

**DIETARY INTAKE ESTIMATIONS AND ANTHROPOMETRIC MEASUREMENTS IN
HEALTHY YOUNG ADULT WOMEN WITH DIFFERING EATING
CHARACTERISTICS**

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ABSTRACT

Objective: To investigate differences in dietary intake variables and anthropometric measurements in healthy young adult women of healthy body mass index (BMI) with high and low scores of cognitive eating restraint (CER), disinhibition (DI), and hunger.

Design: Cross-sectional study in which the Eating Inventory was completed along with the Block Food Frequency Questionnaire and anthropometric measurements using standard procedures and dual-energy X-ray absorptiometry, respectively.

Participants: 65 healthy young adult women.

Setting: This research was conducted in the Bone Laboratory on the campus of the Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Statistical analyses: Independent *t*-tests, Pearson correlation coefficient analyses, and general linear regression models.

Results: Women with high CER scores ($n=32$; mean \pm SD CER score=13.1 \pm 2.4) consumed more fruits per day (2.4 \pm 0.9 svg/d) compared to women with low CER scores ($n=33$; CER score=4.5 \pm 3.0; fruits=1.8 \pm 1.1 svg/d; $p<0.05$). Women with high hunger scores ($n=35$; hunger score=7.5 \pm 2.2) consumed less fruits per day (1.8 \pm 0.9 svg/d) compared to women with low hunger scores ($n=30$; hunger score=3.0 \pm 1.1; fruits=2.4 \pm 1.1 svg/d; $p<0.05$). Women with high compared to low CER scores had higher body weight ($p<0.05$), BMI ($p<0.05$), fat mass ($p<0.05$), and body fat percentage ($p<0.05$), while women with high ($n=31$; DI score=7.6 \pm 2.5)

compared to low (n=34; DI score=2.9±1.0) DI scores were taller ($p<0.05$). Hunger predicted estimated daily dietary intakes of total energy ($p<0.05$), protein ($p<0.01$), and fat ($p<0.01$), while CER ($p<0.05$) and DI ($p<0.05$) predicted estimated daily dietary fruit intake.

Conclusion: In healthy young adult women, eating characteristics can distinguish between some dietary intake patterns and anthropometric measurements. Hunger is a predictor of estimated energy, protein, and fat intake in these women.

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CHAPTER 1

INTRODUCTION

There are many influences that affect eating habits. Some of these influences include heredity; psychological factors; cognitive influences including low self-esteem, depression, and anxiety; alcohol; food cravings; food and eating related thought suppression; and hunger. How individuals cope with influences that affect eating habits is relevant to the present study on cognitive eating restraint (CER), disinhibition (DI), and hunger.

Cognitive Eating Restraint

Cognitive eating restraint, otherwise known as restrained eating or eating restraint, is characterized by self-reported chronic dieting. Restrained eaters tend to binge more frequently, eat in response to emotional stimuli (such as depression and anxiety), and counter-regulate (increase consumption of food after a preload) under certain conditions (1, 2). Dietary restraint is used as a way of controlling body weight (3). Individuals with high CER consciously restrict their dietary intake as a means of losing or maintaining weight, while making the conscious cognitive decision to control eating behaviors, rather than responding to physiological controls such as hunger and satiety (4).

Disinhibition

Eating restraint may be a successful way of limiting caloric intake, but restrained eaters are also known to break the restrained approach towards food once tempted with a high-calorie preload. This temptation may cause individuals with high CER to consume more food and energy than a non-restrained eater, due to normal boundaries of satiety having been distorted (4, 5). Similarities have been found between naturally occurring eating binges and overeating after the consumption of a preload (6). This behavior is known as DI, or the point at which cognitive

control over eating is abandoned and eating continues up to the satiety boundary (7). Disinhibition may occur because of the availability of palatable foods, eating by other people around the restrained eater, or as a response to emotional distress (8). In these circumstances, dietary restrainers will eat more than unrestrained eaters because satiety boundaries are set higher in individuals with high CER compared to unrestrained eaters. Other factors leading to DI include the consumption of a preload believed to be high in energy, an anticipated consumption of a high-calorie food, thinking about a high-calorie food, the intake of alcohol, and different mood states including depression and anxiety (7).

Hunger

Hunger, the intensity with which hunger sensations are perceived and the extent to which such sensations evoke eating, has an important influence on eating by individuals with high CER (8). Food deprivation levels and perceived hunger levels cannot be assumed equal in individuals with and without restrained eating. This assumption is due to the level of hunger being lower for restrained eaters compared to unrestrained eaters, possibly due to the high level of self-control that restrained eaters retain.

Heredity

Heredity appears to subtly influence body structure and size, food intake, fluid intake, the number, timing, and composition of meals and drinks, the time of day a meal is eaten and how large an effect that time of day will have on intake, the degree of stomach filling before and after a meal, the degree of stomach filling on the amount eaten during meals, and how much an individual's intake increases by the presence (number and type) of companions (9). Psychological attributes related to eating behavior also appear to be affected by heredity. These include levels of self-rated hunger before, during, and after a meal, the palatability and

responsiveness to the palatability of foods, and hunger's effect on intake. Psychological factors affecting food intake vary, allowing some individuals to eat whatever and whenever they want, while others restrict intake.

Questionnaires

The Restraint Scale and the Three Factor Eating Questionnaire are frequently used in laboratory studies to examine the food intake and restraint of individuals. An association between higher CER scores and lower overall intake of food (especially fats and carbohydrates) has been the general outcome in most, but not all, of these studies (9). Disinhibition, dietary restraint or CER, and perceived hunger significantly influence body size and eating behaviors of individuals. The comparative role of heredity and environmental factors to DI and dietary restraint is important with regard to overweight, eating disorders, and intake regulation (9).

