

**Magnesium and Diabetes:  
It's Implication for the Health of  
Indigenous Australians**

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**September 2008**

A thesis submitted in partial fulfilment of the requirements for the degree  
of Doctor of Philosophy

## **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 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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## **Dedication**

**This thesis is dedicated to the memory of my parents  
Professor James Rubert Longstreet and Wilda Graul Longstreet**

*They led by example, and their faith in me was without measure.*

*I just wish they were here to see it finished.*

## PUBLICATIONS AND PRESENTATIONS

The following articles have been published or accepted for publication or presentation during the period of PhD candidature, and sections of these articles have been included in the present thesis.

### ***Published Journal Papers:***

Longstreet DA, Heath DL, Vink R. A potential link between magnesium intake and diabetes in Indigenous Australians. *Med J Aust.* 2005 Aug;183(4):219-20.

Longstreet DA, Heath DL, Panaretto KS, Vink R. Correlations suggest low magnesium may lead to higher rates of type 2 diabetes in Indigenous Australians. *Rural Remote Health.* 2007;7(4):843.

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### ***Submitted Journal Papers:***

Longstreet DA, Rolin, SA, Heath DL, Panaretto KS, Vink R. Lower serum magnesium found in Indigenous Australians: implications for type 2 diabetes. *Journal American College Nutrition*, submitted

Longstreet DA, Vink R. Correlation between total and free magnesium concentration in human serum samples. *Magnesium Research*, submitted.

***Published Abstracts:***

Longstreet DA, Heath DL, Panaretto KS, Vink R (2006) Lower serum magnesium levels in Indigenous Australians: Potential causes and their relationship to type 2 diabetes. *Proc. 11<sup>th</sup> International Magnesium Symposium, O30*

Longstreet DA, Heath DL, Savage I, Vink R, Panaretto KS (2007) Estimated nutrient intake of urban Indigenous patients participating in a lifestyle intervention program. *Proc. Dietitians Association of Australia 25<sup>th</sup> National Nutrition & Dietetics Conference, S24*

Longstreet DA, Heath DL, Marshall, EG, Panaretto KS, Vink R (2008) Lower serum magnesium found in Indigenous Australians and its implication for type 2 diabetes. *Diabetes 57 (S1) A103, 359-OR*

***Conference Presentations:***

“Magnesium and diabetes in an urban Indigenous population” Presented 9 September 2006 at the Dietitians Association of Australia– Queensland Professional Development Day, Brisbane, Queensland, Australia

“Lower serum magnesium levels in Indigenous Australians: Potential causes and their relationship to type 2 diabetes” Presented 26 October 2006 at the 11<sup>th</sup> International Magnesium Symposium, Kashikojima, Japan

“Estimated nutrient intake of urban Indigenous patients participating in a lifestyle intervention program” Presented 24 May 2007 at the Dietitians Association of Australia 25<sup>th</sup> National Conference, Hobart, Tasmania, Australia

“Lower serum magnesium found in Indigenous Australians and its implication for type 2 diabetes”. Oral abstract presented 9 July 2008 at the 68<sup>th</sup> scientific sessions of the American Diabetes Association, San Francisco, California, USA

***Other Scientific Presentations:***

“A Study of Magnesium and Diabetes among Urban Indigenous Australians” Presented 22 July 2004, Department of Pathology, University of Adelaide, Adelaide, South Australia, Australia

“Magnesium, Diabetes, and the Urban Indigenous Peoples: What have we learned thus far?” Presented 17 May 2006, Medical staff in-service, Townsville Aboriginal & Islander Health Service, Ltd, Townsville, Queensland, Australia

“Magnesium and diabetes: Implications for the Australian Indigenous people” Presented 21 August 2006 Townsville Hospital Professional Journal Club, Townsville, Queensland, Australia

“The impact of magnesium on diabetes and its implication for the health of Indigenous Australians” Presented 16 January 2008 to the Townsville Aboriginal and Islander Health Service Board of Directors, Townsville, Queensland, Australia; *in completion of the ethical obligation to return research to the Aboriginal and Torres Strait Islander peoples.*

## ACKNOWLEDGEMENTS

This endeavour began when my friend and co-worker, Dr Deanne Heath, recognized the potential in me, and in the research question that I raised. Deanne provided the push and the personal connections to make everything possible. As a remote student placement, her guidance as my local supervisor was essential. Aristotle said, “Well begun is half done.” Deanne led me more than half-way to completion, and her support was sorely missed when illness intervened. I sincerely thank her, for not only her tutelage during the first half of my candidature, but also for the infrequent assistance she was still able to render in spite of her own difficult circumstances during the last two years. We both had some rough sailing, but I know I would not have come this far without Deanne’s guidance. I will always be indebted to Deanne for her help in setting the course; to make my dream a reality.

My deepest gratitude goes to my PhD supervisor Professor Robert Vink, whose expertise, guidance, and confidence kept me on track. Being a remote student was a rougher sea and created more difficulties than any of us expected. Every contact with Bob was like fresh wind in my sails. His coaching kept me on an even keel, and more than a few times Bob had to throw me a lifeline. His unfailing confidence in our eventual success kept me afloat. Without his support and encouragement, I would never have made it to the finish line. Words are insufficient to adequately express my profound appreciation.

