COGNITIVE DIETARY RESTRAINT AND FACTORS RELATED TO BONE MINERAL DENSITY AND BODY WEIGHT IN POSTMENOPAUSAL WOMEN

by

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B.A. (Hon.), Queen's University, 1994

B.Sc., Queen's University, 1996

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

in

THE FACULTY OF GRADUATE STUDIES

(Human Nutrition)

THE UNIVERSITY OF BRITISH COLUMBIA

August 2006

ABSTRACT

Cognitive dietary restraint (ongoing effort to limit dietary intake to manage body weight) is common in young women and has been associated with increased cortisol excretion and reduced bone mineral content (BMC). However, little is known about dietary restraint and its possible association with health in older women. This research addressed this gap by exploring cognitive dietary restraint in postmenopausal women aged 45–75 years. A broad survey of 1071 women assessed dietary restraint and other characteristics, and 78 respondents with *high* or *low* dietary restraint were recruited to complete measures of cortisol excretion, perceived stress, dietary intake, lifetime physical activity, and body composition. **Study 1** examined cortisol excretion and body composition in women with high (n=41) versus low (n=37) dietary restraint. Groups were similar in age, body mass index (BMI), waist-to-hip ratio, current exercise, energy intake, perceived stress, body fat, BMC, and bone mineral density (BMD). However, cortisol excretion was higher in the high restraint group (248.2 ± 61.7 nmol/day versus 204.3 ± 66.1 nmol/day, P=0.01). Lifetime physical activity and current BMD were investigated in those participants in **Study 2**. Teenage physical activity, but not activity during other age periods, predicted postmenopausal BMD at both the lumbar spine (R^2=0.110, P=0.004) and mean proximal femora (ΔR^2=0.106, P=0.002). In **Study 3**, dietary restraint and 'dieting' were compared in the 1071 survey respondents. Controlling for dietary restraint, dieters had *higher* BMI than non-dieters (+4.1 kg/m^2; 95% CI: 3.6, 4.6). Conversely, controlling for dieting status, restrained eaters had *lower* BMI than unrestrained eaters (-1.0 kg/m^2; 95% CI: -1.6, -0.5). Additional differences in food choice motives and psychosocial characteristics indicate that dietary restraint and dieting are not analogous. Finally, in **Study 4**, eating attitudes and weight-related characteristics were explored in survey respondents grouped according to 10-year weight history (maintenance, loss, gain, cycling). Disinhibition of eating control was the strongest predictor of current BMI in each weight history group, accounting for 11-20% of the variance.

Dietary restraint predicted BMI only among women who had experienced weight cycling. Together, these studies suggest subtle differences in eating and activity characteristics contribute to the health of postmenopausal women.

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LIST OF ABBREVIATIONS

ACTH: Adrenocorticotropic hormone

ANOVA: Analysis of variance

ANCOVA: Analysis of covariance

AUC: area under the curve

BMC: bone mineral content (g)

BMD: (areal) bone mineral density (g/cm^2)

BMI: body mass index (kg/m^2)

CDR: cognitive dietary restraint (synonymous with "dietary restraint")

Ch: Chapter

CI: confidence interval

cm: centimetre

CRH: Corticotropin-releasing hormone

CV: coefficient of variation

DEBQ: Dutch Eating Behaviour Questionnaire

DEBQ-R: Dutch Eating Behaviour Questionnaire – restrained eating subscale

dL: decilitre

DSI: Daily Stress Inventory

DXA: dual energy x-ray absorptiometry

FCQ: Food Choice Questionnaire

g: gram

g: gee (unit of acceleration equal to 9.80665 m/s^2)

HLAQ: Historical Leisure Activity Questionnaire

HPA: hypothalamic-pituitary-adrenal

hr: hour

HRT: hormone replacement therapy

IU: international units

kcal: kilocalories

kg: kilogram

L: litre

L1: first lumbar spine vertebra

L2: second lumbar spine vertebra

L3: third lumbar spine vertebra

L4: fourth lumbar spine vertebra

L1-4: lumbar spine vertebrae 1 through 4, inclusive

lbs: pounds

m: metre

MANCOVA: multivariate analysis of covariance

mg: milligram

µg: microgram

min: minutes

mL: millilitre

mmol: millimole

nmol: nanomole

NWBPA: non-weight-bearing physical activity

p: page

PSS: Perceived Stress Scale

RS: Restraint Scale

SATAQ: Sociocultural Attitudes Towards Appearance Questionnaire

SD: standard deviation

SE: standard error

SPAS: Social Physique Anxiety Scale

SPSS: Statistical Package for the Social Sciences

T-score: distance (in SD) from mean young normal BMD

TFEQ: Three-Factor Eating Questionnaire

TFEQ-D: Three-Factor Eating Questionnaire – disinhibition subscale

TFEQ-H: Three-Factor Eating Questionnaire – hunger subscale

TFEQ-R: Three-Factor Eating Questionnaire – cognitive restraint subscale

VGH: Vancouver General Hospital

WBPA: weight-bearing physical activity

WHO: World Health Organization

wk: week

WLOC: Weight Locus of Control

yr: year

PREFACE

I prepared this dissertation according to the requirements for a manuscript-based thesis as described by the Faculty of Graduate Studies at the University of British Columbia.[1] Thus, each of Chapters 2 through 5 was written in a modified manuscript form. Although these manuscript chapters do not contain separate abstracts, they are otherwise intended to stand alone. As a result, all tables, figures, and references are located within the chapter to which they pertain, and there is some overlap in the description of methods between chapters. The first manuscript (Chapter 2) describes my work on my central research question; however, the manuscript chapters could be read in any order. Supplemental analyses, or other items that would typically not be contained in a manuscript, have been included in appendices.

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[1]The University of British Columbia Faculty of Graduate Studies. *Masters and Doctoral Thesis Preparation and Submission*. Available at http://www.grad.ubc.ca/students/thesis/index.asp.

ACKNOWLEDGEMENTS

I would like to acknowledge the following people and organizations whose assistance and support made significant contributions to this research, and to my experience in conducting it.

First, my very sincere thanks to my research supervisor, Dr. Susan Barr. I am extremely grateful for the opportunity to have had you as my mentor during my graduate studies, and greatly value the role you have played in my development as a researcher over these years. Thank you for your commitment to your students, your unwavering support, and your willingness to provide the opportunity to develop as a self-directed researcher. You have been a true inspiration.

This research would not have been possible without the contributions of my study participants, and I sincerely appreciate their time and efforts. I am especially indebted to the 78 women who participated in the second phase of my study. Their conscientious completion of the many and varied tasks was a key element in the quality of data we obtained. It was a real privilege to meet each participant, and my contact with them enriched this experience in ways I could never have imagined.

I gratefully acknowledge the contributions of the members of my Supervisory Committee. Thank you to Dr. Gwen Chapman for her stimulating questions and for being such a good role model. Thank you to Dr. Heather McKay for her thought-provoking questions, her helpful feedback, and for the opportunity to participate in the Bone Health Journal Club – a true highlight for me with respect to its dynamic learning environment and the stimulating example set by Drs. McKay and Khan. Thank you to Dr. Karen Kruse for her interest in the project and her clinical perspective, and to Dr. Wolfgang Linden for his support and insights. I was fortunate to have a Supervisory Committee with such breadth of experience and truly valued our discussions.

Thank you to the staff at Vancouver General Hospital who played a role in my research: I appreciated the assistance of Romy Chan and the technicians in Laboratory Medicine in conducting the urine analyses, and that of Lori Hook, Kevin Hammerstrom, and the technicians in Nuclear Medicine in conducting the DXA scans. A special thank you to Nazneen for her help with scheduling the DXA appointments.

Thank you to Kevin Williams from the Department of Psychology at UBC for his statistical support and insight. I really appreciated the opportunity to discuss my analyses with you, and left every meeting excited about the analysis of my data. Thank you also to Dr. Brian Lentle for assistance in reviewing the DXA scans; your willingness to do this was greatly appreciated.

I would also like to express my gratitude to the people in Food, Nutrition and Health at UBC. Special thanks to Patrick for his ongoing indispensable computer support, especially for retrieving my diet analysis files when they seemed to have disappeared. Thanks also to Maria for taking such good care of us and always being a bright spot at the end of the day; to Dr. Judy McLean for her support and interest in my research, and for her willingness to share her insights with me; and to the Human Nutrition graduate students with whom I have shared this experience. A special thank you to Svetlana Ristovski-Slijepcevic for her friendship and support, and to Larry Mroz for being such a good officemate.

It is with great appreciation that I acknowledge the contribution of those who funded my research project and my doctoral studies. Thank you to the Canadian Institutes of Health Research for funding this study and for the exceptional learning experience of applying for funding and receiving reviewers' comments. A special thank you to the Michael Smith Foundation for Health Research; being selected to receive a Trainee Award was a great honour and made a significant contribution to my development as a researcher. Thank you also to the University of British Columbia for the University Graduate Fellowship award and to the Faculty of Land and Food Systems (formerly Agricultural Sciences) for their support with graduate fellowships and funds to help defer the cost of conference travel. The importance of these monetary contributions to my research and my doctoral studies was profound and is greatly appreciated.

I would also like to acknowledge my gratitude to the many researchers, statisticians, and academics that I have never met directly, but who nonetheless made significant contributions to my research through their work. It is the example set by such interesting and inspirational researchers that make science in general, and human nutrition in particular, so exciting, and I am grateful for their contributions and their expertise. A special note of acknowledgement to Drs. Norman, Streiner, Bland, Tabachnick, Fidell, Cohen, Katz, and Field whose statistics texts were indispensable to me.

And finally, my most heartfelt thanks and appreciation goes to my family, for without their love and support I would certainly not have embarked on this journey nor have completed it so happily. To my Mom and Dad, thank you for being such incredible parents and for supporting me so completely. I am grateful every day for my great fortune in having such wonderful parents. Thank you to Dean and Megan for your support and friendship and the much-appreciated Savary adventures. Thank you to the Husniks for your kind care packages; the perogies and gibanica provided essential fuel in the homestretch of completing this dissertation! And to John, thank you for making all the late nights and early mornings so much fun, for your constant encouragement and support, and for all the little things you do. I cannot imagine this experience without you, and value your contributions more than words can convey.

CO-AUTHORSHIP STATEMENT

Chapters 2 through 5 are manuscripts that have either been accepted for publication (Chapter 2), are currently under review (Chapter 3), or will be submitted for publication (Chapters 4 and 5). For each manuscript, I identified the research questions, conceived of the study design, was a co-applicant on the grant which funded the research, recruited all participants, completed all data collection and management, planned and conducted the data analyses, presented the findings, and wrote and edited the manuscript. My co-authors made significant contributions in the following respects: For each manuscript, Dr. Susan Barr (my research supervisor) was the Principal Investigator on the grant which funded the research, provided ongoing support and consultation on study design and implementation, stimulated discussion of the results, and was the key editor of the paper. For the manuscript presented in Chapter 2, Dr. Wolfgang Linden (a member of my Supervisory Committee) was a co-applicant on the grant which funded the research, contributed to the study design, stimulated discussion of the results, and provided editorial input. For the manuscript presented in Chapter 3, Dr. Heather McKay (a member of my Supervisory Committee) stimulated discussion of the results and provided editorial input.

I agree that these statements are accurate and fair.

Candice Rideout

Dr. Susan Barr

Dr. Wolfgang Linden

Dr. Heather McKay

CHAPTER 1: INTRODUCTION

1.1 Background

The sociocultural context of Western society places value on a thin female body [1, 2], causing many women to experience body dissatisfaction [3-7]. Many women attempt to conform to societal standards of beauty by trying to control their body size and weight (most often through diet and/or exercise). Such efforts have been documented in females across the lifespan: young girls [8], adolescents [9-11], young women [12], and adult women [12, 13] all manipulate diet and/or physical activity in order to lose weight or maintain weight at a certain level.

Given the prevalence of weight-loss and weight-maintenance efforts, it is not surprising that the eating attitudes and behaviours of many women are characterized by high levels of *cognitive dietary restraint* (i.e., the perception that one is constantly monitoring and attempting to limit food intake in an effort to control weight) [14]. For decades, cognitive dietary restraint has been investigated in young women, and researchers have consistently found high levels of restraint in a substantial portion of that population [15]. However, little research has been done on cognitive dietary restraint in older women, many of whom have been exposed to societal expectations for thinness (and may also have been characterized by cognitive dietary restraint) for many years, possibly decades.

Although successful weight loss can confer health benefits for the overweight and obese [16, 17], evidence is accumulating to suggest that a restrained eating pattern (as would occur in individuals with high cognitive dietary restraint) may have detrimental effects on health. These negative effects may be mediated by stress. Specifically, an individual's subjective experience of high dietary restraint appears to act as a subtle stressor [18, 19], activating the physiologic stress response and leading to an increased release of the stress hormone, cortisol. Over the long term, elevations in cortisol may have adverse effects on diverse body systems and functions [20-23]. For example, bone health may be compromised by exposure to elevated levels of cortisol either directly through effects on calcium and bone metabolism [24-26], or indirectly, through effects on the menstrual cycle [27, 28] which regulates reproductive hormones that influence bone.

To date, elevated cognitive dietary restraint in young women has been associated with subclinical menstrual disturbances [29-33], increased salivary [19] and urinary cortisol [18], and possibly lower bone mineral density (BMD) [34, 35]. An association was also observed between eating attitudes (specifically, increased concern regarding food and body weight) and bone mineral content (BMC) during the peripubertal period in young girls [36]. Although there are also reports of no difference in cortisol excretion in women classified as having high or low dietary restraint [37, 38], overall, evidence is growing in support of the hypothesis that high dietary restraint may be a subtle stressor with the potential for adverse physiological effects in girls and young women.

1.2 Rationale

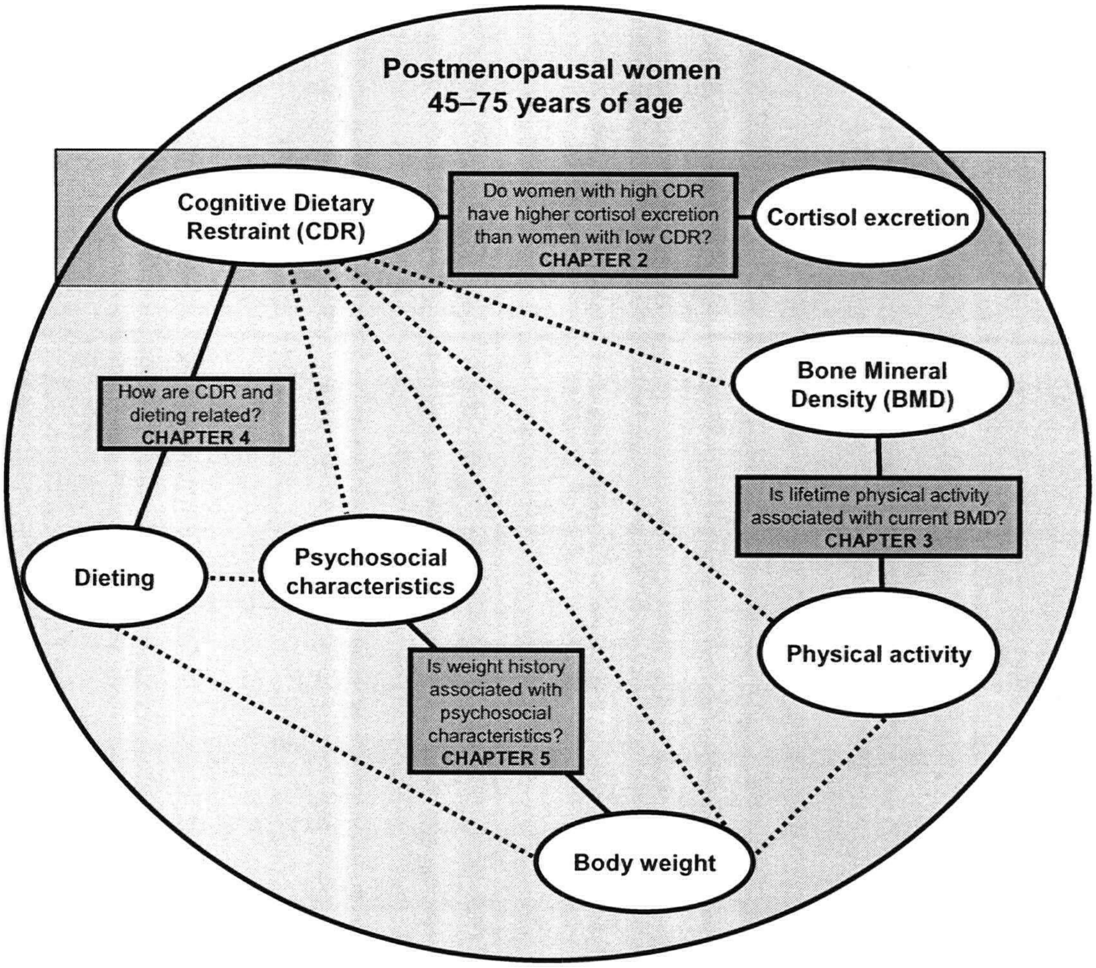
Relationships among cognitive dietary restraint, stress, and cortisol have not been explored in postmenopausal women. This represents a significant gap in our understanding of how eating attitudes and behaviours impact women's health. In fact, if dietary restraint is associated with stress, this could be most pertinent for older women. First, although the evidence is currently limited, cognitive dietary restraint appears to be a relatively stable construct [39-41]. Therefore, given that some women may experience high levels of dietary restraint throughout much of their life, the cumulative effects of a restrained approach to eating may be more evident in the postmenopausal years. If these effects include negative consequences for bone health, highly restrained eaters could be at increased risk for reduced bone density and osteoporosis. Second, there appears to be increased reactivity in the hypothalamic-pituitary-adrenal (HPA) axis and a prolonged stress response in older adults [42, 43], especially older women [42, 44]. Thus, if high dietary restraint is associated with the physiologic stress response in older women, the ensuing elevations in cortisol (and resultant potential negative impacts for bone) could be even greater than those previously documented in young women.

This PhD research was designed primarily to examine possible correlates of high dietary restraint in postmenopausal women. The principal aim was to determine whether women with high dietary restraint excrete more cortisol (a biomarker for stress) than women with low dietary restraint. Possible associations with bone health were also examined. This research focus was predicated on the belief that there would be a distribution of scores for dietary restraint among older women, with sufficient women scoring in the "high" and "low" ranges to make such a comparison between restraint groups feasible. Limited preliminary evidence for this existed (from a single research group who had examined dietary restraint in postmenopausal women in Boston [45-49]), but given the paucity of data in this area, another objective of this research was to more thoroughly explore dietary restraint and its potential correlates in postmenopausal women. Data collected in order to address these central objectives also allowed for additional investigations, including the exploration of physical activity and BMD in postmenopausal women, and consideration of potential associations among psychosocial characteristics and 10-year weight history. Thus, the investigations that resulted from my PhD research spanned several aspects of health in postmenopausal women, as illustrated in **Figure 1.1**. In order to maintain the focus of this chapter on the review of the literature which most contributed to the development of the primary research questions (which are addressed in Chapter 2), literature pertaining to additional investigations is briefly covered in the introduction sections of each respective manuscript's chapter, rather than reviewed here.

1.3 Literature review

In this review, I will provide a summary of the literature that informed the initiation and planning of this study. In order to establish the context in which the research occurred, several

Figure 1.1: The theoretical domain of the studies reported in this dissertation



Notes: This schematic illustration shows the main areas of postmenopausal women's health examined in the various chapters of this dissertation. The questions placed on the solid lines (——) joining particular aspects of health are addressed in the chapters indicated. The central focus of this study was an investigation of cortisol excretion in women with high versus low dietary restraint, as highlighted above. The dashed lines (·······) represent associations which were also examined in this research, although they were not key research questions.

areas are addressed: (i) cognitive dietary restraint; (ii) stress and cortisol excretion, (iii) possible associations between dietary restraint and cortisol excretion, (iv) evidence for the adverse effects of cortisol on bone, and (v) the possible relationship between dietary restraint and bone. The association between dietary restraint and cortisol excretion is my primary focus, given that questions about this possible relationship were central to the design of the study.

1.3.1 Cognitive dietary restraint

1.3.1.1 Definition

Cognitive dietary restraint (also known as cognitive eating restraint or simply dietary restraint) refers to the *conscious effort* to monitor and limit dietary intake in an attempt to achieve or maintain a certain body weight. Dietary restraint has been described as the strict cognitive control of eating behaviour [38] or, more simply, as an individual's tendency to eat less than desired [41]. Restrained eaters do not typically eat in response to physiological cues; rather, they exert cognitive control over their physiological hunger [50]. The cognitive or perceptual nature of the construct is emphasized by findings of generally similar energy intakes among groups of women with high and low restraint [34, 35]. In other words, dietary intake in restrained eaters may not be restricted in absolute terms when compared to dietary intake of unrestrained eaters; it is the *perception* among high restraint women that efforts are being directed towards controlling intake that appears to be important.

Individuals vary in the extent to which they are characterized by dietary restraint, with women typically reporting higher levels than men [15, 51-53]. The characteristic is common among both overweight and normal weight women [35]. In fact, it is not clear how, or if, dietary restraint is associated with BMI. High dietary restraint has been associated with higher weight or BMI in some studies [14, 15, 54, 55], but in others, it has been associated with lower BMI [56].

Yet many reports show no difference in BMI between high and low restraint groups [35, 45, 57] or in dietary restraint between obese and non-obese groups [58].

1.3.1.2 Operationalization of dietary restraint

Dietary restraint is typically assessed using one of three self-administered scales: the Restraint Scale (RS) [59, 60], the restrained eating subscale of the Dutch Eating Behaviour Questionnaire (DEBQ-R) [61], or the cognitive restraint subscale of the Three-Factor Eating Questionnaire (TFEQ-R) [14].

The original RS was developed by Herman and Mack in 1975 to identify chronic dieters [60]. They created a 10-item scale on the basis of face validity, and then selected five items which correlated with the total score $> r = 0.15$ in order to improve internal reliability [60]. Using those five items, the scale had a Cronbach's alpha of 0.65 in a sample of 45 college women [60]. The most commonly used version of the RS was published in 1980, and includes 10 items (4 measuring *weight fluctuation* and 6 measuring *concern for dieting*) [59]. Its internal consistency is adequate, with Cronbach's alpha reported as 0.75 [59] or greater [41]. Test-retest values range from 0.74 after 2.5 years [40] to between 0.91 and 0.95 after one to two weeks [41]. Despite its two apparent subscales, the authors recommend that it be used in its entirety to generate one score for dietary restraint because it aims to measure a pattern of characteristics associated with dieting (specifically, efforts to control eating and the loss of that control) [62]. Also, neither factor alone appears to have the predictive value of the RS as a whole [62].

From the beginning, dietary restraint as measured by the RS was intertwined with both dieting and the loss of control over dietary restraint, as evidenced by questions such as "How often are you dieting?" and "Do you have feelings of guilt after overeating?" [59, 60]. Although it has frequently been used to measure dietary restraint [63], there are persistent concerns with the factor structure of the RS, with many studies reporting three or more factors, depending on the population in which it was administered [41]. This, combined with the tendency for RS scores to be confounded by weight fluctuation and disinhibition, makes it challenging to determine which component of the RS may be associated with variables of interest [41, 64].

The DEBQ-R is the 10-item *restrained eating* subscale of the Dutch Eating Behaviour Questionnaire [61], a 33-item questionnaire which also measures *external eating* (eating that is triggered by external cues such as the sight or smell of foods, or others eating) and *emotional eating* (the tendency to eat in response to emotions such as boredom or irritation). The DEBQ-R has high internal consistency, with a Cronbach's alpha typically 0.90 or greater [41].

The TFEQ [14], also known as the Eating Inventory [65], was developed by Stunkard and Messick in 1985 to address concerns with the RS [14]. Published one year before the DEBQ-R, it is now the most frequently used measure of dietary restraint. Stunkard and Messick drew from an original pool of 67 items to create their questionnaire: the 10 items of Herman and Polivy's RS [59], 40 items from Pudel's Latent Obesity Questionnaire translated into English [14], and 17 items they created based on their own clinical experience. Factor analytic techniques were used to reduce the final questionnaire to 51 refined items assessing three aspects of dietary behaviour: *cognitive dietary restraint* (cognitive control of eating behaviour), *disinhibition* (disinhibition of eating control), and *hunger* (susceptibility to hunger). Each scale is scored separately, with higher scores reflecting a greater tendency to display that trait. The TFEQ-R has shown good internal consistency in different populations, with Cronbach alpha values of between 0.79 and 0.93 [41]. It also demonstrates temporal reliability with a test-retest correlation of 0.91 after two weeks [58]. Although the factor structure of the cognitive restraint scale is generally quite robust [41], it has been suggested that it may also contain two or more factors [55, 56, 58, 66, 67]. Allison and colleagues labelled these *cognitive* and *behavioural* restraint [58] and they were similar to the *rigid* and *flexible* control scales identified by Westenhoefer and colleagues [56, 67]. It has been suggested that these two types of dietary restraint may be differentially associated with success at long-term weight maintenance and with symptoms of eating disorders, mood disturbance and excessive concern with body shape and size [68, 69]. The distinction between flexible and rigid restraint has been shown to be useful in some populations [70], but no studies of these aspects of eating behaviour in postmenopausal women have been reported.

Although all three scales (the RS, DEBQ-R and TFEQ-R) claim to measure the same characteristic, it is clear that they are not analogous. Research has shown that the RS predicts disinhibition, binge eating and salivary output in response to food cues, but does not correlate well with reported energy intakes; conversely, the TFEQ-R and DEBQ-R have negatively predicted energy intake in several studies [63]. Several theoretical papers have made distinctions between dietary restraint as measured by the RS on one hand and as measured by the TFEQ-R or DEBQ-R on the other (sometimes describing the populations identified by the different scales as unsuccessful versus successful dieters, or chronic versus current dieters) [55, 58, 63, 71]. However, in practice, the terms dietary restraint, restrained eating, and dieting continued to be used interchangeably and independent of the scale used to make the assessment.

1.3.1.3 How is dietary restraint related to 'dieting'?

To date, research has shown a lack of conceptual clarity regarding how dietary restraint and dieting relate to one another. Dieting is a socially constructed term with multiple meanings which may change over time [72] and it has been noted that relationships between dietary restraint scores and actual dieting behaviours "are neither direct nor simple" [41, p.160]. Dieting typically refers to the current effort (or commitment) to reduce energy intake in order to lose weight [63]. It may be an actual set of behaviours that contribute to reductions in energy intake, but could also be a cognitive state reflecting a desire to eat less, rather than actually doing it [73].

Like dietary restraint, dieting is more common among women than men [74, 75]. Dietary restraint appears to differ from dieting, which is frequently intermittent (i.e., people go "on" or "off" a diet, and adjust their food intake accordingly). In contrast, cognitive dietary restraint appears to be a more stable characteristic [41], and substantial proportions of those with high restraint do not report current dieting [63]. Yet, many researchers have used the terms dieting and dietary restraint interchangeably. Indeed, both the RS and TFEQ were created in order to measure dieting [14, 60], and the measures are often used to classify research participants as restrained eaters (dieters) or unrestrained eaters (non-dieters) [76]. In fact, three questions in the TFEQ-R include references to dieting (e.g., the true/false questions, "Life is too short to worry about dieting." and "While on a diet, if I eat a food that is not allowed, I consciously eat less for a period of time to make up for it.") [14].

There is typically a positive relationship between the level of dietary restraint and dieting status [15, 55], but not all restrained eaters are dieters, and vice versa. For example, in their study of 226 college-aged men and women, Alexander and Tepper found that the proportion of current dieters among people with a low score for dietary restraint (TFEQ-R score ≤ 4), was low (only 5%), but the proportion increased to 35% of those with a moderate score (TFEQ-R score 5 – 11) and 73% of those with a high score (TFEQ-R score ≥ 12) [15]. Dietary restraint and dieting appear related, but the nature of the relationship requires elucidation.

1.3.1.4 Early research on dietary restraint

Dietary restraint research began with work done by Herman and colleagues roughly 30 years ago. At that time, researchers were interested in comparing determinants of eating behaviour in obese versus normal-weight individuals. It had been suggested that obese individuals were more responsive to external cues (e.g., properties of food, time of day) in their eating behaviour whereas normal-weight individuals tended to manage their eating in response to internal cues such as hunger and satiety [77]. Building on Nisbett's theory that eating characteristics of obese individuals could be due to their efforts to keep their body weight below a biologically determined set-point [78], Herman suggested that many normal-weight eaters may also engage in efforts to keep their body weight below their own particular biological set-point, and habitually restrain their eating in order to do so [60]. For both normal-weight and obese persons, it was hypothesized that when self-imposed dietary restraint was removed (or temporarily suspended), eating would be determined to a greater extent by external rather than internal cues [60, 78].

Early studies supported this notion, and found that restrained eaters exhibited counterregulatory eating behaviour. When exposed to conditions which disrupted the self-control required for dietary restraint (such as high-calorie milk shake preloads [60] or anxiety-inducing circumstances [79]) restrained eaters consumed *more*, whereas unrestrained eaters consumed *less*. This was thought to result from restrained eaters' perception that their dietary restriction is 'all-or-nothing' and that if they have broken their diet, they might as well continue eating [80]. Several studies using the RS to identify restrained eaters supported this disinhibition effect and suggested that when the control required for dietary restraint is disrupted in restrained eaters, overeating results [80]. However, restraint theory has been challenged because these results have not been replicated in studies that used the DEBQ-R or TFEQ-R to measure dietary restraint [63, 81], and questions remain regarding the extent to which these findings are applicable to free-living individuals and everyday eating behaviour.

1.3.1.5 Dietary restraint and eating behaviour

More recently, studies of how dietary restraint is related to natural eating patterns have increased. Commonly, energy intake between groups of restrained and unrestrained eaters (typically assessed by food records) is compared, and it has been found that people with high scores for dietary restraint typically report consuming fewer calories than people with low restraint [18, 38, 47, 51] although this is not always the case [29]. Inconsistent findings could partly result from the use of different scales to measure dietary restraint; the RS typically does not predict intake as well as the restraint scales of the TFEQ or DEBQ [51]. Another reason for inconsistent findings could be related to the nature of dietary restraint's influence on eating; restraint may have a small but consistent influence on all dietary intake, or it could have a larger impact on some eating situations and little to no effect on others [53]. If the former, one would expect to observe a difference in energy intake between restrained and unrestrained eaters. But if the latter, a difference may not be detected, depending on the method of diet assessment and the timeframe captured in the report. The construct validity of all three measures of dietary restraint was recently questioned, given their lack of association with acute energy intake as assessed by unobtrusive observation [82]. Thus, the relationship between measures of dietary restraint and actual caloric intake remains unclear.

Some studies have suggested that, irrespective of energy consumption, other aspects of dietary intake may differ between restrained and unrestrained eaters. For example, individuals with high dietary restraint may select foods that are lower in fat [51, 83] and carbohydrate [51, 54] more frequently than those with low dietary restraint. Studies have also reported that restrained eaters consume more fruits and vegetables [37, 54]. The diets of restrained eaters tend to meet or exceed recommendations for protein and micronutrients, and have reduced fat, cholesterol, and sodium when compared to the diets of unrestrained eaters, supporting the notion that restrained eating could be considered 'healthy eating' [51]. Further work is required to characterize the eating patterns of restrained and unrestrained eaters in natural settings.

1.3.1.6 Dietary restraint and physiology

There is some evidence to suggest that restrained eaters may exhibit physiological differences from unrestrained eaters. For example, dietary restraint has been associated with reductions in fasting insulin levels and postprandial norepinephrine levels [38]. This led to the suggestion that restrained eaters may have lower energy expenditure in comparison to unrestrained eaters, and therefore require a reduced energy intake. The cognitive control over eating manifested by dietary restraint could be a compensatory mechanism to reduce the likelihood of weight gain. This has been supported in some [84], but not all [37, 46, 85], studies in this area.

Young women with high dietary restraint have also been shown to have more frequent subclinical disturbances of the menstrual cycle, such as anovulatory cycles and cycles characterized by shorter luteal phase lengths [29, 30, 33]. These differences do not appear to be confounded by weight, given that BMI between high and low restraint groups was similar in these studies. The mechanism by which dietary restraint may be associated with such menstrual cycle disturbances is not established, but it could be that these effects are mediated by stress. Dietary restraint may be associated with increased stress, and stress is known to interfere with ovarian function and cause menstrual cycle irregularities [86, 87].

1.3.1.7 Dietary restraint in postmenopausal women

The vast majority of studies of dietary restraint have used female subjects between the ages of 18 and 25 years [88]. Although it has sometimes been assumed that older adults do not subscribe to societal standards of 'ideal' weight and shape (and thus may be less likely to be characterized by dietary restraint), such assumptions are now being questioned. Women currently in their fifties and sixties have been exposed to society's thinness ideals for much of their lifetime, and in that respect they may differ from earlier generations of mature women. Therefore, it is not only possible that postmenopausal women may exhibit restrained eating patterns similar to young women, they may actually have had this approach to eating for many years. Yet few data on dietary restraint in postmenopausal women exist to inform such speculations.

Prior to the research contained in this thesis, the only studies of dietary restraint which focused on older women came from a group of researchers at Tufts University in Boston who surveyed more than 600 women aged 55–65 years, a subset of which also completed additional tasks [45-49]. Although it was not specified how (or if) participants were confirmed as postmenopausal, given the participants' age, it is likely that the preponderance would have been classified as postmenopausal according to the accepted criterion of > 1 year passed since last menstrual cycle [89]. These reports provided some interesting insights. For example, the mean score for dietary restraint (assessed with the TFEQ-R) was 10.7, which is somewhat higher than mean scores typically reported in younger women [48, 49]. In their survey sample, the majority (87%) of respondents had experienced weight gain since the age of 30 years; only 8% reported having lost weight, and 5% reported having maintained their weight [49]. Disinhibition (also measured with the TFEQ) was the strongest predictor of weight change and current BMI, but high dietary restraint appeared to slightly moderate the association between disinhibition and weight gain [49]. Given the increasing prevalence and adverse health consequences of obesity, this study suggests that dietary restraint could be beneficial if it reduces the amount of weight gained in the adult years, although it is clear that additional work is required.

The same group also assessed whether the three constructs measured by the TFEQ (dietary restraint, hunger and disinhibition) were associated with any of 22 specific self-reported morbidities (e.g., hypercholesterolemia, indigestion, eczema, cataract) in nonsmoking women aged 55–65 years [48]. They found that after controlling for BMI and other possible confounders, score for disinhibition was associated with slightly increased risk for back pain and constipation, and slightly reduced risk for eczema, whereas score for hunger was associated with a slight increase in risk for eczema [48]. Overall, the differences in risks associated with these characteristics were very small. Furthermore, results were considered significant at $P < 0.05$, and considering the number of analyses conducted, the likelihood of Type I error was high. It was interesting to note that they did not find associations between dietary restraint and any of the morbidities studied. However, a theoretical link was not established for the morbidities that were assessed and data on osteoporosis or low bone mineral density (which could be associated with high dietary restraint) were not reported.

In an effort to determine whether long-term dietary restraint is associated with a variety of health outcomes, 28 unrestrained eaters (TFEQ-R score ≤ 5; mean age = 60 years; mean BMI = 23.8) and 39 restrained eaters (TFEQ-R score ≥ 13; mean age = 59.2 years; mean BMI = 24.5) completed measures of body density, BMD, BMC, cardiopulmonary function, anthropometry, depression and self-reported health status [45]. The high and low restraint groups were similar in almost every respect; only haemoglobin was lower in restrained eaters compared to unrestrained eaters (12.9 versus 13.2 g/dl, $P < 0.05$) but the difference was small and both values fell within the normal range [45]. BMD and BMC were compared for the arms, legs, and total body between the high and low restraint groups using *t* tests, and no significant differences between groups were found [45]. However, it is important to note that these analyses did not control for possible confounders, and that given the wide variance in bone mass in women during this life stage, it is unlikely that the study had adequate statistical power to detect a significant difference, should one have existed. Furthermore, the measurements were not made at clinically relevant sites such as the lumbar spine or proximal femur.

These studies were helpful in suggesting that many older women were characterized by dietary restraint, however many questions remained unanswered. Possible relationships between dietary restraint and cortisol had not been examined in postmenopausal women. Moreover, no work had examined possible associations between dietary restraint and other psychosocial constructs associated with eating behaviour and health in a large group of older women.

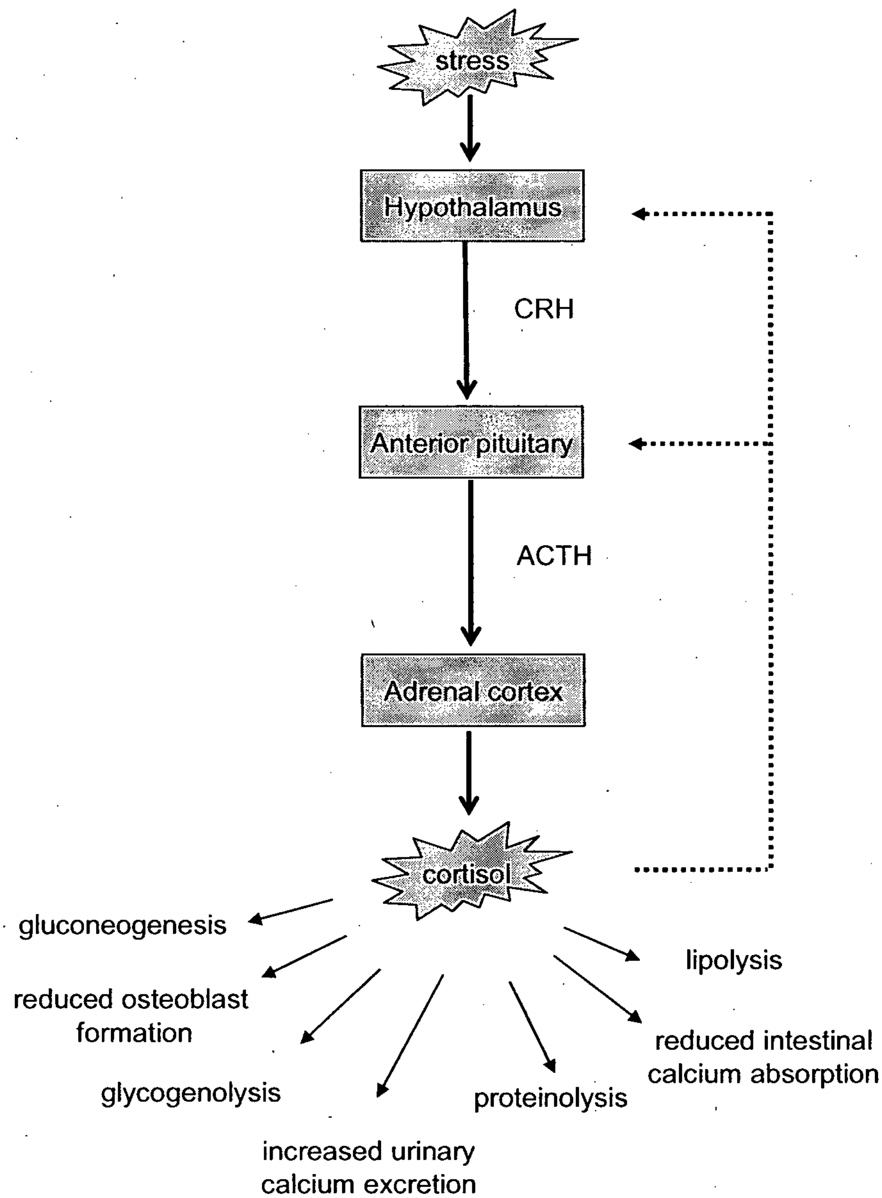
1.3.2 Stress and cortisol

1.3.2.1 Definition

Stress is broadly defined as a disruption to homeostasis [90]. The hypothalamic-pituitary-adrenal (HPA) axis responds to the variety of external and internal demands that is often referred to by the term 'stress.' The HPA axis is one of the body's main allostatic response systems, meaning that it acts to allow the body to maintain stability through a variety of changing conditions [91]. Cortisol, a steroid hormone and biomarker of the stress response, is secreted as a result of activation of the HPA axis. Cortisol plays a critical role in metabolism and mainly acts to mobilize energy [90].

The HPA axis is illustrated in **Figure 1.2**. Corticotropin-releasing hormone (CRH), also referred to as corticotropin releasing factor, is a polypeptide hormone secreted into the portal system by cells in the paraventricular nuclei in the hypothalamus. Under non-stressful conditions, CRH is secreted in a pulsatile fashion according to a circadian rhythm, with the amplitude of the bursts increasing in the early morning hours [92]. CRH is secreted directly into the hypophyseal portal system and reaches the corticotroph cells of the anterior pituitary, where it stimulates the production and secretion of adrenocorticotropic hormone (ACTH), another polypeptide hormone. Although corticotroph cells are actually stimulated by several hypothalamic factors (including vasopressin and oxytocin), CRH is the most potent [93]. ACTH is released into the systemic circulation and travels to the adrenal glands, which are located on top of the kidneys. When stimulated by ACTH, the zona fasciculata cells in the adrenal cortex synthesize and secrete glucocorticoids [93]. Cortisol is the primary glucocorticoid secreted in humans (although, in rodents, corticosterone is the only glucocorticoid produced by the adrenal) [93]. Cortisol secretory bursts occur 14 ± 2 times per day in young women [94]. The marked diurnal variation in cortisol secretion is characterized by an early morning peak (the morning acrophase) which typically occurs 30 minutes after waking, with a trough (nadir) at

Figure 1.2: The HPA axis



Notes: This schematic illustrates the hypothalamic-pituitary-adrenal (HPA) axis. CRH = corticotropin-releasing hormone, ACTH = adrenocorticotropic hormone. Cortisol, the end product of HPA activity, acts on many target tissues and is required for normal metabolic function. Some of the actions of cortisol are indicated. Cortisol production is partly controlled through negative feedback at the level of the hypothalamus and pituitary (indicated by dashed lines).

approximately midnight in people with a fairly typical sleep-wake cycle [95].

Cortisol is the hormone primarily responsible for the physiologic changes associated with the stress response [96]. The majority of circulating cortisol is bound to carriers such as corticosteroid-binding globulin, albumin, or erythrocytes; however, approximately 2% to 15% remains unbound [96]. Cortisol is a small molecule and is highly lipid-soluble; thus, it can easily pass through the lipid bilayer of cells by passive diffusion. In line with the "free hormone concept", it is the unbound or free fraction of cortisol that is responsible for its diverse physiologic effects. Although historically the HPA response to stress was considered nonspecific, such that all types of stressors (whether physiological or psychological) would elicit the same reaction [97], this has been questioned. The cortisol response to stress may be more specific in that it could be activated only by certain types of stressors [98]. Support for this suggestion comes from a recent meta-analysis of 208 laboratory-based stressors studies [99]. As Dickerson and Kemeny report, cortisol is not equally responsive to all types of stressors; rather, it appears that the HPA activity results from stressors that challenge individuals' social self (a part of themselves they feel could be negatively evaluated by others) [99]. This suggests that self appraisals that occur in response to threats of a social-evaluative nature lead to increases in HPA activity, at least in a laboratory setting [99]. Given that dietary restraint is likely motivated by the desire to achieve or maintain a particular body weight perceived as socially preferable, it is possible that these findings could partly explain why restrained eaters may have higher cortisol than unrestrained eaters.

There is a sizable literature on the relation between major stressors and neuroendocrine function, but fewer studies have examined the impact of minor daily stressors on cortisol excretion [100]. In one report, increases in salivary cortisol levels were found in association with naturally occurring daily stressors, although the increases in cortisol were not as large as those typically observed under laboratory conditions in responses to stressors such as a public-speaking test [101].

1.3.2.2 Operationalization of stress

Currently, three approaches can be taken to the measurement of stress: the use of questionnaires, biochemical measures, and physiological measures [90]. The first tends to measure individuals' subjective perception of stress, whereas the second and third measure objective bodily responses. A common questionnaire used to assess the perception of non-specific stress was developed by Cohen and colleagues in 1983 [102]. The Perceived Stress Scale (PSS) is a 14-item scale which prompts respondents to identify the extent to which they consider situations in their life to be stressful, and specifically asks about events occurring within the last month. It has good internal consistency, with Cronbach alpha scores from 0.84 to 0.86 reported [102]. As might be expected for the measurement of something which could change with time, test-retest reliability was 0.85 after two days, but was 0.55 after six weeks [102]. Biochemical measures of the stress response are typically based upon the measurement of cortisol (as a marker of HPA activity) in blood, saliva, or urine. Discrete measurements are easily confounded by time of day, given the marked diurnal variation in cortisol secretion. Thus, in some respects, a 24-hour urine collection is advantageous given that it provides an index of overall cortisol exposure for that complete time period. Physiological measures are slightly less common in research studies, but include things such as heart rate, heart rate variability, and blood pressure [90].

1.3.2.3 Health effects of exposure to elevated cortisol levels

Stressors can be classified as severe (i.e., infrequent but major events) or minor (i.e., the hassles that occur on a daily basis) [101]. Although severe stressors are often the most apparent to individuals, it has been suggested that it is actually the minor stressors that may be most important in the relation between stress and negative health outcomes [103]. Minor stress and hassles have been associated with various health outcomes, including asthma, headache, and (to a lesser extent) diabetes [104]. Minor stress is also an independent predictor of inflammation in rheumatoid arthritis [105] and overall quality of life [106]. Generally speaking, while the frequency and intensity of hassles is associated with various components of health status, only a small percentage of variance in health outcome measures is explained [107].

1.3.3 Associations between dietary restraint and cortisol

One of the major hypotheses that underlies this research is that the ongoing effort involved in monitoring and attempting to limit one's dietary intake acts as a stressor of sufficient magnitude to activate the physiological stress response, leading to increased secretion of cortisol. When this research was originally proposed in 2002, only three studies had examined the possible association between cortisol and dietary restraint. In the first, Pirke and colleagues administered the TFEQ-R to 57 German women between 18 and 24 years of age, and recruited a subset of restrained and unrestrained eaters to complete their study protocol [38]. Restrained eaters (n = 9) were recruited from those who scored above the 75th percentile on the TFEQ-R administered to the sample of 57 women, and unrestrained eaters (n = 13) were recruited from those who scored below the 50th percentile (specific cut-off scores were not specified for either group). Cortisol was measured in blood samples taken overnight (every 30 minutes) through a venous catheter inserted in participants' forearms. Restrained and unrestrained eaters did not differ significantly in cortisol secretion, whether at particular time points over the 12-hour protocol, or as an average of all cortisol measurements [38]. This may indicate that there is no inherent difference in adrenocortical activity between women with high versus low dietary restraint.

However, there were several methodological limitations to this study that preclude firm conclusions in this respect. First, the number of participants was very small, and it was unlikely that there was sufficient statistical power to detect differences between dietary restraint groups. No information was provided regarding whether a power analysis had been done prior to study initiation, but given the notable interindividual variation in cortisol secretion and the likelihood that an association of dietary restraint with cortisol, if present, is likely to be small, it is almost certain that inadequate power existed. Second, the cortisol data were analyzed by comparing high and low restraint groups using the nonparametric Mann-Whitney U test. Whether the cortisol data were normally distributed or not was not indicated (although it may have been, given that most biologic data are). If it was, a parametric analytic technique would have been more powerful and increased the likelihood of detecting differences. The most appropriate way to analyze the cortisol data would have been to use an area under the curve (AUC) analysis, which would have provided an integrated index of cortisol secretion that would be more accurate than calculating the mean value. In fact, the restrained group had higher mean cortisol secretion than the unrestrained group at 10 of 17 time points illustrated (it equalled the unrestrained group for two points and was only lower on five points), so it is possible that a different analysis and/or greater statistical power may have revealed group differences.

Independent of these methodological concerns, these results do not contradict the hypothesis that dietary restraint may act as a stressor among restrained eaters. If dietary restraint is associated with the subjective experience of stress (stress that is associated with perceptions and cognitions), it is more likely that this would be detected during waking hours, when a person is cognitively engaged in decisions regarding eating behaviour and affected by thoughts and feelings about eating. Indeed, two hours before the end of the 12-hour protocol, participants were given a 500 kcal test meal (pudding) [38]. Following that time point, the difference between groups appears to increase, with restrained eaters showing higher cortisol secretion than unrestrained eaters [38]. Again, given the presumable lack of statistical power (and the fact that this range of cortisol values was not specifically compared between groups), we cannot say whether or not a real difference is reflected by these data. However, the trend appears consistent with the hypothesis that if dietary restraint is a source of stress among restrained eaters, food-related cognitions (such as those that would occur following the administration of a test meal) are likely candidates for stressors that could result in elevated cortisol secretion.

The second study which examined dietary restraint and cortisol was conducted by McLean and colleagues at The University of British Columbia [18]. College women between the ages of 20 and 35 years (mean age = 21.6 ± 2.5 years) were recruited to complete a three-day food record and one 24-hour urine collection for the measurement of cortisol on a day when all foods and beverages were provided [18]. Participants were recruited from among 666 university students who completed the TFEQ [31] and scored either high (n=33; defined as a TFEQ-R score in the upper quartile, i.e., ≥ 13) or low (n=29; defined as a TFEQ-R score in the lower quartile, i.e., ≤ 5). McLean and colleagues found that although the two groups did not differ in relative weight or percent body fat, women with high restraint had significantly higher 24-hour urinary cortisol excretion when group means were compared by *t* test (418.8 ± 134.6 nmol versus 354.7 ± 83.7 nmol; $P < 0.05$) [18].

A strength of this study was its use of a 24-hour urine collection, which provided an accurate reflection of the amount of cortisol excreted over the course of a full day. The clear distinction between high and low restraint groups, and the recruitment of an adequate number of participants also added clarity to the interpretation of the results (power analyses indicated that 32 participants would be required in each restraint group in order to detect a significant difference in 24-hour cortisol excretion). This study also controlled for variables which could potentially confound a possible association between cortisol excretion and dietary restraint by excluding women who reported irregular menstrual cycles, who had been diagnosed with an eating disorder, were currently dieting, or who exercised intensely (defined as ≥ seven hours per week) [18]. However, the possible role of perceived stress in the group difference in cortisol excretion cannot be ascertained. The high and low restraint groups differed slightly in their scores for perceived stress (28.6 ± 7.5 versus 25.0 ± 6.5, $P = 0.05$), and perceived stress was positively correlated with dietary restraint score among restrained but not unrestrained eaters [108]. Thus, the results of this study support the hypothesis that dietary restraint could act as a stressor among restrained eaters, but further clarification was required.

The third study, conducted by Anderson and colleagues in New York State, included 85 female college students between the ages of 17 and 49 years (mean age = 19.3 ± 3.8 years; mean BMI = 23.6 ± 4.4) [19]. Upon arrival in the laboratory, participants in this study completed two measures of dietary restraint (the RS and TFEQ-R), had their height and weight measured, and then provided a sample of saliva for subsequent cortisol analysis. All participants provided saliva samples between 9:15 AM and 11:00 AM in an effort to control for the diurnal variation in cortisol secretion. In their primary analyses, Anderson and colleagues treated dietary restraint scores as continuous variables. In univariate correlations, both RS and TFEQ-R scores were positively associated with salivary cortisol ($r = 0.26$, $P < 0.05$ and $r = 0.34$, $P < 0.01$, respectively). Hierarchical regression analyses demonstrated that the TFEQ-R was the strongest predictor of variation in cortisol levels ($\beta = 0.32$, $P = 0.03$); in fact, when the TFEQ-R score was added to the regression, the RS score was no longer a significant predictor of cortisol secretion. In secondary analyses, participants were split into high/low restraint groups (by median split) and when these groups were compared, the difference in cortisol secretion between groups based on median split of TFEQ-R scores was significant (0.32 ± 0.51 μg/dl versus 0.15 ± 0.12 μg/dl, $P = 0.04$) and the difference between groups based on median split of RS scores was not ($P = 0.06$).

A strength of this study was its use of salivary cortisol measurements, as this noninvasive technique for sample collection reduces the likelihood of a confounding stress response due to venipuncture. However, this study was possibly limited by the timing of the saliva sample collection. Although an effort was made to limit sample collections to a two-hour window, at that time of day a two-hour difference could still result in significant variation in cortisol levels, and the mean collection times for each group were not reported. Further, samples were obtained after measuring body weight, and depending on the amount of time that elapsed between the measurement of body weight and the collection of saliva, this may have acutely increased cortisol levels in women with high dietary restraint. Thus, whether prevailing cortisol levels were elevated cannot be ascertained. In general, while the results of this study appear to support the hypothesis that dietary restraint may contribute to stress load and differences in cortisol secretion, the values reported for cortisol secretion in both groups fell notably below typical unstressed values (an unstressed salivary cortisol level for women is approximately 0.50 ± 0.25 μg/dl and the restrained and unrestrained groups mean values were 40-70% below that). Thus, despite associations with dietary restraint scores and differences between those with high and low restraint, it is not clear whether these data support the suggestion that dietary restraint may act as a stressor.

Since the research reported in this dissertation was proposed, one additional study has been published regarding the relationship between dietary restraint and HPA axis activity. Beiseigel and Nickols-Richardson recruited college women 18 to 25 years of age (mean age = 20.4 ± 2.3 years) to complete measures of dietary restraint (the TFEQ), dietary intake (a food frequency questionnaire and four-day food record), cortisol (saliva samples and a 24-hour urine collection), and body composition [37]. Inclusion and exclusion criteria were quite similar to those used in the study by McLean and colleagues [18]. This study did not show differences in resting energy expenditure or urinary or salivary cortisol measurements between women with high and low dietary restraint, but did find that restrained eaters had higher fat mass and % body fat than unrestrained eaters [37]. However, once again, this study is limited by a small sample size. Primary analyses were conducted on restraint groups created by median split of TFEQ-R scores (median score = 9) and included only 31 participants with high and 34 participants with low dietary restraint. Additional analyses were conducted with data from women scoring in the upper or lower 30% of TFEQ-R scores (which more closely approximates the categories for high and low restraint used in previous studies). Thus defined, there were only 21 participants with high and 20 participants with low dietary restraint. Furthermore, the power calculation conducted for this study was based on detecting a difference in TFEQ-R scores between two groups which were created by median split of TFEQ-R scores (whereas it would have been more appropriate to base the power calculation on the key outcome variables); thus, power to detect differences in highly variable factors such as cortisol excretion and BMD was almost certainly lacking. Unfortunately, with insufficient power, firm conclusions from this study cannot be drawn.

One additional report of the association between dietary restraint and cortisol is currently in press [109]. In this study, 170 female undergraduate students (age: 20.4 ± 3.2 years; BMI: 21.2 ± 3.0 kg/m^2) completed Westenhoefer's rigid and flexible control of eating items [67] to assess rigid and flexible dietary restraint. Study participants also completed measures of perceived stress and appearance beliefs and provided two saliva samples for the analysis of cortisol. The first saliva sample was collected 30 minutes after awakening; the second was provided between six and eight hours later, after participants completed the study questionnaire (a subset of 48 participants provided their second saliva sample before completing the questionnaire to examine the possibility of stress associated with questionnaire completion). Morning cortisol was negatively associated with age (r = -0.19, P = 0.01), but was not associated with measures of dietary restraint or appearance-related constructs. However, afternoon salivary cortisol was positively associated with flexible dietary restraint, and cortisol change from morning to afternoon was positively associated with both flexible ($r = 0.17$, $P = 0.03$) and rigid ($r = 0.16$, $P = 0.04$) restraint, as well as beliefs about appearance ($r = 0.19$, $P < 0.05$).

Exploratory factor analysis was conducted using all questionnaire items and revealed three factors: body image and appearance concerns, eating self efficacy, and items related to dieting (which included the items for rigid and flexible dietary restraint) [109]. When these factors were entered as independent variables in a hierarchical regression, the first factor (body-related dysphoria) predicted a small but significant proportion of the variance in afternoon cortisol ($R^2 = 0.03$, $\beta = 0.17$, $P = 0.03$) and cortisol change throughout the day ($R^2 = 0.03$, $\beta = 0.20$, $P = 0.01$). Cortisol was not related to perceived stress, and although perceived stress was univariately associated with flexible and rigid restraint, these associations did not persist in multivariate regression analyses. The items used to assess dietary restraint in this study were slightly different from previous studies which used the TFEQ-R and/or the RS. However, these results provide support for a link between restrained eating and cortisol secretion, and suggest that an important mediating element may be concern with appearance. Given that elevations in morning cortisol secretion may be related to chronic stress [110], and cortisol 30 minutes after awakening was not related to dietary restraint in this study but cortisol later in the day was, the authors suggested that the association between dietary restraint and stress may be in response to cues encountered throughout the day, rather than a chronic addition to the stress burden [109].

Although it did not examine cortisol excretion in the context of dietary restraint directly, another relevant study was conducted by Green and colleagues, who examined cortisol excretion in their randomized trial of supervised dieting versus unsupervised dieting versus nondieting conditions [111]. Participants were healthy premenopausal women aged 20–45 years who were classified as overweight (BMI 25–29). Upon entry, participants were randomized to one of three eight-week conditions: supervised dieting (attendance at a commercially-available weight loss group), unsupervised dieting (asked to follow a diet plan of their choice, provided that it did not include supervision with an organized group), or nondieting control. Participants attended weekly weighing sessions as well as test sessions at baseline and after one, four, and eight weeks. At each test session, participants provided a saliva sample (using a Salivette cotton swab) for the measurement of salivary cortisol upon arrival at the laboratory and again 30 minutes into the test session. During the session, participants had height and weight measured, percentage body fat evaluated, and completed a battery of neuropsychological function tests on a computer (e.g., reaction time, vigilance, verbal recall).

There was no difference in cortisol secretion between groups at baseline; however, after one week, nondieters and supervised dieters both showed a *decrease* in cortisol excretion from arrival at the laboratory to saliva collection 30 minutes later, whereas unsupervised dieters experienced an *increase* in cortisol secretion [111]. No other significant differences between groups were noted at any other time. And while nondieters and supervised dieters showed general improvement in the neuropsychological tasks over the four test sessions, unsupervised dieters did more poorly in the vigilance and verbal recall tasks after one week of dieting only. Green and colleagues interpreted their results as evidence that the early stage of unsupported dieting is associated with impaired cognitive function and elevated corticosteroid secretion. Dietary restraint had been measured in a pre-baseline session using the Revised Restraint Scale [59] to measure "pre-existing chronic dieting susceptibility" (p. 910). Despite random assignment to groups, the nondieting control group had pre-baseline dietary restraint that differed from the two dieting groups (the authors did not indicate whether it was higher or lower than the dieting groups), but dietary restraint does not appear to have been re-assessed during the study, and cortisol data were not specifically analyzed in the context of dietary restraint.

Taken together, these studies provide some initial support for the concept that dietary restraint is associated with increased circulating cortisol. However, additional data were required to confirm this relationship. My study of postmenopausal women was designed to further elucidate possible associations among cognitive dietary restraint, the subjective experience of stress, cortisol excretion, and possible downstream effects on bone.

1.3.4 Associations between cortisol and bone

Many factors contribute to BMD, and this is perhaps especially true during the dynamic postmenopausal phase of life. Genetic, lifestyle, and environmental factors are all known to play a role [112]. Cortisol is also important in bone health across the lifespan. The impact of large amounts of exogenous or endogenous glucocorticoids on BMD is notable. Negative effects occur through the influence of cortisol on bone formation, bone resorption, calcium absorption through the intestine, and calcium excretion through the renal tubule [24]. Of greater relevance to this research, however, is whether subtle elevations in cortisol can also have adverse effects on bone, and several lines of evidence suggest that they do. For example, women with adrenal incidentaloma with subclinical hypercortisolism have lower spinal and femoral BMD than healthy controls [113], and women with depression have subtle increases in serum cortisol and lower values for BMD [114]. In 34 healthy men aged 61–72 years, none of whom was using oral or inhaled corticosteroids, circulating cortisol levels were prospectively associated with bone loss over four years, after adjusting for possible confounding variables [115]. And among 684 generally healthy older adults, higher baseline levels of urinary cortisol were significantly associated with incident fractures over an eight-year follow-up period [116]. Odds of fracture (95% CI) for increasing quartiles of baseline urinary cortisol levels, adjusted for age, gender, race, BMI, physical activity, lower extremity strength, depression score and current use of cigarettes and alcohol, were 1.0; 2.28 (0.91, 5.77); 3.40 (1.33, 8.69); and 5.38 (1.68, 17.21). Data are accumulating to suggest that relatively small elevations in cortisol can have adverse effects on bone, leading to reduced BMD and increased risk for fracture. If the experience of high dietary restraint acts as a stressor of sufficient magnitude to activate the physiologic stress response and cause an increased release of cortisol, high dietary restraint could also be associated with compromised bone health in the long term.

1.3.5 Associations between dietary restraint and bone

Very few studies have assessed whether high levels of dietary restraint are associated with BMD, and in those that have, the results have not been definitive. This is not surprising: given the large number of genetic and lifestyle variables that affect bone, and the resulting inter-individual variability, larger samples would have been required to detect an association with dietary restraint in cross-sectional studies. However, while further investigation is clearly required, the available data do provide limited support for the existence of such an association. For example, in the study of urinary cortisol excretion in young women with high and low levels of dietary restraint conducted by McLean and colleagues [18], total body and lumbar spine BMD and BMC were also measured [34]. In that study, dietary restraint was a significant negative independent predictor of total body BMD and BMC (i.e., higher dietary restraint was associated with lower BMD and BMC), and almost entered the equation to predict lumbar spine BMD (P=0.07). Van Loan and Keim [35] also assessed whole body BMD and BMC, this time in a sample of 185 premenopausal women who varied in age (range = 18–45 years), body weight, and weight stability. An analysis of covariance of women grouped into four weight categories revealed lower BMC (but not BMD) in women with dietary restraint scores above the median in three of four weight categories. That group also studied 78 obese women (BMI 37.6 ± 3.8 kg/m^2) and found that TFEQ-R score was negatively associated with BMC at the femur (r = -0.24, P = 0.04) [117]. Finally, a prospective study of bone mineral accrual in peripubertal girls found that scores on the oral control subscale of the Children's Eating Attitudes Test negatively predicted total body and spinal BMC (controlling for height, weight and Tanner breast stage)

[36]. Although oral control is not synonymous with cognitive dietary restraint, the data nevertheless support an association between eating attitudes and bone starting at a young age. However, the only study to examine BMD in postmenopausal women with high versus low dietary restraint found no difference between restraint groups [45]. Thus, although there is evidence for a possible association between dietary restraint (cognitive control of eating) and bone across the lifespan, the data are by no means conclusive.

1.4 Limits to current knowledge

Reports of dietary restraint in young women provided evidence of its potential negative health implications and suggested that stress may be a mediating mechanism for its possible effects on bone. However, further clarification of the possible relationship between dietary restraint and cortisol excretion was required, in part because of the methodological limitations that characterized some previous reports (specifically regarding the time at which levels of cortisol were measured in the subject's blood [38] or saliva [19]). The literature in the area of dietary restraint as a whole is limited by its reliance on young female study participants, and its almost exclusive use of cross-sectional between-groups or correlational designs. Few studies have examined adult women, and only one group has specifically considered dietary restraint in postmenopausal women. Multiple measurements of dietary restraint over time, or of the other variables of interest (such as cortisol excretion), are also rare.

In order to evaluate the possible adverse consequences of dietary restraint, it was clear that additional data were required from older women. Additional insight regarding mechanisms by which dietary restraint may affect health was also required. Specifically, an assessment of whether high dietary restraint is associated with increased cortisol (reflecting increased stress) in older women was needed to verify the results obtained in young women and also to examine the theoretical extension of the hypothesized relationships. This study was primarily designed to address these gaps in our understanding of the potential health correlates of cognitive dietary restraint in postmenopausal women. As indicated previously, the data collected also permitted several additional investigations which will be introduced more specifically in subsequent chapters.

1.5 Purpose of this study

The primary purpose of this research was to establish whether elevated levels of cognitive dietary restraint were associated with higher cortisol excretion (reflecting the physiologic stress response) in postmenopausal women. Because elevated levels of cortisol may have detrimental effects on BMD [95, 116, 118, 119], possible consequences for bone health were explored. The association between self-reported lifetime physical activity and postmenopausal BMD was also examined. In addition, we explored associations among dietary restraint and other psychosocial and nutrition-related variables to enhance our understanding of eating attitudes and food choice in postmenopausal women. Specifically, the association between dietary restraint and dieting was examined.

1.5.1 Research questions

The following research questions were addressed:

1. Are there significant differences between postmenopausal women with high cognitive dietary restraint and postmenopausal women with low cognitive dietary restraint with respect to: (i) urinary cortisol excretion, (ii) body composition, (iii) nature of dietary restraint (i.e., flexible versus rigid control of eating), (iv) nutrition-related stress, (v) overall perceived stress, or (vi) self-reported dietary intake? *(Chapter 2)*
2. Do aspects of retrospectively self-reported lifetime physical activity predict current lumbar spine and dual proximal femora BMD in a sample of generally healthy postmenopausal

women? *(Chapter 3)*

3. Do postmenopausal women who report engaging in more weight-bearing physical activity (WBPA) during the teenage years (12–18 years of age) have higher BMD at the lumbar spine or dual proximal femora than women who report engaging in less teen WBPA? *(Chapter 3)*
4. Is the distribution of scores for dietary restraint similar in postmenopausal women compared to young women? *(Chapter 4)*
5. Are there significant differences between dietary restraint and dieting with respect to BMI and/or psychosocial variables that could influence eating behaviours and dietary choices (specifically, social physique anxiety [120], awareness and internalization of sociocultural attitudes towards appearance [121], food choice motives [122], self-esteem [123], and weight locus of control [124]) in generally healthy postmenopausal women? *(Chapter 4)*
6. Do postmenopausal women who report having lost weight, gained weight, or experienced weight cycling in the past 10 years differ from those who report having maintained their weight within five lbs during that time with respect to current BMI, dietary restraint, disinhibition, hunger, and/or weight-related psychosocial and lifestyle characteristics? *(Chapter 5)*
7. Do determinants of current BMI differ in postmenopausal women depending on whether they experienced weight maintenance, weight loss, weight gain, or weight cycling in the past 10 years? *(Chapter 5)*

1.5.2 Hypotheses

1.5.2.1 Hypothesis for Chapter 2

Stated in the null form:

1. Postmenopausal women classified as having high dietary restraint will not differ from those classified as having low dietary restraint with respect to the following variables: (i) urinary

cortisol excretion, (ii) body composition, (iii) nature of dietary restraint (i.e., flexible vs. rigid control of eating), (iv) nutrition-related stress, (v) overall perceived stress, and (vi) self-reported dietary intake.

1.5.2.2 Hypotheses for Chapter 3

Stated in the null form:

1. Lifetime physical activity will not show an association with any measure of current BMD in generally healthy postmenopausal women.
2. Postmenopausal women who report engaging in more teenage WBPA will not have higher current BMD than those reporting less teenage WBPA.