Cognitive and Emotional Factors

Cognitive and emotional factors may moderate DI and restrained eating patterns. The diet boundary, one form of cognitive dietary restraint, is set above the hunger boundary and below the satiety level in individuals with high CER compared to individuals without restrained eating. This diet boundary consists of an individual's personal rules regarding the types of food and the amount of food consumed (7). Low self-esteem may lead to a counter-regulation (increased consumption) eating pattern. One study demonstrated that individuals with low self-esteem who were forced to consume a preload had a subsequent counter-regulatory eating pattern (1). Previously, Kirschenbaum and Dykman (1991) found that restrained eaters with lower self-esteem counter-regulated significantly more than restrained eaters who reported high self-esteem.

Counter-regulatory Forms of DI

Another counter-regulatory form of DI is the use of alcohol. In one study, the consumption of alcohol led to an increase in food for restrained eaters, but not for unrestrained eaters (10). Depression and anxiety have the same effects on eating as alcohol does. Anxiety inhibits gastric contractions as well as elevates blood sugar concentration, both of which normally suppress physiological hunger cues (7). However, Stunkard and Messick (1985) showed that when restrained eaters were anxious or depressed, these individuals ate more and gained weight, respectively.

Related Studies

The term craving, referred to as a strong or intense desire or longing, is difficult to define precisely, observe directly, or measure (11). There are a limited number of techniques to measure food cravings, with the most common being self-report on a visual analogue rating scale to specify the degree to which an individual craves a food. Self-perceived food cravings may trigger overeating, binge eating, or overt bulimic behavior, as well as affecting snacking and compliance with dietary guidelines. When compared to men and non-cravers, women are twice as likely to be food cravers and are more frequently concerned about body weight (11). Dieting and caloric restriction can predispose individuals to food cravings, possibly through the mediation of hunger or psychological deprivation. Deprivation of a desirable and irreplaceable food (chocolate) induced more behavior indicative of craving than did deprivation of a less preferred and more easily substituted food (11). Moreover, these effects occurred mainly in restrained eaters, and restrained eating promoted an increased consumption of preferred but previously avoided foods when those foods became available (11).

The effects of a 3-day restriction period from high-carbohydrate or high-protein foods on subsequent food intake and cravings were examined in restrained and unrestrained eaters (12).

Increased cravings for the specific food that was restricted, meaning carbohydrate-restrictors experienced increased cravings for carbohydrates only and protein-restrictors experienced increased cravings for proteins only, were found. After carbohydrate restriction, carbohydrate-restricted participants had a higher intake of croissants (high carbohydrate food) than did either control or protein-restricted participants. On the other hand, after protein-restriction, protein-restricted participants showed only increased cravings but not an increase in intake of chicken (high protein food) when compared to carbohydrate-restricted participants or controls. Overall, carbohydrate restriction appeared to have a greater negative impact, when compared to protein restriction, because of resulting cravings and increased intake of carbohydrates compared to only increased cravings of protein for those experiencing protein restriction (12).

Thought suppression is defined as an attempt at mental control or a conscious attempt to control psychological contents and processes (13). Dieters frequently comment on the inability to stop thinking about food when on a diet. One study examined the suppression of food- and eating-related thoughts and its consequences in individuals with dieting intentions compared to individuals without dieting intentions. The aim of this study was to focus on participants with both high levels of dietary restraint and DI. Individuals with both high DI and CER, characterized by common use of mental control processes leading to ironic effects, were compared to individuals with only high CER. Overall, individuals with high DI and CER used thought suppression more often and also reported more food-related thoughts, compared to individuals with only high CER and individuals with low CER. Soetens and colleagues (2006) also found that attempts at thought suppression by individuals with high DI and CER left these individuals with increased thoughts that they intended to avoid, potentially contributing to preoccupations with food and eating.

Dietary restraint involves the intentional restriction of food intake in an effort to regulate body weight (14). Dietary restrainers ignore physiologic hunger cues, and cognitive distortions (including all-or-nothing thinking and irrational beliefs) become predominant. O’Connell and coworkers (2005) hypothesized that “restrained eaters in the preload condition would experience a greater frequency of food and eating-related thoughts and demonstrate more difficulty suppressing these thoughts, relative to their unrestrained counter-parts.” (p. 43). In addition, it was expected that a larger rebound effect (disinhibiting effect observed after preloading) among restrained eaters in the preload condition, relative to non-preloaded restrained eaters and unrestrained eaters would be observed. Moreover, preloaded restrained eaters would consume more ice cream compared to non-preloaded restrained and unrestrained participants. O’Connell and colleagues (2005) found that when compared to unrestrained eaters, restrained eaters exhibited more food and eating-related thoughts, suggesting they experienced more difficulty suppressing these thoughts. During both the suppression and follow-up expression phases for preloaded participants, there was an increase in verbal references to food-related thought when instructions were to suppress those particular thoughts. However, there was no evidence of a rebound effect, although the rate of these thoughts increased for preloaded participants. Regardless of suppression group and restraint status, preloading was associated with less ice cream consumption across all participants (14).

Studies exploring differences in the suppressive effects of macronutrients on hunger have found inconsistent findings. Compared to meals low in total energy content, meals high in total energy generally reduce hunger to a greater degree (15). After the consumption of preloads with different energy values, similar hunger ratings have also been reported (15). Belief about the energy value of a meal may have a greater effect than actual energy content, including high fiber

foods, which are often recommended to modulate hunger. Kirkmeyer and Mattes (2000) hypothesized that peanuts would have a strong suppressive effect on hunger, because peanuts are high in protein and fiber as well as energy dense and solid. Findings from Kirkmeyer and Mattes' (2000) study showed that over a 3-hour post-ingestive period, the energy content of a preload exerted a stronger influence on hunger than macronutrient composition of the food, energy density, volume, weight, fiber content, sensory properties, or rheology. The rate of hunger recovery after food ingestion was unaffected by these attributes, as well. Total energy balance was maintained, while ingestion of various foods resulted in shifts of subsequent diet composition and affective responses to foods (15).

Rationale

With many of the individuals in the United States living with overweight and obesity, it is important to look at every aspect of individual eating patterns and eating habits and not simply genetics or other obvious related issues such as alcohol, depression, and anxiety. Cognitive eating restraint, DI, and hunger are examples of some of the dieting techniques individuals use to lose or maintain weight. Whether individuals are successful or not with these aspects of dietary intake control, it is important to study these eating-related behaviors to fully understand CER, DI, and hunger food intake regulation by individuals. As previously stated, when compared to men and non-cravers, women are twice as likely to be food cravers and are more frequently concerned about body weight (11). Evaluation of healthy, normal weight, young adult women might provide insights into the extent to which CER, DI, and hunger affect body weight, before body weight or related health conditions confound cognitive control over food intake.

