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Prevalence of Disordered-Eating Behaviors in Undergraduate Female Collegiate Athletes and Nonathletes

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Context: As the number of female college students participating in athletics has grown dramatically in the last few decades, sports medicine health care providers have become more aware of the unique health concerns of athletic women. These concerns include disordered eating, amenorrhea, and osteoporosis: the female athlete triad. Disordered eating appears to be central in the triad, and the literature has conflicting data regarding the influence of athletic participation on disordered-eating behaviors.

Objective: To compare disordered-eating symptoms between collegiate athletes (in lean and non-lean sports) and nonathletes.

Design: A volunteer, cross-sectional cohort study of female students during the 2002–2003 academic year.

Setting: A National Collegiate Athletic Association Division I institution.

Patients or Other Participants: Undergraduate females, including 84 collegiate athletes and 62 nonathletes.

Main Outcome Measure(s): Symptoms associated with disordered eating were assessed using the Eating Disorders Inventory-2, a self-report measure of 91 items, and self-reported weight and menstrual function.

Results: The athletes had significantly lower scores in body dissatisfaction ($P = .01$) and ineffectiveness ($P = .002$). No difference in mean body weight was noted between the 2 groups, but the nonathlete group had a significantly lower desired body weight ($P = .004$). Lean-sport athletes had a higher score on body dissatisfaction ($P = .008$) and lower actual ($P = .024$) and desired body weight ($P = .002$) than non–lean-sport athletes. A total of 7.1% of the collegiate athletes and 12.9% of the nonathletes were classified as having a high risk for disordered eating. Within the athlete sample, the high-risk group included 2.9% of the non–lean-sport athletes and 25% of the lean-sport athletes.

Conclusions: In our study, female athletes did not exhibit more disordered-eating symptoms than women who did not participate in collegiate sports. However, our data suggest that lean-sport athletes are at greater risk for disordered eating than athletes in non-lean sports.

Key Words: female athlete triad, nutrition, psychology

The number of female collegiate athletes has grown from approximately 32 000 in 1971[1] to more than 150 000 in 2000 an increase of more than 500%.[2,] This increased participation by women in collegiate sports has brought increased awareness of the unique physiological and behavioral responses of women to athletic activity. Researchers have demonstrated that women derive significant benefits from exercise, including decreased risks for obesity, hypertension, and type II diabetes mellitus.[3,4] Additionally, studies indicate women who engage in organized sports are at lower risk for teen pregnancy, substance abuse, and depression and have a more positive self-image.[5]

Over the past decade, however, sports medicine health care providers have become more aware of the unique health concerns of athletic women. These concerns have included a complex of 3 conditions—disordered eating, amenorrhea, and osteoporosis—collectively termed the *female athlete triad*.[6] Although these 3 conditions are considered unique diagnostic entities, they are intricately related to each other and combine to influence the health of female athletes. Disordered eating, however, may be central to the development of the triad. Two groups[7,8] have shown that disordered eating, particularly caloric restriction, causes menstrual abnormality. These authors investigated the effect of caloric restriction on 2 hormones involved in the menstrual cycle, luteinizing hormone (LH) and gonadotropin-releasing hormone (GnRH). Gonadotropin-releasing hormone is secreted by the hypothalamus and triggers the secretion of LH from the pituitary. Luteinizing hormone, in turn, stimulates the secretion of estrogen by the ovaries. Loucks et al[7] used hormone assay analyses to examine the effects of exercise and disordered eating on serum hormone levels. Their results indicate that low serum LH in exercising women is caused by low energy availability rather than by exercise. Similarly, Warren and Perlroth[8] reported that the primary cause of GnRH suppression in athletes is caloric restriction.

The causes of disordered eating in women are complex and involve social, psychological, and physiologic factors.[5,9,10]

Table 1. Subject Characteristics (Mean ± SD)

	No.	Age (years)	Actual Weight (kg)	Desired Weight (kg)
All athletes	84	19.7 ± 1.1	65.7 ± 8.8	61.9 ± 8.8*
Lean-sport athletes	16	19.3 ± 1.4†	61.2 ± 9.7	56.0 ± 7.2†
Non–lean-sport athletes	68	19.8 ± 1.0	66.8 ± 8.3	63.2 ± 8.6†‡
Nonathletes	62	20.2 ± 1.2†	64.8 ± 11.5	57.9 ± 7.0*‡

*,†,‡Means having the same symbol differ significantly at $P < .05$.