1.5.2.3 Hypotheses for Chapter 4

Stated in the null form:

1. Scores for dietary restraint will have the same distribution among postmenopausal women as they do among young women.
2. Dietary restraint and dieting will not differ in their association with BMI, psychosocial characteristics, or motives for food choice.

1.5.2.4 Hypotheses for Chapter 5

Stated in the null form:

1. Postmenopausal women who differ in their 10-year weight history (maintenance, loss, gain, cycling) will not differ in current BMI, dietary attitudes, or weight related psychosocial and lifestyle characteristics.
2. Predictors of current BMI will not differ among women with different 10-year weight histories.

1.5.3 Objectives

1.5.3.1 Objectives for Chapter 2

1. To assess and compare cortisol excretion in two 24-hour urine collections taken three months apart in postmenopausal women with high dietary restraint and postmenopausal women with low dietary restraint.
2. To assess and compare total body % fat, and BMD and BMC at the lumbar spine (L1-4) and mean proximal femora in postmenopausal women with high dietary restraint and postmenopausal women with low dietary restraint.
3. To assess and compare (i) the rigid and flexible dimensions of dietary restraint, (ii) nutrition-related stress, (iii) perceived stress, and (iv) self-reported dietary intake in postmenopausal women with high dietary restraint and postmenopausal women with low dietary restraint.

1.5.3.2 Objectives for Chapter 3

1. To determine whether aspects of self-reported lifetime historical leisure activity, anthropometric, and dietary variables are independent predictors of current BMD at the lumbar spine and dual proximal femora.
2. To classify postmenopausal women according to the amount of WBPA reported for the teenage time period and compare those above the median of WBPA with those below the median of activity with respect to BMD at the lumbar spine and proximal femora.

1.5.3.3 Objectives for Chapter 4

1. To identify women considered to have high (TFEQ-R score in the upper quartile) or low (TFEQ-R score in the lower quartile) dietary restraint who may be participants in further studies of dietary restraint, stress, and bone health.

2. To classify women according to level of dietary restraint and dieting status, and independently compare the constructs of dietary restraint and dieting with respect to: (i) current BMI (calculated from self-reported height and weight), (ii) eating attitudes (dietary restraint, disinhibition, hunger), (iii) psychosocial characteristics (self-esteem, social physique anxiety, awareness and internalization of sociocultural attitudes towards appearance), and (iv) motives for food choice.

1.5.3.4 Objectives for Chapter 5

1. To classify women on the basis of their 10-year weight history (weight maintenance, loss, gain, or cycling) and compare weight history groups with respect to: (i) current BMI, (ii) dietary attitudes (cognitive dietary restraint, disinhibition, hunger), and (iii) psychosocial characteristics such as self-esteem, social physique anxiety, and weight locus of control.
2. To determine which dietary and psychosocial variables independently predict current BMI in each of the four weight history groups identified (weight maintenance, loss, gain, cycling) and compare results obtained for each group.

To address the objectives listed for each chapter, this research proceeded in two phases. Phase I consisted of a broad mail-administered survey of postmenopausal women, and Phase II was a detailed comparison of postmenopausal women with high versus low dietary restraint. An overview of the research design is provided in **Appendix 1**.

1.6 References

1. Groesz LM, Levine MP, Murnen SK. The effect of experimental presentation of thin media images on body satisfaction: a meta-analytic review. *Int J Eat Disord* 2002; 31: 1-16.

2. Guillen EO, Barr SI. Nutrition, dieting, and fitness messages in a magazine for adolescent women, 1970-1990. *J Adolesc Health* 1994; 15: 464-72.

3. Bezner JR, Adams TB, Steinhardt MA. Relationship of body dissatisfaction to physical health and wellness. *Am J Health Behav* 1997; 21: 147-55.

4. Anderson AE, DiDomenico L. Diet versus shape content of popular male and female magazines: a dose-response relationship to the incidence of eating disorders. *Int J Eat Disord* 1992; 11: 283-7.

5. Forbes GB, Adams-Curtis LE, Rade B, Jaberg P. Body dissatisfaction in women and men: the role of gender-typing and self-esteem. *Sex Roles* 2001; 44: 461-84.

6. Garner DM, The 1997 body image survey results, in *Psychol Today* 1997; February: 30-44, 74-5, 8, 80, 4.

7. Morry MM, Stastka SL. Magazine exposure: internalization, self-objectification, eating attitudes and body satisfaction in male and female university students. *Can J Behav Sci* 2001; 33: 269-79.

8. Schreiber GB, Robins M, Striegel-Moore R, Obarzanek E, Morrison JA, Wright DJ. Weight modification efforts reported by black and white preadolescent girls: National Heart, Lung, and Blood Institute Growth and Health Study. *Pediatrics* 1996; 98: 63-70.

9. Kann L, Kinchen SA, Williams BI, Ross JG, Lowry R, Hill CV, Grunbaum JA, Blumson PS, Collins JL, Kolbe LJ. Youth risk behavior surveillance--United States, 1997. *MMWR CDC Surveill Summ* 1998; 47: 1-89.

10. Patton GC, Carlin JB, Shao Q, Hibbert ME, Rosier M, Selzer R, Bowes G. Adolescent dieting: healthy weight control or borderline eating disorder? *J Child Psychol Psychiatry* 1997; 38: 299-306.

11. Lowry R, Galuska DA, Fulton JE, Wechsler H, Kann L. Weight management goals and practices among U.S. high school students: associations with physical activity, diet, and smoking. *J Adolesc Health* 2002; 31: 133-44.

12. French SA, Jeffery RW. Consequences of dieting to lose weight: effects on physical and mental health. *Health Psychol* 1994; 13: 195-212.

13. McElhone S, Kearney JM, Giachetti I, Zunft HJ, Martinez JA. Body image perception in relation to recent weight changes and strategies for weight loss in a nationally representative sample in the European Union. *Public Health Nutr* 1999; 2: 143-51.

14. Stunkard AJ, Messick S. The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *J Psychosom Res* 1985; 29: 71-83.

15. Alexander JM, Tepper BJ. Use of reduced-calorie reduced-fat foods by young adults: influence of gender and restraint. *Appetite* 1995; 25: 217-30.

16. Case CC, Jones PH, Nelson K, O'Brian Smith E, Ballantyne CM. Impact of weight loss on the metabolic syndrome. *Diabetes Obes Metab* 2002; 4: 407-14.

17. Muscelli E, Camastra S, Catalano C, Galvan AQ, Ciociaro D, Baldi S, Ferrannini E. Metabolic and cardiovascular assessment in moderate obesity: effect of weight loss. *J Clin Endocrinol Metab* 1997; 82: 2937-43.

18. McLean JA, Barr SI, Prior JC. Cognitive dietary restraint is associated with higher urinary cortisol excretion in healthy premenopausal women. *Am J Clin Nutr* 2001; 73: 7-12.

19. Anderson DA, Shapiro JR, Lundgren JD, Spataro LE, Frye CA. Self-reported dietary restraint is associated with elevated levels of salivary cortisol. *Appetite* 2002; 38: 13-7.

20. Bjorntorp P, Rosmond R. Hypothalamic origin of the metabolic syndrome X. *Ann N Y Acad Sci* 1999; 892: 297-307.

21. Greendale GA, Kritz-Silverstein D, Seeman T, Barrett-Connor E. Higher basal cortisol predicts verbal memory loss in postmenopausal women: Rancho Bernardo Study. *J Am Geriatr Soc* 2000; 48: 1655-8.

22. McEwen BS. Protective and damaging effects of stress mediators. *N Engl J Med* 1998; 338: 171-9.

23. McEwen BS, Stellar E. Stress and the individual. Mechanisms leading to disease. *Arch Intern Med* 1993; 153: 2093-101.

24. Reid I. Glucocorticoid osteoporosis: mechanisms and management. *Eur J Endocrinol* 1997; 137: 209-17.

25. Canalis E. Clinical review 83: Mechanisms of glucocorticoid action in bone: implications to glucocorticoid-induced osteoporosis. *J Clin Endocrinol Metab* 1996; 81: 3441-7.

26. Cooper MS. Sensitivity of bone to glucocorticoids. *Clin Sci (Lond)* 2004; 107: 111-23.

27. Biller BM, Federoff HJ, Koenig JI, Klibanski A. Abnormal cortisol secretion and responses to corticotropin-releasing hormone in women with hypothalamic amenorrhea. *J Clin Endocrinol Metab* 1990; 70: 311-7.

28. Barbarino A, De Marinis L, Folli G, Tofani A, Della Casa S, D'Amico C, Mancini A, Corsello SM, Sambo P, Barini A. Corticotropin-releasing hormone inhibition of gonadotropin secretion during the menstrual cycle. *Metabolism* 1989; 38: 504-6.

29. Barr SI, Prior JC, Vigna YM. Restrained eating and ovulatory disturbances: possible implications for bone health. *Am J Clin Nutr* 1994; 59: 92-7.

30. Barr SI, Janelle KC, Prior JC. Vegetarian vs nonvegetarian diets, dietary restraint, and subclinical ovulatory disturbances: prospective 6-mo study. *Am J Clin Nutr* 1994; 60: 887-94.

31. McLean JA, Barr SI. Cognitive dietary restraint is associated with eating behaviors, lifestyle practices, personality characteristics and menstrual irregularity in college women. *Appetite* 2003; 40: 185-92.

32. Lebenstedt M, Platte P, Pirke KM. Reduced resting metabolic rate in athletes with menstrual disorders. *Med Sci Sports Exerc* 1999; 31: 1250-6.

33. Schweiger U, Tuschl RJ, Platte P, Broocks A, Laessle RG, Pirke KM. Everyday eating behavior and menstrual function in young women. *Fertil Steril* 1992; 57: 771-5.

34. McLean JA, Barr SI, Prior JC. Dietary restraint, exercise, and bone density in young women: are they related? *Med Sci Sports Exerc* 2001; 33: 1292-6.

35. Van Loan MD, Keim NL. Influence of cognitive eating restraint on total-body measurements of bone mineral density and bone mineral content in premenopausal women aged 18-45 y: a cross-sectional study. *Am J Clin Nutr* 2000; 72: 837-43.

36. Barr SI, Petit MA, Vigna YM, Prior JC. Eating attitudes and habitual calcium intake in peripubertal girls are associated with initial bone mineral content and its change over 2 years. *J Bone Miner Res* 2001; 16: 940-7.

37. Beiseigel JA, Nickols-Richardson SA. Cognitive eating restraint scores are associated with body fatness but not with other measures of dieting in women. *Appetite* 2004; 43: 47-53.

38. Pirke KM, Tuschl RJ, Spyra B, Laessle RG, Schweiger U, Broocks A, Sambauer S, Zitzelsberger G. Endocrine findings in restrained eaters. *Physiol Behav* 1990; 47: 903-6.

39. Greenberg BR, Harvey PD. The prediction of binge eating over time. *Addict Behav* 1986; 11: 383-8.

40. Klesges RC, Klem ML, Epkins CC, Klesges LM. A longitudinal evaluation of dietary restraint and its relationship to changes in body weight. *Addict Behav* 1991; 16: 363-8.

41. Gorman BS, Allison DB. Measures of restrained eating. In: Allison DB, ed. *Handbook of Assessment Methods for Eating Behaviors and Weight-related Problems: Measures, Theory and Research*. Thousand Oaks: Sage Publications, 1995: 149-84.

42. Wilkinson CW, Peskind ER, Raskind MA. Decreased hypothalamic-pituitary-adrenal axis sensitivity to cortisol feedback inhibition in human aging. *Neuroendocrinology* 1997; 65: 79-90.

43. Ferrari E, Cravello L, Muzzoni B, Casarotti D, Paltro M, Solerte SB, Fioravanti M, Cuzzoni G, Pontiggia B, Magri F. Age-related changes of the hypothalamic-pituitary-adrenal axis: pathophysiological correlates. *Eur J Endocrinol* 2001; 144: 319-29.

44. Seeman TE, Singer B, Wilkinson CW, McEwen B. Gender differences in age-related changes in HPA axis reactivity. *Psychoneuroendocrinology* 2001; 26: 225-40.

45. Bathalon GP, Hays NP, Meydani SN, Dawson-Hughes B, Schaefer EJ, Lipman R, Nelson M, Greenberg AS, Roberts SB. Metabolic, psychological, and health correlates of dietary restraint in healthy postmenopausal women. *J Gerontol A Biol Sci Med Sci* 2001; 56: M206-11.

46. Bathalon GP, Hays NP, McCrory MA, Vinken AG, Tucker KL, Greenberg AS, Castaneda C, Roberts SB. The energy expenditure of postmenopausal women classified as restrained or unrestrained eaters. *Eur J Clin Nutr* 2001; 55: 1059-67.

47. Bathalon GP, Tucker KL, Hays NP, Vinken AG, Greenberg AS, McCrory MA, Roberts SB. Psychological measures of eating behavior and the accuracy of 3 common dietary assessment methods in healthy postmenopausal women. *Am J Clin Nutr* 2000; 71: 739-45.

48. Hays NP, Bathalon GP, Roubenoff R, Lipman R, Roberts SB. The association of eating behavior with risk for morbidity in older women. *J Gerontol A Biol Sci Med Sci* 2002; 57: M128-33.

49. Hays NP, Bathalon GP, McCrory MA, Roubenoff R, Lipman R, Roberts SB. Eating behavior correlates of adult weight gain and obesity in healthy women aged 55-65 y. *Am J Clin Nutr* 2002; 75: 476-83.

50. Mitchell SL, Perkins KA. Interaction of stress, smoking, and dietary restraint in women. *Physiol Behav* 1998; 64: 103-9.

51. de Castro JM. The relationship of cognitive restraint to the spontaneous food and fluid intake of free-living humans. *Physiol Behav* 1995; 57: 287-95.

52. Neumark-Sztainer D, Sherwood NE, French SA, Jeffery RW. Weight control behaviors among adult men and women: cause for concern? *Obes Res* 1999; 7: 179-88.

53. Legg C, Puri A, Thomas N. Dietary restraint and self-reported meal sizes: diary studies with differentially informed consent. *Appetite* 2000; 34: 235-43.

54. Moreira P, de Almeida MD, Sampaio D. Cognitive restraint is associated with higher intake of vegetables in a sample of university students. *Eat Behav* 2005; 6: 229-37.

55. Ricciardelli LA, Williams RJ. A two-factor model of dietary restraint. *J Clin Psychol* 1997; 53: 123-31.

56. Westenhoefer J, Stunkard AJ, Pudel V. Validation of the flexible and rigid control dimensions of dietary restraint. *Int J Eat Disord* 1999; 26: 53-64.

57. Kemmotsu N, Murphy C. Restrained eaters show altered brain response to food odor. *Physiol Behav* 2006; 87: 323-9.

58. Allison DB, Kalinsky LB, Gorman BS. The comparative psychometric properties of three measures of dietary restraint. *Psychol Assess* 1992; 4: 391-8.

59. Herman CP, Polivy JA. Restrained eating. In Stunkard AJ, ed. *Obesity*. Philadelphia: WB Saunders, 1980: 208-25.

60. Herman CP, Mack D. Restrained and unrestrained eating. *J Pers* 1975; 43: 647-60.

61. van Strien T, Frijters JER, Bergers GPA, Defares PB. The Dutch Eating Behavior Questionnaire (DEBQ) for assessment of restrained, emotional, and external eating behavior. *Int J Eat Disord* 1986; 5: 295-315.

62. Polivy J, Herman CP, Howard KI. Restraint scale: assessment of dieting. In Hersen M, Bellack AS, eds. *Dictionary of Behavioral Assessment Techniques*. New York: Pergamon Press, 1988: 377-80.

63. Lowe MR. The effects of dieting on eating behavior: a three-factor model. *Psychol Bull* 1993; 114: 100-21.

64. Wardle J. The assessment of restrained eating. *Behav Res Ther* 1986; 24: 213-5.

65. Stunkard AJ, Messick S. *The Eating Inventory*. San Antonio: Psychological Corporation, 1988.

66. Bond MJ, McDowell AJ, Wilkinson JY. The measurement of dietary restraint, disinhibition and hunger: an examination of the factor structure of the Three Factor Eating Questionnaire (TFEQ). *Int J Obes Relat Metab Disord* 2001; 25: 900-6.

67. Westenhoefer J. Dietary restraint and disinhibition: is restraint a homogeneous construct? *Appetite* 1991; 16: 45-55.

68. Stewart TM, Williamson DA, White MA. Rigid vs. flexible dieting: association with eating disorder symptoms in nonobese women. *Appetite* 2002; 38: 39-44.

69. Westenhoefer J. The therapeutic challenge: behavioral changes for long-term weight maintenance. *Int J Obes Relat Metab Disord* 2001; 25 Suppl 1: S85-8.

70. Shearin EN, Russ MJ, Hull JW, Clarkin JF, Smith GP. Construct validity of the Three-Factor Eating Questionnaire: flexible and rigid control subscales. *Int J Eat Disord* 1994; 16: 187-98.

71. Heatherton TF, Herman CP, Polivy J, King GA, McGree ST. The (mis)measurement of restraint: an analysis of conceptual and psychometric issues. *J Abnorm Psychol* 1988; 97: 19-28.

72. Chapman GE. From "dieting" to "healthy eating": an exploration of shifting constructions of eating for weight control. In: Sobal J, Maurer D, eds. *Interpreting weight: The social management of fatness and thinness*. New York: Aldine de Gruyter, 1999: 73-87.

73. Neumark-Sztainer D, Jeffery RW, French SA. Self-reported dieting: How should we ask? What does it mean? Associations between dieting and reported energy intake. *Int J Eat Disord* 1997; 22: 437-49.

74. Provencher V, Drapeau V, Tremblay A, Despres JP, Bouchard C, Lemieux S. Eating behaviours, dietary profile and body composition according to dieting history in men and women of the Quebec Family Study. *Br J Nutr* 2004; 91: 997-1004.

75. French SA, Jeffery RW, Wing RR. Food intake and physical activity: a comparison of 3 measures of dieting. *Addict Behav* 1994; 19: 401-9.

76. Roth DA, Herman CP, Polivy J, Pliner P. Self-presentational conflict in social eating situations: a normative perspective. *Appetite* 2001; 36: 165-71.

77. Schachter S, Rodin J. *Obese humans and rats*. Washington DC: Erlbaum/Halsted, 1974.

78. Nisbett RE. Hunger, obesity, and the ventromedial hypothalamus. *Psychol Rev* 1972; 79: 433-53.

79. Herman CP, Polivy J. Anxiety, restraint, and eating behavior. *J Abnorm Psychol* 1975; 84: 666-72.

80. Ruderman AJ. Dietary restraint: a theoretical and empirical review. *Psychol Bull* 1986; 99: 247-62.

81. van Strien T, Cleven A, Schippers G. Restraint, tendency toward overeating and ice cream consumption. *Int J Eat Disord* 2000; 28: 333-8.

82. Stice E, Fisher M, Lowe MR. Are dietary restraint scales valid measures of acute dietary restriction? Unobtrusive observational data suggest not. *Psychol Assess* 2004; 16: 51-9.

83. Rideout CA, McLean JA, Barr SI. Women with high scores for cognitive dietary restraint choose foods lower in fat and energy. *J Am Diet Assoc* 2004; 104: 1154-7.

84. Tuschl RJ, Platte P, Laessle RG, Stichler W, Pirke KM. Energy expenditure and everyday eating behavior in healthy young women. *Am J Clin Nutr* 1990; 52: 81-6.

85. Lawson OJ, Williamson DA, Champagne CM, DeLany JP, Brooks ER, Howat PM, Wozniak PJ, Bray GA, Ryan DH. The association of body weight, dietary intake, and energy expenditure with dietary restraint and disinhibition. *Obes Res* 1995; 3: 153-61.

86. Gordley LB, Lemasters G, Simpson SR, Yiin JH. Menstrual disorders and occupational, stress, and racial factors among military personnel. *J Occup Environ Med* 2000; 42: 871-81.

87. Xiao E, Xia-Zhang L, Ferin M. Inadequate luteal function is the initial clinical cyclic defect in a 12-day stress model that includes a psychogenic component in the rhesus monkey. *J Clin Endocrinol Metab* 2002; 87: 2232-7.

88. Paa HK, Larson LM. Predicting level of restrained eating behavior in adult women. *Int J Eat Disord* 1998; 24: 91-4.

89. Soules MR, Sherman S, Parrott E, Rebar R, Santoro N, Utian W, Woods N. Executive summary: stages of reproductive aging workshop (STRAW). *Climacteric* 2001; 4: 267-72.

90. Noble RE. Diagnosis of stress. *Metabolism* 2002; 51: 37-9.

91. Ferrari E, Casarotti D, Muzzoni B, Albertelli N, Cravello L, Fioravanti M, Solerte SB, Magri F. Age-related changes of the adrenal secretory pattern: possible role in pathological brain aging. *Brain Res Brain Res Rev* 2001; 37: 294-300.

92. Tsigos C, Chrousos GP. Hypothalamic-pituitary-adrenal axis, neuroendocrine factors and stress. *J Psychosom Res* 2002; 53: 865-71.

93. Jacobson L. Hypothalamic-pituitary-adrenocortical axis regulation. *Endocrinol Metab Clin North Am* 2005; 34: 271-92, vii.

94. Bergendahl M, Iranmanesh A, Pastor C, Evans WS, Veldhuis JD. Homeostatic joint amplification of pulsatile and 24-hour rhythmic cortisol secretion by fasting stress in midluteal phase women: concurrent disruption of cortisol-growth hormone, cortisol-luteinizing hormone, and cortisol-leptin synchrony. *J Clin Endocrinol Metab* 2000; 85: 4028-35.

95. Raff H, Raff JL, Duthie EH, Wilson CR, Sasse EA, Rudman I, Mattson D. Elevated salivary cortisol in the evening in healthy elderly men and women: correlation with bone mineral density. *J Gerontol A Biol Sci Med Sci* 1999; 54: M479-83.

96. Kirschbaum C, Hellhammer DH. Salivery cortisol. In Fink G, ed. *Encyclopedia of Stress*, San Diego: Academic Press, 2000: 379-83.

97. Selye H. *The stress of life*. New York: McGraw-Hill, 1956.

98. Weiner H. *Perturbing the organism: the biology of stressful experience*. Chicago: University of Chicago Press, 1992.

99. Dickerson SS, Kemeny ME. Acute stressors and cortisol responses: a theoretical integration and synthesis of laboratory research. *Psychol Bull* 2004; 130: 355-91.

100. van Eck M, Berkhof H, Nicolson N, Sulon J. The effects of perceived stress, traits, mood states, and stressful daily events on salivary cortisol. *Psychosom Med* 1996; 58: 447-58.

101. Smyth J, Ockenfels MC, Porter L, Kirschbaum C, Hellhammer DH, Stone AA. Stressors and mood measured on a momentary basis are associated with salivary cortisol secretion. *Psychoneuroendocrinology* 1998; 23: 353-70.

102. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav* 1983; 24: 385-96.

103. Brantley PJ, Dietz LS, McKnight GT, Jones GN, Tulley R. Convergence between the Daily Stress Inventory and endocrine measures of stress. *J Consult Clin Psychol* 1988; 56: 549-51.

104. Brantley PJ, Jones GN. Daily stress and stress-related disorders. *Ann Behav Med* 1993; 15: 17-25.

105. Thomason BT, Brantley PJ, Jones GN, Dyer HR, Morris JL. The relation between stress and disease activity in rheumatoid arthritis. *J Behav Med* 1992; 15: 215-20.

106. Ames SC, Jones GN, Howe JT, Brantley PJ. A prospective study of the impact of stress on quality of life: an investigation of low-income individuals with hypertension. *Ann Behav Med* 2001; 23: 112-9.

107. Zarski JJ. Hassles and health: a replication. *Health Psychol* 1984; 3: 243-51.

108. McLean JA. Cognitive dietary restraint, food intake and cortisol excretion in premenopausal women. Doctoral dissertation in the School of Family and Nutritional Sciences, The University of British Columbia: Vancouver, 1999 (AAT No. NQ46388).

109. Putterman E, Linden W. Cognitive dietary restraint and cortisol: importance of pervasive concerns with appearance. *Appetite* 2006; in press. doi: 10.1016/j.appet.2006.02.003.

110. Wust S, Federenko I, Hellhammer DH, Kirschbaum C. Genetic factors, perceived chronic stress, and the free cortisol response to awakening. *Psychoneuroendocrinology* 2000; 25: 707-20.

111. Green MW, Elliman NA, Kretsch MJ. Weight loss strategies, stress, and cognitive function: supervised versus unsupervised dieting. *Psychoneuroendocrinology* 2005; 30: 908-18.

112. Brown LB, Streeten EA, Shapiro JR, McBride D, Shuldiner AR, Peyser PA, Mitchell BD. Genetic and environmental influences on bone mineral density in pre- and post-menopausal women. *Osteoporos Int* 2005; 16: 1849-56.

113. Torlontano M, Chiodini I, Pileri M, Guglielmi G, Cammisa M, Modoni S, Carnevale V, Trischitta V, Scillitani A. Altered bone mass and turnover in female patients with adrenal incidentaloma: the effect of subclinical hypercortisolism. *J Clin Endocrinol Metab* 1999; 84: 2381-5.

114. Michelson D, Stratakis C, Hill L, Reynolds J, Galliven E, Chrousos G, Gold P. Bone mineral density in women with depression. *N Engl J Med* 1996; 335: 1176-81.

115. Dennison E, Hindmarsh P, Fall C, Kellingray S, Barker D, Phillips D, Cooper C. Profiles of endogenous circulating cortisol and bone mineral density in healthy elderly men. *J Clin Endocrinol Metab* 1999; 84: 3058-63.

116. Greendale GA, Unger JB, Rowe JW, Seeman TE. The relation between cortisol excretion and fractures in healthy older people: results from the MacArthur studies. *J Am Geriatr Soc* 1999; 47: 799-803.

117. Bacon L, Stern JS, Keim NL, Van Loan MD. Low bone mass in premenopausal chronic dieting obese women. *Eur J Clin Nutr* 2004; 58: 966-71.

118. Israel E, Banerjee TR, Fitzmaurice GM, Kotlov TV, LaHive K, LeBoff MS. Effects of inhaled glucocorticoids on bone density in premenopausal women. *N Engl J Med* 2001; 345: 941-7.

119. van Staa TP, Leufkens HG, Cooper C. Use of inhaled corticosteroids and risk of fractures. *J Bone Miner Res* 2001; 16: 581-8.

120. Hart EA, Leary MR, Rejeski WJ. The measurement of social physique anxiety. *Journal of Sport and Exercise Psychology* 1989; 11: 94-104.

121. Heinberg LJ, Thompson JK, Stormer S. Development and validation of the sociocultural attitudes towards appearance questionnaire. *Int J Eat Disord* 1995; 17: 81-9.

122. Steptoe A, Pollard TM, Wardle J. Development of a measure of the motives underlying the selection of food: the food choice questionnaire. *Appetite* 1995; 25: 267-84.

123. Rosenberg M. *The measurement of self-esteem: society and the adolescent self image.* Princeton, New Jersey: Princeton University Press, 1965.

124. Saltzer EB. The weight locus of control (WLOC) scale: a specific measure for obesity research. *J Pers Assess* 1982; 46: 620-8.

CHAPTER 2

COGNITIVE DIETARY RESTRAINT, CORTISOL EXCRETION, AND BODY COMPOSITION IN POSTMENOPAUSAL WOMEN

A version of this chapter has been published:
Rideout CA, Linden W, Barr SI. High cognitive dietary restraint is associated with increased cortisol excretion in postmenopausal women. *J Gerontol A Biol Sci Med Sci* 2006; 61A: 628-33.

2.1 Introduction

Research has repeatedly shown that many women's eating attitudes and behaviours are characterized by high cognitive dietary restraint (the perception of constantly monitoring and attempting to limit dietary intake in an effort to achieve or maintain a certain body weight) [1]. This characteristic overlaps with, but is not analogous to, dieting, since a large portion of individuals who self-describe cognitive restraint do not report current dieting [2]. Although dietary restraint could be advantageous if it led to a reduction in body weight among overweight or obese women, it may have detrimental health effects in normal-weight women. Specifically, an individual's subjective experience of high dietary restraint may act as a subtle but chronic psychological stressor [3], stimulating activity in the hypothalamic-pituitary-adrenal (HPA) axis and leading to increased release of the stress hormone cortisol [4].

Over the long term, elevated cortisol can have negative effects on diverse body systems and functions [5]. With respect to bone health, the adverse effects of high endogenous cortisol levels and pharmacological doses of glucocorticoids are well-documented [6-8]. Recent reports have shown that even within a normal physiological range, those with higher cortisol excretion have compromised bone health [9-12]. Cortisol exerts negative effects on bone directly through calcium and bone metabolism [8] and, in women, indirectly through its effects on the menstrual cycle [13, 14]. Thus, if high cognitive dietary restraint acts as a stressor sufficient to activate the stress response in women, cortisol secretion may increase and, if this persists over time, bone health may be affected.

Studies of young women have provided support for this hypothesis. High dietary restraint has been associated with increased 24-hour urinary cortisol excretion [3], higher morning salivary cortisol samples [15], menstrual cycle disturbances [16-20], and lower bone mineral content (BMC) [21-23] in premenopausal women aged 18–45 years. However, some reports (possibly lacking sufficient statistical power) have not shown an association between dietary restraint and cortisol excretion [24, 25] or bone [26].

Currently, few studies exist of cognitive dietary restraint in postmenopausal women, and none have examined questions of stress and cortisol excretion. Yet there are compelling reasons to do so. First, some postmenopausal women may have experienced high dietary restraint for many years, possibly decades. If this is associated with persistent elevations in cortisol, corresponding negative health effects may have accumulated. Also, decreased bone mineral density (BMD) and osteoporosis are important health concerns for postmenopausal women. If chronic cognitive dietary restraint increases cortisol excretion and decreases BMC and/or BMD, this result could be most pertinent for this age group.

We designed this study to test the hypothesis that postmenopausal women with high cognitive dietary restraint would have increased urinary cortisol excretion when compared to women with low dietary restraint. Secondary aims were to examine possible differences in body composition (% body fat, BMD, and BMC) and dietary intake between the two groups.

2.2 Methods

2.2.1 Overview of study design

Two groups of healthy postmenopausal women were compared: women with high cognitive dietary restraint ("high restraint") and women with low cognitive dietary restraint ("low restraint"). Power analysis conducted prior to study initiation estimated that 28 participants would be required in each group in order to detect a significant difference in 24-hour urinary cortisol excretion when expressed as a ratio to creatinine excretion ($\alpha = .05$, $\beta = .20$), should one exist. We aimed for an additional 20% to allow for possible attrition and for participants who may not provide complete urine collections. Thus, the recruitment target was a minimum of 68 participants (34 in each group).

Participants were enrolled on an ongoing basis between January and September, 2004.

Upon entry into the study, each participant met individually with an investigator unaware of the participant's restraint status. At that time, she was oriented to the study, provided with all instructions and study materials, and had anthropometric measurements. Participants were also given a questionnaire package to complete at their leisure, and this was returned to us by mail within a few days. Shortly after the orientation visit (typically within one week), participants completed a three-day food record and 24-hour urine collection as they continued with their normal daily activities. This was followed by an interval of roughly three months, during which time participants did not engage in activities related to the study. They then completed a second three-day food record and 24-hour urine collection. Within the following month, body composition was measured using dual energy x-ray absorptiometry (DXA). The study protocol was approved by the Clinical Research Ethics Board at The University of British Columbia (**Appendix 2**), and participants provided written informed consent to participate (**Appendix 3**).

2.2.2 Participants

Postmenopausal women volunteers were recruited from among respondents (n = 1071) initially recruited by newspaper advertisements (**Appendix 4**) to a mail-administered survey of dietary attitudes and body image (**Appendices 5 and 6**). Among other scales, the Three-Factor Eating Questionnaire (TFEQ) [1] was included to measure cognitive dietary restraint, disinhibition (susceptibility to overeating due to a loss of control over intake), and hunger (subjective feeling of hunger). The survey also included the question, "Are you currently trying to lose weight?" (yes/no) as a measure of dieting status [27] and, "How many hours of exercise do you do each week?" as an estimate of habitual physical activity. It also prompted participants to record any medications that they were taking at that time.

Scores for cognitive dietary restraint range from 0–21. To be eligible for participation in this study, a subject's score for dietary restraint must have been either *high* (≥ 13) or *low* (≤ 6).

These cut-off scores were selected because they were the boundaries of the highest and lowest quartiles of the survey sample. Previous studies have used similar cut-off values to classify women with high and low levels of dietary restraint [3, 26, 28]. Additional inclusion criteria included age 45–75 years, minimum one year since last menses, and body mass index (BMI; based on self-report of height and weight) between 18.5 and 25.9 kg/m^2. Participants were excluded if they were taking drugs known to affect cortisol or bone metabolism (e.g., steroid drugs, thyroid hormones, bisphosphonates); had previously been diagnosed with an endocrine disorder, osteoporosis, or an eating disorder; had had a surgical menopause (including oophorectomy); or were currently using hormone replacement therapy (HRT).

Of 1071 survey respondents, 1007 (94%) expressed an interest in participating in the current study (**Appendix 7**). The most common reason for exclusion (n = 445; **Appendix 8**) was a score for cognitive dietary restraint in the "medium" range (score 7–12, inclusive). An additional 190 women were excluded because their self-reported BMI was < 18.5 (n = 19) or > 25.9 (n = 171). A total of 149 women were invited to participate in this study (**Appendix 9**) and after making further exclusions based on the criteria above, 78 enrolled (n = 41 with high and n = 37 with low dietary restraint).

2.2.3 Questionnaires

Shortly after entry into the study, participants completed a questionnaire package (**Appendix 10**) which included a re-administration of the TFEQ [1] with the additional questions used to measure rigid and flexible control of eating proposed by Westenhoefer et al [29]. All TFEQ questions were reproduced as originally indicated by Stunkard and Messick [1], with the exception of the first true/false item, which is part of the disinhibition subscale ("When I smell a sizzling steak or see a juicy piece of meat, I find it very difficult to keep from eating, even if I have just finished a meal"). As has been done previously [30], we replaced the words "a sizzling steak or see a juicy piece of meat" with "the aroma of my favourite food" in order to make the question suitable for people who may not eat meat. The 14 additional items used to measure rigid and flexible control of eating [29] were added to the end of the TFEQ in random order. All items were coded as instructed and summed to produce scores for dietary restraint (0–21), disinhibition (0–16), and hunger (0–14).

The questionnaire package also included the Perceived Stress Scale [31], a 14-item measure of global perceived stress, and the Nutrition Hassles Scale [32], a 48-item measure of general nutrition-related stress and hassles. In addition, we included a question about past use of HRT, and asked participants, "How often did you watch what you eat in a conscious effort to control your weight?" for 10-year periods from the teen years through to the 70's (seven questions). Possible responses to those questions were rarely, sometimes, usually, always, can't recall, and have not yet reached that age. At the end of each 24-hour urine collection, participants also completed the Daily Stress Inventory [33] (**Appendix 11**), a 58-item measure of the number and intensity of stressors experienced in the preceding 24 hours.

2.2.4 Dietary analysis

Participants completed two three-day food records (**Appendix 12**) separated by an interval of approximately three months. We developed the food record for this study and pilot-tested it for clarity and ease of use with five postmenopausal women prior to using it (**Appendix 13**). Each food record was completed for two weekdays and one weekend day. Participants were individually instructed by an investigator regarding how to complete the food record accurately while continuing to eat and drink according to their normal patterns. We provided measuring cups and spoons to enable participants to measure portions consumed (**Appendix 14**), and also presented various strategies (both verbally and in writing) to assist participants in quantifying portions in instances when direct measurement was not possible (e.g., the meal was consumed in a restaurant). Participants were encouraged to include recipes in their food record, as appropriate, and were also asked to record all beverages, including water. Use of dietary supplements was also noted.

Food record data were analyzed using Food Processor for Windows, version 8.1 (database version June 2003, ESHA Research, Salem, Oregon). Canadian database items were used when their nutritional content would differ from equivalent items available in the United States. We averaged the six days for which food record data were collected to compute mean intakes of energy (kcal); carbohydrate, protein, fat, and alcohol (g and % of total energy); water (g); fiber (g); dietary calcium (mg); dietary vitamin D (IU); and caffeine (mg).

2.2.5 24-hour urine collections

Participants completed two 24-hour urine collections for the measurement of urinary cortisol and creatinine excretion. Urine collections were completed on one of the days of each three-day food record, as participants continued with their normal routine (thus, the two urine collections were also separated by an interval of approximately three months). The exact dates on which the urine collections occurred were selected in advance by the participant. An investigator instructed each subject individually on the completion of the 24-hour urine collection, and written directions were also provided (**Appendix 15**). Upon awakening on the day of the collection, the first void of urine was discarded and the time was recorded. All urine subsequently passed in the 24-hour period (up to and including the first morning void on the following day) was collected in a wide-mouthed 1-L measuring cup with handle and then transferred to a 3-L urine collection bottle without preservative. Participants had two 3-L collection bottles available for each collection. The urine was kept cool (in the refrigerator or equivalent) throughout the 24-hour collection period. When the collection was complete, it was immediately transferred by courier from the participant's home to the laboratory at Vancouver

General Hospital for analysis. Participants recorded the start and finish time of each collection and advised us verbally upon completing the collection if they had been unable to collect all urine passed during the collection period. A urine collection was judged to be complete if it lasted 23–25 hours and all voids had been collected during that time.

Upon delivery to the laboratory, the total volume of the urine collection was measured. The complete collection was mixed well, centrifuged for five minutes at 580 *g* and 19 °C, and aliquots of 2–3 mL were taken for analyses. Urinary cortisol excretion (nmol/day) was determined by competitive chemiluminescent immunoassay (Bayer ADVIA Centaur, Tarrytown, New York). The reference interval for cortisol excretion in females by this method is 80–600 nmol/day and the detection range is 5.5–2069 nmol/L. Creatinine excretion (mmol/day) was determined by a modification of the kinetic Jeffe reaction [34] on the RxL Dimension® clinical chemistry system (Dade Behring, Deerfield, Illinois). The CV for this method is 1.1% at a mean of 7.9 mmol/L of creatinine. The reference interval for creatinine excretion in females is 5–16 mmol/day and the assay range is 1–17680 μmol/L. Quality control tests were run on the equipment daily. Cortisol excretion during the 24-hour period was expressed both absolutely and as a ratio to creatinine excretion.

2.2.6 Anthropometry and body composition

Height (cm) without shoes and at full inspiration with the subject's head in the Frankfort horizontal plane [35] was measured to the nearest 0.1 cm using a stadiometer (Seca model 214, Hamburg, Germany). Weight (kg) was measured in light indoor clothing without shoes to the nearest 0.5 kg using an electronic scale (Sunbeam Inc., Boca Raton, Florida). Waist circumference was measured at the narrowest point below the rib cage and above the umbilicus when viewed from the front, and hip circumference was measured at the widest point, both using an inflexible tape measure [35]. All measurements were made in triplicate and then averaged. If one measurement differed from the others by more than 0.5 cm for height, 0.5 kg for weight, or 1.0 cm for waist and hip circumference, a fourth measurement was made and the three most similar were used to calculate the average. From these data, we calculated BMI (kg/m^2) and waist-to-hip ratio.

Body composition, including % body fat, BMD, and BMC, was measured using dual energy x-ray absorptiometry (DXA; Lunar Prodigy, enCORE software, GE Healthcare, Madison, Wisconsin). Regional measurements of % body fat were also made for the arms, legs, and trunk. Additional BMD and BMC measurements were made at the lumbar spine (L1-4) and for both hips. Precision data show that repeat BMD measurements fall within ± 0.01 g/cm^2 for the total body and L1-4 region, and within ± 0.012 g/cm^2 for the mean proximal femora. Quality assurance and control tests were performed on the densitometer each day. In-house precision tests indicated that the CV between technicians was 0.82% to 1.55% for the lumbar spine, and 0.62% to 0.76% for the hip.

Confounding effects of vertebral collapse and other structural abnormalities affect 29-40% of lumbar spine BMD measurements in postmenopausal women (artificially inflating BMD values without contributing to bone strength or reducing fracture risk) [36, 37]. Thus, we examined the T-score for each L1-4 vertebra to determine whether it deviated notably from adjacent L1-4 vertebrae. We excluded vertebrae with a T-score that was either >1 unit higher than adjacent vertebrae or > 0.6 units higher than the mean L1-4 T-score [37].

2.2.7 Statistical analysis

Study variables were examined for normality prior to analyses and statistics were computed using untransformed data. Missing values were excluded from comparisons on a pairwise basis. Descriptive statistics were calculated and are presented as mean ± SD or as proportions. Univariate differences between groups (high versus low restraint) were compared using two-tailed independent-samples *t* tests or chi square, as appropriate. Associations between continuous variables were examined using Pearson correlation coefficients or Spearman's rho.

For group comparisons of urine variables, we conducted analyses on four subsets of the data. First, we examined total 24-hour cortisol and creatinine excretion for all participants providing at least one complete urine collection (n = 74). Total values were calculated as follows: for participants who provided two complete collections (n = 46), the total value for each variable was defined as the mean of the two collections; for participants providing only one complete collection (n = 28), the total value was defined as the amount of each variable measured in that complete collection. We compared participants who provided two complete collections with those who provided one complete collection on key variables using two-tailed independent-samples *t* tests and found no significant differences. Thus, the primary analyses were conducted with this total data set. We also conducted secondary analyses of urine data using three data subsets: i) mean values from participants providing two complete 24-hour collections (n = 46), ii) data from all complete collections at time 1 (n = 64), and iii) data from all complete collections at time 2, approximately three months later (n = 56).

We used multivariate analysis of covariance (MANCOVA), with weight loss effort (yes/no) as a covariate, to examine differences in urine variables (cortisol, creatinine, cortisol:creatinine ratio, and volume) for the total data set and for the subsets of complete collections at time 1 and time 2. We examined differences in urine variables for participants with two complete collections using a repeated-measures MANCOVA with time of collection (first or second collection) as the within-participants factor and weight loss effort (yes/no) as a covariate. In addition, we performed a stepwise multiple linear regression analysis to examine predictors of urinary cortisol excretion. Variables were entered into the regression if they were significantly associated with total cortisol excretion in univariate correlations (all variables were examined for a possible association with cortisol excretion). Interactions between restraint group (high/low) and weight loss effort (yes/no) were examined using two-way analysis of variance (ANOVA) for both energy intake and total cortisol excretion. We examined differences in body composition (% body fat, BMD, BMC) using univariate analyses of covariance (ANCOVA), with age, height, weight, and weight loss effort included as covariates. Women with one or more excluded lumbar vertebrae were excluded from the analysis of lumbar spine BMD or BMC, but were included in other body composition analyses. A Bonferroni adjustment was used to reduce the likelihood of Type I error with multiple comparisons. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 11.5 (SPSS Inc: Chicago, Illinois). Results were considered statistically significant at an overall $P < 0.05$.

2.3 Results

Seventy-eight women with high (n = 41) or low (n = 37) dietary restraint enrolled in the study. One woman in the low restraint group withdrew halfway through due to a personal health crisis. All other participants completed the entire study protocol (98.7% retention rate). Descriptive and anthropometric characteristics of the two groups are presented in **Table 2.1**. There were no significant differences between groups with respect to age; years since menopause (menopausal age); anthropometric measurements; current exercise (hours/week); ethnicity; or proportions reporting menstrual irregularity prior to menopause, use of hormone replacement therapy, or use of diuretic or antihypertensive medications. However, women in the high restraint group were more likely to have indicated that they were trying to lose weight.

2.3.1 Current dietary attitudes and indices of stress

Scores for cognitive dietary restraint, disinhibition, and hunger were assessed using the TFEQ prior to recruitment for this study and re-evaluated upon enrolment 4.1 ± 1.9 months later (range = 1 month – 10 months). Participants' scores on these measures remained largely

Table 2.1: Descriptive and anthropometric characteristics of 78 postmenopausal women with high or low dietary restraint

	High restraint (n = 41)	Low restraint (n = 37)	*P*
Age (yr)	59.1 ± 5.4	58.5 ± 4.9	0.60
Menopausal age (yr)	7.1 ± 5.6	7.5 ± 5.2	0.72
Height (cm)	162.6 ± 7.3	163.9 ± 7.5	0.44
Weight (kg)	60.6 ± 6.8	62.1 ± 6.4	0.33
BMI (kg/m^2)	22.9 ± 2.0	23.1 ± 2.3	0.64
Waist circumference (cm)	77.4 ± 5.5	78.3 ± 7.2	0.52
Hip circumference (cm)	98.3 ± 5.5	100.3 ± 5.7	0.13
Waist-to-hip ratio	0.79 ± 0.05	0.78 ± 0.06	0.57
Current exercise (hr/wk)	4.9 ± 3.1	4.1 ± 3.2	0.25
Ethnicity			
n (%) White	33 (80.5%)	31 (83.8%)	
n (%) Chinese	5 (12.2%)	3 (8.1%)	
n (%) Other	3 (7.3%)	3 (8.1%)	0.84
n (%) reporting irregular menstrual cycles prior to menopause	8 (19.5%)	6 (16.2%)	0.71
n (%) reporting past use of hormone replacement therapy	8 (19.5%)	14 (37.8%)	0.07
n (%) reporting use of anti-hypertensive medication	3 (7.3%)	1 (2.7%)	0.36
n (%) trying to lose weight	19 (46.3%)	8 (21.6%)	0.03

Notes: Data are presented as mean ± SD or n (proportion), as appropriate. Means were compared by two-tailed independent-samples *t* tests and proportions were compared using chi-square.

consistent, with test-retest values of 0.91 for cognitive dietary restraint, 0.91 for disinhibition, and 0.53 for hunger (all $P < 0.0001$). Fifty-seven women (73%) scored within two units of their original score for cognitive dietary restraint (**Appendix 16**).

Table 2.2 displays scores for dietary restraint, disinhibition, hunger, flexible and rigid control of eating, and stress-related indices. Women in the high restraint group had higher scores for both rigid and flexible control of eating than women in the low restraint group; however, disinhibition and hunger scores did not differ between groups. Scores for overall perceived stress, daily stress for both 24-hour urine collection periods, and general nutrition-related stress were also similar for the two groups. **Table 2.2** also shows the correlations of dietary and stress-related variables with 24-hour urinary cortisol excretion. Cognitive dietary restraint was the only variable that correlated significantly with urinary cortisol excretion.

2.3.2 Past efforts to control eating

In order to estimate whether participants engaged in a restrained (or unrestrained) approach to eating in the past, we examined responses to questions regarding how often participants watched what they ate in a conscious effort to control their weight for 10-year periods from their teens through to their 70's (if applicable). Scores for each of the seven questions ranged from 1 (rarely) to 4 (always). High restraint participants were more likely to report a long-term tendency to restrain eating than low restraint participants, as was apparent in the higher mean score for that group (2.4 ± 0.8 versus 1.6 ± 0.5, $t = -5.4$, $P < 0.0001$).

For each question, we used chi square to compare the proportion of women in the high and low restraint groups indicating they "usually" or "always" watched what they ate in an effort to control their weight (reflecting a restrained approach to eating) with the proportion indicating they did so "rarely" or "sometimes" (consistent with an unrestrained approach to eating). A greater proportion of women in the high restraint group indicated that they were more likely to

Table 2.2: A comparison of high and low restraint groups on scores for dietary attitudes and stress, and correlations between those scores and cortisol excretion

	High restraint (n = 41)	Low restraint (n = 37)	*P* for difference[a]	correlation with cortisol excretion[b]	*P* for correlation
Dietary restraint	15.5 ± 2.1	4.1 ± 2.3	<0.001	0.39	0.001
Disinhibition	4.5 ± 2.8	4.1 ± 3.7	0.55	-0.11	0.34
Hunger	2.9 ± 2.3	2.6 ± 2.0	0.48	-0.08	0.52
Rigid Control	8.8 ± 2.3	3.7 ± 2.3	<0.001	0.18	0.15
Flexible Control	4.7 ± 1.9	3.2 ± 2.1	0.004	0.05	0.68
Perceived Stress	18.2 ± 8.1	21.4 ± 8.7	0.11	0.02	0.85
Daily Stress					
time 1[c]	40.2 ± 35.2	37.9 ± 28.0	0.79	0.02	0.89
time 2	33.0 ± 31.6	33.3 ± 35.6	0.97	0.04	0.76
Nutrition Hassles	87.8 ± 43.1	80.2 ± 36.2	0.41	-0.002	0.99

Notes: Data are presented as mean ± SD. Missing values were excluded pairwise, thus the exact n in each group varied by comparison. Dietary restraint (scores range from 0–21), disinhibition (scores range from 0–16), and hunger (scores range from 0–14) were all assessed with the TFEQ [1]. Rigid and flexible control were measured using additional dietary restraint items [29]; scores for rigid control can range from 0 – 16 and those for flexible control can range from 0–12. Scores on the Perceived Stress Scale [31] can range from 0–56. Daily stress score is the sum of stressors score from the Daily Stress Inventory [33] completed for the 24-hour period of the first urine collection (time 1) and for the 24-hour period of the second urine collection (time 2). Nutrition hassles were assessed with the scale developed by Hatton et al [32].

[a] Means compared using two-tailed independent-samples *t* tests.

[b] The total cortisol value (n = 74) was used for all correlations with the exception of those for Daily Stress, in which case cortisol excretion from complete collections at each time were correlated with the Daily Stress Inventory (DSI) sum score for the corresponding 24-hour period. Correlations were calculated using Pearson's correlation coefficients except for the correlation with dietary restraint, for which we used Spearman's rho.

[c] A printing error resulted in the omission of items 39–58 from the DSI completed by 25 participants at time 1. Scores for those 25 participants were excluded from the comparison between groups, and the correlation is for participants who completed the entire DSI and also provided a complete 24-hour urine collection at that time (n = 40).

watch what they ate in a conscious effort to control their weight "usually" or "always" during their teens (33% versus 8%, $X^2 = 6.7$, $P = 0.01$), their 30's (44% versus 8%, $X^2 = 12.7$, $P < 0.0001$), their 40's (56% versus 8%, $X^2 = 20.2$, $P < 0.0001$), their 50's (73% versus 11%, $X^2 = 29.1$, $P < 0.0001$), and their 60's (79% versus 14%, $X^2 = 11.6$, $P = 0.001$). The only time period for which a significant difference was not noted was the 20's (28% versus 16%, $X^2 = 1.4$, $P = 0.23$). Possible differences during the 70's could not be examined, because only two participants were aged ≥ 70 years (both were in the high restraint group).

2.3.3 Diet analysis

Participants completed two three-day food records, separated by an interval of 3.3 ± 0.2 months (range = 2.6 months – 4.2 months). Diet results are presented in **Table 2.3** for participants who provided complete records for all six days. The high and low restraint groups had similar intakes of energy, carbohydrate, fat, alcohol, water, fiber, calcium, vitamin D, and caffeine. Women with high dietary restraint tended to consume a greater proportion of total energy from protein than those with low restraint. Of 76 participants with two complete food records, 58 (76%) took dietary supplements during both food records, four (5%) took supplements during one food record but not the other, and 15 (20%) did not take supplements. Women with high dietary restraint were more likely to take supplements than those with low restraint.

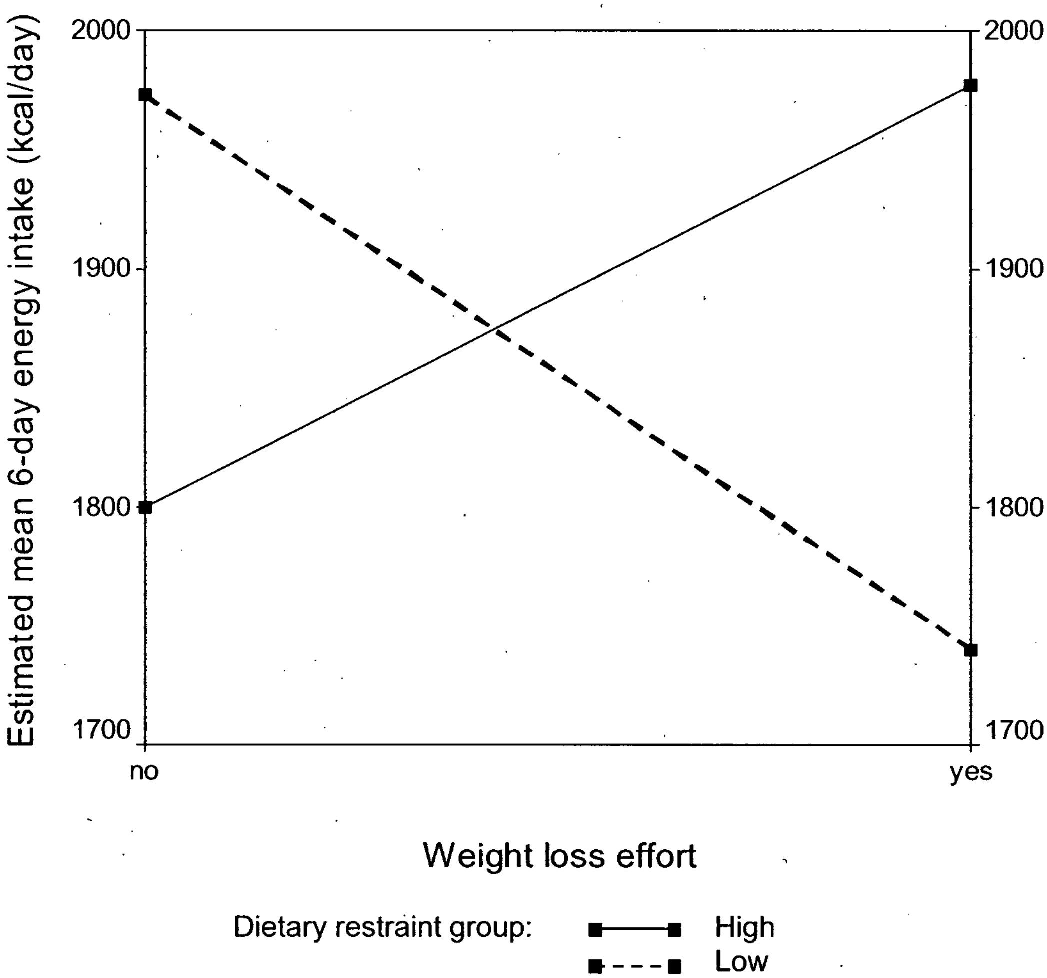
Because women in the high restraint group were more likely to report trying to lose weight, a two-way ANOVA of energy intake by restraint group and weight loss effort was conducted. Results revealed no main effects of restraint group ($F = 0.15$, $P = 0.70$) or weight loss effort ($F = 0.11$, $P = 0.74$), but a significant restraint group-by-weight loss effort interaction ($F = 6.0$, $P = 0.02$), as illustrated in **Figure 2.1**. Within the high restraint group, women who reported trying to lose weight had *higher* energy intakes than those who were not trying to lose

Table 2.3: Dietary results from two three-day food records for postmenopausal women with high or low dietary restraint

	High restraint (n = 40)	Low restraint (n = 36)	*P*
Energy (kcal)	1880 ± 315	1921 ± 359	0.85
Carbohydrate			
g	238.1 ± 52.0	239.6 ± 57.1	0.97
% kcal	49.6 ± 9.2	49.0 ± 8.1	0.86
Protein			
g	79.8 ± 19.0	72.1 ± 16.3	0.18
% kcal	16.5 ± 3.0	14.7 ± 2.5	0.02
Fat			
g	67.8 ± 20.4	70.1 ± 18.9	0.79
% kcal	31.3 ± 6.9	31.8 ± 5.5	0.86
Alcohol			
g	7.4 ± 9.7	13.1 ± 15.0	0.12
% kcal	2.7 ± 3.5	4.5 ± 4.9	0.16
Water (g)	2975 ± 877	2687 ± 814	0.25
Fiber (g)	27.2 ± 9.5	24.3 ± 8.8	0.24
Calcium (mg)	954 ± 314	865 ± 274	0.24
Vitamin D (IU)	155 ± 104	181 ± 97	0.29
Caffeine (mg)	161 ± 141	181 ± 124	0.69
Sodium (mg)	2460 ± 942	2276 ± 642	0.42
n (%) using dietary supplements	38 (92.7%)	24 (66.7%)	0.004

Notes: Data are presented as mean ± SD, with the exception of the proportion of participants using dietary supplements. One subject from each group was excluded from these analyses because intake data were not provided for all six days of food records. Differences between restraint groups were examined using MANCOVA with weight loss effort (yes/no) included as a covariate. The difference in the proportion of each group using supplements was evaluated using chi square.

Figure 2.1: The interaction of dietary restraint group and weight loss effort on mean six-day energy intake



Note: A statistical interaction between dietary restraint group and weight loss effort was detected for mean six-day energy intake ($F = 6.0$, $P = 0.02$).

weight (1977 ± 292 versus 1800 ± 317 kcal/day), while the converse occurred among women in the low restraint group (1740 ± 566 versus 1973 ± 267 kcal/day).

2.3.4 24-hour urine collections

Forty-six (59%) participants provided two complete 24-hour urine collections; 28 (36%) provided a complete urine collection at one time point but not the other, and four (5%) did not provide a complete collection at either time 1 or time 2 (two with high restraint and two with low restraint). Only data from complete urine collections were used in our analyses. A summary of results for all participants is presented in **Table 2.4**. We examined correlations between each variable at time 1 (the first 24-hour urine collection) and time 2 (the second 24-hour urine collection) using data from participants who provided two complete 24-hour collections; these are also reported in **Table 2.4**. Most variables were reasonably consistent over time, but the correlation between the amount of cortisol excreted at time 1 and time 2 was not significant.

Group differences in urine variables are presented in **Table 2.5**. The results were similar for all comparisons: women with high dietary restraint excreted more cortisol than women with low dietary restraint. Dietary restraint group accounted for 4–13% of the variance in cortisol excretion (as indicated by the values for eta squared in **Table 2.5**). Cortisol excretion expressed relative to creatinine was also higher in the high restraint group, as was urine volume. Urine volume was positively associated with cortisol excretion ($r = 0.33$, $P = 0.004$) and also with mean water intake over six days ($r = 0.78$, $P < 0.0001$). Mean water intake tended to be higher in the high restraint group, although the difference was not statistically significant (**Table 2.3**).

Given that women in the high restraint group were more likely to report trying to lose weight, we used a two-way ANOVA to examine differences in cortisol excretion by restraint group and weight loss effort. This revealed a significant main effect of restraint group ($F = 11.3$,

Table 2.4: Cortisol, creatinine, cortisol:creatinine ratio, and volume for complete urine collections at time 1 and time 2, and their correlation with each other

	Time 1 (n = 64)	Time 2 (n = 56)	Correlation (n = 46)	*P*
Cortisol (nmol/d)	232.5 ± 74.5	211.2 ± 72.6	0.17	0.25
Creatinine (mmol/d)	9.0 ± 1.6	8.5 ± 1.5	0.61	<0.0001
Cortisol:creatinine ratio (nmol/mmol)	26.3 ± 8.7	25.2 ± 8.3	0.32	0.03
Volume (L)	2.3 ± 0.9	2.3 ± 0.9	0.79	<0.0001

Notes: Data are presented as mean ± SD for all complete 24-hour urine collections. Correlations were calculated using data from all participants who provided a complete 24-hour urine collection at both time 1 and time 2 (n = 46).

Table 2.5: Urine results for postmenopausal women with high or low cognitive dietary restraint

	n	High restraint	n	Low restraint	Eta squared	*P*
Total value[a]						
Cortisol (nmol)	39	248.2 ± 61.7	35	204.3 ± 66.1	0.09	0.01
Creatinine (mmol)		8.9 ± 1.5		8.7 ± 1.2	0.01	0.36
Cortisol:creatinine (nmol/mmol)		28.5 ± 7.6		23.7 ± 7.4	0.08	0.02
Volume (L)		2.4 ± 0.8		2.1 ± 0.8	0.06	0.04
Both collections[b]						
Cortisol (nmol)	23	233.7 ± 11.1	23	195.9 ± 11.1	0.11	0.02
Creatinine (mmol)		8.8 ± 0.3		8.6 ± 0.3	0.00	0.67
Cortisol:creatinine (nmol/mmol)		27.4 ± 1.3		22.9 ± 1.3	0.11	0.03
Volume (L)		2.6 ± 0.2		2.0 ± 0.2	0.13	0.02
Time 1[a]						
Cortisol (nmol)	33	247.9 ± 73.3	31	216.2 ± 73.3	0.04	0.12
Creatinine (mmol)		9.0 ± 1.7		8.9 ± 1.6	0.01	0.48
Cortisol:creatinine (nmol/mmol)		28.2 ± 9.2		24.3 ± 7.8	0.03	0.16
Volume (L)		2.5 ± 0.81		2.1 ± 0.92	0.06	0.05
Time 2[a]						
Cortisol (nmol)	29	237.6 ± 70.9	27	182.9 ± 64.3	0.13	0.01
Creatinine (mmol)		8.5 ± 1.5		8.4 ± 1.4	0.01	0.57
Cortisol:creatinine (nmol/mmol)		28.2 ± 7.9		22.0 ± 7.7	0.12	0.01
Volume (L)		2.5 ± 0.96		2.0 ± 0.81	0.08	0.04

Notes: Data are presented as unadjusted means ± SD except for data reported for both collections which are unadjusted means ± SE (adjusted means were not greatly different). Values for eta squared indicate the proportion of variance in the dependent variables explained by dietary restraint group (high/low). Total values were defined as follows: for participants providing two complete collections (n = 46), the total value for each variable was the mean of the two collections; for participants providing only one complete collection (n = 28), the total value was the amount of each variable measured in that complete collection.

[a] Group differences were compared with MANCOVA with weight loss effort (yes/no) included as a covariate.

[b] Group differences were compared with repeated-measures MANCOVA with time (first urine collection or second urine collection) as a within-participants factor and weight loss effort (yes/no) included as a covariate. Data are estimated marginal means ± SE. There was a main effect of time ($F = 3.3$, $P = 0.02$) and restraint group ($F = 2.4$, $P = 0.06$) but no time-by-group interaction. The effect of time was only significant for creatinine excretion (sample mean was 8.9 at time 1 and 8.4 at time 2, $F = 12.8$, $P = 0.001$).

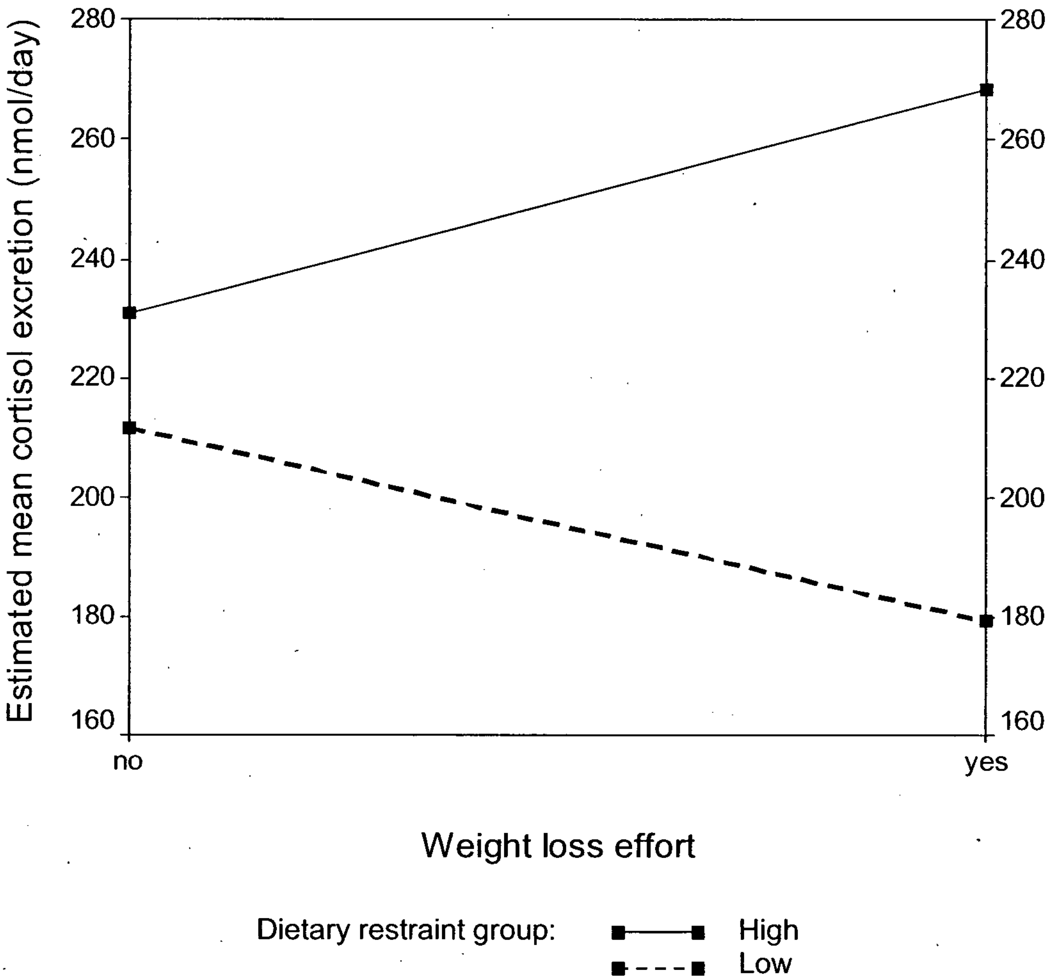
$P = 0.001$), no main effect of trying to lose weight ($F = 0.03$, $P = 0.87$), and a significant restraint group-by-weight loss effort interaction ($F = 4.7$, $P = 0.03$). This interaction is illustrated in **Figure 2.2**. Women with high restraint who were trying to lose weight had *higher* cortisol excretion than those who were not (268.4 ± 70.8 nmol/day versus 230.9 ± 47.8 nmol/day), whereas in the low restraint group, cortisol excretion tended to be *lower* in women who reported trying to lose weight (179.3 ± 58.9 nmol/day versus 211.7 ± 67.3 nmol/day).

Stepwise multiple linear regression analysis was performed to examine the contribution of restraint group to total cortisol excretion, in the context of other explanatory variables. Variables available for entry into the regression model were dietary restraint group (0 = low restraint, 1 = high restraint) and those variables that showed significant associations with cortisol excretion in univariate analyses: urine volume ($r = 0.33$, $P = 0.004$), mean total water intake ($r = 0.34$, $P = 0.003$), energy intake ($r = 0.24$, $P = 0.04$), mean protein consumption ($r = 0.23$, $P = 0.05$), and mean fiber consumption ($r = 0.27$, $P = 0.02$). No anthropometric or body composition variables were associated with cortisol excretion and so were not included in the regression. As shown in **Table 2.6**, two variables predicted cortisol excretion: mean total water intake and dietary restraint group ($R^2 = 0.193$). Dietary restraint group accounted for approximately 7.6% of the variance in cortisol excretion. These results were unchanged when the regression was run with weight loss effort (yes/no) also included as a possible predictor variable.