In the present study, women were divided into high and low CER groups, high and low DI groups, and high and low hunger groups to determine differences in age (y), anthropometric

measurements, and estimated daily dietary intake of energy (kcal/d), protein (g/d), carbohydrate (g/d), fat (g/d), grains (svg/d), vegetables (svg/d), fruits (svg/d), and oils and fats (svg/d). It was hypothesized that these variables would differ between young adult women with low and high CER scores, DI scores, and hunger scores. It was further hypothesized that anthropometric measurements and psychometric properties of eating would be significant predictors of estimated daily dietary intake of total energy (kcal/d), total protein (g/d), total carbohydrate (g/d), total fat (g/d), grains (svg/d), vegetables (svg/d), fruits (svg/d), and oils and fats (svg/d). In addition, women with high compared to low CER; DI; and hunger scores would have greater BW, BMI, fat mass (FM), and body fat percentage (BF%) but no differences in age, body height, and lean body mass (LBM). Moreover, each eating characteristic was expected to be highly associated with all dietary intake variables and anthropometric measurements of BW, BMI, FM, and BF%, and each eating characteristic was hypothesized to predict each dietary intake variable.

REFERENCES

1. Eldredge, K.L. (1993) An investigation of the influence of dieting and self-esteem on dietary disinhibition. *Int J Eat Disord.* 13:57-67.
2. Kirschenbaum, D.S., Dykman B.M. (1991) Disinhibited eating by resourceful restrained eaters. *J Abnorm Psychol.* 100:227-230.
3. Smith, C.F., Geiselman, P.J., Williamson, D.A., Champagne, C.M., Bray, G.A., Ryan, D.H. (1998) Association of dietary restraint and disinhibition with eating behavior, body mass, and hunger. *Eat Weight Disord.* 3:7-15.
4. Dykes, J., Brunner, E.J., Martikainen, P.T., Wardle, J. (2004) 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.* 28:262-268.
5. Lowe, M.R. (1995) Restrained eating and dieting: replication of their divergent effects on eating regulation. *Appetite.* 25:115-118.
6. Rogers, P.J., Hill, A.J. (1989) Breakdown of dietary restraint following mere exposure to food stimuli: interrelationships between restraint, hunger, salivation, and food intake. *Addict Behav.* 14:387-397.
7. Steere, J., Cooper, P.J. (1993) The effects on eating of dietary restraint, anxiety, and hunger. *Int J Eat Disord.* 13:211-219.
8. Lowe, M.R., Maycock, B. (1988) Restraint, disinhibition, hunger and negative affect eating. *Addict Behav.* 13:369-377.
9. de Castro, J.M., Lilenfeld, L.R.R. (2005) Influence of heredity on dietary restraint, disinhibition, and perceived hunger in humans. *Nutr.* 21:446-455.

10. Stunkard, A.J., Messick, S. (1985) The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *J Psychosom Res.* 29:71-83.
11. Polivy, J., Coleman, J., Herman, C.P. (2005) The effect of deprivation on food cravings and eating behavior in restrained and unrestrained eaters. *Int J Eat Disord.* 38:301-309.
12. Coelho, J.S., Polivy, J., Herman, C.P. (2006) Selective carbohydrate or protein restriction: effects on subsequent food intake and cravings. *Appetite.* 47:352-360.
13. Soetens, B., Braet, C., Dejonckheere, P., Roets, A. (2006) ‘When suppression backfires’: The ironic effects of suppressing eating-related thoughts. *J of Health Psych.* 11:655-668.
14. O’Connell, C., Larkin, K., Mizes, J.S., Fremouw, W. (2005) The impact of caloric preloading on attempts at food and eating-related thought suppression in restrained and unrestrained eaters. *Int J Eat Disord.* 38:42-48.
15. Kirkmeyer, S.V., Mattes, R.D. (2000) Effects of food attributes on hunger and food intake. *Int J of Obes.* 24:1167-1175.

CHAPTER 2

DIETARY INTAKE ESTIMATIONS AND ANTHROPOMETRIC MEASUREMENTS IN

HEALTHY YOUNG ADULT WOMEN WITH DIFFERING EATING

CHARACTERISTICS

ABSTRACT

This study was performed to investigate differences in dietary intake variables and anthropometric measurements in healthy young adult women of healthy body mass index (BMI) with high and low scores of cognitive eating restraint (CER), disinhibition (DI), and hunger. Sixty-five healthy young adult women participated in this cross-sectional study in which the Eating Inventory was completed along with the Block Food Frequency Questionnaire, using standard procedures. Anthropometric measurements were taken using dual-energy X-ray absorptiometry. This research was conducted in the Bone Laboratory on the campus of the Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Independent *t*-tests, Pearson correlation coefficient analyses, and general linear regression models were used for statistical analysis. Results show that women with high CER scores ($n=32$; mean \pm SD CER score= 13.1 ± 2.4) consumed more fruits per day (2.4 ± 0.9 svg/d) compared to women with low CER scores ($n=33$; CER score= 4.5 ± 3.0 ; fruits= 1.8 ± 1.1 svg/d; $p<0.05$). Women with high hunger scores ($n=35$; hunger score= 7.5 ± 2.2) consumed less fruits per day (1.8 ± 0.9 svg/d) compared to women with low hunger scores ($n=30$; hunger score= 3.0 ± 1.1 ; fruits= 2.4 ± 1.1 svg/d; $p<0.05$). Women with high compared to low CER scores had higher body weight ($p<0.05$), BMI ($p<0.05$), fat mass ($p<0.05$), and body fat percentage ($p<0.05$), while women with high ($n=31$; DI score= 7.6 ± 2.5) compared to low ($n=34$; DI score= 2.9 ± 1.0) DI scores were taller ($p<0.05$). Hunger predicted estimated daily dietary intakes of total energy ($p<0.05$), protein ($p<0.01$), and fat ($p<0.01$), while CER ($p<0.05$) and DI ($p<0.05$) predicted estimated daily dietary fruit intake for all 65 women. Overall, eating characteristics can distinguish between some dietary intake patterns and anthropometric measurements in healthy young adult women. Hunger is a predictor of estimated energy, protein, and fat intake in these women.

