

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

**A retrospective and cross-sectional study to evaluate the  
effect of dietary acculturation on the dietary calcium  
intake among Filipino women recently immigrated to  
New Zealand**

**A thesis presented in partial fulfilment of the  
requirements for the degree of**

**Master of Science  
in  
Human Nutrition**

**at Massey University, Albany, New Zealand**

**Rosario Pillar Monzales**

**2017**

## Abstract

Filipinos in New Zealand have steadily grown in number over recent decades, and the majority undergo a dietary acculturation process, or the dietary adaptation of individuals in their host country. In the Philippines, the nutrient with the highest inadequacy in the diet is calcium, primarily contributed by fish and indigenous vegetables that are not readily available in New Zealand. The aim of this study is to determine the effect of dietary acculturation on the calcium intake of Filipino women recently immigrated to New Zealand and to explore the primary factors affecting their bone mineral status. Sixty-two (62) healthy pre-menopausal Filipino women (20–45 years old) were recruited. Current and previous dietary calcium intake, serum 25(OH)D (nmol/L) ( $n=61$ ), physical activity data via an accelerometer, and bone mineral density (BMD) and body composition through dual-energy X-ray absorptiometry (DXA) were measured. Gross lean mass was calculated (total mass – [whole body total bone content + total fat mass]). Variables considered to be associated with bone mineral status were applied to a multiple regression analysis using the enter method. The median calcium intake for New Zealand [418 (260, 620) mg d<sup>-1</sup>] after immigration was significantly lower than the intake in the Philippines [506 (358, 823) mg d<sup>-1</sup>],  $Z=-2.41$ ,  $p=0.02$ , medium effect size  $r=0.22$ . The significant predictor of bone mineral status among Filipino women was gross lean mass, whereas current and previous dietary calcium intake, physical activity and serum 25(OH)D were not found to be significant. However, a high prevalence (69%) of serum 25(OH)D <50nmol/L (mild–moderate deficiency) was detected. These findings illustrate the potential detrimental consequences of dietary acculturation on the essential nutrient intake of immigrants, but also provide an opportunity to correct previous dietary inadequacies by exposure to corresponding nutrient-dense foods from the host country.

## **Acknowledgements**

I would like to extend my deepest gratitude to several people who made the completion of this thesis possible.

I would like to thank all of the 62 Filipino women who kindly participated in this study. I would like to acknowledge the time and effort they have put into coming and going to Massey University despite their busy schedules.

I am also extremely thankful to my main supervisor, Dr Pamela von Hurst for her guidance and unceasing support. She has consistently guided me with graciousness and great expertise in conducting and writing my research. I would like to acknowledge her commitment to finishing this research and striving hard for me to write a better thesis report.

I also want to thank my supervisors, Professor Marlena Kruger and Professor Barbara Burlingame, who have provided their expertise and patiently revised my writings.

A big thanks to Liana Norrish, who has been my partner in this research, for her contributions in conducting this study.

A massive thank you to Owen Mugridge, who has good-naturedly assisted me during the visits of the participants. He has also contributed tremendously to the recruitment of participants and to the data analysis of this research. I would like to acknowledge his efforts and his support even outside of working hours, and for volunteering to drop off the accelerometers.

Thank you to Dr Cath Conlon and PC Tong for showing me the ins and outs of participant recruitment and screening questionnaires. Also, I want to extend my appreciation to Joanne Tolentino who has greatly helped in the recruitment of Filipino women in Auckland.

Most importantly, I am extremely grateful to my family (my two sisters, Gia and Kris, and my parents who are now in heaven, Rico and Imelda) and my fiancé Ali, for their love, patience and unwavering support. Also to my ComeUnity whanau and my dearest friends and flatmates in New Zealand, Jacinda, Mroo, Milca, Britta, Orita and Hien, who have stuck with me and provided me encouragement through the toughest times of this research.

I dedicate this research to all immigrants worldwide. Through all of the difficulties in adjusting to a new culture, to finding safety and security in your new community, and to fighting for equality and a sense of belonging to a new society. May you find all these things in your new home.

## Table of contents

Abstract.....	2
Acknowledgements.....	3
List of tables and figures.....	7
Abbreviations.....	9
<b>Chapter 1 — Introduction</b> .....	11
Scope and justification.....	11
Aims, objectives and hypotheses .....	12
Thesis structure .....	12
Researchers’ contributions .....	12
<b>Chapter 2 — Literature review</b> .....	14
Introduction	
Literature review structure .....	14
The Philippines .....	14
Filipino immigration to New Zealand .....	15
Dietary acculturation of Filipinos in New Zealand.....	15
Changes in nutrient intake	
The Filipino diet .....	18
Dietary calcium intake of Filipino women in the Philippines .....	18
High prevalence of osteoporosis among Filipinos in the Philippines .....	20
Primary contributors of calcium in the diet .....	21
Dietary acculturation of Filipinos in New Zealand .....	22
Major sources of calcium in the New Zealand diet	
Factors affecting bone health .....	24
A. Dietary factors .....	24
Calcium.....	24

