Selenium status in a Northern Irish pregnant cohort with iodine deficiency

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Abstract:

Selenium and iodine are trace elements that are maximally concentrated in the thyroid. Iodine is a substrate for thyroid hormone synthesis, while the selenoproteins protect the thyroid from the oxidative stress incurred. We measured plasma selenium concentration in 241 pregnant women in 1st trimester, previously reported to have iodine deficiency. Mean age was 30.3 years (SD 5.4), BMI 26.2 kg/m² (SD 4.9) and 53% reported taking supplements. Median urinary-iodine concentration was 73 µg/L (IQR 37-122) (WHO recommendation, ≥150 µg/L). Mean plasma-selenium concentration was 75 µg/L (SD 7.7) which is below the 80-125 µg/L reported to be optimal. Four-day food diaries revealed a selenium intake of 43µg/day (SD 15.9), also below the 55-70 µg/day reported to be optimal. This is the first report of selenium status in pregnancy on the island of Ireland. The possible combined effects of iodine and selenium deficiencies in pregnancy merit further investigation.

Conflict of interest statement: There are no conflicts of interest

Introduction: Selenium and iodine are trace elements that are maximally concentrated in the thyroid gland.¹ Iodine is an essential substrate for thyroid hormone synthesis while the selenoproteins protect the thyroid from oxidative stress incurred during this process and regulate the amount of active hormone. Selenium availability is affected by soil characteristics (selenium concentration and speciation, organic matter) and geographical factors, therefore status should ideally be assessed across different land-masses.¹⁻³ For example, New Zealand appears to have naturally very low selenium intake compared to some parts of USA, while the UK population is regarded as having moderate risk of selenium deficiency.³

The richest sources of dietary iodine in the UK are dairy products and fish, while for selenium the richest sources are fish, meat and poultry.¹ Up to this point only two publications from the island of Ireland measured blood selenium levels, in breast cancer and phenylketonuria cohorts respectively, in the 1990s.²

Pregnancy: WHO has suggested an increased requirement of iodine in pregnancy and this is reflected by a recommended population median urinary-iodine-concentration (UIC) increase from 100 to 150µg/L for iodine sufficiency in pregnancy.^{4,5} For many years, the population of Great Britain and Ireland was thought to have adequate iodine nutrition. From the 1940s onwards, iodine was added to cattle feed as it enhanced animal fertility and iodine-containing disinfectants were used to clean cows' teats and bulk milk carriers.⁴ The resulting increase in iodine in the food chain has been described as an 'accidental public health triumph'.⁴ However, a re-emergence of mild iodine deficiency based on median urinary-iodine concentration (UIC) across the UK has been reported in pregnant and non-pregnant young female cohorts.^{4,5}

Moderate or severe iodine deficiency during pregnancy is associated with poor cognitive outcomes in the offspring and, while the effect of mild iodine deficiency is less clear, a recent

UK report demonstrated a dose-dependent association between mild-iodine deficiency during the first trimester and childhood cognitive scores.⁶

Plasma or serum selenium concentrations of 80-125 µg/L outside of pregnancy are felt to meet needs for selenoprotein synthesis.^{1-3,7-8} Optimal selenium status in pregnancy is not as clearly defined. UK, European and US intake guidelines differ modestly as set out in Table 1 with, for example, the US Institute of Medicine recommending ~10% and 25% increase in consumption in pregnancy and breastfeeding, respectively.^{2,7-8}

Selenium deficiency in pregnancy has been associated with pre-eclampsia and pre-term birth.² Low dose supplementation (60 µg/day) was found to improve markers of pre-eclampsia and risk of developing pre-eclampsia, but not markers of thyroid autoimmunity in placebo-controlled trials.^{2,9,10} High-dose supplementation (200µg/day) appears to be more successful than low dose supplementation in reducing the risk of postpartum thyroid dysfunction.¹

The possible effects of combined iodine and selenium deficiencies in pregnancy are not well understood. A selenium supplementation program in Zaire in the 1990s, a country with severe dual deficiencies, saw a dramatic deterioration of thyroid function in hypothyroid subjects.¹ This study pointed to selenium deficiency actually mitigating the effects of iodine deficiency and modulating the risk of cretinism. The aim of our study was to explore the selenium status in a UK pregnant cohort already shown to be mildly iodine deficient.

