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.
Exploring body composition and metabolic health amongst NZ European, Pacific Island and Māori women participating in the women’s EXPLORE study

Amanda Whitford
2017

A thesis completed as part of the requirements for
Master of Science in Nutrition and Dietetics
at Massey University, Albany Campus
Auckland, New Zealand
Abstract

Background: In New Zealand, 31.6% of adults are obese. Significant ethnic health inequalities exist; Pacific Islanders and Māori have the highest rates.

Objectives: To investigate the body composition and metabolic health profiles of healthy NZ European, Pacific and Māori women participating in the women’s EXPLORE study.

Methods/Design: Cross sectional design investigating 233 European, 91 Pacific and 84 Māori women. Different body mass index (BMI) and body fat % (BF%) defined body composition profiles were analysed for anthropometric measurements, body fat location, and metabolic biomarkers.

Results: Obese (BF%) Māori women had higher android fat mass than obese (BF%) Europeans (2.53kg vs 2.23kg) with no difference in waist circumference (WC). Non-obese (BMI) Māori had higher WC than non-obese (BMI) NZ Europeans (78cm vs 73.5cm) with android fat differences. Regardless of body composition grouping, no ethnic differences were found for BF%. Obese Pacific women had higher HOMA-IR (5.12-5.45) and insulin (24.28-23.28mU/L) than obese Europeans (2.10-2.61 and 10.07-11.24mU/L respectively), as did obese Māori (3.64-4.35 and 16.76-19.41mU/L respectively). Body composition measures with highest sensitivity across all biomarkers assessed were BF% ≥30 for Europeans, both BF% ≥30 and BMI ≥25 for Pacific, and BMI ≥25 for Māori.

Conclusion: Māori and Pacific women had significantly higher glucose metabolism markers than NZ Europeans despite no differences in BF%. When comparing Māori to NZ Europeans, a higher WC was not always related to a higher android fat mass or vice versa, suggesting that WC may not be an accurate representation of abdominal fat for Māori. In spite of ethnic differences, BF% ≥30 and BMI ≥25 appear most sensitive to detect high biomarkers compared to abdominal measurements.
Acknowledgements

First and foremost, I would like to thank Massey University, and Rozanne Kruger in particular, for the opportunity to be a part of the EXPLORE study to complete my thesis. I would also like to thank Rozanne and Marilize Richter for their ongoing advice, guidance and support throughout this process, especially during the difficult times. Although it has been a challenging journey, I have learned so much from each of them and for this I will always be grateful.

I would also like to thank all of those who were involved with the recruitment, screening, data collection, and data handling for this study.

Finally I would like to thank my family, friends, and Justin for supporting and encouraging me, reminding me to take study breaks, and helping me through the highs and lows along the way.
Table of Contents

List of Tables ........................................................................................................................................ vi
List of Figures ......................................................................................................................................... vii
Abbreviations ....................................................................................................................................... viii

Chapter 1: Introduction .......................................................................................................................... 1

1.1 Background ................................................................................................................................... 1

1.2 Aims and objectives ...................................................................................................................... 7

1.3 Contributors to the research ....................................................................................................... 8

1.4 Structure of the thesis ................................................................................................................... 9

1.5 References ................................................................................................................................... 10

Chapter 2: Literature Review ................................................................................................................ 16

2.1 Introduction ................................................................................................................................. 16

2.2 The global prevalence of obesity ............................................................................................... 16

2.3 Obesity in New Zealand ............................................................................................................. 17

2.4 The aetiology of obesity .............................................................................................................. 18

2.5 The function of adipose tissue ................................................................................................... 19

2.6 The metabolic consequences of obesity ...................................................................................... 20

2.7 Body fat content and distribution ............................................................................................... 26

2.8 Assessment of body composition ............................................................................................... 28

2.9 Body fat profile groups ................................................................................................................. 30

2.10 Alternative body composition measures .................................................................................... 33

2.11 Summary ................................................................................................................................... 35

2.12 Acknowledgements .................................................................................................................... 35

2.13 Conflicts of interest ...................................................................................................................... 36

2.14 References ................................................................................................................................... 37

Chapter 3: Research Manuscript .......................................................................................................... 61

3.1 Abstract ....................................................................................................................................... 62

3.2 Introduction ................................................................................................................................... 63

3.3 Subjects & methods ...................................................................................................................... 66

3.4 Results ......................................................................................................................................... 70

3.5 Discussion ................................................................................................................................... 75

