Gender differences in the effects of eating attitudes and obligatory exercise attitudes on stress: Protective factors against perceived stress

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Kirsten Rene

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ABSTRACT

Gender differences in the effects of eating attitudes and obligatory exercise attitudes on stress: Protective factors against perceived stress

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Waltham, Massachusetts

By Kirsten Rene

Background: Excessive exercise has been found to have both negative physical and psychological health effects, with stress being one of the major pathways linking exercise to health. However, so far it is unclear whether those effects are direct effects of exercise behavior or rather mediated by exercise attitudes. Hence, the current study set out to characterize the association between exercise attitudes and stress measures, considering eating attitudes as well as gender as important moderators. Methods: 54 healthy students (33 female) were asked to complete questionnaires assessing eating and exercise attitudes, eating and exercise behaviors, as well as perceived chronic stress levels. Two days of at home saliva sampling were used to assess basal cortisol profiles. Results: No significant associations were found between self-report data and cortisol. A significant main effect of eating attitudes on perceived stress was found (independent of food intake), beta = 2.59, p = .002, while no main effect of exercise attitudes on perceived
stress was found, beta = 0.01, p = .89. Further, significant interaction effects of both eating attitudes (independent of food intake), and exercise attitudes (independent of exercise behavior) on perceived stress were found, beta = -4.17, p = .045, beta = -0.42, p = .025 respectively. Conclusion: This exploratory study suggests eating attitudes do affect perceived stress over an above of eating behavior. Furthermore, it was found that having more positive eating attitudes acts as a protective factor against perceived stress for females, and that having a higher commitment to exercise acts as a protective factor against perceived stress for males.
# TABLE OF CONTENTS

INTRODUCTION.............................................................................................................1

METHODS.......................................................................................................................9
  Participants..................................................................................................................9
  Procedure...................................................................................................................9
  Measures....................................................................................................................10
  Analytical Plan..........................................................................................................14

RESULTS..........................................................................................................................17
  Preliminary analyses...................................................................................................17
  Testing Hypotheses......................................................................................................18

DISCUSSION....................................................................................................................21
  Limitations and Future Directions..............................................................................27
  Conclusion...................................................................................................................28

REFERENCES..................................................................................................................38
LIST OF TABLES

Table 1 .........................................................................................................................30
Means and Standard Deviations of Descriptive Statistics Split by Gender

Table 2 .........................................................................................................................31
Means and Standard Deviations of Main Measures Split by Gender

Table 3 .........................................................................................................................32
Bivariate Correlation Matrix among primary and secondary variables

Table 4 .........................................................................................................................33
Estimated Coefficients for the Regression models predicting perceived stress by food intake, eating attitudes, gender and eating attitude and gender interaction

Table 5 .........................................................................................................................34
Estimated Coefficients for the Regression models predicting perceived stress by leisure time exercise, obligatory exercise attitudes, gender, and obligatory exercise attitudes and gender interaction
LIST OF FIGURES

Figure 1..................................................................................................................35
Salivary cortisol profiles (means and standard errors) of female and male
participants averaged across two days

Figure 2..................................................................................................................36
Effect of gender and global eating disorder examination score (EDE-Q) on perceived
stress scale

Figure 3..................................................................................................................37
Effect of gender and obligatory exercise (OEQ) on perceived stress scale
While generally believed that exercise is mostly associated with only positive health outcomes through the reduction of stress and stress hormones (i.e. cortisol), recent research suggest that this is not necessarily always true. In fact, exercise can have not only negative physical health outcomes, but negative psychological health outcomes as well. However, so far it is unclear whether those effects are direct effects of exercise behavior or rather mediated by exercise attitudes. Furthermore, exercise attitudes have been linked to eating attitudes, which raises the question whether exercise attitudes mediate potential links between eating attitudes and stress. Lastly, given the known gender-differences in eating disorder prevalence rates as well as muscle dysmorphia prevalence rates, another interesting and so far unanswered question is whether the above associations may differ dependent on gender.

Numerous studies have shown that daily physical activity and regular exercise benefit psychological and physiological health (Sallis & Owen, 1999; Pate, Pratt, Blair, Haskell, Macera, Bouchard, & Buchner, et al., 1995; Lollgen, Bockenhoff, & Knapp, 2009). For example, exercise has been shown to have preventative and rehabilitative benefits with regard to many chronic diseases (Johnson & Krueger, 2007) such as atherosclerosis, Type 2 diabetes, colon cancer, and breast cancer (for more details see: Petersen & Pedersen, 2005). Furthermore, reports such as regular aerobic exercise, resulting in moderate increases in self-reported positive affect (Reed & Buck, 2009) support the notion that exercise has positive effects on psychological functioning (Johnson & Krueger, 2007).
These exercise effects on health are thought to be mediated by reducing stress and its negative health-related effects (Sothmann, 2006). The pathways between perceived stress and health outcomes thereby include two stress systems. The sympathetic nervous system responds to acute stress among others with increases in heart rate and blood pressure. If an individual considers the situation they are in to be a threat, and there are no resources available to deal with this threat, a second system, the hypothalamic pituitary adrenal (HPA) axis comes into play, leading to increased secretion of its end hormone cortisol. In the context of acute stress, the responses of the two systems work in concert and are considered beneficial to health. However, chronic stress in the form of repeated or continuing stress may not only lead to changes in the cortisol response pattern to acute stress, but over time may also lead to long-term changes in basal cortisol levels (for an overview see: McEwen, 2005). Such changes, more specifically blunted increases in cortisol to awakening and/or blunted decrease of cortisol levels over the course of the day (including elevated evening levels) (Fries, Dettenborn, & Kirschbaum, 2009), in turn, have been associated with diseases such as diabetes and cardiovascular disease (Goldstein & McEwen, 2002). Hence, changes in acute stress response patterns as well as changes in basal cortisol levels such as described above are important health markers.