Risk factors contributing to disordered eating in both athletic and nonathletic women include social pressures to be beautiful and thin, poor self-esteem, family dysfunction, sexual abuse, dieting, and biological factors.[5,10] In athletes, additional factors may encourage disordered eating, including self-imposed expectations of athletic perfection and a belief in the inverse relationship between body size and performance.[11] Rosen et al[12] found that 32% of a female collegiate athlete sample practiced pathogenic weight-control behaviors, and 70% of those athletes felt such practices were harmless. Collegiate athletes participating in certain sports are believed to be at greater risk for disordered eating. The ''lean sports'' are those sports that place a competitive or aesthetic value on leanness, including distance running and swimming, gymnastics, dance, and diving.[10,13,14]

Women who compete in organized athletics have conflicting factors that influence eating behaviors. Although athletics have been shown to enhance a positive self-image and decrease the risk for depression among women,[5] additional factors may encourage the development of disordered eating in female athletes. A 1999 National Collegiate Athletic Association study of eating disorders in athletes (562 women and 883 men) showed that 1.1% of the female athletes met the diagnostic criteria for bulimia, but none met the criteria for anorexia nervosa.[15] However, the authors concluded that 13% of the female athletes had ''clinically significant'' pathogenic weight-control behaviors.[15] These results are consistent with those of Sundgot-Borgen,[16] who found that 18% of elite female Norwegian athletes displayed behaviors consistent with eating disorders, compared with only 5% of a group of nonathlete controls. Other researchers have reported similar incidences of disordered eating among female athletes.[16–19]

In contrast, Ashley et al[20] found no difference in eating behaviors between 145 Division I collegiate athletes and a control group of 14 nonathlete subjects enrolled in an advanced program of study. They also found no difference in eating behaviors between lean- and non–lean-sport athletes and athletes in different age groups. Karlson et al[21] examined eating behaviors in female lightweight rowers, distance runners, and a control group (including some varsity athletes) and found no difference in the number of probable eating disorder cases among the 3 groups. Similarly, Marten DiBartolo and Schaffer[22] studied eating attitudes, body satisfaction, and psychological well-being in 94 female athletes and 115 nonathletes at a Division III institution. They reported that ''the scores of the athletes revealed less disordered eating symptomatology and more healthy psychological functioning than the scores of the non-athletes.''[22]

Our research study was stimulated by the conflicting findings of the research regarding the relationship between athletic participation and eating behaviors. We believed there was a need for this study as only one of the previously cited groups compared 2 samples of undergraduate collegiate females (collegiate athletes and nonathletes) at a Division I university. Ashley et al[20] did study athletes and nonathletes at a Division I university, but only 14 nonathlete subjects were surveyed. Therefore, our purpose was to compare disordered-eating symptoms in 2 groups of undergraduate collegiate females (collegiate athletes and nonathletes) at a Division I university. A secondary purpose was to compare disordered-eating symptoms among female athletes in lean sports (swimming and cross-country) and non-lean sports (basketball, volleyball, soccer, field hockey, and softball) and nonathletes.

METHODS

The subjects for this study were female collegiate students representing a sample of convenience at a Division I university, recruited from the female intercollegiate athletes and resident hall volunteers who did not participate in collegiate athletics. A total of 146 undergraduate women consented to participate; 84 were collegiate athletes (mean age = 19.7 ± 1.1 years) and 62 were not athletes in collegiate sports (mean age = 20.2 ± 1.2 years). Athletes were divided into those in lean sports (n = 16) and non-lean sports (n = 68). Before data collection, the study was approved by the university's institutional review board, and all subjects provided informed consent to participate.

