

### Abstract

The multidimensional concept of body image, as experienced by an individual, has immense impact on quality of life, and has recently been linked to various dieting and exercising pathology (Grogan, 2008). The objective of the current study was to evaluate the relationship between body image and "Energy Availability" defined as: net energy [calories consumed minus calories expended in exercise] normalized for lean body mass, among a specific sample of 118 adult female recreational runners. The Appearance Orientation and Appearance Evaluation subscales of the MBSRQ (Cash & Pruzinsky, 2002) as well as a silhouette figural drawing scale were used to assess body image attitudes of participants through an online survey. These measures were separately compared with an individual's Energy Availability, determined through the use of self-reported 3-day food records and activity logs. Additional anthropometric measures including height, weight, age, and body fat percentage were obtained through a laboratory visit during which the patient received an iDXA scan. Energy Availability was observed to have an insignificant negative correlation with both Appearance Orientation scoring and Appearance Evaluation scoring, as well as an insignificant positive correlation with silhouette scoring. The results indicate that individuals who were highly invested in and highly satisfied with their appearance, and who desired a smaller physique displayed the most restrictive (low) Energy Availabilities. A significant portion of the subjects (46%) fell below the Energy Availability threshold of 30 kcal/kg LBM day, recommended to maintain proper reproductive, bone, and physiological functioning (Loucks, 2003). It is therefore necessary to inform avid exercisers and

athletes of their increased energy/caloric intake requirements that result from their physical activity.

Body Image and Energy Availability in Female Runners

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## Introduction

The purpose of the present study is to examine the relationship between body image and eating habits among female recreational runners. Although body image has previously been studied in elite athletes (Petrie, Greenleaf, Reel, & Carter, 2009; Heaney, O'Connor, Naughton, & Gifford, 2008; Rudd & Carter, 2006; Tomten & Hostmark, 2006), there has been less observation in the more general population of physically active individuals. Elite runner studies have supported a negative impact of poor body image with nutritional intake (Beals, 1999). This study examines this same relationship in recreational female runners.

Specifically, this study will observe "Energy Availability" which is defined as:

*(Energy consumed minus energy spent in exercise)/ kg lean body mass*

*(Loucks, 1998).*

It will observe the relationship Energy Availability (EA) has with body image in a sample of women who have consistently run a minimum of 15 miles a week for at least 6 weeks. Since body image is a multidimensional concept, it will be assessed through the use of both the Appearance Evaluation (AE) and Appearance Orientation (AO) subscales of the Multidimensional Body Self Relations Questionnaire (MBSRQ), as well as a self-perception actual to ideal discrepancy determined through the use of silhouette drawings. Each participant's energy balance will be estimated through determining their Energy Availability from energy consumed and expended. The desire to examine the relationship between body image and energy balance in this study defines the three research questions:

1. Does Appearance Orientation, or the degree to which an individual is invested in their appearance, correlate with an individual's Energy Availability?
2. Does Appearance Evaluation, or the degree of criticism an individual places on their appearance, correlate with an individual's Energy Availability?
3. Does the self-ideal discrepancy, determined through the use of a silhouette figural drawing scale, correlate with an individual's Energy Availability?

### **Literature Review**

The multidimensional concept of body image has recently gained heightened awareness in our society (Grogan, 2008; Cash & Pruzinsky, 2002). Body image is no longer thought to be a straightforward mental picture of one's own body, but is a much more complex integration of thoughts and evaluations. The term body image refers to how a person individually experiences their embodiment. This includes their perceptions, beliefs, thoughts, feelings, and actions pertaining to their physical appearance (Cash, 2008). There has been an extensive amount of research on the various impacts an individual's body dissatisfaction has on their quality of life. It has been determined that body image is not a universal experience, but is unique to each individual; no two age or gender groups experience an identical form of body image concern or body dissatisfaction (Hubley & Rusticus, 2006). Therefore, body image has been studied in comparison to many different behaviors, from eating and exercise habits to anxiety and socialization activities. Comparison of body image markers to Energy Availability may be helpful in further identifying the dynamic of poor fueling.

There have been several national surveys conducted in an attempt to understand the severity of body image disturbance in our country, and the issue seems to only be increasing in magnitude. A national survey conducted in 1997 analyzed 4,000 individuals' responses to questions regarding how they see, feel, and are influenced by their bodies (Garner, 1997). The results indicated that 89% of women want to lose weight and 56% of women are dissatisfied with their overall appearance. Although both women and men experience body dissatisfaction, it has consistently been more widespread in females (Rodin, Silberstein, & Striegel-Moore, 1984). It could be predicted that these percentages are even higher today, as female body image disturbance has become so universal that it has been termed a "normative discontent." This term indicates that it has become more commonplace for women to criticize their bodies, than be satisfied with their appearance.

While an individual's body image is formed through the interaction of many factors, body weight has been accepted as the prevailing feature determining one's appearance satisfaction. It has been estimated that as much as 60% of body image is determined by weight alone (Garner, 1997). A study of college females revealed that they perceived their current weight to be 5-23% greater than a healthy weight and 6-26% greater than an attractive weight (Malinauskas, Raedeke, Aeby, Smith, & Dallas, 2006). It is also interesting that these women reported a higher percentage of weight loss necessary to obtain an attractive weight compared to the amount necessary to reach a healthy weight. This indicates that the participants perceive a physically attractive body to be extremely thin and smaller than a healthy, recommended weight. Similar findings were observed in Garner's 1997 national study, in which women

consistently reported an ideal weight lower than their existing weight (Garner, 1997). This pattern was observed regardless of an individual's body dissatisfaction or actual weight, confirming that even women who are currently at the weight desired by most females are still "plagued by feelings of inadequacy".

