Fall 2019

Disordered Eating in Collegiate Athletes: Prevalence and Relationships with Body Composition

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DISORDERED EATING IN COLLEGIATE ATHLETES: PREVALENCE AND RELATIONSHIPS WITH BODY COMPOSITION

A Thesis

Presented to

The Faculty of the Department of Nutrition, Food Science and Packaging

San José State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Sofia Apsey

December 2019

The Designated Thesis Committee Approves the Thesis Titled

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APPROVED FOR THE DEPARTMENT OF NUTRITION, FOOD SCIENCE AND PACKAGING

SAN JOSÉ STATE UNIVERSITY

December 2019

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ABSTRACT

DISORDERED EATING IN COLLEGIATE ATHLETES: PREVALENCE AND RELATIONSHIPS WITH BODY COMPOSITION

by Sofia Apsey

Performance pressures and emphasis on body weight and shape put collegiate athletes at risk for disordered eating. If not identified early, disordered eating behaviors could develop into a clinical eating disorder. While such behaviors are a known problem, prevalence rates are not well established in collegiate athletes. Disordered eating may also relate to physiological changes in athletes, such as body composition and performance, although this relationship is not well understood. The aims of this research were to 1) determine the prevalence of disordered eating risk in NCAA Division I student-athletes and 2) determine if such behaviors are related to baseline and changes in body composition over a competitive season. Athletes (n=58) competing in eight different sports (football, men's and women's soccer, women's basketball, gymnastics, men's and women's track and field, and women's diving), from an urban university, completed the Eating Attitudes Test (EAT-26) questionnaire and two dual-energy X-ray absorptiometry (DXA) body composition scans, one at preseason and another at postseason. While no risk for disordered eating was found in this sample, visceral adipose tissue (VAT) was positively correlated with EAT-26 scores ($r=0.661$, $p=0.038$) among female gymnasts. Reasons for these findings are unclear; however, it is thought that the ethnic diversity of the sample played a role in the absence of disordered eating risk in this study. Further research is needed to better understand if ethnicity plays a role in disordered eating risk.

ACKNOWLEDGMENTS

I would first like to thank my family and friends for their continuous support throughout my education journey. I truly could not have done it without them. I would also like to thank my research team, particularly Dr. Gieng and Kiley Field, for the long hours, feedback, and overall effort they put towards this project. I would like to thank Dr. Mauldin and Dr. Pignotti for their feedback on this project and encouragement to apply for the Circle of Friends Assistance and Don Eden Award.

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LIST OF ABBREVIATIONS

AN: Anorexia Nervosa
BFM: Body Fat Mass
BMI: Body Mass Index
BN: Bulimia Nervosa
DXA: Dual-Energy X-ray Absorptiometry
EAT-26: Eating Attitudes Test – 26 question version
EDNOS: Eating Disorder Not Otherwise Specified
LM: Lean Mass
NCAA: National Collegiate Athletic Association
PBF: Percent Body Fat
SJSU: San José State University
VAT: Visceral Adipose Tissue

CHAPTER 1

Introduction and Literature Review

Clinical eating disorders affect about 30 million people at least once in their lifetime and are more prevalent in females than males (Hudson, Hiripi, Pope Jr, & Kessler, 2007). Binge eating, obsessive calorie counting, chronic restrained eating, purging, frequent dieting, excessive exercise and the use of laxatives and/or diuretics to lose weight are behaviors that can escalate to abnormal levels, warranting the diagnosis of an eating disorder. At subclinical levels, these behaviors describe disordered eating and increase risk for a clinical eating disorder, especially in susceptible individuals such as collegiate athletes (Greenleaf, Petrie, Carter, & Reel, 2009; Neumark-Sztainer, Wall, Larson, Eisenberg, & Loth, 2011). Due to the psychological and physiological effects of eating disorders on the health of athletes, research focused on identifying such behaviors before they become problematic is essential. The objective of this literature review is to explain the difference between clinical eating disorders and subclinical disordered eating behaviors, identify the prevalence of disordered eating behaviors in collegiate athletes, and assess if such behaviors are related to physiological changes over time, such as changes in body composition.

Disordered Eating and Eating Disorder: What's the Difference?

The Diagnostic and Statistical Manual of Mental Disorders (DSM-V), as defined by the American Psychiatric Association, must be used by a medical professional for the diagnosis of a clinical eating disorder. Specific criteria are used to diagnose anorexia nervosa (AN), bulimia nervosa (BN), and eating disorder not otherwise specified

(EDNOS). Example criteria for AN include significant weight loss or maintenance of 85% of normal weight, fear of “being or becoming fat,” severe body dissatisfaction, and amenorrhea. Criteria for BN include but are not limited to recurrent episodes of binge eating followed by purging (occurring twice per week, for at least three months), lack of control during such binge/purge episodes, and severe body image dissatisfaction. Finally, criteria for EDNOS include all criteria for AN except for amenorrhea and significant body weight loss if the individual still falls within the normal range, all criteria for BN except that the binge-purge cycle occurs less frequently than 2 times per week, for fewer than 3 months, an individual of normal body weight regularly uses purging behaviors after eating small amounts of food, and episodes of repeatedly chewing and spitting food instead of fully swallowing it (American Psychiatric Association, 2013).

It is important to understand these strict criteria as they help define the continuum of disordered eating and eating disorder (Beals, 2004). While eating disorders have specific criteria, disordered eating is a phrase used to describe related behaviors and is not a clinical diagnosis. Disordered eating is defined as any form or pattern of abnormal eating behaviors (Torstveit, Rosenvinge, & Sundgot-Borgen, 2008). While many individuals may have behaviors of disordered eating, such as binge eating, use of laxatives and/or diuretics to lose weight, strict calorie restriction, or an overwhelming desire to be thin, such behaviors may be “subclinical” and not fit the specific criteria mentioned above. Temimah Zucker, a therapist and mentor for the National Eating Disorder Association, differentiates disordered eating behaviors from an eating disorder by the “level of obsession around eating disorder thoughts and behaviors.” She states that “it can be normal to think about food when hungry or what one might have for the next meal" but for those dealing with an eating disorder, the "thoughts are generally all-consuming" (Zucker, 2017). Even if an individual does not meet criteria for an eating disorder, disordered eating can cause psychological and physiological damage over time (Sundgot-Borgen & Garthe, 2011), especially in those who may be predisposed to abnormal eating behaviors such as collegiate athletes (Shriver, H., Wollenberg, & Gates, 2016). Physiological consequences include but are not limited to an increased risk for obesity, bone loss, fluid and electrolyte imbalances, gastrointestinal problems, chronic malnutrition, and even death (Anderson, M., 2018).

While the development and onset of eating disorders and disordered eating behaviors is a complex process, it is hypothesized that contributing factors in women include societal pressures to be thin, poor self-esteem, abuse, dieting, genetic factors, and family dysfunction (Reinking & Alexander, 2005). Though research within this field focused on males is lacking, it is thought that factors that influence this group include exposure to media pressures that highlight the ideal body image and functionality in sports related to muscularity and leanness (Chatterton & Petrie, 2013).

Disordered Eating Behaviors Assessment

To detect early signs of abnormal eating behaviors at the subclinical level, a variety of questionnaires have been developed and validated in several populations, including collegiate athletes (Pope, Gao, Bolter, & Pritchard, 2015). The Questionnaire of Eating Disorder Diagnosis (Q-EDD), Eating Attitudes Test (EAT, 26 and 40 item versions), and the Eating Disorder Inventory (EDI) are examples of common instruments, although many others exist.

The Q-EDD is a 50 item self-report instrument for detecting disordered eating behaviors using the DSM-IV criteria (Mintz, O'Halloran, Mulholland, & Schneider, 1997). This specific questionnaire has been validated in collegiate athletes (Sanford-Martens, Davidson, Yakushko, Martens, & Hinton, 2005) and college women (Tylka & Subich, 2004). The questionnaire aims to classify those with and without an eating disorder diagnosis and differentiate between those with AN and BN diagnoses (Mintz et al., 1997). The majority of recent research examining the prevalence of disordered eating behaviors in collegiate athletes uses the Q-EDD (Chatterton & Petrie, 2013; DiPasquale & Petrie, 2013; Greenleaf et al., 2009; Petrie, Greenleaf, Reel, & Carter, 2008; Sanford-Martens et al., 2005), although some studies have used the EAT-26 and EDI.

