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ABSTRACT

Iodine deficiency was not considered a major public health problem in Australia in the 1990s. However, the Australian National Iodine Nutrition Study in the early 2000s provided evidence of the resurgence of iodine deficiency in the Australian population. As a result, mandatory iodine of bread flour was introduced in Australia in late 2009. However, while several studies had assessed the iodine status of Australian children post fortification there were limited data regarding the impact of fortification on the iodine status of pregnant and lactating women and their infants.

The results of this thesis demonstrate that the urinary iodine concentrations (UIC) of lactating, pregnant women and their infants in South Australia post iodine fortification are consistent with an iodine sufficient status, independent of the intake of iodine supplements. However, iodine status of women who did not consume iodine supplements during pregnancy may be suboptimal as indicated by a borderline UIC level.

Breast milk is a sole source of iodine for exclusively breastfed infants, making the measurement of iodine concentration in breast milk clinically relevant. However, there had been limited previous attempts to assess breast milk iodine concentrations (BMICs), largely due to the lack of robust methods for routine analysis. This thesis describes the development and validation of a new method for assessing iodine concentrations in human breast milk. This method was subsequently applied to measure BMIC in samples collected from women from the same region of South Australia before and after the introduction of mandatory iodine fortification. Median BMICs post fortification was well above the suggested cut-off for providing a sufficient iodine supply for full-term infants. Importantly, the median BMICs in the post fortification samples were significantly higher than those of the women before mandatory iodine fortification, independent of iodine supplements, while the proportion of women in the sample with BMICs below 100µg/l was reduced by 28%. These data suggest
that mandatory iodine fortification and recommendations regarding iodine supplements in pregnancy and lactation have been effective in increasing the iodine supplied to the average South Australian infants.

Obesity and insulin resistance are currently major public health issues worldwide, and there is increasing evidence that the nutritional environment experienced in early life is an important determinant of long-term metabolic health. Chapter 6 of this thesis assessed relationships between markers of neonatal and current thyroid function and metabolic health of young children. Fasting glucose concentrations, HOMA-IR and height z-score in male children at 5 years of age were inversely related to neonatal TSH level at birth, however there was no evidence to suggest that current TSH or Tg concentrations were associated with measures of growth or insulin resistance at 5 years of age, in either males or females.

In conclusion, this thesis presents the first data regarding the iodine status of pregnant and lactating women and their infants after the introduction of mandatory iodine fortification, from a large and representative population, and has provided evidence that BMICs have been significantly improved since the introduction of iodine fortification in Australia. This adds important new information regarding the current iodine status of pregnant, lactating women and their infants in Australia, and provides insights into the potential role of neonatal iodine nutrition/thyroid status for long-term metabolic health.
DECLARATION

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution to Dao Hoa Anh Huynh and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Dao Hoa Anh Huynh
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I dedicate this thesis….

…To my parents and my aunt, Le Nguyen, for always believing and supporting me throughout my life

…To my husband, Trung Nguyen, and my son, Khoa Nguyen, for bringing me so much love and happiness

