Original Article

Iodine status in pregnant women living in Melbourne differs by ethnic group

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The iodine status of pregnant women from different ethnic groups in an Australian population was determined by measuring urinary iodine concentration (UIC) from stored spot urine samples. Study subjects were selected from pregnant women participating in a Down Syndrome screening study at Monash Medical Centre in Melbourne, Australia. In total, 263 Vietnamese, 262 Indian/Sri Lankan (ISL) and 277 Caucasian women were included. The median UIC of Caucasian women (52 µg/L) was significantly lower than that of both Vietnamese women (58 µg/L, $P < 0.01$) and ISL women (61 µg/L, $P = 0.03$). The proportion of women who had a UIC below 50µg/L was 48.4% of the Caucasian women, 38.4% of the Vietnamese women and 40.8% of the ISL women. These data are consistent with mild iodine deficiency for each of the groups of pregnant women. The evidence for mild iodine deficiency in these groups of pregnant women is consistent with recent Australian studies in pregnant and non-pregnant individuals. The association of ethnicity with iodine status is most likely due to differences in dietary behaviours. Understanding the factors that influence iodine nutrition in a multiethnic population will be important for identifying the most useful approaches to improving iodine status, evaluating different strategies and the development of appropriate monitoring programs. Action to improve iodine status in the Australian population should include consideration of ethnic differences in diet.

Key Words: iodine nutrition, pregnancy, public health, Australia, Vietnamese, Indian, Sri Lankan, Caucasian women

Introduction

Recent studies[1-7] of the iodine status in population subgroups in Melbourne, Sydney and Tasmania have raised concerns about the adequacy of the diet of Australians. Despite this mounting evidence of suboptimal iodine intake in Australia, limited research has been conducted into factors that may influence iodine status, such as ethnicity. Ethnicity is a powerful predictor of behaviours in a multi-cultural society[8] and may offer important information about specific causes of iodine deficiency and appropriate strategies to address it. In the Australian state of Victoria, more than 20% of the population (more than 960,000 people) speak a language other than English at home.[9] Pregnant women are an important subgroup of the population in which to monitor iodine status because of their susceptibility to iodine deficiency and the severity of the associated consequences to the newborn.[10] The adverse health effects associated with dietary deficiency of iodine (collectively known as iodine deficiency disorders) are wide ranging. Iodine is required for the production of thyroid hormone. Adequate thyroid hormone is particularly important for brain development of the fetus and the neonate. Iodine deficiency in pregnancy can lead to a wide range of neurological defects in the child, from mild blunting of intellect to severe mental retardation. Even mild iodine deficiency during pregnancy can produce subtle deficits in IQ and auditory function.[11,12] Despite this, there are no large studies

to investigate iodine status in pregnant women in Australia and in particular whether there are differences in status between women of differing ethnic backgrounds. Accordingly, we undertook this study to investigate the iodine status of pregnant women from different ethnic groups in an Australian population. Our expectation was that different ethnic groups would have different food habits and they would therefore also differ in iodine status.

Materials and methods

Between 1998 and early 2002 a prospective study of Down syndrome screening strategies was undertaken at the Monash Medical Centre, Melbourne. The screening was part of standard antenatal care and involved the collection of urine and blood samples from approximately 8500 women in early pregnancy. All women who agreed to Down syndrome screening were recruited into the program at their first visit to the antenatal clinic. The proportion of individuals who declined to participate was not recorded.

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However, typical response rates for Down syndrome screening programs average 75-78% of the pregnant population.[13] For the women who agreed to participate, arrangements were made for the biological sample collection to occur between 14 to 20 weeks of gestation. Urine samples were transferred into multiple 2ml Eppendorf tubes and stored at -20°C until assay. A computerized database was developed which included the age, ethnicity and date of the sampling for each participant. The three most abundant ethnic groups in the study sample were found to be Caucasian, Vietnamese and Indian/Sri Lankan (ISL) and therefore urine samples from women in these groups were retrieved from storage for analysis. Urinary iodine concentration was measured using an in-house semi-automated method[14] which ensures the removal of interfering substances. This method has been previously validated[3] and has a detection limit of 10µg/L. Urine samples which were measured to have a value less than 10µg/L were assigned a value of 10µg/L.