It is important in this context to differentiate between psychosocial stress, such as a job interview or an exam, and physiological stress, such as injuries or – to a certain extent – exercise. Looking at exercise as a physiological stressor, it has been shown that cortisol concentrations increase in response to long duration or high intensity exercise (Jacks, Sowash, Anning, McGloughlin, & Andres, 2002). While helping with the demands at hand (e.g., helping to provide the body with enough energy), these increases
in cortisol also pose a health risk, such that exercise-related increased cortisol levels have been found to be associated with increased susceptibility to infection (Gleeson, 2007; Petersen & Pedersen, 2005). Importantly, exercise at any intensity lasting under 40 minutes usually does not elicit significant increases in cortisol secretion and thus are not related to the risks described above (Jacks, Sowash, Anning, McGloughlin, & Andres, 2002). However, besides the physiological stress exercise can pose to the body, exercise is generally considered health beneficial and thought to be so among others by reducing psychological stress and the associated negative physiological changes. For example, it has been found that exercise interventions can reduce and even prevent both anxiety and depression in children and youth (Ahn & Fedewa, 2011). In further support of this finding, in a meta-analysis of physical exercise effects on mental health in children, Ahn and Fedewa (2011) found that on average, physical activity led to improved mental health outcomes, including depression, psychological stress, and emotional disturbance. Similar results were found in a population of older adults (< 65 years), where physical activity mediated the relationship between perceived stress and mental health, which included fatigue, loneliness, and depression (Kwag, Martin, Russell, Franke, & Kohut, 2011). The above literature suggests that although exercise may pose physiological stress to the body, it also helps reducing psychological stress, which in turn can help regulate the stress response and basal cortisol levels (McEwen, 2005).

This raises the interesting question of whether the opposite is true as well, i.e., whether exercise in certain circumstances can act as a psychological stressor and thus have negative health consequences. In a study examining the cortisol stress response in competitive ballroom dancers under social-evaluative threat, it was found that
competitive dancing lead to increases in cortisol compared to cortisol on a control practice day. These increases were greater than those found in response to typical psychosocial stress tests, and were not due to the physical demands of dancing. Further, it was found that cortisol levels were higher when dancing as a couple compared to dancing within a larger group (Rohleder, Beulen, Chen, Wolf, & Kirschbaum, 2007). This study supports the idea that exercise under a social-evaluative condition can act as a psychological stressor and as a result increase cortisol. Indirect support for exercise acting as a psychological stressor and thus having negative health consequences has further been found in the context of disordered eating attitudes (Goldschmidt et al., 2008; Gustafsson, Edlund, Kjellin, & Norring, 2009). Disordered eating attitudes are characterized as obsessive thinking about food/dieting, body image dissatisfaction, preoccupation with being overweight, and fear of fatness. In a study conducted by Goldschmidt, Aspen, Sinton, Tanofsky-Kraff, and Wilfley (2008), disordered eating attitudes were strongly associated with an increased likelihood of showing excessive exercise behaviors, with prevalence ranging from 30-70% (Mond & Calogero, 2009; Shroff, Reba, Thornton, Tozzi, Klump, & Berrettini, et al., 2006). Furthermore, Zmijewski and Howard (2003) investigated the relationship between exercise dependence symptoms and disordered eating attitudes among male and female undergraduates and found that number of exercise-dependence symptoms significantly positively correlated with problematic attitudes toward eating. Interestingly, women scored significantly higher than men on exercise dependence, exercise for weight control and health reasons, dieting, food preoccupation, and displayed more symptoms of bulimia and exercise
dependence. These findings suggest a gender-dependent link between exercise behavior and eating attitudes.

Interestingly, a small number of studies within eating disorder research suggests that it may not only be exercise behavior itself that can lead to negative health consequences, but that exercise attitudes – independent of the actual exercise behavior – may play a role as well. Indirect support for this idea comes from a study by Matheson and Crawford-Wright (2000). They examined the relationship between obligatory exercisers and eating disorder profiles in a healthy population of college students. Obligatory exercisers were characterized as those who showed extremely high commitment to exercise. It was found that obligatory exercisers were significantly different from non-obligatory exercisers in drive for thinness, ineffectiveness, and interpersonal distrust, thus following a pattern similar to clinically diagnosed eating disordered populations. Further, a study by De Young and Anderson (2010) found not only gender differences with regard to eating attitudes and exercise attitudes, such that females scored significantly higher than males on both, but also that negatively motivated reasons for engaging in exercise was a large component in the link between obligatory exercise and negative eating concerns. In summary, although limited so far, the literature suggests a relationship between eating attitudes and exercise attitudes that is independent from actual exercise behavior, supporting the idea that exercise attitudes alone may have an effect on health.

Linking the above findings back to stress and associated changes in cortisol further gives rise to the hypothesis that disordered exercise attitudes may do so by influencing stress perception and thus HPA activity, such that exercise attitudes
themselves may be associated with increased perceived stress levels and associated changes in basal cortisol levels, similar to those seen for excessive exercise behavior. To our knowledge, literature so far is limited to attitudes toward exercise (i.e. performance) in elite athletes. For example, in a study examining elite track athletes, it was found that pressures and concerns to perform well along with social evaluation led to increased stress (McKay, Niven, Lavallee, & White, 2008). However, this study included concerns about performance and evaluation, i.e., stress stemming from social evaluation, not solely attitudes toward exercising itself. Therefore the association between exercise attitudes and stress or changes in basal cortisol levels has yet to be determined.