These feelings of inadequacy have also been attributed to an inaccurate perception of one's own body size. Yale Tockerman (Tockerman & Gardner, 1993) established that the magnitude of body size distortion is related to the perceived discrepancy between the self and the ideal self. Additionally, this self-ideal discrepancy has been identified as a predictor for body image disturbance and disordered eating (Keeton, 1990). The ideal weight Western women identify for themselves is extremely low and is continuously getting smaller; for most women, it could not be obtained through healthy means. As a result of this shrinking ideal, dieting has become an integral part of the lives of many women, especially in their youth (Polivy & Herman, 2007). It is difficult to determine a precise relationship between body image disturbance and disordered eating. The two multidimensional concepts each exist in a continuum with body image attitudes extending from positive body evaluation to complete dissatisfaction (Grogan, 2008), and disordered eating ranging from optimal Energy Availability to low Energy Availability (Lynch & Hoch, 2010). These concepts cooperate and interact differently within each individual's frame of mind. Despite the full spectrum of body image and energy balance possibilities, sub-clinical eating disorders (i.e., an individual with body image and weight control problems similar to clinical eating disorder patients who meets some but not all of the diagnostic criteria) and moderate body

dissatisfaction present frequently among women (Polivy, & Herman, 1987; Beals & Manore, 2000).

The current prejudice against obesity may also contribute to the prevalence of these body image disturbances. A recent survey conducted by Polivy (2007) indicated that dieters and non-dieters alike favor thinness and share a sociocultural preference for thin body types. However, only those who identified themselves as dieters, or those who intentionally restrict food intake as a means of weight control, actively integrated these attitudes toward body size into their own personal values. It is common for women to evaluate their physical body based on an ideal goal of physical thinness, and this can lead them to adopt certain eating patterns and/or exercise behaviors in an effort to reach this goal.

Another study observed the dieting practices of normal weight, overweight, and obese college females, expecting to find a high frequency of dieting (Malinauskas et al, 2006). These researchers underscore that the college experience may provoke dieting in some women as they gain independence and develop a less regulated daily schedule. Disrupted sleeping and eating habits, as well as facility-limited food choices, including unhealthy dining options, often accompany the college lifestyle. The independence and freedom of choice allows for unnoticed diet experimenting such as extreme food restriction and supplement use. These potentially dangerous habits may begin due to a development of body image disturbance. As college females leave their familiar high school environment and are presented with a new group of friends and peers, as well as new body types, it is likely to challenge their body image (Malinauskas et al, 2006). Overall, 83% of the females indicated consciously trying to lose or maintain



their weight through behavior modifications, food restriction, or use of supplements. The most common behaviors practiced included exercising, eating or drinking low fat/fat free versions of foods or drinks, consciously eating less than desired, eating or drinking sugar free versions of foods or drinks, and counting calories. The subjects also indicated that they perceived their current weight to be less than their natural weight, meaning they would expect to be heavier if they discontinued their weight control behaviors. The Malinauskas study highlights the struggle many women experience between body perception, desires, and nutritional manipulations to achieve the desirable body.

Although frequently examined within the college atmosphere, dieting has proven to be popular among all women, regardless of age or environment. A study conducted by Gingras, Fitzpatrick & McCarger (2004) aimed to specifically examine body image disturbances among chronic dieters. The researchers defined a chronic dieter as a person who restricts food choices for two years or more, is persistently concerned with body shape and weight, and is repeatedly dieting to achieve weight loss with or without success. The researchers assessed the body image attitudes of their sample through the use of the Multidimensional Body-Self Relations Questionnaire (MBSRQ) (Cash & Pruzinsky, 2002). This multidimensional instrument allowed the researchers to gain insight into each participant's personal investment in their appearance, fitness, and health. Both physical characteristics and body image attitudes of the chronic dieters were compared to reference norms obtained from the MBSRQ. Despite similarities in height and age, the dieters had greater weight and body mass index (BMI) measures than the reference group. It is interesting to note that while the researchers observed a

positive relationship between chronic dieting and dietary fat restriction, the same relationship was not observed in overall calorie restriction. Additionally, results from the MBSRQ indicated that chronic dieters had significantly lower Appearance Evaluation, lower body satisfaction, and higher self-classified weight than the reference group indicating chronic dieters possess greater concern for their appearance and less satisfaction towards their bodies. The researchers highlighted the need for healthful eating messages to be carefully constructed when given to a dieting population. Weight loss efforts are maintained by many dieters regardless of their actual weight and negative body image persists in spite of being informed of good health status. It has been hypothesized that these weight loss efforts continue because of the individual's negative beliefs about their appearance and body size (Gingras, Fitzpatrick, & McCargar, 2004).

Other research has pointed to negative body image as a predictor of severe eating and dieting pathology, and a lifestyle centered around physical self-consciousness (Petrie et al, 2009; Beals & Manore, 2000). Many young women hold the misguided perception that controlling their weight is solely a matter of will power, and weight change is generally used as the main indicator of a successful diet. This attitude can result in feelings of inadequacy and worthlessness if efforts to reduce weight are not successful (Rosen, 1990). A study of female undergraduate students was conducted to observe the effects of inaccurate weighing, and found that restrained eaters had feelings of self-deprecation after a scale presented their weight as five pound greater than actual weight (McFarlane, Polivy, & Herman, 1998). This indicates that dieting individuals are greatly affected by external factors, and given that these

women became self-rejecting while under the impression of not being a successful dieter suggests that dieting has become part of their identity (Polivy & Herman, 2007). The same study also found that restrained eaters presented lower self-esteem and more concerns for weight and shape in comparison to unrestrained eaters, regardless of inaccurate weighing (McFarlane et al, 1998). These findings bring to light the prevalent interaction between body image and eating habits.

Previous research has argued that the extreme versions of eating abnormalities that present in anorexia nervosa and bulimia nervosa are secondary to an excess concern with weight and shape (Fairburn & Garner, 1986). It is therefore possible that women who are consciously trying to lose or maintain their weight through restrictive eating are more invested in their overall appearance. This relationship was also observed in a study surveying female collegiate athletes (Petrie et al, 2009). Athletes who presented as symptomatic according to results from the Questionnaire for Eating Disorder Diagnoses (Q-EDD) also yielded higher scores on the Appearance Orientation (AO) subscale of the MBSRQ, indicating high individual investment in appearance. Although there was a significant positive relationship between the two variables, the researchers hypothesize that body dissatisfaction is a mediating variable between AO and dietary restraint. The study suggests that female athletes who are highly invested in their appearance are likely to focus on any perceived physical flaws, which would in turn generate body dissatisfaction. The survey results also indicated that symptomatic athletes were more likely to engage in exercise to manage body image anxiety, mood, or physical attractiveness. These findings revealed a division in the motivations of athletes, with exercise incentives specific to appearance rather than health in individuals

who experience body dissatisfaction.