The EDI is a 91 question self-assessment, divided into 12 different scales, that aims to identify disordered eating behaviors. While this instrument has been validated in female patients (Clausen, Rosenvinge, Friborg, & Rokkedal, 2011), it has been used successfully in athletes (Beals & Manore, 2002; Reinking & Alexander, 2005).

The EAT-26, created by Garner et al. (Garner, Olmsted, Bohr, & Garfinkel, 1982), is another instrument used to identify risk for disordered eating, but is not intended for a clinical eating disorder diagnosis. It focuses on questions addressing restrictive eating behaviors, binging, and self-induced vomiting. Individuals that score 20 or higher are classified as "symptomatic" and should be referred to a medical professional for evaluation of a clinical eating disorder. This questionnaire has shown adequate reliability in exercisers (Lane, Lane, & Matheson, 2004), collegiate athletes (Pope et al., 2015), and within the clinical setting (Orbitello et al., 2006).

Questions for these disordered eating instruments are generally broken into subscales that focus on thinness, self-esteem, perfectionism, thoughts about food, emotional regulation, body image, weight-loss behaviors, and in some cases, menstrual history. Since self-report questionnaires are not the most reliable sources of data collection, the addition of interviews with a medical professional is best practice when identifying disordered eating behaviors (Beals, 2004).

Eating Disorders and Disordered Eating in the General Population

Based on the above assessment tools, the prevalence of disordered eating can be estimated. While conclusive data are lacking to establish prevalence rates within the general population, clinical eating disorders generally appear in about 0-10% of the population. A large study done in the United States found that out of 4,023 25- to 45-year-old females, 0.3% met criteria for AN and 8.4% met criteria for BN (Reba-Harreleson et al., 2009). Interestingly, while many did not meet the criteria for a clinical eating disorder, 31% of women showed signs of disordered eating behaviors such as purging to lose weight at least once in their lifetime. These rates were similar to a study looking at Brazilian female college students which found 3.3% to 23.9% of their sample engaging in behaviors such as restricting calories, just drinking liquids and vomiting to lose weight (Alvarenga, Lourenço, Philippi, & Scagliusi, 2013). While eating disorder assessment tools do not diagnose clinical eating disorders, they can help to identify individuals at risk. The earlier disordered eating behaviors are detected, the sooner intervention can take place, and the less likely an individual is to develop a clinical eating disorder.

In a London-based study looking at subclinical disordered eating behaviors in the general population, 10% of the 1,608 individuals classified as symptomatic for disordered eating behaviors (Solmi, Hatch, Hotopf, Treasure, & Micali, 2014), as they did not meet the criteria for a clinical eating disorder. While eating disorders and disordered eating behaviors are of much higher concern within the general female population, research shows that such behaviors also exist within the athletic population (DiPasquale & Petrie, 2013; Greenleaf et al., 2009), including male athletes (Anderson, C. & Petrie, 2012; Chatterton & Petrie, 2013). Some even argue that athletes are at higher risk for the development of disordered eating behaviors, due to perfectionist ideals, competitiveness, and pressures to perform (Sundgot-Borgen & Torstveit, 2010). While these two groups are stereotypically assumed to be at lower risk, studies show that eating disorders and disordered eating behaviors are problematic.

Disordered Eating in Athletes vs. Nonathletes

Within the last two decades, disordered eating research has focused on the athlete population. This is likely due to factors thought to increase risk such as perfectionism, competitiveness, desire to succeed no matter what it takes, and constant focus on performance, exercise, and nutrition (Johnson, Powers, & Dick, 1999). Research comparing abnormal eating behaviors of athletes to their nonathlete counterparts is unclear; however, some believe that nonathletes are at a slightly higher risk (Blair et al., 2017; DiPasquale & Petrie, 2013; Kirk, Singh, & Getz, 2001) due to the risk of body dissatisfaction being greater in students who do not participate in collegiate athletics (Blair et al., 2017). In contrast, Sundgot-Borgen and Torstveit found that higher rates of disordered eating behaviors (23.7%) and clinical eating disorders (13.5%) occurred in elite Norwegian athletes when compared to their nonathlete peers (18.6% and 4.6%, respectively) (2004, 2007). While the majority of research suggests that nonathletes are at higher risk to develop such patterns (Blair et al., 2017; DiPasquale & Petrie, 2013; Kirk et al., 2001; Sanford-Martens et al., 2005; Wollenberg, Gena, Shriver, & Gates, 2015), disordered eating behaviors are present among the athlete population as well. Sanford-Martens et al. (2005) found that while rates for disordered eating were lower in collegiate athletes, about one-fifth (18%) showed signs of symptomatic disordered eating behaviors.

Disordered Eating Risk Factors

Risk factors for the development of disordered eating behaviors are complex and include those that are predispositional, psychological, and sociocultural (Wollenberg, Shriver, & Gates, 2015). Predispositional risk factors include those related to genetics, such as gender and ethnicity. Examples of psychological risk factors are those related to perfectionist ideals and body dissatisfaction. Sociocultural risk factors include those projected by friends, family, and media. It is suggested that groups at the highest risk for the development of such behaviors include females (Striegel-Moore, Silberstein, & Rodin, 1986), Caucasian individuals (Johnson et al., 1999), and athletes (Sundgot-Borgen & Torstveit, 2004).

Risk Factors Specific to Athletes

The high pressure and performance-driven environment of athletics could explain why rates of disordered eating behaviors range from 6.6% to 38% in the athlete group (Abrams, Allen, & Gray, 1993). At the same time, athletes are often more aware of and try to modify their body composition to influence performance factors such as strength, speed, agility, and prevention of injury (Roelofs, Smith-Ryan, Trexler, & Hirsch, 2017; Sanford-Martens et al., 2005). Sport-specific risk factors include a constant focus on performance, cutting weight to make specific weight classes, competitive personalities, an obsessive focus on nutrition, injury, and the pressure to perform in front of others (Johnson et al., 1999; Sundgot-Borgen, 1994)

Research has even gone one step further to identify subgroups of sports that could be at greater risk. Scholars have suggested that athletes participating in aesthetically pleasing (Beals & Manore, 2002), lean-focused (Milligan & Pritchard, 2006) and weight class sports (Chatterton & Petrie, 2013) are at increased risk for developing disordered eating patterns; however, there still seems to be a disagreement in the research as others make counterarguments (Goltz et al., 2013). Dr. Ron Thompson, a psychologist that specializes in eating disorders, defines lean sports in *Eating Disorders in Sport.* He states lean sports are those in which "there is a presumed competitive advantage with a thin shape, lean body, and/or low weight, either in terms of a biomechanical advantage (e.g., leanness promotes better running performance) or in terms of an advantage with judges' scoring of aesthetic/appearance sports (i.e., gymnastics)." Lean sports typically include aesthetic (i.e., gymnastics, diving, etc.), endurance (i.e., running, cycling, etc.), and weight class sports (i.e., wrestling, martial arts, etc.). He also states that today there are few sports, if any, "that don't emphasize a lean type" (Thompson & Sherman, 2011).

Prevalence of Disordered Eating in Female and Male Collegiate Athletes

Current research focuses on female athletes, likely due to their higher risk of developing an eating disorder and engaging in unhealthy weight control measures compared to male athletes (Johnson et al., 1999), although conflicting research may suggest otherwise (Sanford-Mertens et al., 2005; DiPasquale & Petrie, 2013). While prevalence rates of disordered eating among the collegiate athlete population are still unclear, many studies have researched this question. In female collegiate athletes, studies using the EAT-26 found that 6.6% to 38% were symptomatic for disordered eating behaviors (Kirk et al., 2001; Milligan & Pritchard, 2006; Shriver, L. H., Wollenberg, & Gates, 2016; Wollenberg, Gena Suela, 2014). Regarding research evaluating this population using different questionnaires, Greenleaf et al. (2009), using the Q-EDD and Bulimia Test-Revised (BULIT-R), found that 25.5% of female athletes classified as symptomatic for subclinical disordered eating, with some engaging in binge eating, strict methods to prevent weight gain, and 2 hours or more per day of exercise specifically focused on burning calories. These results were comparable to the 25% identified by Beals and Hills (2006) and 34.2% found by Beals and Manore (2002) using the EDI. Lower prevalence (7.1%) was observed by Reinking and Alexander (2005). Prevalence rates using the Q-EDD and EDI are generally higher, although the reason for this is not well understood. Scholars have suggested that differences in prevalence rates could be related to the validity and reliability of questionnaires within specific populations, specific sports of athletes studied, the true presence of disordered eating behaviors, and administration techniques of self-report questionnaires (Beals, 2004).