The above findings relating exercise attitudes to eating attitudes also raise some secondary questions, more specifically: Do eating attitudes, independent from eating behaviors, result in cortisol changes? And furthermore: Is one of the two, eating attitudes or exercise attitudes, a mediator of the other’s relationship to cortisol? Literature that mostly stems from research on disordered eating attitudes supports a link between eating attitudes and stress or stress-related changes in cortisol. For example, eating disordered patients suffering from anorexia nervosa, who have both extremely negative eating behaviors and eating attitudes, have been shown to also exhibit a hyperactive HPA axis, characterized by increased corticotropin-releasing hormone (CRH) levels, normal adrenocortictropic hormone (ACTH) levels, and increased cortisol (Lo Sauro, Ravaldi, Cabras, Faravelli, & Ricca, 2008). However, because these patients have both disordered eating behaviors and disordered eating attitudes, it is difficult to predict whether disordered eating attitudes alone will also result in the same changes in HPA axis activity. More direct support for the existence of an eating behavior-independent
relationship between eating attitudes and stress comes from a study by Bedford, Linden, and Barr (2010) who found that negative eating and body attitudes in healthy females were associated with increased chronic stress, independent of eating behavior (assessed by weight loss effort and energy intake). Further, with regard to physiological health it was found that diastolic blood pressure and mean arterial pressure were higher among women with negative versus neutral or positive eating attitudes, independent of eating behaviors, however there was no significant relationship found between negative eating/body attitudes and urinary free cortisol (a marker of chronic stress). However, several studies have linked elevated concentrations of urinary cortisol to high cognitive dietary restraints in healthy populations (Rideout, Linden, & Barr, 2006; Putterman, & Linden, 2006; Anderson, Shapiro, Lundgren, Spataro, & Frye, 2002). Taken together, these results suggest that eating attitudes alone – independent of eating behavior – can act as a chronic stressor and can be associated with increased level of cortisol, which, in turn, can lead to negative health outcomes.

In summary, negative eating attitudes have been shown to correlate with exercise attitudes as well as with perceived stress, changes in basal cortisol levels, as well as negative health outcomes. However the link between exercise attitudes and perceived stress as well as associated cortisol changes, aside from actual exercise behavior, has yet to be examined. Furthermore, the role eating attitudes play in this association as well as whether gender plays a differential role is unknown, too.

In the current study, we set out to answer these questions. More specifically, we hypothesized that healthy individuals with negative eating attitudes or negative exercise attitudes will show elevated levels of both perceived stress and basal
cortisol. We further hypothesized that there will be a significant relationship between eating attitudes and exercise attitudes, allowing us to explore if eating attitudes mediate the relationship between exercise attitudes and both perceived stress and basal cortisol, or if exercise attitudes mediate the relationship between eating attitudes and both perceived stress and basal cortisol. Further, these effects are predicted to be gender-specific, such that to a larger extent in females, negative attitudes toward eating are associated with elevated stress levels and changes in basal cortisol levels which are associated with negative health outcomes, while to a larger extent in males, having a high commitment to exercise (obligatory exercise attitudes) is a protective factor against stress and its negative consequences.
Methods

Participants

A total of 54 participants (33 females) ages 18 and older were recruited from a pool of individuals who had previously participated in research in our lab, as well as through flyers from the student population at Brandeis University and the surrounding area of Waltham, MA. Participants with incomplete cortisol data, as well as three outliers (2 SD’s above the range) were removed from analyses adjusting the sample size (n=45, 26 females). Participants received an honorarium of $15. The study protocol was approved by the Brandeis University Institutional Review Board.

Procedure

After a phone screening, eligible participants were invited to the Health Psychology Laboratory on a weekday afternoon. After being seated in a comfortable testing room, the study protocol and the consent form were explained in detail. After obtaining informed consent, the participant was asked to complete several questionnaires assessing exercise and eating behaviors and attitudes, as well as perceived stress and body esteem (see below for more details). At the completion of the questionnaire package, participants were explained the at home saliva sampling protocol in which they were asked to take six samples a day for two consecutive days at specific time points throughout the day (wake up, wake up +30 min, wake up + 1 hr, wake up + 4 hrs, wake up + 9 hrs, wake up + 13 hrs). Participants were then scheduled to come back to the Health Psychology Lab, at least two days later, to return the saliva samples. Height,
weight, and body fat measurements were also taken on the second visit. Participants were then compensated and free to leave.

Measures

Self report

The self-report data below is broken up into two different sections: target variables and secondary variables. Target variables are those variables that were included in the hypotheses. Secondary variables are those variables that were used as covariates in data analysis.

Target Variables

Perceived Stress Scale (PSS). The Perceived Stress Scale is a 10-item, self-report inventory aimed at assessing the degree to which situations in an individual’s life are appraised as stressful. Items measure the degree to which respondents find their lives unpredictable, uncontrollable, and overwhelming. Individuals are asked to indicate how often they have felt or thought a certain way during the past month using a 5-point Likert scale (0 = never, 1 = almost never, 2 = sometimes, 3 = fairly often, 4 = very often). Items 4, 5, 7, and 8 are reverse coded, and a higher sum indicates a greater amount of perceived stress. (Cohen, Kamarck, & Mermelstein, 1983).

Obligatory Exercise Questionnaire (OEQ). This 20-item scale measures commitment to exercise (Pasman & Thompson, 1988). Examples of items include, ‘I engage in physical activity on a daily basis,’ my best friends like to exercise,’ and ‘I may miss a day of exercise for no good reason.’ Answers are given on a scale from one to four (1- never, 2- sometimes, 3-usually, 4-always). Numbers 8 and 10 are reverse coded, and
a summary score is computed with higher scores indicating higher endorsement of and engaging in obligatory exercise behaviors. (Pasman & Thompson, 1988).

**Eating Disorder Examination (EDE-Q).** This 36-item self-report measure is derived from the Eating Disorder Examination interview (Cooper, Cooper, & Fairburn, 1989) and assesses eating attitudes by four subscales: dietary restraint, eating concerns, concerns about weight, and concerns about shape (Fairburn & Cooper, 1993). It thereby focuses on the past 28 days and is scored on a scale from 0 – 6 (0 = no days; 1 = 1-5 days; 2 = 6-12 days; 3 = 13-15 days; 4 = 16-22 days; 5 = 23-27 days; 6 = every day). To compute the subscales, an average is computed including all items that make up each specific scale. A global EDE-Q score is then computed by taking the average of the four subscales. Scores of four or higher (16-22 days per month) on items are considered to be in the clinical range, meaning a high global EDE-Q score represents more disordered attitudes toward eating. Frequencies of eating disorder (binge eating and compensatory) behaviors are assessed in terms of the number of episodes that occurred during the past 4 weeks. A high level of agreement between EDE-Q and EDE subscale scores has been demonstrated in both clinical and general population samples (Fairburn & Cooper, 1993).