Subjects completed a questionnaire regarding age, actual weight, desired weight, height, menstrual history, and exercise habits. Symptoms associated with disordered eating were assessed using the Eating Disorders Inventory (EDI-2; Psychological Assessment Resources, Inc, Odessa, FL), a 91-item self-report measure that uses a Likert response scale for each question.[23] The original EDI had 64 items in 8 subscales: Drive for Thinness, Ineffectiveness, Body Dissatisfaction, Interpersonal Distrust, Bulimia, Perfectionism, Maturity Fear, and Interoceptive Awareness. The EDI-2 added 27 items in 3 additional subscales: Impulse Regulation, Social Insecurity, and Asceticism. Higher scores are in the direction of more symptoms. The EDI-2 has been shown to have high reliability when used in college-aged populations.[23,24]

The EDI-2 subscale scores were compared using the Mann-Whitney *U* test, a nonparametric test of differences. This test was selected on the basis of ordinal data generated from the Likert scales in the EDI-2. Interval data (age, weight) were compared between groups using a one-way analysis of variance and Gabriel post hoc tests. Significance level was established at $P = 0.05$, and the Bonferroni correction was performed for the subscale score Mann-Whitney *U* test comparisons to prevent alpha inflation.

RESULTS

The only significant difference in age was between the lean-sport athletes and the nonathletes (Table 1). Although this dif-

Table 2. Eating Disorder Inventory-2 Subscale Scores (Mean ± SD)

Subscale	All Athletes	Lean-Sport Athletes	Non–Lean-Sport Athletes	Nonathletes	Eating-Disorder Group*	Female Collegiate Group†
Drive for Thinness	4.1 ± 5.0	6.9 ± 7.0	3.5 ± 4.2	6.0 ± 5.7	14.5 ± 5.6	5.5 ± 5.5
Bulimia	0.8 ± 1.6	1.4 ± 1.8	0.7 ± 1.5	1.9 ± 2.8	10.5 ± 5.5	1.2 ± 1.9
Body Dissatisfaction	8.4 ± 6.7‡	13.2 ± 8.0§	7.3 ± 6.0§‖	11.3 ± 7.2‡‖	16.6 ± 8.3	12.2 ± 8.3
Ineffectiveness	0.9 ± 1.6‡	0.9 ± 1.3§	0.9 ± 1.7‖	2.4 ± 3.3‡§‖	11.3 ± 7.8	2.3 ± 3.6
Perfectionism	7.0 ± 4.3	6.7 ± 4.0	7.1 ± 4.4	6.0 ± 5.7	8.9 ± 4.9	6.2 ± 3.9
Interpersonal Distrust	1.9 ± 2.5	1.2 ± 1.1	2.0 ± 2.7	1.9 ± 2.8	5.8 ± 4.7	2.0 ± 3.1
Interoceptive Awareness	1.6 ± 2.2	2.4 ± 2.9	1.4 ± 2.0	2.7 ± 3.1	11.0 ± 6.9	3.0 ± 3.9
Maturity Fear	2.7 ± 3.3	2.3 ± 2.3	2.8 ± 3.6	2.4 ± 2.3	4.5 ± 4.7	2.7 ± 2.9
Asceticism	3.5 ± 2.3	4.4 ± 2.5	3.3 ± 2.3	3.9 ± 2.7	8.3 ± 4.7	3.4 ± 2.2
Impulse Regulation	1.5 ± 3.2	2.2 ± 2.3	1.4 ± 3.3	2.1 ± 3.3	6.0 ± 5.3	2.3 ± 3.6
Social Insecurity	2.5 ± 2.4	3.4 ± 2.7	2.2 ± 2.3	3.3 ± 3.4	8.6 ± 4.9	3.3 ± 3.3

*In the eating-disorder group, n = 889, including 129 anorexia nervosa restrictors, 103 with anorexia nervosa bulimia, and 657 with bulimia nervosa.[22]
†In the female collegiate group, n = 205 female nonpatient collegiate students.[22]
‡§‖Means within a row having the same symbol differ significantly at $P < .01$.

ference was statistically significant, the clinical significance of a 1-year difference in age is questionable. No significant difference was noted in the mean actual body weights between the athlete and nonathlete groups, but the lean-athlete group had the lowest mean actual body weight. As anticipated based on the emphasis on leanness in our culture, all groups of female collegiate students had a lower mean desired body weight than actual body weight. The nonathlete group had a significantly lower desired body weight than the athletes, and the lean-sport athletes had a significantly lower desired body weight than the non–lean-sport athletes.