2.3.5 Body composition

Body composition (% body fat, BMC and BMD) was measured using DXA at the end of the study, 4.1 ± 0.7 months after enrollment (range = 3.3–5.7 months). Using pre-set criteria [37], we determined that 25 (32%) participants had T-scores for particular vertebrae that were

Figure 2.2: The interaction of dietary restraint group and weight loss effort on cortisol excretion



Note: A statistical interaction between dietary restraint group and weight loss effort was detected for mean cortisol excretion ($F = 4.7$, $P = 0.03$).

Table 2.6: Multiple linear regression indicated two variables (mean total water intake and dietary restraint group) predicted total urinary cortisol excretion

Variable	B	SE	95% CI	β	*t*	*P*	R^2	R^2 change
Mean total water intake	0.023	0.009	0.006, 0.040	0.296	2.7	0.01	0.118	0.118
Dietary restraint group	37.2	14.5	8.2, 66.2	0.279	2.6	0.01	0.193	0.076

Notes: 73 participants were included in this regression (excluded is one subject with a complete urine collection who did not provide two complete food records). Variables which did not enter the regression were: mean urine volume, mean energy intake, mean protein intake, mean fiber intake. When the regression was also run with weight loss effort available for entry, it did not enter the regression equation.

sufficiently elevated to warrant their exclusion (13 in the high restraint group and 12 in the low restraint group). One vertebra was excluded for 19 participants (76% of cases) and two were excluded for six participants (24% of cases). Among the 25 affected scans, L1 was excluded in four (16%) cases, L2 was excluded in four (16%) cases, L3 was excluded in 16 (64%) cases, and L4 was excluded in seven (28%) cases. Exclusion of these vertebrae resulted in a mean -0.36 ± 0.18 change in lumbar spine T-score (range -0.8 – -0.1) for those participants.

Body composition results are reported in **Table 2.7**. There was no significant difference between women with high restraint and those with low restraint with respect to % body fat, BMD or BMC (total body and regional measurements). We further examined BMD data by comparing the proportion of participants in each restraint group with a T-score ≤ -1 [38] for each of the regions measured. There were no differences in the proportion of women in the high versus low restraint groups with low BMD (T-score ≤ -1) for the total body (18% versus 33%, $X^2 = 2.3$, $P = 0.18$), mean dual hip (50% versus 47%, $X^2 = 0.06$, $P = 0.81$), or lumbar spine (56% versus 56%, $X^2 = 0.002$, $P = 0.96$).

2.4 Discussion

Our data support the hypothesis that high cognitive dietary restraint may be a source of chronic stress for generally healthy postmenopausal women. We found higher cortisol excretion in postmenopausal women with high dietary restraint compared to those with low dietary restraint (whether expressed absolutely or as a ratio to creatinine excretion), thereby extending observations previously made only in young women [3, 15]. We determined that this difference was not explained by differences in perceived stress. In fact, regression analysis indicated that only two variables predicted cortisol excretion: mean total water intake and dietary restraint group (with dietary restraint group accounting for approximately 7.6% of the variance).

Table 2.7: Total body and regional measurements of % body fat, BMC and BMD in postmenopausal women with high or low cognitive dietary restraint

	High restraint (n = 41)	Low restraint (n = 36)	*P*
% body fat			
total body	33 ± 7	33 ± 7	0.95
arms	29 ± 7	29 ± 8	0.68
legs	35 ± 8	37 ± 7	0.63
trunk	33 ± 8	34 ± 8	0.98
BMC (g)			
total body	2227 ± 330	2232 ± 295	0.45
mean dual hip	28 ± 4	28 ± 3	0.97
lumbar spine (L1-4)[a]	54 ± 7	57 ± 12	0.38
BMD (g/cm^2)			
total body	1.09 ± 0.07	1.07 ± 0.07	0.16
mean dual hip	0.89 ± 0.09	0.89 ± 0.10	0.93
lumbar spine (L1-4)[a]	1.04 ± 0.12	1.06 ± 0.13	0.50

Notes: Data are presented as unadjusted means ± SD. In measurements of total body and legs, two participants in the high restraint group were excluded because they had hip replacement surgery in the past. One participant in the low restraint group withdrew halfway through the study, thus body composition data were not available for her. Group differences were compared using a series of univariate ANCOVA, with age, height, weight, and weight loss effort (yes/no) included as covariates. Using the Bonferroni correction to adjust for multiple comparisons, each test would be considered significant at $P < 0.005$.

[a] n = 52 (28 in the high restraint group and 24 in the low restraint group) because 24 participants with one or more lumbar vertebra excluded were not included in these comparisons.

The size of this effect is notable, both within the context of our study, and also within the larger context of significant inter- and intra-individual variation in cortisol excretion [39].

We were surprised to find a relatively strong relationship between mean total water intake and cortisol excretion ($R^2 = 0.118$, $P = 0.01$). Although a previous report linked high fluid intake (5 L/day) and consequent high urine volume (3.8 ± 1.0 L/day) to elevated cortisol excretion [40], other data did not support this relationship [41, 42]. It is possible that the effect of total water intake may be secondary to high dietary restraint. In an effort to limit energy intake, women with high dietary restraint may consume more fluids or foods with higher water content, and consequently have higher urine volumes. In our study, women in the high restraint group consumed ~300 mL more fluid than those in the low restraint group ($P = 0.25$) and excreted roughly that much more urine ($P = 0.04$).

Our results are consistent with past findings of higher cortisol in 24-hour urine collections [3] and morning saliva samples [15] in young women with high dietary restraint. While two other studies reported no difference between women with high and low restraint in cortisol in overnight serum samples [24] and morning saliva and 24-hour urine samples [25], both of those studies were likely underpowered to detect group differences in cortisol. Pirke and colleagues [24] studied only nine participants with high and 13 participants with low dietary restraint (participants' restraint scores were not specified). Furthermore, the overnight protocol would have been unlikely to detect differences associated with the stress of dietary restraint. While Beiseigel and Nickols-Richardson [25] had larger groups (31 participants with high and 34 with low dietary restraint), their groups were based on a median split of restraint scores (median score = 9), and powered only to detect a significant difference in dietary restraint. Although their analysis of a subset of 21 participants with "very high" and 20 participants with "very low" dietary restraint (scores in the upper and lower 30% of scores, respectively) also failed to show a difference in cortisol excretion between groups, it is likely that a larger sample would have been required to detect differences.

While our results supported our primary hypothesis that high cognitive dietary restraint would be associated with higher urinary cortisol excretion, we did not find the hypothesized negative effects in bone. In young women, cognitive dietary restraint has been directly linked to reduced BMC [21-23] and also to mechanisms which could indirectly affect bone, including menstrual cycle disturbances [16-18, 43, 44]. We speculated that since postmenopausal women with high cognitive dietary restraint may have experienced these effects for many years, consequences for bone might be evident. However, we found no differences in BMC or BMD between restraint groups. What could account for the lack of effect in bone, given the confirmation of group differences in cortisol excretion?

First, with cross-sectional data, we cannot confirm how long participants have had high (or low) levels of dietary restraint. If participants only recently adopted a restrained (or unrestrained) approach to eating, consequences for bone might not yet be apparent. However, degree of dietary restraint appears to have been reasonably consistent among these women, given the high test-retest value for dietary restraint ($r = 0.91$ after 4.1 ± 1.9 months) and the observation that participants with high restraint reported being more likely to watch what they ate in order to control their weight during their teens, and from their 30s onward. Second, data do not currently exist to confirm that associations between dietary restraint and increased cortisol persist in the long-term. Although we found a difference between the high and low restraint groups for both urine collections (separated by an interval of three months), this difference may not persist over the course of years. The HPA axis response to a particular stressor can become habituated over time [45]. Yet our data suggest that habituation to the stress of cognitive dietary restraint does *not* occur, since we found higher cortisol excretion in participants with high dietary restraint despite the suggestion that their restraint level appears to have been high for many years. Perhaps women do not habituate to subtle unrecognized stressors such as cognitive dietary restraint, as they would to other overtly identifiable sources of stress. Third, it is important to note that we did not design this study to have sufficient statistical power to detect differences in bone, particularly in the early postmenopausal stage when bone mass is being lost relatively rapidly. This was also the case for a previous report of similar body composition in postmenopausal women with high versus low dietary restraint [26]. Many more participants would have been required to make conclusions regarding effects in bone (or the lack thereof) with confidence.

Whether cognitive dietary restraint is associated with actual dietary restriction is a matter of debate [46]. Some previous studies have shown that women with high dietary restraint report consuming less energy [47, 48], whereas others do not [43]. Our high and low dietary restraint groups did not differ in their mean six-day energy intake. The realistic estimates of energy intake obtained in our study suggest they were good approximations of typical intake. The mean energy intake for the total sample was 1899 ± 335 kcal/day, which compares favourably to mean estimated daily requirements of 1740 kcal for a sedentary lifestyle, and 1956 kcal for a low active lifestyle [49]. The similar energy intakes for the two groups, combined with their similar body weight, body composition, and physical activity levels, suggest that differential underreporting did not occur.

With our finding of higher cortisol excretion in women with high cognitive dietary restraint, our investigation adds to our understanding of how dietary attitudes and perceptions may be associated with differences in physiology. Our results, combined with those from studies of young women, suggest that cognitive dietary restraint is a relatively consistent – and mildly stressful – characteristic at all life stages. However, in the absence of longitudinal studies, we can only make speculations based on cross-sectional data from different age groups. Prospective investigations are warranted to confirm observed differences in HPA activity and to further explore possible implications for bone health.

2.5 References

1. Stunkard AJ, Messick S. The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *J Psychosom Res* 1985; 29: 71-83.

2. Lowe MR. The effects of dieting on eating behavior: a three-factor model. *Psychol Bull* 1993; 114: 100-21.

3. McLean JA, Barr SI, Prior JC. Cognitive dietary restraint is associated with higher urinary cortisol excretion in healthy premenopausal women. *Am J Clin Nutr* 2001; 73: 7-12.

4. Miller DB, O'Callaghan JP. Neuroendocrine aspects of the response to stress. *Metabolism* 2002; 51: 5-10.

5. McEwen BS, Stellar E. Stress and the individual. Mechanisms leading to disease. *Arch Intern Med* 1993; 153: 2093-101.

6. Francucci CM, Pantanetti P, Garrapa GG, Massi F, Arnaldi G, Mantero F. Bone metabolism and mass in women with Cushing's syndrome and adrenal incidentaloma. *Clin Endocrinol (Oxf)* 2002; 57: 587-93.

7. Israel E, Banerjee TR, Fitzmaurice GM, Kotlov TV, LaHive K, LeBoff MS. Effects of inhaled glucocorticoids on bone density in premenopausal women. *N Engl J Med* 2001; 345: 941-7.

8. Cooper MS. Sensitivity of bone to glucocorticoids. *Clin Sci (Lond)* 2004; 107: 111-23.

9. Greendale GA, Unger JB, Rowe JW, Seeman TE. The relation between cortisol excretion and fractures in healthy older people: results from the MacArthur studies. *J Am Geriatr Soc* 1999; 47: 799-803.

10. Raff H, Raff JL, Duthie EH, Wilson CR, Sasse EA, Rudman I, Mattson D. Elevated salivary cortisol in the evening in healthy elderly men and women: correlation with bone mineral density. *J Gerontol A Biol Sci Med Sci* 1999; 54: M479-83.

11. Chiodini I, Guglielmi G, Battista C, Carnevale V, Torlontano M, Cammisa M, Trischitta V, Scillitani A. Spinal volumetric bone mineral density and vertebral fractures in female patients with adrenal incidentalomas: the effects of subclinical hypercortisolism and gonadal status. *J Clin Endocrinol Metab* 2004; 89: 2237-41.

12. Dennison E, Hindmarsh P, Fall C, Kellingray S, Barker D, Phillips D, Cooper C. Profiles of endogenous circulating cortisol and bone mineral density in healthy elderly men. *J Clin Endocrinol Metab* 1999; 84: 3058-63.

13. Biller BM, Federoff HJ, Koenig JI, Klibanski A. Abnormal cortisol secretion and responses to corticotropin-releasing hormone in women with hypothalamic amenorrhea. *J Clin Endocrinol Metab* 1990; 70: 311-7.

14. Barbarino A, De Marinis L, Folli G, Tofani A, Della Casa S, D'Amico C, Mancini A, Corsello SM, Sambo P, Barini A. Corticotropin-releasing hormone inhibition of gonadotropin secretion during the menstrual cycle. *Metabolism* 1989; 38: 504-6.

15. Anderson DA, Shapiro JR, Lundgren JD, Spataro LE, Frye CA. Self-reported dietary restraint is associated with elevated levels of salivary cortisol. *Appetite* 2002; 38: 13-7.

16. McLean JA, Barr SI. Cognitive dietary restraint is associated with eating behaviors, lifestyle practices, personality characteristics and menstrual irregularity in college women. *Appetite* 2003; 40: 185-92.

17. Lebenstedt M, Platte P, Pirke KM. Reduced resting metabolic rate in athletes with menstrual disorders. *Med Sci Sports Exerc* 1999; 31: 1250-6.

18. Schweiger U, Tuschl RJ, Platte P, Broocks A, Laessle RG, Pirke KM. Everyday eating behavior and menstrual function in young women. *Fertil Steril* 1992; 57: 771-5.

19. Barr SI, Prior JC, Vigna YM. Restrained eating and ovulatory disturbances: possible implications for bone health. *Am J Clin Nutr* 1994; 59: 92-7.

20. Barr SI, Janelle KC, Prior JC. Vegetarian vs nonvegetarian diets, dietary restraint, and subclinical ovulatory disturbances: prospective 6-mo study. *Am J Clin Nutr* 1994; 60: 887-94.

21. McLean JA, Barr SI, Prior JC. Dietary restraint, exercise, and bone density in young women: are they related? *Med Sci Sports Exerc* 2001; 33: 1292-6.

22. Van Loan MD, Keim NL. Influence of cognitive eating restraint on total-body measurements of bone mineral density and bone mineral content in premenopausal women aged 18-45 y: a cross-sectional study. *Am J Clin Nutr* 2000; 72: 837-43.

23. Bacon L, Stern JS, Keim NL, Van Loan MD. Low bone mass in premenopausal chronic dieting obese women. *Eur J Clin Nutr* 2004; 58: 966-71.

24. Pirke KM, Tuschl RJ, Spyra B, Laessle RG, Schweiger U, Broocks A, Sambauer S, Zitzelsberger G. Endocrine findings in restrained eaters. *Physiol Behav* 1990; 47: 903-6.

25. Beiseigel JA, Nickols-Richardson SA. Cognitive eating restraint scores are associated with body fatness but not with other measures of dieting in women. *Appetite* 2004; 43: 47-53.

26. Bathalon GP, Hays NP, Meydani SN, Dawson-Hughes B, Schaefer EJ, Lipman R, Nelson M, Greenberg AS, Roberts SB. Metabolic, psychological, and health correlates of dietary restraint in healthy postmenopausal women. *J Gerontol A Biol Sci Med Sci* 2001; 56: M206-11.

27. Lowe MR, Timko CA. What a difference a diet makes: towards an understanding of differences between restrained dieters and restrained nondieters. *Eat Behav* 2004; 5: 199-208.

28. Alexander JM, Tepper BJ. Use of reduced-calorie reduced-fat foods by young adults: influence of gender and restraint. *Appetite* 1995; 25: 217-30.

29. Westenhoefer J, Stunkard AJ, Pudel V. Validation of the flexible and rigid control dimensions of dietary restraint. *Int J Eat Disord* 1999; 26: 53-64.

30. Guest NS, Barr SI. Cognitive dietary restraint is associated with stress fractures in women runners. *Int J Sport Nutr Exerc Metab* 2005; 15: 147-59.

31. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav* 1983; 24: 385-96.

32. Hatton DC, Haynes RB, Oparil S, Kris-Etherton P, Pi-Sunyer FX, Resnick LM, Stern JS, Clark S, McMahon M, Morris C, Metz J, Ward A, Holcomb S, McCarron DA. Improved quality of life in patients with generalized cardiovascular metabolic disease on a prepared diet. *Am J Clin Nutr* 1996; 64: 935-43.

33. Brantley PJ, Waggoner CD, Jones GN, Rappaport NB. A Daily Stress Inventory: development, reliability, and validity. *J Behav Med* 1987; 10: 61-74.

34. Larsen K. Creatinine assay by a reaction-kinetic approach. *Clin Chem Acta* 1972; 41: 209-17.

35. Lee RD, Nieman DC. *Nutritional Assessment.* 2nd ed. Boston, Massachusetts: WCB/McGraw-Hill, 1996.

36. Ryan PJ, Evans P, Blake GM, Fogeman I. The effect of vertebral collapse on spinal bone mineral density measurements in osteoporosis. *Bone Miner* 1992; 18: 267-72.

37. Barden HS, Markwardt P, Payne R, Hawkins B, Frank M, Faulkner KG. Automated assessment of exclusion criteria for DXA lumbar spine scans. *J Clin Densitom* 2003; 6: 401-10.

38. World Health Organization. *Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. WHO Technical Report Series 843*. Geneva: WHO, 1994.

39. Ice GH, Katz-Stein A, Himes J, Kane RL. Diurnal cycles of salivary cortisol in older adults. *Psychoneuroendocrinology* 2004; 29: 355-70.

40. Mericq MV, Cutler GB, Jr. High fluid intake increases urine free cortisol excretion in normal subjects. *J Clin Endocrinol Metab* 1998; 83: 682-4.

41. Fenske M. Urinary free cortisol is not affected by short-term water diuresis. *Clin Chem* 1999; 45: 316-7.

42. Putignano P, Dubini A, Cavagnini F. Urinary free cortisol is unrelated to physiological changes in urine volume in healthy women. *Clin Chem* 2000; 46: 879.

43. Barr SI, Prior JC, Vigna YM. Restrained eating and ovulatory disturbances: possible implications for bone health. *Am J Clin Nutr* 1994; 59: 92-7.

44. Barr SI, Janelle KC, Prior JC. Vegetarian vs nonvegetarian diets, dietary restraint, and subclinical ovulatory disturbances: prospective 6-mo study. *Am J Clin Nut* 1994; 60: 887-94.

45. Schommer NC, Hellhammer DH, Kirschbaum C. Dissociation between reactivity of the hypothalamus-pituitary-adrenal axis and the sympathetic-adrenal-medullary system to repeated psychosocial stress. *Psychosom Med* 2003; 65: 450-60.

46. Stice E, Fisher M, Lowe MR. Are dietary restraint scales valid measures of acute dietary restriction? Unobtrusive observational data suggest not. *Psychol Assess* 2004; 16: 51-9.

47. de Castro JM. The relationship of cognitive restraint to the spontaneous food and fluid intake of free-living humans. *Physiol Behav* 1995; 57: 287-95.

48. Bathalon GP, Tucker KL, Hays NP, Vinken AG, Greenberg AS, McCrory MA, Roberts SB. Psychological measures of eating behavior and the accuracy of 3 common dietary assessment methods in healthy postmenopausal women. *Am J Clin Nutr* 2000; 71: 739-45.

49. Institute of Medicine. *Dietary reference intakes for energy, carbohydrates, fiber, fat, protein and amino acids (macronutrients).* Washington DC: National Academy Press, 2002.

CHAPTER 3

SELF-REPORTED LIFETIME PHYSICAL ACTIVITY AND CURRENT BONE MINERAL DENSITY IN POSTMENOPAUSAL WOMEN

A version of this chapter has been accepted for publication:
Rideout CA, McKay HA, Barr SI. Self-reported lifetime physical activity and bone mineral density in healthy postmenopausal women: the importance of teenage activity. *Calcif Tissue Int* 2006; in press. Date of acceptance: May 2006. Reproduced with kind permission of Springer Science and Business Media.

3.1 Introduction

Osteoporosis and associated fractures are significant health concerns, affecting an estimated one in four women over the age of 50 years and adding billions of dollars to health care expenditures annually [1, 2]. The personal burden associated with osteoporotic fracture is also high. Fractures can be associated with significant disability, with hip fracture being the most debilitating [3]. Low areal bone mineral density (BMD) is an important predictor of fracture risk, and the accelerated bone loss that occurs in the years following menopause contributes to higher rates of osteoporosis and fracture in postmenopausal women. Thus, it is not surprising that a range of strategic interventions (including pharmaceutical, exercise, and dietary approaches) have focused on reducing bone loss after menopause. However, given that one's risk for osteoporosis is determined by a lifetime of protective and damaging factors, it is appropriate to examine the influence of these variables at other life stages as well. A particularly important time for bone mineral accrual is adolescence, when rapid bone accretion contributes to the attainment of peak bone mass at clinically relevant sites such as the lumbar spine and hip [4, 5].

Peak bone mass is hypothesized to be an important contributor to BMD following menopause, when risk for osteoporosis increases dramatically. In fact, it is projected that for every 10% increase in peak BMD, osteoporosis could be delayed by approximately 13 years [6]. Although roughly 60–80% of variation in bone mass is estimated to be under genetic control [7, 8], modifiable factors such as weight-bearing physical activity (WBPA) also make significant contributions [9]. Relatively short-term intervention studies have demonstrated that WBPA can positively affect bone in both youth and young adulthood [10-12]. Observational studies have also shown benefits of WBPA on bone development in youth by comparing bone parameters in young athletes and normally active controls, both during the period of activity [13-19] and many years later [20-22]. But of greater relevance to the general population is whether moderate levels of leisure activity may also have positive effects on bone and, if so, whether benefits of early activity are sustained in later adulthood.

There is some evidence to suggest lasting benefits of activity during youth [23-25]. However, research on lifetime physical activity and bone is often limited by relatively crude estimates of physical activity [26], small samples of postmenopausal women [27], measurement of peripheral bone sites using technology which is less precise than dual energy x-ray absorptiometry (DXA) [25, 28], or examination of a composite index of lifetime activity rather than activity undertaken during discrete age periods [24, 26, 27]. Further, data for bone mineral content (BMC) and/or bone area typically have not been reported [23-26]. Thus, additional research is required to clarify the relationship between moderate lifetime activity and bone in postmenopausal women.

We undertook this cross-sectional retrospective observational study to examine the association of lifetime physical activity with current BMD at the lumbar spine and both proximal femora in postmenopausal women. We address two questions. First, do aspects of lifetime physical activity predict current lumbar spine and proximal femora BMD in a sample of generally healthy postmenopausal women? And second, are there lasting benefits for postmenopausal BMD among women who undertake more WBPA during the teen years, when peak bone mass is being established? Our study aimed to extend past research by focusing on postmenopausal women (an age and gender group at increased risk for osteoporosis); examining associations with BMD, BMC, and bone area; and assessing differences in the prevalence of low BMD (osteopenia and osteoporosis) with respect to teenage WBPA.

3.2 Methods

3.2.1 Participants

We recruited 78 postmenopausal women volunteers from among 1071 respondents to a mail-administered survey of dietary attitudes and body image (**Appendix 6**). Survey respondents indicated whether they would like to be contacted for possible participation in further studies of dietary attitudes, stress [29], and bone health (**Appendix 7**). Respondents were eligible to participate in the current investigation if they were aged 45–75 years, postmenopausal (> 1 year since last menses), and had a body mass index (BMI; calculated from self-reported height and weight) between 18.5 and 25.9 kg/m^2. Potential participants were excluded if they were using medications that could affect bone metabolism (e.g., steroid drugs, bisphosphonates); if they had previously been diagnosed with an endocrine disorder, osteoporosis or an eating disorder; if they had experienced surgical menopause (with oophorectomy); or if they were currently using hormone replacement therapy. Participants in this study differed from each other with respect to aspects of eating attitudes which were not found to be associated with BMD [29]. Ethical approval of the study protocol was obtained from the Clinical Research Ethics Board at The University of British Columbia (**Appendix 2**), and all participants provided written informed consent to participate (**Appendix 3**).

3.2.2 Assessment of historical leisure physical activity

An investigator administered the Historical Leisure Activity Questionnaire (HLAQ) [30] during a personal interview with each participant (**Appendix 17**). This questionnaire is based on those originally reported by Kriska and colleagues [25, 31] and examines time spent in a variety of leisure physical activities from the age of 12 years to the present. The HLAQ is a reliable measure of lifetime physical activity, with test-retest correlations of activity (excluding walking) among postmenopausal women who completed the assessment three months apart ranging from 0.69 for the earliest time period to 0.85 for the most recent [25]. While validity data specific to the HLAQ are not available, it has been shown that postmenopausal women can estimate their leisure physical activity reasonably accurately over long time periods using a similar tool [32].

Each participant was read the list of 39 activities included in the HLAQ (**Appendix 17**) and asked to identify those in which she had participated a minimum of 10 times since the age of 12 years. Participants were also asked to specify any additional activities that were relevant for them, including occupational activities with a notable labor component. For each activity identified by a particular participant, she was prompted to estimate the amount of time she had engaged in that activity during four age periods: teens (12–18 years), early adulthood (19–34 years), mid-adulthood (35–49 years), and later adulthood (≥50 years, if applicable). We used a visual aid illustrating the number of years in each period to assist participants in their estimations, and calculated average weekly participation for each activity during each time period using the equation provided [30], with one modification. In the numerator of the equation, we changed the value for the number of weeks per month from 4 to 4 ⅓ so that the number of weeks in the numerator of the equation would match that in the denominator. (As written, the equation provided with the HLAQ systematically underestimates participants' reports of time spent in activity by roughly 8% because the numerator includes a total of only 48 weeks per year whereas the denominator includes 52 weeks per year; **Appendix 17**).

From these data, we calculated (i) time spent in all leisure physical activity, and (ii) time spent in WBPA, for each of the four discrete age periods as well as a weighted lifetime (age 12 years – present) period. WBPA included all but the following six activities from the HLAQ: bicycling, swimming, canoeing, fishing, scuba diving, and horseback riding. Because accuracy of recall for time spent walking in the past tends to be low [33], and HLAQ activity estimates are most reliable when time spent walking is not included [25, 31], we conducted our primary analyses using the data set excluding estimates of time spent walking.

3.2.3 Bone parameters

We measured BMD (g/cm^2), BMC (g) and bone area (cm^2) at the posterior-anterior lumbar spine (L1-4) and both proximal femora using DXA (Lunar Prodigy, enCORE software, GE Healthcare, Madison, Wisconsin). The mean proximal femora value was used in our analyses. Total body non-bone lean tissue mass (g) was determined from a total body DXA scan. Each day, quality assurance tests using a spine phantom scan were conducted and densitometer calibration was performed. Manufacturer's data indicate that repeat BMD measurements fall within ± 0.01 g/cm^2 for L1-4, and within ± 0.012 g/cm^2 for the proximal femora. In-house precision tests have shown that the coefficients of variation for BMD measurements ranged from 0.82% to 1.55% for the lumbar spine, and from 0.62% to 0.76% for the proximal femur.

Because confounding effects of vertebral collapse and other structural abnormalities may affect 29–40% of lumbar spine BMD measurements in postmenopausal women (artificially inflating BMD values without contributing to bone strength or reducing fracture risk) [34, 35], we examined the T-score for each L1-4 vertebra to determine whether it deviated notably from adjacent vertebrae within the region of interest. We excluded vertebrae with a T-score that was either >1 unit higher than adjacent vertebrae or >0.6 units higher than the mean L1-4 T-score [35]. For participants with one or more vertebrae excluded, adjusted mean L1-4 BMD and T-score values were recalculated from the remaining vertebrae (each vertebra was weighted according to its relative contribution to the total L1-4 area). Analyses of lumbar spine BMC and bone area did not include participants who had one or more vertebrae excluded. In order to determine whether the classification of participants as having normal or low BMD at the lumbar spine according to these criteria matched that which would have been obtained by clinical evaluation of the DXA scans, each affected scan was reviewed by a radiologist.

3.2.4 Dietary intake

Participants completed two three-day food records (each two weekdays and one weekend day; **Appendix 12**). Food records were completed approximately three months apart (range: 2.6–4.2 months). This provided a more representative estimation of typical intake than could have been obtained through one food record by increasing the number of days recorded and reducing the likelihood of participant fatigue. An investigator provided each individual with standardized instruction on how to complete the food record, and participants were asked to eat and drink according to their normal patterns. We provided measuring cups and spoons to enable participants to measure portions consumed, and also presented various strategies (verbally and in writing) to assist participants in quantifying portions when direct measurement was not possible. Food record data were analyzed using Food Processor for Windows, version 8.1 (database version June 2003, ESHA Research, Salem, Oregon), and Canadian database items were used as appropriate. We averaged the six days for which food record data were collected to compute mean daily intakes of energy (kcal), protein (g), carbohydrate (g), fat (g), alcohol (g), caffeine (mg), and dietary and supplemental calcium (mg) and vitamin D (IU).

3.2.5 Anthropometry

Participants had height (cm) and weight (kg) measured while wearing light indoor clothing without shoes. Height was measured to the nearest 0.1 cm at full inspiration using a stadiometer (Seca model 214, Hamburg, Germany). Weight was measured to the nearest 0.5 kg using an electronic scale (Sunbeam Inc., Boca Raton, Florida). Measurements were made in triplicate and then averaged. If one measurement differed from the others by more than 0.5 cm for height or 0.5 kg for weight, a fourth measurement was made, and the three most similar were used to calculate the average. From these data, we calculated BMI (kg/m^2).

3.2.6 Lifestyle and demographic characteristics

Participants completed questionnaires with questions about lifestyle and demographic variables (**Appendix 6**). Questions addressed current exercise (hours/week), past use of hormone replacement therapy (yes/no), ethnicity (11 categories from the most recent census classification collapsed into three categories for analysis: White, Chinese, and other), education level (≤ secondary school, university/college, postgraduate), and annual income range (<\$35,000, \$35,000–\$50,000, >\$50,000). Age at menopause was also reported, from which we calculated menopausal age (number of years since last menses).

3.2.7 Statistical analysis

Data coding and entry were verified and all variables were examined for normality using the Kolmogorov-Smirnov test. Continuous variables were examined for possible outliers (defined as values falling > 3.5 SD from the mean) and, if present, these were excluded. Descriptive statistics were calculated and are presented as mean ± SD for all normally distributed variables, and as median and interquartile range for those that were not normally distributed. Given the nature of the data set (most notably, physical activity estimates of 0 hours/week for particular participants during some time periods), transformations of activity variables to achieve normality resulted in a substantial loss of data. Thus, all analyses were conducted using untransformed (raw) data. Missing values were rare (approximately 1% of total) and appeared random; these were excluded from all analyses on a pairwise basis.

Differences in estimates of physical activity for the four age periods were examined using a Friedman one-way analysis of variance (ANOVA). To determine if particular age periods differed significantly from each other we used the Wilcoxon signed-rank test (with a Bonferroni adjustment for multiple tests). Consistency of participants' activity estimates across the four age periods was examined using intraclass correlation coefficients. Variables associated with current BMD were examined using Pearson's correlation coefficients or Spearman's rho. Given that these analyses were primarily aimed at identifying variables to include in the multiple regression analyses, no adjustment in P-value was made for multiple comparisons. Independent predictors of current lumbar spine and proximal femora BMD for the whole sample were examined using stepwise multiple linear regression models. Variables available for entry included: menopausal age, total body non-bone lean tissue mass, and any variable (activity, dietary, anthropometric, demographic) showing an association with BMD at the particular site. For each step in the multiple regressions, the criterion for a variable to enter the regression equation was $P < 0.05$ and the criterion for its exclusion in subsequent steps was $P > 0.10$. Because the teenage years are a critical time for bone mass accrual and variation in peak bone mass could affect postmenopausal osteoporosis risk [6], we also created high and low teen WBPA groups (by median split of WBPA excluding walking reported for the 12–18 year period) and compared these groups with respect to lumbar spine and proximal femora BMD, BMC, bone area, and T-scores. This was done using analysis of covariance (ANCOVA) with four covariates: mean adult (age 19 years – present) physical activity, mean adult WBPA, menopausal age, and total body non-bone lean tissue mass. Other differences between high and low teen WBPA groups were examined using two-tailed independent-samples t tests, Mann-Whitney U tests, or chi square, as appropriate. All statistics were computed using the Statistical Package for the Social Sciences, version 11.5 (SPSS Inc: Chicago, Illinois) and results were considered statistically significant at $P < 0.05$.

3.3 Results

3.3.1 Participant characteristics

Characteristics of the total sample are reported in **Table 3.1**, along with a comparison of the high and low teen WBPA groups. The sample was predominantly White and well educated. Participants in the high teen WBPA group did not differ significantly from those in the low teen WBPA group with respect to age, height, weight, or BMI. Lifestyle variables were also similar between the groups, with the exception of current exercise, which was higher in the high teen

Table 3.1: Anthropometric, demographic, and lifestyle characteristics of 78 postmenopausal women who completed an assessment of historical leisure physical activity, and a comparison of high and low teen WBPA groups

	Total sample (n = 78)	High teen WBPA (n = 39)	Low teen WBPA (n = 39)	*P*
Age (years)	59.2 ± 5.2	58.4 ± 5.9	59.9 ± 4.3	0.21
Menopausal age (years)	5.9 (3.2 – 9.8)	5.5 (2.4 – 9.0)	6.8 (3.7 – 10.2)	0.54
Height (cm)	163.2 ± 7.4	164.4 ± 7.7	162.0 ± 6.9	0.15
Weight (kg)	61.3 ± 6.6	61.9 ± 6.8	60.7 ± 6.4	0.41
BMI (kg/m^2)	23.0 ± 2.2	22.9 ± 2.1	23.1 ± 2.2	0.66
Ethnicity				
White	64 (82%)	32 (82%)	32 (82%)	
Chinese	8 (10%)	5 (13%)	3 (8%)	
Other	6 (8%)	2 (5%)	4 (10%)	0.56
Education				
≤ Secondary school	25 (32%)	13 (33%)	12 (31%)	
University/college	39 (50%)	21 (54%)	18 (46%)	
Postgraduate	14 (18%)	5 (13%)	9 (23%)	0.49
Annual income				
<$35,000	16 (21%)	6 (15%)	10 (27%)	
$35,000 – $50,000	14 (18%)	10 (26%)	4 (11%)	
>$50,000	46 (61%)	23 (59%)	23 (62%)	0.17
Past use HRT	22 (28%)	11 (28%)	11 (28%)	1.00
Exercise (hours/week)	4.0 (2.9 – 6.0)	5.0 (3.0 – 7.0)	3.0 (1.5 – 5.5)	0.03

Notes: Data are expressed as mean ± SD or median (interquartile range) for continuous variables, and as n (%) for categorical variables. Total percentages for each group may not equal 100 due to rounding. *P*-values are for differences between high and low teen WBPA groups, examined using two-tailed independent-samples *t* tests, Mann-Whitney *U* tests, or chi square, as appropriate. Menopausal age refers to the number of years passed since the last menstrual cycle.

WBPA group. Groups did not differ with respect to dietary variables, as shown in **Table 3.2**. The majority of participants consumed supplemental calcium (59 women, 76%) and vitamin D (58 women, 74%).

3.3.2 Historical leisure physical activity

Table 3.3 shows the number of different activities reported for each of the age periods, and summarizes time spent in total physical activity and WBPA for each period. The number of different activities reported for each age period was similar. Participants reported spending the most time engaged in physical activity during their teens (12–18 years) and later adulthood (≥50 years), and the least amount of time during early adulthood (19–34 years). Time spent in WBPA peaked after age 50 years. Intraclass correlation coefficients for activity measures across the four age periods were 0.75 (95% CI: 0.65, 0.83) for time spent in physical activity and 0.73 (95% CI: 0.61, 0.82) for WBPA, showing consistency of activity estimates for individual participants.

Patterns of lifetime physical activity differed between the high and low teen WBPA groups, with the high teen WBPA group also reporting more WBPA in subsequent life periods, as illustrated in **Figure 3.1**. The difference between high and low WBPA groups was significant for the first three age periods as assessed by Mann-Whitney *U* tests (12–18 years: 4.6 hours versus 0.7 hours, $P < 0.0001$; 19–34 years: 2.3 hours versus 0.9 hours, $P = 0.02$; 35–49 years: 4.4 hours versus 1.5 hours, $P = 0.002$) and approached significance for the ≥50 age period (5.8 hours versus 3.3 hours, $P = 0.06$).

The most common activities reported throughout life were walking (reported by 95% of subjects), bicycling (90%), gardening/yardwork (86%), and swimming (76%). Although walking was a commonly reported activity, primary analyses did not include it in order to improve reliability of overall activity estimates. Other commonly reported WBPAs were hiking

Table 3.2: Dietary characteristics of 78 postmenopausal women who completed an assessment of historical leisure physical activity, and a comparison of high and low teen WBPA groups

	Total sample (n = 78)	High teen WBPA (n = 39)	Low teen WBPA (n = 39)	*P*
Energy intake (kcal/d)	1900 ± 335	1913 ± 343	1886 ± 330	0.73
Protein (g/d)	76.2 ± 18.1	79.9 ± 20.0	72.4 ± 15.4	0.07
Carbohydrate (g/d)	238.8 ± 54.1	232.8 ± 53.3	244.7 ± 54.9	0.34
Fat (g/d)	68.9 ± 19.6	69.1 ± 19.5	68.7 ± 20.0	0.92
Alcohol (g/d)	6.0 (0.03 – 17.5)	7.7 (0.2 – 21.5)	2.9 (0.1 – 10.8)	0.24
Caffeine (mg/d)	136 (64 – 269)	120 (60 – 271)	161 (66 – 274)	0.59
Calcium (mg/d)	1463 ± 691	1544 ± 808	1382 ± 548	0.31
From food	912 ± 297	941 ± 326	882 ± 267	0.39
From supplements	500 (106 – 811)	492 (109 – 841)	517 (0 – 788)	0.76
Vitamin D (IU/d)	573 ± 395	589 ± 406	558 ± 388	0.73
From food	165 (89 – 212)	165 (91 – 214)	167 (82 – 206)	0.98
From supplements	344 (94 – 627)	344 (131 – 615)	367 (0 – 674)	0.77

Notes: Data are expressed as mean ± SD or median (interquartile range) for continuous variables, and as n (%) for categorical variables. Total percentages for each group may not equal 100 due to rounding. *P*-values are for differences between high and low teen WBPA groups, examined using two-tailed independent-samples *t* tests or Mann-Whitney *U* tests, as appropriate.

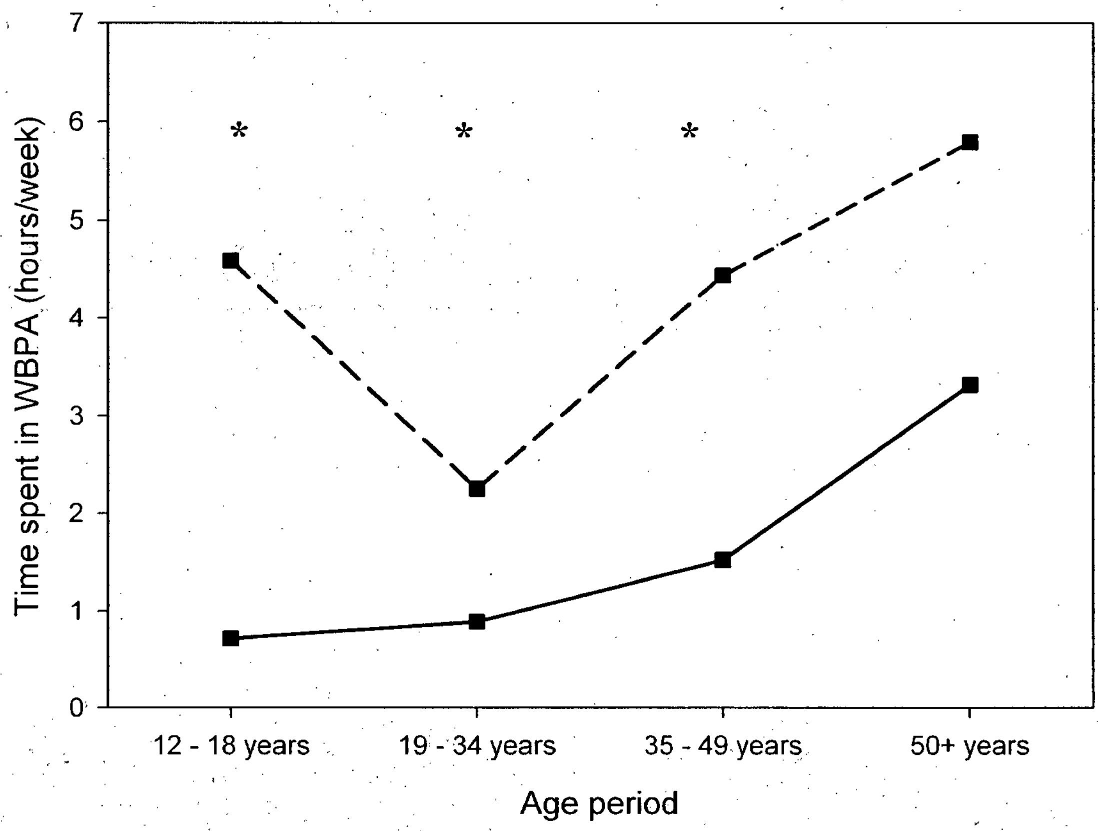
Table 3.3: Number of different physical activities, and estimates of time spent in physical activity reported for age 12 years – present

Age Period	Number of activities	Time spent in physical activity (hr/wk)	Time spent in WBPA (hr/wk)
12 – 18 years	6 (4 – 8)	5.1 (1.8 – 8.5)[1,2]	2.05 (0.7 – 4.9)[1,2]
19 – 34 years	5 (3 – 8)	2.3 (0.8 – 5.2)[3]	1.4 (0.6 – 4.6)[1]
35 – 49 years	6 (4 – 8)	3.8 (1.7 – 7.6)[1]	3.0 (1.2 – 6.9)[2]
≥ 50 years [a]	6.5 (4 – 8)	5.3 (2.5 – 8.9)[2]	3.6 (1.6 – 7.3)[3]
12 years – present	15 (10 – 18)	4.1 (2.6 – 6.7)	3.0 (1.4 – 5.6)

Notes: Data are presented as median (interquartile range). With the exception of number of activities, all estimates exclude time reported walking. For each column, differences in physical activity estimates for the four discrete age periods (determined by Wilcoxon signed-rank test) are indicated by different numerical superscripts.

[a] n = 76 (two participant were aged < 50 years).

Figure 3.1: Median time reported in WBPA for high and low teen WBPA groups across four age periods



Notes: This figure illustrates the median time reported in WBPA in each of four age periods by the high teen WBPA group (dashed line) and the low teen WBPA group (solid line). The high teen WBPA group consistently reported engaging in more WBPA than the low teen WBPA group. Differences were significant for the first three age periods (indicated by asterisks) and approached significance for the ≥50 years period ($P = 0.06$).

(62%), aerobic dance/step aerobics (62%), jogging (60%), strength/weight training (59%), and dancing (58%). The WBPAs most commonly reported for the teen period (age 12–18 years) in particular were walking (54%), skating (49%), and basketball (41%). The least commonly reported activities throughout all age periods were hunting (0%), rock climbing (1%), martial arts (4%) and scuba (4%). Twenty-two subjects reported activities in addition to those listed in the HLAQ. The most common additional activities were pilates (8%) and field hockey (6%).

3.3.3 Bone densitometry results for the total sample and teen WBPA groups

One participant withdrew from the study prior to having her body composition assessed due to a personal health crisis unrelated to bone health. Therefore, analyses of bone data included 77 (98.7%) women. Using pre-set criteria [35], we determined that 25 (32%) participants (12 in the low teen WBPA group and 13 in the high WBPA group) had T-scores for individual vertebrae that were sufficiently elevated to warrant the exclusion of those vertebrae from those participants' lumbar spine bone estimates. One vertebra was excluded for 19 participants and two were excluded for six participants. Among the 25 affected scans, L1 was excluded in four cases, L2 was excluded in four cases, L3 was excluded in 16 cases, and L4 was excluded in seven cases. After exclusion of affected vertebrae, L1-4 BMD and T-score values were re-calculated as weighted averages of remaining vertebrae for those participants. Prior to the exclusion of vertebrae, mean lumbar spine BMD for these participants (n=25) was 1.072 ± 0.142 g/cm^2 (range: 0.847 – 1.483 g/cm^2) and mean lumbar spine T-score was -0.91 ± 1.18 (range: -2.8 – 2.5). After vertebrae were excluded and values were recalculated, there was a mean change of -0.044 ± 0.027 g/cm^2 in lumbar spine BMD (range: -0.11 to -0.001 g/cm^2) for these participants and a mean change of -0.36 ± 0.18 in lumbar spine T-score (range -0.8 to -0.1).

Table 3.4 displays mean values for lumbar spine and mean proximal femora BMD, BMC, area, and T-score, as well as the estimated differences between the high and low teen

Table 3.4: Lumbar spine and proximal femora bone measurements for the total sample and a comparison of high and low teen WBPA groups

	Entire Sample (n = 77)[a]	High teen WBPA (n = 39)	Low teen WBPA (n = 38)	*P*	Estimated difference (95% CI)[b]
Lumbar spine (L1-4)[c]					
BMD (g/cm^2)	1.044 ± 0.128	1.083 ± 0.132	1.002 ± 0.112	0.004	0.091 (0.030, 0.152)
BMC (g)	55.6 ± 9.5	58.6 ± 8.3	52.5 ± 9.8	0.01	7.0 (1.6, 12.2)
Area (cm^2)	52.8 ± 5.2	53.9 ± 3.5	51.6 ± 6.5	0.06	2.6 (-0.2, 5.4)
T-score	-1.13 ± 1.06	-0.81 ± 1.09	-1.48 ± 0.93	0.004	0.75 (0.24, 1.26)
n (%) with low BMD[d]	43 (56%)	17 (44%)	26 (68%)	0.02	
Mean proximal femora[e]					
BMD (g/cm^2)	0.892 ± 0.094	0.918 ± 0.085	0.865 ± 0.095	0.04	0.049 (0.003, 0.095)
BMC (g)	28.1 ± 3.5	29.0 ± 3.5	27.1 ± 3.2	0.09	1.2 (-0.2, 2.7)
Area (cm^2)	31.5 ± 2.4	31.6 ± 2.5	31.4 ± 2.4	0.44	-0.3 (-1.1, 0.5)
T-score	-0.90 ± 0.78	-0.68 ± 0.72	-1.12 ± 0.79	0.04	0.41 (0.03, 0.80)
n (%) with low BMD[d]	38 (49%)	14 (36%)	24 (63%)	0.02	

Notes: Data are presented as unadjusted means ± SD (covariate-adjusted means were not substantially different). Differences in continuous variables were compared by ANCOVA, with menopausal age, total body non-bone lean tissue mass, and adult physical activity and adult WBPA as covariates. Differences in proportions were examined with chi square.

[a] One participant withdrew from the study prior to bone measurements.

[b] Estimated differences are for high teen WBPA – low teen WBPA and were calculated using covariate-adjusted means.

[c] For 25 participants with one or more lumbar spine vertebrae excluded, the adjusted mean L1-4 BMD and T-score values are used. Those 25 participants were excluded from the comparison of lumbar spine BMC and area.

[d] T-scores $\leq$ -1.

[e] Excludes one participant with hip replacement.

WBPA groups for each of those parameters. The high teen WBPA group had higher lumbar spine and mean proximal femora BMD and T-scores than the low teen WBPA group, even when controlling for differences in physical activity during other life stages. Lumbar spine BMC was also significantly higher among those who had engaged in more WBPA in the teen years. Differences in lumbar spine bone area and mean proximal femora BMC approached statistical significance; however, the difference in mean proximal femora area between the groups was negligible.

Using World Health Organization criteria [36] to classify participants with low BMD (T-score $\leq$ -1), roughly half the sample had low BMD; 43 (56%) had low BMD at the lumbar spine (based on T-scores calculated after removal of particular vertebrae) and 38 (49%) had low BMD at the proximal femora. The number of participants classified as having low lumbar spine BMD based on unadjusted T-scores was slightly lower: based on unadjusted scores, 39 (51%) participants would be classified as having low BMD at the lumbar spine. This is four participants fewer than were classified as having low BMD at the lumbar spine based on adjusted T-scores (in each of those four cases, the adjusted T-score was close to the border between the normal and osteopenic categories; adjusted T-score range: -1.2 – -1.0). Clinical review of these four scans indicated that the clinical classification of these participants would likely not have been altered from that based on the unadjusted scans (i.e., although the adjusted T-score was $\leq$ -1.0, in a clinical setting, these four women would have been classified as having normal BMD, rather than osteopenia, at the lumbar spine). Generally, osteopenia was more common than osteoporosis: of 43 participants with low BMD at the lumbar spine, only six met the criteria for osteoporosis (five of whom were in the low teen WBPA group), and only one participant (also in the low teen WBPA group) was classified with osteoporosis at the mean proximal femora. (This pattern was similar when analysis of lumbar spine data was not adjusted for potentially compromised vertebrae: based on those data, 34 participants would be classified with osteopenia at the lumbar spine, and 5 would be classified with osteoporosis). A greater proportion of the low versus high teen WBPA group had low BMD.

3.3.4 Lifetime physical activity and current BMD, BMC and bone area

In exploratory analyses, all activity variables were examined for possible associations with BMD at both the lumbar spine (L1-4) and mean proximal femora for the total sample (**Table 3.5**). We found significant positive associations for measures of physical activity between 12–18 years of age and current BMD at the lumbar spine and both proximal femora. However, no activity estimate for other time periods (19–34 years, 35–49 years, ≥50 years, weighted average 12 years – present) was significantly associated with current BMD at either site, nor was current exercise.

Physical activity estimates were also examined for possible associations with BMC and bone area at the lumbar spine and both proximal femora, also shown in **Table 3.5**. BMC, but not area, was significantly associated with total activity between 12–18 years of age for both the lumbar spine and proximal femora. Associations with WBPA during the teen years were consistent with those estimates, but were not statistically significant ($P = 0.20$ for lumbar spine BMC and $P = 0.11$ for proximal femora BMC). Proximal femora area showed a possible positive association ($P < 0.10$) with physical activity estimates for early adulthood (age 19–34 years), whereas lumbar spine area showed a negative association with total activity for the ≥50 years time period.

3.3.5 Current BMD and estimates of activity *including* walking

Due to the greater reliability of estimates of activity excluding walking, those were used in the primary analyses. However, we also examined correlations between BMD at both sites and estimates of activity including walking. Including walking in the estimates of teen activity

Table 3.5: Correlations of physical activity reported for different age periods with current BMD, BMC and bone area at the lumbar spine and mean proximal femora in postmenopausal women

	Lumbar spine (L1-4)			Mean proximal femora		
	BMD (g/cm^2)	BMC (g)	Area (cm^2)	BMD (g/cm^2)	BMC (g)	Area (cm^2)
Teens (12–18 years)						
Total activity (h/wk)	0.31**	0.30*	0.01	0.33**	0.33**	0.15
WBPA (h/wk)	0.30**	0.19	-0.01	0.29*	0.19	-0.01
Early adulthood (19–34 years)						
Total activity (h/wk)	0.15	0.13	0.01	0.04	0.16	0.20[a]
WBPA (h/wk)	0.12	0.05	0.004	-0.02	0.10	0.20[a]
Mid-adulthood (35–49 years)						
Total activity (h/wk)	0.08	0.04	-0.23	0.07	0.11	0.07
WBPA (h/wk)	0.15	0.07	-0.15	0.12	0.13	0.01
Later adulthood (≥ 50 years)						
Total activity (h/wk)	-0.06	-0.20	-0.30*	-0.01	-0.01	0.04
WBPA (h/wk)	0.04	-0.11	-0.26[a]	0.09	0.06	0.004
Lifetime average (12 years – present)						
Total activity (h/wk)	0.16	0.09	-0.15	0.15	0.19	0.17
WBPA (h/wk)	0.17	0.05	-0.14	0.18	0.19	0.07
Current exercise (h/wk)	0.15	-0.03	-0.16	0.07	0.05	-0.01

Notes: Correlations between variables were examined using Spearman's rho. If present, outliers (>3.5 SD) were removed from analyses (**Appendix 18**). For 25 participants with one or more lumbar spine vertebrae excluded, the adjusted mean L1-4 BMD was used. Those participants were excluded from measures of association with lumbar spine BMC and bone area.

[a] $P < 0.10$ * $P < 0.05$ ** $P < 0.01$

led to nonsignificant associations with BMD (for the lumbar spine, $r_s = 0.07$, $P = 0.55$, and for proximal femora, $r_s = 0.09$, $P = 0.43$). Greater disparity was observed in measures of associations in later adulthood, with the majority showing non-significant negative correlations (**Appendix 19**).

3.3.6 Current BMD and dietary, anthropometric, and demographic variables

All dietary, anthropometric and demographic variables were also examined for possible associations with BMD. We found no significant associations between dietary or anthropometric variables and current BMD at either site. However, two demographic variables were associated with measures of BMD. There was a significant correlation between proximal femora BMD and age ($r = -0.24$, $P = 0.04$). We also noted a significant curvilinear relationship between income and BMD for both the lumbar spine ($R^2 = 0.083$, $F = 3.3$, $P = 0.04$) and proximal femora ($R^2 = 0.120$, $F = 4.9$, $P = 0.01$) such that women with an annual income < \$35,000 or > \$50,000 had lower BMD than women with an annual income of \$35,000–\$50,000. Thus, a quadratic of this variable was created and used in the subsequent regression analyses.

3.3.7 Independent predictors of current BMD

Variables associated with BMD at each site in univariate tests (along with menopausal age and total body non-bone lean tissue mass) were entered into stepwise multiple linear regression models to determine significant predictors of current BMD at each of the lumbar spine and proximal femora. **Table 3.6** shows the results of the regression analyses. WBPA from 12–18 years was the only variable that predicted current lumbar spine BMD, accounting for 11% of the variance. Proximal femora BMD was positively predicted by time spent in activity from 12–18 years (accounting for 10.6% of the variance) and negatively predicted by current age (accounting for 6.9% of the variance).

Table 3.6: Results of two stepwise multiple linear regression analyses to determine predictors of current BMD at the lumbar spine and mean proximal femora

Variable	B	SE	Coefficient (β)	R^2	R^2 change	*t*	*P*
Lumbar spine L1-4[a]							
WBPA 12 – 18 years	0.012	0.004	0.331	0.110	0.110	2.9	0.004
Mean proximal femora[b,c]							
Physical activity 12 – 18 years	0.007	0.002	0.355	0.106	0.106	3.2	0.002
Age	-0.005	0.002	-0.264	0.175	0.069	-2.4	0.02

[a] Variables which did not enter the regression: physical activity 12–18 years, income, menopausal age, total body non-bone lean mass.

[b] Variables which did not enter the regression: WBPA 12–18 years, income, menopausal age, total body non-bone lean mass.

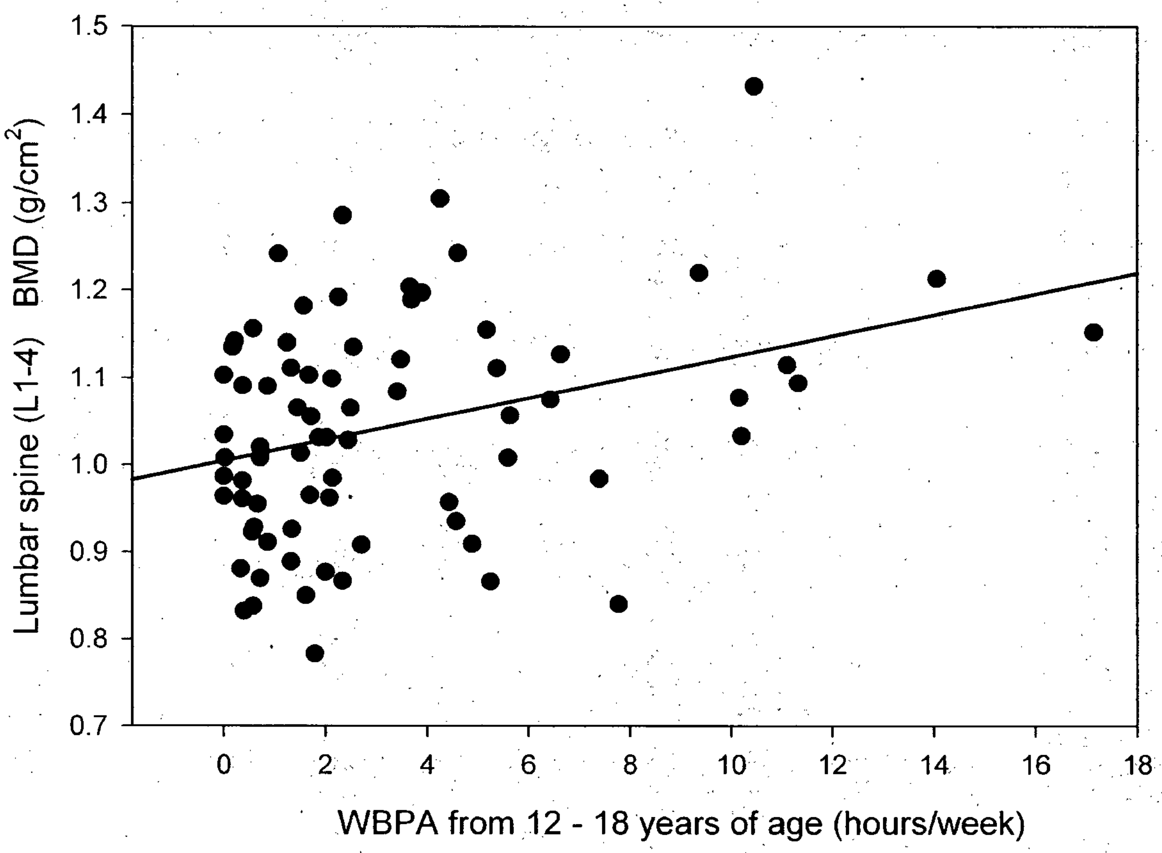
[c] Excludes one participant with hip replacement.

The regression for lumbar spine BMD is illustrated in **Figure 3.2**. One participant with higher lumbar spine BMD than the others (1.43 g/cm^2) was not classified as an outlier (her BMD was 3.04 SD above the mean). However, we also undertook the regression analysis without this participant to ensure that she did not exert undue influence on the results. Excluding this participant, WBPA from 12–18 years remained the only significant predictor of current lumbar spine BMD, $R^2 = 0.075$, $F = 5.6$, $P = 0.02$.

3.4 Discussion

In this cross-sectional retrospective study, we investigated the influence of self-reported lifetime physical activity on current bone parameters in generally healthy postmenopausal women. Our results demonstrate lasting benefit of moderate teenage physical activity on lumbar spine and proximal femora BMD measured approximately 45 years later. Time spent engaged in physical activity between the ages of 12–18 years emerged as a key positive determinant of current BMD, whereas activity at other life stages was not associated with postmenopausal BMD. Our results suggest that increased BMC, rather than bone area, may be responsible for this difference in BMD. When we examined associations between bone parameters and physical activity, we found that activity during the teen years was associated with increased postmenopausal BMC, but not bone area, at both the lumbar spine and mean proximal femora. When the high and low teen WBPA groups were compared, we found that the high teen WBPA group had higher BMC than the low teen WBPA group at the lumbar spine and mean proximal femora (although the difference for the proximal femora did not reach statistical significance, $P = 0.09$). Lumbar spine bone area was possibly greater in the high teen WBPA group than the low teen WBPA group ($P = 0.06$), but there was no difference in the mean proximal femora area between groups. Together, this suggests that increased BMC is primarily responsible for the

Figure 3.2: Scatterplot of current lumbar spine BMD according to time spent in WBPA from 12–18 years of age



Notes: This figure illustrates the association of time engaged in WBPA from 12–18 years of age and lumbar spine (L1-4) BMD ($r = 0.30$, $P < 0.01$). Stepwise multiple linear regression indicated that time spent in WBPA from 12–18 years of age was the only significant predictor of current lumbar spine BMD ($y = 1.005 + 0.013x$), accounting for 11% of the variance ($P = 0.004$).

increased postmenopausal BMD observed with greater teen physical activity, with a possible role for bone area at the lumbar spine.

It appears that sustained osteogenic benefits may occur with relatively modest amounts of physical activity during the teen years. Teenage activity variables were significant independent predictors of current BMD at the lumbar spine and proximal femora, accounting for roughly 11% of the variance. Furthermore, controlling for differences in physical activity in adulthood, women who were above the median of 2.05 hours of weekly teen WBPA had postmenopausal BMD which was approximately 8.4% higher at the lumbar spine ($P = 0.004$) and 5.3% higher at the mean proximal femora ($P = 0.04$). These BMD differences are slightly less than those reported for former athletes compared to inactive controls many years later. For example, Etherington and colleagues reported that former elite athlete women (runners and tennis players) currently aged 40–65 years had 8.7% greater BMD at the lumbar spine and 12.1% greater BMD at the femoral neck than age-matched controls [20]. However, our results are important as they indicate that even less strenuous exercise may have benefits for BMD many years later.

Previously, Kriska and colleagues [25], using an earlier version of the HLAQ, reported weak associations among physical activity in youth and bone in postmenopausal women. They found a correlation between leisure activity (excluding walking) from 14–21 years of age and radial bone area assessed by computerized tomography ($r = 0.14$, $P < 0.05$), an association which persisted after adjusting for possible covariates [25]. More recently, Micklesfield and colleagues [23] used a modified version of the HLAQ to assess lifetime physical activity among women with a mean age of 42.6 ± 8.9 years (menopausal status was not indicated). They found that although total lifetime physical activity was not related to current BMD at the lumbar spine (L1–4) or left proximal femur, physical activity from 14–21 years of age was significantly associated with BMD at both sites [23]. As in our study, they found that BMD was not associated with physical activity estimates for any of the other age periods they assessed (22–34 years, 35–49 years, ≥50 years) [23], but they did not report data for BMC or bone area. Another recent investigation estimated current bone density using quantitative ultrasound attenuation at the calcaneus and found that among 105 socioeconomically disadvantaged women with a mean age of 66 ± 7 years, estimated bone density was associated with the amount of occupational activity performed by women from 22–34 years of age ($r = 0.24$, $P = 0.03$) [28]. By more thoroughly assessing bone parameters in relation to lifetime physical activity, our study builds on these earlier reports and clarifies relationships among early physical activity, postmenopausal BMD, and risk for osteoporosis.

We found that a significant proportion of women in our study unknowingly had low BMD. Among the entire sample, the proportion of participants with low BMD (T-score ≤ -1) [36] was 56% for the lumbar spine and 49% for mean proximal femora. These results are slightly higher than past reports of unknown low BMD in women over 50 years of age using population data [37], perhaps because women with a perceived susceptibility for low BMD (e.g., based on a family history of osteoporosis) may have been more likely to volunteer for a study of bone health. The proportion of women with vertebral deformity (possibly reflecting vertebral fractures) in our study (32%) was consistent with past estimates [34, 35]. However, not all studies in this area have considered possible vertebral deformity when examining lumbar spine scans in postmenopausal women [24, 26]. The importance of doing so is illustrated by our finding that the adjusted lumbar spine BMD and T-score values among participants with one or more vertebrae excluded resulted in a mean change of -0.044 g/cm^2 in BMD and -0.36 change in T-score. Failing to consider the possible influence of vertebral fracture or deformity could lead to artificially inflated values for lumbar spine bone parameters, and could possibly confound associations with physical activity.

We found that whether participants were classified with low BMD (osteoporosis or osteopenia) was related to the amount of physical activity they reported for the 12–18 year age period. Participants who had engaged in more WBPA during the teen years were significantly less likely to demonstrate low BMD (**Table 3.4**). Given that each SD decrease in lumbar spine BMD represents an increase of approximately 2.3 times the relative risk for vertebral fracture [38], the estimated T-score difference between groups of 0.75 at the lumbar spine suggests that, on average, participants in the low teen WBPA group have a relative risk for vertebral fragility fracture that is approximately 1.7 times greater than participants in the high teen WBPA group. Likewise, based on an increase of 2.6 times in the relative risk for hip fracture with each SD decrease in proximal femur BMD [38, 39], the low teen WBPA group has approximately 1.07 times greater risk of hip fracture than the high teen WBPA group. Thus, the implications of relatively small amount of non-athletic WBPA exercise during the teen years are notable.

With respect to patterns of physical activity observed in our sample, several findings are of interest. First, it was somewhat unexpected to note that levels of physical activity after 50 years of age were comparable to, or even higher than, those reported for the teen years. This maintenance of physical activity in adulthood is not consistent with frequent reports of reduced activity after youth [26, 40]. Our sample appears to have engaged in greater lifetime physical activity, and remained more active into the postmenopausal years, than the general population of women [41]. It is possible that women in our study may be more physically active than average due to volunteer bias, given that volunteers for health-related research tend to be more health conscious [42].

Walking is a very common leisure physical activity [43, 44] and it was reported by 95% of our participants. However, it can be especially difficult to accurately quantify common physical activity which is incorporated into daily life [45]. The frequent and non-specific nature of walking may be why the HLAQ is less reliable when estimates of walking time are included [31]. This reduced reliability may stem from inaccurate or distorted estimations of time spent walking, and may contribute to the lack of concordance in our results depending on whether or not walking was included in estimates of physical activity. However, it is also possible that participants' recollections of time spent walking are generally correct but the effect of walking on bone could not be detected in this sample. Given the relatively lower loading and repetitive nature of walking, it would not be expected to exert the same effect as other WBPA with shorter bursts of activity and higher peak strain forces. In a previous study of premenopausal adult women newspaper or letter carriers, long periods of walking (and the associated repetitive low stress loading) were not sufficient for the newspaper carriers to have higher BMD than controls [46]. However, a contrasting result was reported in the study by Micklesfield and colleagues: they found a significant correlation ($r = 0.22$, $P < 0.05$) between proximal femur BMD and time spent walking between 14–21 years of age in women currently aged 22–59 years [23].

Another unexpected result was the negative association observed between L1-4 bone area and measures of physical activity during later adulthood (≥ 50 years), reported in **Table 3.5**. There is no plausible physiological reason to suspect that increased activity after the age of 50 years would lead to reduced bone area, thus this was likely a chance finding.

The results of our study provide insight into how physical activity during adolescence positively affects postmenopausal BMD. However, our data must be interpreted in light of several potential limitations. First, given the cross-sectional design of our study, it is impossible to establish that higher teen WBPA results in higher BMD. Second, physical activity estimates were based on historical recall of habitual activity over long periods of time. Measuring ordinary physical activity performed in the past can be challenging and it is known that people tend to underestimate the amount of time they engage in physical activity [33, 47]. While we endeavored to promote accurate participant recall by prompting participants to relate their activity patterns to specific memories in each time period (such as school, marriage, employment, living environment), we are unable to verify the accuracy of activity estimates. However, anecdotal comments from participants suggest that the boundaries for the age periods in this version of the HLAQ were effective, as they tended to correspond to times of change in many women's lives. And although reliance on self-reported retrospective data is not ideal, it has been shown that recall of physical activity in the distant past is surprisingly good [33]. Third, the broad time periods used in the HLAQ (ranging from seven years to ≥15 years) preclude precise estimates of time spent in activity for particular years. Yet these are unnecessary in a broad retrospective study of this nature, given that sufficient information is obtained in order to rank participants according to their level of physical activity during the different age periods. Fourth, participants' estimates of physical activity may not include all domains of activity. No specific questions about occupational activities are included in the HLAQ, although jobs including manual labor could be included in the additional activities specified by each participant.