**Secondary Variables**

**Godin-Leisure Time Exercise Questionnaire (GLT-EQ).** This scale assesses current exercise level over the past few months. Exercise is divided into three categories: strenuous – heart beats rapidly (i.e. running, jogging, football, soccer, basketball), moderate – not exhausting (i.e. fast walking, baseball, tennis, volleyball, easy swimming) and mild – minimal effort (i.e. yoga, archery, walking, bowling, golf). Participants are asked to record how many times on average during a typical week they did strenuous,
moderate, and mild exercise for more than 15 minutes during their free time. For example, if they did strenuous activity once a day during a typical week for more than 15 minutes, they would record 7 for strenuous activity. To assess total amount of weekly leisure activity, all three levels of exercise are taken into account. Arbitrary numbers are then used to weight the three levels of exercise, with strenuous activity having the most weight, and mild activity having the least. The following formula is used: (9 x weekly amount of strenuous activity) + (5 x weekly amount of moderate activity) + (3 x weekly amount of mild activity) with a higher sum meaning a higher level of exercise engaged in (Godin & Shepard, 1985).

**Food Intake Questionnaire (FI-Q).** This questionnaire is used to measure diet by examining the frequency various foods of six different food groups are eaten during a regular week. The six food groups are: milk products, vegetables, fruits, breads/starches, meat/protein, and fats. Additional categories are beverages and a miscellaneous (i.e. sugar, candy, desserts, Mexican etc.). Possible answers to each category are ‘daily’, ‘often’ (3-6 times/week), ‘sometimes’ (1-2 times/week), and ‘rarely/never.’ (Texas Health Presbyterian Hospital, Dallas). For the current study, only foods with a response of never or often were placed into ‘healthy’ (i.e. 1% milk, fresh fruits, fresh vegetables, poultry) or ‘unhealthy’ (i.e. muffins, hotdogs, bacon, butter) categories, and a healthy to unhealthy food ratio was then computed, with a higher number representing a healthier diet.

**Physiological**

**Bioelectrical Impedance Scale.** This scale was used to BMI, water percentage, normal body fat, and athletic body fat. To get these measures, participant height (m) and
age were entered into the scale followed by the participant stepping onto the scale. Once the participant steps onto the scale, these measures are portrayed on the screen of the scale.

**Cortisol**

**Cortisol Diaries (CD).** Participants were given a diary to record both the scheduled times they were suppose to take all six samples, as well as the actual time they took the respective sample. More specifically, participants computed first the scheduled times based on the time-point they woke up at each of the two testing days (i.e. wake time, wake time + 30 min, wake time + 1 hr, wake time + 4 hrs, wake time + 9 hrs, and wake time + 13 hrs). Each time the participants took a sample, they recorded the actual time they took the sample at. Participants were encouraged to give the exact sampling time independent of how much it deviated from the time they were supposed to take the sample and ensured that deviations, not matter how large, would not result in any penalty. This allowed us to compute a compliance index by computing the difference between scheduled and actual time, which then was used as a covariate in cortisol-related analyses.

**Cortisol Samples.** Salivary cortisol was measured through saliva samples obtained using the salivette (Sarstedt, Newton, NC) collection system. This system consists of a small plastic container holding a sterile cotton roll that is in a larger container for later centrifugation, as well as a lid to avoid drying-out of fluid. Participants were asked to place the cotton roll into their mouth for about two minutes and then to spit the roll back into the small container without touching the sample. Saliva samples were then stored at -30C until completion of the study. Salivettes were then
centrifuged and concentrations of salivary free cortisol were measured using a salivary ELISA kit. Intra- and inter-assay precision, expressed as percent coefficient of variation, were below 10%. Cortisol was measured in nanomoles per liter (nmol/l). Two variables were created to analyze the cortisol data: maximum increase (highest value from the last three time points – lowest value from the first three time points) and maximum decrease (highest value from the first three time points – lowest value from the last three time points). Before computing these variables, an average was taken across days 1 and days 2 of saliva sampling to increase reliability and decrease random error of the data.

**Analytical Plan**

Preliminary analyses: We first computed descriptive statistics on both the demographic and testing parameters, followed by performing Student’s t-tests testing for gender-differences in the aforementioned parameters. A repeated-measures ANOVA with 2(day)x6(samples) within-subject levels was then computed to examine changes over time in the six cortisol values as well as differences between day 1 and day 2 (controlling for compliance). For further analyses, averages between day 1 and day 2 saliva samples were computed to increase reliability, and another repeated-measures ANOVA was computed including gender as a between-subject factor (controlling for compliance). Pearson correlations were computed to test for associations between secondary variables assessing behaviors (GLT-EQ: exercise behavior; FI-Q: eating behavior), key outcome variables assessing stress (cortisol: max increases, max decreases; PSS: perceived stress), and target variables assessing attitudes (EDE-Q: eating attitudes; OEQ: exercise attitudes). To separate behaviors from attitude, the respective behavioral measure was used as a covariate in the respective subsequent analyses testing effects of attitudes on
stress measures (i.e., eating behavior in analyses concerning eating attitudes and exercise behavior in analyses concerning exercise attitudes). Next, regression analyses using recommended procedures for testing interaction effects in multiple regression analyses (Aiken and West, 1991) were performed to examine potential gender-dependent relationships between self-reported perceived chronic stress (PSS) and cortisol measures (max increase, max decrease). More specifically, both regression analyses (outcome variables: max increase, max decrease) included the following variables as predictors: compliance (control variable), gender, PSS (centered), and a gender-by-PSS interaction term.

Testing hypotheses: Several hierarchical regressions were then computed to test our main hypotheses. To test our first hypothesis concerning behavior-independent associations between attitudes and stress, separate regressions were computed with maximum cortisol increase, maximum cortisol decrease, and PSS as a dependent variable. The first set of regressions analyzed if a main effect was found of eating attitudes (EDE-Q global score) on the dependent variables, controlling for food intake (FI-Q) and compliance in the case of cortisol measures as dependent variables. For that, control variables (FI-Q, compliance) were entered at level 1 and EDE-Q at level 2. The second set of regressions analyzed if a main effect was found of exercise attitudes (OEQ, level 2) on the dependent variables, controlling for exercise behavior (GLT-EQ, level 1) and compliance (level 1) in the case of cortisol measures as dependent variable.