Rudd & Carter (2006) surveyed both male and female athletes at a Midwestern university to gain an understanding of the prevalence of eating disorders and body dissatisfaction (Rudd & Carter, 2006). Since the researchers expected that collegiate athletes are at a higher risk of developing disordered eating habits, it was important to also evaluate the presence of body image disturbance. It has been hypothesized by others that body image disturbance is the distinguishing factor separating eating disorders from other psychological conditions that involve eating abnormalities only on occasion (Rosen, 1990). Disordered eating among the athletes in the Rudd, Carter study was measured using the Q-EDD, and athletes from lean and non-lean sports were evaluated. In this study, lean sports were those that emphasized a thin body type for either performance or aesthetic reasons; this category included sports such as gymnastics, swimming, and cross-country. Of 1,655 athletes studied, eating disorder symptoms presented in 18.8% of lean-sport athletes and 12% of non-lean sport athletes. This frequency of disordered eating is much higher than in the general population, and a chi-square analysis revealed that lean sport athletes presented symptoms at a higher frequency than non-lean sport athletes. Over the course of this two-year analysis, 16 total athletes met the full diagnostic criteria for clinical eating disorders. Body image perceptions were determined using questions regarding real versus ideal body weight, fear of gaining weight or becoming fat, weight perceptions, and contextual body satisfaction. The average current weight of the female athletes surveyed was 143 pounds and the average desired weight was 136 pounds (a loss of 7 pounds or 5% body weight of the average female athlete). Additionally, 59% of the

females indicated that they perceived some parts of their body as "too fat." Further analysis of risky behaviors also indicated that female athletes more frequently participated in the disordered eating habits of vomiting, appetite control pills, and dieting in comparison to male athletes (Rudd & Carter, 2006).

Outside of athletic participation, exercise is considered a healthy habit to improve health and mood (Garner, 1997). However, the relationship between exercise and body image is not as simple. Although exercisers have been shown to have a moderately better body image than non-exercisers (Hausenblas & Fallon, 2006), a cause-effect relationship between the two has not yet been determined. There are also several moderating factors that exist between an individual's exercise behavior and body image. One of these factors is age, because while exercise is associated with increased body image in all age groups, the effectiveness has been observed to decrease with age (Hausenblas & Fallon, 2006). Gender is also suspected as an influencing factor in the exercise/body image relationship as exercise has been shown to have a more positive impact on the body image of males in comparison to females (Hausenblas & Fallon, 2002). Past research has also indicated that the type of exercise can influence body image. Participation in a variety of aerobic and anaerobic exercises as well as strenuous or moderate activity levels have been associated with a more positive body image in both males and females when compared with subjects participating in a single type of exercise (Hausenblas & Fallon, 2006). Numerous factors seem to influence the impact of exercise on body image.

Hausenblas and Fallon (2002) analyzed body image, exercise behavior, BMI, and exercise dependence symptoms in college fitness class participants. The

researchers assessed body image through the use of two different scales. A subscale of the MBSRQ, the Body-Areas Satisfaction Scale, was used to measure body satisfaction, while the Social Physique Anxiety Scale was used to measure overall body anxiety. Among the females, body satisfaction and social physique anxiety were most strongly predicted by the individual's BMI; with a higher BMI associated with greater body dissatisfaction and anxiety. However, in male participants, body satisfaction and social physique anxiety were most strongly predicted by exercise behaviors. These results may highlight the importance females place on their body weight in comparison to their male counterparts.

A potentially important behavioral outcome of a poor body image and body dissatisfaction is the amount of fuel an athlete is willing to consume to support exercise. Low energy intake is common among sports and aerobic activities where a lean body is desirable, and possibly even expected, such as endurance running (Heaney et al., 2008). As a result, exercisers who identify themselves as a "runner" may feel pressure to maintain this stereotypical thin or linear physique and may adjust their eating habits accordingly. Some individuals may intentionally decrease their caloric intake in an effort to control body weight and physique, while others may increase their exercise expenditure for the same reasons. Grogan contends that body image can influence whether an individual follows a healthy diet or intentionally restricts eating; healthful eating habits are most frequently linked to positive body evaluations (Grogan, 2008). One way of measuring an individual's diet is by ensuring they are in energy balance, meaning that the energy (or kilocalories) they consume matches the energy they expend. For athletes to achieve balance, it requires them to fully replace the energy

they use to fuel physical activity by adding those additional kilocalories to their diet (Tomten & Hostmark, 2006). However, especially among females who participate in lean sports or exercise regularly, this compensation of exercise energy does not occur (Heaney et al., 2008). Evaluation of energy balance relative to exercise energy expenditure needs to be estimated alongside body image. This comparative measure of energy balance has become known as Energy Availability among sport dietitians (Loucks, 2004).

Energy Availability for an individual is defined as the energy taken in minus the energy used in exercise, and is normalized by the subject's lean body mass. An individual's lean body mass is the mass of the total body minus fat, and is comprised of bone, muscle, water, and essential tissues. Lean body mass is used as a normalizing factor for Energy Availability because it has been determined to be the most significant predictor of basal metabolic rate (i.e., the energy required by the body in the absence of physical activity) (Cunningham, 1980). This calculated value of Energy Availability is also adjusted for energy expended through exercise and represents the amount of unused energy accessible to carryout the biological functions of the body (Lynch & Hoch, 2010).