The comparison of subscale scores (Table 2) between athletes and nonathletes showed no significant difference in 9 of the 11 subscales. It is interesting that both the athlete and nonathlete groups had subscale score values that are similar to values of the female collegiate comparison group reported by Garner.[23] The athletes showed significantly lower (less disordered) scores for the Body Dissatisfaction subscale ($P = .01$) than the nonathletes. This subscale ''measures dissatisfaction with the overall shape and with the size of those regions of the body that are of greatest concern to those with eating disorders.''[23] The athletes in lean sports had a significantly higher Body Dissatisfaction score than the non–lean-sport athletes. However, the Body Dissatisfaction score for the nonathletes and the lean-sport athletes in this study is lower than the Body Dissatisfaction score for the combined disordered-eating group described by Garner and is similar to the nonpatient collegiate student comparison group.[23]

The athletes also had a significantly lower Ineffectiveness subscale score than the nonathletes ($P = .002$). This subscale ''assesses feelings of general inadequacy, insecurity, worthlessness, emptiness, and lack of control over one's life.''[23] Given the Bonferroni correction, the difference on the Drive for Thinness scale was not statistically significant ($P = .013$), but examination of the data showed that the scores for lean-sport athletes (6.9 ± 7.0) and the nonathletes (6.0 ± 5.7) were higher than the scores of the non–lean-sport athletes (3.5 ± 4.2). The Drive for Thinness scale assesses ''excessive concern with dieting, preoccupation with weight, and fear of weight gain.''[23]

Using a preestablished cutoff score of 14 on the Drive for Thinness scale as identifying individuals at risk for disordered eating,[25] we found 7.1% (n = 6) of the collegiate athletes and 12.9% (n = 8) of the nonathletes in this group. Within the athlete group, 2.9% (n = 2) of the non–lean-sport athletes and 25% (n = 4) of the lean-sport athletes were at risk for disordered eating.

Regarding the exercise habits of the nonathletes, we found that 56.4% (n = 35) of these women exercised 3 days or fewer per week and 43.6% (n = 27) exercised 4 or more days per week. A total of 85% (n = 53) of the female nonathletes performed some type of aerobic exercise, with 69.4% (n = 43) performing strengthening exercises and 53.2% (n = 33) performing flexibility exercises. These data suggest that the female nonathlete study participants had variable physical activity levels, but most individuals reported some physical exercise weekly.

Finally, we found no difference between the athlete and nonathlete groups with regard to the prevalence of abnormal menses (oligomenorrhea, amenorrhea). Within both groups, 21% of the subjects reported either oligomenorrhea or amenorrhea. Similarly, no difference was observed in the prevalence of abnormal menses between the lean- and non–lean-sport athletes.

DISCUSSION

Our data do not support the hypothesis that female athletes exhibit greater disordered-eating symptoms than women who do not participate in collegiate sports as assessed by EDI scores, body weight, and menstrual function. In fact, the female athletes had a significantly lower Body Dissatisfaction subscore than the nonathletes, indicating greater satisfaction with their body shape and size. This finding is consistent with the results of the meta-analysis by Smolak et al,[13] who re-

ported that results on this subscale were consistently lower, or less disordered, in athletes than in nonathletes.

The athletes also had a lower Ineffectiveness subscale score, representing a greater sense of control and adequacy in their lives than the nonathletes. These results are in agreement with those of Ziegler et al,[26] who found that a group of elite figure skaters had relative satisfaction with body image. Although it is tempting to conclude that athletic participation may be protective with regard to eating behaviors, Ziegler et al[26] also reported that despite relative body satisfaction, the figure skaters regularly practiced caloric restriction.

