Negative eating and body attitudes are associated with increased daytime ambulatory blood pressure in healthy young women

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ABSTRACT

Background and objective: Various psychosocial stressors have been associated with increased ambulatory blood pressure (ABP) and cortisol in middle-aged women. Given that many young women report negative eating/body attitudes, we examined whether these attitudes were associated with cortisol and ABP in a cross-sectional study.

Methods: 120 non-obese, healthy women aged 19–35 completed questionnaires, measurement of 24-h urinary free cortisol (UFC), and 12-h daytime ABP. Main and interactive effects of eating/body attitudes (average Z-score of Eating/body attitude questionnaires split at zero) and current weight loss effort (yes/no) were examined by General Linear Modeling adjusted for covariates.

Results: Women with negative eating/body attitudes were more likely to report current weight loss attempts (63% versus 21%, p<0.001). Eating/body attitudes or weight loss effort did not have main or interactive effects on age, physical activity level, energy intakes, general stress (average Z-score of psychosocial stress questionnaires) or UFC. Body mass index was higher among those currently trying to lose weight but did not differ by eating/body attitudes. Significant main effects of eating/body attitudes were detected on ABP: diastolic ABP (73.2±0.7 versus 70.3±0.8 mm Hg, p=0.011) and mean arterial pressure (87.3±0.7 versus 84.9±0.8 mm Hg, p=0.032) were higher among women with negative versus neutral/positive eating/body attitudes. There were no weight loss effort main effects for ABP, or weight loss effort-by-Eating/body attitude interactions.

Conclusion: This exploratory study suggests that more negative eating/body-related attitudes may be modestly associated with higher ABP independent of weight loss effort.

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1. Introduction

For more than 100 years, cardiovascular disease (CVD) has been the leading cause of death among American adults (Lloyd-Jones et al., 2005). High blood pressure (BP) or hypertension (systolic BP >140 or diastolic BP >90 mm Hg) is one of the strongest CVD risk factors (Chobanian et al., 2003), and affects nearly one in three Americans (Lloyd-Jones et al., 2008). Although the prevalence of hypertension among young adults is low (Lloyd-Jones et al., 2008), BP while young is associated with BP later in life (Chen and Wang, 2008). Additionally, young adult BP is positively correlated with atherosclerosis (Berenson et al., 1998), and also predicts carotid intima-media thickness (Johnson et al., 2007), another CVD risk marker. Furthermore, young adults with prehypertension (systolic BP 120–139 or diastolic BP 80–89 mm Hg) were shown to have an increased risk of coronary calcium atherosclerosis 15–20 years later, after adjustment for other risk factors including current BP (Pletcher et al., 2008). Thus, BP level even in the young and healthy is related to future CVD risk, accentuating the need to fully understand factors that influence BP in this population.

Evidence is accumulating that the subjective experience of stress may influence cardiovascular outcomes, mediated by the physiological stress response (Dimsdale, 2005). When a stressor is perceived, the central nervous system and peripheral components are activated, seeking to maintain homeostasis via adaptive responses to deal with the perceived threat (McEwen, 2007). Two allostatic mediators of the stress response are activation of the hypothalamus–pituitary–adrenal axis, resulting in increased secretion of the stress hormone cortisol, and stimulation of the sympathetic nervous system which causes BP to rise (McEwan, 2007). Increased cortisol and BP are beneficial during acute stress; however, continuous elevations can lead to allostatic overload causing “wear-and-tear” on body systems (McEwan, 2007). High cortisol levels may also be independently associated with increased BP (Black, 2006).

Abbreviations: ABP, ambulatory blood pressure; ABP-activity, continuous score for activity during ABP; BMI, body mass index; BP, blood pressure; CVD, cardiovascular disease; SD, standard deviation; TFEQ, Three Factor Eating Questionnaire; UBC, University of British Columbia; UFC, 24-h urinary free cortisol.

