2004

Short-term effects of altering the dietary carbohydrate to fat ratio on circulating leptin and satiety in women

Michelle A. Gordon
University of Wollongong

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SHORT-TERM EFFECTS OF ALTERING THE DIETARY CARBOHYDRATE TO FAT RATIO ON CIRCULATING LEPTIN AND SATIETY IN WOMEN

A thesis submitted in fulfilment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

from

UNIVERSITY OF WOLLONGONG

by

MICHELLE A. GORDON, BSc (Honours), MSc (Nutrition & Dietetics)

DEPARTMENT OF BIOMEDICAL SCIENCE

2004
Declaration

I, Michelle A. Gordon, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Department of Biomedical Science, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. All work in this thesis has not been submitted for qualifications at any other academic institution.

Michelle A. Gordon

15\textsuperscript{th} December 2004
Wollongong, Australia
Abstract

Background: Overweight and obesity have reached epidemic proportions and appetite control may be important for its clinical management. Leptin is a plasma protein secreted from adipose tissue that is involved in body weight regulation. The role of leptin in regulating human appetite is not well established. Human feeding studies report that an increased dietary carbohydrate to fat ratio is associated with increased circulating leptin concentrations compared to a decreased dietary carbohydrate to fat ratio. These investigations have generally used diets with extreme variations in macronutrient intake that do not represent normal patterns of consumption. Whether less extreme variations in macronutrient intake have similar effects on circulating leptin and whether there is a relationship with satiety under these conditions is not established. The overall aim of this research was to determine the potential clinical relevance of the effects of altering the dietary carbohydrate to fat ratio on circulating leptin concentrations.

Methods: Three short-term controlled human feeding studies were conducted involving 68 female subjects (age 37 ± 9 (SD) yrs, BMI 26.8 ± 4.1 kg/m²). Study 1 and Study 2 were single-blind parallel design trials where realistic high carbohydrate (carbohydrate:fat= 60:20) or high fat (carbohydrate:fat= 40:40) iso-caloric diets were provided. Study 3 was a double-blind cross-over trial where high carbohydrate (carbohydrate:fat= 60:20) and extreme high fat (carbohydrate:fat= 25:55) diets were provided. The primary outcomes were fasting leptin concentrations and subjective satiety measured on a multi-dimensional and single-dimension visual analogue scales. In Study 3 ad libitum intake was also assessed at a post-intervention buffet breakfast. Two-way repeated measures analysis of variance was used to analyse the effect of the intervention diets over time on the outcome measures.
Results: There was no between group difference in fasting leptin concentrations when realistic high carbohydrate and high fat controlled diets were consumed in Study 1 and Study 2 (p>0.4). This finding was similar when leptin concentrations were adjusted for body composition. Within subjects, changes in recent dietary carbohydrate and fat intake predicted a decrease in leptin concentrations during the intervention, but effects were small. A weak linear relationship between leptin concentrations and subjective satiety score was detected in Study 1 (p=0.06), but no relationship was detected in Study 2 and Study 3 (p>0.7). In Study 3 the more extreme high fat diet reduced leptin concentrations by 21% relative to the high carbohydrate diet (time*diet interaction, p<0.01). There was no influence of this difference in leptin concentration on ad libitum energy or macronutrient intake at the buffet breakfast (95% CI for difference in energy intake -411kJ to 190kJ).

Conclusions: Circulating leptin concentrations are influenced by dietary carbohydrate to fat ratio such that decreasing the carbohydrate content of the diet results in decreased circulating leptin concentrations. However, the potential clinical relevance of this finding to the management of overweight and obesity is likely to be limited as i) extreme dietary patterns are necessary to detect this effect, ii) leptin concentrations were not related to subjective satiety score and iii) differences in leptin concentrations did not influence ad libitum food intake. Further research is necessary to confirm these findings over longer time frames, with different subject groups, twenty four hour blood sampling and ad libitum intake over the entire day.
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Thank you to all members of my research teams. To Dr Brin Grenyer for his expert advice about the psychological aspects of the trials and Sr Sheena McGhee for her support and calm demeanour, thank you. A special thanks to all the women who participated in the studies.

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To my friends who have heard about my thesis many more times than is healthy, thank you for being there and for believing in me. A special thanks go to Jacqui, Vince, Nigel, Janelle and Trace for their encouragement and help with editing.