Energy Availability depends on energy consumption and exercise expenditure in the exercising population. It can be low in physically active individuals due to an increased exercise energy expenditure, such as increasing weekly mileage. Low Energy Availability can also be the result of reduced intake, such as fasting or restricting calories (Lynch & Hoch, 2010). Fear of weight gain has been frequently accepted as the cause behind a low energy intake in lean sport athletes (Tomten & Hostmark, 2006).

Athletes who participate in a sport where low body weight is considered advantageous, frequently hesitate to increase their caloric intake to provide for the energy expended through exercise. Whether intentional or not, lean sport athletes often practice inadequate fueling which places their health and performance at risk (Loucks, 2004).

Many female athletes may be chronically energy deficient. It is estimated that female athletes consume only 70% of the energy consumed by male athletes when calories are normalized for body weight (Loucks, 2004). A consistently low Energy Availability causes physiological distress, metabolic and hormone abnormalities, an imbalance in the continual breaking down and rebuilding of bones (leading to decreased bone mass), and may eventually decrease physical performance (Loucks, DiPietro, & Stachenfeld, 2006). Exercisers are often hesitant to increase food intake if their weight remains stable. Additionally, since females often engage in physical activity as a means of weight control, reduced caloric intake is commonly an intentional part of the training routine. However, since the body has coping mechanisms to restore energy balance (reducing metabolism, slowing glucose utilization, and decreasing reproductive function) an individual may maintain a stable body weight even if their Energy Availability is consistently low (Lynch & Hoch, 2010).

In past research, exercising women have reported satisfaction with the amount of food they consumed during a low Energy Availability treatment of 15 kcal/kg LBM day, and have struggled to consume the full amount of food required for an adequate Energy Availability treatment of 45 kcal/kg LBM day (Loucks, 1998). According to Loucks, it appears that there is no biological "signal" to increase energy intake in compensation for activity-induced expenditure, indicating that hunger may be an insensitive indicator

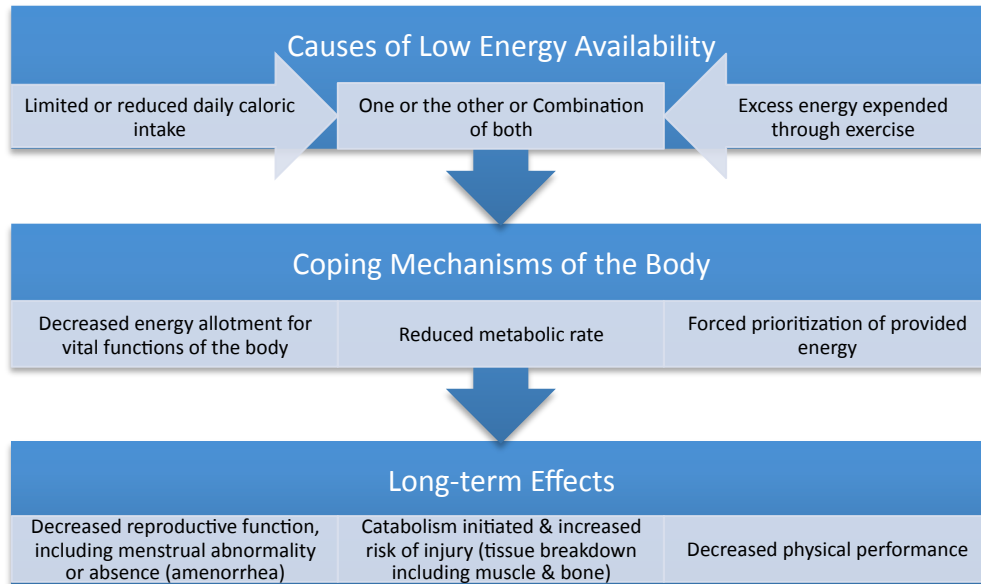


of energy needs (Loucks, 2004; 1998). It is necessary for athletes and avid exercisers to be aware of their energy needs, as menstrual dysfunction, reduced bone mass, and decreased athletic performance can result if they are continuously underfueled (Lynch & Hoch, 2010).

Low Energy Availability has been identified as a proximal cause of menstrual dysfunction in athletic women through its mediating effects on the secretion of luteinizing hormone from the pituitary gland (Loucks, 1998). Luteinizing hormone is essential for reproduction, and plays an important role in female ovulation. The hormone is not released consistently, but rather in highly coordinated "pulses" that fall in a pattern with other hormones of the pituitary, hypothalamus, and ovaries (Harber, 2004). Both the frequency and amplitude of these luteinizing hormone "pulses" have been studied in the presence of inadequate (low) Energy Availability. In a study conducted by Loucks, Verdun, and Heath (1998), the frequency of luteinizing hormone "pulses" was significantly reduced when subjects increased exercise energy expenditure without simultaneously increasing dietary energy intake. This indicates that the synchronous release of luteinizing hormone is related to one's Energy Availability; therefore one's reproductive stability is also related to Energy Availability. The researchers also found that intense exercise alone had no independent effect on luteinizing hormone "pulses," but that exercise contributes to hormone abnormalities only when the energy expended through exercise is not replenished (Loucks, 1998). This indicates that menstrual functioning is not disrupted by intense exercise, but is disturbed by insufficient Energy Availability in exercising individuals.

A second study further examined the correlation between luteinizing hormone and Energy Availability and determined the relationship is not linear, but rather dependent on Energy Availability remaining above a threshold level. The researchers examined dramatically reduced luteinizing hormone "pulses" in subjects with low Energy Availability (10 and 20 kcal/kg LBM), but only observed differences in pulsation when Energy Availability was below 30 kcal/kg LBM (Loucks, 2003). This seminal study revealed the relationship between Energy Availability and luteinizing hormone, and therefore proper reproductive health as it relates to 30 kcal/kg lean mass as a threshold level of Energy Availability. Since luteinizing hormone pulses were only disrupted when the subjects' energy intake fell below 30 kcal/kg LBM, subjects below this level should be aware of the potential biological impacts their eating and/or exercise habits have on their bodies. Informing athletes of the detrimental effects low Energy Availability may have on their health and potentially their physical performance may be a motivating factor for initiating change in those who are not fuelling their bodies properly. The immediate and long-term effects low Energy Availability has on an athlete's body are highlighted in Figure 1.