The distribution of UIC within each ethnic group was skewed towards higher values and therefore is described by the median and the 25th and 75th percentiles. Evaluation of group iodine status was based on UIC categories defined by the World Health Organisation and International Centre for the Control of Iodine Deficiency Disorders (WHO/ICCIDD).[15] These are: normal – median 100 µg/L; mild iodine deficiency – median 50-99 µg/L; moderate iodine deficiency – median 20-49 µg/L; severe iodine deficiency–median <20µg/L). The WHO/ ICCIDD criteria further state that an iodine replete population has no more than 20% of the population with a UIC below 50 µg/L.[15]

Data were analysed using the Statistical Package for the Social Sciences (SPSS Inc, Version 11, Chicago, IL). The UIC data were not normally distributed and therefore non-parametric statistical tests were used. The Kruskall-Wallis test of k independent groups was used to test the hypothesis that quintiles constructed according to the date of urine sampling were drawn from the same distribution. The Mann-Whitney U test was used to assess differences in the distribution of UIC between ethnic groups and across quintiles of urine sampling dates. Multivariate linear regression was used to assess the independent association of ethnicity with UIC after controlling for age and date of sampling. A P value of <0.05 was considered to be statistically significant.

The Monash Medical Centre Human Research and Ethics Committee granted approval for the collection and analysis of the samples.

Results

A total of 341 ISL, 677 Vietnamese and 4551 Caucasian participated in the Down syndrome screening study. Of these, urine samples from 262 ISL women, 263 Vietnamese women and 278 Caucasian women were retrieved from storage. The mean age of the women for whom urine samples were available was 30.3 years (age range: 16.8 to 42.9 years).

An abnormally high UIC (1587 µg/L) was measured in a Caucasian participant. Review of the medical history of the subject did not suggest a reason for this high level.

The result was three times greater than any other (and more than 30 times greater than the median value) and was excluded from all further analyses. After visual inspection of the UIC distributions for each group, there were noted to be a small number of outlying values. There were three outliers in the Caucasian group (319 µg/L, 396 µg/L, 509 µg/L), two in the Vietnamese group (279 µg/L, 552 µg/L), and four in the ISL group (290 µg/L, 291 µg/L, 342 µg/L, 452 µg/L). Removal of these subjects made no material difference to the analyses, so all are retained in the analyses reported here.

Urinary iodine concentration in each ethnic group
The distribution of UIC for Caucasians was significantly lower than that for both the Vietnamese (P <0.01) and the ISL (P = 0.03) group (Fig. 1). The median urinary iodine concentrations in each of the ethnic groups were consistent with mild iodine deficiency. The median UIC in Caucasian women (52 µg/L) was near to the cut-off for moderate deficiency. No significant difference was observed in the distribution of UIC between the Vietnamese and ISL groups (P = 0.67). In multivariate liner regression modelling, after controlling for age and date of sampling, ethnic group remained a significant explanatory factor for UIC (R^2 = 0.07, P<0.01).

Iodine status categorization
Table 1 shows the percentage of each of the ethnic groups where the UIC was less than 50 µg/L. In all cases, these proportions exceed WHO/ICCIDD criteria for an iodine replete population, which states that no more than 20% of the population should fall below 50 µg/L.

Table 1. Percentage of each group of pregnant women with urinary iodine concentration below 50 µg/L

Ethnic Group	N	% with urinary iodine concentration < 50 µg/L
Caucasian	277	48.4
Vietnamese	263	38.4
Indian / Sri Lankan	262	40.8

Urinary iodine concentration over the time period of the collection
The median urinary iodine concentration over the period that the urine samples were collected (1998-2001) was examined by quintile of urine sample collection date (Fig. 2). The collection dates corresponding to each quintile were: quintile 1: 1st Sept 1998 to 15th Sept 1999; quintile 2: 16th Sept 1999 to 11th April 2000; quintile 3: 12th April 2000 to 11th Sept 2000; quintile 4: 12th Sept 2000 to 13th March 2001 and quintile 5: 14th March 2001 to 1st Sept 2001. The null hypothesis that each quintile was drawn from the same distribution was rejected (P<0.001). Quintile 2 was not significantly different to quintile 4 (P = 0.06), quintile 3 was not significantly different to quintile 4 (P = 0.17), and quintile 3 was not significantly different to quintile 5 (P=0.28) by post-hoc testing.
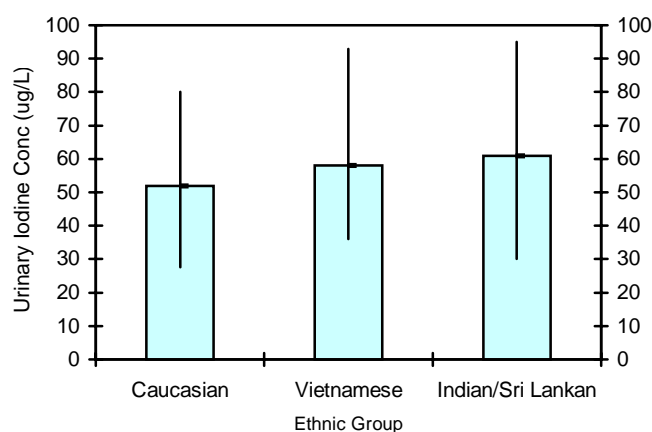
Figure 1. Median, 25th and 75th percentiles of Urinary Iodine Concentration for pregnant women of different ethnic groups.