A gap in the literature exists regarding disordered eating and male athletes. While most research focuses on the female population, disordered eating behaviors and attitudes are prevalent in males (Chatterton & Petrie, 2013; Petrie et al., 2008; Sanford-Martens et al., 2005), but have been routinely overlooked until the last decade. Many times in collegiate athletes eating disorder research, sample sizes of female athletes are much larger, making male results negligible. To date, only two studies focus on disordered eating behaviors solely in male collegiate athletes. In both cases, athletes had similar age and BMI demographics (Chatterton & Petrie, 2013; Petrie et al., 2008). Both studies included a large variety of sports, with the majority of athletes from one study involved in football (n=106) (Petrie et al., 2008). Specific sport demographics were not identified in Chatterton and Petrie (2013). Both studies used the Q-EDD questionnaire to determine the risk for disordered eating and found that 16%-19.2% of male collegiate athletes were at risk for disordered eating behaviors.

Three studies exist looking at disordered eating in a combined sample of male and female collegiate athletes (DiPasquale & Petrie, 2013; Milligan & Pritchard, 2006; Sanford-Martens et al., 2005). When analyzing disordered eating risk by gender within these studies, 9%-21.2% of male collegiate athletes were identified as at risk for disordered eating. Surprisingly, DiPasquale and Petrie (2013) and Sanford-Mertens et al. (2005) both found that male athletes had higher prevalence rates when compared to female athletes (6.5% and 14.5%, respectively). Milligan and Pritchard (2006) was the only study that used the EAT-26 to determine disordered eating in male collegiate athletes and found that only 9% of males were at risk, which is much lower than all other studies focused on collegiate athletes.

It is common for disordered eating research to focus on white, female collegiate athletes. While most research does not specify ethnicity as a demographic, the six studies that do contain primarily white student-athletes, ranging from 58.1%-83.9% of the sample (Anderson & Petrie, 2012; Chatterton & Petrie, 2013; DiPasquale & Petrie, 2013; Greenleaf et al., 2009; Petrie et al., 2008; Sanford-Martens et al., 2005). Furthermore, in those that analyzed the relationship between ethnicity and disordered eating status, three studies claimed that there were no significant differences among groups (Anderson & Petrie, 2012; DiPasquale & Petrie, 2013; Petrie et al., 2008). One study suggested that ethnic minority student-athletes, specifically of Hispanic, African American, American Indian, and Asian Pacific Islander descent, were at lower risk for disordered eating compared to white student-athletes across multiple different sports (Greenleaf et al., 2009).

Due to the large variety of sports that exist, studies commonly group them by sport type, including lean, endurance, aesthetic, ball game, power, and technical sports. Furthermore, differences among lean versus non-lean sports, regarding disordered eating prevalence, are typically analyzed as well. Currently, seven studies argue sport and sport type does not relate to differences in disordered eating risk (Beals & Hill, 2006; DiPasquale & Petrie, 2013; Greenleaf et al., 2009; Kirk et al., 2001; Petrie et al., 2008; Shriver et al., 2016; Wollenberg et al., 2015). In spite of this, three studies suggest that sport type does relate to disordered eating behaviors in collegiate athletes (Beals & Manore, 2002; Milligan & Pritchard, 2006; Wells, Chin, Tacke, & Bunn, 2015). Of those studies, researchers suggest that lean sport athletes (Wells et al., 2015), athletes involved in aesthetic sports (Beals & Manore, 2002), females involved in non-lean sports and males participating in lean sports (Milligan & Pritchard, 2006) are at higher risk for disordered eating.

Eating Disorder and Body Composition

Generally speaking, body fatness has negative implications on performance, especially in sports that involve dynamic movement and "translocation of body weight" (Boileau & Horswill, 2000). Increases in lean muscle mass and decreases in body fat mass are often preferred when athletes enter a collegiate program, although this can vary by sport, gender, training type, and volume (Milligan & Pritchard, 2006). Coaches and trainers must understand the importance of proper nutrition and healthy dietary behaviors when expecting athletes to maximize performance through transformation of body composition. Excessive focus on body image, body weight, eating habits, and food choices could encourage athletes to adopt dangerous disordered eating patterns and put them at risk for a clinical eating disorder. While it is known that athletes are a vulnerable group to disordered eating behaviors, there is a significant gap in the literature looking at the relationship between such behaviors and body composition, specifically body fat mass, lean mass, and body fat percentage. While most research focused on disordered eating behaviors collects anthropometric data such as height, weight, and BMI, none have studied fat mass and lean mass using dual-energy X-ray absorptiometry (DXA) in collegiate athletes. This is known as the gold standard instrument for assessing body composition.

More research is needed to establish prevalence rates of disordered eating behaviors within the athlete population and understand how they relate to physiological changes over time. Menstrual dysfunction in female athletes, also known as amenorrhea, is a common consequence of disordered eating and is specifically related to chronic calorie restriction and maintained low body fat percentage. In a study looking at collegiate female athletes, menstrual dysfunction and/or complete amenorrhea was reported in 26%, with the majority coming from lean versus non-lean sports (Beals & Hill, 2006).

Although limited research exists examining the relationship between subclinical disordered eating patterns and body composition, there is ample evidence that clinical eating disorders severely impact physical well-being and performance in sport. One study has shown that subjects with diagnosed AN had significantly lower body weight, lean mass, and fat mass when compared to a control group, which was expected. Interestingly, when patients regained weight back to normal after a 20-week behavioral program, android-gynoid ratios were significantly higher (10% ± 3%), compared to control subjects (El Ghoch et al., 2014). While the mechanism of this rapid abdominal gain is unknown, high android-gynoid ratios are associated with metabolic syndrome and have been shown to increase the risk for chronic conditions such as cardiovascular disease, insulin resistance, and fatty liver disease.

To better understand the relationship between disordered eating and body composition, it seems appropriate to look at body composition at one point in time and longitudinally, as disordered eating behaviors take time to develop. As mentioned above, no current research exists defining this relationship in athletes with limited research looking at changes in body composition over time, specifically fat mass and lean mass.

Subclinical Disordered Eating Behaviors and Body Composition

As previously stated, limited research exists regarding disordered eating behaviors and their relationship with body composition changes over time. This becomes important in collegiate athletics when performance and injury prevention is greatly influenced by the strength and power of lean mass and the weight and protection of fat mass. No current research exists comparing body composition of asymptomatic athletes for disordered eating to symptomatic athletes at the collegiate level; however, there is limited data from studies that look at physical education students in Iran (Rouzitalab et al., 2015), adolescent swimmers from Rio de Janeiro, Brazil (da Costa, Schtscherbyna, Soares, & Ribeiro, 2013), and adolescent Slovenian athletes (Pustivšek, Hadžić, Dervišević, & Carruthers, 2019). Rouzitalab et al (2015) wanted to see if disordered eating behaviors related to differences in body composition and other anthropometrics. Using the EAT-26 questionnaire, they found that 15.4% of male students classified as symptomatic (EAT-26 > 20) when compared to female students (4.6%). They also found that weight, BMI and waist to hip ratio were significantly higher in female students with disordered eating behaviors, but not in male subjects.

da Costa et al. (2013) looked at disordered eating and its relationships to body composition in adolescent swimmers. They found that about 40% of athletes were at risk for disordered eating. Interestingly, through Bioelectrical Impedance Analysis (BIA), they found that those at risk for disordered eating had significantly higher BMI, higher percentages of body fat mass and lower percentages of lean mass (da Costa et al., 2013). Increases in body fat mass could have negative implications on performance.