Figure 1: Progression of underfueling over time.



## Methodology

### Participants

All of the women in the present study qualified as a recreational runner for a parent study titled “Female Athlete Triad in Recreational Endurance Runners”. Accordingly, all participants met the inclusion criteria that they had run at least 15 miles per week for the previous 6 weeks. Subjects were screened and excluded if they had any condition known to affect bone metabolism or were currently taking corticosteroids. All protocol methods were approved by the Biomedical Institution Review Board of The Ohio State University prior to subject participation (protocol 2009H0177)..

### Instruments

#### Body Composition in Parent Study

In the parent study, the iDXA machine was primarily used to determine bone density and body composition of the participants. Four scans were performed on each

participant: hip, forearm, lumbar spine, and total body scans. Bone mass data was not examined in the present study, as the focus of this study was the complex relationship between body image and Energy Availability. However, the total body scan provided a measure of body fat and lean mass for each participant. Lean mass was used to normalize Energy Availability of each subject.

#### Three-day Food Record & Activity Log in Parent Study

In order to determine the Energy Availability (in kilocalories/kg LBM) of each subject, each individual was asked to complete a three-day food record and activity log. Subjects were instructed to record two weekdays and one weekend day to reflect a typical diet. Food records were reviewed during the lab visit with a study dietitian to allow for better accuracy and confirmation. The food records were then analyzed using the computer software Food Processor SQL (ESHA) to determine calories reported for each individual's diet. Physical activity was estimated using the Bouchard grid where subjects rate the intensity of activity in 15-minute increments throughout the day (Bouchard, 1983). Examples of how various types of physical activity would be ranked are presented in Table 1. The grids were tallied and calculated in accordance with the design of the tool. Activities ranked 6 and above in intensity were considered to be "exercise" in the current study, and calories expended through exercise were calculated using total time spent and METS (an expression of the increased energy expenditure that results from an activity in reference to basal metabolic rate) at an activity level of 6 or above. Together, these tools allowed the caloric intake and energy expended in exercise to be determined for each subject leading to the calculation of Energy Availability.

Table 1. Examples of physical activity and corresponding intensity level used for current study.

Examples of physical activity	Intensity level
Sleeping, resting in bed, sitting while eating/writing/watching TV	1-2
Light activity standing (washing cooking, brushing)	3
Slow walk (24 min/mile), driving, dressing, showering	4
Light manual work Floor sweeping, window washing, painting, waiting on tables, house chores, walking 16-24 min/mile	5
Leisure activities and recreational sports Softball, golf, volleyball, canoeing, bowling, cycling slower than 6.2 mph	6
Manual work at moderate pace Loading/unloading, snow shoveling, barn work	7
Leisure or sport activities of higher intensity Canoeing 3-5 mph, biking 6.2-9.3 mph, dancing, skiing, tennis, swim, walking <16 min/mile	8
Intense manual work or competitive sport Carrying heavy loads, running faster than 11 min/mile, soccer, basketball, biking faster than 9.3 mph	9

### Appearance Orientation & Appearance Evaluation

For the interest of this study, body image was assessed using a large multi-questionnaire offered on-line using SelectSurvey prior to the participants laboratory visit. A portion of this larger questionnaire included two subscales of the Multidimensional Body-Self Relations Questionnaire (MBSRQ); these were Appearance Orientation and

Appearance Evaluation. The MBSRQ is a self-report inventory that was designed to assess the affective, cognitive, and behavioral dimensions of body image (Brown, Cash, & Mikulka, 1990). The stability and overall high reliability of this instrument has been proven through factor analysis for both male and female samples, with variables such as age, race, and marital status proving to be non-significant (Brown et al, 1990). The larger MBSRQ includes multi-item subscales regarding the domains of appearance, fitness, and health/illness, but only two appearance scales were used in the present study. The instrument uses a five point Likert scale ranging from 1, "definitely disagree" to 5, "definitely agree" to assess an individual's attitudes toward their physical appearance.

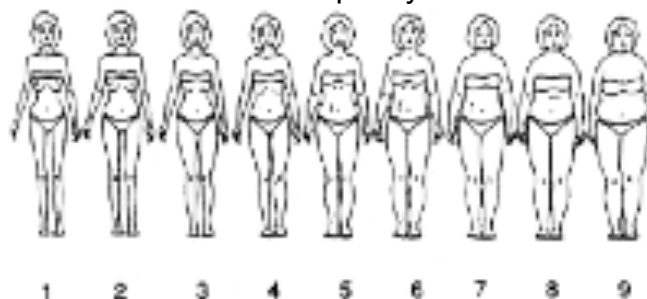
The Appearance Orientation (AO) scale was used in this study to determine the degree of importance physical appearance has to the subject, and what behaviors the individual practices in an effort to maintain or improve their appearance (Brown et al, 1990). A higher score on the AO subscale indicates that an individual is very invested in their physical appearance and their appearance provides a significant source of self-worth. In contrast, a lower score implies that the individual is not invested in their physical appearance and appearance does not play a large contribution in how they define themselves.

The Appearance Evaluation (AE) subscale was also used in this study in order to determine how satisfied an individual is with their physical appearance. A higher AE score demonstrates that an individual is generally pleased with their physical appearance and is not a harsh critic of their appearance. A lower AE score indicates that the individual is dissatisfied with and extremely critical of their appearance.

### Silhouette Drawings

Body perception and dissatisfaction were also measured within SelectSurvey in the present study through the use of female figure silhouette drawings. These scales have been used extensively in body-image research, and have proven to be a valid and reliable indication of body perception and dissatisfaction (Stunkard, 2000). Individuals were presented with a set of 9 silhouette drawings ranging from extremely thin to extremely obese, and were asked to indicate which silhouette represented their current shape and which indicated their ideal body shape. The silhouette drawings the participants were presented with were used to designate their "real" and "ideal" self, and are shown below in Figure 1. The difference between the subjects' actual and ideal figures was used as an indication of the individual's body shape dissatisfaction. In the current study, a negative silhouette difference indicates that the individual's chosen "ideal" silhouette is smaller than what the individual indicated as representing their "real" silhouette. Likewise, a positive silhouette difference indicates that the individual's "ideal" silhouette is larger than their perceived "real" silhouette.