Figure 2. Median, 25th and 75th percentiles of Urinary Iodine Concentration for pregnant women by quintile based on urine sample collection date.
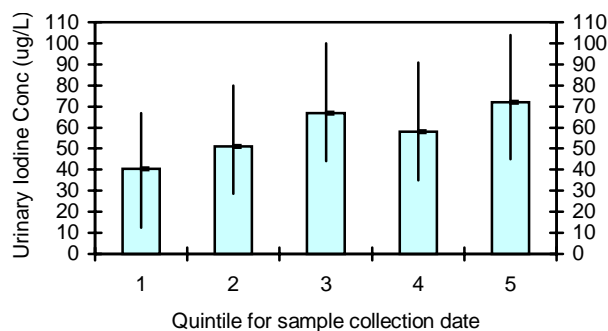
Discussion

The median UIC in the women studied is consistent with a population that is mildly iodine deficient.[15] In addition, the proportion of UIC values falling below 50 µg/L within each ethnic group in 1998-2001 was substantially higher than the WHO/ICCIDD criteria for an iodine replete population. These women are representative of women in early pregnancy from the three respective ethnic groups attending the Monash Medical Centre (MMC) between 1998 and 2001.

For pregnant women, an adequate iodine status is particularly important because of the serious potential detrimental effects of iodine deficiency on fetal development[10,16] and the goitrogenic challenge of pregnancy itself.[17] In iodine replete populations, and in mildly iodine deficient areas, urinary iodine excretion in pregnant women increases by up to 50% compared to non-pregnant controls.[18,19] Pregnancy requires increased hormone production and is associated with increased urine output. The source of the 'extra' required iodine due to pregnancy may be from increased dietary intake and/or depletion of maternal intrathyroidal stores of iodine. In areas of moderate iodine deficiency, urinary iodine remains constant or decreases during pregnancy.[2,17,20] The recommendation for iodine intake for pregnant women in Australia is 150µg/day[21] while the World Health Organization recommends an intake of 200µg/day.[15]

Other measurements of the iodine excretion of pregnant women in Australia have recently been conducted.[1-3,5] At a hospital in northern Sydney in 1998-99, 84 pregnant women, an average of 10 weeks prior to delivery, had a median UIC of 109 µg/L, with 11.9% below 50µg/L.[5] Also in 1998-99, a study of 101 full-term pregnant women from western Sydney had a median UIC of 88 µg/L[3] with 17% below 50 µg/L. In 1999 in Sydney, the UIC of 81 pregnant women was found to be 104 µg/L with 19.8% below 50 µg/L.[1] For 141 pregnant women early in the second trimester of pregnancy and presenting to a teaching hospital in Hobart, Tasmania,[2] the median UIC was 102 µg/L (percentage below 50 µg/L not given). In this Tasmanian study, by the time of delivery, the UIC was 34 µg/L.

However, it is not clear that the results observed in the present study can be appropriately compared to results from previous studies of pregnant women in Australia. A strength of the present study was the systematic collection of urine samples from a large number of pregnant women over a period of many years. The subjects participating in the study included a much larger number of women than previous studies and from different ethnic groups. However, we observed a lower urinary iodine concentration in urine samples which had been stored longer. This was an unexpected finding. The internal quality control stock for the period during which these samples were analysed was reported to be very stable, arguing against the possibility of technical measurement issues influencing the iodine concentration measurement (pers. comm. Gary Ma, ICPMR, 2003).

