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Original Research

Prevalence and Association of Exercise Dependence and Eating Disorder Risk in Collegiate Student-Athletes

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Context: Exercise dependence (EXD) is a compulsive and addictive behavior that can negatively affect physical and mental health, leading to significant impairment or distress. Exercise dependence has been associated with symptoms of eating disorders (EDs). Student-athletes are an at-risk population for EXD and EDs given the physical and psychological demands of competitive sports.

Objective: To examine the EXD and ED risks in student-athletes across sex and sport category and to determine the association between EXD and ED.

Design: Cross-sectional study.

Setting: Collegiate athletics.

Patients or Other Participants: National Collegiate Athletic Association Division I and II student-athletes (n = 1885; age = 19.8 ± 1.4 years; females = 69.6%, n = 1312; males = 30.4%, n = 573).

Main Outcome Measure(s): A web-based survey including demographics, the Exercise Dependence Scale-21, the Eating Attitudes Test-26, and questions about pathogenic behaviors.

Results: Overall, 4.9% (n = 92) of the student-athletes were categorized as at risk for EXD (females = 4.8%, n = 63/1312; males = 5.1%, n = 29/573), with differences across sex and sport categories (all: $\chi^2_{8,1885} = 99.1$, $P < .001$). The ED risk in student-athletes (Eating Attitudes Test-2, pathogenic behavior use, or both) was 22.7% (n = 428; females = 25.5%, n = 334/1312; males = 16.4%, n = 94/573), with differences by sex ($\chi^2_{4,1885} = 10.1$, $P = .039$). Multiple logistic regressions indicated a significant association between the risks of EXD and ED for all student-athletes; athletes at risk for EXD were also at greater risk for EDs (odds ratio = 5.104; 95% CI = 3.237, 8.046) than nondependent-asymptomatic athletes (odds ratio = 2.4068; 95% CI = 1.5618, 3.7089).

Conclusions: Although physical activity has become a public health intervention to improve overall health in populations, EXD can be considered a problem related to physical activity. Exercise dependence can negatively affect physical and mental health, whereas EDs may be psychiatric disorders influenced by EXD, as exercise can be a compensatory behavior to achieve weight loss. To minimize the overall risk of EDs in student-athletes, additional education and awareness are needed. Special attention should be given to any student-athletes, in particular females, who display signs of EXD.

Key Words: mental health, disordered eating, excessive exercise

Key Points

- The prevalence of eating disorders continues to be a concern across collegiate student-athletes in all sports.
- Endurance-sport athletes have an increased prevalence for exercise dependence that, in turn, may predispose them to eating disorders.
- Educational interventions that aim to mitigate excessive exercise and disordered eating should focus on their associations with overall health, sport performance, and long-term injuries.

Physical activity and exercise have become public health interventions for disease prevention to improve overall health in populations, specifically to address the rise in obesity prevalence in the United States. The National Center for Health Statistics[1] reported an 11.9% increase in the prevalence of obesity among adults from 1999–2000 through 2017–2018. Furthermore, severe obesity, which increases the risk of obesity-related complications (eg, coronary heart disease, end-stage renal disease, type 2 diabetes, and hypertension), nearly doubled in prevalence during the same time frame.[1] As of March 2020, the United States has an obesity prevalence of 41.9% and a severe obesity prevalence of 9.2%.[2] Current initiatives are specifically targeted toward childhood obesity and include weight management strategies, which are typically composed of balanced nutrition and regular exercise. Significant psychological and physiological benefits may be observed with regular exercise, including improvements in feelings of depression, anxiety, and low self-esteem. Although exercise can positively affect individuals, we must acknowledge that for a subset of people, excessive exercise can become addictive, and at times they may become dependent on it. Therefore, exercise dependence (EXD) or exercise addiction can also be considered a health problem related to physical activity.[3]

Exercise dependence is a compulsive and addictive behavior that can negatively affect physical and mental health, operationalized as a multidimensional maladaptive pattern of exercise leading to clinically significant impairment or distress.[4,5] de Coverley Veale[6] proposed diagnostic criteria in 1987 that included the following: (1) narrowing of the behavioral repertoire, leading to a stereotyped pattern of exercise with a regular schedule once or more daily; (2) salience with the individual giving increasing priority to maintaining the pattern of exercise over other activities; (3) increased tolerance to the amount of exercise performed over the years; (4) withdrawal symptoms related to a disorder of mood after the cessation of the exercise schedule; (5) relief from or avoidance of withdrawal symptoms via further exercise; (6) subjective awareness of a compulsion to exercise; and (7) rapid reinstatement of the previous pattern of exercise and withdrawal symptoms after a period of abstinence.

