IODINE STATUS OF PREGNANT AND LACTATING WOMEN AND THEIR INFANTS IN SOUTH AUSTRALIA AND THE IMPACTS OF CURRENT AND PERINATAL IODINE NUTRITION STATUS ON BODY COMPOSITION AND INSULIN SENSITIVITY AT 5 YEARS OF AGE

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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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PUBLICATION ARISING FROM THIS THESIS

1. Huynh D, Zhou SJ, Gibson R, Palmer L, Muhlhausler B: Validation of an optimized method for the determination of iodine in human breast milk by inductively coupled plasma mass spectrometry (ICPMS) after tetramethylammonium hydroxide extraction. *J Trace Elem Med Biol* 2014.

COMMONLY USED ABBREVIATIONS

µg/l	microgram per litter
µIU	micro international unit
AI	Adequate Intake
BFB	body fat percentage
BFM	body fat mass
BIA	bioelectrical impedance analysis
BMI	body mass index
BMIC	breast milk iodine concentration
BMR	basal metabolic rate
BW	body weight
CI	confidence interval
CV	coefficient of variation
DEXA	dual-energy X-ray absorptiometry
DHA	Docosahexaenoic acid
DIT	Diiodotyrosine
DOMInO	DHA to Optimise Mother Infant Outcome
EAR	estimated average requirement
ELISA	enzyme-linked immunosorbent assay
HOMA-IR	homeostatic model assessment-insulin resistance
HPLC	high performance liquid chromatography
I^-/I^0	Iodide/Iodine
ICCIDD	International Council for the Control of Iodine Deficiency Disorders
ICPMS	inductively coupled plasma mass spectrometry
IMVS	Institute of Medical and Veterinary Sciences
IQR	interquartile range
ISI	insulin sensitivity index
ISIS	integrated sample introduction system
IUPAC	International Union of Pure and Applied Chemistry
LCPUFA	long chain polyunsaturated fatty acid
LOD	limit of detection
mg/kg	milligram per kilogram
min	minute
MIT	Monoiodotyrosine

ml	millilitre
MQL	method quantitation limit
NATA	National Association of Testing Authorities, Australia
NHMRC	The National Health and Medical Research Council of Australia
NIST	National Institute of Standard and Technology
PF	peritoneal fat
PINK	Pregnancy Iodine and Neurodevelopment in Kids
QC	quality control
QUICKI	quantitative insulin sensitivity check index
RDI	Recommended dietary intake
RSD/SD	Relative standard deviation/standard deviation
Sb	Antimony
SF	abdominal subcutaneous fat
T3/fT3	Triiodothyronine/free Triiodothyronine
T4/fT4	Thyroxine/free Thyroxine
Te	Tellurium
TFM	total fat mass
Tg	Thyroglobulin
TMAH	Tetramethylammonium hydroxide
TPO	Thyroperoxidase
TRH	Thyrotropin releasing hormone
TSH	Thyroid stimulating hormone
UIC	urinary iodine concentration
UL	Upper Level
WHO	World Health Organisation