Figure 1. Silhouette drawings used in the present study to determine a self-ideal discrepancy.



## Results

### Participants

The parent study consented 125 participants, with 118 of those participants having the complete data necessary for inclusion in this analysis. As is typical in human research, some subjects failed to provide diet and/or physical activity data (no Energy Availability). All subjects completed the on-line questionnaire, thus had Appearance Orientation, Appearance Evaluation, and Silhouette scores. The descriptive statistics for the 118 final participants are displayed in Table 2.

Table 2. Descriptive statistics for sample of adult recreational female runners analyzed in this study.

<b>Variable of Interest (Units)</b>	<b>Mean (Std Dev)</b>	<b>Range</b>
<b>Age (years)</b>	35.43 (10.13)	18.4-68.4
<b>Height (inches)</b>	64.43 (2.51)	57.5-71.3
<b>Weight (pounds)</b>	129.96 (17.81)	89.2-203.6
<b>% Body fat (per iDXA)</b>	25.52 (5.51)	14.65-42.85
<b>Years of running</b>	10.41 (8.50)	1-35
<b>Current miles per week</b>	22.85 (9.54)	10-70

### Energy Availability

The Energy Availability of each participant was calculated as described. Reported individual daily caloric intakes ranged from 812-2917 kilocalories (kcal) with a mean intake of 1876 kcal ( $\pm 457$  kcal). Daily energy expended through exercise



ranged from 62-1929 kcals with an average of 606.5 kcals expended per day ( $\pm 320$  kcals). Individual energy availabilities ranged from -10.33 kcal/kg LBM to 57.51 kcal/kg LBM, with an average of 31.16 kcal/kg LBM ( $\pm 14.09$  kcal/kg LBM). Energy Availability for 66 of the participants (56%) was above 30 kcals/kg LBM, while 52 of the participants (44%) had energy availabilities below this threshold set by Loucks. The Energy Availability of three participants in this study was found to be negative, indicating extreme under-fueling. To demonstrate the details of negative Energy Availability, the energy balance of these three subjects is shown in Table 3.

Table 3: Data for three subjects determined to have negative Energy Availability

EA	Height (in)	Weight (lb)	Calories in	Calories out	Exercise Calories	Years run /mileage
-10.3	64.3	176.2	914	3394	1378	30/15
-6.2	65.5	127.4	1233	3297	1500	
-5.0	63.0	122.6	1746	4254	1929	

Body Image Scoring

The body image of each participant was measured through the use of three different scoring techniques. Individual scores from the Appearance Orientation (AO) scale of Cash’s MBSRQ ranged from 21 to 55 out of a possible score range of 12-60. This wide range of scores covers all 5 classifications of AO, from "very low" to "very high" and indicates that the sample's AO attitudes were widely varied. The mean overall score of 40.3 with a standard deviation of 6.64 would qualify the sample as a whole as having "very low" Appearance Orientation or not being strongly invested in their appearance (Brown et al, 1990).

Individual scores from the Appearance Evaluation (AE) scale of Cash’s MBSRQ ranged from 10 to 35 out of a possible range of 7-35, which also covers all 5 possible

ranges of AE from "very low" to "very high". This reinforces the varying body image attitudes that were present in the sample. The mean overall score of 26.3 and standard deviation of 4.11 places the sample in the "high" category for AE or being relatively satisfied with their appearance.

Silhouette difference scores ranged from -5 (indicating the individual desired to be 5 figures smaller than she currently perceived her body size) to 1 (indicating the individual desired to be 1 figure larger than she currently perceived her body size). The mean overall score was -1.1, indicating a general desire for a smaller body size among the sample. Any negative score resulting from this instrument indicates a desire for a smaller body size, and 70% of the sample reported a negative score.

### Statistics

Data were downloaded from SelectSurvey into Excel, and scores were calculated according to the tool methodologies. Data were imported into the SAS statistical software program (version 9.2) for statistical analysis (SAS Institute, Inc.). In addition to Energy Availability and the three measures of body image, descriptive statistics (mean, standard deviation, and ranges) are provided for age, height, weight, and body fat percentage of the sample to provide a backdrop for the analysis. The variables of interest (Energy Availability, AO, AE and silhouette difference) were evaluated using the correlation process (Proc Corr) to answer the research questions; a priori significance was defined as  $p=0.05$  and the Pearson correlation was evaluated to determine the strength of the relationship.

### Answering the Research Questions

*1. Does Appearance Orientation, or the degree to which an individual is invested in their appearance, correlate with an individual's Energy Availability?*

A weak negative trend was observed between Appearance Orientation and Energy Availability ( $r=-0.142$ ,  $p=0.125$ ). Though not considered statistically significant, this correlation does represent a trend that as Appearance Orientation score increased in the participants, Energy Availability generally decreased. This relationship was expected, and indicates that individuals who are more focused on their appearance correspond to lower energy availabilities.

*2. Does Appearance Evaluation, or the degree of criticism an individual places on their appearance, correlate with an individual's Energy Availability?*

An insignificant, weaker negative relationship was also observed between Appearance Evaluation and Energy Availability ( $r=-0.069$ ,  $p=0.460$ ). These results, although not reaching significance, contrast the expected result that Appearance Evaluation would strongly correlate Energy Availability, and indicate individuals who are happier with their bodies are maintaining a lower Energy Availability.