When an individual becomes preoccupied with exercise, suffers from withdrawal symptoms when ceasing exercise, exercises when medically contraindicated, or experiences negative effects on work and relationships, we should be concerned about EXD.[5] Across the exercising populations, the risk for EXD ranges based on the sport category, assessment tools, and age group. Elite athletes, young women, retired athletes, and high achievers and those who suffer from body image dissatisfaction or addictive personalities may be at increased risk for EXD.[7] Athletes engaging in endurance activities displayed a 14.2% EXD prevalence compared with those engaging in ball sports (10.4%) or power disciplines (6.4%).[8] Additionally, prevalence rates for university athletes were higher (6%–9%) than those for nonathlete regular exercisers (3%–7%).[9] Individuals with disordered eating behaviors frequently use exercise compulsively to burn calories, but many individuals who do not have a clinical eating disorder (ED) may also fit the criteria for EXD, and they have a higher prevalence of EXD than those without an ED.[3,10,11] The *Diagnostic and Statistical Manual of Mental Disorders*[4] recognizes EDs (eg, anorexia nervosa, bulimia nervosa, binge eating disorder, and other specified feeding disorders and EDs) as mental health conditions; however, EXD does not have an official diagnosis. Two types of EXD have been proposed. Primary EXD presents as a significant preoccupation with exercise, withdrawal symptoms, distress or impaired function, and no history of another mental health disorder. Secondary EXD can be a complication of an ED.[12]

A bidirectional intertwined association has been proposed between EXD and EDs, and it has been noted that they cannot exist independently. Kostrzewa et al[13] investigated the relationship between excessive exercise and EDs, finding that the odds of an ED diagnosis were 2.5 times higher among excessive exercisers than among individuals who engaged in low activity levels. However, other researchers[14] indicated that EXD will always be secondary, as it is a manifestation of EDs, and that without an ED, EXD cannot be considered a clinically relevant syndrome.[15] Not considering EXD as a syndrome is concerning, as it may present with weight and shape preoccupations, negative attitudes toward nutrition, a drive for thinness, and body image dissatisfaction. Similarly, these same concerns and preoccupations are commonly observed in individuals diagnosed with EDs and those who engage in disordered eating behaviors.[16]

Across the United States, general college students are at risk for EDs, with 35.7% screened being "high risk" for EDs.[17] In addition to being students, collegiate student-athletes face additional demands and stressors associated with their sports, which in turn may predispose them to further mental health challenges, including disordered eating and EDs. Compared with nonathletes, athletes have a higher risk for EDs, and female athletes present with additional predisposing factors.[18,19] Athletes who participate in aesthetic sports, or "leanness"-focused sports, have an increased risk for EDs, given that a thin or lean body or low body weight is perceived as the norm or an advantage to performance.[20]

Therefore, the purpose of our study was to examine EXD and the risk for EDs in student-athletes by sex and sport category. A secondary objective was to determine the association between the EXD and ED risks across student-athletes. We hypothesized that females would have an increased risk for EXD and EDs compared with males and the prevalence would be higher in endurance and aesthetic sports. Additionally, we hypothesized that those athletes at risk for EXD would have increased odds of also being at risk for EDs.

METHODS

Study Design

The study was part of a larger investigation with a cross-sectional design. The data included were descriptive in nature and based on a web-based survey developed from previously validated instruments for quantitative analysis examining EXD and the risk for EDs. This research was approved by the institutional review board. All recruits completed an online informed consent form with the opportunity to decline participation and withdraw from the study at any time.

Participants

Student-athletes from National Collegiate Athletic Association (NCAA) Divisions I and II were invited to complete the survey. A total of 1885 (age = 19.8 ± 1.4 years; females = 69.6%, n = 1312; males = 30.4%, n = 573) individuals from 40 institutions participated in the study. Volunteers were included if they were at least 18 years of age and an active member of a team during the completion of the survey. No exclusion criteria were used.