Finally, a study done by Pustivsek et al. (2019) on adolescent Slovenian athletes aged 15-17 years old, showed that athletes who were at risk for disordered eating (37.7% using the SCOFF questionnaire) had significantly higher BMI values, percentages of body fat, and lower percentages of muscle mass. They used the EAT-26 to assess dietary behaviors but DXA to assess body composition. Currently, studies done by da Costa et al. (2013) and Pustivsek et al. (2019) are the only two available looking at the relationship between disordered eating behaviors and body composition. This warrants the need for further research in populations such as collegiate athletes.

Conclusion

Clinical and subclinical disordered eating behaviors are of concern in the general population and collegiate athletes. It is important to understand the difference between clinical eating disorders and subclinical disordered eating behaviors. Clinical eating disorders, including AN, BN, and EDNOS, must be diagnosed by a medical professional and meet strict DSM-V guidelines. While disordered eating behaviors are also based on these guidelines, they are subclinical in nature but potentiate into a severe eating disorder. Assessing eating disorders and disordered eating behaviors is extremely difficult. Despite this, many self-report questionnaires have been used in different populations to establish prevalence rates, although more research is needed in specific groups such as collegiate athletes.

Disordered eating behaviors are problematic in both female and male athletes, with females reporting more difficulty than males. Furthermore, athletes associated with lean sports, as defined by Dr. Ron Thompson, seem to be at higher risk for the development of disordered eating behaviors. Coaches, athletic trainers, and sports dietitians must understand this to prevent the development of clinical eating disorders and negative consequences that may stem from them. Differences in total weight, body mass index, waist-to-hip ratio, body fat percentage, fat mass and decreased lean mass all relate to individuals with disordered eating behaviors.

Further research is needed to better establish prevalence rates of disordered eating and to clarify the relationships with physiological changes, such as body composition, within the collegiate athlete population. Formatted for the Journal of Science and Medicine in Sport, Chapter 2 will focus on 1) determining the prevalence of disordered eating risk in NCAA Division I student-athletes at an urban university and 2) determining if such behaviors are related to baseline and changes in body composition over a competitive season.

CHAPTER 2

JOURNAL ARTICLE

DISORDERED EATING IN COLLEGIATE ATHLETES: PREVALENCE AND RELATIONSHIPS WITH BODY COMPOSITION

ABSTRACT

Objectives: Disordered eating, although subclinical, increases the risk for clinical eating disorders and has become of concern in US collegiate athletes in part because they are often more aware of and try to modify their body composition to improve performance. Data are lacking to establish prevalence rates of disordered eating to understand the relationship between disordered eating behaviors and body composition in collegiate student-athletes. The aims of this study were 1) to determine the prevalence of disordered eating among NCAA Division I collegiate athletes at an urban university and 2) to determine the relationship between disordered eating risk and body composition.

Methods: NCAA Division I student-athletes (*n* = 58) during the 2018-2019 academic year were recruited from 8 various sports. Disordered eating was assessed using the Eating Attitudes Test (EAT-26) questionnaire. Height and weight were measured and percent body fat, fat mass, lean mass, and visceral adipose tissue were assessed by dual-energy X-ray absorptiometry (DXA) and correlated with EAT-26 scores.

Results: While no athletes were classified as symptomatic for disordered eating (EAT-26 range: 0 to 15), EAT-26 scores were positively correlated with visceral adipose tissue in female gymnasts.

Conclusions: Athletes in this study were not at risk for disordered eating. While the reasons for this are unclear, the sample evaluated is more ethnically diverse than in previous studies. Further research is needed to better understand if ethnicity affects disordered eating risk.

Keywords: eating disorder, athletes, body composition, diet, eating behavior

1. Introduction

Eating disorders are highly complex and must meet strict criteria for clinical diagnosis set by the American Psychiatric Association in the Diagnostic and Statistical Manual of Mental Disorders (DSM-V). However, individuals that do not meet such criteria may still be at risk for subclinical eating behaviors, which is known as disordered eating. These behaviors are problematic and are of concern in the collegiate athlete population.[1] although current prevalence rates vary greatly. While the athletic community is often supportive of personal success and a healthy lifestyle, it may also act as a negative environment when too much emphasis is placed on performance, shape, and body type. Risk factors thought to influence the development of disordered eating behaviors are genetic, psychological, and sociocultural.[2] Furthermore, risk factors specific to athletes include pressures to perform, need to make competition weight classes, and competitive personalities.[3-5] Disordered eating has also been associated with gender,[4] various sports,[6] sport type,[7] and ethnicity[1] and is believed to exist at higher rates in white females (31.8% vs. 14.0% when compared against female minority student-athletes) participating in lean sports.[6]

The development of a clinical eating disorder can disrupt an athlete's mental, emotional, and physical health. Coaches, trainers, and athletic department staff need to understand this as they are ideally positioned to identify disordered eating behaviors early. They also play a central role in creating a healthy environment for athletes to prevent the development of eating disorders. One might assume that individuals with disordered eating behaviors would have lower body weight, BMI, fat mass and lean mass when compared to asymptomatic individuals. Recent research suggests that disordered eating may relate to a higher BMI, a higher percentage of body fat, and lower lean body mass in athletes.[8,9] Differences in body weight, BMI, and body composition could ultimately affect the performance of athletes. While the majority of research on disordered eating is focused on white student-athletes, most likely due to their documented risk of eating disorders and disordered eating behaviors, data are lacking in minority populations. The purpose of this research is to better define prevalence rates of disordered eating in the collegiate athlete population. The primary aims of this study were to 1) determine the prevalence of risk for disordered eating behaviors in collegiate athletes at an NCAA Division I urban university and 2) understand the relationships between such behaviors and anthropometric and body composition measures.

2. Methods

This cross-sectional study was conducted at an NCAA Division I university on the West Coast of the United States during the 2018-2019 academic year. Athletes were recruited through convenience sampling during the Fall 2018, Winter 2019, and Spring 2019 seasons. Included athletes were 18 years or older, enrolled students during the 2018-2019 academic year, members of an NCAA Division I team, and physically healthy prior to and throughout the duration of their entire competitive season. Athletes were excluded from the study if they were injured or unable to participate in their respective sports, had already participated in the study through a different sport (multi-sport athletes), had an existing or prior diagnosis of eating disorder and/or chronic medical condition by a medical professional, or if they were pregnant or planning to become pregnant during the study. Of the 543 student-athletes at the university, 110 were interested and screened. Of those 110, three were injured, and one had an existing chronic condition. When called to schedule an initial appointment, 48 did not respond. Fifty-eight student-athletes were included in the final sample for analysis. Although graduate student-athletes were welcome to participate in the study, all athletes included in the final analysis were undergraduates.

Data were collected during a one-hour appointment, within the initial four weeks of an athlete's specific competitive season. Demographic information including gender, academic year, sport, ethnicity, and hours of training for sport per week, as well as the Eating Attitudes Test (EAT-26) survey, anthropometrics, and body composition, were collected at the appointment by a trained research assistant.

The EAT-26 survey is used to assess behaviors, characteristics, and risks related to eating disorders. It has been validated and used successfully in athletic populations[10,11] at the collegiate level.[12] While it is not intended to diagnose clinical eating disorders, it uses DSM-IV criteria to serve as an initial screening for disordered eating behaviors and includes three different sub-scales: dieting, bulimia and food preoccupation, and oral control.[13] Athletes were initially told that the questionnaire was focused on assessing eating behaviors and debriefed that it was used for identifying disordered eating behaviors after the conclusion of the study. Athletes were classified as symptomatic with EAT-26 scores equal to or greater than 20 and asymptomatic with scores less than 20. Height and weight were measured with a measuring station (Seca 789, Hamburg, Germany). Height was measured to the closest 0.1 centimeters, and weight was measured to the nearest 0.2 pounds, which was later converted to kilograms. Body mass index (BMI) was also calculated. Waist circumference (WC) was measured using a girth measuring tape (Seca 201, Hamburg, Germany) to the closest 0.1 centimeters using the National Health and Nutrition Examination Survey (NHANES) Anthropometry Procedures Manual protocol.[14] A Hologic Horizon W dual-energy X-ray absorptiometry (DXA) scanner (Hologic APEX Software, version 5.6.0.5) was used by a trained DXA technician to assess body composition, which has been validated in many populations, including athletes and active individuals.[15] Because many athletes were taller than the maximum scan area (77 inches), sub-total measurements (whole body minus the head) for body fat percentage (PBF), fat mass (FM), and lean mass (LM) were used for analysis. Estimated visceral adipose tissue (VAT) was calculated by the software after regions of interest were set by the technician.