The last word of thanks must go to my dear family who have been with me every step of the way and without whom the opportunities that lay before me would not be possible.
## List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>ANCOVA</td>
<td>Analysis of covariance</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Analysis of variance</td>
</tr>
<tr>
<td>BIA</td>
<td>Bioelectrical impedance analysis</td>
</tr>
<tr>
<td>BMI</td>
<td>Body mass index</td>
</tr>
<tr>
<td>CCK</td>
<td>Cholecystokinin</td>
</tr>
<tr>
<td>CHO</td>
<td>Carbohydrate</td>
</tr>
<tr>
<td>CNS</td>
<td>Central nervous system</td>
</tr>
<tr>
<td>DH</td>
<td>Diet history</td>
</tr>
<tr>
<td>DR</td>
<td>Dietary restraint</td>
</tr>
<tr>
<td>DXA</td>
<td>Dual energy x-ray absorptiometry</td>
</tr>
<tr>
<td>FR</td>
<td>Food record</td>
</tr>
<tr>
<td>%E</td>
<td>Percentage of energy</td>
</tr>
<tr>
<td>GI</td>
<td>Glycemic index</td>
</tr>
<tr>
<td>GLP-1</td>
<td>Glucagon like peptide-1</td>
</tr>
<tr>
<td>HC</td>
<td>High carbohydrate</td>
</tr>
<tr>
<td>HF</td>
<td>High fat</td>
</tr>
<tr>
<td>kJ</td>
<td>Kilojoule</td>
</tr>
<tr>
<td>MUFA</td>
<td>Monounsaturated fatty acid</td>
</tr>
<tr>
<td>NPY</td>
<td>Neuropeptide Y</td>
</tr>
<tr>
<td>PUFA</td>
<td>Polyunsaturated fatty acid</td>
</tr>
<tr>
<td>SD</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>SEM</td>
<td>Standard error of the mean</td>
</tr>
<tr>
<td>SFA</td>
<td>Saturated fatty acid</td>
</tr>
<tr>
<td>TFEQ</td>
<td>Three factor eating questionnaire</td>
</tr>
<tr>
<td>VAS</td>
<td>Visual analogue scale</td>
</tr>
<tr>
<td>VMH</td>
<td>Ventromedial hypothalamus</td>
</tr>
</tbody>
</table>
Thesis publications and conference abstracts


Chapter 1: Introduction

1.1 Scope of thesis ................................................................. 1
1.2 Overweight and obesity ................................................... 1
  1.2.1 Definition ................................................................. 1
  1.2.2 Prevalence .............................................................. 1
  1.2.3 Implications ............................................................ 2
  1.2.4 Aetiology ............................................................... 3
  1.2.5 Clinical management .............................................. 4
1.3 Dietary carbohydrate to fat ratio ................................... 5
  1.3.1 Recommended intakes ............................................. 5
  1.3.2 Dietary carbohydrate .............................................. 6
  1.3.3 Dietary fat ............................................................ 9
1.4 Appetite regulation ......................................................... 10
  1.4.1 Terminology .......................................................... 10
  1.4.2 Psychological appetite regulation ............................ 10
  1.4.3 Physiological appetite regulation ............................ 11
  1.4.4 Macronutrients and satiety .................................... 13
  1.4.5 Macronutrient preferences .................................... 14
# Chapter 2: Methodology

2.1 Studying the diet and disease relationship .......................................................... 32  
   2.1.1 Study population .......................................................................................... 32  
   2.1.2 Subject compliance .................................................................................... 33  
   2.1.3 Blinding to intervention ............................................................................ 33  
   2.1.4 Intervention efficacy .................................................................................. 34  
2.2 Dietary intake assessment .................................................................................... 34  
   2.2.1 Diet history interview ................................................................................. 34  
   2.2.2 Food records .............................................................................................. 36  
   2.2.3 Dietary underreporting .............................................................................. 37  
2.3 Body composition assessment ............................................................................ 38  
   2.3.1 Dual energy x-ray absorptiometry .............................................................. 38  
   2.3.2 Bioelectric impedance analysis .................................................................. 39  
2.4 Satiety assessment .............................................................................................. 40  
   2.4.1 Subjective satiety scales ............................................................................. 41  
   2.4.2 *Ad libitum* food intake ............................................................................ 42  
2.5 Circulating leptin concentrations ...................................................................... 43  
   2.5.1 Blood collection ......................................................................................... 43  
   2.5.2 Body composition adjustment ................................................................... 44
Chapter 3: Human feeding study 1