…To my younger sisters, Ruby Huynh, Du Nguyen and Alanna Pham, for always supporting and consulting me in whatever I have been doing
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>µg/l</td>
<td>microgram per litter</td>
</tr>
<tr>
<td>µIU</td>
<td>micro international unit</td>
</tr>
<tr>
<td>AI</td>
<td>Adequate Intake</td>
</tr>
<tr>
<td>BFB</td>
<td>body fat percentage</td>
</tr>
<tr>
<td>BFM</td>
<td>body fat mass</td>
</tr>
<tr>
<td>BIA</td>
<td>bioelectrical impedance analysis</td>
</tr>
<tr>
<td>BMI</td>
<td>body mass index</td>
</tr>
<tr>
<td>BMIC</td>
<td>breast milk iodine concentration</td>
</tr>
<tr>
<td>BMR</td>
<td>basal metabolic rate</td>
</tr>
<tr>
<td>BW</td>
<td>body weight</td>
</tr>
<tr>
<td>CI</td>
<td>confidence interval</td>
</tr>
<tr>
<td>CV</td>
<td>coefficient of variation</td>
</tr>
<tr>
<td>DEXA</td>
<td>dual-energy X-ray absorptiometry</td>
</tr>
<tr>
<td>DHA</td>
<td>Docosahexaenoic acid</td>
</tr>
<tr>
<td>DIT</td>
<td>Diiodotyrosine</td>
</tr>
<tr>
<td>DOMInO</td>
<td>DHA to Optimise Mother Infant Outcome</td>
</tr>
<tr>
<td>EAR</td>
<td>estimated average requirement</td>
</tr>
<tr>
<td>ELISA</td>
<td>enzyme-linked immunosorbent assay</td>
</tr>
<tr>
<td>HOMA-IR</td>
<td>homeostatic model assessment-insulin resistance</td>
</tr>
<tr>
<td>HPLC</td>
<td>high performance liquid chromatography</td>
</tr>
<tr>
<td>I/I₀</td>
<td>Iodide/Iodine</td>
</tr>
<tr>
<td>ICCIDD</td>
<td>International Council for the Control of Iodine Deficiency Disorders</td>
</tr>
<tr>
<td>ICPMS</td>
<td>inductively coupled plasma mass spectrometry</td>
</tr>
<tr>
<td>IMVS</td>
<td>Institute of Medical and Veterinary Sciences</td>
</tr>
<tr>
<td>IQR</td>
<td>interquartile range</td>
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<tr>
<td>ISI</td>
<td>insulin sensitivity index</td>
</tr>
<tr>
<td>ISIS</td>
<td>integrated sample introduction system</td>
</tr>
<tr>
<td>IUPAC</td>
<td>International Union of Pure and Applied Chemistry</td>
</tr>
<tr>
<td>LCPUFA</td>
<td>long chain polyunsaturated fatty acid</td>
</tr>
<tr>
<td>LOD</td>
<td>limit of detection</td>
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<td>mg/kg</td>
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<tr>
<td>ml</td>
<td>millilitre</td>
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<tr>
<td>MQL</td>
<td>method quantitation limit</td>
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<tr>
<td>NATA</td>
<td>National Association of Testing Authorities, Australia</td>
</tr>
<tr>
<td>NHMRC</td>
<td>The National Health and Medical Research Council of Australia</td>
</tr>
<tr>
<td>NIST</td>
<td>National Institute of Standard and Technology</td>
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<tr>
<td>PF</td>
<td>peritoneal fat</td>
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<tr>
<td>PINK</td>
<td>Pregnancy Iodine and Neurodevelopment in Kids</td>
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<tr>
<td>QC</td>
<td>quality control</td>
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<td>QUICKI</td>
<td>quantitative insulin sensitivity check index</td>
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<tr>
<td>RDI</td>
<td>Recommended dietary intake</td>
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<tr>
<td>RSD/SD</td>
<td>Relative standard deviation/standard deviation</td>
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<tr>
<td>Sb</td>
<td>Antimony</td>
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<tr>
<td>SF</td>
<td>abdominal subcutaneous fat</td>
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<tr>
<td>T3/T3</td>
<td>Triiodothyronine/free Triiodothyronine</td>
</tr>
<tr>
<td>T4/T4</td>
<td>Thyroxine/free Thyroxine</td>
</tr>
<tr>
<td>Te</td>
<td>Tellurium</td>
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<tr>
<td>TFM</td>
<td>total fat mass</td>
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<tr>
<td>Tg</td>
<td>Thyroglobulin</td>
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<td>TMAH</td>
<td>Tetramethylammonium hydroxide</td>
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<td>Thyroperoxidase</td>
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<td>TSH</td>
<td>Thyroid stimulating hormone</td>
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<td>UIC</td>
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<td>UL</td>
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