Athletes were separated by gender, ethnicity, sport, and sport type to determine if these risk factors related to subthreshold EAT-26 scores. While it is difficult to distinguish the difference between lean and non-lean sports, lean sports were defined according to recent literature as those having "presumed competitive advantage with a thin shape, lean body, and/or low weight, either in terms of a biomechanical advantage or in terms of an advantage with judges' scoring of aesthetic/appearance sports."[1,16] Lean sports within this study included women's swimming, women's gymnastics, and men's and women's track and field (n=26). Football was excluded from this analysis due to its position variety and inconsistency with how lean and non-lean sports were defined.

The Institutional Review Board approved the study protocol (F18054) and all participants provided written informed consent before participating in the study. Shapiro-Wilk tests for normality, non-parametric tests including Mann-Whitney and Kruskal-Willis, and Spearman's rho correlations were performed using SPSS Version 25.0 for Mac (IBM Corp., Armonk, NY, USA).

3. Results

A summary of the demographics, EAT-26 scores, and body composition measures of 58 collegiate athletes can be found in Table 1. All athletes were classified as asymptomatic for disordered eating risk (EAT-26 < 20, range: 0-15). Athletes had an average EAT-26 score of 4.9 ± 3.7, with females (5.5 ± 3.8) scoring higher than males (3.4 ± 3.0, p=0.032, Mann-Whitney test). While Native American/American Indian student-athletes had the highest average EAT-26 scores (7.5 ± 5.0), there were no significant differences among ethnic groups (Kruskal-Wallis test). Further, no significant differences in EAT-26 scores were seen between white versus non-white student-athletes (Kruskall-Wallis Test). While women's track and field had the highest mean EAT-26 scores (9.0 ± 5.7), and football had the lowest (3.3 ± 3.4), no significant differences were seen across sports (Kruskall-Wallis test). Furthermore, no significant differences were seen among EAT-26 scores between lean and non-lean athletes (Mann-Whitney test).

Due to the absence of disordered eating risk, we were unable to compare body composition measures between symptomatic and asymptomatic student-athletes. EAT-26 scores were instead correlated with anthropometric and body composition measures to determine relationships, even at the subthreshold level, and can be found in Table 2.

Table 1
Demographics, EAT-26 scores, and body composition of 58 NCAA Division I student-athletes

Factor		Total n (%)	EAT-26	% Body Fat	Fat Mass (kg)	Lean Mass (kg)	VAT (cm^2)
	Total	58	4.9 ± 3.7	28.7 ± 5.7	28.7 ± 5.8	49.0 ± 12.8	52.3 ± 24.7
Gender*	Male	17 (29.3%)	3.4 ± 3.0	24.0 ± 6.8	22.4 ± 11.9	65.6 ± 10.6	74.2 ± 32.2
	Female	41 (70.6%)	5.5 ± 3.8	30.6 ± 4.0	18.9 ± 4.6	42.2 ± 5.0	43.2 ± 12.9
Sport	Football	13 (22.4%)	3.3 ± 3.4	25.9 ± 6.6	25.7 ± 11.8	68.9 ± 9.6	82.4 ± 32.7
	Women's Soccer	13 (22.4%)	4.3 ± 2.6	30.3 ± 3.6	18.1 ± 4.2	40.9 ± 4.2	40.6 ± 11.6
	Men's Soccer	2 (3.4%)	4.0 ± 1.4	18.5 ± 3.1	12.9 ± 2.0	56.7 ± 2.8	48.4 ± 2.5
	Women's Basketball	4 (6.9%)	6.4 ± 6.4	35.5 ± 2.1	26.0 ± 4.4	47.3 ± 7.0	50.2 ± 7.6
	Women's Swimming[1]	12 (20.7%)	4.9± 3.2	32.3 ± 2.4	20.5 ± 2.8	43.0 ± 4.4	50.7 ± 13.8
	Women's Gymnastics[1]	10 (17.2)	7.0 ± 4.2	28.1 ± 4.2	16.3 ± 3.7	41.3 ± 5.7	38.4 ± 9.9
	Men's Track and Field[1]	2 (3.4%)	3.5 ± 0.7	16.8 ± 0.5	10.6 ± 1.2	52.5 ± 4.3	46.5 ± 0.9
	Women's Track and Field[1]	2 (3.4%)	9.0 ± 5.7	25.3 ± 3.0	13.6 ± 1.4	40.1 ± 2.2	24.9 ± 1.2
Sport Type	Non-Lean	19 (42.2%)	4.6 ± 3.5	28.9 ± 5.2	17.6 ± 4.3	42.8 ± 5.5	43.4 ± 10.8
	Lean	26 (57.8%)	5.9 ± 3.7	30.2 ± 5.6	19.2 ± 5.6	43.9 ± 6.9	43.7 ± 13.5
Ethnicity	White	20 (34.5%)	4.9 ± 3.5	29.3 ± 5.8	21.3 ± 7.9	51.3 ± 13.9	56.7 ± 28.7
	Hispanic/ Latino	10 (17.2%)	4.0 ± 3.0	29.1 ± 7.0	19.5 ± 7.9	47.4 ± 13.6	56.7 ± 21
	Black/African American	9 (15.5%)	4.2 ±4.3	24.4 ± 5.5	18.0 ± 6.4	55.3 ± 10.95	48.1 ± 16.2
	Native American/ American Indian	7 (12.1%)	7.5 ± 5.0	30.3 ± 5.4	21.3 ± 10.9	46.5 ± 14.4	53.7 ± 24.3
	Biracial or Multiracial	12 (20.7)	4.5 ± 3.1	29.6 ± 4.3	18.6 ± 5.7	43.3 ± 9.2	43.7 ± 16.7
White/ Non-White	White	20 (34.4%)	4.9 ± 3.5	29.3 ± 5.9	21.3 ± 7.9	51.3 ± 13.9	56.6 ± 28.7
	Non-White	38 (65.5%)	4.9 ± 3.9	28.4 ± 5.8	19.2 ± 7.4	47.8 ± 12.3	50.0 ± 22.3

Values represent the mean ± standard deviation.
[1] Indicates lean sports
* Indicates significance at the <0.05 level. P-values were calculated with Mann-Whitney and Kruskal-Wallis non-parametric tests.
Note. EAT-26 = Eating Attitudes Test, NCAA = National Collegiate Athletic Association

Table 2
Correlation between EAT-26 scores and body composition measures of 58 NCAA Division I student-athletes

			% Body Fat		Fat Mass		Lean Mass		VAT	
		Total n (%)	Rho	P	Rho	P	Rho	P	Rho	P
Gender	Male	17 (29.3%)	0.042	0.872	-0.091	0.728	-0.379	0.134	-0.120	0.647
	Female	41 (70.6%)	0.059	0.713	0.026	0.872	-0.012	0.941	0.102	0.526
Sport	Football	13 (22.4%)	0.294	0.329	0.186	0.543	-0.117	0.704	0.183	0.549
	Women's Soccer	13 (22.4%)	0.355	0.279	0.388	0.190	0.200	0.513	0.150	0.625
	Men's Soccer	2 (3.4%)	-1.000	0.000	-1.000	0.000	-1.000	0.000	-1.000	0.000
	Women's Basketball	4 (6.9%)	-0.800	0.200	-0.800	0.200	-0.400	0.600	-0.600	0.400
	Women's Swimming[1]	12 (20.7%)	0.155	0.631	0.014	0.965	-0.011	0.974	0.204	0.524
	Women's Gymnastics[1]	10 (17.2)	0.247	0.492	0.247	0.492	0.105	0.773	**0.661***	0.038
	Men's Track and Field[1]	2 (3.4%)	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
	Women's Track and Field[1]	2 (3.4%)	-1.000	0.000	1.000	0.000	-1.000	0.000	-1.000	0.000

[1] Indicates lean sports
* Indicates significance at the <0.05 level. P-values were calculated using Spearman's rho non-parametric test.
Note. No significant correlations existed between EAT-26 scores, sport type, ethnicity, and white vs. student-athletes

While no significant correlations were observed between EAT-26 scores and BMI, WC, PBF, FM, and LM when separated by gender, sport, and ethnicity, VAT was positively correlated with EAT-26 scores (r=0.661, p=0.038) among athletes involved in women's gymnastics.