Our second hypothesis predicted that exercise attitudes or eating attitudes would mediate the relationship between the respective other variable and stress measures. To test this relationship, three correlations need to be present: between eating attitudes and
exercise attitudes, eating attitudes and stress measures, and exercise attitudes and stress measures. In the case of three significant correlations and to test for mediating effects, the above regressions were repeated, this time adding exercise attitudes (at level 1) to the regression models testing for eating attitudes effects on stress measures and adding eating attitudes (at level 1) to models testing for exercise attitudes effects on stress measures. Changes in the predictive value of exercise attitudes from significant to non-significant were considered consistent with the hypothesis that eating attitudes mediated the effects of exercise attitudes on stress measures and vice versa.

Our third hypothesis predicted the above associations to be gender-dependent. Hence, all regression analyses testing hypothesis 1 were repeated adding a third level including gender (centered) as well as an interaction term (gender-by-attitude measure).
Results

Preliminary Analyses

The sample’s descriptive statistics including participants’ mean age, weight, BMI, and body fat split by gender can be found in Table 1. There were no significant gender differences found for age, weight, or BMI, however significant gender differences were found for both normal body fat percentage and athletic body fat percentage, with females having a higher body fat percentage for both measures. Mean scores on cortisol data and questionnaire measures split by gender, can be found in Table 2. There were no significant gender differences found for cortisol increase, cortisol decrease, PSS, FI-Q, or OEQ (all p > .07), however significant gender differences were found for global EDE-Q score (t=2.15, p=.04), indicating that females showed more disordered eating attitudes than men, and for GLT-EQ (t=-2.5, p=.02), indicating that males showed more exercise behavior compared to females.

A 2 (day) x 6 (sample) within-subject repeated-measures ANOVA revealed no significant difference between day 1 and day 2 of saliva collection, F(5, 36) = 1.43, p = .239, however, we found cortisol levels to change significantly over the course of each day, sample: F = 100.28 p < .001, sample-by-day: F = .479, p = .756. More specifically, on both days cortisol levels sharply increased in the morning, peaking 30 minutes after wake-up time, and then decreased throughout the day (see Figure 1). Controlling for compliance did not change the above results. Since no differences between values assessed on day 1 and values assessed on day 2 were found, we next averaged the
respective values across the two days and computed a 2(gender) x 6(average cortisol value) mixed-model ANOVA to test for gender-differences. While the change in cortisol values across the day was still significant, F(3.99, 43) = 115.958, \( p < .001 \), we found no main effect of gender, F(1, 43) = 0.452, \( p = .505 \), and no gender-by-sample interaction effect, F(3.99, 43) = 0.88, \( p = .477 \). Further, controlling for compliance time did not change these results (see Figure 1).

Testing for associations among our key variables, we found no significant correlations between cortisol measures and any of the self-report measures including perceived stress (see Table 3). However, high scores on the EDE-Q were associated with high scores on the PSS indicating that participants who perceived higher chronic stress also reported more eating-related concerns. Further, high scores on the EDE-Q were also associated with high scores on the OEQ, thus linking strong eating-related concerns and strong obligatory exercise attitudes.

With regard to associations among the various stress measures, we found no significant main or gender-dependent interaction effects of perceived stress (PSS) and maximum increase or maximum decrease of cortisol (all \( p > .46 \)).

**Testing Hypotheses**

Next, we computed several hierarchical regressions to test our main hypotheses. In relation to cortisol outcome variables of maximum cortisol increase and maximum cortisol decrease, no significant main effects (all \( p > .10 \)) or gender-dependent effects (all \( p > .28 \)) of any of the target or secondary variables on cortisol measures were found, thus showing that neither behaviors nor attitudes were associated with cortisol.
With regard to analyses concerning perceived stress, a summary of eating attitude-related regression results are presented in Table 4 and exercise attitude-related regression results are presented in Table 5. In relation to our first hypothesis, we found a significant eating behavior-independent main effect of eating attitudes (EDE-Q) score on perceived stress levels (PSS), such that those who had disordered eating attitudes had higher levels of perceived stress, beta = 2.59, p = .002. Interestingly, eating behavior (FI-Q) itself was also associated with PSS at a trend level, beta = -2.764, p = .053, indicating that a healthier diet was associated with lower chronic stress. However, neither exercise attitudes over and above exercise behavior, beta = 0.01, p = .89, nor exercise behavior itself, beta = 0.003, p = .82, were associated with perceived stress, indicating that there was not a significant difference between level of perceived stress for those who showed strong exercise attitudes and those who showed weak exercise attitudes.

In relation to our second hypothesis, we found a significant relationship between eating attitudes and exercise attitudes, \( r(52) = .581, p < .01 \). However mediation analyses could not be performed due to the lack of a significant correlation between exercise attitudes (OEQ) and perceived stress (PSS), \( r(52) = .028, p = .86 \)

Lastly, assessing the role of gender, a significant gender-dependent effect of EDE-Q on PSS was found, beta = -4.17, p = .045, (see Figure 2), indicating that females reported higher perceived stress when they reported having negative eating attitudes, while eating attitudes did not affect perceived stress for males. In addition, a significant gender-dependent effect of OEQ score on PSS, beta = -0.42, p = .025, (see Figure 3), indicated that males reported significantly lower perceived stress when they reported
having high obligatory exercise attitudes, while these obligatory exercise attitudes did not affect perceived stress for females.
Discussion

The current study aimed at elucidating the links between exercise attitudes, eating attitudes, and stress. Below is a summary of the key findings:

(1) Eating and exercise behaviors as well as eating and exercise attitudes were not associated with cortisol measures.

(2) Independent of eating behavior, disordered eating attitudes were associated with higher levels of self-reported perceived stress. Further, unhealthy eating behaviors were also associated with higher levels of self-reported perceived stress.

(3) Neither exercise attitudes, over and above exercise behavior, nor exercise behavior itself, were associated with perceived stress.