Instrumentation

Demographic Questionnaire. Basic personal and demographic information, including age, sex, race or ethnicity, self-reported height and weight (current, lowest, highest, and ideal), and academic status were obtained. We classified academic status as freshman (first-year students), sophomore (second-year students), junior (third-year students), senior (fourth-year students), or fifth-year or graduate student. Student-athletes reported their primary sport, and these data were further organized by sport category using the Sundgot-Borgen[21] classification: endurance (eg, cross-country, swimming, and track middle and long distance), aesthetic (eg, cheerleading, dance, diving, and equestrian), power (eg, football, track and field, and track sprints), non-lean events (discus, hammer, and shot put), ball and team (eg, baseball, basketball, softball, soccer, volleyball, and beach volleyball), and technical sports (eg, golf, tennis, and track and field lean events [high jump and javelin]).

Exercise Dependence Scale-21. The Exercise Dependence Scale-21 (EDS-21) was used to assess EXD. Originally, the EDS was developed with 36 items and then revised to 27 with an internal consistency of 0.93.[22] The instrument was based on the *Diagnostic and Statistical Manual of Mental Disorders-IV*[23] criteria for substance dependence. It consists of the following 7 subscales and was reduced to 21 items: tolerance ($\alpha = .78$), withdrawal ($\alpha = .93$), continuance ($\alpha = .89$), lack of control ($\alpha = .82$), reduction in other activities ($\alpha = .67$), time ($\alpha = .88$), and intention effects ($\alpha = .92$). The 21 items were scored on a 6-point Likert scale (1 = *never* to 6 = *always*), and scores were calculated as the sum of all items. Higher scores indicate more characteristics of EXD, and the tool further differentiates among (1) the risk for EXD, (2) nondependent symptomatic, and (3) nondependent asymptomatic. The EDS-21 specifies if participants present with evidence of (1) physiological dependence (ie, evidence of tolerance and withdrawal) or (2) no physiological dependence (ie, no evidence of tolerance or withdrawal).

Eating Attitudes Test-26. Student-athletes completed the Eating Attitudes Test-26 (EAT-26), a self-administered screening tool that allows clinicians to identify characteristics and behaviors associated with EDs. Originally a 40-item tool, the EAT-26 now contains 26 items scored on a Likert scale (*always* = 3, *usually* = 2, *often* = 1, *sometimes* = 0, *rarely* = 0, *never* = 0) with 1 item that is reverse scored; the intercorrelations suggest the EAT-26 is highly predictive of the total EAT-40 ($r = 0.98$).[24] Five items focus on pathogenic behaviors (ie, binge eating; vomiting; use of laxatives, diet pills or diuretics; excessive exercise; or loss of $\geq$9.07 kg [20 lbs] in the last 6 months) to control or lose weight, 4 items are scored on a Likert scale based on time frames, and the final question is answered either *yes* or *no*. Scores can range from 0 to 78 across the following 3 subscales: dieting, bulimia, and food preoccupation or oral control. Participants with scores of $\geq$20 who are engaging in $\geq$1 pathogenic behavior to control or lose weight or both were defined as *at risk* for EDs, following the guidelines provided by Garner et al.[24]

Procedures

After receiving approval of the study from the institutional review board, we used a snowball sampling method to recruit volunteers. Athletic trainers at NCAA Division I and II institutions were contacted via email and asked to forward the invitation email and web-based survey link to their student-athletes. Student-athletes were able to access the web-based survey via SurveyMonkey for 1 month, and the athletic trainers received 3 reminder emails at 10-day intervals asking them to disseminate the survey to their student-athletes.

Statistical Analysis

All statistical analyses were carried out using SPSS (version 28; IBM Corp) with a significance level of $P < .05$. We carried out 2 a priori power analyses using G*Power statistical software (version 3.1.9.4; Heinrich-Heine Universität Dusseldorf). The first analysis was for sex; applying χ^2 tests, α of .05, and a moderate effect size (0.3), our power calculation indicated a sample of 440 was needed (females = 220, males= 220) for estimated power of 0.95. For the sport category, using χ^2 tests and a large effect size (0.4), our power calculation indicated a sample size of 132 participants (females = 66, males= 66) was needed for estimated power of 0.90. All demographic information (eg, age, sex, height, weight, body mass index, and academic status), EDS-21 scores, EAT-26 scores and subscale scores were examined using basic descriptive statistics, including means, SDs, and frequencies. We calculated a 1-way analysis of variance to compare the EDS-21 total score, EAT-26 total score, and subscale scores with sex and sport category. If assumptions for the homogeneity of variances were not met, the Welch F test was computed, and Games-Howell post hoc tests were used to determine the mean differences within each group. Cross-tabulations and χ^2 analyses were performed to examine the proportion of participants classified as at risk for EXD using the EDS-21 and for EDs using the EAT-26 by sex and sport category; all assumptions for χ^2 analyses were met. A multiple logistic regression was conducted to identify EXD as a predictor of risk for EDs using the combined total and stratified by sex. The variables for EXD as a predictor were (1) at risk, (2) nondependent symptomatic, and (3) nondependent asymptomatic.