There are other possible explanations for the observation. The iodine status of the pregnant women may have changed over the period of the urine collection – although we do not have information on the diet or supplement use for these women, a change in iodine intake of the magnitude observed seems unlikely. There may have been inadequate freezer storage with the earlier samples being subjected to different temperature cycles than the samples collected later. To our knowledge, the urine samples had never been accessed or removed from storage prior to this investigation. There may have been adsorption of iodine with time into the plastic of the storage tube, or other loss of iodine from the sample. We are not aware of any studies that have investigated the change of UIC in stored urine samples over a storage period of 2 to 5 years duration. Quality control samples stored for up to a year at -20°C showed no decline in UIC (pers.comm. Dr Gary Ma, ICPMR, 2003). There was no significant difference over the course of the study in the proportion of subjects recruited from each ethnic group, therefore confounding by ethnic group is not an explanation for the observed increase in UIC by time of sampling.

The lower UIC, if it is a technical artifact, appears to have occurred after approximately three years storage. If the difference in UIC with time is indicative of a problem with sample treatment or storage, then the implication of this is that the estimated population UIC distribution is falsely low, giving rise to a median value that is too low, and proportion of the sample less than 50 µg/L that is too

high. In a study where urine samples were not measured at varying times from their collection, this might not have been noticed. The observed difference with storage time does not alter the conclusion regarding the difference in iodine status between ethnic groups, or the fact that the measurements on pregnant women indicate a population with mild iodine deficiency.

All of the three ethnic groups in this study were categorized as being mildly iodine deficient, with the Caucasian group found to have a significantly lower urinary iodine concentration than both the Vietnamese and ISL groups. The most likely explanation for the observed difference in iodine status is difference in dietary intake as this is the principal route by which iodine enters the body.[15] Dietary iodine intake occurs from food where iodine is naturally present, from iodine added to food during its processing or manufacture, and from the use of dietary supplements or medications which contain iodine. In this study, we did not have measurements on dietary intake of different ethnic groups that might explain the difference in iodine status.

Ethnicity can be an important explanatory factor for health conditions that can give insight into their development.[8] It is not suggested that ethnicity itself is responsible for differences in health status, but that these may be explained by differences between groups of different ethnicity in particular exposures or behaviours. Typically, dietary behaviour differs between ethnic groups and is characteristic of ethnic groups. In view of the large and varied ethnic groups in the Australian population, more emphasis could be placed on target group specific approaches to addressing health issues such as dietary deficiency. It is at least possible that the employment of strategies specifically developed for different ethnic groups will be more effective to ensure adequate dietary intake of all groups within the population than a single solution for the combined population.

Despite the lack of population based surveys at a national level, over the last five years studies in Victoria, NSW and Tasmania have suggested that the iodine status within the groups sampled is sub-optimal.[1-7] A dietary deficiency of iodine is apparent in many developed countries. The iodine nutrition status, based on urinary iodine excretion measurement, appears to be deficient in 14 of 33 (42%) European countries including France, Germany, Greece and Italy.[22] It has been noted that population iodine status in New Zealand appears to be declining.[23] In the United States, population iodine status is replete, but there is evidence that it has declined over recent years.[24,25]

Iodine supplementation programs are advised to correct iodine deficiency of even mild or moderate degree, however they are not without risk.[16] A rapid increase in iodine supply from deficient levels may be followed by a surge in the occurrence of hyperthyroidism. Long-term effects of a high intake of iodine may include an increase in incidence of subclinical and clinical hypothyroidism, and Graves disease may become symptomatic earlier.[16] Both deficiency and excess of iodine should be avoided in populations, as should large and sudden perturbations to the iodine supply. Ideally, the risk for subgroups of the population to have too little or too much

iodine should be minimized. This highlights the need for careful monitoring and surveillance of distinct population subgroups who differ in their food habits, in addition to concern regarding median iodine intake.

Together, the consistent findings of mild iodine deficiency in groups of Australians call for a comprehensive national evaluation of iodine nutrition, and further investigation of the potential implications for the population. The unexpected apparent reappearance of iodine deficiency and its likely relationship to dietary intake demonstrates that systematic and comprehensive surveillance of food intake and nutritional status of Australians should be implemented in the interests of public health. Doctors and other health professionals should be aware of the critical importance of micronutrients in the human diet and that pregnant women even in privileged countries such as Australia are at risk of deficiency. Culturally appropriate dietary recommendations, advice on the use of iodised table salt where salt is used and advice to use appropriate iodine containing supplements may be among the range of strategies for increasing the iodine intake of pregnant women in Melbourne in the short term. In the longer term, it may be prudent to consider the universal iodisation of all salt in Australia, including that used in food manufacture. Any fortification or supplementation program should be carefully monitored and evaluated to guide its continued implementation.

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