(4) Neither was eating attitude a mediator between exercise attitudes and stress, nor were exercise attitudes a mediator between eating attitudes and stress.

(5) Negative eating attitudes were a risk factor only for females (females reported higher perceived stress when they reported having negative eating attitudes, while eating attitudes did not affect perceived stress for males).

(6) Exercise attitudes were protective only for males (males reported significantly lower perceived stress when they reported having high obligatory exercise attitudes, while these obligatory exercise attitudes did not affect perceived stress for females).

In the following, each of the key findings will be discussed.

(1) Eating and exercise behavior – eating and exercise attitudes – basal cortisol levels: Contrary to past findings that certain eating and exercise behaviors have the
potential to influence cortisol levels (Lo Sauro, Ravaldi, Cabras, Faravelli, & Ricca, 2008; Jacks, Sowash, Anning, McGloughlin, & Andres, 2002), the current study did not find associations between food intake (eating behavior) or physical activity (exercise behavior) and cortisol. One explanation for these findings could be that because participants were college students attending the same university, stress from classes and exams could have been effecting their level of cortisol, as literature has supported a positive relationship between school stress, i.e. examinations and presentations and cortisol (Preuß, Schoofs, Schlotz, & Wolf, 2010).

Further, once again, contrary to past literature on cortisol findings (Rideout, Linden, & Barr, 2006; Anderson, Shapiro, Lundgren, Spataro, & Frye, 2002; Rohleder, Beulen, Chen, Wolf, & Kirschbaum, 2007), we did not find that eating and exercise attitudes affected basal cortisol levels in healthy individuals. One reason we may not have found correlations with basal cortisol levels is that we examined a healthy population of students with a relatively low mean perceived stress score. Further, the questionnaire used in the current study (PSS) inquires about stress over the past month. However, high levels of stress over the period of one month may not be long enough to show effects at the level of the HPA axis, as past research, along with the present findings, did not find PSS to correlate with cortisol (Putterman & Linden, 2006, Pruessner, Hellhammer, & Kirschbaum, 1999). On the other hand, it is feasible to assume that those individuals who reported higher stress scores may have been exposed to chronic stress more than just during the one month asked for. However, our lack of finding associations between eating attitudes as well as exercise attitudes with basal cortisol levels does not rule out that those attitudes may have potential negative effects through changes in basal cortisol.
in the long run. It may be the case that our sample was simply too young for those effects to emerge. Therefore, the question of whether exercise attitudes or eating attitudes can lead to changes in basal cortisol levels is still unanswered.

(2) Eating attitudes – eating behavior – perceived chronic stress: Similar to past research linking disordered eating attitudes with increased chronic perceived stress, (Putterman & Linden, 2006; Bedford, Linden, & Barr, 2010), we found negative attitudes alone to be associated with increased perceived stress. Although it is not clear from the current findings or the literatures, this could be due to the fact that those with disordered eating attitudes may also perceive more stress in other areas of their life outside of eating concerns. However, independent of whether it is even plausible to change attitudes without changing behavior, our findings do suggest that altering attitudes alone may have the ability to decrease levels of perceived stress. The current study also found association between eating behavior and perceived stress, taking into account a ratio of healthy to unhealthy foods choices consumed in a typical week. Importantly, our measure of eating behavior was different from that used by others, for example, the one used by Bedford, Linden, and Barr (2010), who controlled for eating behavior by assessing weight loss effort (i.e. trying to lose weight or not) and energy intake (assessed by diet history over the past 12 months). Weight loss effort is not a strong enough representation of eating behavior, because those who report trying to lose weight may be still eating unhealthy foods although limiting their intake of these foods. Further, energy intake does not elute to the quality of the food eaten in contrast to our measure. Hence, the fact that our measure is a more direct measure of eating behavior and linked to chronic stress itself,
further underscores the significance of our finding of an association between eating attitudes and perceived stress over and above eating behavior.

(3) Exercise attitudes – exercise behavior – perceived chronic stress: We did not find support for the hypothesis that healthy individuals would show elevated levels of perceived stress in response to negative attitudes toward exercise. Although to our knowledge there is no literature on the effect of exercise attitudes on perceived stress, this result does contrast that of research finding increased perceived stress to be associated with performance and social evaluation in elite athletes (McKay, Niven, Lavallee, & White, 2008). One reason for this finding could be that exercise attitudes may increase perceived stress of elite athletes more so than non-elite athletes. A second reason for this finding may be that participants included in the study could have different relationships or histories with exercise, i.e. a past of being highly committed to exercise vs. not highly committed. For example, if an individual is usually committed to exercise but at the time of assessment was dealing with other circumstances (exams, family problems, etc.), the individual would continue to keep a positive attitude toward exercising knowing he/she would continue with a normal schedule soon, not leading to an association with perceived stress. However, for the later, because they have never been highly committed to exercise, attitudes they have toward exercise may not cause them stress, or they may not think about exercise at all. In summary, it may be possible that level of competition, i.e., elite vs. not elite, as an effect on the relationship between exercise attitudes and perceived stress. Further, it is also possible that past history of commitment to exercise interacts with current exercise attitudes and thus current exercise attitudes alone are not predictive of perceived level of stress.
It was also found that exercise behavior was not related to perceived stress, contrary to past research linking the engagement in exercise with lower psychological stress (Ahn & Fedewa, 2011, Kwag, Martin, Russell, Franke, & Kohut, 2011). This may be due to the age of participants investigated, i.e., in the current study we assess college-aged students, compared to children and youth assessed in the study by Ahn and Fedewa (2011) and older adults examined by Kwag, Martin, Russell, Franke, and Kohut (2011). Perhaps because college aged students are under extreme pressures to perform well in school, and are experiencing a time where they need to really think about what they want to do with their future, this may be much more important to them at this time than exercise behavior. In contrast, children and older adults do not have these same pressures to deal with, allowing for other variables such as exercise behavior to associate with their level of perceived stress.