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Exposure to laboratory stressors clearly elevates BP and cortisol in otherwise healthy adults (Chida and Hamer, 2008). It is less clear whether chronic psychosocial stressors of limited salience are sufficient to increase BP and cortisol (Dimsdale, 2008). When evaluating the physiological effects of chronic stress, the measurement of clinical BP may be of limited relevance. Perceived stress that is encountered over the course of the day, rather than discrete events or laboratory tasks, may not be captured by a single measurement of BP. Therefore, ambulatory BP (ABP) monitoring while performing the activities of daily living may be a more sensitive tool. After controlling for CVD risk factors including clinical BP, ABP is independently associated with cardiovascular morbidity and mortality (Dolan et al., 2005; Hansen et al., 2006; Sega et al., 2005).

Occupational stressors have received the most attention in the investigation of stress, cortisol and ABP. The results among middle-aged women are inconsistent, such that some, but not all studies report higher ABP and cortisol in women reporting higher occupation-related stress (Brown et al., 2003; James and Bovbjerg, 2001; Goldstein et al., 1999; Kario et al., 2002; Kunz-Ebrecht et al., 2004; Riese et al., 2004; Steptoe et al., 2000; Steptoe and Willemsen, 2004). It could be that women experience other stressors that either interact with work stress or are more relevant to stress perception (Brown et al., 2006; Gallo et al., 2004; Marco et al., 2000). Other chronic stressors associated with ABP and cortisol identified among women include financial stress (Grossi et al., 2001; Steptoe et al., 2005), family/marital stress (Brady and Matthews, 2006; Brisson et al., 1999; Kario et al., 2002; Powell et al., 2002) and lack of social support (Piferi and Lawler, 2006; Steptoe, 2000).

Given that the majority of women, irrespective of relative weight status, report negative attitudes towards food and body (Garner, 1997; McLean and Barr, 2003; Tiggemann, 2004), we and others have hypothesized that eating/body attitudes may be subtle but chronic daily stressors sufficient to activate the physiological stress response, and could be associated with negative health outcomes including menstrual cycle disturbances (Barr et al., 1994a,b; McLean and Barr, 2003; Schweiger et al., 1992; Vescovi et al., 2008) and reduced bone mass or density (Racon et al., 2004; Barrack et al., 2008; McLean et al., 2001a; Van Loan and Keim, 2000; Vescovi et al., 2008). Several studies have detected associations between negative eating/body attitudes and cortisol in healthy women (Anderson et al., 2002; McLean et al., 2001b; Putterman and Linden, 2006; Koo-Loeb et al., 2000; Rideout et al., 2006; Rutters et al., 2009; Therrien et al., 2008). Most work in the area of eating/body stress has employed the Three Factor Eating Questionnaire (TFEQ) Restraint subscale to assess cognitive dietary restraint: the perception that one is constantly monitoring and attempting to limit food intake in an effort to achieve or maintain a perceived ideal body weight (Stunkard and Messick, 1985). Generally, there are no or only minimal differences by level of dietary restraint in women's self-reported energy intakes, relative weight, weight changes or dieting behavior (Lowe et al., 2006; McLean and Barr, 2003; Stice et al., 2007). This suggests that some negative eating/body attitudes are not necessarily indicative of dieting or disordered eating behaviors. Taken together, these studies also support the idea that the experience of negative eating/body attitudes could be associated with the physiological stress response.

Therefore, given that chronic psychosocial stressors are capable of elevating ABP in healthy middle-aged women (Brady and Matthews, 2006; Brisson et al., 1999; Brown et al., 2006; James and Bovbjerg, 2001; Kario et al., 2002; Marco et al., 2000; Piferi and Lawler, 2006; Powell et al., 2002; Riese et al., 2004; Steptoe, 2000; Steptoe and Willemsen, 2004) and that negative eating/body attitudes are common among women (Garner, 1997; McLean and Barr, 2003; Tiggemann, 2004), it is reasonable to postulate that eating/body attitudes may be a source of subtle but chronic stress with the potential to elevate BP. This relationship could be most evident among university-aged women, since others stressors (i.e. occupational, family) would be less significant for most. Thus, the objective of this study was to examine whether healthy, non-obese young women with negative versus neutral/positive eating/body attitudes had higher daytime ABP and 24-h urine free cortisol (UFC). To fully conceptualize the experience of eating/body stress, several body image and eating attitude questionnaires which have previously been associated with cortisol (Anderson et al., 2002; McLean et al., 2001b; Putterman and Linden, 2006; Rideout et al., 2006; Rutters et al., 2009; Therrien et al., 2008) were included because we hypothesized that they may also be associated with BP, an additional health outcome of chronic physiological stress.