4. Discussion

In this study, the prevalence of disordered eating risk was assessed among 58 NCAA Division I student-athletes representing 8 different sports. To our knowledge, this is one of the few studies to assess the prevalence of disordered eating behaviors in a majority-minority sample of collegiate athletes, as well as understand relationships between body composition and subthreshold EAT-26 scores using DXA. We chose to use the EAT-26, as opposed to alternative questionnaires, because of its short length and validity in athletic populations. No athletes in this study met the criteria for disordered eating risk, which is much lower compared to the wide range in prevalence rates (6%-38%) seen in current literature using the EAT-26 questionnaire.[1,6,17] While this study included primarily female athletes participating in lean sports, a population often associated with a higher risk for disordered eating,[18] 65.6% of the sample was minority student-athletes. This is much higher compared to current literature, which focuses on majority white populations. The conclusions suggested by Greenleaf et al. (2009) that minority students are at lower risk for disordered eating, likely due to differences in cultural opinions of idealized body shape, could explain why disordered eating was absent within the present sample. It is believed that Caucasian individuals are at higher risk for disordered eating behaviors,[1,18,19] which may indicate why most literature focuses on this population. Three widely referenced articles looking at disordered eating in collegiate athlete populations include 64.7-83.9% white student-athletes.[1,17,20] Interestingly in these populations, a higher prevalence of disordered eating behaviors was observed in those that studied a larger percentage of white students. While our study found no significant differences between subthreshold EAT-26 scores across the five different ethnic groups and between white and non-white student-athletes, further research is needed to understand if the low prevalence of disordered eating risk observed in minority groups is true, or due to being overlooked by a focus on primarily white populations.

Literature focused on disordered eating across sports and sport types is mixed. While few suggest that there is no difference in disordered eating risk when comparing lean and non-lean sports,[12,16,21] others show that lean sports, aesthetically pleasing and/or weight class sports are at higher risk.[6,9] Since subthreshold EAT-26 scores were not significantly different between lean and non-lean sports within the present study, it is unclear if significant differences would have been seen between athletes at risk. Further research is needed to understand if these conclusions are similar when disordered eating behaviors are prevalent.

While current literature suggests that disordered eating risk relates to higher percent body fat, higher body fat mass, and lower lean mass in athletes,[8,9] disordered eating behaviors were not detected in the present sample. Therefore, it is no surprise that subthreshold EAT-26 scores were not related to anthropometrics, such as BMI and WC, and body compositional measures such as PBF, FM, and LM. Interestingly, VAT was positively correlated with subthreshold EAT-26 scores in female gymnasts, which is consistent with research findings looking at AN patients that regained weight after a 20-week behavioral program.[22] The mechanism linking the relationship between VAT and disordered eating behaviors is unknown. In populations where disordered eating risk is prevalent, further research is needed to understand physiological changes that stem from disordered eating, specifically those related to body composition and pertinent to collegiate athletes.

A strength of this study was the use of DXA to determine percent body fat, subtotal fat mass, subtotal lean mass, and visceral adipose tissue of student-athletes. While the majority of literature only compares disordered eating risk to basic anthropometric measurements such as height, weight, BMI, and waist circumference, this study went one step further and evaluated specific body compositional components of importance to the athletic population. Unlike current literature, this study also included a diverse sample of student-athletes from many different ethnicities and sports. While the diversity of our sample presents as a strength, it may also exist as a limitation. With a higher percentage of Caucasian athletes participating in lean sports, we may have seen a higher prevalence of disordered eating risk, therefore being able to correlate risk with body compositional measures.

Selection bias limited our study, as one coach did not allow participation due to concerns with how the study might influence known disordered eating behaviors among their student-athletes. Our study was also limited by sample size. Future research should be conducted on larger populations of student-athletes from a vast array of ethnicities, sports, and universities. It is possible that the EAT-26 questionnaire underestimated risk within our sample, as it has not been validated in ethnic minority populations. While self-report questionnaires are convenient, future research within this area should consider the addition of interviews and dietary recall to establish disordered eating risk.

5. Conclusion

Due to a wide range of reported prevalence rates of disordered eating risk and minimal body composition data, this study expands available descriptive data within the collegiate athlete population for these variables. The results from this study suggest that disordered eating is not prevalent within the present NCAA Division I student-athlete sample, unlike current literature focused on collegiate athletes. While EAT-26 mean scores were significantly higher in female athletes, the distribution of scores was not significantly different across ethnicity, sport, sport type, and between white and non-white athletes. Current literature suggests that ethnicity and sport type are correlated with disordered eating prevalence; however, more research is needed examining these relationships. Additionally, subthreshold EAT-26 scores were not significantly correlated with BMI, waist circumference, and body composition components including body fat percentage, fat mass, lean mass, and visceral adipose tissue. Further research is needed to understand the relationships between these specific body composition measures and the presence of disordered eating risk in collegiate athletes.

Practical Implications

- Subclinical disordered eating behaviors vary in prevalence among the collegiate athlete population.

- Disordered eating in athletes can vary from no risk to high risk, warranting the need for assessment in all athletes.
- Minority collegiate student-athletes may be at lower risk for disordered eating behaviors.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgments

We would like to thank each athlete that participated in this study. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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CHAPTER 3

Summary and Recommendations

Eating disorders and disordered eating behaviors are problematic within the general population and in vulnerable populations such as collegiate athletes. Diagnostic protocols for eating disorders including AN, BN, and EDNOS, follow strict criteria. When an individual does not meet the criteria for a clinical eating disorder, however, subclinical disordered eating behaviors such as binge eating, obsessive calorie restriction, purging or use of laxatives and diuretics to lose weight, should not be undermined. Over the last three decades, several self-report questionnaires have been developed to identify risk for disordered eating behaviors based on the DSM-V manual, although current research is inconclusive in determining prevalence rates among specific populations such as collegiate athletes. Females typically report disordered eating behaviors more frequently than males; however, the male population is often overlooked. While eating disorders and disordered eating behaviors fall under psychological criteria, physiological consequences that result from such behaviors are an understudied area of research. This is particularly important in the collegiate athlete population, individuals that are often more aware of ways to adjust eating behaviors to influence body composition and ultimately performance. Because of these gaps in the literature, this study aimed to determine the prevalence of disordered eating behaviors in 58 NCAA Division I student-athletes at an urban university using the EAT-26 questionnaire. Additionally, the study sought to understand the relationship between disordered eating behaviors and changes in body composition over each individual's competitive season. Because disordered eating behaviors were not detected in the sample, subthreshold EAT-26 scores were correlated with body compositional measures instead.

Unlike current literature, no athletes in this study were symptomatic for disordered eating behaviors. The results from this study were unexpected, as literature within this field finds that 6-38% of collegiate athletes are symptomatic for disordered eating behaviors. We had hoped to correlate body compositional changes over the season to disordered eating behaviors; however, disordered eating was not prevalent in the sample and the sample size was limited following post-season scans. Following initial appointments of the study, ten athletes failed to return for their final appointment (n=10), and eleven were excluded due to injury during the season (n=11). Thirty-seven athletes completed the study (n=37), which included only one athlete from women's basketball (n=1) and men's track and field (n=1) and no athletes from women's track and field returned for their final scan. This made a correlation with changes in body composition challenging. For these reasons, we decided to use baseline DXA scan measures only and conduct a cross-sectional analysis. Change in body composition over a competitive season of the 37 remaining student-athletes can be found in Appendix D.