As noted earlier, the likelihood of volunteer bias in recruitment to this study must be considered in assessing the generalizability of these findings. We would expect that our results could be generalized to middle-to-upper class women who have been moderately active throughout their lives. Yet it is interesting to note that similar findings were also reported for a very different group of women: socioeconomically disadvantaged black and mixed race women from South Africa [23, 28]. In those studies, it appeared that youth and young adulthood were times when physical activity most affected bone; however, it was largely occupational and transport activities (as opposed to leisure activities) that accounted for the effect [23, 28].

In summary, our results suggest that moderate physical activity during the teen years may confer long-term benefits for bone in postmenopausal women. Our data provide further evidence that the foundation of postmenopausal bone health is established many decades prior to radiologic evidence of low bone mass.

3.5 References

1. Lorrain J, Paiement G, Chevrier N, Lalumiere G, Laflamme GH, Caron P, Fillion A. Population demographics and socioeconomic impact of osteoporotic fractures in Canada. *Menopause* 2003; 10: 228-34.

2. Keen RW. Burden of osteoporosis and fractures. *Curr Osteoporos Rep* 2003; 1: 66-70.

3. Fink HA, Ensrud KE, Nelson DB, Kerani RP, Schreiner PJ, Zhao Y, Cummings SR, Nevitt MC. Disability after clinical fracture in postmenopausal women with low bone density: the fracture intervention trial (FIT). *Osteoporos Int* 2003; 14: 69-76.

4. Bonjour J, Theintz G, Buchs B, Slosman D, Rizzoli R. Critical years and stages of puberty for spinal and femoral bone mass accumulation during adolescence. *J Clin Endocrinol Metab* 1991; 73: 555-63.

5. Bailey DA, McKay HA, Mirwald RL, Crocker PR, Faulkner RA. A six-year longitudinal study of the relationship of physical activity to bone mineral accrual in growing children: the University of Saskatchewan bone mineral accrual study. *J Bone Miner Res* 1999; 14: 1672-9.

6. Hernandez CJ, Beaupre GS, Carter DR. A theoretical analysis of the relative influences of peak BMD, age-related bone loss and menopause on the development of osteoporosis. *Osteoporos Int* 2003; 14: 843-7.

7. Giguere Y, Rousseau F. The genetics of osteoporosis: complexities and difficulties. *Clin Genet* 2000; 57: 161-9.

8. Rizzoli R, Bonjour JP, Ferrari SL. Osteoporosis, genetics and hormones. *J Mol Endocrinol* 2001; 26: 79-94.

9. Welten DC, Kemper HC, Post GB, van Mechelen W, Twisk J, Lips P, Teule GJ. Weight-bearing activity during youth is a more important factor for peak bone mass than calcium intake. *J Bone Miner Res* 1994; 9: 1089-96.

10. MacKelvie KJ, Khan KM, Petit MA, Janssen PA, McKay HA. A school-based exercise intervention elicits substantial bone health benefits: a 2-year randomized controlled trial in girls. *Pediatrics* 2003; 112: e447-52.

11. Snow-Harter C, Bouxsein ML, Lewis BT, Carter DR, Marcus R. Effects of resistance and endurance exercise on bone mineral status of young women: a randomized exercise intervention trial. *J Bone Miner Res* 1992; 7: 761-9.

12. Kontulainen SA, Kannus PA, Pasanen ME, Sievanen HT, Heinonen AO, Oja P, Vuori I. Does previous participation in high-impact training result in residual bone gain in growing girls? One year follow-up of a 9-month jumping intervention. *Int J Sports Med* 2002; 23: 575-81.

13. Ward KA, Roberts SA, Adams JE, Mughal MZ. Bone geometry and density in the skeleton of pre-pubertal gymnasts and school children. *Bone* 2005; 36: 1012-8.

14. Vicente-Rodriguez G, Dorado C, Perez-Gomez J, Gonzalez-Henriquez JJ, Calbet JA. Enhanced bone mass and physical fitness in young female handball players. *Bone* 2004; 35: 1208-15.

15. Haapasalo H, Kannus P, Sievanen H, Pasanen M, Uusi-Rasi K, Heinonen A, Oja P, Vuori I. Effect of long-term unilateral activity on bone mineral density of female junior tennis players. *J Bone Miner Res* 1998; 13: 310-9.

16. Fehling PC, Alekel L, Clasey J, Rector A, Stillman RJ. A comparison of bone mineral densities among female athletes in impact loading and active loading sports. *Bone* 1995; 17: 205-10.

17. Heinonen A, Oja P, Kannus P, Sievanen H, Haapasalo H, Manttari A, Vuori I. Bone mineral density in female athletes representing sports with different loading characteristics of the skeleton. *Bone* 1995; 17: 197-203.

18. Alfredson H, Nordstrom P, Lorentzon R. Bone mass in female volleyball players: a comparison of total and regional bone mass in female volleyball players and nonactive females. *Calcif Tissue Int* 1997; 60: 338-42.

19. Slemenda CW, Johnston CC. High intensity activities in young women: site specific bone mass effects among female figure skaters. *Bone Miner* 1993; 20: 125-32.

20. Etherington J, Harris PA, Nandra D, Hart DJ, Wolman RL, Doyle DV, Spector TD. The effect of weight-bearing exercise on bone mineral density: a study of female ex-elite athletes and the general population. *J Bone Miner Res* 1996; 11: 1333-8.

21. Khan KM, Bennell KL, Hopper JL, Flicker L, Nowson CA, Sherwin AJ, Crichton KJ, Harcourt PR, Wark JD. Self-reported ballet classes undertaken at age 10-12 years and hip bone mineral density in later life. *Osteoporos Int* 1998; 8: 165-73.

22. Duppe H, Gardsell P, Johnell O, Ornstein E. Bone mineral density in female junior, senior and former football players. *Osteoporos Int* 1996; 6: 437-41.

23. Micklesfield L, Rosenberg L, Cooper D, Hoffman M, Kalla A, Stander I, Lambert E. Bone mineral density and lifetime physical activity in South African women. *Calcif Tissue Int* 2003; 73: 463-9.

24. Damilakis J, Perisinakis K, Kontakis G, Vagios E, Gourtsoyiannis N. Effect of lifetime occupational physical activity on indices of bone mineral status in healthy postmenopausal women. *Calcif Tissue Int* 1999; 64: 112-6.

25. Kriska AM, Sandler RB, Cauley JA, LaPorte RE, Hom DL, Pambianco G. The assessment of historical physical activity and its relation to adult bone parameters. *Am J Epidemiol* 1988; 127: 1053-63.

26. Greendale GA, Barrett-Connor E, Edelstein S, Ingles S, Haile R. Lifetime leisure exercise and osteoporosis. The Rancho Bernardo study. *Am J Epidemiol* 1995; 141: 951-9.

27. Brahm H, Mallmin H, Michaelsson K, Strom H, Ljunghall S. Relationships between bone mass measurements and lifetime physical activity in a Swedish population. *Calcif Tissue Int* 1998; 62: 400-12.

28. Kolbe-Alexander TL, Charlton KE, Lambert EV. Lifetime physical activity and determinants of estimated bone mineral density using calcaneal ultrasound in older South African adults. *J Nutr Health Aging* 2004; 8: 521-30.

29. Rideout CA, Linden W, Barr SI. High cognitive dietary restraint is associated with increased cortisol excretion in postmenopausal women. *J Gerontol A Biol Sci Med Sci* 2006; 61A: 628-33.

30. Kriska AM. Historical leisure activity questionnaire. A collection of physical activity questionnaires for health-related research. *Med Sci Sports Exerc* 1997; 29(6) Supplement: 43-5.

31. Kriska AM, Knowler WC, LaPorte RE, Drash AL, Wing RR, Blair SN, Bennett PH, Kuller LH. Development of questionnaire to examine relationship of physical activity and diabetes in Pima Indians. *Diabetes Care* 1990; 13: 401-11.

32. Winters-Hart CS, Brach JS, Storti KL, Trauth JM, Kriska AM. Validity of a questionnaire to assess historical physical activity in older women. *Med Sci Sports Exerc* 2004; 36: 2082-7.

33. Falkner KL, Trevisan M, McCann SE. Reliability of recall of physical activity in the distant past. *Am J Epidemiol* 1999; 150: 195-205.

34. Ryan PJ, Evans P, Blake GM, Fogeman I. The effect of vertebral collapse on spinal bone mineral density measurements in osteoporosis. *Bone Miner* 1992; 18: 267-72.

35. Barden HS, Markwardt P, Payne R, Hawkins B, Frank M, Faulkner KG. Automated assessment of exclusion criteria for DXA lumbar spine scans. *J Clin Densitom* 2003; 6: 401-10.

36. World Health Organization. *Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. WHO Technical Report Series 843*. Geneva: WHO, 1994.

37. Siris ES, Miller PD, Barrett-Connor E, Faulkner KG, Wehren LE, Abbott TA, Berger ML, Santora AC, Sherwood LM. Identification and fracture outcomes of undiagnosed low bone mineral density in postmenopausal women: results from the National Osteoporosis Risk Assessment. *JAMA* 2001; 286: 2815-22.

38. Marshall D, Johnell O, Wedel H. Meta-analysis of how well measures of bone mineral density predict occurrence of osteoporotic fractures. *BMJ* 1996; 312: 1254-9.

39. Cummings SR, Black DM, Nevitt MC, Browner W, Cauley J, Ensrud K, Genant HK, Palermo L, Scott J, Vogt TM. Bone density at various sites for prediction of hip fractures. *Lancet* 1993; 341: 72-5.

40. Evenson KR, Wilcox S, Pettinger M, Brunner R, King AC, McTiernan A. Vigorous leisure activity through women's adult life: the Women's Health Initiative observational cohort study. *Am J Epidemiol* 2002; 156: 945-53.

41. Statistics Canada. *Canadian community health survey 2.1 results: leisure-time physical activity*. 2005; Retrieved November 22, 2005 from http://www.statcan.ca/english/freepub/82-221-XIE/2005001/nonmed/behaviours3.htm.

42. Ganguli M, Lytle ME, Reynolds MD, Dodge HH. Random versus volunteer selection for a community-based study. *J Gerontol A Biol Sci Med Sci* 1998; 53: M39-46.

43. Vaz de Almeida MD, Graca P, Afonso C, D'Amicis A, Lappalainen R, Damkjaer S. Physical activity levels and body weight in a nationally representative sample in the European Union. *Public Health Nutr* 1999; 2: 105-13.

44. McPhillips JB, Pellettera KM, Barrett-Connor E, Wingard DL, Criqui MH. Exercise patterns in a population of older adults. *Am J Prev Med* 1989; 5: 65-72.

45. Cauley JA, LaPorte RE, Sandler RB, Schramm MM, Kriska AM. Comparison of methods to measure physical activity in postmenopausal women. *Am J Clin Nutr* 1987; 45: 14-22.

46. Uusi-Rasi K, Nygard CH, Oja P, Pasanen M, Sievanen H, Vuori I. Walking at work and bone mineral density of premenopausal women. *Osteoporos Int* 1994; 4: 336-40.

47. Feskanich D, Willett W, Colditz G. Walking and leisure-time activity and risk of hip fracture in postmenopausal women. *JAMA* 2002; 288: 2300-6.

CHAPTER 4

DIETARY RESTRAINT VERSUS DIETING IN POSTMENOPAUSAL WOMEN

A version of this chapter will be submitted for publication:
Rideout CA, Barr SI. Dietary restraint and dieting in postmenopausal women: differences in eating cognitions, psychosocial variables, and food choice motives.

4.1 Introduction

Overweight and obesity are increasingly common [1, 2] and associated with decreased health-related quality of life [3]. Many women struggle to control their weight, and report dieting in an effort to lose weight [4]. In Western cultures, the desire to be thinner is common at all ages, even among normal-weight girls and women [5-7]. Given the widespread nature of dieting among women of all body weights, it is essential that we better understand its correlates and consequences. However, the measurement of dieting and our understanding of its role in health are both surprisingly unclear. Although the concept of dietary restraint was introduced as a way to operationalize dieting [8, 9], it has been suggested that dietary restraint and dieting are not strictly analogous [10], and debate regarding the extent to which dietary restraint accurately measures dieting behaviour continues to grow [11].

A portion of this controversy can be attributed to the fact that there is a lack of consensus with respect to what is meant by the term 'dieting.' Although dieting typically refers to intentional energy restriction aimed at weight loss or maintenance [12], it may now also be used to describe healthy changes in eating patterns [13]. Furthermore, dieting may be interpreted differently depending on education, socio-economic status, and other characteristics [14]. Proponents of restraint theory assert that dieting is characterized by the chronic effort to restrict dietary intake and is accompanied by bouts of disinhibition (i.e., overeating after loss of control over dietary restraint) [15]. Yet whether this is characteristic of all self-identified dieters is uncertain. In addition, it must be acknowledged that while researchers commonly use the term 'dieting' to refer to all active weight loss efforts, many women who engage in such efforts shun the term and may not self-identify as dieters (although their behaviours and intentions may be consistent with the generally-accepted definition of dieting).

A further challenge results from the inconsistent use of three scales which purport to measure dietary restraint and dieting: the Restraint Scale (RS) [16], the cognitive restraint scale of the Three-Factor Eating Questionnaire (TFEQ-R) [8], and the Dutch Eating Behaviour Questionnaire restrained eating scale (DEBQ-R) [17]. The RS differs from the other two in that it aims to assess the pattern some restraint theorists consider characteristic of dieting (efforts to control eating and loss of that control) [18]. Yet it has been criticized because its scores are confounded by weight fluctuation and disinhibition [19]. The TFEQ-R and DEBQ-R, on the other hand, were designed to be unidimensional measures of dietary restraint, and may identify so-called successful dieters to a greater extent than does the RS [15, 20].

The primary aim of this study was to compare and contrast restrained eating and dieting (defined as a self-reported current weight loss effort) in postmenopausal women. To this end, we compared two levels of dietary restraint (high/low by median split of scores on the TFEQ-R) and two levels of current dieting status (yes/no). Specifically, we aimed to determine if there are differences in body mass index (BMI), dietary attitudes, psychosocial characteristics, motives for food choice, and other lifestyle variables in postmenopausal women who are i) restrained eaters versus unrestrained eaters, and ii) dieters versus non-dieters, and whether interactions of dietary restraint and dieting could be detected. An additional objective was to characterize this sample of generally healthy community-dwelling postmenopausal women with respect to dietary restraint and dieting, given that the majority of research on dietary restraint has been conducted in young women [21], and few data for postmenopausal women exist [22, 23].

4.2 Methods

We conducted a cross-sectional survey of postmenopausal women volunteers from June 2003 to February 2004. Participants were recruited through newspaper advertisements, posters, and flyers (**Appendix 4**) to complete a questionnaire about dietary attitudes and body image. Potential participants contacted us by telephone to request a questionnaire package; when a request was received, we mailed potential participants a questionnaire (**Appendix 6**) with a letter

(Appendix 5) which provided more information about the study. One reminder letter was sent to those who did not respond to the initial questionnaire by either returning a completed questionnaire or declining further involvement in the study **(Appendix 20)**. At that time, we advised participants that a second questionnaire could be mailed to them, if required. Participants were not paid for their involvement in the study but were advised that they may be eligible to participate in a future study of nutrition and bone health. Also, participants could indicate if they wished to be included in an incentive draw for one of three prizes (gift certificates or cash prizes values at $100, $200, and $300; **Appendix 7**).

The study protocol was reviewed and approved by the Clinical Research Ethics Board at the University of British Columbia **(Appendix 2)**, and all participants consented to participate **(Appendix 5)**.

4.2.1 Participants

Postmenopausal women (≥1 year since the last menstrual cycle) 45–75 years of age with sufficient literacy in English to complete the survey instrument were eligible to participate in this study. Provided these criteria were met, no participant was excluded. We received 1237 requests for questionnaire and a total of 1078 completed questionnaires (response rate = 87.1%). Of 1078 completed questionnaires, seven were excluded because respondents were either older than 75 years of age (n = 2) or could not classified as postmenopausal (n = 5). Thus, the final sample size was 1071 women.

4.2.2 Questionnaire

The questionnaire contained several previously validated psychometric scales to measure aspects of self-reported eating behaviours, motives for food choice, and psychosocial variables that could affect dietary attitudes **(Appendix 6)**. We also assessed dieting status, current body size, weekly exercise, and other lifestyle and demographic characteristics. The questionnaire was pre-tested for clarity by 33 postmenopausal women and took approximately 30 minutes to complete.

To control for possible order effects, six versions of the questionnaire were created to present scales in counterbalanced order across participants (**Appendix 21**). These were distributed in sequence as requests for questionnaires were received. All items were identical in each version of the questionnaire (only the order of presentation of scales varied).

4.2.2.1 Self-reported eating behaviours

Stunkard and Messick's Three-Factor Eating Questionnaire (TFEQ) [8] was used to measure three aspects of self-reported eating behaviour: i) *cognitive dietary restraint* (perceived dietary restriction aimed at achieving or maintaining a particular body weight), ii) *disinhibition* (the tendency to lose control over eating in response to external or internal cues), and iii) *hunger* (the subjective feeling of hunger). This 51-item instrument is comprised of 36 true/false questions and 15 items scored on a 4-point Likert-type scale. The cognitive restraint scale (TFEQ –R) is a widely used measure of dietary restraint, and has advantages over the RS [16] because its assessment of dietary restraint is not confounded by weight fluctuation or disinhibited eating [19]. As has been done previously [24], we changed the wording of the first TFEQ true/false item, which is part of the disinhibition subscale, by replacing the reference to "sizzling steak" with reference to a favourite food in order to make the item suitable for vegetarians. All other TFEQ items were reproduced and scored as suggested [8].

4.2.2.2 Sociocultural attitudes towards appearance

We used the Sociocultural Attitudes towards Appearance Questionnaire (SATAQ) [25] to measure participants' *awareness* of sociocultural attitudes towards appearance (specifically, the value placed on a thin body) and their *internalization* of those attitudes. Higher internalization scores reflect the belief that one must personally meet societal expectations for appearance in order to be happy or successful. The internal reliability of both awareness and internalization subscales is good (with Cronbach's alpha values of 0.71 and 0.88, respectively) [25]. We omitted three items from the internalization scale (items #3, #13, and #14) because they may not be relevant for postmenopausal women (e.g., "Music videos that show thin women make me wish that I were thin"), and re-worded item #6 from the awareness subscale in the positive tone to improve clarity. Thus, there were six awareness subscale items (scores could range from 6 to 36, with higher scores reflecting greater awareness of societal value for thinness) and five internalization subscale items (scores could range from 5 to 30, with higher scores reflecting greater internalization of these attitudes). The elimination of these items did not substantially affect the internal reliability of the scales: the Cronbach's alpha for the awareness scale as completed by our participants was 0.70 and for the internalization scale it was 0.76.

4.2.2.3 Social physique anxiety

The 12-item Social Physique Anxiety Scale (SPAS) was used to measure the extent to which an individual experiences anxiety when she believes others may observe or evaluate her physique [26]. In the college-aged sample used to develop the scale, it was shown to have high internal consistency (Cronbach's alpha = 0.90), strong test-retest reliability ($r = 0.82$ after eight weeks), and to be related to the experience of anxiety during the actual evaluation of one's physique [26]. In postmenopausal women, test-retest reliability was 0.94 after one week [27]. As has been done in previous studies [27, 28], we reworded item #2 in the positive tone to increase clarity. Scores for social physique anxiety can range from 12 to 60; higher scores reflect a greater degree of social physique anxiety.

4.2.2.4 Self-esteem

Self-esteem was measured with Rosenberg's Self-esteem Scale [29]. This 10-item scale is a widely used measure of global self-esteem and one's feelings of personal value. When the scale was first introduced, it was shown to have high internal consistency (Cronbach's alpha = 0.93) in a sample of more than 5000 adolescents [29]. More recently, a Cronbach's alpha of 0.84 and test-retest reliability of 0.80 were reported in a study of 202 adults [30]. Scores can range from 0 to 10. Lower scores reflect *higher* self-esteem and a greater sense of personal value and higher scores reflect *lower* self-esteem and greater dissatisfaction with self.

4.2.2.5 Weight locus of control

The 4-item weight locus of control (WLOC) scale was used to measure individual's locus of control with respect to their personal body weight [31]. Scores on the WLOC scale can range from 4 to 24, with lower scores indicating a more internal orientation (i.e., the belief that one's weight is under one's personal control) and higher scores indicating a more external orientation (i.e., the belief that external factors influence one's body weight). Scores for internal consistency are quite low (Cronbach's alpha = 0.56–0.58) [31]. Given that internal reliability increases as the number of items in a scale increases, it has been suggested that effects reported in association with the WLOC are likely more conservative than those that would be obtained if the scale had more items [32].

4.2.2.6 Motives for food choice

We used the 36-item Food Choice Questionnaire [33] to assess the importance assigned to nine possible motives for food choice: health, convenience, price, sensory appeal, natural content, mood, familiarity, ethical concern, and weight control [33]. Between three and six questions assess the importance attributed to each motive; responses are scored on a scale from one to four, and the total score for each motive is calculated as the mean of scores on relevant items. Food choice motives assessed with this scale have been correlated with actual dietary intake. For example, individuals who indicated that natural content, ethics, weight control, and health were important in their food choices tended to eat more foods that would be considered healthy [34]. Test-retest reliability after two to three weeks was 0.71 for familiarity, 0.73 for sensory appeal, and between 0.77 and 0.83 for the remaining factors [33]. Internal consistency was also good, with Cronbach's alpha scores ranging from 0.72 (for sensory appeal and familiarity) to 0.86 (for natural content) [33].

4.2.2.7 Dieting status

Participants' dieting status was determined with a single item: "Are you trying to lose weight at the present time?" A single unambiguous item like this has been shown to be a robust measure of dieting status [14, 35] and has also shown associations with reduced energy intake [14].

4.2.2.8 Perceptions of current weight

Participants were asked to indicate how they felt about their weight right now, and could select from very underweight, slightly underweight, about right, slightly overweight, or very overweight. We scored this as a continuous variable, with values from 1 (very underweight) to 5 (very overweight).

4.2.2.9 Current body size

We asked participants to estimate their current height and weight (using their preference of imperial or metric units). Self-reported measurements were used to calculate current BMI (kg/m^2). The accuracy of self-reported measurements was examined in a subsample of 78 participants who enrolled in a subsequent study approximately four months after completing this questionnaire [36]. In those participants, height was measured to the nearest 0.1 cm using a stadiometer (Seca model 214, Hamburg, Germany) without shoes at full inspiration, and weight was measured in light indoor clothing without shoes to the nearest 0.5 kg using an electronic scale (Sunbeam Inc., Boca Raton, Florida).

4.2.2.10 Lifestyle and demographic characteristics

Participants reported the average number of hours each week in which they engaged in physical activity sufficient to raise their heart rate. This provided an estimate of habitual weekly exercise. Additional questions inquired about current use of hormone replacement therapy, dietary pattern (mixed, vegetarian or vegan), smoking history (current, former, never), ethnicity (11 categories used in the most recent census [37] collapsed into White, Chinese, and Other), highest level of education completed (≤ secondary school, university/college, postgraduate studies), and annual income (< \$35,000, \$35,000–\$50,000, > \$50,000).

4.2.3 Missing values

For most variables, complete data sets were available. However, although the majority of respondents (n = 848; 79%) completed the entire TFEQ, 173 (16%) omitted ≥ 1 response on the dietary restraint subscale, 100 (9%) omitted ≥ 1 response on the disinhibition subscale, and 77 (7%) omitted ≥ 1 response on the hunger subscale. We compared participants who completed the entire TFEQ with those who did not using two-sided independent samples *t* tests, and noted some significant differences. For example, participants with incomplete dietary restraint scales had higher mean BMI (24.9 versus 24.1, $P = 0.045$) and age (61.3 years versus 59.6 years, $P = 0.003$) than those with complete dietary restraint scores. Therefore, to avoid bias (which could occur if we used only data from respondents who completed each question of the TFEQ) and to retain data from scales which had been meaningfully completed, we included TFEQ data as long as: (i) ≤ 2 responses were missing from the particular subscale, and (ii) ≤ 5 responses were missing from the entire TFEQ (10% of all items). For respondents meeting these criteria, missing TFEQ values were replaced with the median response for that item, and then scores were calculated. This enabled us to calculate a dietary restraint score for 1044 (97%) participants, a disinhibition score for 1046 (97%), and a hunger score for 1049 (97%). Few data were missing for other variables and those that were appeared to be random. Thus, we excluded other missing values on a pairwise basis.

4.2.4 Statistical analysis

Possible order effects were examined by classifying respondents according to the version of questionnaire they completed and then examining group differences on key variables using one-way analysis of variance (ANOVA). We used a Bonferroni correction for multiple comparisons to set the *P*-value for these comparisons at $P < 0.002$. No order effects were detected, thus all analyses were conducted without regard to questionnaire version.

Respondents were classified on the basis of dietary restraint level (high/low by median split) and current dieting status (yes/no) as restrained dieters (n = 342), unrestrained dieters (n = 206), restrained non-dieters (n = 174), and unrestrained non-dieters (n = 298). Median split was used to categorize dietary restraint, as has been done in many previous studies [e.g., 38]. Although this imposes a somewhat artificial boundary (it may not be fully appropriate to classify those in the middle range as having high or low dietary restraint, since there may be some crossover in categories in that range), it enabled us to use the entire data set in our primary analyses. However, we also conducted our analyses in a subset of the sample (n = 562) which included participants who differed to a greater extent in their dietary restraint score. In those analyses, we compared respondents scoring in the lowest quartile (TFEQ-R ≤ 6) and the highest quartile (TFEQ-R score ≥ 13) for dietary restraint.

Descriptive statistics were calculated and are presented as mean ± SD for normally distributed variables, as median (interquartile range) for variables which deviated notably from normality, and as n (%) for categorical variables. Differences in categorical variables between dieters and non-dieters and restrained and unrestrained eaters were examined using chi square. We examined differences in continuous variables between dieters and non-dieters and restrained and unrestrained eaters, as well as the interaction of dieting status and dietary restraint, using contrast codes in multiple regression analyses [39]. This analysis was similar in some respects to a two-way ANOVA, however, ANOVA would not have been appropriate here because, unlike regression, it relies on the assumption of equal group size, and that assumption was not fulfilled. Regression has the additional advantage of controlling for the effect of one variable (e.g., dieting status) when examining group differences associated with the other (e.g., dietary restraint). Because our data did not fulfil the assumption of homoscedasticity (uniformity of variance), we calculated 95% CI using the bias corrected and accelerated bootstrap method [40, 41] using case resampling (with replacement) in 999 random bootstrap samples. In order to examine the effects of dieting status and dietary restraint independent of the possible confounding effects of BMI, we included BMI as a covariate in all regression analyses with the exception of age, menopausal age, height, weight, and BMI.

We also examined the relative importance of variables in predicting either dieting status or dietary restraint score by conducting four additional regression analyses. Two logistic regressions were performed with dieting status (yes/no) as the outcome variable. In the first, predictors included BMI and the eight eating attitude and psychosocial variables under consideration (dietary restraint, disinhibition, hunger, awareness and internalization of sociocultural attitudes towards appearance, social physique anxiety, self-esteem, and weight locus of control). In the second, scores for the nine food choice motives were entered as predictor variables, as well as BMI. For each logistic regression, the Hosmer-Lemeshow goodness-of-fit statistic was used to evaluate how well the model fit the data, and an approximation of R^2 was determined by calculating eta squared using ANOVA (with the outcome predicted by the model as the dependent variable, and the actual outcome as the grouping variable) [42]. In addition, two multiple regression analyses were conducted using dietary restraint score as a continuous outcome variable. In the first, BMI, dieting status, eating attitudes (disinhibition and hunger), and psychosocial characteristics were entered as predictor variables; in the second, predictors were BMI and the nine food choice motives.

Data analyses were conducted using SPSS for Windows (version 11.5, Chicago: SPSS Inc.) and *Arc* statistical software (version 1.06, St. Paul: University of Minnesota) with the bootstrapping add-on [43, 44]. Unless otherwise noted, results were considered statistically significant at $P < 0.05$.

4.3. Results

4.3.1 Descriptive characteristics

Descriptive characteristics of the sample are presented in **Table 4.1**. The majority (87%) was White and had completed postsecondary school or more education (68%). Many (44%) had an annual income >$50 000, and most (62%) had never smoked. Only 7% indicated they were vegetarian and 16% were currently using hormone replacement therapy. Dieters did not differ from non-dieters in any of these respects (data not shown in chapter; refer to **Appendix 22**). The only characteristic to differ significantly between restrained and unrestrained eaters was annual income: a greater proportion of restrained than unrestrained eaters reported higher annual income ($X^2 = 6.6$, $P = 0.04$; **Appendix 22**).

Table 4.1: Descriptive characteristics of 1071 postmenopausal women survey respondents

	n	%
Ethnicity		
White	936	87
Chinese	63	6
Other	67	6
Education		
≤ Secondary school	331	31
University/college	550	51
Postgraduate	186	17
Annual income		
≤ $35,000	309	29
$35,001–50,000	243	23
> $50,000	467	44
Smoking Status		
Current	64	6
Former	339	32
Never	663	62
Vegetarian	76	7
Using hormone replacement therapy	175	16

Note: Ethnicity was measured using 11 categories from the most recent census [37], collapsed into three categories for analysis.

Table 4.2 provides descriptive statistics for variables related to age, weight, and various lifestyle characteristics according to dieting status and level of dietary restraint. For each variable, it also shows the difference between dieters and non-dieters (when controlling for dietary restraint), and between restrained and unrestrained eaters (when controlling for dieting status). Dieters were slightly younger than non-dieters, but menopausal age and height did not differ significantly with dieting or dietary restraint. Dieters weighed *more* than non-dieters and restrained eaters weighed *less* than unrestrained eaters. Similarly, dieters' BMI was *higher* than non-dieters and restrained eaters' BMI was *less* than unrestrained eaters. Remaining regression analyses included BMI as a covariate predictor variable. There were no group differences in weekly exercise or daily caffeine consumption. Restrained eaters consumed slightly fewer alcoholic beverages per week than unrestrained eaters, but dieters and non-dieters did not differ in that regard. Dieters reported feeling more overweight than non-dieters, but restrained eaters did not feel more overweight than unrestrained eaters.

When these differences were examined in the subset of data including only highly restrained (upper quartile TFEQ-R score) and highly unrestrained (lower quartile TFEQ-R score) participants, the difference in BMI associated with dietary restraint was even greater: highly restrained eaters had a BMI which was 1.6 kg/m^2 less than highly unrestrained eaters (95% CI: -2.4, -1.0; $P < 0.0001$). However, the difference in alcohol intake did not persist (B = -0.5, 95% CI: -1.3, 0.2; $P = 0.20$), nor did the difference in age between dieters and non-dieters (B = -1.1, 95% CI: -2.3, 0.0; $P = 0.06$). **Appendix 23** contains a summary of these additional analyses.

Table 4.2: Differences in demographic, lifestyle, and body weight variables in dieters and non-dieters with high or low levels of dietary restraint

	Total sample	Dieting		Not dieting		Dieting difference[a]	Restraint difference[b]
		Restrained	Unrestrained	Restrained	Unrestrained		
n	1071	342	206	174	298		
Age (years)	59.8 ± 6.8	59.4 ± 6.8	58.9 ± 7.1	60.5 ± 6.6	60.3 ± 6.8	-1.2 (-2.1, -0.3)**	0.3 (-0.5, 1.2)
Menopausal age (years)	11.3 ± 8.6	11.0 ± 8.8	11.0 ± 9.2	12.1 ± 8.8	11.3 ± 8.8	-0.7 (-1.8, 0.4)	0.3 (-0.8, 1.5)
Height (cm)	163.4 ± 6.7	163.1 ± 6.4	164.1± 6.9	163.6 ± 6.9	163.6 ± 6.9	0.2 (-1.0, 2.6)	-0.5 (-1.4, 0.4)
Weight (kg)	66.2 ± 12.9	69.8 ± 12.1	72.8 ± 14.2	58.7 ± 7.8	62.2 ± 11.9	10.9 (9.5, 12.4)***	-3.2 (-4.6, -1.5)***
BMI (kg/m^2)	24.8 ± 4.5	26.3 ± 4.1	27.0 ± 4.9	21.9 ± 2.8	23.2 ± 4.0	4.1 (3.6, 4.6)***	-1.0 (-1.6, -0.5)***
Exercise (hr/wk)	4 (2 – 6)	4 (2 – 5.5)	3 (2 – 5)	4 (2.5 – 6)	4 (2 – 6)	-0.1 (-0.6, 0.4)	0.1 (-0.4, 0.5)
Caffeine (cups/day)	2 (1 – 3.5)	2 (1 – 3.5)	2 (1.5 – 3)	2 (1 – 3.5)	2 (1.5 – 3.5)	-0.3 (-0.5, 0.0)	-0.1 (-0.3, 0.2)
Alcoholic beverages (/wk)	1.5 (0 – 5)	1 (0 – 5)	1 (0 – 4)	1.3 (0 – 6)	2 (0 – 7)	-0.4 (-1.1, 0.4)	-0.8 (-1.4, -0.2)*
Feelings about weight [c]	3.8 ± 0.8	4.1 ± 0.5	4.3 ± 0.5	3.2 ± 0.6	3.3 ± 0.8	0.5 (0.4, 0.6)***	-0.002 (-0.06, 0.06)

Notes: Data are presented as mean ± SD or median (interquartile range). Dietary restraint status was determined based on median split. Menopausal age refers to the number of years passed since the last menstrual cycle. Analyses of exercise, caffeine, alcohol, and feelings about weight included BMI as an additional covariate predictor variable. Missing values were excluded on a pairwise basis, so the exact n for each comparison varied. Participants with incomplete TFEQ-R scales or who did not indicate current dieting status could not be classified according to restraint and dieting status; thus, the n's for those groups do not total 1071. No interaction effects (i.e., a joint effect of dietary restraint and dieting) were detected.

[a] Difference (95% CI) between dieters and non-dieters (controlling for dietary restraint status).

[b] Difference (95% CI) between restrained eaters and unrestrained eaters (controlling for dieting status).

[c] Responses fell on a 5-point scale (1=very underweight, 2=underweight, 3=about right, 4=overweight, 5=very overweight)

* $P < 0.05$ ** $P < 0.01$ *** $P < 0.001$

4.3.2 Accuracy of self-reported height and weight

Reported height and weight was verified by direct measurement 4.1 ± 1.9 months after returning the questionnaire in 41 restrained and 37 unrestrained eaters who went on to complete another study [36]. Self-reported and measured height and weight were highly correlated (r = 0.96 for height, r = 0.95 for weight, both $P < 0.0001$). The correlation between self-reported and measured BMI was somewhat lower (r = 0.89, $P < 0.0001$), but still strong. There were no significant differences between restrained and unrestrained eaters regarding the accuracy of self-reported measurements (data not shown in chapter, refer to **Appendix 24**).

4.3.3 Dietary attitudes and psychosocial characteristics

The internal consistency (Cronbach's alpha) for TFEQ subscales and each of the other psychosocial characteristics measured in this sample is reported in **Appendix 25**. Descriptive statistics for dietary attitudes and psychosocial characteristics, as well as the difference in each variable between dieters and non-dieters, and restrained and unrestrained eaters, are provided in **Table 4.3**. Dietary restraint was significantly higher among restrained eaters than unrestrained eaters (by definition). The difference in dietary restraint score between dieters and non-dieters was smaller, but also significant. There was a small interaction of dietary restraint and dieting status on level of dietary restraint, illustrated in **Figure 4.1**, such that the difference in dietary restraint scores between dieters and non-dieters was slightly greater at low levels of dietary restraint than it was at high levels of dietary restraint. Dieters had higher scores for disinhibition, hunger, awareness of sociocultural attitudes towards appearance, and social physique anxiety than non-dieters, but restrained eaters did not differ from unrestrained eaters in those respects. Both dieters and restrained eaters internalized sociocultural attitudes towards appearance more than their non-dieting or unrestrained counterparts. Dieters had lower self-esteem than non-

Table 4.3: Self-reported dietary attitudes and psychosocial characteristics in dieters and non-dieters with high or low levels of dietary restraint

	Total sample	Dieting		Not dieting		Dieting difference[a]	Restraint difference[b]
		Restrained	Unrestrained	Restrained	Unrestrained		
n	1071	342	206	174	298		
Dietary restraint[c]	9.8 ± 4.4	13.6 ± 2.7	6.7 ± 1.9	13.1 ± 2.5	5.6 ± 2.3	1.0 (0.6, 1.3)***	7.2 (6.9, 7.5)***
Disinhibition	5.5 ± 4.1	7.0 ± 4.0	7.6 ± 4.4	3.4 ± 2.8	3.6 ± 3.2	2.4 (1.9, 3.0)***	-0.1 (-0.5, 0.4)
Hunger	4.1 ± 3.3	4.7 ± 3.5	5.5 ± 3.7	3.0 ± 2.5	3.2 ± 2.6	1.4 (1.0, 1.9)***	-0.3 (-0.7, 0.1)
SATAQ – Awareness	21.9 ± 4.1	22.7 ± 3.9	22.4 ± 4.2	21.4 ± 4.2	21.0 ± 3.8	1.0 (0.4, 1.5)**	0.5 (-0.02, 1.0)
SATAQ – Internalization	12.7 ± 4.4	13.9 ± 4.4	13.1 ± 4.9	12.6 ± 4.2	11.3 ± 3.7	1.7 (1.1, 2.4)***	1.0 (0.4, 1.6)***
Social physique anxiety	32.8 ± 10.3	36.4 ± 10.0	37.0 ± 9.9	28.2 ± 8.2	28.5 ± 9.2	5.2 (4.1, 6.5)***	0.3 (-0.7, 1.4)
Self-esteem[c]	1 (0 – 2)	1 (0 – 2)	1 (0 – 3)	0 (0 – 1)	0 (0 – 1)	0.5 (0.2, 0.8)***	-0.2 (-0.5, 0.05)
Weight locus of control	8.4 ± 3.4	8.3 ± 3.4	9.0 ± 3.1	7.5 ± 2.3	8.6 ± 3.5	0.1 (-0.4, 0.5)	-0.7 (-1.1, -0.3)***

Notes: Data are presented as mean (standard deviation) or median (interquartile range). All analyses included BMI as an additional covariate predictor variable. Missing values were excluded on a pairwise basis, so the exact n for each comparison varied. Participants with incomplete TFEQ-R scales or who did not indicate current dieting status could not be classified according to restraint and dieting status; thus, the n's for those groups do not total 1071.

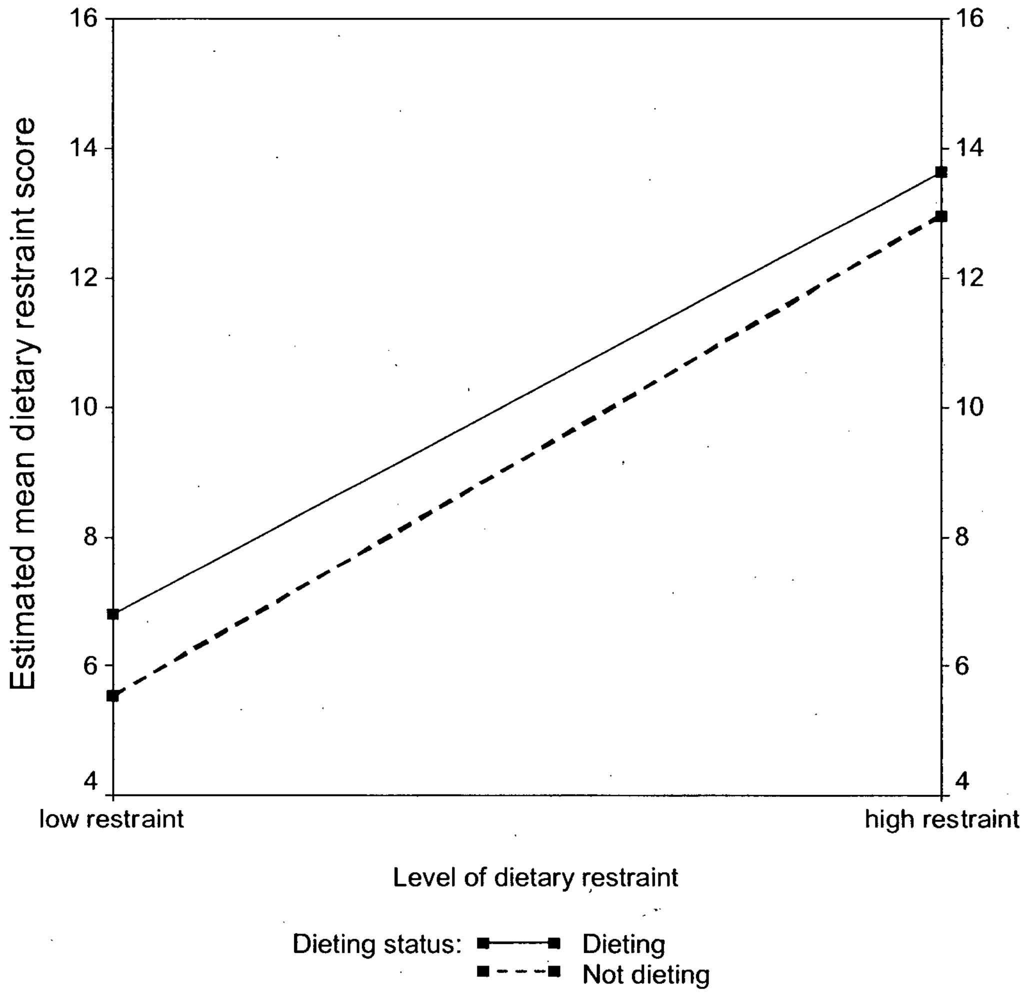
[a] Difference (95% CI) between dieters and non-dieters (controlling for dietary restraint status).

[b] Difference (95% CI) between restrained eaters and unrestrained eaters (controlling for dieting status).

[c] Interaction effect of dietary restraint and dieting status (see Figures 4.1 and 4.2).

** *P* <0.01 *** *P* <0.001

Figure 4.1: The interaction of dietary restraint and dieting status on score for dietary restraint



Notes: A statistical interaction between dietary restraint group (based on a median split of scores for dietary restraint) and dieting status was detected for dietary restraint score, controlling for effects of BMI (B = -0.7, 95% CI: -1.2, -0.1; $P = 0.03$). Scores for dietary restraint were measured with the TFEQ-R [8] (scores can range from 0 to 21, with higher scores indicating higher dietary restraint).

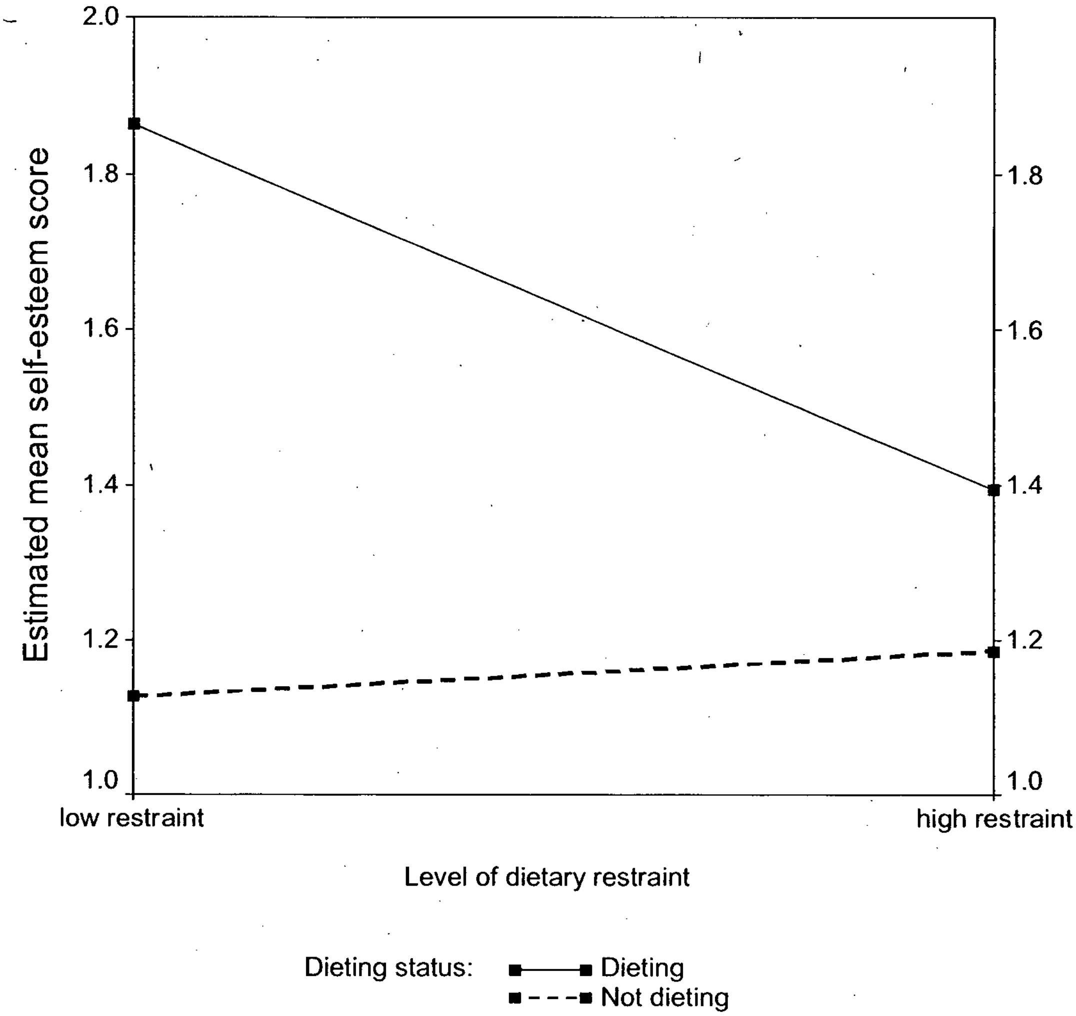
dieters (note: higher scores reflect *lower* self-esteem). Although there was no main effect of dietary restraint on self-esteem, there was an interaction between dietary restraint and dieting status such that dieters with low dietary restraint had lower self-esteem than dieters with high dietary restraint, as illustrated in **Figure 4.2**. Dietary restraint was associated with a difference in scores for weight locus of control (the high restraint group had a lower mean score, indicating a more internal weight locus of control), but dieters did not differ from non-dieters in this respect.

When these analyses were conducted with only those respondents classified as highly restrained and highly unrestrained eaters (i.e., those participants falling in the upper and lower quartiles of the distribution of scores for dietary restraint), the same differences were noted between dieters and non-dieters and restrained and unrestrained eaters. In addition, the difference in self-esteem between highly restrained and highly unrestrained eaters (such that highly restrained eaters had scores reflecting slightly higher self-esteem) bordered statistical significance ($P = 0.05$). However, the interactions of dieting status and dietary restraint did not persist for dietary restraint score (B = -0.2, 95% CI: -1.0, 0.4; $P = 0.56$) nor self-esteem (B = -0.4, 95% CI: -0.9, 0.2; $P = 0.28$). These additional analyses for highly restrained and highly unrestrained eaters are presented in **Appendix 26**.

4.3.4 Dietary and psychosocial characteristics as predictors of dieting and restraint

Results of the logistic regression conducted to examine the extent to which BMI and each of the dietary attitudes and psychosocial characteristics predicted dieting status are shown in **Table 4.4**. Four variables were significant independent positive predictors of dieting status: BMI, dietary restraint, disinhibition, and social physique anxiety. The full model including all nine predictors predicted 76.1% of all cases (73.0% of non-dieters and 78.7% of dieters), but was not significant according to the Hosmer-Lemeshow goodness-of-fit test ($X^2 = 12.3$, $P = 0.14$).

Figure 4.2: The interaction of dietary restraint and dieting status on score for self-esteem



Notes: A statistical interaction between dietary restraint group (based on a median split of scores for dietary restraint) and dieting status was detected for self-esteem score, controlling for effects of BMI (B = -0.5, 95% CI: -1.0, -0.02; $P = 0.04$). Scores for self-esteem were measured with the Rosenberg Self-Esteem Scale [29] (scores can range from 0 to 10, with higher scores indicating *lower* self-esteem).

Table 4.4: Logistic regression analysis of dieting status as a function of BMI, dietary attitudes, and psychosocial variables

Variable	B (SE)	Wald Test	*P*	Odds Ratio (95% CI)
BMI	0.199 (0.03)	53.1	0.000	1.2 (1.16, 1.29)
Dietary restraint	0.168 (0.02)	65.4	0.000	1.2 (1.14, 1.23)
Disinhibition	0.159 (0.03)	24.6	0.000	1.2 (1.10, 1.25)
Hunger	0.005 (0.03)	0.02	0.89	1.0 (0.94, 1.08)
SATAQ – Awareness	-0.001 (0.02)	0.004	0.95	1.0 (0.96, 1.07)
SATAQ – Internalization	0.027 (0.02)	1.4	0.24	1.0 (0.98, 1.07)
Social physique anxiety	0.028 (0.01)	5.5	0.02	1.0 (1.0, 1.1)
Self-esteem	-0.03 (0.05)	0.3	0.58	1.0 (0.88, 1.08)
Weight locus of control	0.004 (0.03)	0.02	0.90	1.0 (0.95, 1.06)
(Constant)	-8.358 (0.82)	104.5	0.000	–

Notes: The full model predicted 76.1% of all cases, but was not significant according to the Hosmer-Lemeshow goodness-of-fit test ($X^2 = 12.3$, $P = 0.14$). However, the model accounted for 26.8% of the variance in dieting status ($P < 0.0001$).

[a] Odds ratio is Exp β value from SPSS.

However, the model accounted for 26.8% of the variance in dieting status ($P < 0.0001$).

The same predictors (with dieting status substituted for dietary restraint score) were entered into a multiple regression analysis to predict score for dietary restraint (treated as a continuous variable). Those results, shown in **Table 4.5**, indicate that seven variables were significant independent predictors of dietary restraint score: BMI, hunger and WLOC were negative predictors of dietary restraint, and dieting status, internalization of sociocultural attitudes towards appearance, social physique anxiety, and self-esteem were positive predictors of dietary restraint. (Note that because lower scores for self-esteem reflect higher self-esteem, the direction of association with self-esteem scores shows that the relationship between self-esteem and dietary restraint is a positive one). The R^2 for the entire model was 0.162, indicating that those variables accounted for 16.2% of the variance in dietary restraint score ($P < 0.0001$).

When the results of these two regression analyses are compared, two main areas of overlap emerge. Both dieting status and dietary restraint are predicted by each other and by BMI. However, there was an important difference with respect to BMI: it *positively* predicted dieting status (indicating that those with higher BMI would be more likely to be trying to lose weight) whereas it *negatively* predicted dietary restraint score (indicating that lower BMI predicted higher scores for dietary restraint). Both dieting and dietary restraint were predicted by higher levels of social physique anxiety. Disinhibition was a significant predictor of dieting status, but did not predict dietary restraint. Dietary restraint was, however, also predicted by hunger, internalization of sociocultural attitudes towards appearance, self-esteem, and WLOC. BMI, eating attitudes, and psychosocial characteristics together predicted roughly 10% more variance in dieting status than they did in dietary restraint score.

Table 4.5: Results of a multiple linear regression analysis to predict dietary restraint score on the basis of BMI, dieting status, dietary attitudes, and psychosocial characteristics

Variable	B (95% CI)	β	*t*	*P*
BMI	-0.126 (-0.198, -0.055)	-0.130	-3.5	0.001
Dieting	2.909 (2.298, 3.519)	0.329	9.4	0.000
Disinhibition	-0.005 (-0.106, 0.096)	-0.005	-0.1	0.92
Hunger	-0.112 (-0.217, -0.007)	-0.085	-2.1	0.04
SATAQ – Awareness	0.028 (-0.043, 0.100)	0.026	0.8	0.44
SATAQ – Internalization	0.129 (0.058, 0.199)	0.129	3.6	0.000
Social physique anxiety	0.038 (0.000, 0.076)	0.089	2.0	0.05
Self-esteem	-0.190 (-0.348, -0.033)	-0.085	-2.4	0.02
Weight locus of control	-0.230 (-0.311, -0.150)	-0.173	-5.6	0.000
(Constant)	10.453 (8.341, 12.565)	–	9.7	0.000

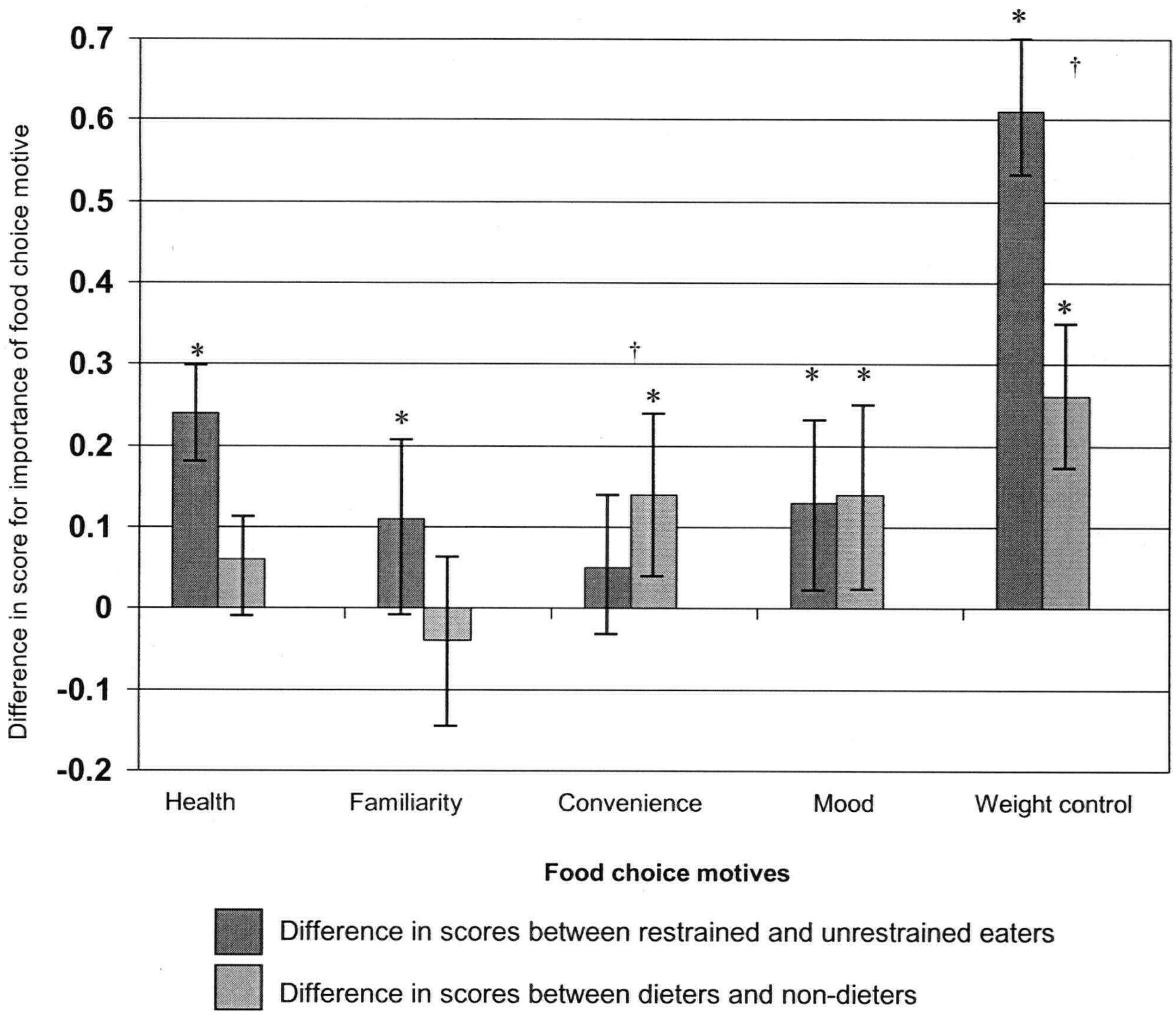
Notes: Dietary restraint score was treated as a continuous variable in this analysis. R^2 for the entire model was 0.162 ($P < 0.0001$).

4.3.5 Food choice motives

We examined the importance of various motives for food choice and compared restrained eaters and unrestrained eaters, and dieters and non-dieters. BMI was included as a covariate in these analyses. **Figure 4.3** illustrates the differences between restrained and unrestrained eaters, and dieters and non-dieters, on five food choice motives for which significant differences were found. Restrained eaters were more motivated by health (B = 0.24, 95% CI: 0.18, 0.30; $P <$ 0.0001) and familiarity (B = 0.11, 95% CI: 0.01, 0.21; $P = 0.02$) than unrestrained eaters, but there was no effect of dieting status on those motives and no interaction. Convenience was more important for dieters than non-dieters (B = 0.14, 95% CI: 0.04, 0.23; $P = 0.006$), but there was no effect of dietary restraint. There was, however, an interaction between dietary restraint and dieting on the importance of convenience: the importance of convenience decreased slightly for dieters with high restraint whereas it increased for non-dieters with high restraint **(Figure 4.4)**. Mood was a more important motive for restrained than unrestrained eaters (B = 0.13, 95% CI: 0.03, 0.24; $P = 0.01$) and dieters than non-dieters (B = 0.014, 95% CI: 0.02, 0.23; $P = 0.02$). Weight control was also a more important food motive for restrained than unrestrained eaters (B = 0.62, 95% CI: 0.54, 0.70; $P < 0.0001$) and dieters than non-dieters (B = 0.25, 95% CI: 0.17, 0.35; $P < 0.0001$). There was an interaction of dietary restraint and dieting status on the importance of weight control on food choice: non-dieters with high restraint were more similar to dieters than non-dieters with low restraint **(Figure 4.5)**.

These differences in food choice motives, while significant, were quite small, ranging from a 3% difference in scores between restrained and unrestrained eaters for familiarity, to a 15% difference in scores between those groups for weight control. There were no significant differences associated with dietary restraint, dieting status, or their interaction with respect to the four remaining food choice motives assessed (price, natural content, sensory appeal, and ethical concern) (data not shown in chapter; refer to **Appendix 27**).

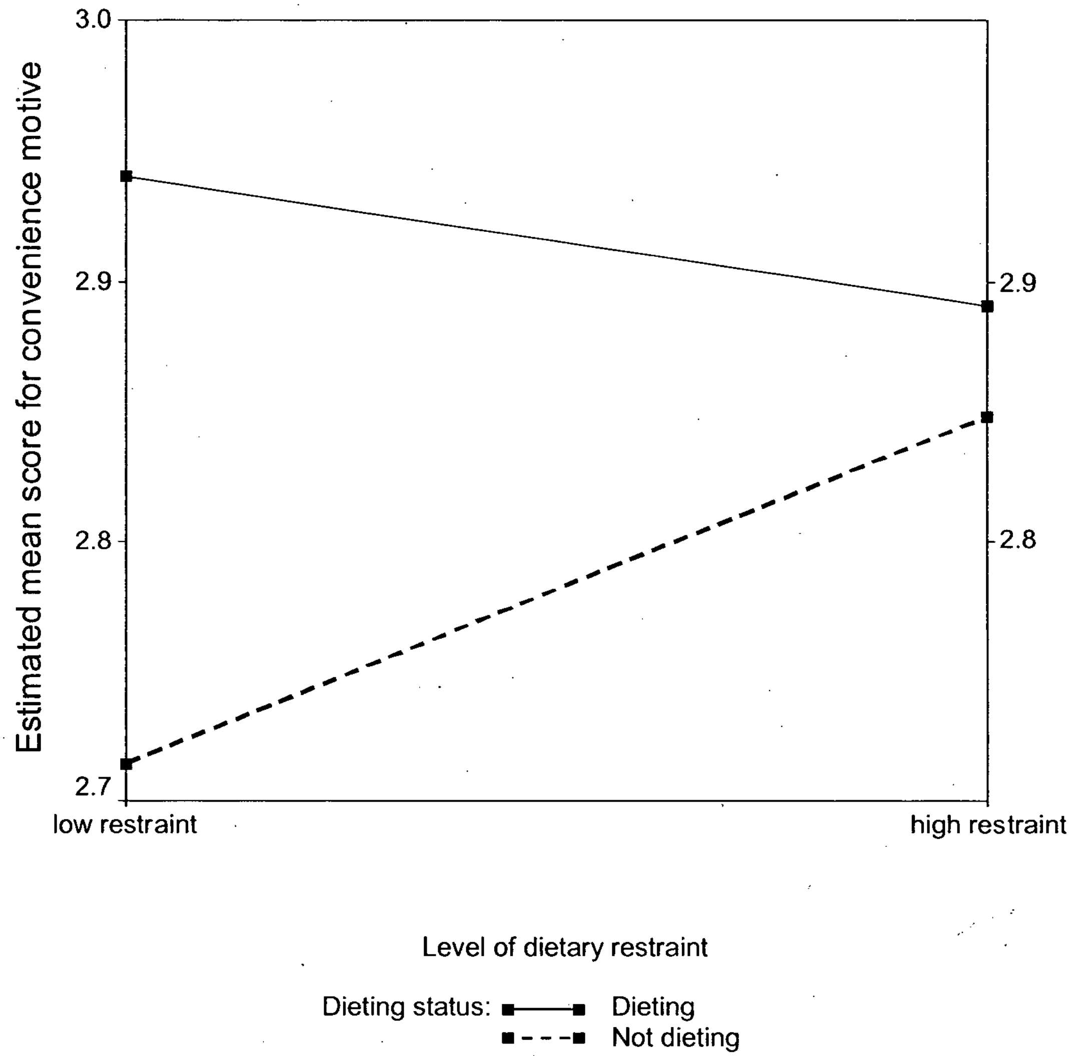
Figure 4.3: Differences in food choice motives between restrained and unrestrained eaters and dieters and non-dieters



* Significant main effect difference ($P < 0.05$)
† Significant interaction of dietary restraint and dieting status ($P < 0.05$)

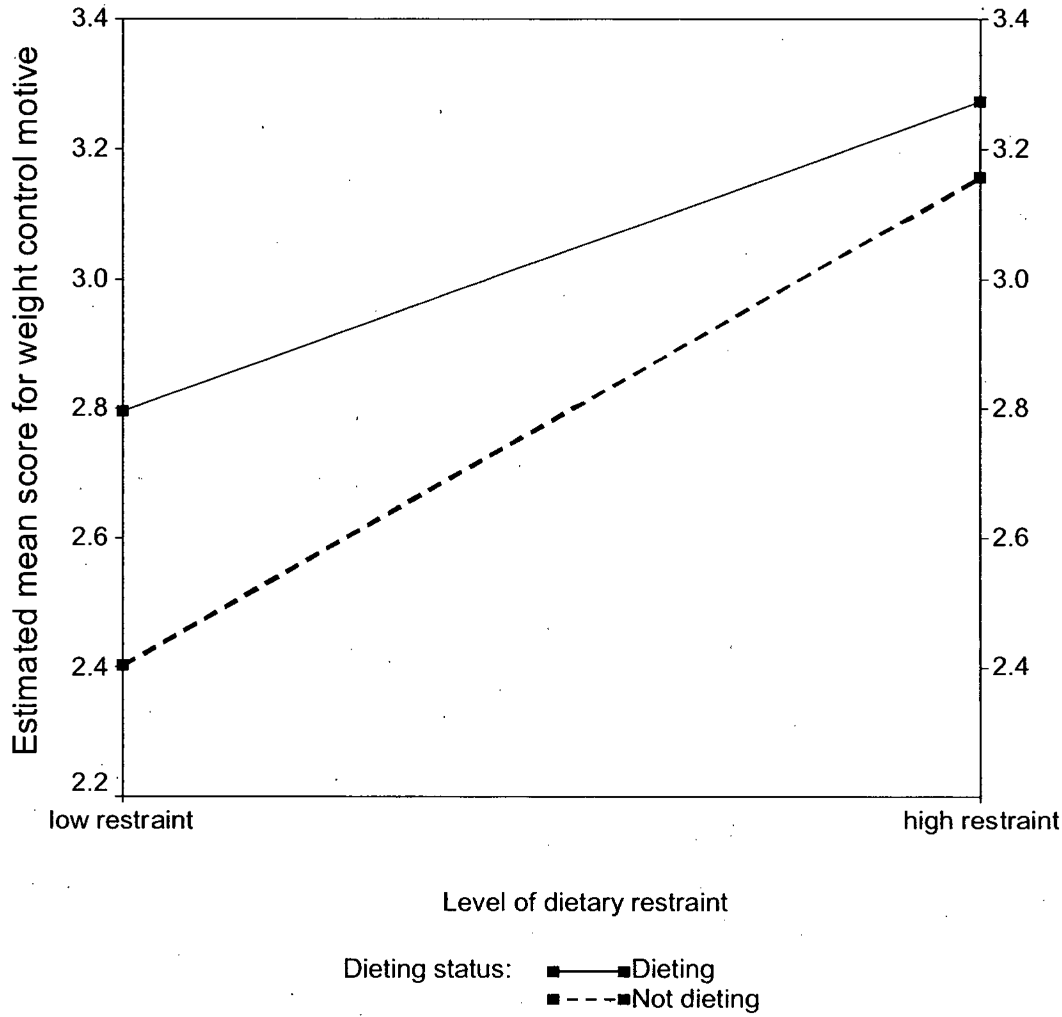
Notes: Error bars represent 95% CI. Shaded bars represent difference in scores for the particular food motive between restrained and unrestrained eaters (based on a median split of scores for dietary restraint) and dieters and non-dieters. Differences were examined using contrast codes in multiple regression. All analyses controlled for BMI. The importance of each food choice motive was measured with the Food Choice Questionnaire [33] and scores for each motive can range from 1 to 4, with higher scores reflecting more importance attributed to that motive. Here, larger shaded bars would indicate greater difference between groups.

Figure 4.4: The interaction of dietary restraint and dieting status on score for convenience as a motive for food choice



Notes: A statistical interaction between dietary restraint group (based on a median split of scores for dietary restraint) and dieting status was detected for convenience as a food choice motive, controlling for effects of BMI (B = -0.2, 95% CI: -0.4, -0.01; $P = 0.049$). The importance of convenience as a food choice motive was measured with the Food Choice Questionnaire [33] (scores can range from 1 to 4, with higher scores reflecting greater importance placed on that food choice motive).

