Short Communication

Iodine deficiency in pregnant women in the ACT

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In response to growing concern of an iodine deficiency emergence in Australia, this study was conducted to document the iodine status of pregnant women in the ACT. One hundred women presenting to the antenatal clinic at The Canberra Hospital answered a brief dietary questionnaire and provided a spot urine sample for the measurement of urine iodine excretion. The results revealed that the majority of women were consuming a diet low in iodine, confirmed by suboptimal concentrations of iodine in their urine.

Key words: diet, iodine, pregnancy.

Introduction

Iodine is an essential trace element required for normal production of thyroid hormones thyroxine (T4) and triodothyronine (T3). Iodine deficiency disorders (IDD) in adults include a spectrum of disorders ranging from the most familiar effect of enlarged thyroid glands (goitre) to a range of growth, developmental and neurological abnormalities of varying severity.[1]

In particular, thyroid hormones are crucial for normal neurological development *in utero* and the early years of life. Fetal iodine deficiency results from maternal iodine deficiency and is associated with higher incidence of stillbirths, spontaneous abortions and congenital abnormalities.[1] Neonatal iodine deficiency is linked to early brain development abnormalities, mental defects and increased mortality.[1] Accordingly, the International Council for the Control of Iodine Deficiency Disorders/World Health Organisation (ICCIDD/WHO) recommends a daily iodine intake of 100 μg/day for adults, 150 μg/day for women of reproductive age, and 250 μg/day for pregnant and lactating women.[2]

Iodine uptake in humans is almost exclusively via dietary intakes and this makes IDD unique, as even though they are a major public health problem, they are also readily preventable by appropriate and easily accessible dietary supplementation. The most abundantly natural source of iodine is seafood and seaweed but iodine can also be found in fresh produce grown in soil containing iodine, or in milk which have been disinfected by iodine-containing disinfectants.[3]

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Since the 1960s, Australia has been declared iodine replete, with the exception of Tasmania, the mountainous island state which has been long recognised as iodine deficient.[4] However, recent published studies of iodine status in pregnant women in south-eastern states of Australia (New South Wales and Victoria) for the past 10 years have consistently suggested inadequate iodine intake.[5,6]

We elected to investigate the iodine status in a group at particular risk of iodine deficiency, namely pregnant women, who have a greater iodine requirement as they supply their growing fetus.

Materials and methods

This study was approved by the ACT Health Human Research Ethics Committee, and written consent was obtained from all participating women.

Patients

Pregnant women of any gestation attending the antenatal clinic at the Canberra Hospital were informed of the purpose and methodology of the study. Consent was obtained from each woman, and confidentiality was assured prior to participation in the dietary survey and provision of urine samples. There were no exclusion criteria to the selection of patients.

Collection of samples for this study occurred between February 2009 and May 2009.

Questionnaire

A shortened version of the questionnaire from Leung[7] was adopted. The abridged questionnaire ascertained each subject's age, ethnicity, highest level of education, place of birth and place of residence 2 years previously. Further

medical information was gathered regarding any previous thyroid pathology, known family history of thyroid pathology, and the use of any prescription medications and/or health foods. The questionnaire finally required subjects to record their consumption of iodine-containing foods over the last 24 h, the last week and the last month: sushi, fish, salt, fast food and multivitamins. This information was used to estimate the level of each subject's dietary iodine intake.

Urine iodine measurements

Random urine samples were collected and refrigerated. Samples were then aliquoted and stored frozen at −20°C prior to analysis. Urinary iodine excretion (UIE) was measured with the Sandell–Kothoff reaction and was based on the reference methodology by Ohashi and colleagues, which is an ICCIDD/WHO-approved method.[8] The method used solutions of known concentrations for a calibration curve (Bioclone Australia Pty Limited, Sydney, NSW, Australia).

The degree of dilution within urine samples was assessed using urinary iodine:creatinine ratio, a commonly used ratio to account for variation of dilution in urine samples.[9–11] Urinary creatinine was measured by ACT Pathology, Canberra Hospital using a routine, approved method (Abbott ci8200 Architect, Abbott Park, IL, USA).

Results

Questionnaire

The questionnaire results for the consumption of iodine-rich foods found that 44% of the women in the study had eaten no fish and 84% of women had not eaten sushi in the previous 4 weeks. Whilst 69% of women reported frequent use of salt with their meals, less than half of these used iodised salt.