INTRODUCTION

Cognitive eating restraint (CER), disinhibition (DI), and hunger are eating characteristics that have been linked to disturbed patterns of eating in studies designed to elucidate psychological attributes related to eating disorders (1, 2, 3). Cognitive eating restraint is the conscientious effort to restrict food intake to control or manipulate body weight (BW) to prevent weight gain. Disinhibition is the point at which restrained eating is consciously abandoned and eating commences to satiety. Hunger is the expression of the physiological sensation that drives food intake. These three factors – CER, DI, and hunger – have been extensively studied for their influence on food intake regulation in individuals with eating disorders (4, 5).

In today's obesity prone environment, a degree of CER may be desirable. With nearly 67% of the adult population in the United States being overweight (6), cognitive control over food intake is critical. Factors that control DI and hunger in relation to CER are important to understand, particularly in individuals of normal body weight so that overweight is prevented while eating disorders are avoided. Most studies of the three factors of CER, DI, and hunger have been conducted in populations of persons with established eating abnormalities (7, 8).

Therefore, the purpose of the current study was to investigate differences in dietary intake variables and anthropometric measurements in healthy young adult women of normal body mass index (BMI) with high and low scores of CER, DI, and hunger. In addition, relationships were examined between eating characteristics (i.e., CER, DI, and hunger), dietary intake variables, and anthropometric status, and predictors of dietary intake variables were explored. It was hypothesized that women with high compared to low CER, DI, and hunger scores would have higher estimated daily dietary intakes of total energy, protein, carbohydrate, fat, grains, vegetables, fruits, and oils and fats, as DI and hunger would override CER. In addition, it was

hypothesized that women with high compared to low CER; DI; and hunger scores would have greater BW, BMI, fat mass (FM), and body fat percentage (BF%) due to a culmination of years of DI and hunger overcompensating for CER, but no differences in age, body height, and lean body mass (LBM). Moreover, each eating characteristic was expected to be highly associated with all dietary intake variables and anthropometric measurements of BW, BMI, FM, and BF%, and each eating characteristic was hypothesized to predict each dietary intake variable.

PARTICIPANTS AND METHODS

This study was authorized by the Institutional Review Board for Research Involving Human Subjects at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Participants provided written informed consent before participation in any procedure.

Participants

Sixty-five women completed the study, which was advertised as a project on chronic dieting and bone health. Women were recruited by electronic mail notices, posted flyers, and word-of-mouth and resided in the local community and surrounding areas. Women were included if between 18 to 25 years of age, eumenorrheic, non-pregnant, non-lactating, without metabolic or endocrine disorder(s), including osteopenia and osteoporosis, and chronic disease(s). Exclusion criteria included BMI of <19 or >25, use of medication(s) to treat medical condition(s) or disease(s), diagnosed eating disorder(s), disruption of menstruation within the past 12 months, use of oral contraceptives for <18 months (if used), parity ≥ 1 , habitual use of tobacco products and alcohol within the past 12 months, and participation in >7 hours of hard and very hard physical activity per week during the past year.

Eating Characteristics

All women self-completed the Three-Factor Eating Questionnaire or Eating Inventory (EI) (8). The EI is a 51-item questionnaire that measures CER (21 items); DI (16 items); and hunger (14 items). Paper-and-pencil forms were completed after which an investigator scored each subscale (CER; DI; and hunger) of the EI according to standard guidelines (9). Women were categorized into high or low CER; DI; and hunger groups based on the median score for each subscale found in participants in the current study. The median split for CER was high CER >9 and low CER ≤ 9 ; DI was high DI >4 and low DI ≤ 4 ; and hunger was high hunger >4 and low hunger ≤ 4 .

Dietary Intake Estimation

In interview format, an investigator trained by a registered dietitian completed the Block Food Frequency Questionnaire with each participant. Frequency and quantity of food and beverage items consumed during the past year were queried. Two-dimensional pictures and three-dimensional food models were used during these interviews to facilitate accuracy in portion size estimation and consistency in estimation across participants. Questionnaires were analyzed by one investigator using the Block DietSYS software package (version 5.9,1999, Block Dietary Data Systems, Berkeley, CA) to produce estimated daily dietary intake of total energy (kcal/d); total protein (g/d), carbohydrate (g/d), and fat (g/d); and servings of grains (svg/d), vegetables (svg/d), fruits (svg/d), and oils and fats (svg/d).

Anthropometric Measurements

Women wore lightweight clothing and were shoeless during completion of anthropometric measurements. A calibrated electronic scale (Scaletronix, Wheaton, IL) was used to measure BW to the nearest 0.1 kg. A calibrated stadiometer (Detecto, Webb City, MO) was used to measure body height to the nearest 0.1 cm. Body mass index (kg/m^2) was calculated

by one investigator using each participant's weight and height data. Total body (TB) FM (kg), LBM (kg), and BF% were measured using dual-energy X-ray absorptiometry (DXA; version 8.25a, 2000, Whole Body Analysis Software, QDR4500A, Hologic Inc., Bedford, MA). One investigator conducted and analyzed all DXA scans. Quality control procedures for these body composition measurements were performed by weekly scanning of an external soft tissue bar and prior to any DXA scans. Test-retest reliability of this DXA has resulted in coefficient of variation for TB FM <1.8%, TB LBM <1.1%, and TB BF% <1.8% (10).

General Procedures

All women completed study procedures between the hours of 0700 to 0930. Women arrived in the laboratory in a fasted state (12 to 14 hr fast) and were provided breakfast foods and beverages after completion of the EI and anthropometric measurements. Urinary pregnancy tests (QuPID One-Step, Stanbio Labs, Boerne, TX) were completed before any DXA scan; all pregnancy tests were negative.