No undertaking such as this can be completed without the help, support and encouragement of many people. I also acknowledge and sincerely appreciate the assistance of the following people:

***Indigenous support and collaboration:*** The Townsville Aboriginal and Islander Health Service, Ltd; especially all the people who participated in the needs assessment study

***Medical supervisor:*** Dr Kathryn Panaretto

***Assistance with community consultations and cultural aspects:*** Rachael Atkinson, Jacinta Elston, and especially, Emily Marshall

***Participant recruitment:*** Marlene Griffiths, Emily Marshall, Dr. Paolo Morsico, Dr. Kathryn Panaretto, Dr. Katrina Forster, Dr. Karen Sander, Dr. Nicki O'Reilly, Dr. Danielle Haller, and Jason Warnock

***Assistance with statistics:*** Stéphanie Alexia Rolin of Dartmouth College, Hanover, NH, USA

***Analysis and management of blood samples:*** Christine Hall of James Cook University, Townsville, QLD, and Anna Leonard of University of Adelaide, Adelaide, SA

***Tutoring on Map Info software:*** Janis Puce and Dr. David King of James Cook University, Townsville, QLD

***Equipment grant:*** from the Neil Sachse Foundation



## ABBREVIATIONS

ABS	Australian Bureau of Statistics
ACR	Albumin to creatinine ratio
ADA	American Diabetes Association
AI	Adequate Intake
ATP	Adenosine triphosphate
BMI	Body Mass Index
BMR	Basal Metabolic Rate
BP	Blood pressure
BSL	Blood glucose
Ca <sub>i</sub>	Ionic Calcium
CRP	C-reactive protein
DNA	Deoxyribonucleic acid
EAR	Estimated Average Requirement
ESRD	End stage renal disease
GP	General Practitioner
HbA <sub>1c</sub>	Glycosylated haemoglobin
HDL	High density lipoprotein
HOMA	Homeostasis model assessment
LDL	Low density lipoprotein
LGA	Local Government Area
MgATP	Magnesium- Adenosine triphosphate complex
Mg <sub>i</sub>	Ionic or free serum magnesium
Mg <sub>s</sub>	Total serum magnesium
NHLBI	National Heart Lung and Blood Institute

NNS	1995 National Nutrition Survey
NRV	Nutrient Reference Value
RDA	Recommended Daily Allowance
RDI	Recommended Dietary Intake
RNA	Ribonucleic acid
SD	Statistical Division
sd	standard deviation
sem	standard error of the mean
TAIHS	Townsville Aboriginal and Islander Health Service, Ltd
TCA cycle	Tricarboxylic acid cycle
UL	Upper Level of Intake
WAT	Walkabout Together Program

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## ABSTRACT

Diabetes in Indigenous Australians occurs at a younger age and at almost four times the rate of non-Indigenous Australians. While the cause for this health disparity is multifactorial, recent studies suggest that nutrition, and particularly magnesium intake, may play a role in onset of diabetes and related pathologies. No study has ever examined whether there is any relationship between diabetes and magnesium intake in Indigenous Australians, and the present study therefore sought to establish whether any such interrelationship existed. As part of this study, dietary magnesium intake was estimated in an urban cohort of Aboriginal and Torres Strait Islander subjects and compared to the average Australian dietary intake. An ecological study then explored environmental correlates, and specifically the magnesium level in drinking water, to diabetes mortality. Finally, total and free serum magnesium concentrations were determined to identify any differences in magnesium status between diabetic and non-diabetic Indigenous and non-Indigenous Australians, and also to compare which of the two parameters was a more sensitive measure of magnesium status and diabetic risk.

All Aboriginal and Torres Strait Islander people that were recruited for this study were patients of the Townsville Aboriginal and Islander Health Services, Townsville, North Queensland, who presented for health monitoring and subsequently required fasting blood tests as part of that routine care. Additional non-Indigenous people were recruited from five GP practices in the Townsville area. Inclusion criteria included persons over the age of 15 (Tanner Stage 5) who had lived in the Townsville area for at least ten days. Exclusion criteria included chronic diarrhoea, alcoholism or binge drinking in the past two weeks, use of diuretics, consumption of magnesium supplements, reduced renal function (urinary albumin to creatinine ratio exceeding  $> 2.5$  mg/mmol in men and  $> 3.5$  mg/mmol in women), severe mental illness, pregnancy, or breastfeeding. Our results indicated that 60% of the Indigenous people assessed in this study had a dietary intake of magnesium that

was below the estimated average magnesium requirement for half the national population. Additionally, the average magnesium intake in Indigenous Australians was significantly less than the intake of non-Indigenous Australians ( $p < 0.001$ ). A significant negative correlation was found between the incidence of diabetes related mortality and the concentration of magnesium in drinking water in Queensland, confirming previous reports from the USA that drinking water magnesium may be an important factor in development of diabetes. The needs assessment study confirmed that diabetes in both Indigenous and non-Indigenous Australians was associated with reduced levels of total serum magnesium, and more importantly, that total serum magnesium was lower in Indigenous Australians who did not have diabetes compared with their non-Indigenous counterparts ( $p = < 0.001$ ). In the absence of diabetes, the prevalence of hypomagnesaemia was 17.2% for the non-Indigenous but 36.9% for the Indigenous subjects. Finally, the ionic serum magnesium analysis confirmed the results of the total serum magnesium study, and demonstrated that ionic magnesium was strongly correlated to the total magnesium concentration ( $r: 0.75$ .  $p < 0.001$ ), with the relationship being apparent irrespective of either diabetic ( $r: 0.66$  to  $0.81$ .  $p < 0.001$ ) or ethnicity ( $r = 0.71$  to  $0.81$ .  $p < 0.001$ ). We conclude that although not causal, the evidence suggests that magnesium may be a significant contributing factor to diabetes in Australia, especially for Aboriginal and Torres Strait Islander peoples, and that further investigation of the potential relationship between magnesium and diabetes in the Australian Indigenous populations, and possible corrective interventions, is highly warranted.