3.6 Strengths and Limitations ............................................................................................................. 84
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.7 Conclusion</td>
<td>84</td>
</tr>
<tr>
<td>3.8 References</td>
<td>86</td>
</tr>
<tr>
<td>Section 4: Conclusions and Recommendations</td>
<td>105</td>
</tr>
<tr>
<td>4.1 Overview and Conclusions</td>
<td>105</td>
</tr>
<tr>
<td>4.2 Strengths of the research</td>
<td>108</td>
</tr>
<tr>
<td>4.3 Limitations of the research</td>
<td>108</td>
</tr>
<tr>
<td>4.4 Recommendations for future research</td>
<td>109</td>
</tr>
<tr>
<td>4.5 References</td>
<td>111</td>
</tr>
<tr>
<td>Appendix A: Supplementary Methods</td>
<td>113</td>
</tr>
<tr>
<td>A.1 References</td>
<td>119</td>
</tr>
<tr>
<td>Appendix B: Supplementary Results</td>
<td>121</td>
</tr>
<tr>
<td>Appendix C: Consent Form</td>
<td>126</td>
</tr>
<tr>
<td>Appendix D: Screening Questionnaire</td>
<td>127</td>
</tr>
<tr>
<td>Appendix E: Anthropometry and blood pressure data sheet</td>
<td>132</td>
</tr>
<tr>
<td>Appendix F: Instructions for authors for Nutrition Reviews</td>
<td>134</td>
</tr>
<tr>
<td>Appendix G: Instructions for authors for Asia Pacific Journal of Clinical Nutrition</td>
<td>137</td>
</tr>
</tbody>
</table>
List of Tables

Table 1: World Health Organisation BMI classifications  2
Table 2.1: A summary of cross sectional studies investigating inflammatory markers and body composition  53
Table 2.2: Traditional and alternative body composition and metabolic profiles  54
Table 2.3: Summary of studies investigating the normal BMI and high body fat % profile, and related body composition/metabolic outcomes  55
Table 2.4: Summary of ethnic comparisons of body composition measures with or without metabolic biomarkers  57
Table 3.1: Characteristics of NZ European women classified in subgroups according to normal or high BMI & body fat % criteria  96
Table 3.2: Ethnic distribution in BMI and BF % groups  97
Table 3.3: Anthropometric and clinical characteristics of participants classified by BMI and ethnicity  98
Table 3.4: Anthropometric and clinical characteristics of participants classified by body fat % and ethnicity  100
Table 3.5: Sensitivity and Specificity of anthropometric measures in relation to metabolic health biomarkers  103
Table A.1: Biomarkers and laboratories used for analysis  117
Table B.1: Number and percentage of participants with abnormal biomarkers in each ethnic and body composition group (BMI and BF%)  121
B.2: Spearman’s correlation co-efficient between body compositional measures, overall and by ethnicity  123
B.3: Spearman’s correlation co-efficient for body composition measurements and metabolic variables by ethnicity  124
B.4: Areas under the receiver operating curve for body composition measurements in relation to biomarkers of metabolic health, overall and by ethnicity  125
List of Figures

Figure 2.1: Obesity related disturbances in adipose tissue and how they relate to inflammation and insulin resistance 59
Figure 2.2: Flow chart depicting the potential links between obesity and metabolic disease 60
Figure 3.1a: Prevalence of high metabolic biomarkers in obese women by BMI 104
Figure 3.1b: Prevalence of high metabolic biomarkers in obese women by fat % 104
Figure A.1: Initial Study Design 117
Abbreviations

AG android gynoid
ASMM appendicular skeletal muscle mass
ATM adipose tissue macrophage
BF body fat
BIA bioelectrical impedance analysis
BMD bone mineral density
BMI body mass index
BP blood pressure
Chol/HDL cholesterol to high density lipoprotein ratio
CRP c-reactive protein
CVD cardiovascular disease
DXA dual-energy x-ray absorptiometry
FFA free fatty acids
FM fat mass
FFM fat free mass
HbA1c glycated haemoglobin
HC hip circumference
HDL high density lipoprotein
HH high BMI, high body fat %
HOMA-IR homeostasis model of insulin resistance
IFG impaired fasting glucose
IGT impaired glucose tolerance
IL interleukin
IR insulin resistance
LBM lean body mass
LDL low density lipoprotein
MCP-1 monocyte chemotactic protein 1
MHO metabolically healthy obese
NH normal BMI, high body fat %
NN normal BMI, normal body fat %
NWO normal weight obesity
NZE New Zealand European
OGTT oral glucose tolerance test
VLDL very low density lipoprotein
SAT subcutaneous adipose tissue
Se sensitivity
Sp specificity
SNS sympathetic nervous system
TC total cholesterol
T2D Type II diabetes
TG triglycerides
TLR-4 Toll like receptor 4
TNF-α tumor necrosis factor
VAT visceral adipose tissue
WC waist circumference
WHO world health organisation
WtHR waist to height ratio
WHR waist to hip ratio