3.1 Rationale ......................................................................................................... 46
3.2 Aims & hypotheses ....................................................................................... 47
3.3 Methods ........................................................................................................ 47
   3.3.1 Subjects .............................................................................................. 47
   3.3.2 Experimental protocol ......................................................................... 49
   3.3.3 Menstrual cycle data ........................................................................... 50
   3.3.4 Anthropometric data ........................................................................... 50
   3.3.5 Body composition data ....................................................................... 50
   3.3.6 Dietary intake data .............................................................................. 51
   3.3.7 Intervention diet .................................................................................. 52
   3.3.8 Subjective satiety evaluation ............................................................... 54
   3.3.9 Biochemical analysis .......................................................................... 54
   3.3.10 Statistical analysis ............................................................................ 56
3.4 Results .......................................................................................................... 56
   3.4.1 Subject characteristics ........................................................................ 56
   3.4.2 Menstrual cycle data ........................................................................... 57
   3.4.3 Diet history intake ............................................................................... 58
   3.4.4 Food record dietary intake ................................................................. 58
   3.4.5 Diet history and food record differences ............................................. 59
   3.4.6 Intervention dietary intake ................................................................. 59
   3.4.7 Intervention and 24hr food record differences .................................... 60
   3.4.8 Leptin and body fat relationship ......................................................... 61
   3.4.9 Serum leptin concentration ................................................................. 61
   3.4.10 Serum leptin adjusted for body fat .................................................... 62
   3.4.11 Dietary predictors of adjusted leptin ................................................ 63
   3.4.12 Serum insulin concentration ............................................................ 64
### 3.4.13 Serum leptin and insulin relationship ................................................65
### 3.4.14 Serum glucose concentration ...........................................................66
### 3.4.15 Subjective satiety score ....................................................................66
### 3.4.16 Serum leptin and satiety relationship ................................................67
### 3.5 Discussion ....................................................................................................68
### 3.6 Conclusions ..................................................................................................76

## Chapter 4: Human feeding study 2

4.1 Rationale.......................................................................................................77
4.2 Aims & hypotheses .......................................................................................78
4.3 Methods ........................................................................................................79
   4.3.1 Subjects..............................................................................................79
   4.3.2 Experimental protocol .........................................................................80
   4.3.3 Dietary restraint ..................................................................................81
   4.3.4 Anthropometric data ...........................................................................81
   4.3.5 Body composition data........................................................................81
   4.3.6 Dietary intake data..............................................................................81
   4.3.7 Intervention diet ..................................................................................82
   4.3.8 Subjective satiety evaluation...............................................................83
   4.3.9 Biochemical analysis ...........................................................................83
   4.3.10 Statistical analysis ............................................................................83
4.4 Results ..........................................................................................................84
   4.4.1 Subject characteristics ........................................................................84
   4.4.2 Menstrual cycle data ...........................................................................84
   4.4.3 Diet history intake ...............................................................................85
   4.4.4 Dietary restraint ..................................................................................86
   4.4.5 Food record intake ..............................................................................86
   4.4.6 Diet history and food record differences .............................................88
   4.4.7 Intervention dietary intake .................................................................88
   4.4.8 Intervention and food record differences ............................................89
Chapter 5: Human feeding study 3