It was not surprising that no relationships were seen between disordered eating behaviors and body composition as all athletes were asymptomatic for disordered eating. The lack of prevalence of disordered eating behaviors in this study may be explained by the diversity of the sample. The majority of current literature examining disordered eating behaviors focuses on white student-athletes, which was not the case in our study sample. While there isn't a consensus about whether ethnicity has a large effect on the development and presence of disordered eating, some suggest that minority individuals are at a much lower risk. Further research is needed to understand this relationship.

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APPENDIX A

IRB APPROVAL

SJSU SAN JOSÉ STATE UNIVERSITY

Office of Research
Division of
Academic Affairs

San José State University
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SAN JOSE STATE UNIVERSITY
HUMAN SUBJECTS INSTITUTIONAL REVIEW BOARD

IRB Notice of Approval

Date of Approval: 5/21/2018

Study Title: The Relationship among Diet Quality, Eating Behavior and Body Composition in Health San Jose State University NCAA Division 1 Athletes

Primary Investigator(s): Dr. John Gieng

Student(s): Sofia Apsey, Kiley Field

Other Team Members: Dr. Kasuen Mauldin, Dr. Giselle Pereira Pignotti

Funding Source: None

IRB Protocol Tracking Number: F18054

Type of Review

☐ Exempt Registration: Category of approval §46.104(d)()
☒ Expedited Review: Category of approval §46.110(a)(4 & 7)
☐ Full Review
☐ Modifications
☐ Continuing Review

Special Conditions
☐ Waiver of signed consent approved
☐ Waiver of some or all elements of informed consent approved
☐ Risk determination for device:
☐ Other:

Continuing Review
☒ Is not required. Principal Investigator must file a status report with the Office of Research one year from the approval date on this notice to communicate whether the research activity is ongoing. Failure to file a status report will result in closure of the protocol and destruction of the protocol file after three years.

APPENDIX B

CONSENT FORM

CONSENT FORM FOR YOUR PARTICIPATION IN A RESEARCH STUDY

TITLE OF THE STUDY

The relationship among diet quality, eating behavior and body composition in healthy San José State University NCAA Division I athletes

NAME OF THE RESEARCHER

John Gieng, PhD, Assistant Professor, San José State University, Department of Nutrition, Food Science, & Packaging

INTRODUCTION

This consent may contain words that you do not understand. Please ask the investigator or the study staff to explain words or information that you do not clearly understand.

This is a research study. Research studies include only people who choose to participate. As a study participant you have the right to know about the procedures that will be used in this research study so that you can make the decision whether or not to participate. The information presented here is simply an effort to make you better informed so you may give or withhold your consent to participate in this research study.

You are being asked to participate in this study because you are a healthy collegiate athlete currently participating on a San José State University NCAA Division I sport.

This study is being sponsored by the Department of Nutrition, Food Science, and Packaging, San José State University.

In order to participate in this study, it will be necessary to give your written consent.

WHY IS THIS STUDY BEING DONE?

The overall purpose of this study is to evaluate the relationship among diet quality, eating behavior and body composition in healthy San José State University NCAA Division I athletes.

There are two specific aims for this research:

1. To identify the prevalence of various eating behaviors in healthy San José State University NCAA Division I athletes and to determine if they are associated with changes in whole body fat and lean muscle levels over a competitive season.

2. To determine the correlation between diet quality calculated through the Dietary Inflammatory Index (DII) score, and bone mineral density (BMD) or self-reported past injury rates in healthy San José State University NCAA Division I athletes, and if these correlations vary based on sport type.

HOW MANY PEOPLE WILL TAKE PART IN THIS STUDY?

About 90 people will take part in this research study at San José State University.

WHAT IS INVOLVED IN THE STUDY?

Initial screening: Determine if you qualify to participate in this study.

All participants must: 1) be at least 18 years old; 2) registered as an SJSU student during the 2018-2019 academic year; and 3) an official member of a SJSU NCAA Division I sports team.

All participants must not: 1) already be enrolled as a participant in this study; 2) currently injured; 3) diagnosed by a medical professional with a chronic disease (ALS, Alzheimer's, dementia, cancer, COPD, cystic fibrosis, diabetes, heart disease, obesity, osteoporosis, or others not listed); 4) diagnosed by a medical professional with an eating disorder (anorexia nervosa, bulimia nervosa, binge eating disorder, pica, rumination disorder, or restrictive food intake disorder); and 5) if female, not currently pregnant or plan to become pregnant during the competitive season.

Visit 1. Begin the informed consent process, describe the study purpose and requirements, and begin the initial data collection.

During the first week of your competitive sports season, pre-season data collection will occur. During this appointment, located at either YUH 242 or HB 103 on the San José State University main campus, you will be asked to complete a paper survey that is comprised of general demographic information, history of injury, and current eating behavior. You will then complete a whole-body dual-energy X-ray absorptiometry (DXA) scan to measure total body fat, lean tissue, and bone mineral density (BMD). The DXA instrument will be performed by either Dr. Gieng, Dr. Mauldin, or Dr. Pignotti, all of whom are certified to operate this instrument.

For the whole-body DXA scan procedure you will need to:

1. Remove all metal objects, including clothing containing metal
2. Remove at least your outer clothes and change into shorts and a t-shirt or wear a hospital gown
3. Measure height & weight
4. Lie on the DXA padded table
5. A research technician will position your body on the table

6. Lie still for 7 minutes for the body composition scan

After your scan, you will be interviewed to complete a 30 minute 24-hour diet recall with either Sofia Apsey or Kiley Field. This in-person initial appointment will take approximately 90 minutes total.

Over the following month, you will be contacted by phone to complete two additional 24-hour diet recalls with either Sofia Apsey or Kiley Field. Each interview will take approximately 30 minutes.

Visit 2. Follow-up data collection and debrief.

During the last week of your competitive season, you will return for a follow-up appointment to complete postseason whole-body DXA scan, to be completed by Dr. Gieng, Dr. Mauldin, or Dr. Pignotti. Additionally, you will be debriefed as part of the conclusion of your participation in this study. This follow-up appointment should take no longer than 30 minutes total.

HOW LONG WILL I BE IN THE STUDY?

Completion of all measures and data collection will take approximately 2-4 months depending on your sport (one competitive season).

You can stop participating at any time. Your decision to withdraw from the study will not affect in any way your status as a SJSU student or athlete.

WHAT ARE THE RISKS OF THE STUDY?

While participating in the study, you are at risk for the side effects described below. You should discuss these with the investigator and/or your doctor if you have questions or concerns. There may be other side effects that we cannot predict.

You will be exposed to very minimal levels of radiation during the DXA scan. The level of radiation exposure for one scan is less than the background levels that a person typically received in one day or on a cross-country flight. Radiation effects are cumulative. You should always inform future doctors of your participation in this study. If you participate in this study, you will be exposed to the minimum number of DXA scans needed to collect data, which is two scans.

However, if you are currently pregnant, this may affect the health of the fetus. Because of this, all participants who are pregnant or planning on getting pregnant during the time frame of the study will not be included to protect the fetus.

If you choose to review your whole-body DXA scan results, which include total body fat, lean tissue and bone mineral density values, you should know that this may pose a psychological risk. Additionally, the survey items related to eating behavior may cause psychological discomfort due to questions related to eating. The identity of your responses will remain completely confidential between you and the research team. If your results provoke body dissatisfaction beliefs or perpetuate disordered eating behaviors, please contact SJSU Counseling and Psychological Services at counseling.services@sjsu.edu, or seek help from a medical professional.

POTENTIAL BENEFITS

If you agree to take part in this study, there may or may not be direct health benefit to you. You may expect to benefit from taking part in this research to the extent that you are contributing to health knowledge. In addition, you will have the opportunity to receive free body composition measures and results, including body fat percentage, lean tissue mass, fat mass, and bone mineral density. Participants can also choose to review general diet information with researchers and learn more about an anti-inflammatory diet.

COMPENSATION

There is no compensation for your participation in this study.

