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Iodine status assessment in Campania (Italy) as determined by urinary iodine excretion

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Abstract

Objective: Mild iodine deficiency was first documented in Campania in the 1990s. We assessed the urinary iodine nutritional status of schoolchildren in Campania before the introduction of legislation for salt iodization and compared the findings with previous results to evaluate to what extent "silent" iodine prophylaxis, which accompanies socioeconomic advances, affects iodine status.
Methods: We examined 10552 schoolchildren aged 9–13 y from the five Campania provinces. The study was conducted from April 1999 to October 2002. Urinary iodine excretion was measured in morning urine samples with the AutoAnalyzer 3, an automated system based on the Sandell-Kolthoff reaction. Data were interpreted according to World Health Organization criteria.
Results: The median urinary iodine excretion level in Campania was less than 100 $\mu\mu$g/L, which indicates insufficient iodine intake. Mild iodine deficiency was identified in all provinces, namely Napoli, Salerno, Caserta, Avellino, and Benevento, with median urinary iodine excretions of 87, 81, 72, 64, and 61 μg/L, respectively. Overall, the analysis of frequency distribution showed values below 50 and 100 μg/L in 32% and 61% of children, respectively. These values were lower than those previously reported for Campania.
Conclusion: This study confirms that Campania is a mild iodine deficiency area. The decrease in iodine deficiency versus previous studies indicates that silent prophylaxis plays a relevant role in this condition, but it is not sufficient to eradicate it. Our data will serve as a basis for future evaluations of iodine status in Campania.

Keywords: Urinary iodine excretion; Iodine intake; Iodine deficiency; Goiter; Iodine prophylaxis

Introduction

Iodine is the main substrate for thyroid hormone biosynthesis and is thus essential for thyroid function [1,2]. An adequate iodine intake is necessary for normal growth, development, and functioning of the brain and body. Iodine can be assumed only through the diet [1], and an iodine-deficient diet is associated with a wide spectrum of disorders, collectively known as *iodine deficiency disorders* (IDDs) [3].

Accordingly to the World Health Organization (WHO) [4,5], an optimal iodine intake is 150–300 μg/d, which corresponds to a median urinary iodine excretion (UIE) of 100–200 μg/L. A median UIE from 50 to 100 μg/L indicates mild iodine deficiency, values from 20 to 50 μg/L indicate moderate iodine deficiency, and values below 20 μg/L indicate severe iodine deficiency.

Mild iodine deficiency causes slight changes in thyroid gland morphology without altering thyroid function; this condition is classified as *endemic euthyroid goiter*. Subjects living in areas of moderate iodine deficiency are at risk of

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hypothyroidism and mental retardation. Severe iodine deficiency can result in hypothyroidism and goiter associated with such relevant clinical manifestations as endemic cretinism. Consequently, the socioeconomic consequences of IDDs are potentially very serious [5,6].

At present, iodine deficiency is a public health problem in 54 countries worldwide. In particular, nearly 60% of school-age children in Europe have an insufficient intake of iodine [7]. According to the WHO, measurement of UIE is the most accurate method with which to assess a population's iodine status [4,5] In fact, 90% of iodine intake is excreted in urine. Various groups have investigated iodine nutritional status by monitoring UIE in areas of Italy other than Campania [8–10]. Previous studies of UIE in children and adults have shown that, based on WHO criteria, Campania is an area with mild to moderate iodine deficiency [11–13].

The consequences of iodine deficiency and of IDDs can be prevented by ensuring an optimal iodine intake [7]. Various strategies have been devised to achieve this aim, one of the most effective being food fortification with iodized salt. In addition, it appears that the ''silent'' prophylaxis, namely the increased consumption of iodine-rich products associated with socioeconomic development, plays a significant role in IDD prevention [10,14,15]. Despite such encouraging results, silent iodine prophylaxis alone may not be sufficient to eradicate completely iodine deficiency.