In order to differentiate stress that is specific to eating and body image from “general stress”, chronic perceived stress and stressful events for the days of cortisol and ABP monitoring were assessed. We hypothesized that those with negative eating/body attitudes were not highly stressed people in general, but experienced stress specific to food and perceived weight. Finally, in order to distinguish between the potential effect of cognitive versus behavioral aspects of eating/body attitudes, current weight loss effort was also examined. We hypothesized that cortisol and ABP would not differ by weight loss effort, supporting our hypothesis that it is the subjective experience of chronic stress related to food and weight, rather than behaviors, that are associated with negative health outcomes.

2. Methods and materials

2.1. Participants

Potential participants were recruited from University of British Columbia (UBC) classes and the community between August and December 2006 for a 2-year bone density study. Eligibility was assessed by telephone interview in 148 interested women. Criteria included: age 19–35, no pregnancy/breastfeeding currently or within 12 months, regular menses (self-reported menses every 21–35 days in the previous ≥6 months), non-obese (self-reported body mass index (BMI) 18–30 kg/m²), consistent sleep patterns (arise and retire at approximately the same time most days) and absence of medical conditions (current or previous diagnosis of eating disorder, polycystic ovarian syndrome, Cushing’s syndrome, inflammatory conditions, hypertension, hyperthyroidism or hirsutism) or use of medications (oral contraceptives, progesterone or glucocorticoids currently or within the past 6 months) that could affect study variables. Of the 142 eligible women screened, 140 were oriented to the study. Data collection for the cross-sectional study presented here occurred 6–12 months following enrolment. During that time interval, seven participants moved, four no longer wanted to participate and two became ineligible. Results are reported for the 120 women with complete data. The study protocol was approved by the university’s Clinical Research Ethics Board, and written informed consent was obtained from all participants. Participants were provided with travel compensation and a $30 gift card for their participation.

2.2. Procedure

Participants met with an investigator at UBC for study orientation. A questionnaire package was given to complete at home which included a food frequency questionnaire and validated self-report instruments (described below), as well as questions to elicit demographic information and weight loss effort. Height and weight were measured in duplicate. From these data, BMI was calculated.

Participants were fitted with an ABP monitor including demonstration of cuff placement on the non-dominant arm over the brachial artery. A sample reading was performed to familiarize them with the process. Monitoring for 12 h was completed within three days on a “normal day”, avoiding any unusual physical or mental stresses, or heavy physical activity while wearing the monitor. Detailed written...
instructions similar to those provided verbally were given for review prior to starting the procedure. The monitor was programmed to take blinded measurements of ABP and heart rate every 30 min. Participants were instructed to keep their arm still during readings and, if possible, to be seated. If there was too much movement, the monitor was programmed to abort and re-try 1 min later. Immediately after each reading, participants recorded their concurrent activity in a provided diary. After 12 h, participants removed the monitor and completed the Daily Stress Inventory (Brantley et al., 1987).

Materials and oral and written instructions for home completion of a 24-h urine collection were reviewed. Participants were instructed to complete the urine collection within several weeks of the meeting, on a different “normal day”, after reviewing written instructions. On the day of collection, participants discarded their first urine void, recorded the time this occurred and then collected all subsequent voids for 24 h including a void at the recorded time the following morning. After their last void, participants completed the Daily Stress Inventory (Brantley et al., 1987).

2.3. Questionnaires

2.3.1. Eating and body attitudes

A large number of psychometric scales have been developed to assess eating/body attitudes (Gorman and Allison, 1995). The purpose of this exploratory study was to look at eating/body attitudes from a global perspective rather than focusing on specific eating and/or body related traits. Therefore, seven questionnaires/subscales relating to similar yet specific eating/body attitudes that are frequently reported in the literature were employed. As these questionnaires are highly intercorrelated (Garner, 1991; Gorman and Allison, 1995), and there is little justification to focus on one measure over another, we calculated a single standardized “eating/body attitude” Z-score.