Roles and sources of calcium .....	24
Vitamin D .....	25
Roles and metabolism of vitamin D .....	25
Dietary sources of vitamin D .....	27
Food, supplements and fortified foods	
Measurement of vitamin D .....	28
Factors affecting vitamin D status .....	29
Other dietary factors affecting bone health .....	31
Protein .....	31
Phosphorus .....	31
Magnesium .....	32
Vitamin C .....	33
B. Lifestyle factors affecting bone health .....	33
Physical activity .....	33
Body composition .....	34
Fat-free mass and percentage body fat	
Contraceptive use .....	35
Smoking .....	36
Concerns on bone health of Filipino immigrants .....	37
Peak bone mass .....	37
Low vitamin D status risks specific to Filipino women .....	38
Skin colour .....	38
Adiposity .....	38
Sun avoidance .....	39
Measurement of bone mineral status .....	40
Bone mineral density measurement .....	40
Conclusion .....	41

<b>Chapter 3 — Research study manuscript</b> .....	42
Abstract .....	42
Introduction .....	43
Methods.....	44
Study protocol .....	44
Participants .....	44
Data collection methods .....	44
Data collection measures .....	45
Biochemical analyses .....	45
Development of food frequency questionnaire .....	46
Statistical analysis .....	47
Results.....	47
Discussion .....	52
Differences in dietary calcium intake .....	52
Predictors of bone mineral status .....	54
Limitations of the study .....	57
Conclusion and recommendations .....	57
<b>Chapter 4 — Conclusion and recommendations</b> .....	59
Conclusion .....	59
Strengths and limitations of the study .....	59
Final recommendations .....	61
<b>Appendix A</b> Supplementary methods .....	63
<b>Appendix B</b> Supplementary results .....	80
<b>Appendix C</b> Questionnaires and materials used in conducting the research .....	85
<b>References</b> .....	112

## **List of tables and figures**

### **Tables**

Table 1. Dietary acculturation studies among Filipinos

Table 2. Recommended intake for women and mean nutrient intake and adequacy of Filipino households

Table 3. Contributing food groups to calcium intake by population groups

Table 4. Comparison of calcium intake per food group for Filipino and New Zealand adults

Table 5. Comparison of dietary and non-dietary sources of vitamin D

### ***Research study manuscript***

Table 1. Demographic and physical characteristics of all participants

Table 2. Comparison of dietary calcium intake in the Philippines versus in New Zealand ( $n=62$ )

Table 3. Comparison of contributing food groups to previous and current dietary calcium intakes

Table 4. Current bone mineral status of Filipino women living in New Zealand

Table 5a. Hip total: predictors of hip Z-score among Filipino women living in New Zealand

Table 5b. Spine: predictors of lumbar Z-score among Filipino women living in New Zealand

Table 5c. Whole body: predictors of whole body Z-score among Filipino women living in New Zealand

Table 6. Comparison of lumbar and femoral neck bone mineral density (BMD) values between the participants from a previous Filipino study (Torralba et al., 2004) versus current study participants

### ***Appendices***

Table 1. Measurements and methods validity

Table 2. Correlations between predictor variables and bone mineral status

Table 3. Testing for correlations between body fat percentage and gross lean mass



## **Figures**

Figure 1. Philippines in the world map

Figure 2. Dietary acculturation process of immigrants in the United States

Figure 3. Change in bone mass of women with age

Figure 4. Vitamin D metabolism (synthesis and activation)

## ***Appendices***

Figure 1. Scatterplot diagram between gross lean mass and hip (total) Z-score

Figure 2. Scatterplot diagram between gross lean mass and lumbar Z-score

Figure 3. Scatterplot diagram between gross lean mass and whole body Z-score

Figures 4 and 5. Histogram and Q–Q plots for gross lean mass

Figure 6. Scatterplot diagram between gross lean mass and body fat percentage

## Abbreviations

25(OH)D	25-hydroxyvitamin D
ACC	Accident Compensation Corporation
ANOVA	analysis of variance
ANS	Adult Nutrition Survey
ATP	adenosine triphosphate
BMC	bone mineral content
BMD	bone mineral density
BMI	body mass index
C	Celsius
CT	computed tomography
CV	coefficient of variation
d <sup>-1</sup>	per day
DMPA	depot-medroxyprogesterone acetate
DXA	dual-energy X-ray absorptiometry
EAR	estimated average requirement
FFQ	food frequency questionnaire
FNRI	Food and Nutrition Research Institute
FHFFQ	Fred Hutchinson Food Frequency Questionnaire
g	gram
g/cm <sup>2</sup>	gram per square centimetre
GP	general practitioner
IOM	Institute of Medicine
ID-LC-MS/MS	isotope-dilution liquid chromatography-tandem mass spectrometry
IU	International Unit
IU/day	International Unit per day
kcal/day	kilocalorie per day
kg	kilogram
kj	kilojoule
m	month
MYFCD	Malaysian Food Composition Database
mg	milligram
HNRU	Human Nutrition Research Unit
ml	millilitre
MOH	Ministry of Health
MSc	Master's of Science
n	number
ng/ml	nanogram per millilitre
NIST	National Institute for Standards and Technology
nmol/L	nanomole per litre
NZ	New Zealand
PBM	peak bone mass
PH	Philippines
PIXI	peripheral instantaneous X-ray imaging
PTH	parathyroid hormone
RDI	recommended dietary intake
RENI	recommended energy and nutrient intake
RNI	recommended nutrient intake

SD	standard deviation
NHANES	National Health and Nutrition Examination Survey
US	ultrasound
USDA	United States Department of Agriculture
UV	ultraviolet
UVB	ultraviolet beta radiation
VDR	vitamin D receptor
vs	versus
WHR	waist-to-hip ratio
WHO	World Health Organization
y	year
μg	microgram
μSv	microsieverts