(4) Mediation: Replicating earlier findings (Matheson & Crawford-Wright, 2000; De Young and Anderson, 2010), we did find support for a relationship between eating attitudes and exercise attitudes. However, since we could not establish a link between exercise attitude and perceived stress, we were unable to test for mediation. Or in other words, we did not find any support that either one of the attitude measured mediates the association between the other attitude measure and perceived stress. This is interesting, because it suggest that eating and exercise attitudes have independent effects on perceived stress, which is contrary to eating disorder literature suggesting a close relationship between the two attitudes that is further associated with negative health outcomes (Matheson and Crawford-Wright, 2000; De Young and Anderson, 2010). The current findings suggest that this is not applicable to a healthy population and thus that
the inter-dependency of eating attitudes and exercise attitudes may be indicative of a disorder.

(5) Eating attitudes – gender – perceived stress: One of the major findings of this study was that the association between eating attitudes and perceived stress is gender-specific. More specifically, having healthy attitudes toward eating was found to be a protective factor against perceived stress for females, while for males, eating attitudes did not predict perceived stress levels. This may be because there are many pressures from society and the media for females – contrary to men – to be thin (McCreary & Sasse, 2000), so in having healthy eating attitudes, females may feel as if they are following what is expected of them from society, thus decreasing their stress. Further, this finding suggests that it may be health-beneficial for females to attempt to alter their attitudes about eating, specifically attitudes about their weight, shape, and dietary restraint. Lastly, this finding mirrors those findings from eating disorder research, in which negative dietary cognitions and limited food intake are highly prevalent in females (Muise et al., 2003), however, it also adds knowledge in showing that these attitudes do not affect perceived stress in healthy males, a population not traditionally studied in the eating disorder research.

(6) Exercise attitudes – gender – perceived stress: Lastly, having high obligatory exercise attitudes, or high commitment to exercise, was found to be a protective factor against perceived stress for males, while in this case, it did not affect females. This may be because there are many pressures from society and the media for males to be muscular and in shape (McCreary & Sasse, 2000). So parallel to what was said above about females, in having a high commitment to exercise, males may feel as if they are
following what is expected of them from society, thus decreasing their stress. Further, this finding suggests that it may be beneficial for males to attempt to alter their commitment to exercise. Lastly, this finding mirrors findings from research on muscle dysmorphia, where a high commitment to exercise and weight lifting is extremely prevalent in males (Leone, Sedory, & Gray, 2005), and extends it to a healthy population.

In summary, the above findings suggest that although both eating and exercise attitudes were not found to be associated with cortisol, eating attitudes alone do have the potential to affect perceived stress. This is important due to the fact that perceived chronic stress can eventually lead to health-relevant changes in basal cortisol levels. This finding further raises the important question as to why self-reported stress is not representative of physiological outcomes. As already stated above, this could be due to the fact that stress that was reported has not been of long enough duration to affect physiological measures. Further, as it has already been found that eating disorders are more prevalent in females, and muscle dysmorphia is more prevalent in males, the current research extends these findings to a healthy population of students, and further finds that eating attitudes do not effect perceived stress in males and exercise attitudes do not effect perceived stress in females. Lastly, it would be interesting to link our findings to actual health outcomes and further, to examine alternative pathways linking attitudes and health outcomes, given that we did not find a significant link with cortisol.

Limitations and Future Directions

Although our hypothesis that negative eating and exercise attitudes lead to changes in levels of cortisol was not supported, several factors may have contributed to this negative finding: First, we controlled for the time lag between when participants
were supposed to take a saliva samples and the time he/she actually too it in all analyses and did not find compliance to chance any of our results. However, because the saliva samples were taken at home and participants reported the times they took the samples at, it is not possible to know if these reported times are accurate.

Also, although behaviors such as diet and exercise were controlled for, the fact that the sample was made up of college students poses the possibility that class and exam stress may have been extremely prevalent in this population making it difficult to find correlations between attitudes and cortisol.

Another limitation of the current study is the timeframe it used. As questionnaires inquired about the past month or past few months, it would be interesting to question participants about the past year or two years to get more of a chronic measure of perceived stress. It would also be interesting to conduct a longitudinal study with healthy participants to see if similar attitudes that increased perceived stress, if continued, eventually influence basal cortisol levels.

**Conclusion**

This study included both physiological and self-reported measures of stress to help further our knowledge and understanding of the effects eating and exercise attitudes alone, independent of the behavior of eating and exercising, have on stress. We found that in a healthy population of students, eating and exercise attitudes were not associated with physiological measures of stress, more specifically, basal cortisol levels. However, we did find that eating attitudes were linked to perceived stress, such that those with negative eating attitudes also reported increased perceived stress. However, we could not confirm a relationship between exercise attitudes and perceived stress. Further, we also
demonstrated that gender plays a large differential role, such that having healthy attitudes
towards eating lead to lower perceived stress in females, while having obligatory
attitudes toward exercise lead to lower perceived stress in males.
Table 1

*Means and Standard Deviations of Descriptive Statistics Split by Gender*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Females (N=26)</th>
<th>Males (N=19)</th>
<th>Total (N=45)</th>
<th>t (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>20.27 (2.24)</td>
<td>20.84 (2.29)</td>
<td>20.51 (2.25)</td>
<td>-.84 (.41)</td>
</tr>
<tr>
<td>Weight</td>
<td>63.82 (12.43)</td>
<td>70.96 (11.15)</td>
<td>66.83 (12.30)</td>
<td>-1.99 (.05)</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>23.74 (3.92)</td>
<td>22.88 (3.18)</td>
<td>23.38 (3.61)</td>
<td>.79 (.44)</td>
</tr>
<tr>
<td>Normal body fat</td>
<td>34.11 (8.57)</td>
<td>22.17 (5.05)</td>
<td>29.07 (9.37)</td>
<td>5.85 (.00)</td>
</tr>
<tr>
<td>Athletic body fat</td>
<td>26.12 (6.47)</td>
<td>13.54 (4.37)</td>
<td>20.80 (8.43)</td>
<td>7.32 (.00)</td>
</tr>
</tbody>
</table>
Table 2