The scales used in this study included the TFEQ, which pertains to three dimensions of eating attitudes: Cognitive Dietary Restraint, the perception that one is constantly monitoring and attempting to limit food intake to achieve a perceived ideal body weight; Disinhibition, which is the tendency to overeat when restraint is removed; and Hunger, which assesses susceptibility to hunger (Stunkard and Messick, 1985). Two subscales from the Eating Disorders Inventory were included: Drive for Thinness with higher scores indicating extreme concern with weight, dieting and the intense pursuit of thinness, and Bulimia which assesses one’s tendency to think about and engage in uncontrolled overeating (Garner, 1991). The shortened Body Shape Questionnaire was used to measure participants’ body dissatisfaction caused by feelings of being fat (Evans and Dolan, 1993). The Beliefs About Appearance Scale assesses the degree of agreement with beliefs about the perceived importance of appearance for relationships, achievement, self-view and feelings (Spangler and Stice, 2001). These beliefs are thought to underlie the desire to restrict eating, criticize the body and focus on appearance-related stimuli (Spangler and Stice, 2001).

To calculate the eating/body attitude Z-score, Z-scores were initially calculated for each questionnaire or subscale ([participant score – questionnaire mean]/questionnaire SD). The Z-scores were then summed and divided by seven (the number of questionnaires/subscales included) to yield the eating/body attitude Z-score. Because higher scores on the eating/body attitude questionnaires reflect more negative eating/body attitudes, the signs of the Z-scores were reversed so that negative (Z-score < 0) or neutral/positive (Z-score ≥ 0) attitudes towards food and body.

2.3.2. General stress

The Perceived Stress Scale was used to evaluate participants’ perception of stress during the previous month (Cohen et al., 1983). To account for everyday minor stressful events, the Daily Stress Inventory (Brantley et al., 1987) was completed after ABP and cortisol assessments. This instrument includes two subscales, Frequency and Impact. From these three questionnaires/subscales, a single standardized “general stress” Z-score was calculated as described above for eating/body attitudes. Higher general stress Z-scores reflect higher levels of perceived psychosocial stress.

2.3.3. Weight loss effort

Participants were asked “are you currently trying to lose weight?” and grouped as those reporting and not reporting current weight loss attempts. To determine energy intake, the Diet History Questionnaire (v.1, National Cancer Institute, 2002) was completed. Scannable questionnaires were analyzed with a Canadian version of the program (Csizmadia et al., 2007). All reported energy intakes were within the range considered biologically plausible (600–3500 kcal).

2.4. Urine analyses

At the Vancouver General Hospital Laboratory, 24-h urine volume was measured in duplicate, and aliquots were frozen and stored prior to analysis of urinary free cortisol (UFC, nmol/24 h) by high-throughput liquid chromatography and tandem mass spectrometry (Taylor et al., 2002).

2.5. ABP measurement

The Spacelabs 90207 ABP monitor (Redmond, WA) measured 12-h average systolic BP, diastolic BP, mean arterial pressure and heart rate. Monitoring for 12 h relative to 24 h avoids discomfort during sleep (Beltman et al., 1996) and provides meaningful data regarding stress during participants’ typical activities. We have found that 8-h and 24-h measurements correlated with r = 0.90 (unpublished observation).

Participants’ data were reviewed following the modified Casadei criteria (Wimnicki et al., 1997). Readings were considered artificial if: systolic BP < 70 or > 240 mm Hg, diastolic BP < 40 or > 140 mm Hg, or heart rate < 40 or > 125 beats per minute. When any of these criteria were met, all data for that time point were excluded. This resulted in 18 participants having one reading excluded and three participants having two readings excluded. Paired t-tests revealed that ABP before and after data editing were not significantly different (data not shown). After editing, the mean ± standard deviation (SD) number of readings per participant was 23.4 ± 1.5, range 18–26.

Activity during ABP monitoring can affect ABP measurements (Caylaars et al., 2004; Leary et al., 2000). To account for concurrent activity level in this study, participants recorded what they were doing in a diary at the time of each ABP reading. Each entry was then coded as either sedentary and given a score of one (e.g. sitting in class/work, watching television, studying/reading) or active and given a score of two (e.g. laundry, cooking, walking). A continuous score for activity during ABP (ABP-activity) was derived by summing the diary codes and dividing by the number of ABP readings available for each participant. As physical fitness may also be associated with ABP, the Baecke Questionnaire of Habitual Physical Activity was used to determine usual activity levels at work, in sport, and during leisure (Baecke et al., 1982).