Statistical Analyses

Statistical analyses were performed with SPSS (version 10.0, SPSS, Inc., Chicago, IL). Descriptive statistics (mean±SD) were computed to describe participant characteristics of the entire sample (N=65) and by EI subscales (i.e., CER; DI; and hunger). Independent sample *t*-tests were performed to test for differences in variables between high and low CER groups; DI groups; and hunger groups. Pearson correlation analyses were performed to examine the bivariate relationship between the EI variables of CER; DI; and hunger and dietary intake and anthropometric variables for the entire sample. General linear regression analyses were performed with the entire sample to identify predictors of dietary intake variables, using CER;

DI; and hunger as independent variables. Statistical significance was set at $p < 0.05$ for all analyses.

RESULTS

Participant characteristics are presented in Table 1 for the entire sample and by high and low CER; DI; and hunger groups. These 65 women had anthropometric data in ranges considered normal for their ages.

Eating Characteristics

By study design, separation of women into high and low CER; DI; and hunger groups, based on median scores, resulted in significant differences in CER ($p < 0.0001$); DI ($p < 0.0001$); and hunger ($p < 0.0001$) scores between groups (Table 1). Cognitive eating restraint score was independent of DI and hunger scores, and DI score was independent of CER and hunger scores. However, high hunger score existed with high DI score (Table 1).

Dietary Intake Estimation

Statistically significant differences in estimated daily dietary intakes of total energy, total protein, total carbohydrate, and total fat did not exist between women with high compared to low CER scores. Intake of daily servings of grains, vegetables, and oils and fats also did not differ between women with high versus low CER scores. However, women with high CER score consumed more (2.4 ± 0.9 svg/d) fruits per day compared to women with low CER score (1.8 ± 1.1 svg/d) ($p < 0.05$).

When comparing women with high DI score to women with low DI score, there were no statistically significant differences between any estimated dietary intake variables (Table 1). Similarly, there were no statistically significant differences in estimated dietary intake variables

between women with high and low hunger scores, except for estimated intake of fruits ($p<0.05$) (Table 1). Women with high hunger score consumed significantly fewer (1.8 ± 0.9 svg/d) servings of fruits each day compared to women with low hunger score (2.4 ± 1.1 svg/d).

Anthropometric Measurements

Age was not significantly different between women in the high versus low CER; DI; and hunger groups (Table 1). Although BW ($p<0.05$), BMI ($p<0.05$), FM ($p<0.05$), and BF% ($p<0.05$) were significantly greater in women with high CER score compared to low CER score, body height and LBM did not differ between eating restraint groups (Table 1). Women with high DI score were significantly taller ($p<0.05$) compared to women with low DI score; however, BW, BMI, LBM, FM, and BF% did not significantly differ between DI groups (Table 1). Statistically significant differences in body height, BW, BMI, LBM, FM, and BF% between women with high and low hunger scores were not found (Table 1).

Table I. Cognitive eating restraint, disinhibition, and hunger scores for all women and groups of women based on median splits

Variable	Mean \pm SD						
	All women (N=65)	Cognitive eating restraint		Disinhibition		Hunger	
		Low score (n=33)	High score (n=32)	Low score (n=34)	High score (n=31)	Low score (n=30)	High score (n=35)
Cognitive eating restraint	8.7 \pm 5.1	4.5 \pm 3.0	13.1 \pm 2.4****	8.4 \pm 4.7	9.1 \pm 5.6	9.4 \pm 5.0	8.2 \pm 5.2
Disinhibition	5.2 \pm 3.0	4.9 \pm 2.8	5.5 \pm 3.2	2.9 \pm 1.0	7.6 \pm 2.5****	3.9 \pm 2.4	6.3 \pm 3.1***
Hunger	5.4 \pm 2.9	5.7 \pm 3.1	5.1 \pm 2.6	4.8 \pm 2.6	6.0 \pm 3.0	3.0 \pm 1.2	7.5 \pm

							2.2****
Energy (kcal/d)	2102 ± 679	2180 ± 700	2022 ± 657	2150 ± 688	2050 ± 676	2031 ± 696	2164 ± 668
Protein (g/d)	74 ± 28	73 ± 23	74 ± 32	76 ± 30	72 ± 26	68 ± 26	79 ± 29
Carbohydrate (g/d)	292 ± 92	295 ± 93	288 ± 93	302 ± 96	281 ± 88	291 ± 95	292 ± 92
Fat (g/d)	74 ± 29	79 ± 30	69 ± 27	74 ± 28	74 ± 29	69 ± 28	78 ± 29
Grains (svg/d)	2.8 ± 1.1	2.7 ± 1.1	2.9 ± 1.0	3.0 ± 1.1	2.7 ± 1.0	2.9 ± 1.1	2.8 ± 1.0
Vegetables (svg/d)	2.1 ± 1.2	2.1 ± 1.2	2.2 ± 1.3	2.3 ± 1.3	2.0 ± 1.2	2.3 ± 1.3	2.0 ± 1.2
Fruits (svg/d)	2.1 ± 1.1	1.8 ± 1.1	2.4 ± 0.9*	2.3 ± 1.2	1.9 ± 0.8	2.4 ± 1.1	1.8 ± 0.9*
Oils and fats (svg/d)	2.6 ± 1.3	2.8 ± 1.4	2.5 ± 1.2	2.6 ± 1.4	2.6 ± 1.3	2.6 ± 1.4	2.6 ± 1.3
Age (yr)	20.4 ± 2.4	20.1 ± 2.4	20.7 ± 2.3	20.1 ± 2.2	20.7 ± 2.5	20.2 ± 2.4	20.5 ± 2.4
Height (cm)	163.8 ± 5.9	163.6 ± 6.1	164.0 ± 5.8	162.8 ± 6.2	164.9 ± 5.5*	163.3 ± 6.2	164.2 ± 5.7
Weight (kg)	58.7 ± 6.6	56.8 ± 6.4	60.6 ± 6.3*	57.9 ± 6.2	59.5 ± 7.0	59.0 ± 7.6	58.3 ± 5.6
Body mass index (kg/m ²)	21.7 ± 2.3	21.1 ± 2.2	22.3 ± 2.3	21.3 ± 2.3	22.1 ± 2.3	21.8 ± 2.8	21.6 ± 1.8
Lean body mass (kg)	43.3 ± 4.1	42.8 ± 3.8	43.9 ± 4.4	42.9 ± 3.9	43.8 ± 4.3	43.2 ± 4.3	43.5 ± 4.0
Fat mass (kg)	15.7 ± 4.1	14.6 ± 3.8	17.0 ± 4.2*	15.2 ± 3.8	16.1 ± 4.4	15.8 ± 4.5	15.6 ± 3.8
Body fat							