Multivitamin use was common in this group of pregnant women with 63% stating that they had taken multivitamins in the past 24 h and 70% having taken them in the past 4 weeks. Nearly half (29 of 63) of the women who took multivitamins on a daily basis were taking a brand that contained no iodine (Elevit; Bayer Australia Limited, Pymble, NSW, Australia). Women recently arrived in Australia were less likely to use multivitamin preparations.

Urine iodine measurement

For our sample of 100 women, the median iodine excretion was 62 μg/L, with a range of 12–750 μg/L. The frequency distribution of UIE is shown in Fig. 1. Eighty-four per cent of women had a UIE <150 μg/L, which is the WHO-recommended concentration commensurate with an adequate iodine intake of 250 μg/day during pregnancy,[2] and 4% had UIE <20 μg/L. Women taking supplements (either iodised salt or vitamin preparations containing iodine) had a higher median UIE (72.9 μg/L) than did women not taking iodine supplements (median UIC 49.0 μg/L).

Because hydration state may vary markedly between women for simple physiological reasons, we also measured creatinine concentration on all samples and expressed our data as a ratio of iodine:creatinine. The relationship between UIE and iodine:creatinine ratio is shown in Fig. 2. There was a substantial variation in hydration status of the women, with $r^2 = 0.497$.

Discussion

The involvement of iodine in the synthesis of thyroid hormones is crucial for normal neurological development *in utero* and the early years of life. Therefore, iodine deficiency is considered 'the single most importance cause of preventable brain damage and mental retardation' globally.[5]

The purpose of the questionnaire and the UIE measurements conducted in this study was to discover

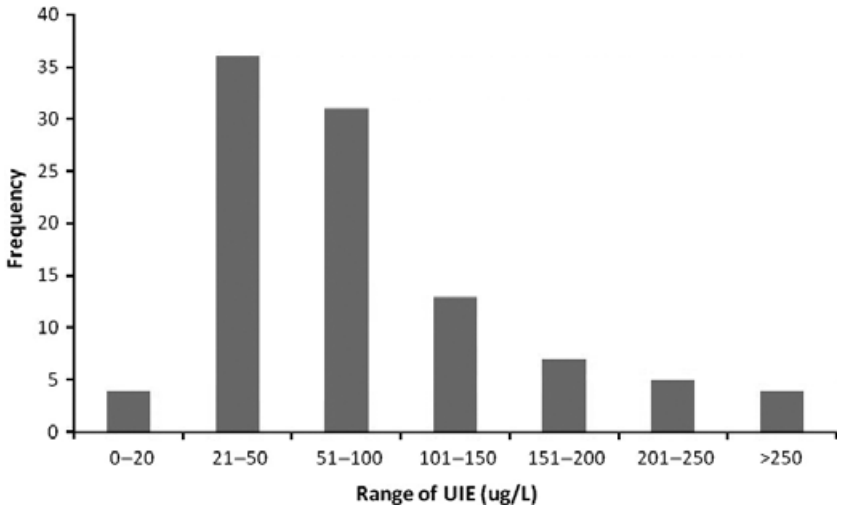

Figure 1 The distribution of urinary iodine excretion results.

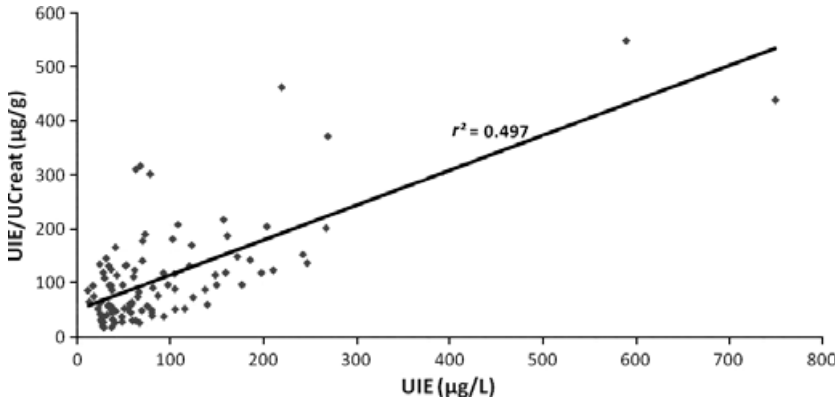

Figure 2 Correlation graphs between UIE and Iodine/creatinine ratio of the pregnant women group (r^2 = 0.497).

