

INVITED REVIEW

Iodine status in Danish pregnant and breastfeeding women including studies of some challenges in urinary iodine status evaluation



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ABSTRACT

Denmark was previously iodine deficient with regional differences. Moderate iodine deficiency appeared in West Denmark and mild iodine deficiency in East Denmark and also Danish pregnant and breastfeeding women suffered from iodine deficiency. The Danish mandatory iodine fortification of salt was introduced in the year 2000 and has increased iodine intake in the Danish population. However, median urinary iodine concentration in the general population and in pregnant and breastfeeding women is still below the level recommended, corresponding to mild iodine deficiency. Certain characteristics may challenge the evaluation of urinary iodine status in pregnancy and during breastfeeding. This review also addresses methodological challenges related to spot urine sampling conditions and the use of iodine supplement and discusses the use of non-pregnant population groups as a proxy for iodine intake in pregnant women.

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Introduction

Iodine is required for the synthesis of thyroid hormones and the crucial role of thyroid hormones during early brain development makes adequate iodine intake in pregnant and breastfeeding women imperative [1]. Monitoring of population iodine status is important worldwide, and suboptimal iodine status has been shown both in developed and developing countries [2].

The recommended method to assess iodine status in a population is to collect spot urine samples for measurement of urinary iodine concentration (UIC) and calculation of median UIC [3]. According to the World Health Organization (WHO), the United Nations Children's Fund (UNICEF), and the International Council for the Control of Iodine Deficiency Disorders (ICCIDD) [3], a median UIC in the range from 50 to 99 $\mu\text{g/L}$ corresponds to mild iodine deficiency, from 20 to 49 $\mu\text{g/L}$ is moderate iodine deficiency and severe iodine deficiency is when the median UIC is below 20 $\mu\text{g/L}$.

Efforts to prevent iodine deficiency include universal food fortification programs and/or the recommendation of individual iodine supplementation. The Danish population previously suffered from mild to moderate iodine deficiency and a mandatory iodine fortification of salt was introduced in the year 2000 [4]. Iodine status in the general Danish population and in pregnant and breastfeeding women specifically has been evaluated both before and after the iodine fortification was introduced. In this review we describe urinary iodine status in Danish pregnant and breastfeeding women before and after the iodine fortification of salt and compare the urinary iodine status in these subgroups with that of the general population.

Historically, iodine status in a population was evaluated from the collection of spot urine samples in schoolchildren and it has been considered whether data on non-pregnant population groups can be used as a proxy for iodine status in pregnant women [5]. However, the conclusion has often been that a median UIC indicating sufficient iodine intake in schoolchildren may not indicate sufficient iodine intake in pregnant women [6]. The evaluation of iodine status from spot urine samples is challenging and many methodological details may influence the results [7]. In this review we also focus on some of the challenges related to the evaluation of iodine status in pregnant and breastfeeding women and we speculate whether disparities in results of urinary iodine status in different population groups may in part be explained by different urine sampling conditions.

Iodine status before the iodine fortification of salt

Denmark was previously iodine deficient with regional difference caused by different levels of iodine in drinking water [8]. Divided by the Great Belt, East Denmark had mild iodine deficiency and as illustrated in Fig. 1 West Denmark had moderate iodine deficiency with a median UIC below 50 $\mu\text{g/L}$.

Iodine status in Danish pregnant and breastfeeding women had been examined before the introduction of the iodine fortification of salt. The investigations [9–13] were mainly performed in West Denmark with previously most pronounced iodine deficiency. As illustrated in Fig. 1, the iodine intake in pregnant and breastfeeding women in this part of Denmark was inadequate with a median UIC on the border of mild to moderate iodine deficiency. Examination of pregnant women showed signs of thyroidal stress with increasing thyroid volume and serum TSH, and high levels of serum thyroglobulin (Tg) [10].

At this time, 35% of Danish pregnant women reported intake of iodine containing supplements when they arrived for delivery [11] approximating the frequency of iodine supplement intake in the Danish population in general [14]. The inadequate iodine status

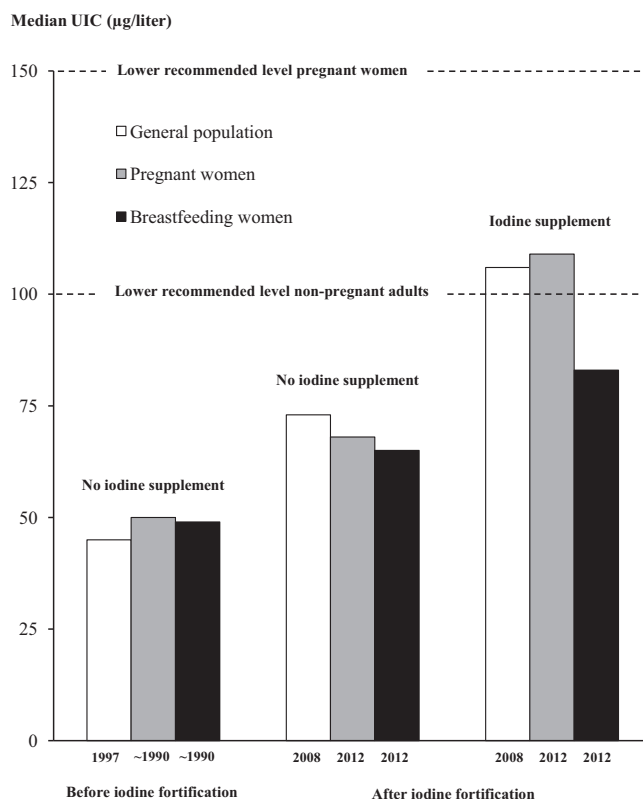


Fig. 1. Median urinary iodine concentration (UIC) observed in various studies in the general population as well as in pregnant and breastfeeding women living in West Denmark. Results were stratified by time of examination (before/after the introduction of the mandatory iodine fortification of salt introduced in the year 2000) and iodine supplement intake.

Source: Data from [15,16] for the general population, [10,13] for pregnant and breastfeeding women before the iodine fortification, and [17,18] for pregnant and breastfeeding women after the iodine fortification. Data for pregnant and breastfeeding women before the iodine fortification were averaged from two investigations with data collection from 1987 [10] and from 1994 [13].

in Danish pregnant women led to intervention studies with iodine supplement in pregnancy [10,13]. Pregnant women taking iodine supplement had higher median UIC and the changes in thyroid volume, serum TSH and serum Tg were ameliorated [10]. One concern about iodine supplement intake has been the possible risk of aggravation of thyroid autoimmunity in the postpartum period. However, in a Danish randomized controlled trial, iodine supplement intake in pregnancy was not associated with a higher frequency or more severe postpartum thyroid dysfunction [13].

Iodine status after the iodine fortification of salt

A voluntary iodine fortification of salt was introduced in Denmark in 1998, but the voluntary approach turned out to be insufficient, and a mandatory iodine fortification of household salt and salt used for commercial production of bread was implemented in the year 2000 [4]. The Danish investigation of iodine intake and thyroid disease (DanThyr) has monitored iodine status in East and West Denmark before and after the mandatory iodine fortification of salt. In both regions, iodine intake had increased after the introduction of the mandatory iodine fortification of salt and the combined median UIC (East and West Denmark) was 101 $\mu\text{g/L}$ in 2005 [14]. A follow-up study of the same individuals before and after iodine fortification also showed a significant increase in median UIC from 1997 to 2008 [15,16] as depicted for no iodine supplement users in West Denmark in Fig. 1. The combined median

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