percentage (%)	26.5 ± 4.8	25.1 ± 4.1	27.9 ± 5.1*	26.5 ± 4.8	26.6 ± 4.8	27.0 ± 5.2	26.1 ± 4.4
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* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; **** $p < 0.0001$

Correlation and General Linear Regression Analyses

Pearson correlation coefficients indicated that CER score was not significantly related to DI or hunger score; however, DI score was significantly and positively associated with hunger score ($r=0.45$, $p < 0.0001$) for all women ($N=65$). Cognitive eating restraint score was significantly and negatively related to estimated daily dietary intake of total fat ($r=-0.24$, $p < 0.05$) and positively related to intakes of grains ($r=0.26$, $p < 0.05$) and fruits ($r=0.25$, $p < 0.05$) (Table 2). Disinhibition score was significantly and negatively associated with estimated daily dietary intake of fruits ($r=-0.27$, $p < 0.05$). Hunger score was significantly and positively related to estimated daily dietary intakes of total energy ($r=0.30$, $p < 0.05$), protein ($r=0.35$, $p < 0.01$), and fat ($r=0.36$, $p < 0.01$) (Table 2).

Cognitive eating restraint score for all 65 women was significantly and positively associated with BW ($r=0.29$, $p < 0.05$), BMI ($r=0.31$, $p < 0.05$), and FM ($r=0.26$, $p < 0.05$). Disinhibition and hunger scores were not significantly associated with any of these anthropometric variables (Table 2).

Table II. Pearson correlation coefficient for the relationship between mean CER, DI, and hunger scores, and mean dietary intake and anthropometric measurements

Variable	Cognitive eating restraint score	Disinhibition score	Hunger score
Cognitive eating restraint score	1.00		
Disinhibition score	0.13	1.00	
Hunger score	-0.12	0.45****	1.00
Energy (kcal/d)	-0.18	0.04	0.30*
Protein (g/d)	0.02	0.12	0.35**
Carbohydrate (g/d)	-0.11	-0.06	0.19
Fat (g/d)	-0.24*	0.16	0.36**
Grains (svg/d)	0.26*	-0.10	0.01
Vegetables (svg/d)	0.14	-0.19	-0.09
Fruits (svg/d)	0.25*	-0.27*	-0.19
Oils and fats (svg/d)	-0.23	0.18	0.14
Age (yr)	0.17	0.21	0.05
Height (cm)	0.05	0.17	0.08
Weight (kg)	0.29*	0.15	0.08
Body mass index (kg/m ²)	0.31*	0.21	0.13
Lean body mass (kg)	0.18	0.20	0.12
Fat mass (kg)	0.26*	0.09	0.09
Body fat percentage (%)	0.23	-0.03	0.01

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; **** $p < 0.0001$

General linear regression analyses indicated that hunger score was the only significant predictor of estimated daily dietary intakes of total energy ($p<0.05$), total protein ($p<0.01$), and total fat ($p<0.01$) (Table 3). Cognitive eating restraint ($p<0.05$) and DI ($p<0.05$) scores predicted estimated daily dietary intake of fruits for all 65 women. Although these factors were statistically significant, CER, DI, and hunger scores explained only a small percentage of the variance in these dietary intake variables (Table 3). None of the eating characteristics from the EI were able to significantly predict estimated daily dietary intakes of carbohydrate, grains, vegetables, and oils and fats.

Table III. Group Regression Analysis

Variable	Predictor	R2	Model adjusted R2	Unstandardized $\beta \pm$ standard error	Standardized β	Predictor P-value	Model P-value
Total energy (kcal/d)	Constant			1.737 \pm 0.183		<0.0001	
	Hunger	0.09	0.08	0.071 \pm 0.030	0.301	0.02	0.02
Total protein (g/d)	Constant			0.055 \pm 0.007		<0.0001	
	Hunger	0.13	0.11	0.003 \pm 0.001	0.354	<0.01	0.006
Total fat (g/d)	Constant			0.057 \pm 0.007		<0.0001	
	Hunger	0.13	0.12	0.003 \pm 0.001	0.363	<0.01	0.005

	Constant						
	Cognitive eating restraint score	0.07		2.095 ± 0.309		<0.0001	
Fruits (svg/d)	Disinhibition score	0.16	0.13	0.061 ± 0.025	0.307	<0.05	
				-0.102 ± 0.042	-0.298	<0.05	0.009

DISCUSSION

In support of the hypothesis, women with high CER score had significantly higher fruit intake compared to women with low CER score. However, no other dietary intake variable was significantly higher in the high compared to low CER; DI; and hunger groups, as anticipated. In fact, fruit intake was significantly lower in women with high hunger score compared to low hunger score. Consistent with hypotheses, women with high CER score had greater BW, BMI, FM, and BF% than women with low CER score. Contrary to hypothesized, no other differences in anthropometric measurements were found between these women with high and low CER; DI; and hunger scores, except for greater height in women with high compared to low DI scores. Eating characteristics were associated with some, but not all (as hypothesized), dietary intake variables and anthropometric variables of BW, BMI, FM, and BF%. Cognitive eating restraint score predicted total fat intake, DI predicted intake of fruits, and hunger predicted total energy, protein, and fat intakes.

