Applied nutritional investigation

Iodine nutritional status in pregnant women of two historically different iodine-deficient areas of Catalonia, Spain

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A B S T R A C T

Objective: Catalonia (Spain) has a historically worse situation of mild iodine deficiency in the Pyrenees Mountains compared with the coastal region. The aim of this study was to evaluate the current iodine status in pregnant women living in these two areas.

Methods: An epidemiologic prospective survey included 267 consecutive pregnancies in the Catalan mountains (n = 139) and coast (n = 128) studied during the first trimester; an additional subset of 135 women from the initial cohort was available for evaluation in the third trimester.

Urinary iodine (UI) was measured, and questionnaires to determine iodized salt and seafood consumption and potassium iodide supplementation were administered.

Results: The median UI in the first trimester was 163 μg/L for the entire cohort, with differences between mountain and coastal regions (209 versus 142 μg/L, P = 0.007). The highest prevalence of iodized salt consumption was in the mountain area (58% versus 36.4%, P < 0.001). For the entire group, a higher median UI was found in iodized salt consumers compared with non-consumers (193 versus 134 μg/L, P < 0.001). In the third trimester, an increase of median UI was seen in those to whom iodine supplements were given during pregnancy (190 versus 154 μg/L, P = 0.015).

Conclusion: A reversal in the historically iodine-deficient situation was observed in the Catalan Pyrenees compared with the coastal area, with a globally acceptable iodine status in pregnant women of the two geographic locations. Iodized salt consumption seems to have contributed to maintaining an acceptable iodine status in this population.

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Introduction

Over the past 20 years, efforts aimed at increasing the iodination of the population in Catalonia have been made [1]. The results have shown a significant decrease in the prevalence of goiter [2,3].

However, according to epidemiologic studies performed recently in Catalonia [4], there are still a significant number of women in their reproductive years who do not achieve the optimal iodine intake for a safe gestational response to the increased thyroid hormonal demands from the fetoplacental unit. Iodine sufficiency during pregnancy is of major relevance because it may directly influence thyroid hormonal production in critical stages of gestation such as the first trimester. The first half of the first trimester is a silent period in which the woman is usually
unaware of her pregnancy and is of major relevance to fetal brain development if the maternal thyroid is unable to produce the required amounts of thyroxin [5]. Therefore, an optimal iodine nutritional state for potential pregnant women is very important for the prevention of fetal morbidity related to iodine insufficiency.

As in many European countries, Catalonia has shown, from an historical point of view, areas of profound iodine deficiency, such as in the mountain region of the Pyrenees, whereas other regions near the coast have been considered much better iodinated. After the first epidemiologic study performed in 1985 [6], a map of iodine status was available for the population living in Catalonia. In the Pyrenees area, the average urinary iodine (UI) was 64 to 80 μg/L and goiter prevalence 45% to 52%. In the coastal area, the average UI was 90 to 109 μg/L and goiter prevalence 9% to 20%. From this information, subsequent campaigns promoting iodized salt consumption were implemented, particularly in those areas more affected by iodine deficiency, such as the Pyrenees. The result of these campaigns was a marked improvement of iodine nutrition in the general population [2,3], and recent epidemiologic studies have indicated that in both regions the iodine status of the general population remains remarkably improved [4]. Despite this new situation, data on iodine deficiency in pregnant women in Catalonia have been lacking until very recently. The International Council for Iodine Deficiency Disorders (ICIDD) has recommended performing periodical screening studies to have continually updated information on iodine deficiency in at-risk populations, such as in Catalonia [7].

We conducted an observational prospective study to compare two cohorts of pregnant women from two different areas of Catalonia: the first area, the mountainous region of the Pyrenees, has a history of serious iodine deficiency, and the second one, the Mediterranean coastal area of Maresme with no antecedents of iodine deficiency, has had an apparently acceptable iodinated status since the 1980s [8].

Materials and methods

An observational and prospective study was designed in which two cohorts of pregnant women, one from the Catalan Pyrenees and the other from the Catalan coast (Maresme), were followed from the first to the third trimester of pregnancy. Sample size was calculated assuming a z error of 0.05, a statistical power of 90%, a mean difference between groups of 50 μg/L and a standard deviation of 120 μg/L in the two groups, thus requiring 121 individuals per group.