*3. Does the self-ideal discrepancy, determined through the use of a silhouette figure drawing scale, correlate with an individual's Energy Availability?*

A positive trend was observed between the silhouette difference score and Energy Availability ( $r=0.180$ ,  $p=0.0511$ ), but was also not "statistically significant". Again, this represents a very important trend that as a silhouette score becomes more negative (or as an individual desires to be smaller than they currently are), Energy Availability also decreases. This trend was the expected result from the research question, and indicates that a negative "real-ideal" differential corresponds to a more restrictive diet

and/or higher exercise energy expenditure. The relationships observed from the analysis of the research questions are highlighted below in Table 4

Table 4: Observed relationships between Body Image Scoring and Energy Availability.

	<b>Appearance Orientation</b>	<b>Appearance Evaluation</b>	<b>Silhouette Scoring</b>
<b>Energy Availability</b>	r=-0.142 p=0.125	r=-0.069 p=0.460	r=0.180 p=0.0511

### Discussion and Conclusion

This study provides some insight into the complicated relationship between body image and eating habits within a female athletic population. Since participation came from runners of many different heights, weights and ages, it is not surprising that their eating habits also showed great variation in terms of net caloric intake and Energy Availability. However, it is alarming that 46% of the women (54 individuals) were determined to have Energy Availabilities less than 30.0 kcal/kg LBM. This threshold proposed by Loucks (2003) indicates the calorie minimum an individual should meet to ensure normal function of luteinizing hormone, an essential hormone in maintaining reproductive health. Additionally, if women consistently come short of this requirement, they put themselves at risk of hypo-estrogenemia (low estrogen), which can result in both reproductive and bone health problems. When an individual's Energy Availability is consistently kept at a level low enough to suppress estrogen levels the rate of bone resorption increases (Loucks, DiPietro, & Stachenfeld, 2006). Increased bone resorption without an increase in bone formation uncouples these mechanisms of bone metabolism, and overtime results in reduced bone mass density and increased risk of

fracture. Since almost half of this sample did not meet the threshold, this represents a need for improvement in the way recreational female runners are fueling their bodies. It is necessary to educate physically active women on the long-term damage they may cause their bodies if they maintain these habits.

Although this high prevalence of under fueling is concerning, it is possible that this percentage is not actually as severe as this study reports. Previous studies have noted that people tend to underestimate the amount of food they have eaten when completing an inventory of their eating habits (Black et al, 1991). If this holds true in this study, some of the women may have omitted some "mindless snacking" from their 3-day food logs by mistake or unknowingly reported smaller portions than they actually consumed. Additionally, activity logs of the participants may not be consistent as the women subjectively chose an activity level for each time interval. If the subjects chose a higher exercise level than they were actually performing for a given workout, their activity logs would display an overestimation of the calories that individual had expended through exercise. Both of these factors individually or combined would decrease the reported Energy Availability of the subjects, thus it is possible that the results may be an overestimate of the number of runners falling below the 30 kcal / kg LBM threshold.

Again, because of the wide range of heights, weights and ages that are represented in the sample, it is not surprising that the variety of Appearance Orientation and Appearance Evaluation scores cover all classifications of both MBSRQ body image assessments. These wide score ranges may also indicate that women who participate in high-endurance sports have very individualized body image experiences. The range

of Appearance Orientation scores may indicate that for some of the participants, the appearance of the body plays a substantial role in their feelings of self-worth, while to other women appearance is an insignificant factor on their sense of self. This may indicate different motivations for running that are present in the sample. For example, subjects who have high Appearance Orientation may engage in running as a means of weight control, as their appearance plays a major influence on their self-esteem, while those who have low Appearance Orientation may run out of enjoyment or for health benefits. The mean Appearance Orientation score categorizes the sample as "very low" in Appearance Orientation, which would indicate that the participants are not highly invested in their appearance. This average ranking implies that the subjects receive the majority of their self-affirmation from sources other than appearance, such as academic ability, work performance, or personal relationships.

Likewise, the variety of Appearance Evaluation scores indicates that not all athletic women evaluate their body similarly. It is clear that not all women who classify themselves as "runners" have the same body type, and even those with similar figures can have very different feelings about their embodiment. Appearance Evaluation covered a wide spectrum in the female runners in this study, but the average score places the group of women in the "high" category, indicating that as a whole they are relatively satisfied with their appearance. One can hypothesize that many of these runners feel as though their running regime helps them achieve this satisfaction. In addition, the neurochemistry of endorphins and enkephalins may allow for this sense of satisfaction (Morgan, 1985).

The perceived "real-ideal" discrepancy presented through the silhouette scoring provides insight into the overall weight-loss desires of the current sample, and seems counter to the AE findings. The average silhouette difference was  $-1.1$ , indicating these physically active women desired to have a smaller body shape than they currently believed they had. This could also represent a general feeling of being overweight or needing to lose weight in order to be considered "normal" as women have consistently held these views in the past (Mintz & Betz, 1986). Only 31% (37 individuals) of the sample did not indicate a desire for a smaller body shape, through having a "real-ideal" discrepancy of 0 or above. Additionally, only 4% (5 individuals) of the sample desired a larger body size than they currently perceived themselves to have. Negative silhouette scores were representative of a general desire for weight loss among the sample, as 69% of the individuals selected an ideal silhouette figure that is smaller than what they perceive to be their current silhouette figure. This desire for a smaller body may be the result of women perceiving themselves as heavier than they actually are, as has been observed in previous studies (Mintz & Betz, 1986). The current Western cultural ideal of an extremely thin physique may also attribute to the general desire for weight loss in this sample. Since the "ideal" figure is nearly impossible to obtain through healthy means, most women may feel that they "fail" to meet the ideal, resulting in their discontent (Polivy & Herman, 2007; Rodin et al, 1984).

Although it was non-significant, the observed negative correlation between Appearance Orientation and Energy Availability would have indicated that a higher individual investment in appearance corresponded with lower Energy Availability. Past researchers have hypothesized that body dissatisfaction is a mediating variable

between AO and dietary restraint (Petrie et al, 2009). This model is applicable to the current study in that dietary restriction (such as limiting calories, skipping meals, or avoiding "bad" foods) and/or overcompensation with exercise would result in a lower Energy Availability. Accordingly, the observed trend between Energy Availability and Appearance Orientation reveals that subjects who are highly focused on their appearance were likely the ones practicing these habits.