RESULTS

A total of 1950 collegiate student-athletes from 40 NCAA Division I and II institutions began the study and 1885 completed it, yielding a rate of 96.7% (females = 69.6%, n = 1312, age = 19.8 ± 1.4 years; males = 30.4%, n = 573, age = 19.6 ± 1.4 years) and ultimately meeting the estimated power calculation. Student-athletes were engaged in a total of 23 sports, which we categorized via the Sundgot-Borgen guidelines[21]: endurance (37.3%, n = 704), aesthetic (18.6%, n = 351), power (9.2%, n = 174), ball and team (25.4%, n = 478), and technical (9.4%, n = 178). Academic status was as follows: 29.1% (n = 548) freshmen (first-year students), 26.1% (n = 492) sophomores (second-year students), 23.8% (n = 448) juniors (third-year students), and 21.1% (n = 397) seniors (fourth-year students) and graduate students. Self-reported physical measures are displayed in Table 1.

Exercise Dependence

According to the EDS-21, 4.9% (n = 92; females = 63, males = 29) of student-athletes were at risk for EXD, with differences by sex and sport category ([all: $\chi^2_{8,1885}$ values = 99.1, $P < .001$). The proportions of those at risk for EXD are presented in Table 2. Raw scores for the EDS-21 are given in Table 3. Differences were observed for sport category and EDS-21 total scores (Welch $F_{1,1880} = 35.6$, $P < .001$). The Games-Howell post hoc test revealed differences between endurance (54.4 ± 21.4) and aesthetic (40.7 ± 16.0; $P < .001$), ball and team (50.7 ± 19.0; $P = .019$), and technical (47.7 ± 18.5; $P < .001$) and between aesthetic (40.7 ± 16.0) and power (50.4 ± 18.2; $P < .001$), ball and team (50.7 ± 19.0; $P < .001$), and technical (47.7 ± 18.5; $P < .001$) sports.

The Risk for EDs

The ED risk across student-athletes is provided in Table 4. Overall, 22.7% (n = 428) of student-athletes presented

Table 1. Demographic Information, Mean ± SD[a]

Characteristic	Sport(s)					
	All (N = 1885)	Endurance (n = 704)	Aesthetic (n = 351)	Power (n = 174)	Ball and Team (n = 478)	Technical (n = 178)
Females, No.[a]	1312	445	296	109	334	128
Age, y	19.8 ± 1.4	20.1 ± 1.4	19.7 ± 1.4	20.1 ± 1.8	19.4 ± 1.3	20.1 ± 1.4
Weight, kg						
Current	63.3 ± 10.1	61.8 ± 8.6	59.2 ± 8.1	69.9 ± 16.8	66.8 ± 9.1	62.7 ± 8.0
Ideal	60.8 ± 8.9	59.6 ± 7.6	56.5 ± 6.6	66.1 ± 14.0	64.6 ± 8.5	60.1 ± 6.5
Current – ideal	2.5 ± 3.5	2.2 ± 2.7	2.7 ± 3.2	3.8 ± 5.6	2.2 ± 4.1	2.5 ± 2.8
Height, cm	167.8 ± 9.9	168.5 ± 11.5	163.8 ± 6.6	167.4 ± 13.5	170.7 ± 8.6	167.9 ± 6.1
Body mass index, kg/m^2	22.5 ± 4.0	21.9 ± 4.2	22.0 ± 2.4	25.4 ± 8.5	22.9 ± 2.4	22.2 ± 2.3
Males, No.[a]	573	259	55	65	144	50
Age, y	19.6 ± 1.4	19.5 ± 1.3	19.9 ± 1.7	19.6 ± 1.7	19.7 ± 1.3	20.1 ± 1.2
Weight, kg						
Current	83.0 ± 12.4	79.7 ± 8.3	83.0 ± 19.4	96.1 ± 17.1	84.2 ± 10.0	79.2 ± 6.4
Ideal	84.5 ± 12.1	81.4 ± 8.1	82.5 ± 17.8	97.6 ± 17.4	86.5 ± 9.7	80.3 ± 5.5
Current – ideal	–1.6 ± 4.0	–1.7 ± 3.8	0.5 ± 5.2	–1.6 ± 5.3	–2.3 ± 3.2	–1.1 ± 3.0
Height, cm	183.6 ± 6.8	184.5 ± 6.3	179.9 ± 7.2	184.5 ± 6.2	183.1 ± 7.3	183.1 ± 6.3
Body mass index, kg/m^2	24.6 ± 3.1	23.4 ± 1.8	25.5 ± 5.0	28.1 ± 4.1	25.1 ± 2.1	23.7 ± 2.2