When comparing our results to another study, we found an interesting relationship. In a randomized controlled study, premenopausal women who were overweight and obese consumed

either a low-carbohydrate, high-protein (LCHP) diet or a high-carbohydrate, low-fat (HCLF) diet for BW loss (11). Women in the LCHP diet group reported a decrease in the EI hunger score, while women in the HCLF diet group reported no change in hunger (a high hunger score at baseline) during the 6-week weight loss intervention. Scores for CER increased after one week (compared to baseline scores) in both the LCHP and HCLF diet groups, indicating that all women were consciously restraining their food intake. Comparison to the current study is interesting, because healthy young adult women in the present study with high CER scores reported high fruit intake, while women with high hunger scores reported low fruit intake. Hunger may be best satisfied with high-protein, high-fat foods rather than high-carbohydrate foods such as fruits. Higher fruit intake by women with high CER scores may not be producing greater satiety. Regression analyses of the current study support this supposition as hunger score for all women did not predict carbohydrate or fruit intakes. The greater the hunger score, the greater the total energy intake, likely met by protein and fat intakes.

In contrast to our study's findings, Coelho and colleagues (2006) examined cravings in restrained and unrestrained eaters to investigate the effects of a 3-day restriction period of high-carbohydrate or high-protein foods on subsequent food intake and cravings. There was an increase in cravings for the specific food that was restricted, either carbohydrate or protein. Once allowed to consume the food for which they were restricted, participants in the carbohydrate-restricted group consumed a larger amount of the restricted food, compared to the protein-restricted group who only showed increased cravings and not increased consumption of the restricted food. If one assumes that cravings lead to hunger, results of the current study, show an opposite effect. Hunger significantly predicts protein intake, but not carbohydrate intake. However, Coelho and coworkers (2006) showed an increase in cravings, or hunger, for

both carbohydrate and protein, yet only the carbohydrate-restricted participants, but not the protein-restricted participants, actually consumed more food. The current study suggests that individuals with high CER should have had a higher craving and hunger for protein, rather than for carbohydrates.

Limitations to the present study existed. Information and measurements from participants were limited due to data being pulled from previous study. In addition, the accuracy of responses to the EI and Block Food Frequency Questionnaire was dependent upon participant integrity and the assumption that each participant responded in an honest fashion. The sample size for the study was small, women were from a limited geographic region, and only women were included in the study. Larger studies are warranted that include women from a wider age range, men, and additional geographic regions.

CONCLUSIONS AND IMPLICATIONS

In healthy young adult women, eating characteristics can distinguish between some dietary intake patterns and anthropometric measurements. Cognitive eating restraint and DI scores predicted intake of fruits; hunger score predicted total energy, protein, and fat intakes in the whole sample of women. These results can be used as a guide to show why individuals choose certain foods and how it is related to BW, FM, and BF%. Knowing this, clinicians can help those practicing restraint to lose or maintain BW and help individuals make the best food choices when hunger strikes or when an individual feels the need to eat when DI occurs. Choosing healthier forms of energy, carbohydrate, protein, and fat leads to a change in overall diet, which in turn leads to a healthier lifestyle. Preventing unhealthy eating habits may lead to fewer cases of obesity and other eating disorders.

REFERENCES

1. Coelho, J.S., Polivy, J., Herman, C.P. (2006) Selective carbohydrate or protein restriction: effects on subsequent food intake and cravings. *Appetite*. 47:352-360.
2. Dykes, J., Brunner, E.J., Martikainen, P.T., Wardle, J. (2004) 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*. 28:262-268.
3. Soetens, B., Braet, C., Dejonckheere, P., Roets, A. (2006) ‘When suppression backfires’: The ironic effects of suppressing eating-related thoughts. *J of Health Psych*. 11:655-668.
4. Kirschenbaum, D.S., Dykman B.M. (1991) Disinhibited eating by resourceful restrained eaters. *J Abnorm Psychol*. 100:227-230.
5. Steere, J., Cooper, P.J. (1993) The effects on eating of dietary restraint, anxiety, and hunger. *Int J Eat Disord*. 13:211-219.
6. “National Center for Health Statistics.” Centers for Disease Control and Prevention. 2008.14 July 2008. <<http://www.cdc.gov/nchs/fastats/overwt.htm>>.
7. Ouwens, M.A., van Strien, T., van der Staak, C.P.F. (2003) Tendency toward overeating and restraint as predictors of food consumption. *Appetite*. 40:291-298.
8. Stunkard, A.J., Messick, S. (1985) The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *J Psychosom Res*. 29:71-83.
9. Stunkard, A.J., Messick, S. (1988) *Eating Inventory Manual*. San Antonio, TX, Psychological Corporation, Harcourt Brace.
10. Beiseigel, J.M. (2003) Bone mineral density and biomarkers of bone turnover in young-adult females with and without cognitive eating restraint. Dissertation submitted to the faculty of Virginia Polytechnic Institute and State University.

11. Nickols-Richardson, S.M., Coleman, M.D., Volpe J.J., Hosig, K.W. (2005) Perceived hunger is lower and weight loss is greater in overweight premenopausal women consuming a low-carbohydrate/high-protein vs high-carbohydrate/low-fat diet. *J Am Diet Assoc.* 105:1433-1437.

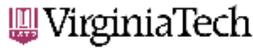
CHAPTER 3

CONCLUSIONS AND FUTURE DIRECTIONS

Overall, the separation of women into high and low CER; DI; and hunger scores resulted in significant differences in CER; DI; and hunger scores between groups. A high hunger score existed with high DI score. Women with high CER score had significantly higher fruit intake compared to women with low CER score. Fruit intake was significantly lower in women with high hunger score compared to low hunger score. Women with high CER score had greater BW, BMI, FM, and BF% than women with low CER score. In the whole sample of women, CER and DI scores predicted intake of fruits, while hunger score predicted total energy, protein, and fat intakes. Results indicate an unbalanced diet, which could be causing an increase in BW, BMI, FM, and BF% in some of the women.