*Means and Standard Deviations of Main Measures Split by Gender*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Females (N=26)</th>
<th>Males (N=19)</th>
<th>Total (N=45)</th>
<th>t (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Cortisol Increase</td>
<td>11.66 (9.82)</td>
<td>11.99 (6.28)</td>
<td>11.80 (8.45)</td>
<td>-.13 (.90)</td>
</tr>
<tr>
<td>Max Cortisol Decrease</td>
<td>23.75 (7.98)</td>
<td>24.87 (5.02)</td>
<td>24.22 (6.84)</td>
<td>-.58 (.57)</td>
</tr>
<tr>
<td>Perceived Stress (PSS)</td>
<td>17.19 (6.49)</td>
<td>13.68 (5.99)</td>
<td>15.71 (5.46)</td>
<td>1.87 (.07)</td>
</tr>
<tr>
<td>Eating Disorder Examination (EDE-Q)</td>
<td>1.42 (1.22)</td>
<td>.78 (.76)</td>
<td>1.15 (1.09)</td>
<td>2.15 (.04)</td>
</tr>
<tr>
<td>Food Intake Ratio (FI-Q)</td>
<td>1.55 (.54)</td>
<td>1.62 (.85)</td>
<td>1.58 (.68)</td>
<td>-.33 (.75)</td>
</tr>
<tr>
<td>Obligatory exercise (OEQ)</td>
<td>40.54 (11.48)</td>
<td>43.00 (9.84)</td>
<td>41.58 (10.77)</td>
<td>-.75 (.46)</td>
</tr>
<tr>
<td>Godin Leisure Time (GLT-EQ)</td>
<td>51.23 (32.03)</td>
<td>113.53 (104.46)</td>
<td>77.53 (77.56)</td>
<td>-2.5 (.02)</td>
</tr>
</tbody>
</table>
### Table 3

**Bivariate Correlation Matrix among primary and secondary variables**

<table>
<thead>
<tr>
<th></th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
<th>7.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cort Incr</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Cort Decr</td>
<td>.517**</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. PSS</td>
<td>.058</td>
<td>-.029</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. EDE-Q</td>
<td>-.108</td>
<td>-.039</td>
<td>.458**</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. FI-Q</td>
<td>-.164</td>
<td>-.030</td>
<td>-.291</td>
<td>-.079</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. OEQ</td>
<td>-.230</td>
<td>.027</td>
<td>.028</td>
<td>.581**</td>
<td>.141</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>7. GLT-EQ</td>
<td>.042</td>
<td>-.045</td>
<td>.034</td>
<td>-.072</td>
<td>-.186</td>
<td>.21</td>
<td>—</td>
</tr>
</tbody>
</table>

*Note.* Cort Incr=maximum cortisol increase, Cort Decr=maximum cortisol decrease, PSS=perceived stress scale, EQE-Q=global eating disorder examination score, FI-Q=food intake ratio good: bad, OEQ=obligatory exercise questionnaire, GLT-EQ=Godin leisure time exercise questionnaire

**p < .01, *p < .05.**
Table 4

*Estimated Coefficients for the Regression models predicting perceived stress food intake, eating attitudes, gender, and eating attitude and gender interaction*

<table>
<thead>
<tr>
<th>Predictor</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>20.07(8.43), &lt;.001</td>
<td>19.56(9.10), &lt;.001</td>
<td>18.63(8.06), &lt;.001</td>
</tr>
<tr>
<td>FI-Q</td>
<td>-2.76(-1.99), .053</td>
<td>-2.44(-1.94), .059</td>
<td>-1.50(-1.17), .25</td>
</tr>
<tr>
<td>EDE-Q</td>
<td>2.59(3.32), .002</td>
<td>3.30(3.63), .001</td>
<td></td>
</tr>
<tr>
<td>gender</td>
<td>-2.84(-1.60), .112</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EDE-Q*gender</td>
<td>-4.17(-2.07), .045</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²(p)</td>
<td>.084(.053)</td>
<td>.191(.002)</td>
<td>.069(.045)</td>
</tr>
<tr>
<td>F (df1, df2)</td>
<td>3.964(1, 43)</td>
<td>7.962(2, 42)</td>
<td>5.678(4, 40)</td>
</tr>
</tbody>
</table>

Note. β(t), p. FI-Q: food intake questionnaire, ratio of good to bad foods; EDE-Q: eating disorder examination, global score
Table 5

Estimated Coefficients for the Regression models predicting perceived stress by leisure time exercise, obligatory exercise attitudes, gender, and obligatory exercise attitudes and gender interaction

<table>
<thead>
<tr>
<th>Predictor</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>15.49(11.19), &lt;.001</td>
<td>15.52(10.95), &lt;.001</td>
<td>16.95(12.26), &lt;.001</td>
</tr>
<tr>
<td>GLT-EQ</td>
<td>&lt;0.01(0.23), .82</td>
<td>&lt;0.001(0.19), .85</td>
<td>&lt;0.01(0.62), .54</td>
</tr>
<tr>
<td>OEQ</td>
<td>0.01(0.13), .89</td>
<td>0.172(0.16), .12</td>
<td></td>
</tr>
<tr>
<td>gender</td>
<td></td>
<td></td>
<td>-3.84(-1.92), .062</td>
</tr>
<tr>
<td>OEQ*gender</td>
<td></td>
<td></td>
<td>-0.42(-2.34), .025</td>
</tr>
<tr>
<td>$R^2$ (p)</td>
<td>.001(.82)</td>
<td>.000(.89)</td>
<td>.11(.025)</td>
</tr>
<tr>
<td>F (df1, df2)</td>
<td>0.05(1, 43)</td>
<td>0.03(2, 42)</td>
<td>2.61(4, 40)</td>
</tr>
</tbody>
</table>

Note. $\beta(t)$, $p$. GLT-EQ: Godin leisure time exercise questionnaire; OEQ: obligatory exercise questionnaire
Figure 1. Salivary cortisol profiles (means and standard errors) of female and male participants averaged across two days.
Figure 2. Effect of gender and global eating disorder examination score (EDE-Q) on perceived stress scale.
Figure 3. Effect of gender and obligatory exercise (OEQ) on perceived stress scale
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Preuß, D., Schoofs, D., Schlotz, W., & Wolf, O. T. (2010). The stressed student:
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