The insignificance of the correlation between Energy Availability and Appearance Evaluation limit the commentary, but the weak negative correlation between Appearance Evaluation and Energy Availability was not the anticipated result. Had they reached significance, the findings would have indicated that Energy Availability was higher (more kcal/kg LBM day) in subjects who were less satisfied with their bodies (lower AE score) and lower in subjects who are more satisfied with their bodies. It was expected that Energy Availability would be lower in subjects who were less satisfied with their bodies, as limiting Energy Availability could be a means of changing one's body and potentially becoming more satisfied. Alternatively, the unexpected findings could be an indication that individuals who have been maintaining a more restrictive Energy Availability have a thinner physique and may therefore be more satisfied with their appearance. If women allow themselves to fuel properly, it stands to reason that body size might be larger and this could be a source of dissatisfaction for these runners. Additionally, women who eat more when depressed or dissatisfied may be engaged in a constant cycle of dissatisfaction and eating leading to a larger body size and high dissatisfaction. However, correlative studies provide no clear cause-effect relationship



between the variables of Energy Availability and Appearance Evaluation, and the present correlations were insignificant.

The interaction of these two variables therefore remains a "chicken or the egg" conundrum, as it is difficult to determine which variable precedes the other. It could be that an individual's self-evaluation of appearance would alter their eating and/or exercising habits, (therefore changing their Energy Availability) or the habitual Energy Availability of an individual would result in a particular Appearance Evaluation. The interaction between the two variables is likely complex and is potentially unique to each individual. It is possible that women who reported lower Appearance Evaluation scores are more "tuned in" to what they are eating in comparison to their appearance-satisfied counterparts. Women who are more critical in evaluating their body could be more likely to practice specific eating behaviors and/or dieting techniques. If this occurred in the present sample, it is likely that the food records of unsatisfied individuals are more thorough and less likely to include underestimations or omissions. This would also influence the relationship between Appearance Evaluation and Energy Availability, and may be an important contributor to the data variability.

The positive correlation found between silhouette scoring and Energy Availability was highly anticipated, but is limited statistically as a trend. This indicates that Energy Availability is higher in individuals who desire to gain weight or achieve a larger physique, and Energy Availability is conversely lower in those who desire to lose weight or obtain a smaller physique. If maintained over time, both of these net energy practices would likely direct an individual's body weight in the corresponding and desired direction of gain/loss to become more similar to the idealized larger/smaller silhouette figure.

The results of this study correspond with past research revealing the significant presence of under-fueling and eating disorders within an athletic population, especially female athletes (Heaney et al., 2008, Rudd & Carter, 2006, Tomten & Hostmark, 2006). It is important to take steps to alter these harmful behaviors and prevent their development in the future. The first method of accomplishing this goal should be increasing the nutritional education received by athletic individuals. Female athletes should be made aware of how many calories their diets should contain according to their individual sport, current weight, and training regimen. It is important to also point out to athletes that their level of hunger may not always be an adequate indicator of their energy needs. Since it is possible that physical activity may decrease their desire to eat (Loucks, 2004; 1998), athletes need to fuel their bodies out of habit to ensure that they are meeting their daily calorie requirements. For individuals who are hesitant to increase their energy intake, it may be necessary to ask a professional to help provide a better estimate how much energy they expend through exercise daily and compare it to their intake. These individuals need to be aware that even a moderate calorie deficit can be extremely damaging to their body if it is maintain over a long period of time.

Once athletes are aware of how much energy and re-fueling they should include in their diet, they should also be educated on the potential health consequences that will result if they fail to do so. For junior high, high school, and collegiate athletes this means that information sessions should be held early on, before the initial participation in a sport, in hopes of preventing poor fueling and disordered eating habits from developing. Individuals who are suspect of not following a proper diet should be given extra attention and receive individualized meetings with a registered dietitian. It should be

stressed to the athlete that their eating habits will not only have an impact on their metabolism and physical performance now, but may have a lasting impact on their health in the future. The consequences of disordered eating should not be sugarcoated or suppressed when they are explained to female athletes. An individual who realizes the impact their eating habits will have on their future may become leary of under-fueling their body and will therefore be more likely to develop and maintain healthy habits. Adoption of a healthy lifestyle to reach a healthy body should be the goal.

One of the underlying causes of disordered eating habits among all females is the extremely thin ideal body that is universally present in the western culture. This results in excess concern with weight and body dissatisfaction among all women, including athletes (Fairburn & Garner, 1986). It is important to alleviate this body dissatisfaction, as improving body image can be a means of decreasing the prevalence of disordered eating. Athletes should be made aware that achieving this ideal body is unrealistic. It should be pointed out that there is an extremely low percentage of women who actually embody the figure that is displayed in the media, and that pictures of these women are also digitally altered through airbrushing. It is not realistic to achieve this false beauty.

In addition to educating athletic females, it is important to monitor their health status if they are involved in an organized sport. One method of doing this would be to exclude amenorrheic athletes from participating in training sessions until the reappearance of a normal menstrual cycle, similar to the “no go” status of an injured knee or ankle. This would force athletes to maintain healthy eating habits since the absence of a monthly period is a key indicator of disorder eating and under-fueling.

Another method of monitoring the health of athletes would be to require weight or body fat percentage measurements throughout the duration of their training. Athletes should be made aware that these requirements would be set in place for their own benefit, and that it is not safe to participate in a rigorous training schedule if they cannot maintain a healthy weight. However, measuring weight and body fatness is a highly debatable practice and might actually lead to a higher rate disordered eating when the results are shared with the athletes.

Future research should focus on determining the most effective way to educate athletes about the importance of proper nutrition and persuade them to practice healthy habits in their everyday lives. This study examined the complex relationship between body image and disordered eating because both occur frequently and simultaneously among female athletes. It is necessary to integrate education on both of these topics at a young age for all females. It is hopeful that women who stop trying to achieve an unrealistic body shape and are aware of the health problems they will endure if they are not feeding their body properly will begin to practice a healthier lifestyle.

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