We report UIE levels in Campania schoolchildren and analyzed the effects of silent prophylaxis by comparing our results with previous studies. In addition, we have established a UIE setpoint that can be used to evaluate the effects of mandatory salt fortification in the Campania population in the future.

Materials and methods

We selected a population of school-age children for this study because of ready access to schools, and because this populations reflects current rather than remote iodine nutritional status in the community [7]. The study population was constituted by 10 552 schoolchildren from the five Campania provinces (Napoli, Salerno, Caserta, Avellino, and Benevento): 5487 boys and 5065 girls 9 to 13 y of age. The population was selected according to well-established criteria as reported elsewhere [16]. Parents provided signed informed consent to the study. Avellino and Benevento are mainly inland mountain/hill zones, whereas Caserta, Napoli, and Salerno are mainly coastal, lowland zones.

From April 1999 to October 2002, urine samples were collected in the morning into screw-cap plastic tubes. All urine samples were taken to the laboratory, frozen, and stored at $-20\,^{\circ}C$ until analysis. Urine iodine levels were analyzed with an automated system (Autoanalyzer 3 system, Bran + Luebbe GmbH, Nordestedt, Germany), using the ceric-arsenious acid reaction and a modified digestion method in which the conventional acid digestion was replaced by ultraviolet irradiation [17]. Calibration of the analyzer was performed according to the manufacturer's instructions, using standard potassium iodide solutions in low, medium, and high concentrations of iodine, in triplicate in each assay. Standards and reference ranges are appropriate for children [7]. According to the statistician's suggestions, 676 samples below the analytical sensitivity of the method (5 μg/L) were excluded from the analysis, as were 369 samples with a UIE above 350 μg/L because such high values have been attributed to extradietary iodine intake [8].

The results are reported as medians rather than means, because urinary iodide levels of schoolchildren are not normally distributed [5]. We used the Wilcoxon-Mann-Whitney test for comparisons. $P < 0.05$ was considered statistically significant.

Median UIE values and interquartile ranges (IQRs) of the 8874 samples collected in the five provinces of Campania are shown in Fig. 1. Overall, the median UIE was 79 μg/L (IQR 39–140), with no significant difference between male and female subjects (data not shown).

Results

The median UIE value was always below 100 μg/L, although it varied among provinces: Benevento and Avellino had the lowest median UIE values (61 μg/L, IQR 29–114, and 64 μg/L, IQR 32–113, respectively) and Napoli (87 μg/L, IQR 46–151) and Salerno (81 μg/L, IQR 41–152) the highest. Schoolchildren in the province of Caserta had a median UIE value of 72 μg/L (IQR 36–129). The Wilcoxon-Mann-Whitney rank sum test revealed statically significant differences in the median UIE when Avellino, Benevento, and Caserta provinces were compared with the provinces of Napoli and Salerno.

According to the Italian National Institute of Statistics [18], Campania is divided into four geographic zones that differ in altitude and distance from the coast (inland mountains, inland hills, coastal hills, and lowlands). The median UIE and IQR calculated for each zone are listed in Table 1. The UIE differed significantly among various geographic zones.

We next clustered UIE in four classes: 5–19, 20–49, 50–99, and 100–350 μg/L (Fig. 2). As expected, the highest percentages of samples with a UIE from 5 to 19 μg/L occurred in Avellino (14%) and Benevento (18%), and the lowest were in Napoli (9%) and Salerno (10%). Moreover, in the provinces of Avellino and Benevento, about 40% of schoolchildren had UIE values below 50 μg/L, whereas the highest percentage of samples from 100 to 350 μg/L occurred in schoolchildren in the provinces of Napoli (44%) and Salerno (43%). The iodine deficiency status of schoolchildren in Caserta province was intermediate between those of Napoli and Salerno. Therefore, the highest degree of iodine deficiency in Campania occurred in Avellino and Benevento provinces, which correspond to the areas with largest number of areas classified