Figure 4.5: The interaction of dietary restraint and dieting status on score for weight control as a motive for food choice



Notes: A statistical interaction between dietary restraint group (based on a median split of scores for dietary restraint) and dieting status was detected for weight control as a food choice motive, controlling for effects of BMI (B = -0.28, 95% CI: -0.45, -0.12; $P < 0.0001$). The importance of weight control as a food choice motive was measured with the Food Choice Questionnaire [33] (scores can range from 1 to 4, with higher scores reflecting greater importance placed on that food choice motive).

4.3.6 Food choice motives as predictors of dieting status and dietary restraint

Table 4.6 shows the results of a logistic regression analysis of dieting status as an outcome of BMI and food choice motives. In addition to BMI, four food choice motives showed a significant relationship with dieting status: dieting status was negatively predicted by familiarity and price (indicating that dieters placed less importance on these motives) and positively predicted by convenience and weight control (indicating these motives were more important). The full model (with all 10 predictors) predicted 74% of cases (73% of non-dieters and 75% of dieters), but did not reach statistical significance ($X^2 = 14.0$, $P = 0.08$). However, the model accounted for 23% of the variance in dieting status ($P < 0.0001$).

The same analysis was done for dietary restraint score. As shown in **Table 4.7**, in addition to BMI, four food choice motives predicted dietary restraint score: health and weight control were positive predictors of dietary restraint score, and price and natural content were negative predictors (model $R^2 = 0.377$, $P < 0.0001$).

Comparing the results of these two regressions, dieting and dietary restraint are both positively predicted by weight control and negatively predicted by price. Convenience as a food motive was a positive predictor and familiarity was a negative predictor of dieting status, but neither of these motives was significant in predicting dietary restraint score. Dietary restraint was positively predicted by health and negatively predicted by natural content, neither of which was significant in predicting dieting status. Food choice motives account for a greater proportion of the variance in dietary restraint score than they do in dieting status.

Table 4.6: Logistic regression analysis of dieting status as a function of BMI and motives for food choice

Variable	B (SE)	Wald Test	P	Odds Ratio (95% CI)[a]
BMI	0.274 (0.02)	134.4	0.000	1.31 (1.26, 1.38)
Health	0.082 (0.2)	0.169	0.68	1.09 (0.74, 1.6)
Familiarity	-0.331 (0.12)	7.8	0.005	0.72 (0.57, 0.91)
Convenience	0.343 (0.13)	7.1	0.008	1.41 (1.09, 1.81)
Mood	0.187 (0.11)	2.7	0.099	1.21 (0.97, 1.51)
Weight control	0.898 (0.13)	50.1	0.000	2.5 (1.9, 3.1)
Price	-0.411 (0.12)	12.0	0.001	0.663 (0.53, 0.84)
Natural content	-0.102 (0.12)	0.69	0.41	0.90 (0.71, 1.14)
Sensory appeal	0.052 (0.14)	0.14	0.71	1.05 (0.80, 1.39)
Ethical concern	0.038 (0.11)	0.12	0.73	1.04 (0.84, 1.29)
Constant	-8.99 (0.89)	101.2	0.000	–

Notes: The full model correctly predicted 74% of cases but was not considered significant according to the Hosmer-Lemeshow goodness-of-fit test ($X^2 = 14.0$, $P = 0.08$). However, the model accounted for 23% of the variance in dieting status ($P < 0.0001$).

[a] Odds ratio is Exp β value from SPSS

Table 4.7: Results of a multiple regression analysis to determine the relative importance of food choice motives in predicting dietary restraint score

Variable	B (95% CI)	β	t	P
BMI	-0.075 (-0.123, -0.025)	-0.076	-2.9	0.003
Health	1.28 (0.71, 1.86)	0.145	4.4	0.000
Familiarity	0.09 (-0.25, 0.42)	0.015	0.5	0.61
Convenience	-0.309 (-0.676, 0.058)	-0.048	-1.6	0.099
Mood	-0.085 (-0.417, 0.247)	-0.015	-0.5	0.62
Weight control	3.553 (3.21, 3.90)	0.585	20.3	0.000
Price	-0.801 (-1.14, -0.47)	-0.129	-4.7	0.000
Natural content	-0.368 (-0.733, -0.004)	-0.065	-2.0	0.048
Sensory appeal	-0.278 (-0.691, 0.135)	-0.036	-1.3	0.19
Ethical concern	-0.018 (-0.333, 0.298)	-0.003	-0.1	0.91
Constant	2.097 (-0.121, 4.315)	–	1.9	0.06

Notes: Dietary restraint score was treated as a continuous variable in this analysis. R^2 for the entire model was 0.377 ($P < 0.0001$).

4.4 Discussion

Our findings suggest that dietary restraint is not analogous to dieting in postmenopausal women. The results of our comparisons of dieters versus non-dieters and restrained eaters versus unrestrained eaters were dissimilar and included some important distinctions. This implies that these were not parallel comparisons; rather, the groups identified as dieters and restrained eaters were quite divergent.

One surprisingly clear indication of the difference between dieting and dietary restraint was the finding that BMI showed opposite associations with each construct. When controlling for dietary restraint, dieters had notably *higher* BMI than non-dieters (4.1 kg/m^2 difference), whereas controlling for dieting status, restrained eaters had slightly *lower* BMI (1 kg/m^2 difference) than unrestrained eaters. In fact, the difference between restrained and unrestrained eaters increased to 1.6 kg/m^2 when we examined the difference in BMI between highly restrained (scoring in the upper quartile) and highly unrestrained (scoring in the lower quartile) eaters. Past research has been unclear regarding whether BMI differs in women in association with dietary restraint, with many studies indicating that there is no relationship [e.g., 22, 45-47]. Indeed, in this sample, the univariate correlation between dietary restraint and BMI was not significant ($r = -0.006$, $P = 0.84$; **Appendix 28**), and if high and low restraint groups were to be compared using a t test (which would not control for the effects of dieting status), no difference in BMI would be found between restrained and unrestrained eaters (24.8 ± 4.2 versus 24.8 ± 4.7; $t = -0.02$, $P = 0.99$) or highly restrained and highly unrestrained eaters (24.3 ± 3.8 versus 24.6 ± 5.0; $t = 0.76$, $P = 0.45$). The finding that BMI is actually lower among restrained eaters when dieting status is controlled for is an important and meaningful distinction.

The results of our regression analyses examining predictors of dieting status and dietary restraint have interesting implications for restraint theory. Restraint theory asserts that dieting leads to overeating or bingeing [48]. From this perspective, dietary restraint equates to dieting and disinhibition in dieters results from their dietary restraint [15]. Our results both support and refute these ideas. True, dietary restraint and disinhibition were independent predictors of dieting status: higher scores for both constructs were associated with being on a diet **(Table 4.4)**. However, it is notable that dietary restraint itself was not associated with disinhibition **(Table 4.5)**. These results are consistent with the notion that dietary restraint and disinhibition go hand in hand for dieters. However, they also underscore the distinction between dieting and dietary restraint.

Our results suggest that dietary restraint as measured by the TFEQ-R, when considered independent of dieting status, may be characteristic of women who have been successful at suppressing weight gain. This group appears to be what van Strien [20] and others would describe as 'successful dieters' because of their low susceptibility towards failure of restraint (disinhibition). However, given the limitations of that term (since it considers all restrained eaters as dieters, which we know is often not the case [10], and indeed our results suggest that the distinction between dieters and restrained eaters may be greater than the overlap), it seems clear that we need to modify the terminology that is used when referring to dietary restraint and dieting. Restrained eaters (as identified by the TFEQ-R) appear distinct from dieters. They appear to engage in long-term cognitive control over the amount and types of food consumed, whereas dieters may be more likely to engage in acute episodes of caloric restriction interspersed with periods of disinhibition. Although several past attempts have been made at refining our terminology with respect to what dietary restraint scales actually measure, the terms originally used to describe the scales remain the most heavily used. For example, it was previously suggested that since disinhibition implies prior inhibition, the term should be changed to 'susceptibility to eating problems' or 'externally triggered eating' [20, 49]. However, the use of the term disinhibition continues, just as the casual use of the terms dieting and dietary restraint has also persisted.

We assessed dieting status with the question, "Are you trying to lose weight at the present time?" as have others [50]. Although this question does not directly assess dieting per se, it accurately reflects the behavioural intent to lose weight and may avoid some of the negative associations some women have with the word 'dieting.' Although this could lead to the misclassification of women who were trying to lose weight by increasing physical activity rather than restricting dietary intake, this does not appear to have been the case, given our finding that dieters with low dietary restraint did not exercise more than dieters with high dietary restraint. This suggests that the unrestrained dieters were not substituting increased exercise (energy output) for dietary restriction in their efforts to lose weight. These results contrast the report of French and colleagues, who found that women aged 35.8 ± 8.2 years who were currently dieting to lose weight reported expending approximately twice as many kcal in physical activity as non-dieters, in addition to consuming fewer kcal in their diet [51].

Our results clearly support the concept that dietary restraint is applicable to postmenopausal women. In fact, the mean score for dietary restraint observed in this sample (9.8) was slightly higher than mean scores ~9.0 typically reported in studies of young women [19, 51], although it was slightly lower than the mean score of 10.7 obtained in a survey of postmenopausal American women [22, 23]. Our finding that restrained eaters are more likely to be motivated by health when making food choices is consistent with past studies which have shown that restrained eaters are more likely to make healthier food choices [52, 53] and avoid sweets [51].

This study makes a significant contribution to our understanding of how a common measure of dietary restraint is similar to, and different from, dieting. By comparing the two constructs in multiple regression with contrast codes, we were able to examine the independent effects of each characteristic, since multiple regression controls for overlap among predictors. Previous studies have not controlled for current dieting status when examining differences between restrained and unrestrained eaters. Yet our results must be interpreted in light of our study's limitations. This was a cross-sectional study of non-randomly selected volunteers, and we relied on self-report measures of height, weight, and all other characteristics. Also, we used only one measure to assess dietary restraint (the TFEQ-R). Although previous studies have shown that dietary restraint as measured by the TFEQ-R is quite similar to dietary restraint as measured by the DEBQ-R [19], it is possible that aspects of our results may have been different if we had used the RS to identify restrained and unrestrained eaters.

For our primary analyses, we classified women as restrained or unrestrained eaters by using a median split of restraint scores. High and low restraint groups were required for the analyses we planned (so that contrast code comparisons could be made with the dieting status groups), and by using median split, we were able to include all respondents in the primary analyses. Yet it must be acknowledged that the classification of participants with scores close to the median could be considered somewhat arbitrary, and that anytime one uses a median split dichotomy for a characteristic measured by a continuous scale there is a loss of information [20] and increased likelihood of Type I error [54]. We attempted to reduce the effect of this on our interpretation of our results by also conducting our analysis in highly restrained and highly unrestrained eaters (those who fell in the upper and lower quartile of scores for dietary restraint). These analyses used a subset of our sample which differed to a greater extent with respect to scores for dietary restraint to examine whether the pattern of results was similar to that obtained in the large group classified by median split. These secondary analyses suggested that the difference in alcohol intake between women with high and low restraint and the interaction of restraint and dieting on scores for dietary restraint and self-esteem were not real.

Another potential limitation was that our treatment of missing TFEQ values would have reduced variance in those variables, thus decreasing the likelihood of detecting significant associations with other variables. In this respect, multiple imputation would have been a preferable approach to replacing missing values. However, it is unlikely that this was a significant issue in our results, given our large sample size and relatively small proportion of missing TFEQ values which were replaced with the median.

Our results suggest that there is significant divergence in the populations identified as dieters and restrained eaters, and that to automatically classify women with high levels of dietary restraint as dieters would be misguided. It has been noted previously that a large proportion of people with high scores for dietary restraint do not report current dieting [10, 55], and that measures of dietary restraint are only weakly related to behaviours thought to be indicative of dieting (such as dietary energy restriction) [51]. Recent data from studies of dietary restraint and caloric intake measured by unobtrusive observation also indicated that scores for dietary restraint were not associated with short-term dietary restriction [11]. These results, combined with our own, indicate that researchers should not use an individual's score for dietary restraint as a proxy for dieting status, or otherwise infer that the two constructs are analogous. Furthermore, studies in which this was done should be interpreted in light of the growing evidence that dietary restraint is a separate, albeit related, characteristic from dieting. We speculate that the TFEQ-R score for dietary restraint reflects ongoing efforts to limit dietary intake, whereas dieting involves slightly different intentions and acute episodes of perceived dietary restriction. However, further work is required to more clearly differentiate how these constructs relate to actual behaviours and to determine their possible health implications independent of one another.

4.5 References

1. Katzmarzyk PT. The Canadian obesity epidemic, 1985-1998. *CMAJ* 2002; 166: 1039-40.

2. Mokdad AH, Ford ES, Bowman BA, Dietz WH, Vinicor F, Bales VS, Marks JS. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *JAMA* 2003; 289: 76-9.

3. Ford ES, Moriarty DG, Zack MM, Mokdad AH, Chapman DP. Self-reported body mass index and health-related quality of life: findings from the behavioral risk factor surveillance system. *Obes Res* 2001; 9: 21-31.

4. Paeratakul S, York-Crowe EE, Williamson DA, Ryan DH, Bray GA. Americans on diet: results from the 1994-1996 continuing survey of food intakes by individuals. *J Am Diet Assoc* 2002; 102: 1247-51.

5. Allaz AF, Bernstein M, Rouget P, Archinard M, Morabia A. Body weight preoccupation in middle-age and ageing women: a general population survey. *Int J Eat Disord* 1998; 23: 287-94.

6. Strauss RS. Self-reported weight status and dieting in a cross-sectional sample of young adolescents: National Health and Nutrition Examination Survey III. *Arch Pediatr Adolesc Med* 1999; 153: 741-7.

7. Serdula MK, Mokdad AH, Williamson DF, Galuska DA, Mendlein JM, Heath GW. Prevalence of attempting weight loss and strategies for controlling weight. *JAMA* 1999; 282: 1353-8.

8. Stunkard AJ, Messick S. The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *J Psychosom Res* 1985; 29: 71-83.

9. Herman CP, Mack D. Restrained and unrestrained eating. *J Pers* 1975; 43: 647-60.

10. Lowe MR. The effects of dieting on eating behavior: a three-factor model. *Psychol Bull* 1993; 114: 100-21.

11. Stice E, Fisher M, Lowe MR. Are dietary restraint scales valid measures of acute dietary restriction? Unobtrusive observational data suggest not. *Psychol Assess* 2004; 16: 51-9.

12. Wadden TA, Brownell KD, Foster GD. Obesity: responding to the global epidemic. *J Consult Clin Psychol* 2002; 70: 510-25.

13. Brownell KD, Rodin J. The dieting maelstrom. Is it possible and advisable to lose weight? *Am Psychol* 1994; 49: 781-91.

14. Neumark-Sztainer D, Jeffery RW, French SA. Self-reported dieting: How should we ask? What does it mean? Associations between dieting and reported energy intake. *Int J Eat Disord* 1997; 22: 437-49.

15. Heatherton TF, Herman CP, Polivy J, King GA, McGree ST. The (mis)measurement of restraint: an analysis of conceptual and psychometric issues. *J Abnorm Psychol* 1988; 97: 19-28.

16. Herman CP, Polivy JA. Restrained eating. In: Stunkard AJ, ed. *Obesity*. Philadelphia: WB Saunders, 1980: 208-25.

17. van Strien T, Frijters JER, Bergers GPA, Defares PB. The Dutch Eating Behavior Questionnaire (DEBQ) for assessment of restrained, emotional, and external eating behavior. *Int J Eat Disord* 1986; 5: 295-315.

18. Polivy J, Herman CP, Howard KI. Restraint scale: assessment of dieting. In: Hersen M, Bellack AS, eds. *Dictionary of Behavioral Assessment Techniques*. New York: Pergamon Press, 1988: 377-80.

19. Gorman BS, Allison DB. Measures of restrained eating. In: Allison DB, ed. *Handbook of Assessment Methods for Eating Behaviors and Weight-related Problems: Measures, Theory and Research*. Thousand Oaks: Sage Publications, 1995: 149-84.

20. van Strien T. Success and failure in the measurement of restraint: notes and data. *Int J Eat Disord* 1999; 25: 441-9.

21. Paa HK, Larson LM. Predicting level of restrained eating behavior in adult women. *Int J Eat Disord* 1998; 24: 91-4.

22. Hays NP, Bathalon GP, McCrory MA, Roubenoff R, Lipman R, Roberts SB. Eating behavior correlates of adult weight gain and obesity in healthy women aged 55-65 y. *Am J Clin Nutr* 2002; 75: 476-83.

23. Hays NP, Bathalon GP, Roubenoff R, Lipman R, Roberts SB. The association of eating behavior with risk for morbidity in older women. *J Gerontol A Biol Sci Med Sci* 2002; 57: M128-33.

24. Guest NS, Barr SI. Cognitive dietary restraint is associated with stress fractures in women runners. *Int J Sport Nutr Exerc Metab* 2005; 15: 147-59.

25. Heinberg LJ, Thompson JK, Stormer S. Development and validation of the sociocultural attitudes towards appearance questionnaire. *Int J Eat Disord* 1995; 17: 81-9.

26. Hart EA, Leary MR, Rejeski WJ. The measurement of social physique anxiety. *Journal of Sport and Exercise Psychology* 1989; 11: 94-104.

27. Ransdell LB, Wells CL, Manore MM, Swan PD, Corbin CB. Social physique anxiety in postmenopausal women. *J Women Aging* 1998; 10: 19-39.

28. Lantz CD, Hardy CJ, Ainsworth BE. Social physique anxiety and perceived exercise behavior. *Journal of Sport Behavior* 1997; 20: 83-93.

29. Rosenberg M. *The measurement of self-esteem. Society and the adolescent self image.* Princeton, New Jersey: Princeton University Press, 1965.

30. Salyers MP, McHugo GJ, Cook JA, Razzano LA, Drake RE, Mueser KT. Reliability of instruments in a cooperative, multisite study: employment intervention demonstration program. *Ment Health Serv Res* 2001; 3: 129-39.

31. Saltzer EB. The weight locus of control (WLOC) scale: a specific measure for obesity research. *J Pers Assess* 1982; 46: 620-8.

32. Holt CL, Clark EM, Kreuter MW. Weight locus of control and weight-related attitudes and behaviors in an overweight population. *Addict Behav* 2001; 26: 329-40.

33. Steptoe A, Pollard TM, Wardle J. Development of a measure of the motives underlying the selection of food: the food choice questionnaire. *Appetite* 1995; 25: 267-84.

34. Pollard TM, Steptoe A, Wardle J. Motives underlying healthy eating: using the food choice questionnaire to explain variation in dietary intake. *J Biosoc Sci* 1998; 30: 165-79.

35. Lowe MR, Timko CA. What a difference a diet makes: towards an understanding of differences between restrained dieters and restrained nondieters. *Eat Behav* 2004; 5: 199-208.

36. Rideout CA, Linden W, Barr SI. High cognitive dietary restraint is associated with increased cortisol excretion in postmenopausal women. *J Gerontol A Biol Sci Med Sci* 2006; 61A: 628-33.

37. Statistics Canada. Canadian Census long form questionnaire, 2001. Retrieved April 20, 2006 from http://www.statcan.ca/english/sdds/instrument/3901_Q2_V2_E.pdf.

38. Anderson DA, Shapiro JR, Lundgren JD, Spataro LE, Frye CA. Self-reported dietary restraint is associated with elevated levels of salivary cortisol. *Appetite* 2002; 38: 13-7.

39. Cohen J, West SG, Aiken L, Cohen P. *Applied multiple regression/correlation analysis for the behavioral sciences*. 3rd ed. Mahwah, New Jersey: Lawrence Erlbaum Associates, Inc, 2003.

40. Davison AC, Hinkley DV. *Bootstrap Methods and their Application.* New York: Cambridge University Press, 1997.

41. Efron B, Tibshirani RJ. *An Introduction to the Bootstrap.* New York: Chapman and Hall, 1993.

42. Tabachnick BG, Fidell LS. *Using Multivariate Statistics*. 4th ed. Boston: Allyn and Bacon, 2001.

43. Cook RD, Weisberg S. *Applied regression including computing and graphics*. St. Paul, Minnesota: John Wiley & Sons, Inc, 1999.

44. *Arc* version 1.06. St. Paul: University of Minnesota, 2004. Available at http://www.stat.umn.edu/arc/software.html.

45. Bellisle F, Clement K, Le Barzic M, Le Gall A, Guy-Grand B, Basdevant A. The Eating Inventory and body adiposity from leanness to massive obesity: a study of 2509 adults. *Obes Res* 2004; 12: 2023-30.

46. Dykes J, Brunner EJ, Martikainen PT, Wardle J. Socioeconomic gradient in body size and obesity among women: the role of dietary restraint, disinhibition and hunger in the Whitehall II study. *Int J Obes* 2004; 28: 262-8.

47. Provencher V, Drapeau V, Tremblay A, Despres JP, Lemieux S. Eating behaviors and indexes of body composition in men and women from the Quebec family study. *Obes Res* 2003; 11: 783-92.

48. Polivy J, Herman CP. Dieting and binging. A causal analysis. *Am Psychol* 1985; 40: 193-201.

49. Westenhoefer J, Broeckmann P, Munch AK, Pudel V. Cognitive control of eating behaviour and the disinhibition effect. *Appetite* 1994; 23: 27-41.

50. Oliver G, Wardle J. Perceived effects of stress on food choice. *Physiol Behav* 1999; 66: 511-5.

51. French SA, Jeffery RW, Wing RR. Food intake and physical activity: a comparison of 3 measures of dieting. *Addict Behav* 1994; 19: 401-9.

52. Beiseigel JA, Nickols-Richardson SA. Cognitive eating restraint scores are associated with body fatness but not with other measures of dieting in women. *Appetite* 2004; 43: 47-53.

53. de Castro JM. The relationship of cognitive restraint to the spontaneous food and fluid intake of free-living humans. *Physiol Behav* 1995; 57: 287-95.

54. Maxwell SE, Delaney HD. Bivariate median splits and spurious statistical significance. *Psychol Bull* 1993; 113: 181-90.

55. Alexander JM, Tepper BJ. Use of reduced-calorie reduced-fat foods by young adults: influence of gender and restraint. *Appetite* 1995; 25: 217-30.

CHAPTER 5

REPORTED 10-YEAR WEIGHT HISTORY AND WEIGHT-RELATED FACTORS IN POSTMENOPAUSAL WOMEN

A version of this chapter will be submitted for publication:
Rideout CA, Barr SI. Reported 10-year weight history is associated with current body mass index, eating attitudes, and other weight-related factors in postmenopausal women.

5.1 Introduction

With rates of overweight and obesity on the rise throughout the world [1, 2], interest in their health consequences has increased dramatically. It is clear that obesity is associated with adverse health risks, especially risk for cardiovascular disease and stroke [3, 4]. There is further evidence that overweight and obesity are associated with hypertension, dyslipidemia, and type 2 diabetes across the lifespan [3, 5, 6]. For older adults, risks associated with excessive body weight may be especially relevant. Not only is age an additional risk factor for many health conditions for which obesity is also a risk factor, but body weight also tends to increase with age [7, 8]. Postmenopausal women may be especially vulnerable to the possible consequences of adult weight gain, given the tendency to gain weight in the years around the menopausal transition [9-12].

Although common, the implications of adult weight gain are not negligible. Regardless of body mass index (BMI) attained, adult weight gain is associated with risk for various cancers [13-15] and cardiovascular disease [10]. Adult weight loss, on the other hand, has been associated with reduced risk for type 2 diabetes [16], improvements in cardiac risk profiles, and reduced hypertension [17]. Adult weight fluctuation (also referred to as weight cycling) appears to play an important role in health as well. For example, in a large prospective study of hip fracture, those with the greatest variability in weight over a 12-year period had the highest risk of fracture, independent of BMI and linear trend in weight change [18].

Although research has begun to unravel the implications of changes in adult body weight, little is known about characteristics associated with different weight histories. In particular, it is unknown how women who have experienced changes in body weight may differ from those who have maintained their weight with respect to dietary, psychosocial, and lifestyle factors. If we had a greater understanding of how women who experienced weight changes in adulthood (loss, gain, or cycling) differ from those who maintained their weight, we could perhaps better target health promotion programs to promote weight maintenance. For example, past studies have found that disinhibition of eating control [19] is strongly associated with current body weight, while dietary restraint has a negligible association [20, 21]. This would suggest that focusing on disinhibition may be more effective than approaches which typically aim at increasing dietary restraint. However, whether these associations hold true irrespective of body weight history is unknown. It is possible that the factors which are most important in determining an individual's body weight could be influenced partly by individual weight history (and vice versa).

This study was undertaken to determine whether there are differences in current BMI, eating attitudes, and psychosocial factors among groups of postmenopausal women with different self-reported 10-year weight histories. We surveyed postmenopausal women volunteers and classified them according to their self-reports of whether they had maintained weight, lost weight, gained weight, or experienced weight cycling in the past 10 years. We aimed to address two main questions. First, how do women who report changes in weight over 10 years differ from those who maintained their weight during that time with respect to current BMI, dietary attitudes, and weight-related psychosocial and lifestyle characteristics? And second, do determinants of current BMI differ in postmenopausal women depending on whether they experienced weight maintenance, loss, gain, or cycling in the past 10 years?

5.2 Methods

We conducted a cross-sectional mail-administered survey of postmenopausal women volunteers between June 2003 and February 2004. Participants were recruited primarily through advertisements in community newspapers (**Appendix 4**) and were eligible to participate if they met both inclusion criteria: age 45–75 years, and $\geq$1 year since last menstrual cycle. Potential participants contacted us by phone and heard a recorded message which provided more information about the study. Interested participants could request that a questionnaire package be sent to them by mail. The package included an explanatory letter addressed to the participant (**Appendix 5**), the questionnaire (**Appendix 6**), and a stamped addressed return envelope. In cases where participants did not initially respond by either returning a completed questionnaire or declining participation in the study, one reminder letter was mailed in which we indicated that another copy of the questionnaire could be sent to the participant, if needed (**Appendix 20**). Participants were not paid for their involvement in the study, but they were advised that if they returned a completed questionnaire, they could be entered in a random draw for three prizes (choice of cash or gift certificates) and that if they were interested and deemed eligible, they could be invited to participate in a further study of nutrition and bone health. The study protocol was approved by the Clinical Research Ethics Board of The University of British Columbia (**Appendix 2**) and all respondents consented to participate (**Appendix 5**).

5.2.1 Participants

Of 1237 women who requested a survey package, 1078 returned a completed questionnaire (response rate = 87.1%). Data from seven respondents were not retained in the final analyses: five were not classified as postmenopausal (<1 year had passed since their last menstrual cycle) and two were older than our target age group (at 76 and 80 years of age). Thus, our final sample size was 1071.

5.2.2 Questionnaire

The study questionnaire assessed current body size, 10-year weight history, dietary attitudes, perceptions of personal body weight, dieting status, psychosocial factors possibly associated with body weight (self-esteem, social physique anxiety, weight locus of control), weekly hours of exercise, and other lifestyle and demographic factors. It was pilot-tested by 33 postmenopausal women and evaluated for clarity and readability. Different versions of the questionnaire (sent sequentially as requests were received) presented psychometric scales in counter-balanced order across participants (**Appendix 21**), allowing us to control for possible order effects.

5.2.2.1 Current body size

Current height and weight were self-reported and used to calculate body mass index (BMI; kg/m^2). BMI was classified as underweight (<18.5), normal weight (18.5 – 24.9), overweight (25.0 – 29.9), or obese (≥ 30) according to World Health Organization (WHO) criteria [22]. In a subset of participants (n=78) who went on to participate in a subsequent study [23], height (cm) and weight (kg) were measured directly and used to calculate BMI (4.1 ± 1.9 months after completing this questionnaire). In those participants, height was measured to the nearest 0.1 cm using a stadiometer (Seca model 214, Hamburg, Germany) without shoes at full inspiration. Weight was measured in light indoor clothing without shoes to the nearest 0.5 kg using an electronic scale (Sunbeam Inc., Boca Raton, Florida).

5.2.2.2 Reported 10-year weight history

Participants reported whether they had, over the last 10 years: stayed within 5 lbs (2.27 kg) of their current weight, lost weight (> 5 lbs), gained weight (> 5 lbs), or experienced weight cycling (i.e, patterns of weight gain and loss > 5 lbs). For participants reporting changes in weight, the number of lbs (or kg) lost, gained, or cycled was also reported.

5.2.2.3 Dietary attitudes

We used the Three-Factor Eating Questionnaire (TFEQ) [19] to measure three aspects of self-reported eating behaviour: cognitive dietary restraint (the perception of constantly monitoring and making an effort to restrict dietary intake in an effort to achieve or maintain a certain body weight), disinhibition (susceptibility to overeating due to a loss of control over eating), and hunger (the subjective feeling of hunger). This 51-item instrument is comprised of 36 true/false questions and 15 items scored on a 4-point Likert-type scale. As has been done previously [24], we changed the wording of the first true/false item, which is part of the disinhibition subscale. This item typically reads, "When I smell a sizzling steak or see a juicy piece of meat, I find it very difficult to keep from eating, even if I have just finished a meal" but we replaced the words "a sizzling steak or see a juicy piece of meat" with "the aroma of my favourite food" in order to make the question suitable for vegetarians. All other TFEQ items were reproduced and scored as suggested [19].

Given that past research has suggested the three factors measured by the TFEQ may not be unidimensional in nature [25, 26], we also examined participants' scores on aspects of dietary restraint, disinhibition, and hunger. Specifically, we calculated scores for: i) *flexible control of eating* (i.e., a graduated approach to dietary restraint) and *rigid control of eating* (i.e., a dichotomous "all or nothing" approach to dietary restraint) [26], ii) *habitual susceptibility* to disinhibition (i.e., recurrent disinhibition), *emotional susceptibility* to disinhibition (i.e., disinhibition associated with negative mood states), and *situational susceptibility* to disinhibition (i.e., disinhibition triggered by specific environmental circumstances) [25], and iii) *internal* and *external locus* of hunger (reflecting hunger that is internally regulated or which results from external cues, respectively) [25].

5.2.2.4 Perceptions of current weight

Participants indicated whether they felt they were currently very underweight, slightly underweight, about right, slightly overweight, or very overweight. A similar item has been used to assess perceived overweight in the past [27]. We treated this item as a continuous variable and scored it from 1 (very underweight) to 5 (very overweight).

5.2.2.5 Dieting status

This was assessed with the question "Are you trying to lose weight at the present time?" A single simple question has been shown to be a robust measure of dieting status (i.e., current efforts to lose weight) [28, 29] and this item has been used to assess dieting status previously [27].

5.2.2.6 Self-esteem

Rosenberg's 10-item Self-esteem Scale was used to measure participants' feelings of self-worth [30]. Lower scores on this scale reflect feelings of *higher* self-esteem and personal value, whereas higher scores reflect *lower* self-esteem and greater feelings of dissatisfaction with oneself. High internal consistency (Cronbach's alpha of 0.93) and test-retest reliability ($r = 0.80$) were reported when the scale was introduced [30]. More recently, a Cronbach's alpha of 0.84 and test-retest reliability of 0.80 were reported in a study of 202 adults [31].

5.2.2.7 Social physique anxiety

We used the 12-item Social Physique Anxiety Scale to assess the level of anxiety participants may experience when they perceive that their physique is being evaluated by others [32]. It has good internal consistency (Cronbach's alpha = 0.90) and test-retest reliability ($r = 0.82$ after 8 weeks) [32]. In keeping with recent research [33, 34], we re-worded the second item in the positive tone in order to increase clarity.

5.2.2.8 Weight locus of control

We included this short (4-item) scale to measure the extent to which participants believe that their body weight is under their personal control [35]. Scores can range from 4–24. Lower scores reflect an internal locus of control (the belief that one's body weight is under one's control) whereas higher scores reflect an external locus of control (the belief that personal body weight is largely influenced by factors over which one has no control). Because the scale is comprised of so few items, its internal and test-retest reliability are relatively low (Cronbach's alpha = 0.56, $r = 0.67$ after 24 days) [35], and effects associated with the WLOC scale are likely smaller than those that could be obtained if the scale contained more items [36].

5.2.2.9 Lifestyle and demographic factors

Participants reported the number of hours in which they engaged in physical activity sufficient to raise their heart rate each week (weekly exercise). They also indicated use of hormone replacement therapy (HRT), typical diet (mixed, vegetarian, vegan, other), smoking habits (current, former, never), ethnicity (according to categories used in the most recent census [37]), highest level of education completed (≤ secondary school, university/college, postgraduate studies), and annual income (<$35,000, $35,000–$50,000, >$50,000).

5.2.3 Missing values

For most variables, complete data sets were available. However, although the majority of respondents (n = 848; 79%) completed the entire TFEQ, between 7% and 16% of participants omitted items from one of its three subscales. Participants with complete TFEQs varied from those with incomplete questionnaires in that they were slightly older and had slightly higher BMI. Therefore, to avoid bias in the dataset while retaining data only from scales that had been meaningfully completed, we included TFEQ scores as long as: (i) ≤ 2 responses were missing from the particular subscale, and (ii) ≤ 5 responses were missing from the entire TFEQ (10% of all items). For respondents meeting these criteria, missing TFEQ values were replaced with the median response for that item, and then scores were calculated. This enabled us to calculate a dietary restraint score for 1044 (97%) participants, a disinhibition score for 1046 (97%), and a hunger score for 1049 (97%). Few data were missing for other variables and those that were appeared to be random. Thus, we excluded other missing values on a pairwise basis.

5.2.4 Statistical analysis

Participants were categorized into one of four groups according to self-reported 10-year weight history: maintained weight within 5 lbs or 2.27 kg (n = 350; 33%), lost weight (n = 152; 14%), gained weight (n = 384; 36%), and experienced weight cycling (n = 169; 16%). Sixteen (1.5%) respondents did not report their 10-year weight history and were excluded from comparisons of these groups. Possible order effects were examined by classifying respondents according to the version of questionnaire they completed and then examining differences on key variables using one-way analysis of variance (ANOVA). No order effects were detected; therefore, all analyses were conducted without regard to questionnaire version.

Data are presented as mean ± SD or n (%), unless otherwise noted. Differences in categorical variables between groups were examined by chi square analysis. Group differences in continuous variables were examined by multiple regression, using three dummy codes for the four weight history groups. The three groups who reported changes in weight in the last 10 years (lost weight, gained weight, experienced weight cycling) were compared to the group of weight maintainers (the reference group). Current age and BMI were included as additional predictor variables in comparisons of eating attitudes and psychosocial characteristics between weight history groups to control for effects of those variables. We used multiple regression to examine possible differences in continuous variables between weight history groups rather than analysis of covariance (ANCOVA) because the four weight history groups differed in size, and regression does not rely on the assumption of equal group size as does ANCOVA. Multiple regression is also useful because it examines independent prediction by controlling for possible overlap among predictor variables. The assumption of homoscedasticity (homogeneity of variance between groups) was also not met for these comparisons, which, if ignored, could lead to biased estimates of standard error and confidence intervals (CIs). We corrected for this by estimating 95% CIs using the bias corrected and accelerated bootstrap method [38-40] by case resampling (with replacement) in 999 random bootstrap samples.

To examine possible associations among current BMI, eating attitudes, and psychosocial variables for the total sample and each weight history, we calculated Pearson's correlation coefficients. A Bonferroni adjustment for multiple comparisons was used to set statistical significance at $P < 0.001$ for correlation analyses. To examine predictors of current BMI for each of the four weight history groups as well as for the total sample, we used stepwise multiple linear regression analysis. Five regressions were performed (one for each weight history group and one for the total sample). For each regression analysis, BMI was the dependent variable, and the following nine independent variables were available for entry: scores for dietary restraint, disinhibition, hunger, self-esteem, social physique anxiety, and WLOC; current age; menopausal age; and current weekly hours of exercise. For the regression run in the total sample, the three dummy variables coding weight history group were also available for selection. For each step in each regression, the criterion for a variable to enter the regression equation was $P < 0.05$ and the criterion for its exclusion in subsequent steps was $P > 0.10$. Regression analyses were conducted using *Arc* statistical software (version 1.06, St. Paul: University of Minnesota) with the bootstrapping add-on [41, 42], and all other analyses were conducted using SPSS for Windows (version 11.5, Chicago: SPSS Inc.).

5.3 Results

5.3.1 Descriptive and weight-related characteristics

Mean age for all participants was 59.8 ± 6.8 years, menopausal age was 11.3 ± 8.6 years, and weekly exercise was 4.3 ± 3.7 hours. As a whole, the sample had a mean BMI of 24.8 ± 4.5, which is at the upper limit of the normal weight category [22]. The majority was White (n = 936; 87%) and had never smoked (n = 653; 61%). Among the total sample, 736 (69%) had completed postsecondary school, 467 (44%) had an annual income >$50,000, 175 (16%) were using HRT medication, and 76 (7%) were vegetarian. Weight history groups did not differ in education, income, HRT use, or % vegetarian (**Appendix 29**).

However, 10-year weight history was associated with several differences in descriptive and weight-related characteristics, as shown in **Table 5.1**. Age, but not menopausal age, was significantly different among the weight history groups. On average, women who gained weight or experienced weight cycling were younger than those who had maintained their weight. Height did not differ between groups, but both weight and BMI were lowest in the group of women who had maintained their weight. Weekly exercise was lowest among those who gained weight, with women in that group reporting, on average, 1.4 hours less activity per week. Greater proportions of the gained weight and weight cycled groups were White, and women who had maintained their weight were more likely to report never having smoked.

The median absolute weight change was similar among groups reporting a change in weight over the past 10 years, also shown in **Table 5.1**. However, when weight change was calculated as a percentage of weight 10 years ago, we found that the gained weight group gained a greater proportion of their body weight than the lost weight group lost (13% versus 11%, $t = -2.56$, $P = 0.01$). The proportion of each group classified as overweight or obese was highest among those who had gained weight or experienced weight cycling, and lowest among those who had maintained their weight. Controlling for current BMI, women who had gained weight

Table 5.1: Descriptive and weight-related characteristics of postmenopausal women grouped according to self-reported 10-year weight history

	Maintained weight (n = 350)	Lost weight (n = 152)	Gained weight (n = 384)	Weight cycled (n = 169)
Age (years)	61.1 ± 7.0	60.2 ± 6.2	59.3 ± 6.8	58.2 ± 6.6
Difference (95% CI) from weight maintainers	–	-0.9 (-2.1, 0.3)	-1.7 (-2.7, -0.7)***	-2.8 (-4.1, -1.7)***
Menopausal age (years)	12.0 ± 8.9	10.7 ± 7.7	11.3 ± 9.4	10.2 ± 8.3
Height (cm)	163.2 ± 6.7	163.2 ± 7.0	163.5 ± 6.6	164.0 ± 6.9
Weight (kg)	59.4 ± 9.3	64.3 ± 11.3	71.9 ± 13.6	69.3 ± 12.2
Difference (95% CI) from weight maintainers	–	4.9 (2.8, 7.0)***	12.5 (10.9, 14.3)***	9.9 (7.9, 12.2)***
BMI (kg/m^2)	22.3 ± 3.1	24.2 ± 4.1	26.9 ± 4.7	25.7 ± 4.1
Difference (95% CI) from weight maintainers	–	1.9 (1.2, 2.6)***	4.6 (4.0, 5.2)***	3.5 (2.7, 4.2)***
Exercise (hours/week)	4.0 (2.5 – 6.0)	4.0 (2.5 – 6.8)	3.0 (1.5 – 5.0)	4.0 (2.0 – 5.0)
Difference (95% CI) from weight maintainers	–	-0.2 (-0.9, 0.7)	-1.4 (-2.0, -0.9)***	-0.9 (-1.6, -0.2)**
Ethnicity***				
n (%) White	294 (85%)	128 (85%)	347 (91%)	153 (91%)
n (%) Chinese	36 (10%)	10 (7%)	12 (3%)	4 (2%)
n (%) Other	18 (5%)	12 (8%)	24 (6%)	12 (7%)
Smoking history***				
n (%) Current	14 (4%)	6 (4%)	22 (6%)	20 (12%)
n (%) Past	91 (26%)	53 (35%)	130 (34%)	62 (37%)
n (%) Never	243 (70%)	91 (61%)	232 (60%)	87 (52%)
Absolute weight change in past 10 years (kg)	–	6.8 (4.5 – 11.3)	6.8 (4.5 – 9.1)	6.8 (4.5 – 11.3)
n (%) BMI 25–29.9***	44 (14%)	41 (28%)	147 (39%)	64 (39%)
n (%) BMI ≥30***	11 (3%)	10 (7%)	77 (20%)	22 (13%)
Feel overweight	3.3 ± 0.7	3.5 ± 0.7	4.2 ± 0.6	4.0 ± 0.7
Difference (95% CI) from weight maintainers	–	-0.04 (-0.1, 0.1)	0.4 (0.3, 0.5)***	0.3 (0.2, 0.4)***
n (%) trying to lose weight***	98 (28%)	62 (41%)	280 (74%)	119 (71%)

Notes: Values are mean ± SD, median (interquartile range), or n (%). Groups with a history of weight change (lost, gained, cycled) were compared to weight maintainers using dummy codes in multiple regression; significant differences are shown as adjusted difference from weight maintainers (95% CI). Menopausal age refers to the number of years passed since the last menstrual cycle. BMI was included as a covariate for feeling overweight. Categorical differences were examined with chi square.

** $P < 0.01$ ***$P < 0.001$ (for difference from maintained weight group).

or experienced weight cycling both felt more overweight than women who had maintained their weight. Women in the gained weight and weight cycled groups were also more likely to report a current weight loss effort (current dieting).

It was interesting to note that regardless of weight history, a greater proportion of women indicated that they thought that they were overweight than would actually be classified as overweight or obese according to WHO criteria [22]. In the maintained weight group, only 17% were classified as either overweight or obese on the basis of BMI calculated from self-reported height and weight, but 37% reported thinking that they were currently overweight. Similar differences were observed in the other weight history groups: among those who lost weight, 35% were overweight or obese and 48% reported thinking they were overweight; in the gained weight group, 59% were overweight or obese and 93% reported thinking they were overweight; and in the weight cycled group, 52% were overweight or obese and 80% reported thinking they were overweight. This pattern did not change when 0.9 kg/m^2 was added to BMI estimates (the mean difference between self-reported and measured BMI in the subsample for which direct measurement was available, as indicated below).

5.3.2 Accuracy of reported height and weight

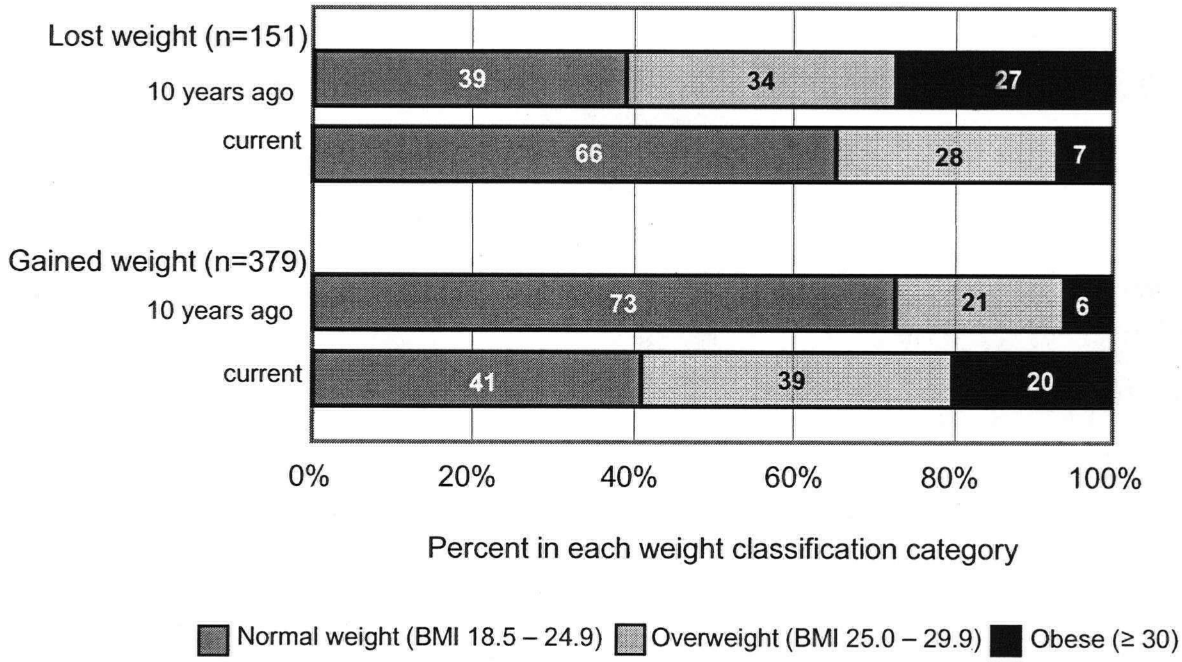
The accuracy of self-reported height and weight was examined in a subset of 78 women who participated in a second study of nutrition, stress, and bone health [23]. Self-reported and measured height and weight were highly correlated ($r = 0.96$ for height and $r = 0.95$ for weight, both $P < 0.0001$). Mean BMI from self-reported data was 22.1 ± 1.8, whereas BMI calculated from measurements of height and weight was 23.0 ± 2.2. Only three (4%) participants *under*estimated their height by ≥ 2 cm, but 30 (39%) *over*estimated their height by at least 2 cm. Bias in the opposite direction was observed with self-reported weight. Current weight was *under*estimated by ≥ 1 kg in 39 (50%) participants and *over*estimated by at least that amount in only seven (9%) participants. BMI based on self-reported height and weight was strongly correlated with measured BMI ($r = 0.89$, $P < 0.0001$). The combined effect of bias in height and weight estimated was indicated by the finding that measured BMI was ≥ 1 kg/m^2 *less* than reported BMI in only one (1%) participant, whereas measured BMI was ≥ 1 kg/m^2 *more* than reported in 31 (40%) participants.

5.3.3 Changes in BMI and body weight classification over 10 years

Among women who lost weight, BMI decreased from 27.4 ± 5.3 to 24.2 ± 4.1 over 10 years, whereas among women who gained weight, BMI increased from 23.6 ± 3.5 to 26.9 ± 4.7 in that time. As illustrated in **Figure 5.1**, the lost weight and gained weight groups demonstrated notable shifts in the distribution of body weight classification over 10 years. As a group, the majority of women who gained weight (73%) had a BMI in the normal weight range [22] 10 years ago, but after weight gain, the majority (59%) was now classified as either overweight or obese. Conversely, among women who had lost weight, the majority (61%) had a BMI in the range for either overweight or obese 10 years ago, but after weight loss, the majority (66%) was now classified as having a BMI in the normal range. At the individual level, body weight classification changed for 71 (48%) of the women who lost weight and 159 (44%) of the women who gained weight.

Among women who lost weight in the past 10 years, although dietary restraint was not associated with current BMI, it was positively associated with the *amount* of weight lost ($r = 0.21$, $P = 0.01$). In that group, the amount of weight lost over 10 years was also positively associated with scores for disinhibition ($r = 0.28$, $P = 0.001$) and hunger ($r = 0.18$, $P = 0.03$). Among women who had gained weight in the past 10 years, there was no association between dietary restraint and the amount of weight gained ($r = -0.02$, $P = 0.66$). The amount of weight

Figure 5.1: Body weight classification shifted towards normal weight among women who lost weight and towards overweight and obese among women who gained weight



Note: the n for each group is the number providing sufficient data for the calculation of BMI.

gained was, however, positively associated with disinhibition ($r = 0.36$) and hunger ($r = 0.23$), both $P < 0.0001$.

5.3.4 Differences in eating attitudes and psychosocial characteristics

Table 5.2 shows mean scores for eating attitudes and psychosocial characteristics, and compares scores from women who experienced a weight change to those who maintained their weight. All comparisons were controlled for current age and BMI. Women who lost weight or experienced weight cycling had higher dietary restraint than those who had maintained their weight or gained weight. A similar pattern was observed with scores for the flexible and rigid dimensions of dietary restraint (**Appendix 30**). Disinhibition of eating control and perceived hunger were lowest among women who had maintained their weight over the past 10 years, and highest among those who had gained weight or experienced weight cycling. Similar results were obtained on comparisons of habitual disinhibition, situational disinhibition, and external locus for hunger; however, there were no differences between groups in emotional disinhibition or internal locus for hunger (**Appendix 30**). Self-esteem was lowest among women who had gained weight in the past 10 years (note: lower self-esteem is reflected by a higher score). Social physique anxiety was greatest among women who had gained weight or experienced weight cycling. Women who lost weight had a slightly lower score for WLOC than those who had maintained their weight (reflecting a more inward orientation, consistent with the belief that changes in their body weight are under their personal control).

5.3.5 Associations of current BMI with eating attitudes and psychosocial characteristics

For the total sample, higher BMI was associated with higher scores for disinhibition and hunger, lower self-esteem, greater social physique anxiety, and a more external WLOC **(Table**

Table 5.2: Eating attitudes and psychosocial characteristics in postmenopausal women grouped according to self-reported 10-year weight history

	Maintained weight (n = 350)	Lost weight (n = 152)	Gained weight (n = 384)	Weight cycled (n = 169)
Dietary restraint				
Unadjusted score	9.1 ± 4.3	11.1 ± 4.6	9.3 ± 4.2	10.9 ± 4.4
Difference (95% CI) from weight maintainers	–	2.1 (1.2, 3.0)***	0.5 (-0.2, 1.2)	2.1 (1.2, 2.9)***
Disinhibition				
Unadjusted score	3.5 ± 3.1	5.4 ± 4.0	6.7 ± 4.3	7.1 ± 4.1
Difference (95% CI) from weight maintainers	–	1.1 (0.5, 1.8)***	1.2 (0.7, 1.8)***	1.9 (1.3, 2.7)***
Hunger				
Unadjusted score	3.2 ± 2.8	3.8 ± 3.2	4.9 ± 3.5	4.9 ± 3.4
Difference (95% CI) from weight maintainers	–	0.3 (-0.3, 0.9)	0.7 (0.3, 1.2)**	0.9 (0.3, 1.5)**
Self-esteem				
Unadjusted score	1.0 ± 1.7	1.1 ± 1.7	1.7 ± 2.1	1.6 ± 2.1
Difference (95% CI) from weight maintainers	–	-0.06 (-0.4, 0.3)	0.4 (0.1, 0.7)*	0.3 (-0.1, 0.6)
Social physique anxiety				
Unadjusted score	27.9 ± 8.6	31.2 ± 10.0	36.4 ± 10.0	36.3 ± 10.0
Difference (95% CI) from weight maintainers	–	1.4 (-0.4, 3.2)	4.3 (3.0, 6.0)***	4.6 (2.7, 6.4)***
Weight locus of control				
Unadjusted score	8.1 ± 3.3	7.2 ± 3.0	9.0 ± 3.2	8.5 ± 3.8
Difference (95% CI) from weight maintainers	–	-1.1 (-1.7, -0.5)**	0.3 (-0.2, 0.9)	-0.1 (-0.8, 0.6)

Notes: Scores are presented as unadjusted mean ± SD. Higher scores on the self-esteem scale reflect *lower* self-esteem. All comparisons included age and BMI as covariates. Differences from weight maintainers were calculated with multiple regression and are based on covariate-adjusted means.

$^*P < 0.05$ $^{**}P < 0.01$ $^{***}P < 0.001$ (for difference from maintained weight group).

5.3). Dietary restraint was not associated with current BMI. However, the flexible and rigid dimensions of dietary restraint showed opposite associations: flexible restraint was negatively associated with BMI whereas rigid restraint showed a positive association. Correlations obtained with the habitual, emotional, and situational aspects of disinhibition were consistent with those found with the total disinhibition score; likewise, internal and external hunger scores were associated with BMI in much the same way as total hunger.

Associations of BMI with eating attitudes and psychosocial characteristics were also examined within each weight history group, and these are also presented in **Table 5.3**. Consistent positive associations were noted for disinhibition, hunger, and social physique anxiety (although the association between hunger and BMI was not considered statistically significant for the weight cycled group). However, some factors showed different patterns of association in different weight history groups. Although no aspect of dietary restraint was associated with current BMI for the maintained weight, lost weight, or gained weight groups, dietary restraint (and flexible restraint in particular) showed a significant negative association with current BMI among women who reported weight cycling over 10 years. And although an inverse association between self-esteem and BMI was noted for the sample as a whole, when weight history groups were examined separately, this association was only observed among women who had gained weight in the past 10 years.

5.3.6 Predictors of current BMI according to 10-year weight history

Table 5.4 shows the results of stepwise multiple linear regression analyses to determine the predictors of current BMI in each of the four weight history groups. Disinhibition and age were positive predictors of BMI for each group (although it was menopausal age rather than age that entered the regression equation in the weight cycled group). Disinhibition consistently

Table 5.3: Correlations of eating attitudes and psychosocial characteristics with current BMI among postmenopausal women in the total sample and each weight history group

	Total sample (n = 1071)	Maintained weight (n = 350)	Lost weight (n = 152)	Gained weight (n = 384)	Weight cycled (n = 169)
Dietary restraint	-0.01	0.08	0.09	-0.03	-0.25***
Flexible control	-0.15***	-0.02	-0.05	-0.15	-0.33***
Rigid control	0.12***	0.08	0.22**	0.11	-0.05
Disinhibition	0.50***	0.37***	0.45***	0.45***	0.33***
Habitual	0.46***	0.32***	0.36***	0.45***	0.30***
Emotional	0.38***	0.29***	0.28***	0.36***	0.26***
Situational	0.38***	0.28***	0.41***	0.31***	0.24**
Hunger	0.31***	0.20***	0.29***	0.27***	0.18*
Internal locus	0.24***	0.14	0.24***	0.23***	0.14
External locus	0.32***	0.23***	0.30***	0.28***	0.19*
Self-esteem	0.20***	0.06	-0.03	0.26***	-0.01
Social physique anxiety	0.46***	0.28***	0.35***	0.42***	0.28***
Weight locus of control	0.15***	0.02	0.22**	0.12*	0.18*

Notes: higher scores on the self-esteem scale reflect *lower* self-esteem. Using a Bonferroni correction for multiple comparisons, a P < 0.001 (denoted by ***) is considered significant.

* $P < 0.05$ **$P < 0.01$ *** $P < 0.001$

Table 5.4: Results of separate stepwise multiple linear regression analyses to determine predictors of current BMI among postmenopausal women with different self-reported 10-year weight histories

Variable	B (95% CI)	β	R^2	R^2 change	*P*
Maintained weight (n = 343)[a]					
Disinhibition	0.335 (0.227, 0.443)	0.333	0.138	0.138	<0.001
Age	0.125 (0.082, 0.168)	0.284	0.212	0.074	<0.001
Social physique anxiety	0.075 (0.033, 0.118)	0.209	0.234	0.023	0.001
Self-esteem	-0.255 (-0.469, -0.040)	-0.135	0.249	0.015	0.02
Exercise	-0.078 (-0.151, -0.004)	-0.106	0.259	0.010	0.04
Lost weight (n = 151)[b]					
Disinhibition	0.460 (0.313, 0.608)	0.462	0.199	0.199	<0.001
Age	0.142 (0.045, 0.239)	0.216	0.244	0.046	0.004
Weight locus of control	0.238 (0.038, 0.437)	0.174	0.274	0.030	0.02
Gained weight (n = 379)[c]					
Disinhibition	0.356 (0.235, 0.476)	0.327	0.205	0.205	<0.001
Social physique anxiety	0.111 (0.060, 0.163)	0.239	0.240	0.035	<0.001
Age	0.086 (0.024, 0.147)	0.125	0.255	0.015	0.007
Weight cycled (n = 166)[d]					
Disinhibition	0.383 (0.237, 0.528)	0.382	0.111	0.111	<0.001
Dietary restraint	-0.188 (-0.320, -0.056)	-0.201	0.165	0.054	0.005
Exercise	-0.235 (-0.396, -0.075)	-0.209	0.201	0.036	0.004
Menopausal age	0.075 (0.003, 0.146)	0.151	0.222	0.021	0.04

Note: the n available for each regression was the number of participants in each group providing sufficient data for the calculation of BMI.

[a] Variables which did not enter the regression: dietary restraint, hunger, weight locus of control, menopausal age.

[b] Variables which did not enter the regression: dietary restraint, hunger, self-esteem, social physique anxiety, menopausal age, exercise.

[c] Variables which did not enter the regression: dietary restraint, hunger, self-esteem, weight locus of control, menopausal age, exercise.

[d] Variables which did not enter the regression: hunger, self-esteem, social physique anxiety, weight locus of control, age.

predicted the most variance in BMI, regardless of 10-year weight history (11% to 20% of the variance in the different weight history groups). Among women who had maintained their weight, other significant predictors of current BMI were social physique anxiety (accounting for 2.3% of the variance in BMI), self-esteem (accounting for 1.5% of the variance), and current exercise (accounting for 1.0% of the variance). For the group of women who reported having lost weight, WLOC was the only additional significant predictor of current BMI, accounting for 3.0% of the variance. For women who reported a history of weight gain, social physique anxiety was the only additional significant predictor of current BMI (predicting 3.5% of the variance). The only group for which dietary restraint was a significant predictor of current BMI was the weight cycled group; for those women, dietary restraint negatively predicted current BMI, accounting for 5.4% of the variance. Exercise was also a significant negative predictor of current BMI in that group (predicting 3.6% of the variance).

A similar analysis was conducted to determine significant predictors of current BMI for the total sample (**Appendix 31**). Once again, disinhibition was the first variable to enter, and accounted for the most variance in BMI ($R^2 = 0.252$, $P<0.001$). This was followed by history of weight gain in the past 10 years (R^2 change = 0.066; $P < 0.001$). Social physique anxiety and current age each positively predicted slightly more than 2% of the variance in current BMI, and history of weight cycling accounted for 1.3% of the variance. Other positive predictor variables to enter the regression included history of weight loss and WLOC, and negative predictors included current weekly exercise, self-esteem, and hunger (although each of these additional variables was statistically significant, the size of the effects were not large – each accounted for < 1% of the total variance in BMI). The only variables not to enter the regression equation in the total sample were dietary restraint and menopausal age.

5.4 Discussion

This study provides unique insights into characteristics of women with various weight histories (weight maintenance, loss, gain, or cycling). We found both striking similarities and clear differences between weight history groups. Disinhibition of eating control, rather than dietary restraint, emerged as the most important variable in predicting current BMI irrespective of weight history, consistently accounting for the greatest amount of variance in BMI for each weight history group and for the total sample. Differences in adult weight history are likely due to a variety of factors [43], although previous studies suggested the importance of disinhibition in predicting adult BMI and weight gain [44]. Yet, this study was the first to examine disinhibition and other factors related to body weight in the context of postmenopausal women's weight history. Finding that disinhibition was the most important predictor of current BMI across weight history groups has implications for obesity prevention initiatives, suggesting that health promotion strategies should focus on reducing disinhibition rather than increasing dietary restraint. And the relatively positive profile of weight maintainers (with respect to current BMI and psychosocial characteristics) supports an emphasis on weight maintenance (versus weight loss) as a health target.

At a population level, individuals' weight history is an important contributor to BMI, as evidenced by the fact that variables for all three weight history patterns entered the regression to predict current BMI for the total sample. Although the analyses reported in **Table 5.1** had demonstrated that, on average, each group experiencing weight change in the past 10 years had higher BMI than weight maintainers, the regression to predict BMI in the total sample confirmed that these differences persist in an analysis which also controlled for additional weight-related factors (including psychosocial, demographic, and lifestyle characteristics).

Although participants were not selected on the basis of their 10-year weight history, we found that weight history varied substantially: approximately one third of our survey respondents reported having maintained their weight over the past 10 years, one third had gained weight, and roughly equal proportions of the remainder had lost weight or experienced weight cycling. The change in body weight among those who lost or gained weight (11–13 % of their body weight 10 years ago) was sufficient to change the weight classification category for 43% of those experiencing weight changes. This magnitude of change in weight is consistent with what has previously been associated with improvement (in the case of weight loss) or deterioration (in the case of weight gain) of various health parameters [45-47]. For example, Truesdale and colleagues analyzed data from >15 000 participants in the prospective Atherosclerosis Risk in Communities (ARIC) study and found that overweight adults who lost weight and attained normal weight status had lower total and LDL cholesterol and similar HDL and triglyceride levels when compared to normal weight adults with a history of weight maintenance [45]. As a group, the majority of study participants with a history of weight gain shifted from normal weight 10 years ago to overweight and obese today. This could be associated with increased risk for adverse health outcomes [3, 4] and underscores the importance of weight gain prevention, and possibly weight loss promotion, among those who have gained weight.

It was interesting to observe that differences in psychosocial variables between weight history groups persisted when analyses controlled for BMI, given that not all previous work has examined differences independent of BMI. For example, overweight and obesity have sometimes been associated with reduced self-esteem [48], although this has not always been the case [49]. Our findings clarify and extend these observations by controlling for the effects of current BMI and examining the association between BMI and self-esteem in the context of 10 year weight history. We found that women who had gained weight had lower self-esteem than those who had maintained their weight, and it was only among women who had gained weight that BMI was correlated with lower values for self-esteem. Controlling for current BMI, women who had gained weight or experienced weight cycling also felt more overweight than those who had maintained their weight.

Based on past reports that the factors measured by the TFEQ may not be univariate in nature [25, 26], we measured components of dietary restraint, disinhibition, and hunger. We found that the distinction between rigid and flexible control of eating may be useful when considering the construct of dietary restraint. Although dietary restraint was not associated with BMI in the sample as a whole, flexible restraint showed a significant negative correlation, and rigid restraint showed a significant positive correlation, with current BMI. Past researchers have reported similar results [26, 50]. However, the distinction between rigid and flexible restraint was not consistent among weight history subgroups. Also, the proposed components of disinhibition and hunger generally matched the results of the total disinhibition and hunger scores, and did not seem to contribute clarity to our understanding of the relationship between these aspects of eating and weight-related variables.

This investigation provided interesting insights into the correlates of current weight and weight history in postmenopausal women and presented striking evidence of the importance of disinhibition in predicting BMI, irrespective of weight history. However, this study was limited by its cross-sectional retrospective design and its reliance on self-reported height and weight. When accuracy of self-reported data was examined by direct measurement of height and weight in a subset of 78 participants, we found that weight was under-reported by a mean of 1.2 kg. Roberts obtained a similar result in Welsh adults aged 18–64 years: women in that study under-reported their weight by 1.1 kg [51]. Yet the underestimation of weight tends to be greater among heavier women [52], and our validation of self-reported estimates was in women largely classified as normal weight. Thus, it is possible that there could be a bias in the accuracy of BMI estimates associated with weight. Furthermore, although we considered predictors of current BMI for different weight history groups, these cross-sectional data cannot indicate whether variables associated with BMI contribute to, or result from, higher BMI. It seems possible that disinhibition of eating control may lead to higher BMI, and that differences in factors such as self-esteem and social physique anxiety may be a consequence of changes in body weight; however, prospective data would be required to confirm these relationships.

Despite these limitations, this exploration of reported 10-year weight history in postmenopausal women has yielded several interesting insights that are worthy of further study. Prospective data with periodic measurements of height, weight, eating attitudes, and psychosocial variables are needed to confirm the relationships suggested by this study. Intervention trials targeted at reducing disinhibition are also warranted.

5.5 References

1. Mokdad AH, Ford ES, Bowman BA, Dietz WH, Vinicor F, Bales VS, Marks JS. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *JAMA* 2003; 289: 76-9.

2. Katzmarzyk PT. The Canadian obesity epidemic, 1985-1998. *CMAJ* 2002; 166: 1039-40.

3. Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. The disease burden associated with overweight and obesity. *JAMA* 1999; 282: 1523-9.

4. Zamboni M, Mazzali G, Zoico E, Harris TB, Meigs JB, Di Francesco V, Fantin F, Bissoli L, Bosello O. Health consequences of obesity in the elderly: a review of four unresolved questions. *Int J Obes (Lond)* 2005; 29: 1011-29.

5. Boyd GS, Koenigsberg J, Falkner B, Gidding S, Hassink S. Effect of obesity and high blood pressure on plasma lipid levels in children and adolescents. *Pediatrics* 2005; 116: 442-6.

6. Hannon TS, Rao G, Arslanian SA. Childhood obesity and type 2 diabetes mellitus. *Pediatrics* 2005; 116: 473-80.

7. Lissner L, Sjostrom L, Bengtsson C, Bouchard C, Larsson B. The natural history of obesity in an obese population and associations with metabolic aberrations. *Int J Obes Relat Metab Disord* 1994; 18: 441-7.

8. He XZ, Baker DW. Changes in weight among a nationally representative cohort of adults aged 51 to 61, 1992 to 2000. *Am J Prev Med* 2004; 27: 8-15.

9. Sternfeld B, Wang H, Quesenberry CP, Jr., Abrams B, Everson-Rose SA, Greendale GA, Matthews KA, Torrens JI, Sowers M. Physical activity and changes in weight and waist circumference in midlife women: findings from the study of women's health across the nation. *Am J Epidemiol* 2004; 160: 912-22.

10. Wing RR, Matthews KA, Kuller LH, Meilahn EN, Plantinga PL. Weight gain at the time of menopause. *Arch Intern Med* 1991; 151: 97-102.

11. Sammel MD, Grisso JA, Freeman EW, Hollander L, Liu L, Liu S, Nelson DB, Battistini M. Weight gain among women in the late reproductive years. *Fam Pract* 2003; 20: 401-9.

12. Macdonald HM, New SA, Campbell MK, Reid DM. Longitudinal changes in weight in perimenopausal and early postmenopausal women: effects of dietary energy intake, energy expenditure, dietary calcium intake and hormone replacement therapy. *Int J Obes Relat Metab Disord* 2003; 27: 669-76.

13. Trentham-Dietz A, Newcomb PA, Egan KM, Titus-Ernstoff L, Baron JA, Storer BE, Stampfer M, Willett WC. Weight change and risk of postmenopausal breast cancer (United States). *Cancer Causes Control* 2000; 11: 533-42.

14. Lahmann PH, Schulz M, Hoffmann K, Boeing H, Tjonneland A, Olsen A, Overvad K, Key TJ, Allen NE, Khaw KT, Bingham S, Berglund G, Wirfalt E, Berrino F, Krogh V, Trichopoulou A, Lagiou P, Trichopoulos D, Kaaks R, Riboli E. Long-term weight change and breast cancer risk: the European prospective investigation into cancer and nutrition (EPIC). *Br J Cancer* 2005; 93: 582-9.

15. Trentham-Dietz A, Nichols HB, Hampton JM, Newcomb PA. Weight change and risk of endometrial cancer. *Int J Epidemiol* 2005: dyi226.

16. Wannamethee SG, Shaper AG. Weight change and duration of overweight and obesity in the incidence of type 2 diabetes. *Diabetes Care* 1999; 22: 1266-72.