Smolak et al[13] noted the inconsistency in the literature on the relationship between athletic participation and disordered-eating behaviors. They performed a meta-analysis of 34 studies on disordered eating involving 2459 athletes and 8858 nonathletes. Studies selected for this meta-analysis included those that compared female athletes and nonathletes regarding eating behaviors or female athletes who completed an eating-disorder questionnaire for which normative data were available (such as the EDI). The 34 studies crossed sport types, age groups, and elite and nonelite competition. The effect size *(d)* was calculated using means and standard deviations of the eating-disorder measure in the athlete and nonathlete groups. The effect size represents the magnitude of the independent variable effect on the dependent variable in standard deviation terms, which can be compared across studies. From the individual study *d* values, an overall effect size was calculated. The authors found an overall effect size of .07, significantly different from zero but marked by considerable heterogeneity. This positive effect size, although very small, supported their hypothesis that athletes ''show more eating problems''[13] than nonathletes. Our findings are not consistent with the results of this meta-analysis.

According to our results, athletes in lean sports did show greater disordered-eating symptoms and were at greater risk for disordered eating than athletes in the non–lean-sports and nonathletes. These data support additional findings of the meta-analysis by Smolak et al.[13] Making sense out of the research on disordered eating in athletes is difficult, because study results have been divergent. This problem is largely a result of different research methods, participants, sports studied, eating-disorder measures, and statistical analyses. However, two themes are consistent across the research findings on disordered eating. First, the risk of disordered-eating behaviors is greater in female athletes than in male athletes. Second, the risk of disordered eating is greater in those sports that emphasize leanness or body image, particularly at higher levels of competition. Our study supports the second theme. Although the ''be-thin-to-win'' mentality is pervasive among female athletes, particularly in lean sports, evidence also exists for the positive effects of athletic participation on female athletes.[9,22] Our study suggests that for women in the non-lean sports, the positive effects of athletic participation outweigh the pressures of competitive collegiate athletics with regard to eating behaviors.

Our study has some limitations that could affect the validity of our results. First, there are limitations regarding the study population. All participants were students at one Midwestern, private, Division I university in one academic year. Second, the sample was one of convenience of 146 female students who agreed to participate in the study. Their consent was obtained after an informational session regarding the study, so some students with eating issues may have chosen not to participate. Another limitation was that our study involved self-reporting of eating behaviors, menstrual function, and body weight.

Ongoing attention to disordered-eating behaviors in collegiate athletes is needed. Although the EDI scores of the athletes were in the ranges described by Garner[23] for a ''normal'' collegiate comparison group, a greater percentage of athletes in the lean-sport group was at high risk for disordered eating using the preestablished cutoff score of 14 on the Drive for Thinness scale.[25] The athletes in the lean sports also had higher mean scores for the Drive for Thinness scale than the non–lean-sport athletes and nonathletes, although this difference was not significant. These data lend support to previous reports that the women who are involved in lean sports are at a higher risk for disordered-eating behaviors than athletes in the non–lean sports and nonathletes.[13,14,27]

Although the details of intervention for disordered eating are beyond the scope of this paper, the best intervention is a sound preventive program. Athletic departments in colleges and universities should target this central issue in the female athlete triad. Because sports medicine providers, including athletic trainers, physicians, and physical therapists, see athletes on a frequent basis, they must be aware of this problem and be involved in prevention programs and early identification of such conditions. Preparticipation examinations should include appropriate screening tools for disordered eating, and educational sessions should be available to promote healthy eating and training methods. Further research should be performed on the pathophysiology of the triad and associated risk factors, the effectiveness of preventive and intervention measures, and the prevalence of this problem in minority populations and younger age groups. The ultimate goal of research should be recognition of the unique health care needs of female athletes to maximize the safe and healthy participation of women in sports.

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REFERENCES

1. National Collegiate Athletic Association. *Achieving Gender Equity: A Basic Guide to Title IX and Gender Equity in Athletics for Colleges and Universities.* 3rd ed. Overland Park, KS: National Collegiate Athletic Association; 1999. ED435362.
2. National Collegiate Athletic Association. *1982–2001 NCAA Sports Sponsorship and Participation Report.* Indianapolis, IN: National Collegiate Athletic Association; 2002.
3. Blair SN, Kohl HW 3rd, Paffenbarger RS Jr, Clark DG, Cooper KH, Gibbons LW. Physical fitness and all-cause mortality: a prospective study of healthy men and women. *JAMA.* 1989;262:2395–2401.
4. Pate RR, Pratt M, Blair SN, et al. Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA.* 1995;273:402–407.
5. Putukian M. The female athlete triad. *Curr Opin Orthop.* 2001;12:132–141.
6. Yeager KK, Agostini R, Nattiv A, Drinkwater B. The female athlete triad: disordered eating, amenorrhea, osteoporosis. *Med Sci Sports Exerc.* 1993; 25:775–777.
7. Loucks AB, Verdun M, Heath EM. Low energy availability, not stress of exercise, alters LH pulsatility in exercising women. *J Appl Physiol.* 1998; 84:37–46.