5.1 Rationale ................................................................. 110
5.2 Aims & hypotheses .................................................. 111
5.3 Methods ................................................................... 112
   5.3.1 Subjects .......................................................... 112
   5.3.2 Experimental protocol ........................................ 113
   5.3.3 Anthropometric data .......................................... 114
   5.3.4 Bioelectric impedance analysis ........................... 114
   5.3.5 Dietary intake data ............................................ 114
   5.3.6 Intervention diet ................................................ 115
   5.3.7 Sensory evaluation .......................................... 116
   5.3.8 Buffet breakfast ................................................ 117
   5.3.9 Subjective satiety evaluation ............................... 118
   5.3.10 Biochemical analysis ......................................... 119
   5.3.11 Statistical analysis .......................................... 119
5.4 Results........................................................................................................119
  5.4.1 Subject characteristics .....................................................................119
  5.4.2 Menstrual cycle data ......................................................................121
  5.4.3 Diet history intake ..........................................................................121
  5.4.4 Dietary restraint .............................................................................122
  5.4.5 Food record intake ..........................................................................123
  5.4.6 Intervention dietary intake .............................................................124
  5.4.7 Intervention and food record differences ........................................125
  5.4.8 Sensory evaluation ..........................................................................125
  5.4.9 Ad libitum breakfast intake .............................................................126
  5.4.10 Debriefing questionnaire ...............................................................128
  5.4.11 Leptin and body fat relationship....................................................128
  5.4.12 Serum leptin concentrations .........................................................129
  5.4.13 Dietary predictors of leptin ............................................................129
  5.4.14 Serum insulin concentrations .......................................................130
  5.4.15 Serum glucose concentrations .....................................................131
  5.4.16 Subjective satiety score, multi-dimensional scale .........................132
  5.4.17 Subjective satiety score, single dimension scales .........................132
  5.4.18 Subjective satiety and ad-libitum intake .......................................133
  5.4.19 Dietary restraint, leptin and subjective satiety ................................134
  5.4.20 Serum leptin and satiety, multi-dimensional scale .......................134
  5.4.21 Serum leptin and satiety, single dimension scales.........................135
  5.5 Discussion ............................................................................................135
  5.6 Conclusions ........................................................................................145

Chapter 6: Summary and conclusions

6.1 Potential clinical relevance of research findings......................................146
  6.1.1 Realistic dietary carbohydrate to fat ratio and circulating leptin .......147
  6.1.2 Extreme dietary carbohydrate to fat ratio and circulating leptin ......148
  6.1.3 Mechanisms of macronutrient effects on circulating leptin .............149
6.1.4 Circulating leptin concentrations and subjective satiety .......... 150
6.1.5 Circulating leptin concentrations and ad libitum intake ........... 151
6.2 Limitations of research ............................................................... 151
6.3 Conclusions .............................................................................. 152
6.4 Future research directions ......................................................... 152

Chapter 7: References

7.1 Cited references ...................................................................... 154

Appendix 1: Human feeding study 1
Appendix 2: Human feeding study 2
Appendix 3: Human feeding study 3
List of Tables

3.1 Study 1: Intervention diet composition ........................................ 53
3.2 Study 1: Intervention meal plan ................................................... 53
3.3 Study 1: Subject characteristics .................................................... 57
3.4 Study 1: Menstrual cycle data ....................................................... 57
3.5 Study 1: Habitual dietary intake ..................................................... 58
3.6 Study 1: Day 0 dietary intake ....................................................... 59
3.7 Study 1: Day 0 and habitual intake difference .............................. 59
3.8 Study 1: Intervention dietary intake .......................................... 60
3.9 Study 1: Intervention and Day 0 intake differences ..................... 61
3.10 Study 1: Post-hoc dietary predictors of serum leptin ................. 64
4.1 Study 2: Intervention diet composition ....................................... 82
4.2 Study 2: Intervention drink composition .................................... 82
4.3 Study 2: Subject characteristics ............................................... 84
4.4 Study 2: Habitual dietary intake ............................................... 85
4.5 Study 2: Restrained and unrestrained eaters characteristics .......... 86
4.6 Study 2: Restrained and unrestrained eaters habitual diet .......... 87
4.7 Study 2: Day 0 dietary intake .................................................... 87
4.8 Study 2: Day 0 and habitual intake difference ............................ 88
4.9 Study 2: Part 1 and Part 2 dietary intake .................................. 89
4.10 Study 2: Intervention dietary intake ......................................... 89
4.11 Study 2: Intervention and Day 0 intake difference .................. 90
4.12 Study 2: Post-hoc dietary predictors of serum leptin ............... 93
4.13 Study 2: Leptin and satiety, restrained and unrestrained eaters .. 101
5.1 Study 3: Intervention diet composition ..................................... 116
5.2 Study 3: Intervention meal plan ............................................. 116
5.3 Study 3: Sensory properties of milkshake formulas .................. 117
5.4 Study 3: Buffet breakfast foods ............................................. 118
5.5 Study 3: Subject characteristics ............................................ 120
5.6 Study 3: Habitual dietary intake ............................................. 121
<table>
<thead>
<tr>
<th>5.7</th>
<th>Study 3: Restrained and unrestrained eaters characteristics</th>
<th>122</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.8</td>
<td>Study 3: Restrained and unrestrained eaters habitual diet</td>
<td>123</td>
</tr>
<tr>
<td>5.9</td>
<td>Study 3: Day 0 dietary intake</td>
<td>124</td>
</tr>
<tr>
<td>5.10</td>
<td>Study 3: Intervention dietary intake</td>
<td>125</td>
</tr>
<tr>
<td>5.11</td>
<td>Study 3: Sensory evaluation of milkshake formulas</td>
<td>126</td>
</tr>
<tr>
<td>5.12</td>
<td>Study 3: Ad libitum breakfast intake</td>
<td>127</td>
</tr>
<tr>
<td>5.13</td>
<td>Study 3: Post-buffet satiety ratings</td>
<td>127</td>
</tr>
<tr>
<td>5.14</td>
<td>Study 3: Post-hoc dietary predictors of serum leptin</td>
<td>130</td>
</tr>
<tr>
<td>5.15</td>
<td>Study 3: Relationship between satiety and dietary intake</td>
<td>133</td>
</tr>
<tr>
<td>5.16</td>
<td>Study 3: Leptin and satiety, restrained and unrestrained eaters</td>
<td>134</td>
</tr>
</tbody>
</table>
# List of Figures