2.6. Statistical analyses

Data were coded, verified, entered into SPSS software (v.17, SPSS Inc., 2008) and crosschecked for accuracy. Physiologic variables were examined for outliers (mean ± 4SD) and none were present. Descriptive statistics were used to characterize the sample. Pearson’s correlations were used to identify correlates that could potentially confound analyses of ABP and UFC. Partial correlations adjusted for potential confounders were conducted between eating/body attitude Z-score, general stress Z-score, UFC and ABP. Chi-square, independent t-tests and General Linear Modeling (with appropriate
covariates) were used to examine differences between women with negative versus neutral/positive eating/body attitudes, and between those reporting and not reporting current weight loss attempts. Interactive effects were also examined in order to differentiate between the cognitive and behavioral aspects of eating/body attitudes. As cortisol metabolism may differ between Asians and Caucasians (Lin et al., 1999), interactions between ethnicity and eating/body attitudes were examined with regard to UFC. For all analyses, cases were excluded pairwise and the significance level for all analyses was \( p \leq 0.05 \).

3. Results

3.1. Participant characteristics

All women were normotensive (systolic BP \( \leq 135 \) and diastolic BP \( \leq 85 \) mm Hg). Most participants were currently students (86%) and single (91%). All had completed some post-secondary education. Similar to the student population of UBC, 62.5% of the sample was Asian and the remainder was Caucasian. Current weight loss attempts were reported by 41%. Six women (5%) started using oral contraceptives between the cognitive and behavioral aspects of eating/body attitudes. As cortisol metabolism may differ between Asians and Caucasians (Lin et al., 1999), interactions between ethnicity and eating/body attitudes were examined with regard to UFC. For all analyses, cases were excluded pairwise and the significance level for all analyses was \( p \leq 0.05 \).

3.2. Correlation analyses

In univariate analysis, UFC was correlated with the volume (L) of urine collected \( (r = 0.27, p = 0.004) \), and urine volume was therefore included as a covariate in subsequent analyses. As shown in Table 1, volume-adjusted UFC was positively correlated with general stress and ABP (with age, BMI and ABP-activity added as covariates).

More negative eating/body attitudes were associated with higher BMI and general stress, and lower physical activity level. ABP was not associated with general stress \( (\text{Table 1}) \), or BMI, energy intakes or physical activity level (data not shown). Age was associated with diastolic BP \( (r = 0.21, p = 0.023) \). ABP-activity was associated with diastolic BP \( (r = 0.18, p = 0.046) \) and mean arterial pressure \( (r = 0.22, \, p = 0.015) \), and tended to be associated with systolic BP \( (r = 0.18, \, p = 0.053) \). Age and ABP-activity were therefore included as ABP covariates. After adjustment, there were still no relationships among ABP and BMI, physical activity level or energy intakes (data not shown). However, as BMI is associated with ABP in the literature and was associated with eating/body attitudes, BMI was also included as an ABP covariate. After controlling for age, BMI and ABP-activity, more negative eating/body attitudes were associated with higher diastolic BP and mean arterial pressure.

Associations between ABP and the individual eating/body attitude scales, adjusted for age, BMI and activity during ABP monitoring, are shown in Table 2. With the exception of the cognitive dietary restraint scale, questionnaire scores were associated with diastolic ABP and MAP, and the associations with disinhibition, the Body Shape Questionnaire, and the Eating Disorders Inventory bulimia subscale were significant.

3.3. Differences by eating/body attitudes and weight loss effort

Women with more negative eating/body attitudes were significantly more likely to report current weight loss attempts than those with neutral/positive attitudes \( (63\% \text{ versus } 21\%, X^2 = 22.5, p = 0.001) \).

The main and interactive effects of eating/body attitude level and weight loss effort on study outcome variables are presented in Table 3. There was a significant main effect of current weight loss effort on BMI, such that women currently trying to lose weight had significantly higher BMI values. There was no main effect on BMI of eating/body attitude nor was there an eating/body attitude-by-weight loss effort interaction.