Further studies should be conducted to examine data and outcomes similar to this study. Through this, conclusions can be made to determine whether these results are found true in other groups of individuals in a broader area. Using the results of this study, future studies can be conducted using these particular foods associated with CER score (fat, grains, and fruit), DI (fruit), and hunger as a predictor of energy, protein, and fat intakes. The level of desire for each food can also be measured to determine preferred food choices. Future studies might also look into the duration an individual practices these eating habits before obesity or another eating disorder results. Other future studies might examine individuals with eating disorders and their level of CER, DI, and hunger might give us a better look at the relationship between dietary intake variables and anthropometric status. Another future study might look into the relationship between high vs. low attitudes and how well they regulate body composition.

APPENDIX A



Office of Research Compliance
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FWA000005721 expires 12/20/10
IRB # is IRB00000667

DATE: June 4, 2008

MEMORANDUM

TO: William G. Herbert
Dana McGeorge
Sharon M. Nickols-Richardson

Approval date: 6/4/2008
Continuing Review Due Date: 5/20/2009
Expiration Date: 6/3/2009

FROM: David M. Moore 

SUBJECT: IRB Expedited Approval: "Food Intake Patterns and Diet Quality in Young-Adult Women with Cognitive Eating Characteristics", IRB # 08-342

This memo is regarding the above-mentioned protocol. The proposed research is eligible for expedited review according to the specifications authorized by 45 CFR 46.110 and 21 CFR 66.110. As Chair of the Virginia Tech Institutional Review Board, I have granted approval to the study for a period of 12 months, effective June 4, 2008.

As an investigator of human subjects, your responsibilities include the following:

1. Report promptly proposed changes in previously approved human subject research activities to the IRB, including changes to your study forms, procedures and investigators, regardless of how minor. The proposed changes must not be initiated without IRB review and approval, except where necessary to eliminate apparent immediate hazards to the subjects.
2. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.
3. Report promptly to the IRB of the study's closing (i.e., data collecting and data analysis complete at Virginia Tech). If the study is to continue past the expiration date (listed above), investigators must submit a request for continuing review prior to the continuing review due date (listed above). It is the researcher's responsibility to obtain re-approval from the IRB before the study's expiration date.
4. If re-approval is not obtained (unless the study has been reported to the IRB as closed) prior to the expiration date, all activities involving human subjects and data analysis must cease immediately, except where necessary to eliminate apparent immediate hazards to the subjects.

Important:

If you are conducting federally funded non-exempt research, please send the applicable OSP/grant proposal to the IRB office, once available. OSP funds may not be released until the IRB has compared and found consistent the proposal and related IRB application.

cc: File
Department Reviewer: Kathy Hosig

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REFERENCES

- Beiseigel, J.M. (2003) Bone mineral density and biomarkers of bone turnover in young-adult females with and without cognitive eating restraint. Dissertation submitted to the faculty of Virginia Polytechnic Institute and State University.
- Coelho, J.S., Polivy, J., Herman, C.P. (2006) Selective carbohydrate or protein restriction: effects on subsequent food intake and cravings. *Appetite*. 47:352-360.
- de Castro, J.M., Lilenfeld, L.R.R. (2005) Influence of heredity on dietary restraint, disinhibition, and perceived hunger in humans. *Nutr*. 21:446-455.
- Dykes, J., Brunner, E.J., Martikainen, P.T., Wardle, J. (2004) 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*. 28:262-268.
- Eldredge, K.L. (1993) An investigation of the influence of dieting and self-esteem on dietary disinhibition. *Int J Eat Disord*. 13:57-67.
- Kirkmeyer, S.V., Mattes, R.D. (2000) Effects of food attributes on hunger and food intake. *Int J of Obes*. 24:1167-1175.
- Kirschenbaum, D.S., Dykman B.M. (1991) Disinhibited eating by resourceful restrained eaters. *J Abnorm Psychol*. 100:227-230.
- Lowe, M.R. (1995) Restrained eating and dieting: replication of their divergent effects on eating regulation. *Appetite*. 25:115-118.
- Lowe, M.R., Maycock, B. (1988) Restraint, disinhibition, hunger and negative affect eating. *Addict Behav*. 13:369-377.
- “National Center for Health Statistics.” Centers for Disease Control and Prevention. 2008.14 July 2008. <<http://www.cdc.gov/nchs/fastats/overwt.htm>>.

- Nickols-Richardson, S.M., Coleman, M.D., Volpe J.J., Hosig, K.W. (2005) Perceived hunger is lower and weight loss is greater in overweight premenopausal women consuming a low-carbohydrate/high-protein vs high-carbohydrate/low-fat diet. *J Am Diet Assoc.* 105:1433-1437.
- O'Connell, C., Larkin, K., Mizes, J.S., Fremouw, W. (2005) The impact of caloric preloading on attempts at food and eating-related thought suppression in restrained and unrestrained eaters. *Int J Eat Disord.* 38:42-48.
- Ouwens, M.A., van Strien, T., van der Staak, C.P.F. (2003) Tendency toward overeating and restraint as predictors of food consumption. *Appetite.* 40:291-298.
- Polivy, J., Coleman, J., Herman, C.P. (2005) The effect of deprivation on food cravings and eating behavior in restrained and unrestrained eaters. *Int J Eat Disord.* 38:301-309.
- Rogers, P.J., Hill, A.J. (1989) Breakdown of dietary restraint following mere exposure to food stimuli: interrelationships between restraint, hunger, salivation, and food intake. *Addict Behav.* 14:387-397.
- Smith, C.F., Geiselman, P.J., Williamson, D.A., Champagne, C.M., Bray, G.A., Ryan, D.H. (1998) Association of dietary restraint and disinhibition with eating behavior, body mass, and hunger. *Eat Weight Disord.* 3:7-15.
- Soetens, B., Braet, C., Dejonckheere, P., Roets, A. (2006) 'When suppression backfires': The ironic effects of suppressing eating-related thoughts. *J of Health Psych.* 11:655-668.
- Steere, J., Cooper, P.J. (1993) The effects on eating of dietary restraint, anxiety, and hunger. *Int J Eat Disord.* 13:211-219.
- Stunkard, A.J., Messick, S. (1985) The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *J Psychosom Res.* 29:71-83.

Stunkard, A.J., Messick, S. (1988) Eating Inventory Manual. San Antonio, TX, Psychological Corporation, Harcourt Brace.