Materials, Methods and Subjects: Plasma selenium concentrations were measured in a cohort of 241 first-trimester pregnant women at their booking appointment at the Regional Maternity Hospital in Belfast. Spot-urine samples were taken for urinary iodine measurement. In addition women were asked to complete iodine-specific food frequency questionnaires (FFQ) and to keep four-day diet diaries. Plasma selenium was measured in our

Regional Trace Metals Laboratory, royal Victoria Hospital by inductively coupled plasma mass spectrometry with CVs of <5%. Urinary iodine concentration was measured using a multiplate persulphate digestion method followed by Sandell-Kolthoff colorimetry and expressed as $\mu\text{g/L}$.⁶ The intra-assay coefficient of variation (CV) for urinary iodine was 15% for low QC (mean 30.5 $\mu\text{g/L}$) and 8% for high QC (mean 95.0 $\mu\text{g/L}$). Urinary creatinine concentration was measured singly using an ILAB 600 chemistry analyser (Werfen) using the Jaffe rate method with CV <4%.⁶ Statistical analyses were conducted using the statistical Package for the Social Sciences software (version 23.0; SPSS, Inc USA) and significance set at $P < .05$. Median and interquartile range were used to present nonnormally distributed data and to allow comparison with other studies. Log transformations were, however, carried out to allow for parametric testing and back transformed for presentation purposes. To compare means between groups, one-way ANOVA was used. Correlations between continuous variables were assessed using Pearson's correlation coefficients. In order to allow comparison with other papers, we have presented the unadjusted data. Iodine:creatinine ratio (ICR) ($\mu\text{g/g creat}$) was calculated by dividing the UIC ($\mu\text{g/L}$) by the urinary creatinine (g/L). In this cohort we previously reported mild-moderate iodine deficiency throughout all the trimesters of pregnancy and the first trimester data are detailed below for completeness.⁵

Results and Discussion:

Mean age and BMI were 30.3 years (SD 5.4) and 26.2 kg/m^2 (SD 4.9), respectively. Forty-seven % of the women were nulliparous and 35% had a high deprivation score. Fifty-five % of women reported taking supplements containing iodine and selenium (typically 140-150 $\mu\text{g/day}$ and 30 $\mu\text{g/day}$ respectively). Median 1st-trimester UIC was 73 $\mu\text{g/L}$ (IQR 37-122) which is below the WHO recommendation of 150 $\mu\text{g/L}$; median iodine: creatinine ratio (UI: Creat) was 102 $\mu\text{g/g}$ which is below the proposed value of 150 $\mu\text{g/g}$.⁵

Mean plasma selenium concentration was 75 µg/L (SD 7.7). Of 73 participants who completed a four-day diet diary, estimated mean selenium intake was 43.3µg/day (SD15.9) which is below US, UK and European guidelines.

An iodine-based FFQ was completed by 197 participants. Both plasma selenium and UI: Creat (but not UIC) were positively correlated with consumption of white fish and full fat yoghurt ($p < 0.05$). However, these foods were not frequently consumed, with 51% women reporting consumption either never or < 1 /month. Similarly only 3% of women reported eating full-fat yoghurt daily while 59% reported never or < 1 /month. Cheese, dairy desserts and oily fish consumption were positively associated with selenium levels ($p < 0.05$) but not iodine status. Consumption of cheese was high (68% reporting ≥ 2 -3 times/ week), while dairy desserts and oily fish consumption was low (58% and 49% reporting never or < 1 /month respectively). Milk consumption was strongly associated with iodine status ($p < 0.006$) but not significantly with selenium status ($p = 0.07$). Milk consumption was low, with 36% of women drinking none or < 140 ml (1/4 pint) per day.

Conclusion: This is the first report, to our knowledge, of selenium status in a pregnant cohort on the island of Ireland; levels are in the mildly deficient range and are accompanied by mild iodine deficiency. The possible effects of mild but combined iodine and selenium deficiencies in pregnancy merit further investigation and may inform the iodine-fortification debate in the UK and Ireland.

Conflict of interest statement: There are no conflicts of interest

Table 1: Recommended intake of selenium according to various authorities

	Europe EFSA ⁸ AI	USA IOM ⁷ RDA	UK COMA/SACN ² RNI
Adult	70µg/day	55µg/day	60µg/day
Pregnancy	70µg/day	60µg/day	60µg/day
Lactation	85µg/day	70µg/day	75µg/day

EFSA- European Food Standards Agency; AI-adequate intake; IOM- US Institute of Medicine; RDA-recommended daily allowance; COMA- Committee of medical aspects of Food and Nutrition Policy; SACN- Scientific Advisory Committee on Nutrition; RNI- Reference nutrient intake

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