17. Juhaeri, Stevens J, Chambless LE, Nieto FJ, Jones D, Schreiner P, Arnett D, Cai J. Associations of weight loss and changes in fat distribution with the remission of hypertension in a bi-ethnic cohort: the Atherosclerosis Risk in Communities study. *Prev Med* 2003; 36: 330-9.

18. Meyer HE, Tverdal A, Selmer R. Weight variability, weight change and the incidence of hip fracture: a prospective study of 39,000 middle-aged Norwegians. *Osteoporos Int* 1998; 8: 373-8.

19. Stunkard AJ, Messick S. The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *J Psychosom Res* 1985; 29: 71-83.

20. Lindroos A, Lissner L, Mathiassen M, Karlsson J, Sullivan M, Bengtsson C, Sjostrom L. Dietary intake in relation to restrained eating, disinhibition, and hunger in obese and nonobese Swedish women. *Obes Res* 1997; 5: 175-82.

21. Dykes J, Brunner EJ, Martikainen PT, Wardle J. Socioeconomic gradient in body size and obesity among women: the role of dietary restraint, disinhibition and hunger in the Whitehall II study. *Int J Obes* 2004; 28: 262-8.

22. World Health Organization. *Obesity: Preventing and Managing the Global Epidemic: Report of the WHO Consultation on Obesity*. Geneva: WHO, 1997.

23. Rideout CA, Linden W, Barr SI. High cognitive dietary restraint is associated with increased cortisol excretion in postmenopausal women. *J Gerontol A Biol Sci Med Sci* 2006; 61A: 628-33.

24. Guest NS, Barr SI. Cognitive dietary restraint is associated with stress fractures in women runners. *Int J Sport Nutr Exerc Metab* 2005; 15: 147-59.

25. Bond MJ, McDowell AJ, Wilkinson JY. The measurement of dietary restraint, disinhibition and hunger: an examination of the factor structure of the Three Factor Eating Questionnaire (TFEQ). *Int J Obes Relat Metab Disord* 2001; 25: 900-6.

26. Westenhoefer J, Stunkard AJ, Pudel V. Validation of the flexible and rigid control dimensions of dietary restraint. *Int J Eat Disord* 1999; 26: 53-64.

27. Oliver G, Wardle J. Perceived effects of stress on food choice. *Physiol Behav* 1999; 66: 511-5.

28. Lowe MR, Timko CA. What a difference a diet makes: towards an understanding of differences between restrained dieters and restrained nondieters. *Eat Behav* 2004; 5: 199-208.

29. Neumark-Sztainer D, Jeffery RW, French SA. Self-reported dieting: How should we ask? What does it mean? Associations between dieting and reported energy intake. *Int J Eat Disord* 1997; 22: 437-49.

30. Rosenberg M. *The measurement of self-esteem. Society and the adolescent self image.* Princeton, New Jersey: Princeton University Press, 1965.

31. Salyers MP, McHugo GJ, Cook JA, Razzano LA, Drake RE, Mueser KT. Reliability of instruments in a cooperative, multisite study: employment intervention demonstration program. *Ment Health Serv Res* 2001; 3: 129-39.

32. Hart EA, Leary MR, Rejeski WJ. The measurement of social physique anxiety. *Journal of Sport and Exercise Psychology* 1989; 11: 94-104.

33. Lantz CD, Hardy CJ, Ainsworth BE. Social physique anxiety and perceived exercise behavior. *Journal of Sport Behavior* 1997; 20: 83-93.

34. Ransdell LB, Wells CL, Manore MM, Swan PD, Corbin CB. Social physique anxiety in postmenopausal women. *J Women Aging* 1998; 10: 19-39.

35. Saltzer EB. The weight locus of control (WLOC) scale: a specific measure for obesity research. *J Pers Assess* 1982; 46: 620-8.

36. Holt CL, Clark EM, Kreuter MW. Weight locus of control and weight-related attitudes and behaviors in an overweight population. *Addict Behav* 2001; 26: 329-40.

37. Statistics Canada. Canadian Census long form questionnaire, 2001. Retrieved April 20, 2006 from http://www.statcan.ca/english/sdds/instrument/3901_Q2_V2_E.pdf.

38. Pardoe I. An Introduction to Bootstrap Methods using Arc. St. Paul: University of Minnesota, 2000: Available at http://www.stat.umn.edu/arc/bootmeth.pdf.

39. Efron B, Tibshirani RJ. *An Introduction to the Bootstrap.* New York: Chapman and Hall, 1993.

40. Davison AC, Hinkley DV. *Bootstrap Methods and their Application.* New York: Cambridge University Press, 1997.

41. Cook RD, Weisberg S. *Applied regression including computing and graphics.* St. Paul, Minnesota: John Wiley & Sons, Inc, 1999.

42. *Arc* version 1.06. St. Paul: University of Minnesota, 2004. Available at http://www.stat.umn.edu/arc/software.html.

43. McCrory MA, Suen VMM, Roberts SB. Biobehavioral influences on energy intake and adult weight gain. *J Nutr* 2002; 132: 3830-4.

44. Hays NP, Bathalon GP, McCrory MA, Roubenoff R, Lipman R, Roberts SB. Eating behavior correlates of adult weight gain and obesity in healthy women aged 55-65 y. *Am J Clin Nutr* 2002; 75: 476-83.

45. Truesdale KP, Stevens J, Cai J. The effect of weight history on glucose and lipids: the Atherosclerosis Risk in Communities study. *Am J Epidemiol* 2005; 161: 1133-43.

46. Goldstein DJ. Beneficial health effects of modest weight loss. *Int J Obes Relat Metab Disord* 1992; 16: 397-415.

47. Colditz GA, Willett WC, Rotnitzky A, Manson JE. Weight gain as a risk factor for clinical diabetes mellitus in women. *Ann Intern Med* 1995; 122: 481-6.

48. French SA, Perry CL, Leon GR, Fulkerson JA. Self-esteem and change in body mass index over 3 years in a cohort of adolescents. *Obes Res* 1996; 4: 27-33.

49. Gortmaker SL, Must A, Perrin JM, Sobol AM, Dietz WH. Social and economic consequences of overweight in adolescence and young adulthood. *N Engl J Med* 1993; 329: 1008-12.

50. Provencher V, Drapeau V, Tremblay A, Despres JP, Lemieux S. Eating behaviors and indexes of body composition in men and women from the Quebec family study. *Obes Res* 2003; 11: 783-92.

51. Roberts RJ. Can self-reported data accurately describe the prevalence of overweight? *Public Health* 1995; 109: 275-84.

52. Spencer EA, Appleby PN, Davey GK, Key TJ. Validity of self-reported height and weight in 4808 EPIC-Oxford participants. *Public Health Nutr* 2002; 5: 561-5.

CHAPTER 6

CONCLUSION

6.1 General conclusions

This research was the first to explore relationships among cognitive dietary restraint, stress, and cortisol in postmenopausal women. It also makes significant contributions to our understanding of how teenage physical activity may be related to postmenopausal bone health more than four decades later; how dieting and dietary restraint relate to one another; and how BMI, eating attitudes and psychosocial characteristics can vary in association with 10-year weight history.

Each investigation reported herein focused on the role of some aspect of everyday activity in postmenopausal women's health. Few things are as embedded in our daily lives as eating and physical activity, or have such capacity to influence health. Dietary restraint is a subtle characteristic, yet, as shown in Chapter 2, there was a difference in cortisol excretion between women with high versus low restraint. Although the possible health implications of this difference require clarification, this increase in allostatic load may contribute to diminished health in various ways [1]. Whether bone health may be affected by this difference in cortisol excretion remains unclear; dietary restraint with its associated increase in cortisol excretion did not show associations with body composition (BMD, BMC, or % body fat) in our sample. However, an important finding, reported in Chapter 3, was that leisure physical activity reported for the teen years predicted postmenopausal BMD. Although several studies had suggested that young athletes go on to have higher bone mass in adulthood compared to peers who had not engaged in athletic activity as youths [2-4], it was less clear whether nonathletic leisure activity during youth could also have sustained benefits for bone [5-7]. Our finding that teenage leisure activity predicted approximately 10% of the variance in postmenopausal BMD at both the lumbar spine and mean proximal femora supports the role of peak bone mass in risk for osteoporosis decades later. Our comparison of dieting and dietary restraint, reported in Chapter 4, makes an important contribution to the literature in that area. Debate regarding how, or if, the two concepts are related has occurred intermittently for almost two decades [8-14]. Our analysis revealed that some aspects of restraint theory were supported (e.g., the connection between dietary restraint and disinhibition in dieters). However, dietary restraint as measured by the TFEQ-R actually differed a great deal from dieting (defined as a current effort to lose weight), suggesting that the two constructs should not be considered analogous. Finally, another aspect of body weight was considered in Chapter 5 by examining if dietary restraint, disinhibition, or other characteristics varied in terms of their ability to predict current BMI, depending on 10-year weight history. The finding that the majority of women in our sample (n = 705; 66%) had reported weight change (loss, gain, cycling) greater than 5 lbs in the past 10 years underscores the fluidity of body weight, and our need to better understand factors associated with weight change. Disinhibition emerged as the characteristic with the strongest association with BMI for each weight history group, suggesting that behavioural strategies to promote weight maintenance in adulthood should focus on the reduction of disinhibition rather than the increase of dietary restraint. A summary of the hypotheses of this research, and the relevant outcomes of the investigations, can be found in **Table 6.1**.

Prior to the completion of this research, little was known about the extent to which the concept of dietary restraint may be applicable to postmenopausal women. It was intuitively plausible that dietary restraint may be higher in postmenopausal women compared to younger women, given their longer exposure to societal norms for thinness and the changes in body weight associated with the menopausal transition. Yet it was also possible that postmenopausal women could be less restrained in their approach to eating, if with increased age comes increased acceptance of body size and reduced efforts to control it. Although Hays and colleagues [15, 16] had surveyed women aged 55–65 years in the Boston area and found a mean score for dietary restraint (measured by the TFEQ-R) which was slightly higher than that often reported in young women [17, 18], replication and extension of those findings were needed. In our broad survey of

Table 6.1: Summary of results in relation to hypotheses

Ch.	Research Question	Hypothesis (stated in the null form)	Result
2	Are there significant differences between postmenopausal women with high and low cognitive dietary restraint with respect to: urinary cortisol excretion, body composition, nature of dietary restraint (i.e., flexible vs. rigid control of eating), nutrition-related stress, overall perceived stress, or self-reported dietary intake?	Postmenopausal women classified as having high dietary restraint will not differ from those classified as having low dietary restraint with respect to each of those variables.	Women with high restraint had higher 24-hr cortisol excretion, but did not differ in body composition, nature of dietary restraint, reported stress, or dietary intake.
3	Do aspects of retrospectively self-reported lifetime physical activity predict current lumbar spine and dual proximal femora BMD in a sample of postmenopausal women?	Lifetime physical activity will not show an association with any measure of current BMD in generally healthy postmenopausal women.	Activity from 12–18 yrs, but not during other periods, positively predicted current lumbar spine and proximal femora BMD.
3	Do postmenopausal women who report engaging in more weight-bearing physical activity (WBPA) during the teen years have higher lumbar spine or dual proximal femora BMD than women who report engaging in less teen WBPA?	Postmenopausal women who report engaging in more teenage WBPA will not have higher current BMD than those reporting less teenage WBPA.	Women above the median of teenage WBPA had 8.4% higher lumbar spine and 5.3% higher proximal femora BMD.
4	Is the distribution of the scores for dietary restraint similar in postmenopausal women compared to young women?	Scores for dietary restraint will have the same distribution among postmenopausal women as they do among young women.	Restraint scores in this sample were similar to those in young women (slightly higher mean).
4	Are there significant differences between dietary restraint and dieting with respect to BMI and/or psychosocial variables such as social physique anxiety, awareness and internalization of sociocultural attitudes towards appearance, food choice motives, self-esteem, and weight locus of control in postmenopausal women?	Dietary restraint and dieting will not differ in their association with BMI, psychosocial characteristics, or motives for food choice.	Dietary restraint and dieting showed a different pattern of results (e.g., BMI was higher in dieters but lower in restrained eaters, dieters had lower self-esteem, etc.).
5	Do postmenopausal women who report having lost weight, gained weight, or experienced weight cycling in the past 10 years differ from those who report having maintained their weight within 5 lbs with respect to current BMI, dietary restraint, disinhibition, hunger, and weight-related psychosocial and lifestyle characteristics?	Postmenopausal women who differ in their 10-year weight history (maintenance, loss, gain, cycling) will not differ in current BMI, dietary attitudes, or weight related psychosocial and lifestyle characteristics.	Reported 10-yr weight history was associated with differences in BMI and other characteristics (e.g., weight maintainers had lowest BMI and disinhibition).
5	Do determinants of current BMI differ in postmenopausal women depending on whether they experienced weight maintenance, loss, gain, or cycling in the past 10 years?	Predictors of current BMI will not differ among women with different 10-year weight histories.	Some differences in predictors of BMI existed, but disinhibition consistently strongest predictor.

postmenopausal women aged 45–75 years (reported in Chapters 4 and 5), we found that scores for dietary restraint were roughly normally distributed, with a mean score of 9.8 (SD = 4.4). This is approximately one unit less (or, approximately 5% lower) than the mean score obtained by Hays and colleagues [15, 16], but it is also higher than scores typically reported for young women. This slight shift upwards in the distribution of dietary restraint (reflecting higher restraint) was further evidenced by the cut-off scores we used to identify women with high and low levels of dietary restraint for our study of cortisol excretion (reported in Chapter 2). As with similar studies, our upper quartile scored ≥ 13 on the TFEQ-R [19, 20], but our lower quartile included women with scores ≤ 6, which is one unit higher than the lower quartile boundary reported previously [19, 20]. These results suggest that postmenopausal women experience dietary restraint to the same, or greater, extent as younger women.

With this knowledge of the relevance of dietary restraint to postmenopausal women comes renewed appreciation of the importance of understanding its implications. In fact, it appears that dietary restraint (i.e., cognitive control over eating in an effort to achieve or maintain a certain body weight) may be normative to some extent among women of all ages and sizes in Western societies. Thus, if high dietary restraint is associated with consequences for health, the effects of even small differences could be significant.

To address our primary research question, namely, whether high dietary restraint is associated with increased 24-hour urinary cortisol excretion, we compared 41 women with high and 37 women with low dietary restraint. We found that the two groups were remarkably similar in virtually every respect. However, cortisol excretion was higher among high restraint women (although it was well within the normal range for both groups). Finding higher cortisol excretion among postmenopausal women with high dietary restraint was particularly interesting because it appeared that the majority of the high restraint group had had a restrained approach to eating for much of their life (section 2.3.2). Although HPA reactivity to stress typically habituates over time, this may not be the case for certain types of stress or for certain people ('high responders') [21, 22]. Given that elevated cortisol has now been reported in both young women [23, 24] and older women who appear to have been restrained eaters for many years (Chapter 2), it seems that habituation to its subtle stress does not fully occur.

Our finding of higher cortisol in restrained eaters is important in many ways. First, our sample size was selected to provide adequate statistical power to detect a significant difference in 24-hour urinary cortisol excretion. This is a significant advantage over two past studies reporting no difference in cortisol between restrained and unrestrained eaters [25, 26] which lacked sufficient statistical power. It is misleading to draw conclusions from inadequately powered studies; by ensuring we had adequate statistical power ($\beta = 0.20$), we could be confident that sample size would not be an issue in the interpretation of our cortisol results. Second, for the first time, the possible association between perceived stress and cortisol was eliminated as a potential explanation for the difference in cortisol excretion between women with high and low restraint. Previous studies were unable to do this. Anderson and colleagues found cortisol excretion was positively associated with dietary restraint ($r = 0.34$, $P < 0.01$), but they did not consider the possible role of perceived stress [23]. McLean and colleagues found young women with high dietary restraint excreted more cortisol in their urine than those with low dietary restraint (419 ± 135 nmol/day versus 355 ± 84 nmol/day, $P < 0.05$), but high restraint women in that study reported slightly but significantly higher scores for perceived stress [27]. In this study, restrained and unrestrained eaters did not differ in global perceived stress measured at the start of the study, nor did they differ in the amount of stress experienced during each 24-hour period during which they collected urine for cortisol analysis **(Table 2.2)**. Surprisingly, not only did these measures of stress not vary between groups, they were themselves unrelated to cortisol excretion **(Table 2.2)**. Past research had shown higher urinary cortisol excretion on stressful days (as measured by the Daily Stress Inventory we used to assess participants' experience of stress during their 24-hour urine collections) [28], although findings have been inconsistent [29].

We eliminated the possibility that differences in perceived stress may have accounted for the differences in cortisol excretion between restraint groups, but our results cannot confirm the nature of the association between cortisol excretion and dietary restraint. Consistent findings of higher cortisol excretion among restrained eaters in adequately powered studies [23, 24] suggest that this is a 'real' difference but causation cannot be determined from the cross-sectional studies that have been conducted thus far. While our results complement previous reports and are consistent with our hypothesis that dietary restraint may be an ongoing subtle stressor for women (thus activating the HPA axis and leading to increased cortisol secretion), other explanations for the difference in cortisol excretion between groups should also be examined.

There are several possible confounders of cortisol excretion, and the possibility that they could account for the difference in cortisol excretion between our high and low dietary restraint groups must be considered. The exclusion criteria for the study eliminated the possibility that certain factors known to influence cortisol (such as Cushing's Syndrome or the use of steroid drugs) could influence our findings, but other factors may have played a role. For example, fasting (severe energy restriction) can lead to increased cortisol secretion [30]. Reduced energy intake among restrained eaters cannot explain the difference observed in our study, however, since energy intake was both reasonable (mean intakes were slightly less than energy requirements for a low active lifestyle [31]) and did not differ between groups **(Table 2.3)**. Level of physical activity on the day of urine collections could also confound cortisol excretion, given observations of increased cortisol in association with exercise [32, 33]. Although precise data regarding participants' activity on the day of their urine collections were not obtained, anecdotal reports suggested that most participants planned their urine collection for a day in which they did not engage in unusually high levels of activity. Typical activity was moderate

(4.5 ± 3.1 hours per week), and restraint groups did not differ in their estimates of habitual physical activity (**Table 2.1**). Thus, it is unlikely that differences in exercise between groups could account for the difference in cortisol excretion.

Sodium intake and high blood pressure could be other potentially confounding variables [34]. Cortisol excretion is higher on high sodium diets (200 mmol/day, i.e., 4600 mg/day, in experimental conditions) [34, 35]. However this, too, was unlikely to have played a role in the difference we observed between our high and low restraint groups. The sodium intake of our participants was not excessive (2373 ± 814 mg/day) and it did not differ between groups (**Table 2.3**). And although the proportion of normotensives and hypertensives in our study cannot be determined (since measurements of blood pressure were not made), very few reported use of anti-hypertensive drugs or diuretics at the time of the Phase I questionnaire (n = 4, with no significant difference in the proportion using those medications between the two restraint groups; **Table 2.1**). Thus, while the possible role of hypertension in our results cannot be fully ascertained, it is unlikely to have been significant.

Another factor which appears to influence HPA activity and could thus confound our results is low birthweight [36, 37]. For every kg increase in birthweight, fasting morning plasma cortisol has been shown to decrease by 24 nmol/L (a small but statistically significant amount) [37]. Again, we cannot ascertain the possible role of this factor in our results, because information on participants' birthweight was not obtained. However, it is unlikely that the two restraint groups would have differed systematically in birthweight, since low birthweight has also been associated with greater central adiposity later in life [38], and waist-to-hip ratio and trunk fat did not differ between groups. As a result, if this variable had any effect, its possible influence on our results was likely small.

Thus, it appears that the difference in cortisol excretion between high and low restraint groups is due to their difference in dietary restraint. The hypothesis which guided this research was that dietary restraint may act as a subtle but chronic source of stress for women. Our use of a 24-hour urine collection to measure total 24-hour cortisol excretion had the advantage of reducing the possible effect of diurnal variation on cortisol measurements; however, it precluded information regarding exactly when restrained eaters may experience elevations in cortisol excretion. The difference could be due to differences in the rise in morning cortisol levels. A higher rise in cortisol has previously been found in association with abdominal obesity and blood pressure [39, 40], memory loss [41], and the ongoing stress of unemployment [42]; whereas higher nocturnal cortisol has been observed in conditions such as dementia [43]. Given the preliminary findings of Pirke and colleagues [25], it is unlikely that restrained and unrestrained eaters differ in night cortisol levels, although a larger study would be required to be certain. It has been noted that there are meal-related peaks in cortisol secretion throughout the day [44]. Perhaps restrained eaters experience peaks of greater amplitude in association with meals, or other instances associated with eating cognitions (such as when shopping for food). Studies with multiple measurements of cortisol (as could be obtained by using a Salivette to sample saliva [44]) are required to compare restrained and unrestrained eaters throughout the day to determine whether the increase in cortisol appears in association with possible eating-related stressors.

6.2 Strengths and limitations

Our survey was only the second to examine dietary restraint in postmenopausal women, although it was the first to specifically clarify postmenopausal status (as self-reported >1 year since last menses). We recruited a large sample, and endeavoured to increase representation of women from a variety of socioeconomic backgrounds by placing the majority of our recruitment advertisements in community newspapers which are distributed widely and are available free of charge. However, as is characteristic of the majority of health research using volunteers [45], our survey respondents differed in some respects from the general population. For example, our participants had more education than the general population of women aged 45 to 64 years living in the lower Mainland area of British Columbia (the most comparable group for which the census data were available [46]). Only 2% of our respondents had not completed high school, compared to 23% of all women aged 45 to 64 years in the general area; 29% of our respondents completed high school (versus 26%) and 68% completed postsecondary education (versus 52%). Survey respondents were also more likely to be White and have a higher annual income. These factors should be taken into consideration when considering the extent to which our results can be generalized. Although past research has shown that dietary restraint does not differ with socioeconomic status [47], we found that restrained eaters were more likely to report a higher annual income (**Appendix 22**). Thus, it is possible that our results are most applicable for women of higher socioeconomic status.

There was a high response rate to the survey, with 87% returning completed questionnaires. This can likely be attributed partly to characteristics of the target group (which may be more likely to comply with research requests than others) and also to aspects of our recruitment. We sent questionnaires to women who requested them, rather than sending them unsolicited, and undoubtedly this would have contributed to an increased likelihood of receiving a completed questionnaire. In addition, each questionnaire was accompanied by a letter of introduction addressed to the potential participant (**Appendix 5**), and although respondents were not paid, incentives such as the draw for prizes and the possibility of participation in the second study were included. Such measures tend to increased response rates to mail-administered questionnaires [48]. Although a second letter was sent to potential participants who had not responded to the initial mailing (**Appendix 20**), this resulted in the additional return of relatively few questionnaires (n = 34, 20% of those sent a reminder). The high response rate to the survey strengthens the validity of our results, because it reduces the possibility of response bias (although it does not address the bias that results from using self-selected volunteers as participants).

As is common with survey research, the first phase of this study was limited by its reliance on self-report, and given the cross-sectional nature of the study, we were limited by a single measurement of each variable of interest. In the case of our investigation of weight history, this necessitated reliance on a retrospective self-report of weight change in the past 10 years. In addition, although the majority of the Phase I questionnaire consisted of previously validated and reliable psychometric tools, they also had limitations. The TFEQ [49], despite its wide use in a variety of populations, contains several items which are ambiguous. Lack of clarity could threaten the construct validity of the TFEQ. The Phase I questionnaire also lacked several questions that could have aided in the interpretation of the results or provided additional insights. In addition, it would have been helpful if several Phase I questionnaire items were more rigorous. For example, habitual weekly exercise was estimated by participants' response to a single question, "How many hours of exercise do you do each week?" (with exercise defined as "activity of sufficient intensity to raise your heart rate"; Section H, question 6 in **Appendix 6**). Our estimate of habitual activity would have been more robust had we used a validated tool such as the Baecke habitual physical activity questionnaire [50]. Although additional questions would have increased the length of the questionnaire, and thus potentially reduced the number of completed questionnaires received, a small number of additional items would have been useful.

Despite the numerous tasks associated with participation in the second phase of this research (completion of which typically spanned four to six months), participant retention was extraordinarily high. Only one person was unable to complete all components of the study (98.7% retention rate). Similar to the high response rate for the Phase I questionnaire, this is likely attributable both to the commitment of the participants as well as the measures taken to facilitate their involvement in the study. For example, all study tasks were clearly described during the initial meeting with the participant and written instructions were also provided (**Appendices 12 and 15**). In addition, reminder post-it notes were attached to the materials required to complete each task (**Appendix 14**), and telephone support was available to the participants throughout the study, as needed. Each participant was involved in setting the dates for her food records and urine collections (**Appendix 32**) and reminders of important dates were included on the fridge magnet provided with her initial study package (**Appendix 33**), in the thank you note sent after each participant had completed her first 24-hour urine collection and three-day food record (**Appendix 34**), and in a reminder letter sent shortly before the second round of tasks was to begin (**Appendix 35**).

6.3 Future directions

The investigations reported in this dissertation could be considered stepping stones for future research in several areas. First, the following studies could build on our main finding of differences in cortisol excretion between women with high and low dietary restraint:

1. As indicated briefly above, one way to further determine whether differences in cortisol between restrained and unrestrained eaters may be due to differences in restraint-associated stress would be to conduct a study similar to this one, but using multiple measurements of salivary cortisol rather than 24-hour urine collections.
2. Thus far, cortisol has been used exclusively as a biomarker for stress in studies that have examined possible associations between dietary restraint and stress. One way to confirm that these differences could be explained by differences in stress (while eliminating the possibility that they are due to other factors influencing HPA activity), would be to use other measures of the stress response. For example, ambulatory blood pressure monitoring could be used as another test of HPA reactivity [51, 52].

3. Another interesting investigation would be to examine women with high and low dietary restraint under stress challenge (e.g., the Trier stress test [53]). If women with high dietary restraint have higher baseline cortisol levels, and a greater degree of change in cortisol excretion, that would suggest that perhaps women with high restraint are characterized by overall heightened reactivity to stress. Should they have higher baseline cortisol, but the same degree of cortisol/stress response to challenge as that observed in women with low restraint, that would suggest that the groups do not differ in their response to general stressors, and would support the hypothesis that there is some other sort of difference (e.g., a higher physiological set-point for cortisol, or increase in low-level stress responses to food and restraint-related thoughts and decisions).

Second, our comparison of dietary restraint and 'dieting' also highlights the need for additional work in this area. Specifically:

1. A complete psychometric evaluation of the TFEQ is required, including: an analysis of internal reliability (Cronbach's alpha for each subscale), determination of the corrected item-total correlation coefficients, identification of poorly functioning items (defined as items that, once deleted, increase the alpha for the subscale by >0.10 or items that have a correlation of less than 0.30 with the relevant subscale score), and, most importantly, a review of its construct validity. Although some work has been done in this area since the publication of the TFEQ [54, 55], future studies must move beyond an analysis of the psychometric properties of the instrument to include an integration of that analysis with a clarification of the construct validity of the scale.
2. Qualitative studies of the meaning of dieting, dietary restraint, and restrained eating are warranted. It is clear both from our work and that of others [56, 57] that there is a lack of clarity in the use of these terms both in a research setting and in everyday life. Qualitative studies (including interviews and/or focus groups) could provide insight into

women's interpretations of these concepts, and their understanding of the role these dietary attitudes and behaviours play in their lives. It would be appropriate to conduct studies of this nature in both younger women and postmenopausal women.

Prospective studies are another clear opportunity for future studies in this area. In fact, we are fortunate to have received funding from the Canadian Institutes of Health Research to conduct a three year follow-up of the women who completed this study. This presents several opportunities to address important research questions:

1. A prospective study will allow for investigation of the possible effect of dietary restraint on rate of change of bone parameters. Our initial comparison of women with high and low dietary restraint was powered to detect differences in cortisol excretion. Possible differences in body composition, especially bone mineral density, were also of interest given preliminary indications that dietary restraint may be associated with compromised bone health [58, 59], but many more participants would have been required to draw conclusions about the possible effects on bone. With this prospective follow-up, we will have sufficient statistical power to test the hypothesis that restrained eaters may experience greater loss of BMD over three years than unrestrained eaters.
2. Although participants were not paid for their involvement in the second phase of the study, they received extensive personal feedback regarding the results of their dietary analysis (**Appendix 36**) and bone density scan (**Appendix 37**). A copy of the DXA scan results was also provided for the participant to give to her physician (**Appendix 38**). Participants' perceptions of these materials, and whether this feedback had any effect on their behaviour, could provide important insight for knowledge translation and health communication.
3. The investigation reported in Chapter 5 was a retrospective analysis of weight change. By prospectively following these women, we will be able to examine the role of aspects

of eating measured by the TFEQ (dietary restraint, disinhibition, hunger) and other psychosocial characteristics in prospective changes in weight and body composition.

My PhD research has enhanced our understanding of the roles of cognitive dietary restraint, lifetime physical activity, and factors related to body weight in the health of postmenopausal women. It built on past research in this area, added valuable insights to our understanding of diet and activity in women's health, and suggested several lines of future investigation.

6.4 References

1. McEwen BS, Stellar E. Stress and the individual. Mechanisms leading to disease. *Arch Intern Med* 1993; 153: 2093-101.

2. Duppe H, Gardsell P, Johnell O, Ornstein E. Bone mineral density in female junior, senior and former football players. *Osteoporos Int* 1996; 6: 437-41.

3. Etherington J, Harris PA, Nandra D, Hart DJ, Wolman RL, Doyle DV, Spector TD. The effect of weight-bearing exercise on bone mineral density: a study of female ex-elite athletes and the general population. *J Bone Miner Res* 1996; 11: 1333-8.

4. Khan KM, Bennell KL, Hopper JL, Flicker L, Nowson CA, Sherwin AJ, Crichton KJ, Harcourt PR, Wark JD. Self-reported ballet classes undertaken at age 10-12 years and hip bone mineral density in later life. *Osteoporos Int* 1998; 8: 165-73.

5. Micklesfield L, Rosenberg L, Cooper D, Hoffman M, Kalla A, Stander I, Lambert E. Bone mineral density and lifetime physical activity in South African women. *Calcif Tissue Int* 2003; 73: 463-9.

6. Kriska AM, Sandler RB, Cauley JA, LaPorte RE, Hom DL, Pambianco G. The assessment of historical physical activity and its relation to adult bone parameters. *Am J Epidemiol* 1988; 127: 1053-63.

7. Damilakis J, Perisinakis K, Kontakis G, Vagios E, Gourtsoyiannis N. Effect of lifetime occupational physical activity on indices of bone mineral status in healthy postmenopausal women. *Calcif Tissue Int* 1999; 64: 112-6.

8. Ogden J. The measurement of restraint: confounding success and failure? *Int J Eat Disord* 1993; 13: 69-76.

9. Heatherton TF, Herman CP, Polivy J, King GA, McGree ST. The (mis)measurement of restraint: an analysis of conceptual and psychometric issues. *J Abnorm Psychol* 1988; 97: 19-28.

10. van Strien T. Success and failure in the measurement of restraint: notes and data. *Int J Eat Disord* 1999; 25: 441-9.

11. Lowe MR. The effects of dieting on eating behavior: a three-factor model. *Psychol Bull* 1993; 114: 100-21.

12. Stice E, Fisher M, Lowe MR. Are dietary restraint scales valid measures of acute dietary restriction? Unobtrusive observational data suggest not. *Psychol Assess* 2004; 16: 51-9.

13. Ricciardelli LA, Williams RJ. A two-factor model of dietary restraint. *J Clin Psychol* 1997; 53: 123-31.

14. Karlsson J, Persson LO, Sjostrom L, Sullivan M. Psychometric properties and factor structure of the Three-Factor Eating Questionnaire (TFEQ) in obese men and women.

Results from the Swedish Obese Subjects (SOS) study. *Int J Obes Relat Metab Disord* 2000; 24: 1715-25.

15. Hays NP, Bathalon GP, Roubenoff R, Lipman R, Roberts SB. The association of eating behavior with risk for morbidity in older women. *J Gerontol A Biol Sci Med Sci* 2002; 57: M128-33.

16. Hays NP, Bathalon GP, McCrory MA, Roubenoff R, Lipman R, Roberts SB. Eating behavior correlates of adult weight gain and obesity in healthy women aged 55-65 y. *Am J Clin Nutr* 2002; 75: 476-83.

17. Laessle RG, Tuschl RJ, Kotthaus BC, Pirke KM. A comparison of the validity of three scales for the assessment of dietary restraint. *J Abnorm Psychol* 1989; 98: 504-7.

18. Gorman BS, Allison DB. Measures of restrained eating. In: Allison DB, ed. *Handbook of Assessment Methods for Eating Behaviors and Weight-related Problems: Measures, Theory and Research*. Thousand Oaks: Sage Publications, 1995: 149-84.

19. Bathalon GP, Hays NP, Meydani SN, Dawson-Hughes B, Schaefer EJ, Lipman R, Nelson M, Greenberg AS, Roberts SB. Metabolic, psychological, and health correlates of dietary restraint in healthy postmenopausal women. *J Gerontol A Biol Sci Med Sci* 2001; 56: M206-11.

20. McLean JA, Barr SI. Cognitive dietary restraint is associated with eating behaviors, lifestyle practices, personality characteristics and menstrual irregularity in college women. *Appetite* 2003; 40: 185-92.

21. Schommer NC, Hellhammer DH, Kirschbaum C. Dissociation between reactivity of the hypothalamus-pituitary-adrenal axis and the sympathetic-adrenal-medullary system to repeated psychosocial stress. *Psychosom Med* 2003; 65: 450-60.

22. Epel ES, McEwen B, Seeman T, Matthews K, Castellazzo G, Brownell KD, Bell J, Ickovics JR. Stress and body shape: stress-induced cortisol secretion is consistently greater among women with central fat. *Psychosom Med* 2000; 62: 623-32.

23. Anderson DA, Shapiro JR, Lundgren JD, Spataro LE, Frye CA. Self-reported dietary restraint is associated with elevated levels of salivary cortisol. *Appetite* 2002; 38: 13-7.

24. McLean JA, Barr SI, Prior JC. Cognitive dietary restraint is associated with higher urinary cortisol excretion in healthy premenopausal women. *Am J Clin Nutr* 2001; 73: 7-12.

25. Pirke KM, Tuschl RJ, Spyra B, Laessle RG, Schweiger U, Broocks A, Sambauer S, Zitzelsberger G. Endocrine findings in restrained eaters. *Physiol Behav* 1990; 47: 903-6.

26. Beiseigel JA, Nickols-Richardson SA. Cognitive eating restraint scores are associated with body fatness but not with other measures of dieting in women. *Appetite* 2004; 43: 47-53.

27. McLean JA, Cognitive dietary restraint, food intake and cortisol excretion in premenopausal women. Doctoral dissertation in the School of Family and Nutritional Sciences, The University of British Columbia: Vancouver, 1999 (AAT No. NQ46388).

28. Brantley PJ, Dietz LS, McKnight GT, Jones GN, Tulley R. Convergence between the Daily Stress Inventory and endocrine measures of stress. *J Consult Clin Psychol* 1988; 56: 549-51.

29. Cummins SE, Gevirtz RN. The relationship between daily stress and urinary cortisol in a normal population: an emphasis on individual differences. *Behav Med* 1993; 19: 129-34.

30. Bergendahl M, Iranmanesh A, Pastor C, Evans WS, Veldhuis JD. Homeostatic joint amplification of pulsatile and 24-hour rhythmic cortisol secretion by fasting stress in midluteal phase women: concurrent disruption of cortisol-growth hormone, cortisol-luteinizing hormone, and cortisol-leptin synchrony. *J Clin Endocrinol Metab* 2000; 85: 4028-35.

31. Institute of Medicine. *Dietary reference intakes for energy, carbohydrates, fiber, fat, protein and amino acids (macronutrients).* Washington DC: National Academy Press, 2002.

32. Luger A, Deuster PA, Kyle SB, Gallucci WT, Montgomery LC, Gold PW, Loriaux DL, Chrousos GP. Acute hypothalamic-pituitary-adrenal responses to the stress of treadmill exercise: physiologic adaptations to physical training. *N Engl J Med* 1987; 316: 1309-15.

33. Luger A, Deuster PA, Gold PW, Loriaux DL, Chrousos GP. Hormonal responses to the stress of exercise. *Adv Exp Med Biol* 1988; 245: 273-80.

34. Litchfield WR, Hunt SC, Jeunemaitre X, Fisher NDL, Hopkins PN, Williams RR, Corvol P, Williams GH. Increased urinary free cortisol :a potential intermediate phenotype of essential hypertension. *Hypertension* 1998; 31: 569-74.

35. Kerstens MN, van der Kleij FG, Boonstra AH, Sluiter WJ, Koerts J, Navis G, Dullaart RP. Salt loading affects cortisol metabolism in normotensive subjects: relationships with salt sensitivity. *J Clin Endocrinol Metab* 2003; 88: 4180-5.

36. Phillips DIW, Barker DJP, Fall CHD, Seckl JR, Whorwood CB, Wood PJ, Walker BR. Elevated plasma cortisol concentrations: a link between low birth weight and the insulin resistance syndrome? *J Clin Endocrinol Metab* 1998; 83: 757-60.

37. Phillips DIW, Walker BR, Reynolds RM, Flanagan DEH, Wood PJ, Osmond C, Barker DJP, Whorwood CB. Low birth weight predicts elevated plasma cortisol concentrations in adults from 3 populations. *Hypertension* 2000; 35: 1301-6.

38. Gunnarsdottir I, Birgisdottir BE, Benediktsson R, Gudnason V, Thorsdottir I. Association between size at birth, truncal fat and obesity in adult life and its contribution to blood pressure and coronary heart disease; study in a high birth weight population. *Eur J Clin Nutr* 2004; 58: 812-8.

39. Wallerius S, Rosmond R, Ljung T, Holm G, Bjorntorp P. Rise in morning saliva cortisol is associated with abdominal obesity in men: a preliminary report. *J Endocrinol Invest* 2003; 26: 616-9.

40. Rosmond R, Bjorntorp P. The hypothalamic-pituitary-adrenal axis activity as a predictor of cardiovascular disease, type 2 diabetes and stroke. *J Intern Med* 2000; 247: 188-97.

41. Greendale GA, Kritz-Silverstein D, Seeman T, Barrett-Connor E. Higher basal cortisol predicts verbal memory loss in postmenopausal women: Rancho Bernardo Study. *J Am Geriatr Soc* 2000; 48: 1655-8.

42. Ockenfels MC, Porter L, Smyth J, Kirschbaum C, Hellhammer DH, Stone AA. Effect of chronic stress associated with unemployment on salivary cortisol: overall cortisol levels, diurnal rhythm, and acute stress reactivity. *Psychosom Med* 1995; 57: 460-7.

43. Ferrari E, Casarotti D, Muzzoni B, Albertelli N, Cravello L, Fioravanti M, Solerte SB, Magri F. Age-related changes of the adrenal secretory pattern: possible role in pathological brain aging. *Brain Res Brain Res Rev* 2001; 37: 294-300.

44. Kirschbaum C, Hellhammer DH. Salivery cortisol. In: Fink G, ed. *Encyclopedia of Stress*. San Diego: Academic Press, 2000: 379-83.

45. Ganguli M, Lytle ME, Reynolds MD, Dodge HH. Random versus volunteer selection for a community-based study. *J Gerontol A Biol Sci Med Sci* 1998; 53: M39-46.

46. Statistics Canada. 2001 Community Profiles: Vancouver Census Metropolitan Area. Ottawa: Statistics Canada, 2001. Retrieved April 4, 2004 from http://www12.statcan.ca/english/profil01/CP01/Index.cfm?Lang=E.

47. Dykes J, Brunner EJ, Martikainen PT, Wardle J. Socioeconomic gradient in body size and obesity among women: the role of dietary restraint, disinhibition and hunger in the Whitehall II study. *Int J Obes* 2004; 28: 262-8.

48. Edwards P, Roberts I, Clarke M, DiGuiseppi C, Pratap S, Wentz R, Kwan I. Increasing response rates to postal questionnaires: systematic review. *BMJ* 2002; 324: 1183-5.

49. Stunkard AJ, Messick S. The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *J Psychosom Res* 1985; 29: 71-83.

50. Baecke J, Burema J, Frijters J. A short questionnaire for the measurement of habitual physical activity in epidemiological studies. *Am J Clin Nutr* 1982; 36: 936-42.

51. Schwartz JE, Pickering TG, Landsbergis PA. Work-related stress and blood pressure: current theoretical models and considerations from a behavioral medicine perspective. *J Occup Health Psychol* 1996; 1: 287-310.

52. Noble RE. Diagnosis of stress. *Metabolism* 2002; 51: 37-9.

53. Kirschbaum C, Pirke KM, Hellhammer DH. The "Trier Social Stress Test' - a tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology* 1993; 28: 76-81.

54. Bond MJ, McDowell AJ, Wilkinson JY. The measurement of dietary restraint, disinhibition and hunger: an examination of the factor structure of the Three Factor Eating Questionnaire (TFEQ). *Int J Obes Relat Metab Disord* 2001; 25: 900-6.

55. Mazzeo SE, Aggen SH, Anderson C, Tozzi F, Bulik CM. Investigating the structure of the eating inventory (Three-Factor Eating Questionnaire): a confirmatory approach. *Int J Eat Disord* 2003; 34: 255-64.

56. Brownell KD, Rodin J. The dieting maelstrom. Is it possible and advisable to lose weight? *Am Psychol* 1994; 49: 781-91.

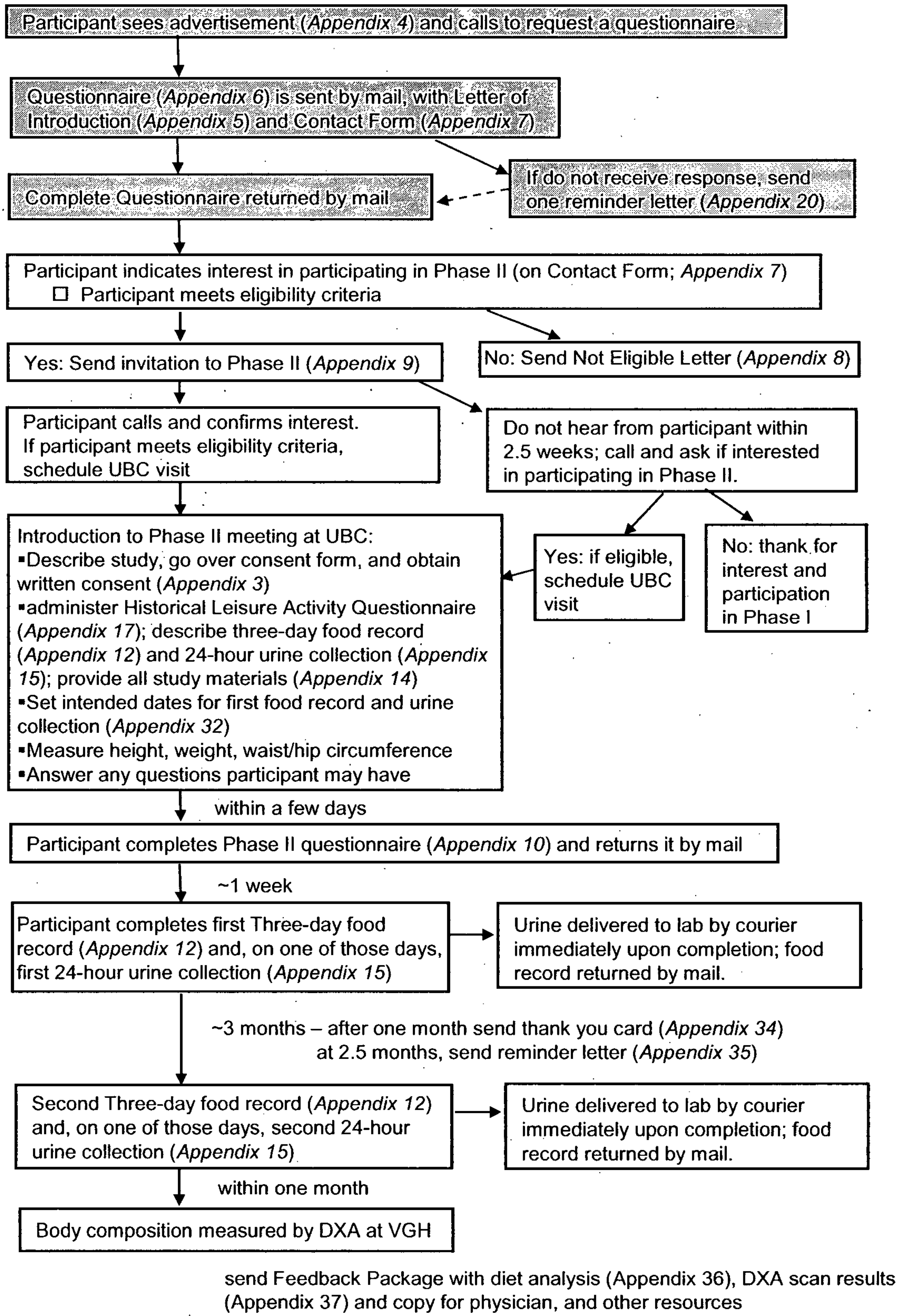
57. Neumark-Sztainer D, Jeffery RW, French SA. Self-reported dieting: How should we ask? What does it mean? Associations between dieting and reported energy intake. *Int J Eat Disord* 1997; 22: 437-49.

58. McLean JA, Barr SI, Prior JC. Dietary restraint, exercise, and bone density in young women: are they related? *Med Sci Sports Exerc* 2001; 33: 1292-6.

59. Van Loan MD, Keim NL. Influence of cognitive eating restraint on total-body measurements of bone mineral density and bone mineral content in premenopausal women aged 18-45 y: a cross-sectional study. *Am J Clin Nutr* 2000; 72: 837-43.

APPENDIX 1: Overview of research design

This flow diagram illustrates the sequence of events for participants in the study, from the beginning of the Phase I survey (shaded boxes) to the end of Phase II (white boxes).



take part in this study, you are still free to withdraw at any time and without giving any reason for your decision. If you do not wish to participate, you do not have to provide any reason for your decision not to participate, nor will there be any negative consequence to you.

Purpose: The purpose of this part of this observational study (Phase II) is to investigate possible associations among dietary attitudes and behaviours and bone health in women following menopause. Similar studies have been conducted in young women, but information is lacking regarding the experiences of postmenopausal women (for whom bone health and osteoporosis are important health issues).

Study Procedures: As one of approximately 70 volunteer participants in this study, you will be asked to do the following:

1) complete a questionnaire package in which you will be asked about your attitudes and beliefs (this will take approximately 20 minutes of your time.)
2) have your height, weight, and waist circumference measured while you are wearing light indoor clothing,
3) maintain a detailed record of everything you eat and drink over the course of three days (in a food diary which will be provided to you) twice – now and again roughly 3 months from now,
4) collect two 24-hour urine samples,
5) have your bone density measured using dual energy x-ray absorptiometry (DEXA). (This procedure takes approximately half an hour and it involves exposure to a very low dose of radiation – an amount comparable to the amount that you would receive if you spent several hours outdoors.)

Your participation in this study will involve one visit to UBC and one visit to Vancouver General Hospital (VGH). During the visit to UBC, you will complete the questionnaire and have your height, weight, and weight circumference measured; roughly 4 months later, during the visit to VGH, you will have your bone density assessed. In between these visits, you will complete the following tasks: now, and then again roughly 3 months from now, you will keep a 3-day food record and collect a 24-hour urine sample (for a total of two 3-day food records and two 24-hour urine samples). Your involvement in this study will take a total of approximately 7 hours of your time. If we receive research funding to measure your bone density again in 2-3 years' time, we will contact you to ask whether you would like to do this. You would, of course, be free to decline to participate.

Exclusions: You cannot participate in this study if any of the following apply to you:

1) You are taking prednisone, dexamethasone, steroid drugs, thyroid hormones or anticonvulsive drugs,
2) You work at night or have an unusual sleep/wake cycle,
3) You have been diagnosed with an endocrine disorder (e.g. Cushing's Syndrome or Addison's Disease),
4) You have had a surgical menopause (i.e. a hysterectomy),
5) You have previously been diagnosed with osteoporosis, or
6) You are currently using hormone replacement therapy (HRT).

- ☐ I understand that my participation in this study is voluntary and that I am completely free to refuse to participate or to withdraw from this study at any time and without changing in any way the quality of care that I receive.

- ☐ I have read this form and I freely consent to participate in this study.

- ☐ I have been told that I will receive a dated and signed copy of this form.

Printed Name of Participant:	Signature:	Date:
________________________	________________________	________________________
Printed Name of Witness:	Signature:	Date:
________________________	________________________	________________________
Printed Name of Principal Investigator or Designated Representative:	Signature:	Date
________________________	________________________	________________________

APPENDIX 5: Phase I letter of introduction

THE UNIVERSITY OF BRITISH COLUMBIA

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Faculty of Agricultural Sciences
2205 East Mall
Vancouver, B.C. Canada V6T 1Z4
Phone: (604) 822-2502
Fax: (604) 822-5143

[Date]

[Participant's Name and Address]

Dear [Participant],

Thank you very much for your interest in this study, "An Exploration of Postmenopausal Women's Attitudes towards Eating and Body Image." It is being conducted by Candice Rideout, a Ph.D. candidate in Human Nutrition at the University of British Columbia, as a part of her Ph.D. thesis. The aim of the study is to gather information about postmenopausal women's attitudes and behaviours towards food and body image. While a great deal of research has focused on eating attitudes and body image issues in young women, less is known about the experiences of women who have completed menopause. Therefore, this study aims to explore and characterize these factors among postmenopausal women between the ages of 45 and 75 years.

Your participation in this study simply involves completing the enclosed questionnaire. This will likely take approximately 30 minutes of your time, but feel free to take as much time to complete the questionnaire as you require. For us to gather valuable information about your attitudes and feelings, it is important that you answer each of the questions in the questionnaire. However, if for any reason you do not wish to complete a particular item, please just leave it and go on to the next one. You are under no obligation to participate in this study, and you may refuse to participate at any time without negative consequence to you.

Once you complete the survey, please return it in the enclosed postage-paid addressed envelope. If you would like to receive a summary of the results of the study by mail in approximately one year's time, please complete the enclosed Contact Form and return it with your questionnaire. If desired, you may return the form separately to further ensure your anonymity. Once your completed questionnaire has been received, you will be entered into a draw for one of several prizes (gift certificates valued at $300, $200, or $100, or the equivalent in cash).

This questionnaire-based study is also being used to screen and recruit women for the second phase of this research project, which will investigate the relationships among eating behaviours and bone health. If you think you might be interested in participating in this second study, please complete the appropriate section of the Contact Form and return it. Your participation in Phase II would be completely voluntary and indicating your interest at this time in no way obligates you to participate in the future.

APPENDIX 6: Phase I questionnaire

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Office Use Only
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___C ___CV ___E ___EV

An Exploration of Postmenopausal Women's Attitudes towards Eating and Physique Perception

Phase I Questionnaire

Thank you very much for volunteering to complete this questionnaire. Your answers are completely confidential, so please answer each question as honestly and accurately as possible.

The questionnaire consists of several sections in which you will be asked to indicate whether a given statement is true or false for you or to choose from several options the answer that is most applicable to you. Specific instructions will be given for each section.

When you have completed the questionnaire, please return it in the stamped, addressed envelope provided.

Thank you for your participation!

Section A:

Please circle whether the statements below are true (T) or false (F) for you.

		True	False
1.	When I smell the aroma of my favourite food, I find it very difficult to keep from eating, even if I have just finished a meal..................................	T	F
2.	I usually eat too much at social occasions, like parties and picnics...........	T	F
3.	I am usually so hungry that I eat more than three times a day.................	T	F
4.	When I have eaten my quota of calories, I am usually good about not eating any more..	T	F
5.	Dieting is so hard for me because I just get too hungry..........................	T	F
6.	I deliberately take small helpings as a means of controlling my weight.......	T	F
7.	Sometimes things just taste so good that I keep on eating even when I am no longer hungry..	T	F
8.	Since I am often hungry, I sometimes wish that while I am eating, an expert would tell me that I have had enough or that I can have something more to eat..	T	F
9.	When I feel anxious, I find myself eating...	T	F
10.	Life is too short to worry about dieting..	T	F
11.	Since my weight goes up and down, I have gone on reducing diets more than once..	T	F
12.	I often feel so hungry that I just have to eat something..........................	T	F
13.	When I am with someone who is overeating, I usually overeat too...........	T	F
14.	I have a pretty good idea of the number of calories in common food..........	T	F
15.	Sometimes when I start eating, I just can't seem to stop........................	T	F
16.	It is not difficult for me to leave something on my plate.......................	T	F
17.	At certain times of the day, I get hungry because I have gotten used to eating then..	T	F
18.	While on a diet, if I eat food that is not allowed, I consciously eat less for a period of time to make up for it..	T	F

		True	False
19.	Being with someone who is eating often makes me hungry enough to eat also..	T	F
20.	When I feel blue, I often overeat...	T	F
21.	I enjoy eating too much to spoil it by counting calories or watching my weight..	T	F
22.	When I see a real delicacy, I often get so hungry that I have to eat right away..	T	F
23.	I often stop eating when I am not really full as a conscious means of limiting the amount that I eat...	T	F
24.	I get so hungry that my stomach often seems like a bottomless pit...........	T	F
25.	My weight has hardly changed at all in the last two years.....................	T	F
26.	I am always hungry so it is hard for me to stop eating before I finish the food on my plate..	T	F
27.	When I feel lonely, I console myself by eating..................................	T	F
28.	I consciously hold back at meals in order not to gain weight..................	T	F
29.	I sometimes get very hungry late in the evening or night......................	T	F
30.	I eat anything I want, any time I want...	T	F
31.	Without even thinking about it, I take a long time to eat.......................	T	F
32.	I count calories as a conscious means of controlling my weight..............	T	F
33.	I do not eat foods because they make me fat.....................................	T	F
34.	I am always hungry enough to eat at any time....................................	T	F
35.	I pay a great deal of attention to changes in my figure........................	T	F
36.	While on a diet, if I eat a food that is not allowed, I often then splurge and eat other high calories foods..	T	F

37. How often are you dieting in a conscious effort to control your weight?

1	2	3	4
Rarely	*Sometimes*	*Usually*	*Always*

38. Would a weight fluctuation of 5 lbs affect the way you live your life?

1	2	3	4
Not at all	*Slightly*	*Moderately*	*Very much*

39. How often do you feel hungry?

1	2	3	4
Only at meals	*Sometimes between meals*	*Often between meals*	*Almost always*

40. Do your feelings of guilt about overeating help you to control your food intake?

1	2	3	4
Never	*Rarely*	*Often*	*Always*

41. How difficult would it be for you to stop eating halfway through dinner and not eat for the next four hours?

1	2	3	4
Easy	*Slightly difficult*	*Moderately difficult*	*Very difficult*

42. How conscious are you of what you are eating?

1	2	3	4
Not at all	*Slightly*	*Moderately*	*Extremely*

43. How frequently do you avoid "stocking up" on tempting foods?

1	2	3	4
Almost never	*Seldom*	*Usually*	*Almost always*

44. How likely are you to shop for low calorie foods?

1	2	3	4
Unlikely	*Slightly likely*	*Moderately likely*	*Very likely*

45. Do you eat sensibly in front of others and splurge alone?

1	2	3	4
Never	*Rarely*	*Often*	*Always*

46. How likely are you to consciously eat slowly in order to cut down on how much you eat?

1	*2*	*3*	*4*
Unlikely	*Slightly likely*	*Moderately likely*	*Very likely*

47. How frequently do you skip dessert because you are no longer hungry?

1	*2*	*3*	*4*
Almost never	*Seldom*	*At least once/week*	*Almost daily*

48. How likely are you to consciously eat less than you want?

1	*2*	*3*	*4*
Unlikely	*Slightly likely*	*Moderately likely*	*Very likely*

49. Do you go on eating binges though you are not hungry?

1	*2*	*3*	*4*
Never	*Rarely*	*Sometimes*	*At least weekly*

50. On a scale of 0 to 5, where 0 means no restraint in eating (eating whatever you want, whenever you want it) and 5 means total restraint (constantly limiting food intake and never "giving in"), what number would you give yourself? (please circle the number)

0 Eat whatever you want, whenever you want it

1 Usually eat whatever you want, whenever you want it

2 Often limit food intake, but often "give in"

3 Usually limit food intake, but often "give in"

4 Usually limit food intake, rarely "giving in"

5 Constantly limit food intake, never "giving in"

51. To what extent does this statement describe your eating behaviour?

"I start dieting in the morning, but because of any number of things that happen during the day, by evening I have given up and eat what I want, promising myself to start dieting again tomorrow."

1	*2*	*3*	*4*
Not like me	*A little like me*	*Pretty good description of me*	*Describes me perfectly*

<u>Section B</u>:
Please answer each question as truthfully as possible by circling the number that corresponds to the correct answer for you.

1. Women who appear in TV shows and movies project the type of appearance that I see as my goal.

1	*2*	*3*	*4*	*5*
Completely disagree		*Neither agree nor disagree*		*Completely agree*

2. I believe that clothes look better on thin models.

1	*2*	*3*	*4*	*5*
Completely disagree		*Neither agree nor disagree*		*Completely agree*

3. I do <u>not</u> wish to look like the models in the magazines.

1	*2*	*3*	*4*	*5*
Completely disagree		*Neither agree nor disagree*		*Completely agree*

4. I tend to compare my body to people in magazines and on TV.

1	*2*	*3*	*4*	*5*
Completely disagree		*Neither agree nor disagree*		*Completely agree*

5. In our society, fat people are regarded as unattractive.

1	*2*	*3*	*4*	*5*
Completely disagree		*Neither agree nor disagree*		*Completely agree*

6. Photographs of thin women make me wish that I were thin.

1	*2*	*3*	*4*	*5*
Completely disagree		*Neither agree nor disagree*		*Completely agree*

7. Attractiveness is very important if you want to get ahead in our culture.

1	*2*	*3*	*4*	*5*
Completely disagree		*Neither agree nor disagree*		*Completely agree*

8. It's important for people to work hard on their figures/physiques if they want to succeed in today's culture.

1	*2*	*3*	*4*	*5*
Completely disagree		*Neither agree nor disagree*		*Completely agree*

9. Most people do <u>not</u> believe that the thinner you are, the better you look.

1	2	3	4	5
Completely disagree		*Neither agree nor disagree*		*Completely agree*

10. People think that the thinner you are, the better you look in clothes.

1	2	3	4	5
Completely disagree		*Neither agree nor disagree*		*Completely agree*

11. In today's society, it's <u>not</u> important to always look attractive.

1	2	3	4	5
Completely disagree		*Neither agree nor disagree*		*Completely agree*

<u>Section C</u>:

For each of the following items, please indicate the degree to which the statement is characteristic or true of you:

1. I am comfortable with the appearance of my physique/figure.

1	2	3	4	5
Not at all characteristic	*Slightly characteristic*	*Moderately characteristic*	*Very characteristic*	*Extremely characteristic*

2. I would worry about wearing clothes that might make me look too thin or overweight.

1	2	3	4	5
Not at all characteristic	*Slightly characteristic*	*Moderately characteristic*	*Very characteristic*	*Extremely characteristic*

3. I wish I wasn't so uptight about my physique/figure.

1	2	3	4	5
Not at all characteristic	*Slightly characteristic*	*Moderately characteristic*	*Very characteristic*	*Extremely characteristic*

4. There are times when I am bothered by thoughts that other people are evaluating my weight or muscular development negatively.

1	2	3	4	5
Not at all characteristic	*Slightly characteristic*	*Moderately characteristic*	*Very characteristic*	*Extremely characteristic*

5. When I look in the mirror I feel good about my physique/figure.

1	2	3	4	5
Not at all characteristic	*Slightly characteristic*	*Moderately characteristic*	*Very characteristic*	*Extremely characteristic*

6. Unattractive features of my physique/figure make me nervous in certain social settings.

1	2	3	4	5
Not at all characteristic	*Slightly characteristic*	*Moderately characteristic*	*Very characteristic*	*Extremely characteristic*

7. In the presence of others, I feel apprehensive about my physique/figure.

1	2	3	4	5
Not at all characteristic	*Slightly characteristic*	*Moderately characteristic*	*Very characteristic*	*Extremely characteristic*

8. I am comfortable with how fit my body appears to others.

1	2	3	4	5
Not at all characteristic	*Slightly characteristic*	*Moderately characteristic*	*Very characteristic*	*Extremely characteristic*

9. It would make me uncomfortable to know others were evaluating my physique/figure.

1	2	3	4	5
Not at all characteristic	*Slightly characteristic*	*Moderately characteristic*	*Very characteristic*	*Extremely characteristic*

10. When it comes to displaying my physique/figure to others, I am a shy person.

1	2	3	4	5
Not at all characteristic	*Slightly characteristic*	*Moderately characteristic*	*Very characteristic*	*Extremely characteristic*

11. I usually feel relaxed when it is obvious that others are looking at my physique/figure.

1	2	3	4	5
Not at all characteristic	*Slightly characteristic*	*Moderately characteristic*	*Very characteristic*	*Extremely characteristic*

12. When in a bathing suit, I often feel nervous about the shape of my body.

1	2	3	4	5
Not at all characteristic	*Slightly characteristic*	*Moderately characteristic*	*Very characteristic*	*Extremely characteristic*

Section D:

The following series of questions ask you to indicate the importance of the following characteristics of the food you choose to eat. Please indicate how important each characteristic is to you by circling the most appropriate response to the following:

It is important to me that the food I eat on a typical day…

	Not at all important	A little important	Moderately important	Very important
1. Is easy to prepare……………………………	1	2	3	4
2. Contains no additives………………………	1	2	3	4
3. Is low in calories……………………………	1	2	3	4
4. Tastes good…………………………………	1	2	3	4
5. Contains natural ingredients………………	1	2	3	4
6. Is not expensive……………………………	1	2	3	4
7. Is low in fat…………………………………	1	2	3	4
8. Is familiar……………………………………	1	2	3	4
9. Is high in fibre and roughage……………	1	2	3	4
10. Is nutritious…………………………………	1	2	3	4
11. Is easily available in shops and supermarkets………………………………	1	2	3	4
12. Is good value for the money………………	1	2	3	4
13. Cheers me up………………………………	1	2	3	4
14. Smells nice…………………………………	1	2	3	4
15. Can be cooked very simply………………	1	2	3	4
16. Helps me cope with stress………………	1	2	3	4
17. Helps me control my weight………………	1	2	3	4
18. Has a pleasant texture……………………	1	2	3	4
19. Is packaged in an environmentally friendly way…………………………………………	1	2	3	4

		Not at all important	A little important	Moderately important	Very important
20.	Comes from countries I approve of politically	1	2	3	4
21.	Is like the food I ate when I was a child	1	2	3	4
22.	Contains a lot of vitamins and minerals	1	2	3	4
23.	Contains no artificial ingredients	1	2	3	4
24.	Keeps me awake/alert	1	2	3	4
25.	Looks nice	1	2	3	4
26.	Helps me relax	1	2	3	4
27.	Is high in protein	1	2	3	4
28.	Takes no time to prepare	1	2	3	4
29.	Keeps me healthy	1	2	3	4
30.	Is good for my skin/teeth/hair/nails etc	1	2	3	4
31.	Makes me feel good	1	2	3	4
32.	Has the country of origin clearly marked	1	2	3	4
33.	Is what I usually eat	1	2	3	4
34.	Helps me to cope with life	1	2	3	4
35.	Can be bought in shops close to where I live or work	1	2	3	4
36.	Is cheap	1	2	3	4

<u>Section E</u>:

Please indicate the extent to which you agree with the following statements by circling the appropriate number.

1. Whether I gain, lose, or maintain my weight is entirely up to me.

1	*2*	*3*	*4*	*5*	*6*
Strongly disagree					*Strongly agree*

2. Being the right weight is largely a matter of good fortune.

1	*2*	*3*	*4*	*5*	*6*
Strongly disagree					*Strongly agree*

3. No matter what I intend to do, if I gain or lose weight, or stay the same in the near future, it is just going to happen.

1	*2*	*3*	*4*	*5*	*6*
Strongly disagree					*Strongly agree*

4. If I eat properly, and get enough exercise and rest, I can control my weight in the way I desire.

1	*2*	*3*	*4*	*5*	*6*
Strongly disagree					*Strongly agree*

Section F:

Please record the appropriate answer per item, depending on whether you strongly agree, agree, disagree, or strongly disagree with it.

1 = Strongly agree
2 = Agree
3 = Disagree
4 = Strongly disagree

______ 1. On the whole, I am satisfied with myself.

______ 2. At times I think that I am no good at all.

______ 3. I feel that I have a number of good qualities.

______ 4. I am able to do things as well as most people.

______ 5. I feel I do not have much to be proud of.

______ 6. I certainly feel useless at times.

______ 7. I feel that I am a person of worth, at least on an equal plane with others.

______ 8. I wish I could have more respect for myself.

______ 9. All in all, I am inclined to feel that I am a failure.

______ 10. I take a positive attitude towards myself.

Section G:

Please respond to the following questions by checking off the option that is most appropriate for you.

1. When you think about how much you "watch your weight" now compared to 10 years ago, do you "watch your weight"...

______ more than you did 10 years ago

______ about the same as you did 10 years ago

______ less than you did 10 years ago

2. When you think about what you eat in terms of how it affects your health, do you "watch what you eat"...

______ more than you did 10 years ago

______ about the same as you did 10 years ago

______ less than you did 10 years ago

3. When you think about what you eat in terms of trying to reach or maintain a certain weight, do you "watch what you eat"...

______ more than you did 10 years ago

______ about the same as you did 10 years ago

______ less than you did 10 years ago

4. Has your weight remained stable over the last 10 years? (If your weight has changed, please fill in the approximate number of pounds).

______ Yes, I have been within 5 lbs of my current weight for the past 10 years.

______ No, I lost weight over the past 10 years

How many lbs have you lost over the past 10 years? ____________ lbs

______ No, I gained weight over the past 10 years

How many lbs have you gained over the past 10 years? __________ lbs

______ No, my weight goes up and down

How much does your weight go up and down? ______________ lbs

5. How do you feel about your weight right now?

I think I am…

______ Very underweight
______ Slightly underweight
______ About right
______ Slightly overweight
______ Very overweight

6. Are you trying to lose weight at the present time?

______ Yes
______ No

<u>Section H</u>:

The following information will help us interpret the results of this questionnaire. It is important that all questions be completed. If you do not know the exact value for any of the questions, please provide your best estimate.

1. What was the date of your last menstrual cycle? ______________ (approximate mth and year)

2. Before your menstrual cycle ("periods") started to change as you entered menopause, would you say that your menstrual cycles were:

______ mostly regular
______ sometimes irregular
______ often irregular
______ I can't recall

3. Are you currently using hormone replacement therapy?

______ Yes
______ No

4. How would you describe your typical diet?

______ Mixed: meat, dairy products, eggs, fruits & vegetables, grains
______ Vegetarian: dairy products, eggs, fruits & vegetables, grains, but <u>no</u> meat
______ Vegan: I exclude all animal products
______ Other (please specify) ____

5. Do you smoke?

_______ Yes, I currently smoke approximately __________ cigarettes per day
_______ No, I quit smoking __________ weeks/months/years ago
_______ No, I never smoked regularly
_______ Other (please specify) ____

6. How many hours of exercise do you do each week? (By "exercise" we mean activity of sufficient intensity to raise your heart rate).