No main or interactive effects of eating/body attitudes or weight loss effort were observed on age, physical activity level, general stress Z-score, BMI-adjusted energy intakes or volume-adjusted UFC. Ethnicity did not have a main or interactive (with eating/body attitude or weight loss effort) effect on UFC (data not shown).

A significant main effect of eating/body attitude on ABP was detected, such that higher diastolic BP and mean arterial pressure were seen in those with more negative eating/body attitudes. There was no main effect of weight loss effort or a weight loss effort-by-eating/body attitude interaction on ABP. Differences in diastolic BP \( (p = 0.023) \) and mean arterial pressure \( (p = 0.054) \) by eating/body

### Table 1

<table>
<thead>
<tr>
<th>Mean ± SD</th>
<th>Correlation coefficients</th>
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|                                   | Eating/body attitudes Z-score | General stress Z-score | UFC  
| All participants                 | 0.03                         | 0.08                     | 0.00                      |
| Age (years)                      | 22.8 ± 3.5                    | 0.03                     | 0.08                      | 0.05                      |
| Body mass index (kg/m²)          | 21.8 ± 2.5                    | -0.35***                 | -0.13                     | 0.02                      |
| Physical Activity*               | 0.19*                        | 0.06                     | 0.03                      |
| General stress Z-score           | 0.0 ± 0.8                     | -0.23*                   | 0.25**                     |
| Energy intake (kcal)             | 1531 ± 513                    | 0.19*                    | 0.25**                     |
| URF (mmol/24 h)                  | 70.5 ± 33.6                   | -0.11                    | 0.25**                     |
| Systolic ABP (mm Hg)             | 115.2 ± 6.5                   | -0.10                    | 0.24**                     |
| Diastolic ABP (mm Hg)            | 71.8 ± 5.6                    | -0.24**                  | 0.18                      |
| Mean arterial pressure (mm Hg)   | 86.2 ± 5.4                    | 0.21*                    | 0.16                      |

Correlation is significant at \( p=0.05 \) (*) or \( p=0.01 \) (**). ABP: mean 12-h daytime ambulatory blood pressure; eating/body attitudes Z-score: Z-score derived from the Three Factor Eating Questionnaire Restraint, Disinhibition and Hunger subscales, the Eating Disorder Inventory-2 Drive For Thinness and Bulimia subscales, the Body Shape Questionnaire and the Beliefs About Appearance Scale (sign of Z-score reversed so that negative scores reflected negative eating/body attitudes); general stress Z-score: Z-score derived from Perceived Stress Scale, and Daily Stress Inventory Frequency and Impact subscales collected on the days of cortisol and ABP assessment; SD: standard deviation; UFC: 24-h urinary free cortisol.

### Table 2

<table>
<thead>
<tr>
<th></th>
<th>SBP</th>
<th>DBP</th>
<th>MAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive dietary restraint</td>
<td>0.02</td>
<td>0.00</td>
<td>0.03</td>
</tr>
<tr>
<td>Disinhibition</td>
<td>0.12</td>
<td>0.23**</td>
<td>0.22*</td>
</tr>
<tr>
<td>Hunger</td>
<td>0.10</td>
<td>0.18</td>
<td>0.15</td>
</tr>
<tr>
<td>Body Shape Questionnaire</td>
<td>0.06</td>
<td>0.24**</td>
<td>0.22*</td>
</tr>
<tr>
<td>Beliefs About Appearance Scales</td>
<td>0.02</td>
<td>0.10</td>
<td>0.08</td>
</tr>
<tr>
<td>Drive for thinness</td>
<td>-0.01</td>
<td>0.14</td>
<td>0.13</td>
</tr>
<tr>
<td>Bulimia</td>
<td>0.08</td>
<td>0.27**</td>
<td>0.22*</td>
</tr>
</tbody>
</table>

SBP: mean 12-h systolic blood pressure; DBP: mean 12-h diastolic blood pressure; MAP: mean arterial pressure; \( p<0.05; ** p<0.01 \).
Our findings suggest that in this group of women, the experience of negative eating/body attitudes, rather than specific weight loss efforts, may be a source of continued stress that could result in chronic activation of the physiological stress response in this group. We found that women with negative eating/body attitudes had higher 12-h average diastolic BP and mean arterial pressure than women with more positive attitudes. Several of our findings suggest that the differences in ABP may be related to the cognitive aspects of eating/body attitudes rather than behaviors or relative weight status. First, BMI, energy intakes and physical activity level did not differ by eating/body attitude level, indicating that differences in ABP were not related to physiological stress due to energy deprivation or conversely, to excessive body weight. Secondly, although women with more negative attitudes were more likely to report current weight loss attempts, ABP did not differ by weight loss effort. Thirdly, there was no interactive effect between eating/body attitudes and weight loss effort for any variables measured in this study.