whether iodine deficiency was a public health issue in the ACT, in a particularly vulnerable group, pregnant women. Our study indicates inadequate dietary iodine intake in a particularly at risk group. This is evident by minimal intake of iodine-rich food sources, such as fish and sushi, and iodised salt at the time of the survey. Most concerning is whilst more than 60% of participants took multivitamins, of these half took a form that contained no iodine.

Measurement of UIE revealed that 84% of women had concentrations below 150 μg/L, the criteria recommended by the World Health Organisation (WHO) for sufficient iodine repletion in pregnant women.[2] Even worse, 40% of women had UIE below 50 μg/L, which is substantially below the WHO-recommended value. Because of our integrated society, ready transport of food and heavy use of processed food, it seems unlikely that Canberra is unique within Australia. A further concern that we identified was that even in those women taking iodine supplements, UIE although higher than in those women not taking supplements, was still well below the WHO recommendations.

Recent published studies of iodine status in pregnant women in south-eastern states of Australia (New South Wales and Victoria) for the past 10 years have consistently suggested inadequate iodine intake in a variety of patient groups.[5,6,9,12]

The 2006 Food Standards Australia and New Zealand (FSANZ) Total Diet Survey also showed over 50% of women of child bearing age (19 years and older) had an inadequate intake of dietary iodine.[3] These data support an emerging trend of iodine deficiency amongst Australian pregnant women. Data suggesting similar trends of iodine deficiency emergence have also been found in the USA and New Zealand.[13]

Possible explanations for the re-emergence of iodine deficiency in Australia have been explored by several studies, and it seems a combination of key factors at play. It is postulated to be a combination of cessation of iodine-fortification food programme in 1960s, reduction in using iodine-based disinfectants in dairy industry and reductions in consumption of household iodised salt, coupled with increase in consumption of processed food which does not utilise iodised salt.[5]

In the context of this national and international experience, and information from recent studies and the 2006 FSANZ Total Diet Survey, in 2008, FSANZ initiated Proposal P1003 which proposes for mandatory fortification of iodine in Australia following advice and confirmation of the prevalence of iodine deficiency report prepared by AHMAC.[14] The ramifications were such that by October 2009, most bread in Australia became fortified with iodine. Other countries which have been seen to introduce government interventions to combat iodine deficiencies include Switzerland, Germany and New Zealand.[5] A common and robust strategy in developing countries is mandatory iodisation of household salt; however, this strategy may not prove to be effective in Australia where processed and manufactured foods are the major source of salt intake.[14] The NHMRC has also recommended that additional iodine supplements should be prescribed for all pregnant Australian women, as the iodine in fortified bread alone remains inadequate for the extra need of iodine during pregnancy and lactation period.[15]

The re-emergence of iodine deficiency, as evident by recent studies [5,6,9,12] and our study, suggests that ongoing monitoring of iodine deficiency status is important, particularly in vulnerable populations such as pregnant women and the young. Strategies which could also improve the effectiveness of existing fortification programme may include education programmes, awareness campaign and increasing advocacy of iodine supplementations.

Results of urinary creatinine also suggested that the hydration status of the women in our study varied markedly. This has important considerations for how studies are performed in the future. A person with a highly concentrated urine may have an apparently normal UIE based upon concentration alone. Using creatinine to correct for hydration status is widely used in clinical medicine, for example in assessing the effectiveness of low iodine diet preparation for radioiodine therapy.[16] Although the iodine/creatinine ratio may also overestimate iodine uptake in patients with malnutrition status because of their low C_r

levels, the cost of urine creatinine measurement is very small, much smaller than iodine measurement, and it would be beneficial to be used routinely in future field studies, particularly in geographical settings where hydration status have higher variations.[16]

Our study was a limited one, designed to provide a snapshot of the iodine status of pregnant women in the ACT. We have limited information on dietary habits and gestational timing. Nevertheless, our results show quite clearly that iodine deficiency is a significant problem in an urban, apparently healthy population in a First World country.

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