_________ hours

7. What type(s) of exercise do you participate in?

____

____

____

8. How many cups of beverages containing caffeine (e.g. coffee, tea, soda pop) do you drink *on a typical day*?

_________ cups

9. How many beverages containing alcohol (e.g. 1 glass of beer, a glass (3 oz) of wine, a shot (1 oz) of hard liquor such as rum or gin) do you drink *each week*?

_________ beverages

10. Please list any medications that you are currently taking:

____

____

____

____

11. Have you ever been diagnosed with osteoporosis? If you have been diagnosed with osteoporosis, please indicate when you received the diagnosis.

_______ Yes, I was diagnosed in ______________________ (approximate month and year)
_______ No

12. Today's date: ______________________ (day/month/year)

13. Your birth date: ______________________ (day/month/year)

14. How tall are you? ______ feet ______ inches (or ______ cm)

15. How much do you weigh? __________ lbs (or ________ kg)

16. What is your ethnicity? (please check the appropriate option):

______	White	______	South East Asian
______	Chinese	______	Latin American
______	South Asian	______	Japanese
______	Black	______	Korean
______	Arab/West Asian	______	North American Aboriginal
______	Filipino	______	Other (please specify): ________________

17. What is the highest level of education that you have *completed*?

______ I have not completed any formal schooling
______ Elementary school (up to grade 6)
______ Secondary school (high school; up to grade 12)
______ Post-secondary college diploma or university degree
______ Graduate or professional degree (e.g. Master's, PhD, MBA, MD, etc.)

18. Would you estimate your household income to be:

______ Under $20,000 per year
______ Between $20,000 and $35,000 per year
______ Between $35,001 and $50,000 per year
______ Between $50,001 and $80,000 per year
______ More than $80,001 per year

You have now reached the end of the questionnaire. Thank you very much for your time and participation. Please read the information on the next page and then return this completed questionnaire in the stamped addressed envelope provided. Thank you!

APPENDIX 7: Phase I contact form

We greatly appreciate your participation in this study, and we would be pleased to share the results of our research with you (results should be available in approximately one year's time). If you are interested in receiving a written summary of the results of this project, please indicate that in the following section (or write the same information on a separate sheet, if desired, and mail it in separately).

Also, we are currently recruiting women for a more detailed study of dietary attitudes and behaviours and bone health. Participants in that study will have their diet analyzed, their bone density measured, and collect urine samples (and they will receive individual feedback regarding the results of those measurements). If you might be interested in participating in that study, please indicate that in the following section as well. Indicating your interest at this time does not obligate you to take part in the study, it simply means that we will contact you and provide you with more information.

- -

Please complete this section if:
(1) you would like a summary of the results of this research project, or
(2) you would like to participate in the next phase of the research (examining diet and bone health):

I would (please check one or both):

______ like to receive a summary of the results of this research project

______ be interested in being contacted for possible participation in the study of dietary attitudes and behaviours and bone health.

Name: ____

Permanent Address:

____

____

____

E-mail address (if available): _____________________

Telephone Number: ____________________________

Thank you very much!

APPENDIX 9: Phase II recruitment letter

THE UNIVERSITY OF BRITISH COLUMBIA

Food, Nutrition and Health
Faculty of Agricultural Sciences
2205 East Mall
Vancouver, B.C. Canada V6T 1Z4
Phone: (604) 822-2502
Fax: (604) 822-5143

[Date]

[Participant Name and Address Information]

Dear [Participant],

Thank you very much for returning your completed questionnaire for our study "An Exploration of Postmenopausal Women's Attitudes towards Eating and Body Image." Your participation in our research project is greatly appreciated, as is your expression of interest in the second part of the study. We are writing to you now to invite you to participate in the next phase of the research (Phase II: "Dietary Attitudes, Stress, and Bone Health in Women Following Menopause").

This research study is being funded by the Canadian Institutes of Health Research and, like Phase I, is being conducted by Candice Rideout (a Ph.D. candidate in Human Nutrition) as a part of her Ph.D. thesis. This phase of the study will further explore postmenopausal women's eating attitudes and behaviours, and investigate their relation to stress and bone health. Similar studies have been conducted in young women, but information is lacking regarding the experiences of postmenopausal women (for whom bone health and osteoporosis are important health issues).

If you choose to participate in this phase of the project, you will be asked to do the following:

1) complete a questionnaire package similar to the one you completed in Phase I,
2) have your height, weight, and waist circumference measured while wearing light indoor clothing,
3) maintain a detailed record of everything you eat and drink over the course of three (3) days (in a food diary which will be provided to you) twice – now, and again roughly 3 months from now,
4) collect two (2) 24-hour urine samples,
5) have your bone density measured using dual energy x-ray absorptiometry (DEXA). (This non-invasive procedure takes approximately half an hour and it involves exposure to a very low dose of radiation – an amount similar to what you would receive if you spent several hours outdoors.)

If you choose to participate in this study, you will make one visit to the University of British Columbia (UBC) and one visit to Vancouver General Hospital (VGH). During the visit to UBC, you will be given an orientation to the study, and provided with all materials required for your participation; in addition, you will complete a questionnaire and have your height, weight, and weight circumference measured. Roughly 4 months later, during the visit to VGH, you will have your bone density assessed. In between these visits, you will complete the following tasks:

APPENDIX 10: Phase II questionnaire

THE UNIVERSITY OF BRITISH COLUMBIA

Food, Nutrition and Health
Faculty of Agricultural Sciences
2205 East Mall
Vancouver, B.C. Canada V6T 1Z4
Phone: (604) 822-2502
Fax: (604) 822-5143

Office Use Only
____
___C ___CV
___E ___EV

Phase II Questionnaire:

Dietary Attitudes, Stress, and Bone Health in Women Following Menopause

This questionnaire consists of several sections. You will be asked to answer questions by indicating whether a given statement is true or false for you, or to choose from several options the answer that is most applicable to you. Specific instructions are given for each section.

Your answers are completely confidential, so please answer each question as honestly and accurately as possible.

When you have completed the questionnaire, please return it in the stamped, addressed envelope provided.

Thank you for your participation in Phase II!

Section A:

Please circle whether the statements below are true (T) or false (F) for you.

		True	False
1.	When I smell the aroma of my favourite food, I find it very difficult to keep from eating, even if I have just finished a meal..	T	F
2.	I usually eat too much at social occasions, like parties and picnics..........................	T	F
3.	I am usually so hungry that I eat more than three times a day............................	T	F
4.	When I have eaten my quota of calories, I am usually good about not eating any more..	T	F
5.	Dieting is so hard for me because I just get too hungry.......................................	T	F
6.	I deliberately take small helpings as a means of controlling my weight...............	T	F
7.	Sometimes things just taste so good that I keep on eating even when I am no longer hungry..	T	F
8.	Since I am often hungry, I sometimes wish that while I am eating, an expert would tell me that I have had enough or that I can have something more to eat..	T	F
9.	When I feel anxious, I find myself eating..	T	F
10.	Life is too short to worry about dieting..	T	F
11.	Since my weight goes up and down, I have gone on reducing diets more than once...	T	F
12.	I often feel so hungry that I just have to eat something.......................................	T	F
13.	When I am with someone who is overeating, I usually overeat too.........................	T	F
14.	I have a pretty good idea of the number of calories in common food..................	T	F
15.	Sometimes when I start eating, I just can't seem to stop......................................	T	F
16.	It is not difficult for me to leave something on my plate......................................	T	F
17.	At certain times of the day, I get hungry because I have gotten used to eating then..	T	F
18.	While on a diet, if I eat food that is not allowed, I consciously eat less for a period of time to make up for it..	T	F

		True	False
19.	Being with someone who is eating often makes me hungry enough to eat also	T	F
20.	When I feel blue, I often overeat	T	F
21.	I enjoy eating too much to spoil it by counting calories or watching my weight	T	F
22.	When I see a real delicacy, I often get so hungry that I have to eat right away	T	F
23.	I often stop eating when I am not really full as a conscious means of limiting the amount that I eat	T	F
24.	I get so hungry that my stomach often seems like a bottomless pit	T	F
25.	My weight has hardly changed at all in the last two years	T	F
26.	I am always hungry so it is hard for me to stop eating before I finish the food on my plate	T	F
27.	When I feel lonely, I console myself by eating	T	F
28.	I consciously hold back at meals in order not to gain weight	T	F
29.	I sometimes get very hungry late in the evening or night	T	F
30.	I eat anything I want, any time I want	T	F
31.	Without even thinking about it, I take a long time to eat	T	F
32.	I count calories as a conscious means of controlling my weight	T	F
33.	I do not eat some foods because they make me fat	T	F
34.	I am always hungry enough to eat at any time	T	F
35.	I pay a great deal of attention to changes in my figure	T	F
36.	While on a diet, if I eat a food that is not allowed, I often then splurge and eat other high calorie foods	T	F

37. How often are you dieting in a conscious effort to control your weight?

1	2	3	4
Rarely	*Sometimes*	*Usually*	*Always*

38. Would a weight fluctuation of 5 lbs affect the way you live your life?

1	2	3	4
Not at all	*Slightly*	*Moderately*	*Very much*

39. How often do you feel hungry?

1	2	3	4
Only at meals	*Sometimes between meals*	*Often between meals*	*Almost always*

40. Do your feelings of guilt about overeating help you to control your food intake?

1	2	3	4
Never	*Rarely*	*Often*	*Always*

41. How difficult would it be for you to stop eating halfway through dinner and not eat for the next four hours?

1	2	3	4
Easy	*Slightly difficult*	*Moderately difficult*	*Very difficult*

42. How conscious are you of what you are eating?

1	2	3	4
Not at all	*Slightly*	*Moderately*	*Extremely*

43. How frequently do you avoid "stocking up" on tempting foods?

1	2	3	4
Almost never	*Seldom*	*Usually*	*Almost always*

44. How likely are you to shop for low calorie foods?

1	2	3	4
Unlikely	*Slightly likely*	*Moderately likely*	*Very likely*

45. Do you eat sensibly in front of others and splurge alone?

1	2	3	4
Never	*Rarely*	*Often*	*Always*

46. How likely are you to consciously eat slowly in order to cut down on how much you eat?

1	2	3	4
Unlikely	*Slightly likely*	*Moderately likely*	*Very likely*

47. How frequently do you skip dessert because you are no longer hungry?

1	*2*	*3*	*4*
Almost never	*Seldom*	*At least once/week*	*Almost daily*

48. How likely are you to consciously eat less than you want?

1	*2*	*3*	*4*
Unlikely	*Slightly likely*	*Moderately likely*	*Very likely*

49. Do you go on eating binges though you are not hungry?

1	*2*	*3*	*4*
Never	*Rarely*	*Sometimes*	*At least weekly*

50. On a scale of 0 to 5, where 0 means no restraint in eating (eating whatever you want, whenever you want it) and 5 means total restraint (constantly limiting food intake and never "giving in"), what number would you give yourself? *(please circle the number)*

0 Eat whatever you want, whenever you want it

1 Usually eat whatever you want, whenever you want it

2 Often limit food intake, but often "give in"

3 Usually limit food intake, but often "give in"

4 Usually limit food intake, rarely "giving in"

5 Constantly limit food intake, never "giving in"

51. To what extent does this statement describe your eating behaviour?

"I start dieting in the morning, but because of any number of things that happen during the day, by evening I have given up and eat what I want, promising myself to start dieting again tomorrow."

1	*2*	*3*	*4*
Not like me	*A little like me*	*Pretty good description of me*	*Describes me perfectly*

52. Do you deliberately restrict your intake during meals even though you would like to eat more?

1	*2*	*3*	*4*
Always	*Often*	*Rarely*	*Never*

Please circle whether the statements below are true (T) or false (F) for you.

		True	False
53.	I would rather skip a meal than stop eating in the middle of one	T	F
54.	I try to stick to a plan when I lose weight	T	F
55.	I eat diet foods, even if they do not taste very good	T	F
56.	Without a diet plan I wouldn't know how to control my weight	T	F
57.	I avoid some foods on principle even though I like them	T	F
58.	I prefer light foods that are not fattening	T	F
59.	If I eat a little bit more during one meal, I make up for it at the next meal	T	F
60.	I alternate between times when I diet strictly and times when I don't pay much attention to what and how much I eat	T	F
61.	A diet would be too boring a way for me to lose weight	T	F
62.	If I eat a little bit more on one day, I make up for it the next day	T	F
63.	I pay attention to my figure, but I still enjoy a variety of foods	T	F
64.	Sometimes I skip meals to avoid gaining weight	T	F
65.	Quick success is most important for me during a diet	T	F

<u>**Section B**</u>:

The questions in the following scale ask you about your feelings and thoughts during the past month. In each case, you will be asked to indicate how often you felt or thought in a certain way.

Although some of the questions are similar, there are differences between them and you should treat each one as a separate question. The best approach is to answer each question fairly quickly. That is, don't try to count up the number of times you felt a particular way, but rather indicate the alternative that seems like a reasonable estimate.

For each question, choose from the following alternatives:

0: never
1: almost never
2: sometimes
3: fairly often
4: very often

1. In the last month, how often have you been upset because of something that happened unexpectedly?

0	1	2	3	4
Never	*Almost never*	*Sometimes*	*Fairly often*	*Very often*

2. In the last month, how often have you felt that you were unable to control the important things in life?

0	1	2	3	4
Never	*Almost never*	*Sometimes*	*Fairly often*	*Very often*

3. In the last month, how often have you felt nervous and “stressed”?

0	1	2	3	4
Never	*Almost never*	*Sometimes*	*Fairly often*	*Very often*

4. In the last month, how often have you dealt successfully with irritating life hassles?

0	1	2	3	4
Never	*Almost never*	*Sometimes*	*Fairly often*	*Very often*

5. In the last month, how often have you felt that you were effectively coping with important changes that were occurring in your life?

0	1	2	3	4
Never	*Almost never*	*Sometimes*	*Fairly often*	*Very often*

6. In the last month, how often have you felt confident about your ability to handle your personal problems?

0	1	2	3	4
Never	*Almost never*	*Sometimes*	*Fairly often*	*Very often*

7. In the last month, how often have you felt that things were going your way?

0	1	2	3	4
Never	*Almost never*	*Sometimes*	*Fairly often*	*Very often*

8. In the last month, how often have you found that you could not cope with all the things that you had to do?

0	*1*	*2*	*3*	*4*
Never	*Almost never*	*Sometimes*	*Fairly often*	*Very often*

9. In the last month, how often have you been able to control irritations in your life?

0	*1*	*2*	*3*	*4*
Never	*Almost never*	*Sometimes*	*Fairly often*	*Very often*

10. In the last month, how often have you felt that you were on top of things?

0	*1*	*2*	*3*	*4*
Never	*Almost never*	*Sometimes*	*Fairly often*	*Very often*

11. In the last month, how often have you been angered because of things that happened that were outside of your control?

0	*1*	*2*	*3*	*4*
Never	*Almost never*	*Sometimes*	*Fairly often*	*Very often*

12. In the last month, how often have you found yourself thinking about things that you have to accomplish?

0	*1*	*2*	*3*	*4*
Never	*Almost never*	*Sometimes*	*Fairly often*	*Very often*

13. In the last month, how often have you been able to control the way you spend your time?

0	*1*	*2*	*3*	*4*
Never	*Almost never*	*Sometimes*	*Fairly often*	*Very often*

14. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

0	*1*	*2*	*3*	*4*
Never	*Almost never*	*Sometimes*	*Fairly often*	*Very often*

Section C:

Hassles are irritants that can range from minor annoyance to fairly major pressures, problems, or difficulties. They can occur few or many times. Listed are a number of ways in which a person can feel hassled about nutrition and diet. Please rate the following items according to the irritability of those hassles experienced during the past month.

	Not irritating	*Slightly irritating*	*Somewhat irritating*	*Moderately irritating*	*Quite irritating*	*Very irritating*	*Extremely irritating*
1. Concerns about eating the right foods........................	□	□	□	□	□	□	□
2. Cravings for foods not on your diet..........................	□	□	□	□	□	□	□
3. Finding the right foods..........	□	□	□	□	□	□	□
4. Avoiding favourite foods........	□	□	□	□	□	□	□
5. Figuring out which foods to buy................................	□	□	□	□	□	□	□
6. Preparing food......................	□	□	□	□	□	□	□
7. Time spent preparing food.....	□	□	□	□	□	□	□
8. Taste of food on diet............	□	□	□	□	□	□	□
9. Foods not satisfying..............	□	□	□	□	□	□	□
10. Time required to shop for food...............................	□	□	□	□	□	□	□
11. Choosing food to eat............	□	□	□	□	□	□	□
12. Digesting food......................	□	□	□	□	□	□	□
13. Going out to dinner............	□	□	□	□	□	□	□
14. Not going out to dinner.........	□	□	□	□	□	□	□
15. Eating right when not at home..............................	□	□	□	□	□	□	□
16. Family problems over food...............................	□	□	□	□	□	□	□
17. Lack of control over diet.........	□	□	□	□	□	□	□
18. Learning new recipes...........	□	□	□	□	□	□	□
19. Don't like what you eat.........	□	□	□	□	□	□	□
20. Planning menus....................	□	□	□	□	□	□	□
21. Feeling hungry......................	□	□	□	□	□	□	□
22. Keeping track of cholesterol...	□	□	□	□	□	□	□

	Not irritating	*Slightly irritating*	*Somewhat irritating*	*Moderately irritating*	*Quite irritating*	*Very irritating*	*Extremely irritating*
23. Keeping track of salt............	□	□	□	□	□	□	□
24. Keeping track of fat..............	□	□	□	□	□	□	□
25. Keeping track of calories.........	□	□	□	□	□	□	□
26. Eating junk food..................	□	□	□	□	□	□	□
27. Reading nutrition labels............	□	□	□	□	□	□	□
28. Eating too much.....................	□	□	□	□	□	□	□
29. Understanding which foods you should eat..........................	□	□	□	□	□	□	□
30. Finding time to eat...................	□	□	□	□	□	□	□
31. Food portions........................	□	□	□	□	□	□	□
32. Remembering to eat..............	□	□	□	□	□	□	□
33. Telling others about diet.........	□	□	□	□	□	□	□
34. Holidays and special occasions.	□	□	□	□	□	□	□
35. Remembering when to eat.......	□	□	□	□	□	□	□
36. Changing food habits..............	□	□	□	□	□	□	□
37. Refusing food that is offered....	□	□	□	□	□	□	□
38. Avoiding sweets.................	□	□	□	□	□	□	□
39. Not enjoying food................	□	□	□	□	□	□	□
40. Eating enough vegetables........	□	□	□	□	□	□	□
41. Eating enough fruit...............	□	□	□	□	□	□	□
42. Eating when not hungry............	□	□	□	□	□	□	□
43. Cost of food........................	□	□	□	□	□	□	□
44. Keeping track of sugar...........	□	□	□	□	□	□	□
45. Keeping track of vitamins........	□	□	□	□	□	□	□
46. Keeping track of minerals........	□	□	□	□	□	□	□
47. Embarrassment about diet.......	□	□	□	□	□	□	□
48. Boring food........................	□	□	□	□	□	□	□

Section D:

The next set of questions are about your diet and health. Please read each of the following statements, then answer the questions by checking the box next to the answer that best describes your experience during the past month. Some of the questions may look alike or seem like others, but each question is different, and should be answered by itself.

1. During the past month, how healthy were the foods you ate?
   - ☐ Not healthy at all
   - ☐ Slightly healthy
   - ☐ Somewhat healthy
   - ☐ Moderately healthy
   - ☐ Quite healthy
   - ☐ Very healthy
   - ☐ As healthy as they could be

2. During the past month, did you think that you were getting all the nutrients that you need from the foods that you ate?
   - ☐ No, not at all
   - ☐ No, almost none
   - ☐ Less than half of my needs
   - ☐ Only about half
   - ☐ More than half, but not all of my needs
   - ☐ Yes, almost everything
   - ☐ Yes, everything that I need

3. During the past month, have you been worried or concerned about how your diet has been affecting your health?
   - ☐ Extremely so
   - ☐ Very much so
   - ☐ Quite a bit
   - ☐ Some but not a lot
   - ☐ A little bit
   - ☐ Practically never
   - ☐ Not at all

4. Do you think you worried about the effect of your diet on your health more than other people did, during the past month?
   - ☐ Yes, all of the time
   - ☐ Yes, most of the time
   - ☐ Yes, a good bit of the time
   - ☐ Yes, some of the time
   - ☐ A little of the time
   - ☐ No, hardly any of the time
   - ☐ No, none of the time

5. During the past month, did you think that your diet improved your health?
   - ☐ Yes, definitely so
   - ☐ Yes, very much so
   - ☐ Yes, quite a lot
   - ☐ For the most part
   - ☐ Some, but not a lot
   - ☐ Not very much
   - ☐ Not at all

6. How balanced do you think your diet was during the past month?
   - ☐ Extremely well balanced
   - ☐ Very well balanced
   - ☐ Well balanced
   - ☐ Somewhat balanced
   - ☐ A little balanced
   - ☐ Not very balanced
   - ☐ Not balanced at all

7. Do you feel healthier now than you did one month ago?
   - ☐ Yes, definitely so
   - ☐ Yes, very much so
   - ☐ Yes, quite a lot
   - ☐ For the most part
   - ☐ Some, but not a lot
   - ☐ Not very much
   - ☐ Not at all

<u>Section E</u>:

The following questions are about how your diet influences your social life. Please read each of the following statements, and then answer the questions by checking the box next to the answer that best describes your experience during the past month. Some of the questions may look alike or seem like others, but each question is different, and should be answered by itself.

1. During the past month, how satisfied were you with your social life?
   - ☐ Extremely satisfied
   - ☐ Very satisfied
   - ☐ Quite satisfied
   - ☐ Somewhat satisfied
   - ☐ Quite unsatisfied
   - ☐ Very unsatisfied
   - ☐ Extremely unsatisfied

2. How much of the time during the past month would you say that your diet interfered with parties, holidays and special occasions?
   - ☐ All of the time
   - ☐ Most of the time
   - ☐ A lot of the time
   - ☐ A good bit of the time
   - ☐ Some of the time
   - ☐ A little of the time
   - ☐ None of the time

3. How much of the time during the past month would you say that your diet interfered with the quality of your family relationships?
   - ☐ All of the time
   - ☐ Most of the time
   - ☐ A lot of the time
   - ☐ A good bit of the time
   - ☐ Some of the time
   - ☐ A little of the time
   - ☐ None of the time
   - ☐ Not applicable

4. How much of the time during the past month would you say that your diet interfered with socializing at work?
   - ☐ All of the time
   - ☐ Most of the time
   - ☐ A lot of the time
   - ☐ A good bit of the time
   - ☐ Some of the time
   - ☐ A little of the time
   - ☐ None of the time
   - ☐ Not applicable

5. How much of the time during the past month would you say that your diet interfered with socializing with friends?
   - ☐ All of the time
   - ☐ Most of the time
   - ☐ A lot of the time
   - ☐ A good bit of the time
   - ☐ Some of the time
   - ☐ A little of the time
   - ☐ None of the time

6. Do you think that your diet had a positive effect on your social life during the past month?
   - ☐ No, not at all
   - ☐ Hardly any effect
   - ☐ A little effect
   - ☐ Somewhat
   - ☐ Quite a bit
   - ☐ Yes, very much so
   - ☐ Yes, definitely so

7. Do you feel more attractive now than you did one month ago?
   - ☐ No, not at all
   - ☐ Hardly any effect
   - ☐ A little effect
   - ☐ Somewhat
   - ☐ Quite a bit
   - ☐ Yes, very much so
   - ☐ Yes, definitely so

8. How confident have you felt about your diet during the past month?
   - ☐ Not at all confident
   - ☐ A little confident
   - ☐ Somewhat confident
   - ☐ Moderately confident
   - ☐ Quite confident
   - ☐ Very confident
   - ☐ Extremely confident

<u>Section F</u>:
Please rate each of the following items according to how these things have affected your mood within the last month.

1. During the past month, how angry have you been about having an illness that demands changes in your normal eating habits?
   - ☐ Extremely angry
   - ☐ Very angry
   - ☐ Quite angry
   - ☐ Moderately angry
   - ☐ Somewhat angry
   - ☐ A little angry
   - ☐ Not angry at all
   - ☐ Not applicable

2. During the past month, how irritable have you been?
   - ☐ Extremely irritable
   - ☐ Very irritable
   - ☐ Quite irritable
   - ☐ Moderately irritable
   - ☐ Somewhat irritable
   - ☐ A little irritable
   - ☐ Not irritable

3. During the past month, how frustrated have you been?
   - ☐ Extremely frustrated
   - ☐ Very frustrated
   - ☐ Quite frustrated
   - ☐ Moderately frustrated
   - ☐ Somewhat frustrated
   - ☐ A little frustrated
   - ☐ Not frustrated at all

4. How impatient have you been in the past month?
   - ☐ Not impatient at all
   - ☐ A little impatient
   - ☐ Somewhat impatient
   - ☐ Moderately impatient
   - ☐ Quite impatient
   - ☐ Very impatient
   - ☐ Extremely impatient

5. How stressed have you felt during the past month?
   - ☐ Extremely stressed
   - ☐ Very stressed
   - ☐ Quite stressed
   - ☐ Moderately stressed
   - ☐ Somewhat stressed
   - ☐ A little stressed
   - ☐ Not at all stressed

6. During the past month, how much of the time have you felt in control of your diet?
   - ☐ All of the time
   - ☐ Most of the time
   - ☐ A good bit of the time
   - ☐ Some of the time
   - ☐ A little of the time
   - ☐ Hardly any of the time
   - ☐ None of the time

7. Do you feel younger now than you did one month ago?
   - ☐ Yes, definitely so
   - ☐ Yes, very much so
   - ☐ Yes, quite a lot
   - ☐ For the most part
   - ☐ Some, but not a lot
   - ☐ Not very much
   - ☐ Not at all

Section G:
Please answer the following additional questions.

1. During the past month, how would you rate your overall quality of life?
   - ☐ Excellent
   - ☐ Great
   - ☐ Good
   - ☐ Moderate
   - ☐ Not very good
   - ☐ Fairly poor
   - ☐ Very bad

2. During the past month, did you feel relieved knowing your diet was as healthy as it could be?
   - ☐ No, not at all
   - ☐ Only slightly
   - ☐ A little
   - ☐ Somewhat
   - ☐ Yes, for the most part
   - ☐ Yes, very much so
   - ☐ Yes, extremely relieved

3. Have you ever used hormone replacement therapy (HRT)?

☐ No
☐ Yes →

If you answered yes (i.e., you have used hormone replacement therapy in the past), please provide the approximate date you started and stopped using hormone replacement therapy:

Approximate start date: ______________________________
(month/year)

Approximate finish date: ______________________________
(month/year)

4. Next, we would like to ask you about how often you watched what you ate in a conscious effort to control your weight at various times in the past.

How often did you watch what you ate in a conscious effort to control your weight...

... in your <u>teens</u>?

1	2	3	4	5
Rarely	*Sometimes*	*Usually*	*Always*	*Can't recall*

...in your <u>20's</u>?

1	2	3	4	5
Rarely	*Sometimes*	*Usually*	*Always*	*Can't recall*

...in your <u>30's</u>?

1	2	3	4	5
Rarely	*Sometimes*	*Usually*	*Always*	*Can't recall*

...in your <u>40's</u>?

1	2	3	4	5
Rarely	*Sometimes*	*Usually*	*Always*	*Can't recall*

...in your <u>50's</u>?

1	2	3	4	5	6
Rarely	*Sometimes*	*Usually*	*Always*	*Can't recall*	*Have not yet reached my 50's*

...in your <u>60's</u>?

1	2	3	4	5	6
Rarely	*Sometimes*	*Usually*	*Always*	*Can't recall*	*Have not yet reached my 60's*

...in your <u>70's</u>?

1	2	3	4	5	6
Rarely	*Sometimes*	*Usually*	*Always*	*Can't recall*	*Have not yet reached my 70's*

5. Have you ever been diagnosed with an eating disorder by a physician?

☐ Yes

If you answered yes, please indicate the following:

What type of eating disorder were you diagnosed with? ____________________

When did you receive this diagnosis? ______________________ (month/year)

For how long did you experience this eating disorder? ____________________

☐ No

If you answered no, please indicate the following:

Although you were never diagnosed with an eating disorder by a physician, do you think that you ever had an undiagnosed eating disorder?

☐ *No*

☐ *Yes*

What sort of eating disorder do you think you had?

____

When did you experience this eating disorder?

____(month/year)

For how long did you experience this eating disorder?

____

6. Additional Comments (you may include comments on the back of the questionnaire as well, if desired):

____

____

APPENDIX 11: Daily stress inventory

Participant #: ____________

Urine Collection #: ________

Please complete this short questionnaire on the morning you complete your 24-hour urine collection, and then return it to Candice along with your completed Three-day Food Record in the stamped addressed envelope provided.

Below are listed a variety of events that may be viewed as stressful or unpleasant. Read each item carefully and decide whether or not that event occurred within the past 24 hours. If the event did not occur, place an "X" in the space next to that item. If the event did occur, indicate the amount of stress that it caused you by placing a number from 1 to 7 in the space next to that item (see numbers below). Please answer as honestly as you can so that we may obtain accurate information.

X = did not occur in the past 24 hours	4 = caused some stress
1 = occurred but was not stressful	5 = caused much stress
2 = caused very little stress	6 = caused very much stress
3 = caused a little stress	7 = caused me to panic

		Response ("X" or 1–7)
1.	Performed poorly at a task..	________
2.	Performed poorly due to others..	________
3.	Thought about unfinished work..	________
4.	Hurried to meet a deadline..	________
5.	Interrupted during task/activity..	________
6.	Someone spoiled your completed task.....................................	________
7.	Did something you are unskilled at...	________
8.	Unable to complete a task..	________
9.	Was unorganized..	________
10.	Criticized or verbally attacked..	________
11.	Ignored by others..	________
12.	Spoke or performed in public...	________

X = did not occur in the past 24 hours	4 = caused some stress
1 = occurred but was not stressful	5 = caused much stress
2 = caused very little stress	6 = caused very much stress
3 = caused a little stress	7 = caused me to panic

		Response ("X" or 1–7)
13.	Dealt with rude waiter/waitress/salesperson	________
14.	Interrupted while talking	________
15.	Was forced to socialize	________
16.	Someone broke a promise/appointment	________
17.	Competed with someone	________
18.	Was stared at	________
19.	Did not hear from someone you expected to hear from	________
20.	Experienced unwanted physical contact (crowded, pushed)	________
21.	Was misunderstood	________
22.	Was embarrassed	________
23.	Had your sleep disturbed	________
24.	Forgot something	________
25.	Feared illness/pregnancy	________
26.	Experienced illness/physical discomfort	________
27.	Someone borrowed something without your permission	________
28.	Your property was damaged	________
29.	Had minor accident (broke something, tore clothing)	________
30.	Thought about the future	________
31.	Ran out of food/personal article	________
32.	Argued with spouse/boyfriend/girlfriend	________
33.	Argued with another person	________

		Response ("X" or 1–7)
34.	Waited longer than you wanted..	____________
35.	Interrupted while thinking/relaxing..	____________
36.	Someone "cut" ahead of you in a line..	____________
37.	Performed poorly at a sport/game..	____________
38.	Did something that you did not want to do...............................	____________
39.	Unable to complete all plans for today.......................................	____________
40.	Had car trouble...	____________
41.	Had difficulty in traffic..	____________
42.	Money problems..	____________
43.	Store lacked a desired item...	____________
44.	Misplaced something...	____________
45.	Bad weather...	____________
46.	Unexpected expenses (fines, traffic ticket, etc.)..........................	____________
47.	Had confrontation with an authority figure................................	____________
48.	Heard some bad news..	____________
49.	Concerned over personal appearance....................................	____________
50.	Exposed to feared situation or object.....................................	____________
51.	Exposed to upsetting TV show, movie, book.............................	____________
52.	"Pet peeve" violated (someone fails to knock, etc.)......................	____________
53.	Failed to understand something..	____________
54.	Worried about another's problems..	____________
55.	Experienced narrow escape from danger.................................	____________
56.	Stopped unwanted personal habit (overeating, smoking, nail-biting)..	____________
57.	Had problem with kid(s)..	____________
58.	Was late for work/appointment...	____________

How to Complete your Three-day Food Record:

Record *everything* you eat and drink on each of three consecutive days (two weekdays and one weekend day). Please be clear and specific – provide as much detail as you can! Eat as you normally would over the course of these three days. It is important to our research that you maintain your regular eating and drinking patterns (this will also enable us to provide the most useful feedback to you). Remember that your diet is not being evaluated or compared to a "standard diet" – we are simply trying to gather information about how and what you usually eat.

Please follow these guidelines:

☑ **Write information for only one food or beverage item on each line.**
Try to record everything you eat and drink as you prepare it, or immediately after you have finished. Keep the food record with you and record your intake as you eat – don't rely on your memory to do it later!

☑ **Include <u>all</u> foods and drinks consumed.**
Don't forget snacks, drinks throughout the day (including alcoholic beverages and water), and details such as cream/milk in coffee or tea, etc.

☑ **Specify the <u>type</u> of food/beverage (provide details).**
For example, indicate whether "1 cup of milk" was homogenized, 2%, 1%, or skim.

☑ **Include the <u>name brand</u> of foods.**
For example, *Oreo* cookies, *Starbuck's* tall 1% latte, *Snackwell* brownies, *Stouffer's* macaroni and cheese, *Bread Garden* cinnamon knot, etc.

☑ **Record each component of "combination foods" on a separate line.**
For example, if you eat a ham and cheese omelet, record the items on separate lines: 2 eggs (on one line) + 1 oz cheddar cheese (on the next line) + 1 slice Maple Leaf cooked ham from packaged slices (on the next line) + 1 tsp butter in pan (on the next line). Please *include recipes* for homemade foods (e.g., sauces or soups) when that would be easier than trying to write each component of the food (don't forget to include the total amount – volume or number of servings – made by the recipe).

☑ **Record the <u>amount</u> of foods consumed as accurately as possible.**
You may find it helpful to measure the volume of the glasses and bowls that you normally use before you start your food record.

- ☑ **Use a *volume* measurement** (e.g., cups, tablespoons, teaspoons, milliliters) for items such as beverages, soups, pasta, cereals, rice, other grains, small or cut vegetables (e.g., peas or chopped carrots), cut fruit, tinned foods, sauces, salad dressings, butter, condiments, etc.

- ☑ **Use a *weight* measurement** (e.g., ounces or grams) for items such as meat, fish, poultry, cheese, etc. Use the labels on packages to help you. For example, if your package of Havarti cheese contains 176 grams and you ate approximately ¼ of the package, you would record that you ate 44 grams of Havarti cheese.

- ☑ **Use a *size* measurement** (e.g., large/medium/small, "whole", "piece", give dimensions) for items such as whole fruits, whole vegetables, cookies, eggs, cake, pieces of cheese, etc.

☑ **Indicate the <u>location</u> of your meal/snack.**
Record where you ate or drank the item(s) – for example, at home, a particular restaurant (please specify), in the car/on the bus, at your desk at work, etc.

☑ **If you use supplements and/or medications, write them on separate lines.**

☑ **Use as many pages as you need for each day's record.**
Try to start a new day on a new page, and indicate the date at the top of the page.

☑ **Answer the questions on page 21 at the end of each day.**

☑ **Use the *Food Record Checklist* (p. 4) and *Describing Portion Sizes* (p. 6) as references.**
They may assist you in filling out the food record completely and accurately.

<u>The following example may guide you in completing your Three-day Food Record:</u>

Date: <u>Friday, October 3, 2003</u>

Time	Food or Beverage	Description (name brand, type, how prepared)	Amount Eaten	Location
8am	*Raisin Bran*	*Kellogg's*	*1 cup*	*Home*
"	*milk, on cereal*	*Lucerne 2%*	*¾ cup*	"
"	*orange juice*	*Minute Maid "premium original"*	*1 cup*	"
"	*bagel*	*Dempster's cinnamon raisin, toasted*	*½ bagel*	"
"	*cream cheese*	*Kraft Philadelphia lite*	*1 tablespoon*	"
10:30am	*coffee*	*Edward's regular grind, brewed*	*1 ½ cups*	*Friend's house*
"	*cream*	*Dairyland cream (10% BF)*	*2 tablespoons*	"
"	*sugar*	*Roger's ("Plantation Raw")*	*2 little packets*	"

When several items are consumed at the same time, you do not need to enter repeating values (such as time and location) on each line. Writing it on the first line for that meal/snack is sufficient.

Describe the food or beverage as clearly as possible. Insert recipes or package labels into your booklet, if you think these would be

Use measuring cups and spoons and the "describing portion sizes" information (located on pages 6 and 7) to estimate portion sizes as accurately as possible.

Food Item Checklist

This checklist may help you to remember to record some of the details of the foods and beverages you consume. You can use it as a resource to assist you in completing your Three-day Food Record.

Portion Description
- ☐ Weight in ounces or grams?
- ☐ Dimensions in inches or centimetres?

Beverages
- ☐ Sugar or creamer?
- ☐ Regular or decaffeinated?
- ☐ With or without ice?
- ☐ Regular or sugar-free?
- ☐ Alcohol content?
- ☐ Name of drink and ingredients (mixed drinks)

Breads
- ☐ Homemade or commercial brand?
- ☐ Brand name?
- ☐ White, whole wheat, multigrain, sourdough, etc?
- ☐ Butter, margarine or other condiments added?

Cereal
- ☐ Milk, sugar, fruit, or other toppings added?
- ☐ Type of milk (e.g., 2%, skim, etc.)?
- ☐ Dry or cooked measure?

Combination Foods
- ☐ Included recipe?
- ☐ % fat of meat used in dish?
- ☐ Poultry skin left on or removed?
- ☐ Salad dressings, sauces, or mayo added?

Dairy
- ☐ Is yogurt fruited or plain?
- ☐ Is creamer liquid or powder?
- ☐ % fat of milk or yogurt?
- ☐ Indicate brand name of substitutes such as nondairy creamer.
- ☐ Type of cheese?

Desserts
- ☐ Homemade, mix, or commercial?
- ☐ Single or double crust pie?
- ☐ Whipped topping added?
- ☐ Frosting?
- ☐ Dimensions?

Eggs
- ☐ Preparation method clear?
- ☐ Fat used?
- ☐ White, brown, enriched?

Fast Food
- ☐ What restaurant?
- ☐ If not a national fast food chain, describe the food in detail.
- ☐ Size order of fries and other items?
- ☐ Extra toppings on sandwich?

Fats/Oils
- ☐ Stick, tub, or liquid margarine?
- ☐ Reduced-calorie or reduced-salt product?
- ☐ Brand name?

Fish
- ☐ Water or oil packed?
- ☐ Baked or fried?
- ☐ With batter or without?
- ☐ Type of fat added?
- ☐ Raw or cooked weight?
- ☐ Fresh or canned?

Fruit
- ☐ Fresh, canned, or frozen?
- ☐ With or without skin?
- ☐ Small, medium or large (for whole fruit) or volume measurement (for cut fruit)?

Grains (e.g., rice, oatmeal, etc.)
- ☐ Added butter, margarine, syrup, jam, or honey?
- ☐ Volume, weight, or dimensions given?
- ☐ How prepared (e.g., added water or milk)?

Meats
- ☐ Preparation method?
- ☐ Light or dark meat?
- ☐ Raw or cooked?

Soups
- ☐ Prepared with milk, water, or cream?
- ☐ Low-sodium or regular?
- ☐ Chunky or broth type?

Medications
- ☐ Type?
- ☐ Dose?

Supplements
- ☐ Vitamin/mineral supplements?
- ☐ Herbal supplements?
- ☐ Type, brand name, amount?

Sweets
- ☐ Brand name and size?
- ☐ Package weight?
- ☐ Don't forget hard candy, chocolate, treats throughout the day.

Table-added items
- ☐ Added salt?
- ☐ Butter/margarine?
- ☐ Gravy?
- ☐ Sugar?
- ☐ Dressings or sauces?

Vegetables
- ☐ Raw or cooked?
- ☐ Fresh, frozen, or canned?
- ☐ Added fat or sauce?

"Forgotten Foods" (often consumed between meals, and many people forget to write them down)
- ☐ Crackers or cookies
- ☐ Salty snacks (nuts, chips, cheesies, etc.)
- ☐ Alcoholic beverages

Describing Portion Sizes

Whenever possible, exactly measure the portions of foods and beverages you eat and drink over these three days (a portion is the amount of a particular food/beverage that you eat/drink). Using measuring cups and spoons and/or measuring the dimensions of a food will provide the most accurate estimation of size. However, there may be times when you cannot precisely measure an amount (e.g., you are at a restaurant). You may find these guidelines helpful in describing your portion sizes in those instances.

A **medium** apple or peach is about the size of a tennis ball.

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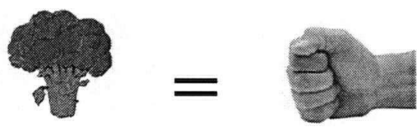
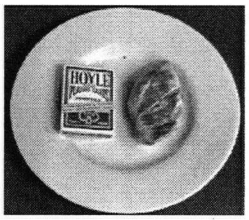
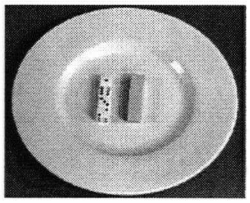
1 cup of mashed potatoes, vegetables (e.g., broccoli), or pasta is about the size of your fist.



3 ounces of meat is about the size and thickness of a deck of playing cards.

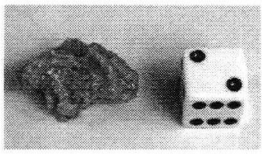


1 ounce of cheese is about the size of 4 stacked dice.

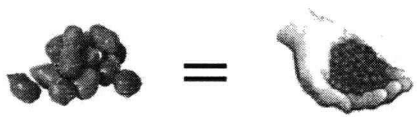


½ **cup** of ice cream is about the size of a tennis ball.

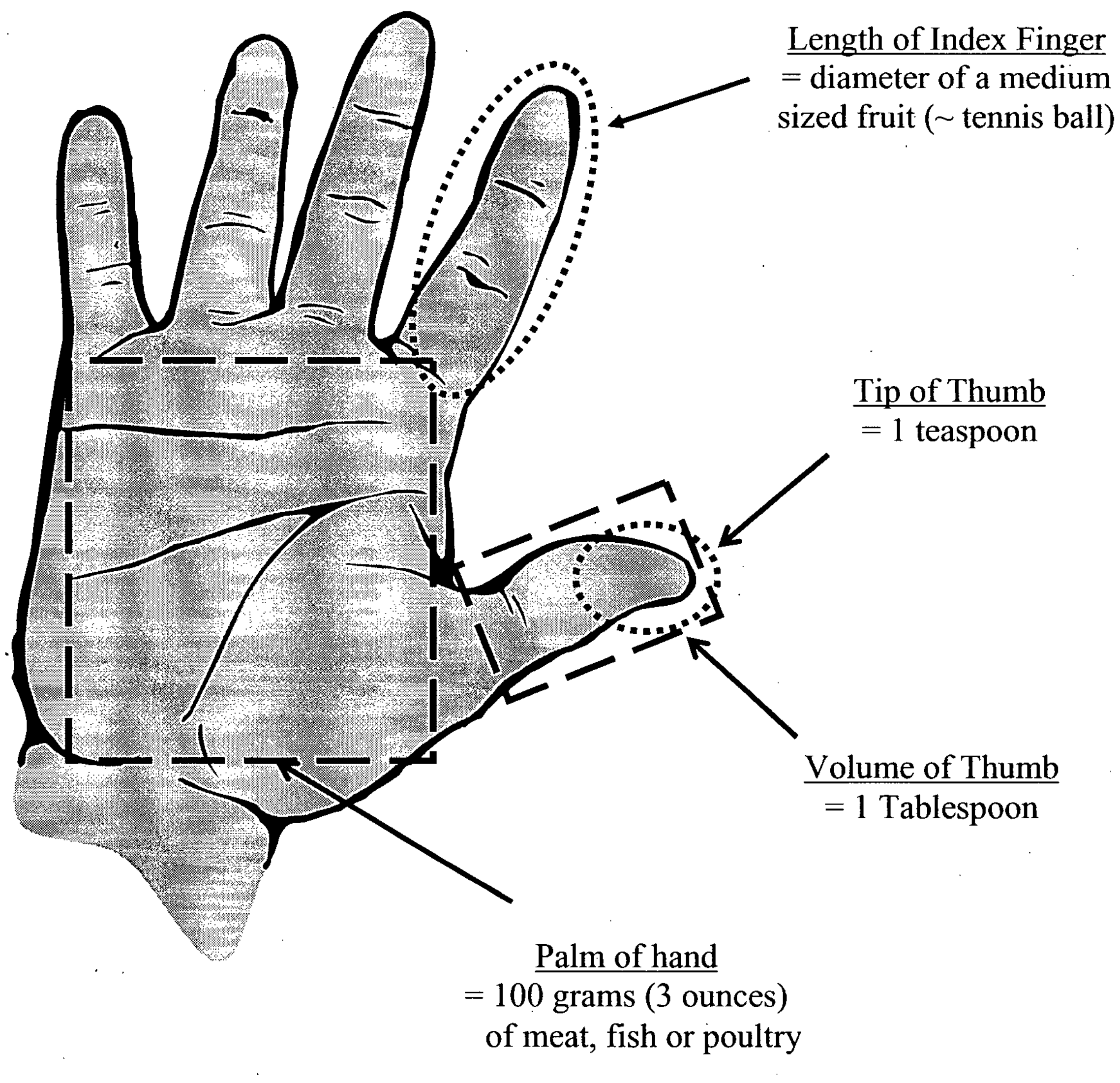
1 teaspoon of butter (or peanut butter, or jam) is about the size of one die, or the tip of your thumb.



1 ounce of nuts or hard candies is a small handful.



Remembering the following approximate measurements may come in "handy" when you are estimating your portion sizes:



Date: ___________ *Note: this is an example of the pages used to record foods and beverages (each Food Record contained 13 page)*

Time	Food or Beverage	Description (brand name, type, how prepared, etc.)	Amount Eaten	Location

1. Was Day 1 (date: ________________) a typical day for you?

☐ yes

☐ no ⟶ If it was not a typical day,
A) please specify how it was different:

B) would you estimate that similar days would occur…
☐ once a year or less often?
☐ more than once a year, but less than once a month?
☐ more than once a month, but less than once a week?

2. Was Day 2 (date: ________________) a typical day for you?

☐ yes

☐ no ⟶ If it was not a typical day,
A) please specify how it was different:

B) would you estimate that similar days would occur…
☐ once a year or less often?
☐ more than once a year, but less than once a month?
☐ more than once a month, but less than once a week?

3. Was Day 3 (date: ________________) a typical day for you?

☐ yes

☐ no ⟶ If it was not a typical day,
A) please specify how it was different:

B) would you estimate that similar days would occur…
☐ once a year or less often?
☐ more than once a year, but less than once a month?
☐ more than once a month, but less than once a week?

APPENDIX 13: Form for pilot-testing food record

Three-day Food record Pilot Test: Feedback Form

Please answer the following questions (adding comments whenever possible), and then return this form along with your completed Food Record in the stamped addressed envelope provided. Once the dietary analysis of your Food Record is complete (in roughly 6 weeks time), you will be sent a summary of the results. Candice will contact you shortly thereafter to answer any questions you may have about the dietary analysis.

1. Did you find the Food record easy to use?

1	*2*	*3*	*4*	*5*
Not at all easy				*Very easy*

Why?

2. Were the instructions on pages 2 and 3 of the Food Record helpful?

1	*2*	*3*	*4*	*5*
Not at all helpful				*Very helpful*

Why?

3. Was the Food Item Checklist (on pages 18 and 19) helpful?

1	*2*	*3*	*4*	*5*
Not at all helpful				*Very helpful*

Why?

4. Was "Describing your Portion Sizes" (on pages 20 and 21) helpful?

1	*2*	*3*	*4*	*5*
Not at all helpful				*Very helpful*

Why?

5. Was enough space provided for you to record all the food items you consumed over the three days?

Yes No

Comments:

6. Did you find it difficult to answer the questions on page 17?

Yes No

Comments:

7. Was the Orientation Session (in which you were provided with instructions regarding how to complete the Food Record helpful?

1	*2*	*3*	*4*	*5*
Not at all helpful				*Very helpful*

Why?

8. Were any telephone conversations you had with Candice (e.g., on the first day you were scheduled to complete the Food Record) helpful?

1	*2*	*3*	*4*	*5*
Not at all helpful				*Very helpful*

Why?

9. Were your questions answered satisfactorily?

Yes No

Comments:

10. Did any questions occur to you during the days you were completing the Food Record (i.e., would you have liked clarification on points not mentioned in the orientation session or in telephone calls)?

11. Did you find that maintaining the Food Record for these three days altered your dietary patterns in any way? (If so, how?)

12. Did you find anything particularly useful?

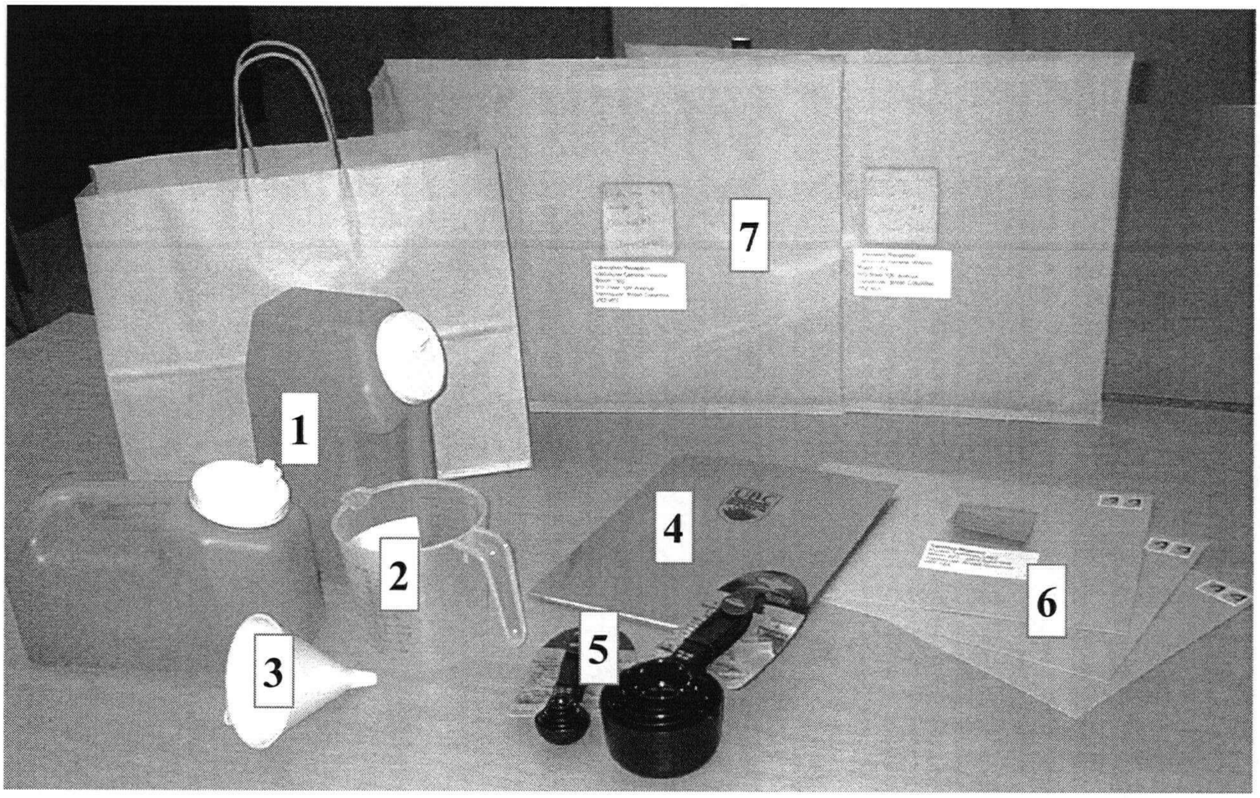
13. Did you find anything particularly challenging?

14. What would you most like to learn from the dietary analysis of your Food Record?

15. Any additional comments?

Thank you very much for you time and effort in the pilot-testing of the Three-day Food Record. Your participation in this part of the research is greatly appreciated!

APPENDIX 14: Contents of Phase II package



1. Two 3-litre urine collection containers
2. A plastic measuring cup with which to collect urine
3. A plastic funnel to transfer urine from the measuring cup to the collection container, if needed
4. Study folder (including a summary of the tasks to be completed in Phase II, the participant's copy of the signed consent form, the Phase II questionnaire, two three-day food record booklets, written instructions for urine collection, fridge magnet with the participant's key Phase II dates)
5. Measuring cups and spoons to be used during the three days for which dietary intake was recorded
6. Three stamped addressed envelopes labeled with post-it reminders (one for returning the Phase II questionnaire, and two for returning the three-day food records)
7. Two large padded envelopes for sending the complete urine collection to the laboratory for analysis, also labeled with post-it reminders (each contained a requisition form for the urine collection, labels to affix to the collection container(s), and a copy of the Daily Stress Inventory to be completed the morning the urine collection is over)

Contents of Your Phase II Package:

1) Folder Containing:
    a. "Your Participation in Phase II" sheet
    b. Consent Form (original signed form stays with researcher, copy to you)
    c. Phase II Questionnaire (to be completed in the couple of days following your UBC visit and then returned to researcher in stamped addressed envelope)
    d. Instructions for 24-hour Urine Collection
    e. Two 3-day Food Record booklets
    f. Reminder magnet
    g. Business card with contact information

2) Two orange 24-hour Urine Collection containers

3) Plastic measuring cup for 24-hour Urine Collection

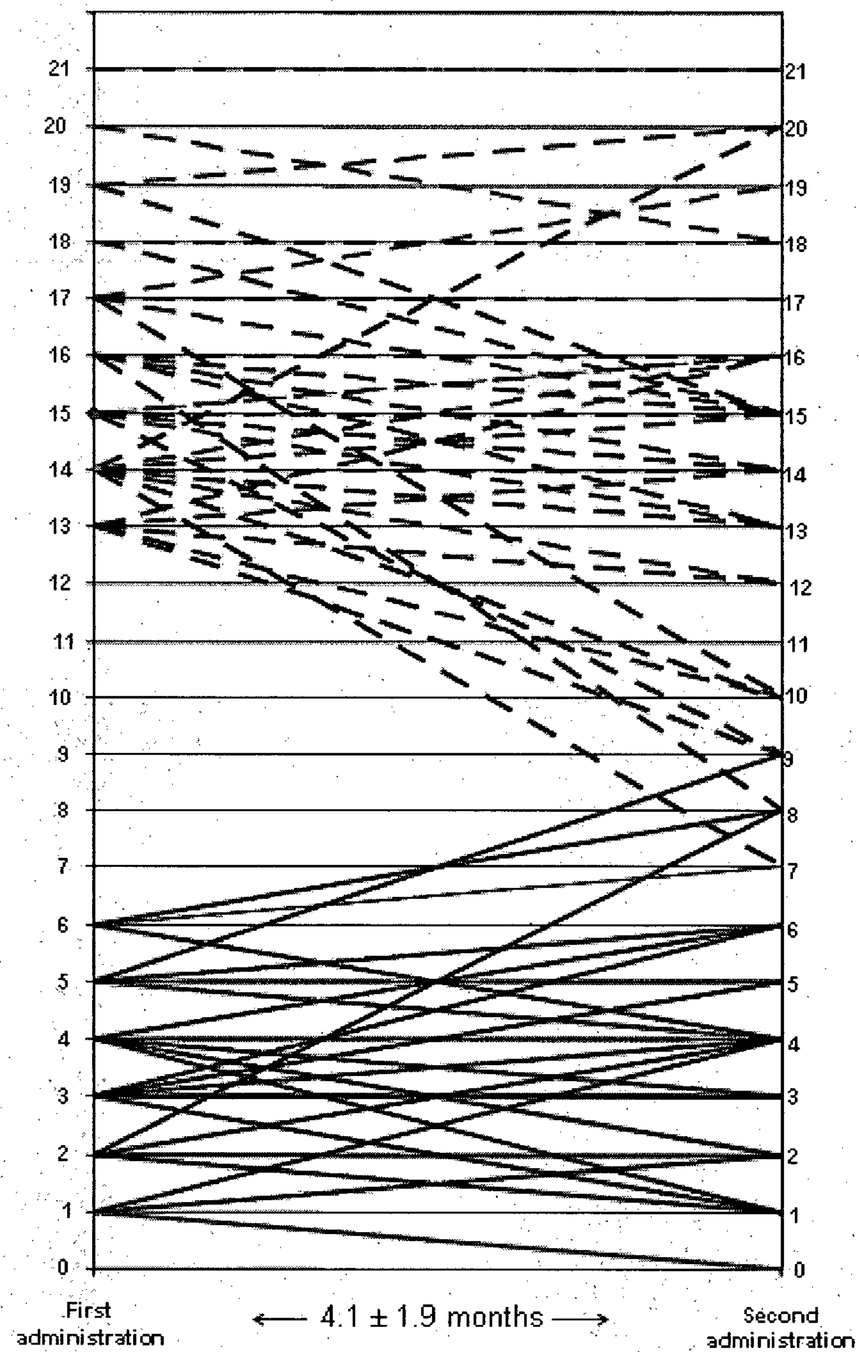
4) Funnel to facilitate transfer of urine from plastic measuring cup to orange container

5) A set of measuring cups and spoons for 3-day Food Record

6) Two padded addressed envelopes for delivery of urine sample to VGH, each containing:
    a. a copy of the *Research Analysis Requisition* form (on which you will write the start/stop times for collection)
    b. a label to affix to the orange container indicating your name and the start/stop times for the collection
    c. a mini-questionnaire to be completed the morning on which the 24-hour urine collection ends (and then returned to Candice in a different envelope, along with the completed Food Record)

7) Three stamped addressed envelopes for the return of materials to Candice:
    a. one for the return of the Phase II Questionnaire (to be done ASAP)
    b. one for the return of the *first* Food Record and the mini-questionnaire completed after the first 24-hour urine collection
    c. one for the return of the *second* Food Record and the mini-questionnaire completed after the first 24-hour urine collection

APPENDIX 16: Test-retest data for 78 postmenopausal women who completed the TFEQ-R twice, at an interval of 4.1 ± 1.9 months



Notes: This figure illustrates scores obtained by Phase II participants the first and second time they completed the TFEQ-R (note that some lines coincide because some participants obtained the same scores as other participants on both the first and second administrations, so the lines between their first and second scores overlap). Scores on the TFEQ-R can range from 0 to 21, with higher scores reflecting higher dietary restraint. Women recruited to Phase II were classified as having high dietary restraint (TFEQ-R score ≥ 13; dashed lines) or low dietary restraint (TFEQ-R score ≤ 6; solid lines) on the first administration. No participant changed categories based on those score cut-offs on the second administration 4.1 ± 1.9 months later (range: 1–10 months). Thirty participants scored high both times and 30 participants scored low both times, and 15 participants obtained the exact same score on both administrations.

Restraint groups in Chapter 2 were those recruited to the study (i.e., they were based on initial TFEQ-R scores). If a median split of TFEQ-R scores on the second administration had been used to categorize Phase II participants into high/low restraint categories instead, only four participants would have been differently classified (two high restraint participants would have been classified as low restraint and two low restraint participants would have been classified as high restraint). The results of our analyses would not have changed (for example, the difference in our primary outcome variable, urinary cortisol excretion, would have been 245.4 ± 62.2 nmol/day for the high restraint group versus 207.8 ± 68.6 nmol/day for the low restraint group, $P = 0.02$). Likewise, if we only consider data from the subset of 60 participants who scored high (≥ 13) or low (≤ 6) both times, the same result was obtained: 247.4 ± 64.0 nmol/day for consistently high restraint participants versus 201.9 ± 72.3 nmol/day for consistently low restraint subjects, $P = 0.02$.

APPENDIX 17: Historical leisure activity questionnaire

<u>Historical Leisure Activity Questionnaire</u>

Leisure Activity(s) and Code	Time/Age Period											
	12-18 years (7 yr total)			19-34 years (15 yr total)			35-49 years (15 yr total)			≥ 50 years (___ yrs total)		
	# yr	mth/yr	hr/wk	# yr	mth/yr	hr/wk	# yr	mth/yr	hr/wk	# yr	mth/yr	hr/wk

Please circle all activities done more than 10 times during lifetime.

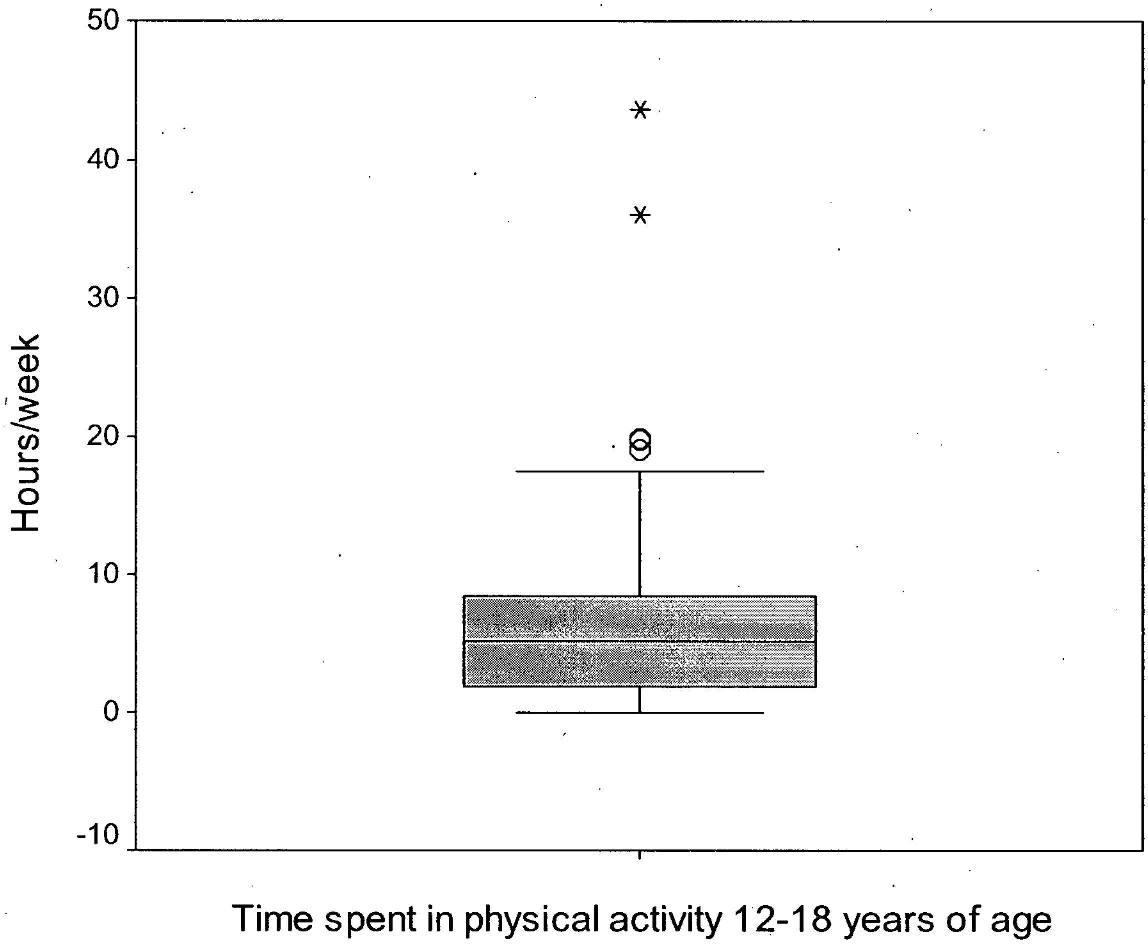
01 Jogging (outdoor, treadmill)
02 Swimming (laps, snorkeling)
03 Bicycling (indoor, outdoor)
04 Softball/baseball
05 Volleyball
06 Bowling
07 Basketball
08 Skating (roller, ice, blading)
09 Martial arts (karate, judo)
10 Tai Chi
11 Calisthenics/toning exercises
12 Wood chopping
13 Water/coal hauling
14 Walking for exercise (outdoor, indoor at mall or fitness centre, treadmill)
15 Football/soccer
16 Racquetball/handball/squash
17 Horseback riding
18 Hunting
19 Fishing
20 Aerobic dance/step aerobic
21 Water aerobics
22 Dancing (square, line, ballroom)
23 Gardening or yardwork
24 Badminton
25 Strength/weight training
26 Rock climbing
27 Scuba diving
28 Stair master
29 Fencing
30 Hiking
31 Tennis
32 Golf
33 Canoeing/rowing/kayaking
34 Water skiing
35 Jumping rope
36 Snow skiing (X-country, Nordic trk)
37 Snow skiing (downhill)
38 Snow shoeing
39 Yoga
40 Other

We modified the equation provided with the HLAQ to increase the accuracy of the estimates of time spent in physical activity:

Equation as given:
(yr participated in activity) X (months/yr) X (<u>4 wk</u>/month) X (hrs/wk) ÷ (total yr in period) ÷ (52 wk/yr)

Because this results in a numerator containing a maximum of 48 weeks and a denominator containing 52 weeks, we changed the underlined portion of the formula to $4\frac{1}{3}$ wk to correct for this (multiplying the result of the given formula by 52/48 also has the same effect as changing the weeks in the numerator).

APPENDIX 18: Boxplot showing two extreme outliers in estimates of physical activity from 12–18 years of age



Note: box length is interquartile range

O = outliers (identified by SPSS as values which are 1.5–3 box lengths from the edge of the box)
* = extreme outliers (identified by SPSS as values > 3 box lengths from the edge of the box)

This figure illustrates the distribution of estimates for time spent in physical activity from 12–18 years of age. We defined outliers as those values falling > 3.5 SD from the mean; these are the extreme outliers shown here. One or two such outliers were detected in 7 of 10 estimates of physical activity – the 10 activity estimates were 1) time spent in physical activity and 2) time spent in WBPA for each of five age periods (teens, young adulthood, mid-adulthood, later adulthood, weighted lifetime average). These outliers were excluded from analyses of associations with bone data.

