added salt by food industry, bakers, butchers, and at home. Considering that in Germany approximately (1) 30% of the commercially available salted foods are produced with iodised salt [8], (2) 80% of the households use iodised table salts for cooking and food preparation [8], and (3) 1–1.5 g of the table salt is hereby actually ingested (on average) per

EJN 780

Table 1 Epidemiological criteria for assessing iodine nutrition based on median urinary iodine concentrations (UI) in school-age children according to World Health Organization, UNICEF, and International Council for Control of Iodine Deficiency Disorders[11]

Median UI (μg/l)	Iodine intake	Iodine nutrition
<20	Insufficient	Severe iodine deficiency
20–49	Insufficient	Moderate iodine deficiency
50–99	Insufficient	Mild iodine deficiency
100–199	Adequate	Optimal

Table 2 Iodine content in a sample of fruit juices, commercially available in Germany [5]

Juice	Label	Iodine concentration (μg/l)
Orange juice	Apfelsinensaft, Fruchtoase	n. m.
Orange juice	Apfelsinensaft, Amecke's	n. m.
Orange juice	Orangensaft, Hohes C	n. m.
Orange juice	Orangensaft, Sole Vita	n. m.
Apple juice	Gold-Apfelsaft, Albi	n. m.
Apple juice	Apfelsaft, Apfelblüte	n. m.
Apple juice	Apfelsaft naturtrüb, Paradiso	n. m.
Apple juice	Apfelsaft naturtrüb, Becker's Bester	n. m.
Multiple fruit juice	Multi12, Albi	7.4
Multiple fruit juice	Mehrfruchtsaft, Fruchtoase	6.1
Multiple fruit juice	Multi-Vitamin, Hohes C	n. m.
Multiple fruit juice	Vital Fit ACE Vitamingetränk, Wesergarten	6.8
Cherry fruit juice	Gold-Kirsche, Albi	n. m.
Cherry fruit juice	Kirschsaft, Granini	n. m.

Quantified by Cer-Arsenite method (Sandell and Kolthoff reaction) after alkaline ashing; n.m., non-measurable (<0.5 μg/100 ml)

day by adolescents and adults [10], it can be calculated that roughly 40% of the theoretical maximum iodine intake via iodised salt will contribute to the improvement of iodine status.

Applying this figure to the NVS data provided for 14–18-years-old German adolescents [reported median values: 73 and 83 μg/d (no iodised salt considered) and 161 and 215 μg/d (all ingested salt assumed to be iodised) for girls and boys, respectively] and considering in addition the 35% (females) and 27% (males) overestimation of the total foods' intrinsic iodine content by beverages, this finally results in corrected average daily intakes of 108 and 136 μg/d for the respective sexes.

The latter (corrected) NVS data correspond quite closely to the iodine biomarker measurements obtained in the so-called KiGGS study of the Robert Koch Institute. In the KiGGs study, median urinary iodine concentrations of 102.9 μg/l (girls) and 115.6 μg/l (boys) were determined for 14–17-years-old adolescents. Assuming an average daily urine volume of 1.1 l in this age group [12] and an average fecal iodine loss of 10%, then the above urinary iodine concentration measurements in KiGGS translate into estimates of daily iodine intakes of 125 μg/d (corrected NVS: 108 μg/d) and 140 μg/d (corrected NVS: 136 μg/d). Thus, after considering the almost negligible iodine concentrations of beverages and a portion of approximately 40% of salt intake as iodised salt, a reasonable agreement can be seen between urinary biomarker measurements and the food table-based NVS.

Altogether, the current iodine nutrition in Germany can be characterized as almost adequate. However, it must be borne in mind that continuous effort and regularly monitoring are necessary to maintain this level of iodine supply. If the food industry, bakers, and butchers continue to lower the use of iodised salt in their products (as preliminary data suggest) then iodine deficiency in Germany is threatening again.

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