WHAT ARE THE COSTS?

There is no cost to you for the study procedures.

CONFIDENTIALITY

Information will be stored in the investigator's locked file and identified by code only. Original data collection instruments, along with a code key connecting your name to specific information about you, will be locked in a separate, secure location, and only accessible by research team members affiliated with this research study, unless you give written permission to share your information.

Data and findings will be presented to the Nutrition, Food Science and Packaging Department and potentially among larger conferences and publications, however, all data presented will be non-identifiable.

The results of this study may be used for teaching purposes, presented at a professional meeting, or published in a peer-reviewed journal. However, your name or other identifying information will not be used in any publication or teaching materials without your specific permission. Additionally, your data without any identifying information may be used to address other related research questions.

PARTICIPANT RIGHTS

Your participation in this study is completely voluntary. You can refuse to participate in the entire study or any part of the study without any negative effect on your relations with San José State University. You also have the right to skip any question you do not wish to answer. This consent form is not a contract. It is a written explanation of what will happen during the study if you decide to participate. You will not waive any rights if you choose not to participate, and there is no penalty for stopping your participation in the study.

QUESTIONS OR PROBLEMS

You are encouraged to ask questions at any time during this study.

For further information about the study, please contact John Gieng, PhD at john.gieng@sjsu.edu or 408-924-1277.

Complaints about the research may be presented to Dr. Ashwini Wagle at ashwini.wagle@sjsu.edu or 408-924-3110.

For questions about participants' rights or if you feel you have been harmed in any way by your participation in this study, please contact Dr. Pamela Stacks, Associate Vice President of the Office of Research, San José State University, at 408-924-2479.

SIGNATURES

FEMALES: Because the radiation could harm a fetus, we are required to have written consent that you are NOT pregnant before undergoing a DXA scan. If you are pregnant or have any possibility of being pregnant, you cannot participate in any part of this study.

For the initial appointment DXA scan:

I, (print name) ___________________________, am certain that I am NOT pregnant.

Signature: ____ Date: _________________

For the follow-up appointment DXA scan:

I, (print name) ___________________________, am certain that I am NOT pregnant.

Signature: ____ Date: _________________

Your signature indicates that you voluntarily agree to be a part of the study, that the details of the study have been explained to you, that you have been given time to read this document, and that your questions have been answered. You will receive a copy of this consent form for your records.

Participant Signature

____

Participant's Name (printed)   Participant's Signature   Date

Researcher Statement

I certify that the participant has been given adequate time to learn about the study and ask questions. It is my opinion that the participant understands his/her rights and the purpose, risks, benefits, and procedures of the research and has voluntarily agreed to participate.

____

Signature of Person Obtaining Informed Consent Date

APPENDIX C

EAT-26 SURVEY

Instructions: Please check a response for each of the following statements:

	Always	Usually	Often	Sometimes	Rarely	Never
1. Am terrified about being overweight.	❑	❑	❑	❑	❑	❑
2. Avoid eating when I am hungry.	❑	❑	❑	❑	❑	❑
3. Find myself preoccupied with food.	❑	❑	❑	❑	❑	❑
4. Have gone on eating binges where I feel that I may not be able to stop.	❑	❑	❑	❑	❑	❑
5. Cut my food into small pieces.	❑	❑	❑	❑	❑	❑
6. Aware of the calorie content of foods that I eat.	❑	❑	❑	❑	❑	❑
7. Particularly avoid food with a high carbohydrate content (i.e. bread, rice, potatoes, etc.)	❑	❑	❑	❑	❑	❑
8. Feel that others would prefer if I ate more.	❑	❑	❑	❑	❑	❑
9. Vomit after I have eaten.	❑	❑	❑	❑	❑	❑
10. Feel extremely guilty after eating.	❑	❑	❑	❑	❑	❑
11. Am preoccupied with a desire to be thinner.	❑	❑	❑	❑	❑	❑
12. Think about burning up calories when I exercise.	❑	❑	❑	❑	❑	❑
13. Other people think that I am too thin.	❑	❑	❑	❑	❑	❑
14. Am preoccupied with the thought of having fat on my body.	❑	❑	❑	❑	❑	❑
15. Take longer than others to eat my meals.	❑	❑	❑	❑	❑	❑
16. Avoid foods with sugar in them.	❑	❑	❑	❑	❑	❑
17. Eat diet foods.	❑	❑	❑	❑	❑	❑
18. Feel that food controls my life.	❑	❑	❑	❑	❑	❑
19. Display self-control around food.	❑	❑	❑	❑	❑	❑
20. Feel that others pressure me to eat.	❑	❑	❑	❑	❑	❑
21. Give too much time and thought to food.	❑	❑	❑	❑	❑	❑
22. Feel uncomfortable after eating sweets.	❑	❑	❑	❑	❑	❑
23. Engage in dieting behavior.	❑	❑	❑	❑	❑	❑
24. Like my stomach to be empty.	❑	❑	❑	❑	❑	❑
25. Have the impulse to vomit after meals.	❑	❑	❑	❑	❑	❑
26. Enjoy trying new rich foods.	❑	❑	❑	❑	❑	❑

EAT-26: Garner et al. 1982, Psychological Medicine, 12, (871 878); adapted/reproduced by D. Garner with permission.

APPENDIX D

CHANGE IN BODY COMPOSITION OF 37 NCAA DIVISION I STUDENT-ATHLETES

Table 3

Change in body composition measures of 37 NCAA Division I student-athletes over a competitive season

Factor		Total n (%)	Δ % Body Fat	Δ Fat Mass (kg)	Δ Lean Mass (kg)	Δ VAT (cm^2)
Gender	Total	37	0.1 ± 1.4	0.1 ± 1.4	-0.2 ± 1.2	1.4 ± 8.0
	Male	10 (27%)	0.4 ± 0.9	0.5 ± 1.3	-0.1 ± 1.6	3.8 ± 6.8
	Female	27 (73%)	0.3 ± 1.5	-0.5 ± 1.4	-0.2 ± 1.0	0.5 ± 8.4
Sport	Football	7 (18.9%)	0.4 ± 1.1	0.6 ± 1.6	0.2 ± 1.6	4.1 ± 8.0
	Women's Soccer	9 (24.3%)	0.7 ± 1.5	0.4 ± 1.3	-0.4 ± 1.5	1.4 ± 6.0
	Men's Soccer	2 (5.4%)	0.5 ± 0.1	0.3 ± 0.2	-0.5 ± 0.5	4.6 ± 4.1
	Women's Basketball	1 (2.7%)	-0.9	-1.4	-0.3	8.7
	Women's Swimming[1]	10 (27.0%)	-0.7 ± 1.7	-0.4 ± 1.7	0.3 ± 0.7	-0.4 ± 11.6
	Women's Gymnastics[1]	7 (8.9%)	0.4 ± 1.0	0.1 ± 0.7	-0.5 ± 0.7	-0.4 ± 6.2
	Men's Track and Field[1]	1 (2.7%)	0.8	0.3	-1.3	0.0
	Women's Track and Field[1]	0	-	-	-	-
Ethnicity	White	20 (34.5%)	-0.4 ± 1.3	-0.4 ± 1.3	-0.2 ± 1.4	-0.2 ± 7.6
	Hispanic/ Latino	10 (17.2%)	0.8 ± 1.3	0.8 ± 1.3	-0.3 ± 1.0	3.7 ± 6.6
	Black/African American	9 (15.5%)	-0.4 ± 1.0	-0.1 ± 0.8	0.7 ± 1.3	3.8 ± 6.6
	Native American/ American Indian	7 (12.1%)	0.2 ± 0.8	0.1 ± 0.8	0.1 ± 1.0	4.0 ± 6.1
	Biracial or Multiracial	12 (48%)	0.4 ± 1.7	0.1 ± 1.4	-0.4 ± 1.2	-0.9 ± 10.8

Values represent means ± standard deviations.

[1] Indicates lean sports

* Indicates significance at the <0.05 level. P-values calculated by Mann-Whitney and Kruskal-Wallis non-parametric tests.

Note. NCAA = National Collegiate Athletic Association

APPENDIX E

DXA SCAN EXAMPLE