8. Warren MP, Perlroth NE. The effects of intense exercise on the female reproductive system. *J Endocrinol.* 2001;170:3–11.
9. Putukian M. The female athlete triad. *Clin Sports Med.* 1998;17:675–696.
10. Otis CL, Drinkwater B, Johnson M, Loucks A, Wilmore J. American College of Sports Medicine position stand: the female athlete triad. *Med Sci Sports Exerc.* 1997;29:i–ix.
11. Sanborn CF, Horea M, Siemers BJ, Dieringer KI. Disordered eating and the female athlete triad. *Clin Sports Med.* 2000;19:199–213.
12. Rosen LW, McKeag DB, Hough DO, Curley V. Pathogenic weight control behaviors in female athletes. *Physician Sportsmed.* 1986;14(1):79–86.
13. Smolak L, Murnen SK, Ruble AE. Female athletes and eating problems: a meta-analysis. *Int J Eat Disord.* 2000;27:371–380.
14. West RV. The female athlete: the triad of disordered eating, amenorrhoea and osteoporosis. *Sports Med.* 1998;26:63–71.
15. Johnson C, Powers PS, Dick R. Athletes and eating disorders: the National Collegiate Athletic Association study. *Int J Eat Disord.* 1999;26: 179–188.
16. Sundgot-Borgen J. Prevalence of eating disorders in elite female athletes. *Int J Sport Nutr.* 1993;3:29–40.
17. Davis C, Cowles M. A comparison of weight and diet concerns and personality factors among female athletes and non-athletes. *J Psychosom Res.* 1989;33:527–536.
18. Benson JE, Allemann YE, Theintz GE, Howald H. Eating problems and caloric intake levels in Swiss adolescent athletes. *Int J Eat Disord.* 1990; 4:479–487.
19. Evers CL. Dietary intake and symptoms of anorexia nervosa in female university dancers. *J Am Diet Assoc.* 1987;87:66–68.
20. Ashley CD, Smith JF, Robinson JB, Richardson MT. Disordered eating in female collegiate athletes and collegiate females in an advanced program of study: a preliminary investigation. *Int J Sport Nutr.* 1996;6:391–401.
21. Karlson KA, Becker CB, Merkur A. Prevalence of eating disordered behavior in collegiate lightweight women rowers and distance runners. *Clin J Sport Med.* 2001;11:32–37.
22. Marten DiBartolo P, Shaffer C. A comparison of female college athletes and nonathletes: eating disorder symptomatology and psychological well-being. *J Sport Exerc Psychol.* 2002;24:33–41.
23. Garner DM. *Eating Disorders Inventory-2: Professional Manual.* Odessa, FL: Psychological Assessment Resources, Inc; 1991.
24. Garner DM, Olmsted MP, Polivy J. Development and validation of a multi-dimensional eating disorder inventory for anorexia nervosa and bulimia. *Int J Eat Disord.* 1983;2:15–34.
25. Garner DM, Olmsted MP, Polivy J, Garfinkel PE. Comparison between weight-preoccupied women and anorexia nervosa. *Psychosom Med.* 1984; 46:255–266.
26. Ziegler PJ, Khoo CS, Sherr B, Nelson JA, Larson WM, Drewnowski A. Body image and dieting behaviors among elite figure skaters. *Int J Eat Disord.* 1998;24:421–427.
27. Drinkwater BL, Nilson K, Chesnut CH 3rd, Bremner WJ, Shainholtz S, Southworth MB. Bone mineral content of amenorrheic and eumenorrheic athletes. *N Engl J Med.* 1984;311:277–281.