Recruitment for the study was performed during 2000 and 2003 by gynecologic services at primary health care centers or hospitals where the pregnant women were being monitored; all participants were recruited in the first trimester. In the three local hospitals of the Pyrenees (Puigcerdà, La Seu d’Urgell, Vielha, and Tremp), the recruitment rate was proportional to the annual birth rate of every center (in 1999: 101, 149, 73, and 117, respectively). In the coast (Urgell), the number of annual births in this area was approximately 1200.

In the Pyrenees area, the average urinary iodine (UI) was 64 to 80 μg/L and goiter prevalence 9% to 20%. After this epidemiologic study performed in 1985 [6], a map of iodine status was available for the population living in Catalonia. The number of annual births in this area was approximately 1200.

Results

Two hundred sixty-seven pregnant women were consecutively recruited in the first trimester of gestation: 128 in the coast area and 139 in the Pyrenees area (20 in Puigcerdà, 44 in La Seu d’Urgell, 33 in Vielha, and 42 in Tremp). In 135 of them, an additional urine sample was obtained during the third trimester of pregnancy. Mean age was 29 ± 4 yr, mean gestational age when first seen was 9.5 ± 2 wk. 95% of the participating women were of Caucasian origin, and 47% were multiparous, with no differences in the prevalence of this condition between the two geographic areas. Table 1 lists the main characteristics of the two study populations. The mean age and the gestational age of the women also studied during the third trimester were not different from those in which sample was obtained during the first trimester.

Data of UI in the first trimester for the two different geographic areas are presented in Table 2. During the first trimester, women in the Pyrenees had higher UI concentrations than those of the coastal area. A higher prevalence of iodized salt consumption was detected in the mountains compared with the coast (58% versus 36.4%, P < 0.001). For the entire group, a higher median UI was found in iodized salt consumers compared with non-consumers (193 versus 134 μg/L, P < 0.001). In the subset of women from whom an additional sample was obtained in the third trimester, an increase of median UI was seen in those to whom iodine supplements were given during pregnancy (190 versus 154 μg/L, P = 0.015). These supplements contained 150 μg of potassium iodide.

In the first trimester, fish consumption was also higher in the Pyrenees group (Table 1); in the third trimester, in the subset in which a sample was available, there were no differences in the prevalence of iodized salt consumption in either region (coast group, 75.9%; Pyrenees group, 83.3%; not significant). In the Pyrenees, iodized salt consumers had a higher median UI compared with women who did not consume iodized salt (223 versus 114 μg/L, P < 0.001). However, this was not seen in the coastal area, where the median UI was similar for consumers and

### Table 1

Comparison of main characteristics of study samples

<table>
<thead>
<tr>
<th></th>
<th>Coast (n = 128)</th>
<th>Pyrenees (n = 139)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previously known dysfunction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypothyroidism</td>
<td>1 (0.8%)</td>
<td>1 (0.8%)</td>
<td>0.707</td>
</tr>
<tr>
<td>Hypothyroidism</td>
<td>9 (7.5%)</td>
<td>6 (4.9%)</td>
<td></td>
</tr>
<tr>
<td>Iodized salt consumption</td>
<td>43 (36.4%)</td>
<td>76 (58.0%)</td>
<td>0.001</td>
</tr>
<tr>
<td>Period of iodized salt consumption (y)</td>
<td>1 (0–24)</td>
<td>5 (0–15)</td>
<td>0.001</td>
</tr>
<tr>
<td>Age (y)</td>
<td>29.10 ± 4.02</td>
<td>29.40 ± 4.89</td>
<td>0.584</td>
</tr>
<tr>
<td>Number of children</td>
<td>0.46 ± 0.62</td>
<td>0.47 ± 0.83</td>
<td>0.931</td>
</tr>
<tr>
<td>Number of pregnancies</td>
<td>0.43 ± 0.63</td>
<td>0.47 ± 0.83</td>
<td>0.986</td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>35 (28.5%)</td>
<td>44 (33.6%)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>59 (47.9%)</td>
<td>54 (41.2%)</td>
<td>0.091</td>
</tr>
<tr>
<td>Formerly</td>
<td>29 (23.6%)</td>
<td>33 (25.2%)</td>
<td></td>
</tr>
<tr>
<td>Fish consumption (≥3 times/wk)</td>
<td>13 (10.7%)</td>
<td>27 (20.8%)</td>
<td>0.028</td>
</tr>
</tbody>
</table>

* Values are presented as number of subjects (percentage), median (range), or mean ± SD.
Table 2