The difficulty in defining and measuring specific psychosocial stressors and relating them to physiological indicators of the stress response outside of the laboratory setting is well recognized (Dimsdale, 2008). This may partly explain why it is not clear whether the association we observed between higher ABP and more negative eating/body attitudes is specific to stress concerning food and weight or psychosocial stress in general. Our measure of general stress was significantly associated with UFC measured over 24 h, our indicator of usual chronic stress-induced hypothalamic–pituitary–adrenal axis activation, and tended to be associated with 12-h average diastolic BP (r = 0.18, p = 0.052) and mean arterial pressure (r = 0.16, p = 0.088). As both eating/body attitudes and general stress were associated with indicators of the physiological stress response, it does appear that we were able to operationalize the experience of “usual” stress. However, our data do not allow us to isolate the effect of different sources of psychological stress on the physiological stress response from each other. Furthermore, we cannot establish the directionality of the association between eating/body attitudes and/or general stress and ABP: while it is hypothesized that higher BP is a result of the reported experience of higher levels of chronic stress (occupation, family, financial, eating/body attitudes), it could be that elevated BP increases the negative evaluation of life events.

It is also possible that women with more negative eating/body attitudes perceive more stress in other aspects of life and are highly stressed individuals, although this is also not clear from our findings or the literature. In the current study, more negative eating/body attitudes were associated with higher general stress. Associations between perceived stress and eating/body attitude measures have also been observed among large groups of university-aged women (Ball and Lee, 2002; Johnson and Wardle, 2005; McLean and Barr, 2003; Putteman and Linden, 2006; Tiggemann, 2004). However, no difference in perceived stress was found among women with high versus low scores on eating/body attitude measures, despite higher 24-h urinary cortisol among women with more negative eating/body attitudes (Koo-Loeb et al., 2000; Rideout et al., 2006).

Surprisingly, we did not confirm that negative eating/body attitudes were associated with UFC. The majority of previous studies that were adequately powered and of strong experimental design, have found higher cortisol in women with more negative eating/body attitudes (Anderson et al., 2002; Koo-Loeb et al., 2000; McLean et al., 2001b; Putteman and Linden, 2006; Rideout et al., 2006; Rutters et al., 2009; Therrien et al., 2008). As these studies examined individual questionnaires (in most cases, cognitive dietary restraint) we also performed correlations between individual questionnaire scores and volume.
adjusted UFC, and found no significant relationships ($R_p = -0.33$ to 0.14, $p = 0.140$–0.731). It could be that chronic stress related to eating and body resulted in preferential activation of the sympathetic nervous system. It has been suggested that increased cortisol may result from negative affect, lack of control, distress or misery; while sympathetic nervous system activation (indicated by catecholamine levels) may be associated with higher subjective effort under stress or mental arousal (Goldstein et al., 1999). Variables not measured in this study (affect, control, anxiety, etc.) could be more strongly associated with BP in young women or could be mediating the relationship that was observed between eating/body attitudes and ABP.

To our knowledge, only one other study has examined eating attitudes in relation to ABP. Among 53 healthy university-aged women, there were no differences in 24-h ABP between those with very high or very low scores on the Eating Disorder Inventory Bulimia subscale, although the women with higher scores showed an exaggerated cardiovascular reaction to a laboratory speech task and had higher 24-h urinary cortisol (Koo-Loeb et al., 2000). Similarly to our study, the women in this study did not meet the diagnostic criteria for eating disorders and did not differ in BMI or energy intake. However, the methodology differed substantially from the current study. Specifically, their participants completed the 24-h ABP and urine assessments after administration of the diagnostic interview for bulimia nervosa; answering questionnaires regarding eating attitudes, coping, depression, anxiety, stress and self-esteem; and performing a laboratory stress test. Thus, findings do not reflect participants’ “usual” cortisol and ABP, which was the goal of the current study. Interestingly, when eating/body attitudes questionnaires were examined individually in the current study, positive associations with diastolic BP and MAP were observed in almost all cases (providing justification for our use of an eating/body attitudes Z-score), and associations with scores on the Eating Disorder Inventory Bulimia subscale, the Disinhibition subscale of the TFEQ, and the Body Shape Questionnaire (reflecting body dissatisfaction) were significant.