APPENDIX 19: Associations between current BMD and estimates of activity *including* walking

	Lumbar spine (L1-4) BMD		Mean proximal femora BMD	
	Excluding walking	Including walking	Excluding walking	Including walking
Teens (12–18 years)				
Total activity (h/wk)	0.31**	0.15	0.33**	0.09
WBPA (h/wk)	0.30**	0.07	0.29*	0.01
Early adulthood (19–34 years)				
Total activity (h/wk)	0.15	-0.14	0.04	-0.27*
WBPA (h/wk)	0.12	-0.13	-0.02	-0.31*
Mid-adulthood (35–49 years)				
Total activity (h/wk)	0.08	-0.09	0.07	-0.11
WBPA (h/wk)	0.15	-0.061	0.12	-0.07
Later adulthood (12 years – present)				
Total activity (h/wk)	-0.06	-0.18	-0.01	-0.19
WBPA (h/wk)	0.04	-0.12	0.09	-0.12

Notes: Because research has shown that HLAQ estimates of activity are more reliable when walking is not included, our primary analyses did not include time spent walking in estimates of physical activity. The associations between activity estimates and BMD when time spent walking is included are shown here for comparison.

* $P < 0.05$ **$P < 0.01$

APPENDIX 21: Counter-balancing of scales in the six versions of the Phase I questionnaire

Version	Order of presentation of scales					
	1st	2nd	3rd	4th	5th	6th
A	TFEQ	SATAQ	SPAS	FCQ	WLOC	SE
B	SE	TFEQ	SATAQ	SPAS	FCQ	WLOC
C	WLOC	SE	TFEQ	SATAQ	SPAS	FCQ
D	FCQ	WLOC	SE	TFEQ	SATAQ	SPAS
E	SPAS	FCQ	WLOC	SE	TFEQ	SATAQ
F	SATAQ	SPAS	FCQ	WLOC	SE	TFEQ

TFEQ: Three-factor Eating Questionnaire (measures dietary restraint, disinhibition, hunger)

SATAQ: Sociocultural Attitudes towards Appearance Questionnaire (measures awareness and internalization of societal attitudes towards appearance)

SPAS: Social Physique Anxiety Scale

FCQ: Food Choice Questionnaire

WLOC: Weight Locus of Control scale

SE: Self-esteem Scale

Note: The questionnaire included in Appendix 6 is a "version A" questionnaire.

APPENDIX 22: Descriptive characteristics for the total sample of survey respondents and comparisons of dieters and non-dieters and restrained and unrestrained eaters

	Total sample	Dieting		X^{2a}	P^a	Dietary Restraint		X^{2b}	P^b
		yes	no			high	low		
Ethnicity									
White	936 (87%)	489 (88%)	430 (88%)			453 (87%)	454 (89%)		
Chinese	63 (6%)	28 (5%)	33 (7)			29 (6%)	31 (6%)		
Other	67 (6%)	41 (7%)	26 (5)	3.0	0.22	39 (8%)	27 (5%)	2.2	0.34
Education									
≤ secondary school	331 (31%)	174 (31%)	150 (31%)			163 (31%)	158 (31%)		
University/college	550 (51%)	291 (52%)	249 (51%)			264 (51%)	270 (53%)		
Postgraduate	186 (17%)	94 (17%)	90 (18%)	0.46	0.80	94 (18%)	85 (17%)	0.54	0.77
Annual income									
≤ $35 000	309 (29%)	153 (29%)	148 (32%)			139 (28%)	161 (33%)		
$25 001–50 000	243 (23%)	132 (25%)	107 (23%)			111 (22%)	122 (25%)		
> $50 000	467 (44%)	248 (47%)	212 (45%)	1.2	0.56	251 (50%)	205 (42%)	6.6	0.04
Smoking Status									
Current	64 (6%)	28 (5%)	35 (7%)			28 (5%)	34 (7%)		
Former	339 (32%)	188 (34%)	145 (30%)			175 (34%)	157 (31%)		
Never	663 (62%)	343 (61%)	308 (63%)	3.4	0.18	318 (61%)	321 (63%)	1.5	0.47
Vegetarian	76 (7%)	37 (7%)	38 (8%)	0.51	0.48	38 (7%)	34 (7%)	0.16	0.69
Using HRT	175 (16%)	92 (16%)	82 (17%)	0.01	0.91	87 (17%)	86 (17%)	0.002	0.97

Notes: All values are presented as n (%). The only significant difference was in the distribution of restrained and unrestrained eaters in the categories for annual income.

[a] Differences between dieters and non-dieters were examined by chi square (X^2).

[b] Differences between restrained and unrestrained eaters were examined by chi square (X^2).

APPENDIX 23: Differences in demographic, lifestyle, and body weight variables in a subsample of 562 dieters and non-dieters in the upper or lower quartile for dietary restraint score

	Dieting		Not dieting		Dieting difference[a]	Restraint difference[b]
	Upper quartile restraint	Lower quartile restraint	Upper quartile restraint	Lower quartile restraint		
n	202	90	93	177		
Age (years)	59.7 ± 6.7	59.3 ± 6.6	60.6 ± 6.3	59.9 ± 6.8	-1.1 (-2.3, 0.0)	0.5 (-0.7, 1.6)
Menopausal age (years)	10.8 ± 9.0	11.6 ± 9.5	11.9 ± 8.6	11.2 ± 9.0	-0.7 (-2.3, 0.9)	-0.1 (-1.7, 1.5)
Height (cm)	162.9 ± 6.6	164.1 ± 7.2	164.1 ± 7.3	163.4 ± 7.0	0.3 (-1.6, 0.9)	0.01 (-1.3, 1.3)
Weight (kg)	68.0 ± 10.8	72.8 ± 15.1	57.9 ± 7.2	62.7 ± 13.4	10.0 (8.0, 12.3)***	-4.5 (-6.8, -2.3)***
BMI (kg/m^2)	25.6 ± 3.5	27.0 ± 5.3	21.5 ± 2.5	23.5 ± 4.6	3.8 (3.2, 4.6)***	-1.6 (-2.4, -1.0)***
Exercise (h/wk)	4 (2.5 – 6.)	3 (1 – 4)	4 (2.5 – 6)	3 (1 – 6)	0.03 (-0.6, 0.9)	0.6 (-0.2, 1.2)
Caffeine (cups/day)	2 (1 – 3.5)	2 (1 – 3)	2 (1 – 3.5)	2 (1 – 3.5)	-0.04 (-0.4. 0.3)	-0.3 (-0.7, 0.1)
Alcoholic beverages (/wk)	1 (0 – 4)	1 (0 – 3)	1 (0 – 4)	2 (0 – 7)	-0.5 (-1.3, 0.4)	-0.5 (-1.3, 0.2)
Feelings about weight [c]	4.1 ± 0.5	4.3 ± 0.5	4.1 ± 0.5	3.4 ± 0.8	0.5 (0.4, 0.6)***	-0.07 (-0.2, 0.02)

Notes: Data are presented as mean (SD) or median (interquartile range). Analyses of exercise, caffeine, alcohol, and feelings about weight included BMI as an additional covariate predictor variable. Missing values were excluded on a pairwise basis, so the exact n for each comparison varied. No interaction effects (i.e., a joint effect of dietary restraint and dieting) were detected.

[a] Difference between dieters and non-dieters (95% CI).

[b] Difference (95% CI) between highly restrained eaters (TFEQ-R score ≥ 13) and highly unrestrained eaters (TFEQ-R score ≤ 6).

[c] Responses fell on a 5-point scale (1=very underweight, 2=underweight, 3=about right, 4=overweight, 5=very overweight)

*** $P < 0.001$

APPENDIX 24: Self-reported and measured height, weight, and BMI in restrained and unrestrained eaters.

	Total (n=78)	Restrained (n=41)	Unrestrained (n=37)
Height			
Reported (cm)	164.7 ± 7.6	164.1 ± 7.7	165.3 ± 7.6
Measured (cm)	163.2 ± 7.4	162.6 ± 7.3	163.9 ± 7.5
Difference (cm)	1.3 (0.4 – 3.1)	1.4 (0.4 – 3.3)	1.1 (0.2 – 3.0)
Correlation	0.96***	0.96***	0.97***
Weight			
Reported (kg)	59.9 ± 6.1	59.4 ± 6.5	60.5 ± 5.7
Measured (kg)	61.3 ± 6.6	60.6 ± 6.8	62.1 ± 6.4
Difference (kg)	-1.2 (-2.2 – -0.3)	-1.3 (-1.9 – -0.5)	-1.2 (-2.4 – -0.03)
Correlation	0.95 ***	0.97***	0.92***
BMI			
Reported (kg/m^2)	22.1 ± 1.8	22.1 ± 1.8	22.1 ± 1.8
Measured (kg/m^2)	23.0 ± 2.2	22.9 ± 2.0	23.1 ± 2.3
Difference (kg/m^2)	-0.8 (-1.4 – -0.3)	-0.9 (-1.4 – -0.3)	-0.7 (-1.5 – -0.2)
Correlation	0.89***	0.92***	0.87***

Notes: Data are presented as mean ± SD or median (interquartile range). Correlation is the Pearson correlation coefficient for the association between measured values and values based on self-report. Although the correlation between reported and measured weight appears to be somewhat stronger in the high restraint group, there was no group difference in the discrepancy between self-report and measured values either absolutely (t = -0.9, P = 0.37) or when expressed as a ratio (reported/measured) (t = -0.8, P = 0.45). Both groups reported approximately 101% of their height value, and 98% of their weight value. The difference in reported versus measured BMI was also not significant between groups (t = -0.6, P = 0.53).

***$P < 0.0001$

APPENDIX 25: Reliability analyses for psychometric scales used in the Phase I questionnaire

Reliability analysis was conducted for each TFEQ subscale (cognitive restraint, disinhibition, hunger) as well as each of the other psychosocial characteristics measured in the Phase I Questionnaire. A summary of the results of this analysis is presented below.

Summary of Cronbach alpha results:

Scale	Cronbach's alpha
TFEQ – Restraint subscale	0.81
TFEQ – Disinhibition subscale	0.87
TFEQ - Hunger	0.82
Social Physique Anxiety Scale	0.93
SATAQ – Internalization subscale	0.76
SATAQ – Awareness subscale	0.70
Rosenberg's Self-esteem Scale	0.79
Weight Locus of Control Scale	0.58
Food Choice Questionnaire – Health	0.79
Food Choice Questionnaire – Mood	0.87
Food Choice Questionnaire – Convenience	0.82
Food Choice Questionnaire – Sensory Appeal	0.72
Food Choice Questionnaire – Natural Content	0.87
Food Choice Questionnaire – Price	0.80
Food Choice Questionnaire – Weight Control	0.76
Food Choice Questionnaire – Ethical Concern	0.76

Further detail is provided in each of the following tables. Each table lists the items that form the subscale and indicates i) the correlation between each item and the total score for that construct, ii) the sample mean if an item were to be excluded from the calculation of the total score, and iii) Cronbach's alpha for the scale if an item were to be deleted.

The analyses of TFEQ subscales were conducted on the TFEQ dataset *prior to* the replacement of missing values with the median.

1. TFEQ – Cognitive restraint subscale (TFEQ-R)

The internal consistency of the TFEQ-R in this sample was good, with a Cronbach's alpha of 0.81. The mean score (including all items) was 9.9.

TFEQ Item		Item-total correlation	Mean if item deleted	Cronbach's alpha if item deleted
4.	When I have eaten my quota of calories, I am usually good about not eating any more.	0.18	9.5	0.81
6.	I deliberately take small helpings as a means of controlling my weight.	0.43	9.4	0.80
10.	Life is too short to worry about dieting.	0.30	9.3	0.81
14.	I have a pretty good idea of the number of calories in common food.	0.23	9.2	0.81
18.	While on a diet, if I eat a food that is not allowed, I consciously eat less for a period of time to make up for it.	0.37	9.5	0.80
21.	I enjoy eating too much to spoil it by counting calories or watching my weight.	0.37	9.2	0.80
23.	I often stop eating when I am not really full as a conscious means of limiting the amount that I eat.	0.35	9.6	0.81
28.	I consciously hold back at meals in order not to gain weight.	0.49	9.6	0.80
30.	I eat anything I want, any time I want.	0.43	9.2	0.80
32.	I count calories as a conscious means of controlling my weight.	0.40	9.7	0.80
33.	I do not eat some foods because they make me fat.	0.44	9.6	0.80
35.	I pay a great deal of attention to changes in my figure.	0.36	9.3	0.80
37.	How often are you dieting in a conscious effort to control your weight?	0.42	9.7	0.80
38.	Would a weight fluctuation of 5 lbs affect the way you live your life?	0.30	9.6	0.81
40.	Do your feelings of guilt about overeating help you to control your food intake?	0.47	9.6	0.80
42.	How conscious are you of what you are eating?	0.22	9.0	0.81
43.	How frequently do you avoid "stocking up" on tempting foods?	0.31	9.2	0.81
44.	How likely are you to shop for low calorie foods?	0.43	9.3	0.80
46.	How likely are you to consciously eat slowly in order to cut down on how much you eat?	0.32	9.7	0.81
48.	How likely are you to consciously eat less than you want?	0.44	9.6	0.80
50.	On a scale of 0 to 5, where 0 means no restraint in eating (eating whatever you want, whenever you want it) and 5 means total restraint (constantly limiting food intake and never "giving in"), what number would you give yourself?	0.55	9.5	0.79

2. TFEQ – Disinhibition subscale (TFEQ-D)

The internal consistency of the TFEQ-D in this sample was good, with a Cronbach's alpha of 0.87. The mean score (including all items) was 5.5.

TFEQ Item		Item-total correlation	Mean if item deleted	Cronbach's alpha if item deleted
1.	When I smell my favourite food, I find it very difficult to keep from eating, even if I have just finished a meal	0.55	5.2	0.86
2.	I usually eat too much at social occasions, like parties and picnics.	0.41	5.1	0.86
7.	Sometimes things just taste so good that I keep on eating even when I am no longer hungry	0.52	4.9	0.86
9.	When I feel anxious, I find myself eating.	0.61	5.1	0.85
11.	Since my weight goes up and down, I have gone on reducing diets more than once.	0.52	5.1	0.86
13.	When I am with someone who is overeating, I usually overeat too.	0.54	5.3	0.86
15.	Sometimes when I start eating, I just can't seem to stop.	0.64	5.3	0.85
16.	It is not difficult for me to leave something on my plate.	0.39	5.1	0.87
20.	When I feel blue, I often overeat.	0.66	5.1	0.85
25.	My weight has hardly changed at all in the last 10 years.	0.33	5.1	0.87
27.	When I feel lonely, I console myself by eating.	0.61	5.2	0.85
31.	Without even thinking about it, I take a long time to eat.	0.11	4.8	0.88
36.	While on a diet, if I eat a food that is not allowed, I often then splurge and eat other high calorie foods.	0.56	5.4	0.86
45.	Do you eat sensibly in front of others and splurge alone?	0.51	5.4	0.86
49.	Do you go on eating binges though you are not hungry?	0.59	5.3	0.86
51.	To what extent does this statement describe your eating behavior? "I start dieting in the morning, but because of any number of things that happen during the day, by evening I have given up and eat what I want, promising to myself to start dieting again tomorrow."	0.55	5.3	0.86

3. TFEQ – Hunger subscale (TFEQ-H)

The internal consistency of the TFEQ-H in this sample was good, with a Cronbach's alpha of 0.82. The mean score (including all items) was 4.1.

TFEQ Item		Item-total correlation	Mean if item deleted	Cronbach's alpha if item deleted
3.	I am usually so hungry that I eat more than three times a day.	0.55	3.8	0.80
5.	Dieting is so hard for me because I just get too hungry.	0.59	3.8	0.80
8.	Since I am often hungry, I sometimes wish that while I am eating, an expert would tell me that I have had enough or that I can have something more to eat.	0.52	4.0	0.81
12.	I often feel so hungry that I just have to eat something.	0.54	3.7	0.80
17.	At certain times of the day, I get hungry because I have gotten used to eating then.	0.20	3.5	0.83
19.	Being with someone who is eating often makes me hungry enough to eat also.	0.48	3.8	0.81
22.	When I see a real delicacy, I often get so hungry that I have to eat right away.	0.37	3.9	0.82
24.	I get so hungry that my stomach often seems like a bottomless pit.	0.57	4.0	0.80
26.	I am always hungry so it is hard for me to stop eating before I finish the food on my plate.	0.55	4.0	0.81
29.	I sometimes get very hungry late in the evening or at night.	0.36	3.8	0.82
34.	I am always hungry enough to eat at any time.	0.54	4.0	0.81
39.	How often do you feel hungry?	0.59	4.0	0.80
41.	How difficult would it be for you to stop eating halfway through dinner and not eat for the next four hours?	0.42	3.8	0.81
47.	How frequently do you skip dessert because you are no longer hungry?	0.17	3.9	0.83

4. Social Physique Anxiety Scale

The internal consistency of the Social Physique Anxiety Scale in this sample was very good, with a Cronbach's alpha of 0.93. The mean score (including all items) was 32.8.

Social Physique Anxiety Scale Item		Item-total correlation	Mean if item deleted	Cronbach's alpha if item deleted
1.	I am comfortable with the appearance of my physique/figure. [*reverse scored*]	0.72	29.8	0.92
2.	I would worry about wearing clothes that might make me look too thin or overweight.*	0.52	29.7	0.93
3.	I wish I wasn't so uptight about my physique/figure.	0.69	30.5	0.92
4.	There are times when I am bothered by thoughts that other people are evaluating my weight or muscular development negatively.	0.75	30.8	0.92
5.	When I look in the mirror, I feel good about my physique/figure. [*reverse scored*]	0.70	29.6	0.92
6.	Unattractive features of my physique/figure make me nervous in certain social settings.	0.73	30.6	0.92
7.	In the presence of others, I feel apprehensive about my physique/figure.	0.77	30.9	0.92
8.	I am comfortable with how fit my body appears to others. [*reverse scored*]	0.66	29.8	0.92
9.	It would make me uncomfortable to know others were evaluating my physique/figure.	0.72	30.2	0.92
10.	When it comes to displaying my physique/figure to others, I am a shy person.	0.65	29.9	0.92
11.	I usually feel relaxed when it is obvious that others are looking at my physique/figure. [*reverse scored*]	0.59	29.3	0.92
12.	When in a bathing suit, I often feel nervous about the shape of my body.	0.72	29.8	0.92

5. Weight Locus of Control Scale

The internal consistency of Weight Locus of Control Scale in this sample was low, with a Cronbach's alpha of 0.58. The mean score (including all items) was 8.4.

Weight Locus of Control Scale Item		Item-total correlation	Mean if item deleted	Cronbach's alpha if item deleted
1.	Whether I gain, lose, or maintain my weight is entirely up to me. [*reverse scored*]	0.39	6.6	0.50
2.	Being at the right weight is largely a matter of good fortune.	0.34	5.9	0.54
3.	No matter what I intend to do, if I gain or lose weight, or stay the same in the near future, it is just going to happen.	0.34	6.2	0.54
4.	If I eat properly, and get enough exercise and rest, I can control my weight in the way I desire. [*reverse scored*]	0.41	6.5	0.48

6. Sociocultural Attitudes towards Appearance Questionnaire – Internalization subscale

The internal consistency of the Internalization subscale of the Sociocultural Attitudes towards Appearance Questionnaire in this sample was good, with a Cronbach's alpha of 0.76. The mean score (including all items) was 12.7.

Sociocultural Attitudes towards Appearance Questionnaire Item		Item-total correlation	Mean if item deleted	Cronbach's alpha if item deleted
1.	Women who appear in TV shows and movies project the type of appearance that I see as my goal.	0.58	10.4	0.70
2.	I believe that clothes look better on thin models.	0.50	9.6	0.72
3.	I do not wish to look like the models in the magazines. [*reverse scored*]	0.44	10.2	0.74
4.	I tend to compare my body to people in magazines and on TV.	0.55	10.4	0.71
6.	Photographs of thin women make me wish that I were thin.	0.56	10.1	0.70

7. Sociocultural Attitudes towards Appearance – Awareness subscale

The internal consistency of the Awareness subscale of the Sociocultural Attitudes towards Appearance Questionnaire in this sample was good, with a Cronbach's alpha of 0.70. The mean score (including all items) was 21.9.

	Sociocultural Attitudes towards Appearance Questionnaire Item	Item-total correlation	Mean if item deleted	Cronbach's alpha if item deleted
5.	In our society, fat people are regarded as unattractive.	0.42	17.8	0.66
7.	Attractiveness is very important if you want to get ahead in our culture.	0.54	18.0	0.63
8.	It's important for people to work hard on their figures/physiques if they want to succeed in today's culture.	0.49	18.5	0.64
9.	Most people do not believe that the thinner you are, the better you look. [*reverse scored*]	0.37	18.6	0.68
10.	People think that the thinner you are, the better you look in clothes.	0.43	18.3	0.66
11.	In today's society, it's not important to always look attractive. [*reverse scored*]	0.36	18.2	0.68

8. Rosenberg's Self-esteem Scale

The internal consistency of Rosenberg's Self-esteem Scale in this sample was good, with a Cronbach's alpha of 0.79. The mean score (including all items) was 1.4.

Rosenberg's Self-esteem Scale Item	Item-total correlation	Mean if item deleted	Cronbach's alpha if item deleted
1. On the whole, I am satisfied with myself.	0.47	1.2	0.77
2. At times I think that I am no good at all.	0.52	1.2	0.76
3. I feel I have a number of good qualities.	0.26	1.4	0.79
4. I am able to do things as well as most people	0.40	1.3	0.78
5. I feel I do not have much to be proud of.	0.48	1.3	0.77
6. I certainly feel useless at times	0.53	1.1	0.76
7. I feel that I am a person of worth, at least on an equal plane with others.	0.36	1.3	0.78
8. I wish I could have more respect for myself.	0.52	1.1	0.77
9. All in all, I am inclined to feel that I am a failure.	0.54	1.3	0.77
10. I take a positive attitude towards myself.	0.60	1.3	0.75

9. Food Choice Questionnaire – Health Motive

The internal consistency of the Health motive factor of the Food Choice Questionnaire in this sample was good, with a Cronbach's alpha of 0.79. The mean summed score (including all items) was 20.1. Note that this mean score differs from that reported in the body of the thesis, because mean scores for each food choice motive are typically obtained by averaging the items for each motive (which are scored between 1 and 4), as directed by the authors of the questionnaire. In the analysis presented in this appendix, the mean summed score is reported instead to make the "mean if item deleted" information meaningful.

Food Choice Questionnaire Item	Item-total correlation	Mean if item deleted	Cronbach's alpha if item deleted
9. Is high in fibre and roughage	0.78	17.0	0.78
10. Is nutritious	0.76	16.5	0.76
22. Contains a lot of vitamins and minerals	0.74	16.8	0.74
27. Is high in protein	0.81	17.4	0.81
29. Keeps me healthy	0.75	16.4	0.75
30. Is good for my skin/teeth/hair/nails etc.	0.74	16.6	0.74

10. Food Choice Questionnaire – Mood Motive

The internal consistency of the Health motive factor of the Food Choice Questionnaire in this sample was good, with a Cronbach's alpha of 0.87. The mean summed score (including all items) was 13.2. Note that this mean score differs from that reported in the body of the thesis, because mean scores for each food choice motive are typically obtained by averaging the items for each motive (which are scored between 1 and 4), as directed by the authors of the questionnaire. In the analysis presented in this appendix, the mean summed score is reported instead to make the "mean if item deleted" information meaningful.

Food Choice Questionnaire Item	Item-total correlation	Mean if item deleted	Cronbach's alpha if item deleted
13. Cheers me up	0.63	10.8	0.86
16. Helps me cope with stress	0.72	11.2	0.84
24. Keeps me awake/alert	0.56	11.1	0.87
26. Helps me relax	0.78	11.2	0.83
31. Makes me feel good	0.59	10.3	0.86
34. Helps me to cope with life	0.76	11.2	0.83

11. Food Choice Questionnaire – Convenience Motive

The internal consistency of the Health motive factor of the Food Choice Questionnaire in this sample was good, with a Cronbach's alpha of 0.82. The mean summed score (including all items) was 14.3. Note that this mean score differs from that reported in the body of the thesis, because mean scores for each food choice motive are typically obtained by averaging the items for each motive (which are scored between 1 and 4), as directed by the authors of the questionnaire. In the analysis presented in this appendix, the mean summed score is reported instead to make the "mean if item deleted" information meaningful.

Food Choice Questionnaire Item	Item-total correlation	Mean if item deleted	Cronbach's alpha if item deleted
1. Is easy to prepare	0.65	11.3	0.77
11. Is easily available in shops and supermarkets	0.51	11.1	0.81
15. Can be cooked very simply	0.72	11.4	0.75
28. Takes no time to prepare	0.66	11.9	0.76
35. Can be bought in shops close to where I live or work	0.50	11.4	0.81

12. Food Choice Questionnaire – Sensory Appeal Motive

The internal consistency of the Health motive factor of the Food Choice Questionnaire in this sample was good, with a Cronbach's alpha of 0.72. The mean summed score (including all items) was 12.6. Note that this mean score differs from that reported in the body of the thesis, because mean scores for each food choice motive are typically obtained by averaging the items for each motive (which are scored between 1 and 4), as directed by the authors of the questionnaire. In the analysis presented in this appendix, the mean summed score is reported instead to make the "mean if item deleted" information meaningful.

Food Choice Questionnaire Item	Item-total correlation	Mean if item deleted	Cronbach's alpha if item deleted
4. Tastes good	0.35	8.8	0.75
14. Smells nice	0.60	9.7	0.60
18. Has a pleasant texture	0.57	9.6	0.63
25. Looks nice	0.56	9.8	0.63

13. Food Choice Questionnaire – Natural Content Motive

The internal consistency of the Health motive factor of the Food Choice Questionnaire in this sample was good, with a Cronbach's alpha of 0.87. The mean summed score (including all items) was 9.3. Note that this mean score differs from that reported in the body of the thesis, because mean scores for each food choice motive are typically obtained by averaging the items for each motive (which are scored between 1 and 4), as directed by the authors of the questionnaire. In the analysis presented in this appendix, the mean summed score is reported instead to make the "mean if item deleted" information meaningful.

Food Choice Questionnaire Item	Item-total correlation	Mean if item deleted	Cronbach's alpha if item deleted
2. Contains no additives	0.76	6.3	0.80
5. Contains natural ingredients	0.71	6.0	0.84
23. Contains no artificial ingredients	0.77	6.3	0.79

14. Food Choice Questionnaire – Price Motive

The internal consistency of the Health motive factor of the Food Choice Questionnaire in this sample was good, with a Cronbach's alpha of 0.80. The mean summed score (including all items) was 8.2. Note that this mean score differs from that reported in the body of the thesis, because mean scores for each food choice motive are typically obtained by averaging the items for each motive (which are scored between 1 and 4), as directed by the authors of the questionnaire. In the analysis presented in this appendix, the mean summed score is reported instead to make the "mean if item deleted" information meaningful.

Food Choice Questionnaire Item		Item-total correlation	Mean if item deleted	Cronbach's alpha if item deleted
6.	Is not expensive	0.68	5.5	0.69
12.	Is good value for the money	0.59	4.9	0.78
36.	Is cheap	0.67	5.9	0.70

15. Food Choice Questionnaire – Weight Control Motive

The internal consistency of the Health motive factor of the Food Choice Questionnaire in this sample was good, with a Cronbach's alpha of 0.76. The mean summed score (including all items) was 8.7. Note that this mean score differs from that reported in the body of the thesis, because mean scores for each food choice motive are typically obtained by averaging the items for each motive (which are scored between 1 and 4), as directed by the authors of the questionnaire. In the analysis presented in this appendix, the mean summed score is reported instead to make the "mean if item deleted" information meaningful.

Food Choice Questionnaire Item		Item-total correlation	Mean if item deleted	Cronbach's alpha if item deleted
3.	Is low in calories	0.65	6.0	0.61
7.	Is low in fat	0.56	5.6	0.70
17.	Helps me control my weight	0.56	5.9	0.71

16. Food Choice Questionnaire – Familiarity Motive

The internal consistency of the Health motive factor of the Food Choice Questionnaire in this sample was good, with a Cronbach's alpha of 0.73. The mean summed score (including all items) was 6.0. Note that this mean score differs from that reported in the body of the thesis, because mean scores for each food choice motive are typically obtained by averaging the items for each motive (which are scored between 1 and 4), as directed by the authors of the questionnaire. In the analysis presented in this appendix, the mean summed score is reported instead to make the "mean if item deleted" information meaningful.

Food Choice Questionnaire Item	Item-total correlation	Mean if item deleted	Cronbach's alpha if item deleted
8. Is familiar	0.60	3.8	0.59
21. Is like the food I ate when I was a child	0.45	4.4	0.76
33. Is what I usually eat	0.63	3.8	0.54

17. Food Choice Questionnaire – Ethical Concern Motive

The internal consistency of the Health motive factor of the Food Choice Questionnaire in this sample was good, with a Cronbach's alpha of 0.76. The mean summed score (including all items) was 7.1. Note that this mean score differs from that reported in the body of the thesis, because mean scores for each food choice motive are typically obtained by averaging the items for each motive (which are scored between 1 and 4), as directed by the authors of the questionnaire. In the analysis presented in this appendix, the mean summed score is reported instead to make the "mean if item deleted" information meaningful.

Food Choice Questionnaire Item	Item-total correlation	Mean if item deleted	Cronbach's alpha if item deleted
19. Is packaged in an environmentally friendly way	0.50	4.3	0.77
20. Comes from countries I approve of politically	0.66	5.1	0.59
32. Has the country of origin clearly marked	0.61	4.9	0.64

APPENDIX 26: Self-reported dietary attitudes and psychosocial characteristics in a subsample of 562 dieters and non-dieters in the upper or lower quartile for dietary restraint score

	Dieting		Not dieting		Dieting difference[a]	Restraint difference[b]
	Upper quartile restraint	Lower quartile restraint	Upper quartile restraint	Lower quartile restraint		
n	202	90	93	177		
Dietary restraint	15.4 ± 2.0	4.8 ± 1.3	15.0 ± 1.8	4.1 ± 1.5	0.6 (0.3, 0.9)***	10.7 (10.5, 11.0)***
Disinhibition	6.8 ± 4.0	7.4 ± 4.5	3.1 ± 2.3	3.5 ± 3.2	2.6 (2.0, 3.4)***	-0.1 (-0.7, 0.4)
Hunger	4.7 ± 3.5	5.3 ± 3.8	2.6 ± 2.1	3.1 ± 2.7	1.7 (1.0, 2.2)***	-0.4 (-0.9, 0.2)
SATAQ – Awareness	22.7 ± 4.0	22.7 ± 4.1	21.6 ± 4.5	21.1 ±4.2	1.1 (0.2, 1.8)**	-0.6 (-0.3, 1.2)
SATAQ – Internalization	14.4 ± 4.4	13.4 ± 5.0	12.6 ± 4.3	11.4 ± 3.8	2.1 (1.1, 2.9)***	1.1 (0.2, 1.8)**
Social physique anxiety	36.7 ± 10.3	37.4 ± 9.8	28.0 ± 8.1	29.2 ± 8.8	5.5 (3.9, 7.3)***	0.2 (-1.3, 1.7)
Self-esteem	1 (0 – 2)	1 (0 – 3)	0 (0 – 1)	0 (0 – 2)	0.5 (0.1, 0.9)**	-0.3 (-0.6, 0.0)[d]
Weight locus of control[c]	8.2 ± 3.5	8.6 ± 2.9	6.7 ± 2.5	9.3 ± 3.7	-0.1 (-0.7, 0.5)	-1.3 (-1.8, -0.8)***

Notes: Data are presented as mean (SD) or median (interquartile range). All analyses included BMI as an additional covariate predictor variable. Missing values were excluded on a pairwise basis, so the exact n for each comparison varied. No interaction effects (i.e., a joint effect of dietary restraint and dieting) were detected.

[a] Difference between dieters and non-dieters (95% CI).

[b] Difference (95% CI) between highly restrained eaters (TFEQ-R score ≥ 13) and highly unrestrained eaters (TFEQ-R score ≤ 6).

[c] Interaction effect of dietary restraint and dieting status, $P = 0.001$

[d] $P = 0.05$ **$P < 0.01$ ***$P < 0.001$

APPENDIX 27: Differences in food choice motives between dieters and non-dieters and restrained and unrestrained eaters

	Dieting		Not dieting		Dieting difference[a]	Restraint difference[b]
	Restrained	Unrestrained	Restrained	Unrestrained		
Health	3.5 ± 0.4	3.2 ± 0.5	3.5 ± 0.4	3.2 ± 0.5	0.05 (-0.01, 0.1)	0.2 (0.2, 0.3)**
Familiarity	2.0 ± 0.7	2.0 ± 0.8	2.0 ± 0.7	1.9 ± 0.7	-0.03 (-0.1, 0.1)	0.1 (0.0, 0.2)*
Convenience[c]	2.9 ± 0.7	3.0 ± 0.7	2.8 ± 0.6	2.7 ± 0.7	0.1 (0.04, 0.2)**	0.04 (-0.04, 0.1)
Mood	2.3 ± 0.8	2.3 ± 0.8	2.2 ± 0.8	2.0 ± 0.7	0.1 (0.02, 0.2)**	0.1 (0.02, 0.2)*
Weight control[c]	3.3 ± 0.6	2.8 ± 0.6	3.1 ± 0.6	2.4 ± 0.7	0.3 (0.2, 0.4)**	0.6 (0.5, 0.7)**
Price	2.7 ± 0.7	2.7 ± 0.7	2.7 ± 0.7	2.7 ± 0.7	-0.1 (-0.2, 0.03)	0.01 (-0.1. 0.1)
Natural content	3.1 ± 0.8	3.0 ± 0.8	3.2 ± 0.7	3.1 ± 0.8	0.0 (-0.1, 0.1)	0.1 (0.0, 0.2)
Sensory appeal	3.2 ± 0.6	3.2 ± 0.6	3.1 ± 0.6	3.1 ± 0.6	0.1 (0.0, 0.1)	0.0 (-0.1, 0.1)
Ethical concern	2.4 ± 0.8	2.3 ± 0.8	2.4 ± 0.9	2.3 ± 0.8	0.0 (-0.1. 0.1)	0.1 (-0.1, 0.2)

Notes: Data are presented as mean (SD) or median (interquartile range). All analyses included BMI as an additional covariate predictor variable. Food choice motives were assessed with the Food Choice Questionnaire, and the score for each motive can range from 1 to 4, with higher scores reflecting greater importance attached to that motive.

[a] Difference between dieters and non-dieters (95% CI).

[b] Difference (95% CI) between highly restrained eaters (TFEQ-R score ≥ 13) and highly unrestrained eaters (TFEQ-R score ≤ 6).

[c] interaction of dieting status and dietary restraint.

*$P < 0.05$ **$P < 0.01$

APPENDIX 28: Univariate correlations between dietary restraint, BMI, age, other eating attitudes, and psychosocial characteristics

	TFEQ-R	BMI	Age	exercise	TFEQ-D	TFEQ-H	SATAQ-A	SATAQ-I	SPAS	SE	WLOC
TFEQ-R	1.00	-0.006	0.14	0.050	0.06*	-0.004	0.10***	0.18***	0.14***	-0.01	-0.05
BMI		1.00	0.06	-0.17***	0.50***	0.31***	0.15***	0.07*	0.39***	0.20***	-0.04
Age			1.00	0.16***	-0.14***	-0.05	-0.10***	-0.14***	-0.17***	-0.13***	0.03
Exercise				1.00	-0.12***	-0.09***	-0.04	-0.08*	-0.21***	-0.06	0.01
TFEQ-D					1.00	0.66***	0.25***	0.31***	0.57***	0.38***	-0.06***
TFEQ-H						1.00	0.20***	0.27***	0.44***	0.35***	-0.07***
SATAQ-A							1.00	0.38***	0.36***	0.22***	-0.01
SATAQ-I								1.00	0.42***	0.30***	0.003
SPAS									1.00	0.51***	-0.10***
SE										1.00	-0.07*
WLOC											1.00

Notes: Values shown are Pearson correlation coefficients. TFEQ-R: dietary restraint; TFEQ-D: disinhibition; TFEQ-H: hunger; SATAQ-A: awareness of sociocultural attitudes towards appearance; SATAQ-I: internalization of sociocultural attitudes towards appearance; SPAS: social physique anxiety scale; SE: self-esteem; higher scores reflect *lower* self-esteem; WLOC: weight locus of control

*$P < 0.05$ ***$P < 0.001$

APPENDIX 29: Descriptive characteristics which did not vary among weight history groups

Characteristic	Maintained weight (n = 350)	Lost weight (n = 152)	Gained weight (n = 384)	Weight cycled (n = 169)	X^2	*P*
Education						
≤ Secondary school	108 (31%)	48 (32%)	114 (30%)	57 (34%)		
University/college	169 (49%)	73 (48%)	214 (56%)	83 (49%)		
Postgraduate	71 (20%)	30 (20%)	55 (14%)	29 (17%)	7.4	0.29
Annual income						
<$35,000	94 (28%)	47 (32%)	104 (29%)	59 (36%)		
$35,000–$50,000	85 (25%)	30 (21%)	93 (26%)	31 (19%)		
>$50,000	157 (47%)	68 (47%)	163 (45%)	72 (44%)	6.2	0.40
Currently use HRT	59 (17%)	15 (10%)	68 (18%)	32 (19%)	5.9	0.12
Vegetarian	28 (8%)	12 (8%)	22 (6%)	14 (8%)	2.0	0.58

Notes: Data are presented as n (%). HRT = hormone replacement therapy.

APPENDIX 30: Aspects of dietary restraint, disinhibition, and hunger in postmenopausal women grouped according to 10-year weight history

	Total	Maintain	Lose	Gain	Cycle
Dietary restraint	9.8 ± 4.4	9.1 ± 4.3	11.1 ± 4.6	9.3 ± 4.2	10.9 ± 4.4
Difference (95% CI)[a]	–	–	2.1 (1.2, 3.0)*	0.5 (-0.2, 1.2)	2.1 (1.2, 2.9)*
Flexible control	3.5 ± 1.7	3.5 ± 1.7	3.9 ± 1.8	3.2 ± 1.7	3.7 ± 1.8
Difference (95% CI)[a]	–	–	0.5 (0.1, 0.9)*	-0.1 (-0.4, 0.2)	0.4 (0.02, 0.7)*
Rigid control	3.0 ± 1.7	2.6 ± 1.6	3.4 ± 1.8	2.9 ± 1.7	3.5 ± 1.7
Difference (95% CI)[a]	–	–	0.8 (0.5, 1.2)*	0.2 (-0.1, 0.5)	0.8 (0.5, 1.1)*
Disinhibition	5.5 ± 4.1	3.5 ± 3.1	5.4 ± 4.0	6.7 ± 4.3	7.1 ± 4.1
Difference (95% CI)[a]	–	–	1.1 (0.5, 1.8)*	1.2 (0.7, 1.8)*	1.9 (1.3, 2.7)*
Habitual susceptibility	1.1 ± 1.4	0.5 ± 0.9	1.1 ± 1.4	1.4 ± 1.6	1.7 ± 1.5
Difference (95% CI)[a]	–	–	0.4 (0.1, 0.6)*	0.3 (0.1, 0.5)*	0.7 (0.5, 1.0)*
Emotional susceptibility	1.1 ± 1.3	0.7 ± 1.1	1.1 ± 1.2)	1.4 ± 1.3	1.3 ± 1.3
Difference (95% CI)[a]	–	–	0.2 (-0.02, 0.6)	0.2 (-0.02, 0.4)	0.2 (-0.1, 0.4)
Situational susceptibility	1.9 ± 1.6	1.4 ± 1.4	1.8 ± 1.6	2.3 ± 1.6	2.3 ± 1.5
Difference (95% CI)[a]	–	–	0.2 (-0.1, 0.5)	0.3 (0.1, 0.6)*	0.4 (0.2, 0.8)*
Hunger	4.2 ± 3.3	3.2 ± 2.8	3.8 ± 3.2	4.9 ± 3.5	4.9 ± 3.4
Difference (95% CI)[a]	–	–	0.3 (-0.3, 0.9)	0.7 (0.3, 1.2)*	0.9 (0.3, 1.5)*
Internal locus	1.5 ± 1.8	1.2 ± 1.6	1.4 ± 1.8	1.8 ± 1.9	1.8 ± 1.9
Difference (95% CI)[a]	–	–	0.02 (-0.3, 0.4)	0.2 (-0.1, 0.5)	0.3 (-0.02, 0.6)
External locus	1.5 ± 1.5	1.1 ± 1.3	1.4 ± 1.4	1.9 ± 1.6	1.8 ± 1.6
Difference (95% CI)[a]	–	–	0.1 (-0.2, 0.3)	0.3 (0.1, 0.6)*	0.3 (0.02, 0.6)*

Notes: Scores are presented as mean ± SD. Scores can range as follows: dietary restraint range: 0 – 21; flexible and rigid control: 0 – 7; disinhibition: 0 – 16; habitual susceptibility to disinhibition: 0 – 5; emotional susceptibility: 0 – 3; situational susceptibility: 0 – 5; for hunger: 0 – 14; internal locus and external locus for hunger: 0 – 6. Higher scores reflect higher levels of that characteristic. All comparisons included age and BMI as covariates. Data for dietary restraint, disinhibition, and hunger were reported in Table 5.2, but are duplicated here to facilitate comparison with the sub-factors proposed by Westenhoefer and colleagues (1999) and Bond and colleagues (2001).

[a] Difference (95% CI) from weight maintainers. These differences were calculated with multiple regression and are based on covariate-adjusted means.

* Bootstrap $P < 0.05$ for difference from maintained weight group.

APPENDIX 31: Results of multiple regression to determine predictors of current BMI in the total survey sample (n = 1071)

Variable	B (95% CI)	β	R^2	R^2 change	*P*
Disinhibition	0.403 (0.323, 0.483)	0.373	0.252	0.252	<0.001
Gain	2.88 (2.32, 3.45)	0.310	0.217	0.066	<0.001
Social physique anxiety	0.089 (0.059, 0.119)	0.204	0.341	0.023	<0.001
Age	0.112 (0.079, 0.145)	0.171	0.362	0.022	<0.001
Cycle	1.80 (1.10, 2.50)	0.147	0.375	0.013	<0.001
Lose	1.05 (0.35, 1.75)	0.082	0.380	0.005	0.003
Exercise	-0.071 (-0.132, -0.009)	-0.058	0.384	0.004	0.02
Self-esteem	-0.149 (-0.283, -0.015)	-0.065	0.388	0.003	0.03
Weight locus of control	0.082 (0.014, 0.149)	0.061	0.391	0.003	0.02
Hunger	-0.099 (-0.188, -0.010)	-0.073	0.394	0.003	0.03

Notes: Variables which did not enter the regression were: dietary restraint and menopausal age. The dummy variables coding 10-year weight history (lose, gain, cycle) were available for entry in this regression for the total sample, and each entered the equation (with a history of weight gain entering after disinhibition and accounting for 6.6% of the variance in BMI). This demonstrates that aspects of 10-year weight history are independent predictors of current BMI when effects of other psychosocial and demographic variables are considered in a sample of postmenopausal women with various weight histories, that disinhibition remains the variable which is the greatest independent predictor of current BMI and that other characteristics contribute to the variance as well.

APPENDIX 35: Reminder letter for the second round of Phase II tasks

THE UNIVERSITY OF BRITISH COLUMBIA

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Phone: (604) 822-2502
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[Date]

[Participant Name and Address Information]

Dear [Participant],

Thank you once again for your participation thus far in our study, "Dietary Attitudes, Stress, and Bone Health in Women Following Menopause." As you know, your last few tasks are approaching. Here is an outline of what remains, with some reminders of the most important points.

1. **Your second Three-day Food Record (scheduled for <u>Sunday, June 6 to Tuesday, June 8</u>):**

☐ *Reminder:* the instructions for completing the Food Record are located on pages 2 and 3 of the Food Record. Please take a few moments to review them prior to starting your Food Record, and call me if you have any questions.

☐ For the three days you maintain the Food Record (i.e., Sunday, Monday, Tuesday), you will record *everything* you eat and drink in the Food Record booklet. *Eat and drink as you normally would* during those three days and record everything as accurately as possible in the Food Record.

☐ Include recipes (with the total amount made by the recipe and the amount you ate) and labels for items in your Food Record, if applicable.

☐ Don't forget to answer the questions on page 21 of the Food Record! (One question for each day).

2. **Your second 24-hour Urine Collection (this is scheduled for <u>Monday, June 7</u>):**

☐ *Reminder:* the instructions for completing the 24-hour urine collection are located on the yellow sheet in your study folder. Please review them prior to starting your 24-hour collection, and call me if you have any questions.

☐ The 24-hour period for your urine collection starts when you get up on the morning of Monday June 7 to start your day, go the bathroom, and *flush that first urine down the toilet.* The time that you flush the first urine down the toilet is the "start time" for your 24-hour collection (write it down). Collect <u>*all*</u> the urine you excrete for the next 24 hours, using the measuring cup to collect it as you go to the bathroom and then pouring it into the orange collection container. Keep the orange container with the urine *cool* during the 24-hour collection (preferably in the fridge).

☐ Your collection will end on *Tuesday morning (June 8)*, when you go to the bathroom approximately 24 hours after your "start time" from the day before. *Add this last urine to the orange container* and write down this time as your "stop time."

Continued on reverse...

Eating a variety of nutritious foods contributes to a healthy diet. To help you assess the variety of your diet, your average intake over the 6 days you maintained a Food Record was compared to the recommendations contained in Canada's Food Guide to Healthy Eating (a copy of which is included in your blue folder).

	Canada's Food Guide recommends (servings per day):	**You averaged (servings per day):**
Grain Products	5 – 12	2.4
Vegetables and Fruit	5 – 10	6.1 (2.0 vegetable servings and 4.1 fruit servings)
Milk Products	3 – 4	2.7
Meat and Alternatives	2 – 3	1.8
Other Foods (e.g. fats, oils, sweets)	Use in moderation	10.9

*please consult the back of the Food Guide for descriptions of what is considered a "serving"

Grain products such as breads, cereals, rice, and pasta are important because they provide complex carbohydrates (starches). These are good sources of energy, especially in low-fat diets. They also provide vitamins, minerals, and fibre.
You may wish to consider increasing the number of servings of grain product you eat.

Vegetables and fruits are important because they provide vitamins (such as vitamins A and C, and folate) and minerals (such as iron, magnesium, and potassium). They are naturally low in fat and sodium, and also provide good sources of fibre.
You are eating enough servings of fruits and vegetables.

Milk products are important because they provide protein, vitamins, and minerals – especially calcium.
You are consuming enough milk and dairy products (your calcium-fortified "So Good" soy milk was included in this, too, since each glass of soy milk provides approximately the same nutrients as a glass of milk).

Meat and alternative products (such as beans, tofu and peanut butter) are important because they supply protein, B vitamins, iron, and zinc.
You may wish to consider slightly increasing your servings of meat or alternatives.

The most recent nutrition recommendations indicate that in order to meet your nutritional needs and minimize your risk for chronic disease, you should consume:

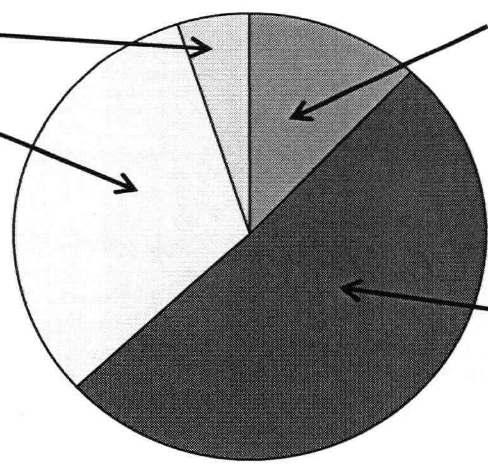
45 – 65% of your total calories from carbohydrates
Carbohydrates are important sources of energy. Some parts of your body (e.g. your brain) must use carbohydrates as their fuel!

20 – 35% of your total calories from fat
Fat is also an important source of energy, and it can help with the absorption of various vitamins and the development of tissues. There are several types of fat in the diet. "Monounsaturated" and "polyunsaturated" fats can help reduce blood cholesterol levels and lower the risk of heart disease. You may have heard of "omega 3" and "omega 6" fatty acids – these are both types of polyunsaturated fats. Other types of fat are not as healthy as the monounsaturated and polyunsaturated fats. "Saturated" fat, "trans fat" and "cholesterol" have no known benefit in preventing chronic disease. Although both plant and animal foods contain fat, animal foods tend to have a greater proportion of saturated fat (the type of fat that tends to be solid at room temperature). Choosing lower fat versions of these foods is thus recommended.
It is recommended that you have **5 – 10% of your calories from polyunsaturated fat** (this type of fat is found in canola oil, flaxseed oil, walnuts, and pumpkin seeds). A recommendation for the amount of monounsaturated fat is still being debated, and while it is recognized that healthy diets will contain some of the other fats (saturated fat, trans fat, cholesterol), it is recommended that the intake of those fats be kept **as low as possible**.

10 – 35% of your total calories from protein.
Proteins also supply energy to the body. In addition, they are important in the structure of cells and in the regulation of various processes.

The only other source of calories in our diets is alcohol. Although vitamins and minerals are essential, it is only the so-called macronutrients (carbohydrate, protein, fat) and alcohol that contribute energy for your body to use as fuel.

On average, your breakdown of calories was as follows:



Overall, your breakdown of energy fell within the recommendations.

To determine whether your diet was providing enough vitamins and minerals over the 6 days you maintained a Food Record, the nutrient content of the foods and beverages you consumed were compared to current recommendations.

The following page illustrates the result of this analysis.

Note that the first bar on the graph compares your dietary intake to recommendations for women of your age of average height and weight who have a *light activity level*. Because energy (calorie) requirements vary a great deal depending on your body size and activity level, this result should not be used to judge whether your caloric intake is appropriate.

A better assessment of how much energy your body needs is provided by whether or not your body weight is being maintained.

- If your weight is stable (i.e., you weigh more or less the same amount over time), then you are meeting your energy needs. In other words, if your weight stays about the same, then you are getting enough (but not too much) energy/calories from your diet.

- However, if you are gaining – or losing – weight, your calorie intake is greater – or less – than what is needed for weight maintenance. If you do not wish to continue gaining or losing weight, you may decide to decrease (or increase) your calories in order to keep your weight stable.

As you can see from the graph on the following page, you are meeting or exceeding the recommended intake for the majority of vitamins/minerals. However, your intake of both calcium and vitamin D falls short of recommended levels. (And while your consumption of both sodium and cholesterol appears "low" on the graph, that is a good thing!). Although your supplements serve as a good addition to help ensure you meet recommendations, you may wish to increase your dietary intake of calcium and vitamin D (since adequate dietary sources of vitamins/minerals are usually preferable to supplements). To help you increase your consumption of vitamin D and calcium from foods, you could consider increasing your consumption of:

- Dairy products, tofu made with calcium sulfate, green vegetables such as bok choy, calcium-fortified juices and soy/rice beverages (all good sources of calcium)
- Fatty fish (e.g., herring, mackerel, salmon, sardines) or vitamin D-fortified foods such as milk or soy/rice beverages (all good sources of vitamin D)

Note that while supplements were not included in this analysis, you could add the contributions of your supplements to the "value" column on the graph to see what your intake would be from both foods and supplements.

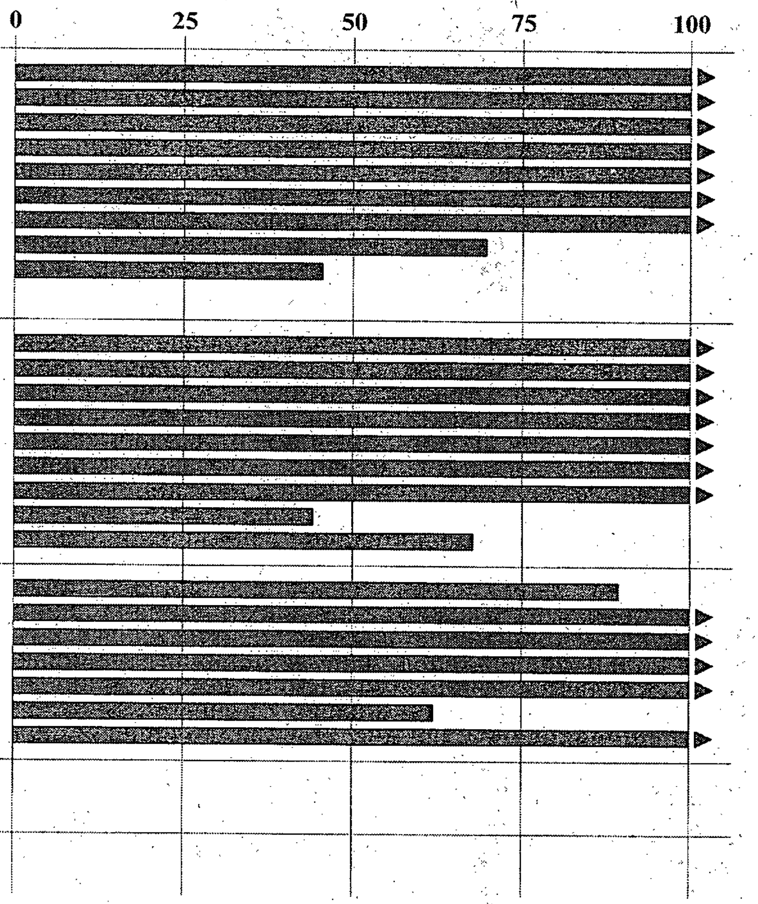
26 [2182] 6 day summary

Total Weight: 19505.61 g (688.03 oz-wt.)

% comparison to: **Female (51-70 years)**

Bar Graph

Nutrient	Value	Goal %
Basic Components		
Calories	2193.24	119%
Protein	66.91 g	139%
Carbohydrates	277.58 g	109%
Dietary Fiber	28.77 g	111%
Fat - Total	87.80 g	153%
Saturated Fat	26.85 g	146%
Mono Fat	31.60 g	154%
Poly Fat	12.87 g	70%
Cholesterol	136.75 mg	46%
Water	2778.45 g	
Vitamins		
Vitamin A RE	1848.05 RE	264%
Thiamin-B1	1.38 mg	125%
Riboflavin-B2	1.77 mg	161%
Niacin-B3	15.68 mg	112%
Vitamin-B6	1.69 mg	113%
Vitamin-B12	3.01 mcg	125%
Vitamin C	258.32 mg	344%
Vitamin D IU	176.97 IU	44%
Folate	271.27 mcg	68%
Minerals		
Calcium	1072.95 mg	89%
Iron	13.73 mg	172%
Magnesium	428.68 mg	134%
Phosphorus	1256.59 mg	180%
Potassium	3689.37 mg	105%
Sodium	1487.61 mg	62%
Zinc	9.75 mg	122%
Other Fats		
Omega 3 Fatty Acids	0.64 g	
Omega 6 Fatty Acids	9.65 g	
Other		
Alcohol	14.59 g	
Caffeine	227.42 mg	



Calcium and vitamin D are two important nutrients with respect to bone health.

The booklet "Osteoporosis and You" (from the Canadian Osteoporosis Society) provides some information about calcium and vitamin D on its pages 6 through 11. Note that the Osteoporosis Society makes recommendations for calcium and vitamin D intake that are slightly higher that the general recommendations for healthy adults.

A summary of the recommendations – and your average intake over the 6 days you maintained the Food Records – is summarized in the following chart:

	Recommended Adequate Intake for adults 51 – 70 years of age	Osteoporosis Society Recommendation (for adults over 50 years)	Your average intake
Calcium	1200 mg/day	1500 mg/d	1072.95 mg/day
Vitamin D	400 IU/day	800 IU/day	176.97 IU/day

**It would be a good idea to increase the amount of calcium and vitamin D in your diet by adding some calcium-rich foods and good sources of vitamin D (see the "Osteoporosis and You" booklet and "Calcium… Do You Get Enough?" pamphlet for suggestions). Calcium-fortified foods (such as calcium-fortified orange juice) may also be helpful.*

Your supplements will also enable you to meet the recommended calcium intake. It would be a good idea to continue using the supplement as you are now, by "dividing the dose" and consuming the supplement with food. By dividing your calcium supplement (taking one in the morning and one in the evening), you will absorb more calcium than if you took both at the same time.

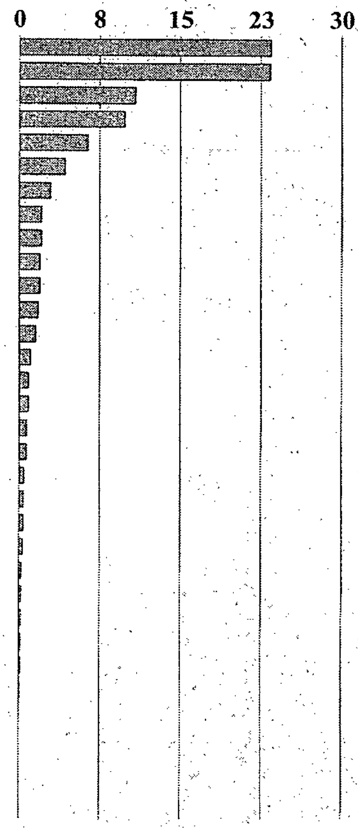
On the next page…
To give you an idea of how the different items you had to eat or drink contributed to the calcium content of your diet, you can look at the graph on the following page. One day was selected from your Food Records, and the sources of calcium for that day are illustrated (from the item that provided the most calcium to the items that provided the least).

26 [2182]Record#1Day#1CR

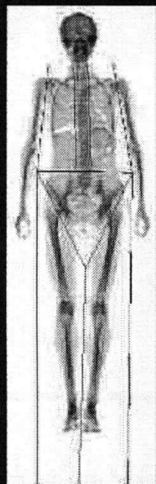
Total Weight: 2864.58 g (101.04 oz-wt.)

Sources & Amounts for Calcium

Amount	Food Item	Calcium (mg)	
3/4 cup	MILK, PART SKIM, 2% B.F.	222.51	23%
3/4 cup	SOY-BASED BEVERAGE, FLUID, ENRICHED	221.80	23%
4 tbs	YOGOURT, PLAIN, <1% B.F.	102.90	11%
5 tbs	YOGOURT, FRUIT BOTTOM, 1% -> 2% B.F.	93.40	10%
1 each	Flour Tortilla-7-8 inch-RTB	61.25	6%
2 piece	BREAD, WHOLE WHEAT, TOASTED, SLICE	40.50	4%
4 oz-wt	CHICKEN, GROUND, LEAN, CKD	28.08	3%
1/2 cup	Campbell's V8 100% Vegetable Juice CAM	20.00	2%
1/2 each	Grapefruit-Raw, Medium FDA	20.00	2%
1 piece	CANDIES, TRUFFLES, PREP F/REC	18.60	2%
1 tbs	MILK, PART SKIM, 2% B.F.	18.54	2%
4 each	PRUNES, DRIED	17.14	2%
1/2 oz-wt	CREAM, SOUR, CULTURED, 14% B.F.	15.12	2%
1/2 cup	Post Banana Nut Crunch Cereal-RTE KFT	10.62	1%
6 oz-wt	ALCOHOLIC, BEER, REGULAR, 5% ALCOHOL,CAN	8.51	1%
1 each	Dried Date Plums-Each	8.50	1%
3/2 cup	TEA, HERB, BREWED	7.11	1%
3/2 cup	COFFEE, BREWED	7.10	1%
1 cup	Water	4.73	0%
8 oz-wt	Water	4.54	0%
1/2 oz-wt	SAUCE, SALSA, RTS	4.25	0%
1/2 each	Banana-Medium-7" to 7 7/8" Long-Each	3.54	0%
4 oz-wt	Water	2.27	0%
1/2 oz-wt	Diced Tomatoes-Cnd DLM	2.25	0%
1/2 tbs	SWEETS, JAMS & PRESERVES	2.00	0%
1/2 tbs	Butter-Salted-Cup	1.68	0%
1 tbs	LIME JUICE, RAW	1.38	0%
4 oz-wt	CARBONATED DRINK, TONIC WATER (QUININE)	1.13	0%
1 tsp	White Granulated Sugar-Cup	0.04	0%
1/2 oz-wt	Kraft Real Mayonnaise KFT	0	0%
1 oz-wt	ALCOHOLIC, GIN, 40% ALCOHOL	0	0%
	Total	949.50	100%



Pages 1 – 3: Results for your "total body"



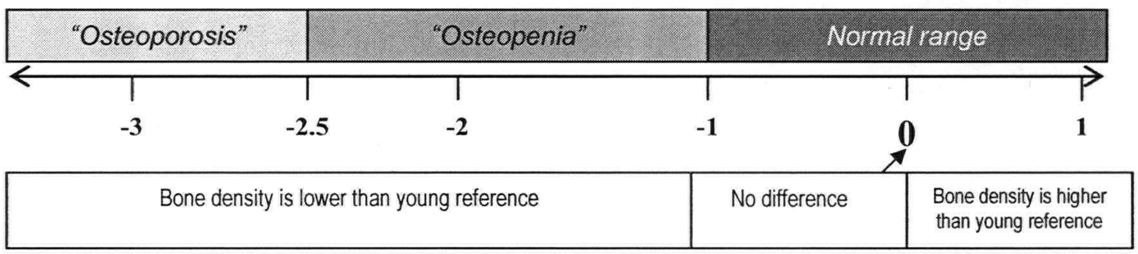
The first 3 pages of the attached report provide the results of the "total body" portion of the test. It breaks the body down into compartments (e.g., left arm, left leg, left trunk, etc.) and indicates the composition of the body in each of those areas.

The following definitions may help you understand the information provided:

- **<u>BMD</u>**: This stands for "Bone Mineral Density" – the average concentration of bone mineral in the area of bone being measured.

- **<u>T-score</u>**: This number indicates the difference between your personal result and that of young healthy women ~30 years old (i.e., women at their "peak bone mass"). The T-score is used to diagnose osteoporosis and osteopenia (if your T-score is between -1 and -2.5, you meet the criteria for osteopenia in that area; if it is less than -2.5, you meet the criteria for osteoporosis in that area).

  The T-score difference is represented by standardized units as illustrated:



- **<u>Z-score</u>**: Similar to the T-score in that it compares your own personal measurement to others' – but in this case, the comparison is made to other women *the same age as you* (instead of the young "peak bone mass" value). If your Z-score is a positive number (i.e., it is above zero), then your bone density is relatively greater than other women of your age. If your Z-score is a negative number (i.e., it is less than zero and has a "-" in front of it), then your bone density is less than other women of your age, on average.

- **<u>BMC (g)</u>**: This stands for "Bone Mineral Content" – the absolute amount of bone mineral in the particular section of bone being measured.

- **<u>Area (cm^2)</u>**: This indicates the size (area) of the bone being measured.

- **<u>Tissue (%Fat)</u>**: The percentage of fat in the muscle tissue in that area.

- **<u>Region (%Fat)</u>**: The percentage of fat in that area as a whole (includes the fat in muscle tissue as well as other fat in the area being measured). The average % fat value (depending on age) is ~35–38% (shown by the darkest curved line on the graph on page 3).

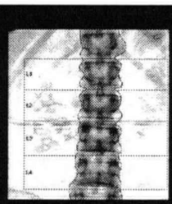
- **<u>Tissue (g)</u>**: The weight of the tissue in that area (in grams).

- **<u>Fat (g)</u>**: The weight of the fat in that area (in grams).

- **<u>Lean (g)</u>**: The weight of the lean tissue in that area (in grams).

Your personal result for your "total body" bone mineral density is indicated by the white square in the graph on the first page. As you can see, your bone density falls in the "<u>normal</u>" range for the total body.

Pages 4 – 5: Results for your "lumbar spine"



The next two pages (pages 4 and 5) provide the results of the bone density scan of the "lumbar spine" (i.e., the lower portion of the spine at the base of your back). This is one of the sites that is often measured for the diagnosis of osteoporosis.

As you can see on the graph on page 4, personal results can fall in one of three ranges: **"normal"** (i.e., bone mineral density is in the desired range), **"osteopenia"** (i.e., bone mineral density is lower than what is considered normal), or **"osteoporosis"** (i.e., bone density is low and risk for fracture is increased).

Your personal result is indicated on that graph by the white box. As you can see, your bone density falls in the "<u>normal</u>" range at the lumbar spine.

Please keep in mind that the reference point for what is considered "normal" is the bone mineral density of young healthy women at the age of ~30 years, and all women will lose bone mass as they age. The T-score values compare your bone density to this young reference (the T-score is used for the diagnosis of osteoporosis and osteopenia: a T-score less than -2.5 meets the criteria for osteoporosis and a T-score between -1 and -2.5 would be considered osteopenia).

You may find the information in the booklet "Osteoporosis and You" (specifically the definitions on page 5) helpful in understanding these different categories.

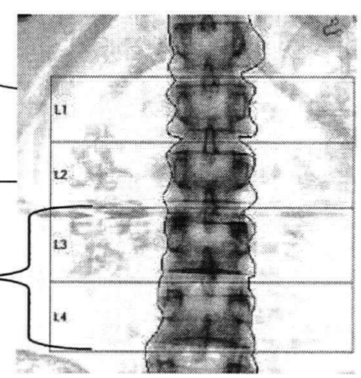
The Z-score values compare your personal results to other women *at the same age*. If your Z-score is a *positive* number (i.e., above 0), then your bone density is relatively *greater* than other women of your age. If your Z-score is a *negative* number (i.e., it is less than 0 and has a "-" in front of it), then your bone density is *less* than other women of your age.

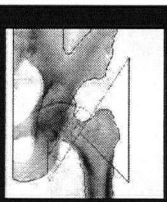
In the table below the graph on page 4, the "Region" (e.g., "L1", "L2", "L1-L2" etc.) refers to the measurement for the specific vertebral body (or bodies) in your spine. You can see that the image of your own spine shows the areas filled by the four vertebral bodies measured during this part of the scan.

L1
(i.e., lumbar spine vertebral body #1)

L2
(i.e., lumbar spine vertebral body #2)

L3-L4
(i.e., lumbar spine vertebrae #3 and #4)





Pages 6 – 7: Results for your hips

The next two pages (pages 6 and 7 – the last pages of the report) provide the results of the bone density scan of your hips. This is also one of the sites often measured for the diagnosis of osteoporosis.

The presentation of these results is formatted in much the same way as the results for your lumbar spine. The graph on page 6 shows where your personal measurements fall (you will notice that there are two white squares on this graph – one representing each of your left and right hip). Again, the T-score values compare your result to that of healthy young women, and the Z-scores compare your personal results to other women of your age.

Your personal result as indicated on the graph by the white boxes indicates that your bone density falls in the "normal" range in both hips.

The chart on the last page breaks down the results of the scan of your hip into the various regions measured there as well. The values of greatest interest are the last four – the total BMD value for the left hip, the total BMD value for the right hip, the mean value (which is the average BMD value for both of your hips), and the difference (which indicates how different the value for one hip is from the other). This information is also presented in the chart under the picture of your hips on page 6.

Please bring your physician the second copy of these results. He/she will be able to answer questions you may have about the clinical implications of these results.

If you have any questions about any of this information – or anything in your personal results package – please do not hesitate to contact me!