<table>
<thead>
<tr>
<th>Urinary iodine of two geographic samples during the first trimester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coast</td>
</tr>
<tr>
<td>(n = 128)</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Urinary iodine (µg/L)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Median</td>
</tr>
<tr>
<td>Urinary iodine ≤150 µg/L</td>
</tr>
<tr>
<td>Urinary iodine ≤50 µg/L</td>
</tr>
</tbody>
</table>

non-consumers (151 versus 138 µg/L, P = not significant). In those women with samples available at the third trimester, an intake of polyvitaminic compounds containing a minimum of 150 µg of iodine was higher in the coast group (58.8% versus 42.2%, P < 0.049). In the third trimester, the median UI was higher in the consumers of iodine supplementation (190 versus 154 µg/L, P = 0.015). In women who smoked, a positive correlation was found between UI and the number of smoked cigarettes (r = 0.223, P = 0.013). A logistic regression analysis was performed to determine the effect of the different variables (zone, age, and iodized salt) on iodine status and the results are presented in Table 3. Multiple linear regression showed a significant effect of fish consumption (times/week; β = 75.2, P = 0.017) and the duration of previous iodized salt consumption (months; β = 5.69, P = 0.024) on the UI concentration, adjusting for geographic area and age.

Discussion

The recommendations made by the World Health Organization (WHO) and the ICIDD indicate that a median UI higher than 150 µg/L reflects an optimal iodine nutritional state in pregnant women [7]. This UI concentration corresponds to a daily iodine intake higher than 200 µg during pregnancy. Based on this premise, the two cohorts of women from these two different geographic areas of Catalonia showed an adequate iodine intake in the Pyrenees but a level slightly below 150 µg/L in the coast group. In the latter group, the median UI was similar to the data described in the previous epidemiologic study performed in adults living in Catalonia [4]. During pregnancy, iodine requirements increase considerably [10], and this is the reason the most recent ICCID document recommends 250 µg/d as the optimal intake of iodine for pregnant women [7].

In our study we found a median UI of 209 µg/L in pregnant women of the Pyrenees, whereas, unexpectedly, women from the historically non–iodine-deficient area of Maresme, near the northern coast of Barcelona, had a lower UI; however, when the time of declared iodized salt consumption was evaluated, a much longer period was found in the Pyrenees women compared with those of the coastal area, confirming the success of the campaigns and a prolonged effect on iodine nutrition. A previous study by our group found a fairly good UI concentration of 189 µg/L in schoolchildren 4 y old living in the same area of this coastal region, in the town of Mataró [8]. A potential explanation of these slightly dissimilar data would be related to a different iodized salt consumption because iodized salt consumption was 46% in the children but 36% in the pregnant women. Other iodine sources, such as dairy products mainly consumed by children, could also explain these differences. Conversely, it was surprising to find no differences in the UI between women consuming and not consuming iodized salt in this region of the coast of Maresme. No clear explanation for this finding has been found, unless the true content of iodine in the “iodized salt” was lower than declared or that the actual consumption was lower than reported by these women. In contrast, in “non-iodized salt” consuming women, other unrecognized iodine sources may have been supplied to them, exerting an equalizing effect when comparisons are made between the two groups and thus explaining the value of 134 µg/L found in non-consumers. Further, because the declared time of iodized salt consumption was not longer than 1 y on average for those women living in the coast, thyroid iodine stores may not have sufficient to reflect differences in UI concentrations. A survey of pregnant women in Rome (Italy) after a recent salt iodination program has demonstrated an insufficient iodine intake in this population [11]. These results support an active iodine supplementation during pregnancy.

In the first trimester, the median UI of the entire pregnant group was slightly higher than that of non-pregnant women in the Catalan study (163 versus 148 µg/L). Similar results have been found in other studies [12–15].

Spain is a country with a very heterogeneous iodine-deficiency map, with some areas of the country showing areas of concern in relation to iodine intake and others with a much better situation [16]. Catalonia is an area of Spain showing better data. As an example, in Málaga (coastal Andalucia), the median UI in pregnant women was found to be lower than 100 µg/L [17], and the same applies for the region of el Bierzo, in the northwest Iberian peninsula [18]. Also surprising is that in the city of Vigo, in the northwest coastal area of Galicia, where a previous study performed in 1995 [19] in schoolchildren showed good median UI (115 µg/L), and a recent study in pregnant women population reported a median UI of 113 µg/L, much lower than 150 µg/L [20]. In relation to other European countries, the reported data also indicate a better situation in Catalonia with the exception of Sweden [21].