In this study, UFC was modestly associated with ABP. Although the mechanism linking cortisol and BP is not conclusively established, it is well documented that conditions of hypercortisolism, such as Cushing’s syndrome, are also associated with hypertension (Black, 2006). It is not currently known whether higher cortisol within physiologically normal levels is associated with higher BP: associations between higher 24-h UFC and 24-h ABP have been observed in some (de Jongh et al., 2007) but not all studies of healthy middle-aged adults (Grewen et al., 2004). As well, higher 24-h UFC has been found in middle-aged adults with untreated hypertension versus matched normotensive (Kral et al., 2007; Shamim et al., 2001). Our findings add support to the hypothesis that slightly higher cortisol may negatively impact BP in healthy young individuals.

Future studies examining young women’s eating/body attitudes and indicators of the physiological stress response will be improved by addressing our limitations. In most studies, ABP and urinary stress hormones are assessed concurrently. That we did not do this may be a limitation although the purpose of our study differed from previous work as we were not seeking to determine whether particular situations resulted in activation of the stress response. Instead, we sought to examine whether long-standing, intrinsic beliefs and values about eating and body activated the stress response. We felt that concurrent ABP and urine assessments would increase subject burden and perhaps result in artifactual elevations. However, conducting these measurements on separate days would be expected to attenuate their relationship, so the fact that we observed associations provides evidence of their ongoing relationship. Another issue is that participants chose when to complete the procedures. This likely resulted in choice of a less active day, as participants appear to reduce their activity levels during ABP procedures (Costa et al., 1999). Related to this was our inability to objectively verify physical activity during ABP monitoring by accelerometers. Our participants recorded their concurrent activity which, although not perfect, appeared to capture general activity during ABP monitoring as it was associated with 12-h average ABP measures. Lastly, this study is limited by our relatively small, homogenous sample. Our sample included healthy, non-obese, urban, well-educated young women, with a large proportion being of Asian descent (which is true for the city of Vancouver and the university population). These factors may also contribute to the relatively low BMI which was observed among participants; accordingly, additional research among women with a broader range of relative weight status is warranted.

Despite these potential limitations, our findings of an association between more negative eating/body attitudes and higher ABP contribute to the limited knowledge of variables that influence the BP of healthy, non-obese, young women. Given that young adulthood BP is independently associated with future CVD risk (Berenson et al., 1998; Chen and Wang, 2008; Johnson et al., 2007; Fletcher et al., 2008), it is important that we understand the correlates of BP while young as even small influences appear to have a cumulative effect on BP over time. Moreover, as negative eating/body attitudes are almost normative among young women today (Garner, 1997; McLean and Barr, 2003; Tiggemann, 2004), our findings of higher ABP among these women may be meaningful. However, we recognize that they have limited generalizability and hope that this exploratory study stimulates additional research. We recommend that future research, in addition to addressing the limitations outlined, include young working women, women with children and overweight/obese individuals. Future studies would also be improved by assessing catecholamines and affective state in relation to eating/body attitudes, cortisol and ABP. Also, having women note when they are engaged in eating- and body-related activities during ABP monitoring (i.e. cooking, grocery shopping, eating, and reading magazines) would allow for examination of whether these particular activities affect BP. In addition, different insights could be gained through conducting laboratory-based studies to assess whether an acute BP response occurs in women with negative eating/body attitudes in association with food- or weight-related cues. In conclusion, the subjective experience of negative eating/body attitudes was associated with increased ABP independent of weight loss effort in these healthy young women.

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Conflict of interest statement

The authors have nothing to disclose.

Ethical approval

The procedures of this study received ethics approval from the University of British Columbia’s Clinical Research Ethics Board on May 11, 2006 (reference number: CO5-0257), and approval was renewed annually.

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