[a] Except where otherwise indicated.

with a combined risk for EDs (EAT-26 score or use of pathogenic behaviors or both), with differences by sex and sport category [$\chi^2_{4,1885} = 10.1$, $P = .039$]. Looking at females specifically, we found differences by sport category ($\chi^2_{4,1312} = 10.1$, $P = .038$). Raw scores for the EAT-26 and subscales are shown in Table 5. Differences were demonstrated for sex and the EAT-26 total score (Welch $F_{1,1885} = 55.2$; $P < .001$), the dieting subscale (Welch $F_{1,1885} = 97.3$; $P < .001$), and the bulimia subscale (Welch $F_{1,1885} = 15.4$; $P < .001$). Most sport categories except for power displayed differences by sex and EAT-26 scores individually, including endurance (Welch $F_{1,1885} = 19.7$; $P < .001$), aesthetic (Welch $F_{1,1885} = 26.7$; $P < .001$), ball and team (Welch $F_{1,1885} = 18.9$; $P < .001$), and technical (Welch $F_{1,1885} = 9.0$; $P = .003$). Moreover, we noted differences between sport category and the dieting subscale (Welch $F_{1,1885} = 32.5$; $P = .039$) and the bulimia subscale (Welch $F_{1,1885} = 3.2$; $P = .012$). The Games-Howell post hoc test revealed differences in the dieting subscale and sport category for aesthetic and ball and team (3.5 ± 5.1 versus 2.5 ± 4.5; $P = .025$) sports and in the bulimia subscale and sport category for power versus aesthetic (1.9 ± 2.6 versus 1.2 ± 2.0; $P = .037$) and power versus ball and team (1.9 ± 2.6 versus 1.2 ± 1.7; $P = .014$) sports.

Associations Between EXD and the Risk for EDs

Multiple logistic regressions (Table 6) indicated a significant association between EXD and the ED risk for all athletes. Among student-athletes at risk for EXD, the odds of being at risk for EDs were approximately 5 times higher than among those who were nondependent asymptomatic (odds ratio [OR] = 5.1; 95% CI = 3.237, 8.046), more than

Table 2. Proportions of Participants Classified as At Risk for Exercise Dependence

Participants	Student-Athletes, % (No.)			
Sport Category	At Risk	Nondependent Symptomatic	Nondependent Asymptomatic	P Value[a]
All	4.9 (92)	53.9 (1016)	41.2 (777)	<.001
Endurance	8.0 (56)	59.7 (420)	32.4 (228)	
Aesthetic	0.9 (3)	37.6 (132)	61.5 (216)	
Power	4.0 (7)	57.5 (100)	38.5 (67)	
Ball and team	4.4 (21)	56.1 (268)	39.5 (189)	
Technical	2.8 (5)	53.9 (96)	43.3 (77)	
Females	4.8 (63)	52.9 (694)	42.3 (555)	<.001
Endurance	7.9 (35)	60.7 (270)	31.5 (140)	
Aesthetic	1.0 (3)	36.1 (107)	62.8 (186)	
Power	4.6 (5)	58.7 (64)	36.7 (40)	
Ball and team	5.1 (17)	54.8 (183)	40.1 (134)	
Technical	2.3 (3)	54.7 (70)	43.0 (55)	
Males	5.1 (29)	56.2 (322)	38.7 (222)	.032
Endurance	8.1 (21)	57.9 (150)	34.0 (88)	
Aesthetic	0 (0)	45.5 (25)	54.5 (30)	
Power	3.1 (2)	55.4 (36)	41.5 (27)	
Ball and team	2.8 (4)	59.0 (85)	38.2 (55)	
Technical	4.0 (2)	52.0 (26)	44.0 (22)	

[a] $P < .05$.