Previous iodine nutritional status may be of importance when monitoring the response to iodine supplementation during pregnancy. In our study, in the group of women not taking iodine supplementation, the UI increased no higher than 130 µg/L, similar to published values of women with a basal UI lower than 80 µg/L in whom supplementation with 100 or 150 µg of potassium iodide was performed during the first trimester [22–26]. The interpretation of these data is very controversial because pregnancy is a state in which an increase in glomerular filtration rate [27] tends to induce an iodine negative balance; a modest increase in UI in previously deficient women may be explained by a tendency to retain iodine according to the deficient status.

It is very speculative at this point to propose an explanation for our results; the factors, perhaps dairy products, responsible for the silent iodine prophylaxis in Catalonia are currently unknown. Moreover, it is unlikely that a single factor could explain such differences in geographic areas so distant from one other in the Catalanian region, and the same probably applies to different protection situations in other regions of Spain and Europe. An interesting possibility would have been the existence of different concentrations of iodine in the water but this was not

Table 3

<table>
<thead>
<tr>
<th>First trimester</th>
<th>Bivariate</th>
<th>Multivariate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR</td>
<td>95% CI</td>
</tr>
<tr>
<td>Area</td>
<td>1.96</td>
<td>1.20–3.19</td>
</tr>
<tr>
<td>Age</td>
<td>1.07</td>
<td>1.01–1.13</td>
</tr>
<tr>
<td>Iodized salt</td>
<td>2.36</td>
<td>1.40–3.96</td>
</tr>
</tbody>
</table>

CI, confidence interval; OR, odds ratio

* Dependent variable: iodine sufficiency (urinary iodine >150 µg/L).
the case, because in the Pyrenees area of Cerdanya the concentration of iodine in the water is remarkably low (2.5 µg/L), whereas the median UI in this particular population is quite high (median 175 µg/L) [3]. The only feasible explanation thus far seems to be that the general consumption of iodized salt has probably been increasing steadily, particularly in Catalonia, and iodized salt may be being introduced in some nutritional products, thus implicating a silent increase in iodine consumption in the population.

In addition, while answering the questionnaire, a remarkable number of women realized that they were consuming iodized salt without being aware of it. Moreover, in the present study, when the results of the different participating centers of the Pyrenees were analyzed separately (data not shown), striking differences were seen, with a much higher UI in the samples coming from the Alt Urgell area (median 274 µg/L) compared with the Pallars area (median 76 µg/L). The iodine content in dairy products has also been proposed as a potential explanatory factor regarding changes in iodine nutritional status in the populations; milk consumption has been related to UI [28] and in certain European countries milk intake has also been linked to protection from iodine deficiency [29–33]. A recent study [34] showing an elevated iodine content (250 ± 58 µg/L) in milk manufactured in Spain, especially in the Pyrenees area, may in part explain our results.

Some studies have shown negative effects of tobacco consumption and the thyroid gland in pregnant women and in the fetus [35,36]. We observed a positive correlation between the number of smoked cigarettes and the UI concentration. Because smoking can increase UI excretion [37], smoking may have worsened iodine nutrition by UI wastage in the present population; this should be taken into account when evaluating the results of our studies.

According to our data, we believe that as a general recommendation for pregnancy, supplementation with at least 150 µg/d of potassium iodide still applies even in apparently favorable iodine nutritional conditions such as those of Catalonia. This practice is reinforced by the new recommendations made in 2007 [7], supporting a target value of approximately 250 µg/d as the optimal iodine intake during pregnancy. However, the best scenario is the one in which iodized salt consumption would have been consistently high during the pregestational condition, because this seems to be related to optimal UI concentrations during pregnancy, thus leading to a correspondingly high median UI throughout pregnancy, indicating that the thyroid iodine stores are sufficiently loaded [38]. In Catalonia, the reported consumption of iodized salt is still below 90% as recommended by the WHO [8,39,40]. This fact supports the supplementation of the pregnant population with potassium iodide.

In summary, pregnant women living in Catalonia have an acceptable iodine nutritional status, with an inversion of the historical relation between mountain and coastal areas according to UI concentration data. Even if the situation in Catalonia and in Spain is currently better compared with the past, periodic epidemiologic surveys are warranted to confirm that this tendency is not reversed. In the future, it will be interesting to investigate the iodine content in food, to better understand the sources of iodine in the diet that are contributing to a potential silent prophylaxis of iodine deficiency in Catalonia.

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**References**