1.1 Hypothesised relationship between dietary carbohydrate, circulating leptin and satiety .......................................................... 31
2.1 Harris-Benedict equation .................................................................. 37
3.1 Study 1: Experimental timeline .......................................................... 50
3.2 Study 1: Serum leptin and body fat relationship ............................... 61
3.3 Study 1: Serum leptin concentrations over time ............................... 62
3.4 Study 1: Serum leptin adjusted for body fat over time .................... 63
3.5 Study 1: Serum insulin concentrations over time ............................ 64
3.6 Study 1: Serum insulin and leptin relationship .............................. 65
3.7 Study 1: Serum glucose concentrations over time .......................... 66
3.8 Study 1: Satiety score over time ...................................................... 67
3.9 Study 1: Serum leptin and satiety relationship ............................... 67
4.1 Study 2: Experimental timeline ...................................................... 81
4.2 Study 2: Serum leptin and body fat relationship ............................ 90
4.3 Study 2: Serum leptin concentrations over time, parts ................. 91
4.4 Study 2: Serum leptin concentrations over time, diets ................ 92
4.5 Study 2: Serum leptin adjusted for body fat over time .................. 93
4.6 Study 2: Serum insulin concentrations over time .......................... 94
4.7 Study 2: Serum insulin and leptin relationship ............................ 95
4.8 Study 2: Serum glucose concentrations over time ...................... 95
4.9 Study 2: Satiety score over time ................................................... 96
4.10 Study 2: Hunger score over time ................................................. 97
4.11 Study 2: Fullness score over time ............................................... 97
4.12 Study 2: Desire to eat score over time ......................................... 98
4.13 Study 2: Prospective consumption score over time ..................... 99
4.14 Study 2: Average satiety score over time, parts .......................... 100
4.15 Study 2: Average satiety score over time, diets .......................... 100
4.16 Study 2: Serum leptin and satiety relationship, multi-dimensional satiety scale........................................................................................................102
4.17 Study 2: Serum leptin and satiety relationship, single dimension satiety scale........................................................................................................102
5.1 Study 3: Experimental timeline............................................................113
5.2 Study 3: Serum leptin and body fat relationship...............................128
5.3 Study 3: Serum leptin concentrations over time, diets.................129
5.4 Study 3: Serum insulin concentrations over time.........................130
5.5 Study 3: Serum glucose concentrations over time.......................131
5.6 Study 3: Average satiety score over time, multi-dimension...........132
5.7 Study 3: Average satiety score over time, single dimension........133
5.8 Study 3: Serum leptin and satiety relationship, multi-dimensional satiety scale........................................................................................................134
5.9 Study 3: Serum leptin and satiety relationship, single dimension satiety scale........................................................................................................135