Table 3. Raw Scores for the Exercise Dependence Scale-21 in Collegiate Student-Athletes, Mean ± SD

Student-Athletes	All	Females	Males
All	49.9 ± 19.9	49.3 ± 20.0	51.2 ± 19.8
Endurance	54.4 ± 21.4	54.7 ± 21.2	53.7 ± 21.9
Aesthetic	40.7 ± 16.0	40.4 ± 16.1	42.4 ± 15.7
Power	50.4 ± 18.2	51.0 ± 19.6	49.5 ± 17.0
Ball and team	50.7 ± 19.0	50.6 ± 19.6	51.0 ± 17.7
Technical	47.7 ± 18.5	46.6 ± 18.3	50.5 ± 18.7

2 times higher than among nondependent-symptomatic athletes (OR = 2.4; 95% CI = 1.5618, 3.7089), and similarly 2 times higher among nondependent-symptomatic versus nondependent-asymptomatic athletes (OR = 2.12, 95% CI = 1.664, 2.702). Among females, the odds of being at risk for ED were 7 times higher for those at risk for EXD than those who were nondependent asymptomatic (OR = 7.2; 95% CI = 4.142, 12.418) or nondependent symptomatic (OR = 3.0; 95% CI = 1.8017, 5.1429); the odds were also higher among those who were nondependent symptomatic than those who were nondependent asymptomatic (OR = 2.4; 95% CI = 1.781, 3.118). Significant associations were found for nondependent-symptomatic versus nondependent-asymptomatic student-athletes (OR = 1.7; 95% CI = 1.013, 2.701).

DISCUSSION

The health benefits of exercise are important; however, EXD can increase the risk to those who have a risk for EDs. The motives behind increasing exercise loads can be intrinsic or extrinsic: for many athletes, they can be related to their physical appearance, body image, or the belief that a thinner body will improve their performance. The purposes of our study were to assess the prevalence of the risks for EXD and EDs among collegiate student-athletes by sex and sport category and to determine if there was an association between EXD and EDs. In accordance with our hypothesis, the prevalence of EXD and EDs was higher in females than males. Furthermore, participants at risk for EXD had increased odds of being at risk for EDs.

Table 5. Raw Scores for the Eating Attitudes Test-26 and Subscales in Collegiate Student-Athletes, Mean ± SD

	Score			
Student-Athletes	Eating Attitudes Test-26	Dieting Subscale	Bulimia Subscale	Oral Control Subscale
All	5.8 ± 7.7[a]	3.1 ± 5.2[a]	1.4 ± 2.1[a]	1.4 ± 2.0
Endurance	5.9 ± 8.3[a]	3.1 ± 5.5[a]	1.4 ± 2.2[a]	1.5 ± 2.2
Aesthetic	6.2 ± 7.5[a]	3.5 ± 5.1[a]	1.2 ± 2.0	1.4 ± 2.1
Power	6.9 ± 9.1[a]	3.4 ± 6.0[a]	1.9 ± 2.6	1.6 ± 2.2
Ball and team	5.1 ± 6.4[a]	2.5 ± 4.5[a]	1.2 ± 1.7	1.4 ± 1.9
Technical	5.7 ± 7.1[a]	3.0 ± 5.0[a]	1.4 ± 2.2	1.2 ± 1.6
Females	6.6 ± 8.3	3.7 ± 5.7	1.5 ± 2.5	1.4 ± 2.1
Endurance	6.9 ± 9.0	3.9 ± 6.2	1.6 ± 2.5	1.4 ± 2.1
Aesthetic	6.7 ± 8.0	3.9 ± 5.4	1.3 ± 2.1	1.5 ± 2.2
Power	7.9 ± 8.7	4.3 ± 5.8	2.0 ± 2.8	1.6 ± 2.1
Ball and team	5.7 ± 7.3	3.1 ± 5.1	1.3 ± 1.9	1.4 ± 1.9
Technical	3.6 ± 3.3	1.3 ± 2.3	1.0 ± 1.1	1.3 ± 1.7
Males	4.1 ± 5.9	1.6 ± 3.6	1.1 ± 1.6	1.4 ± 2.0
Endurance	4.3 ± 6.6	1.7 ± 3.8	1.1 ± 1.8	1.5 ± 2.2
Aesthetic	3.6 ± 2.9	1.7 ± 2.4	0.9 ± 1.0	1.0 ± 1.1
Power	5.1 ± 9.5	2.0 ± 6.0	1.6 ± 2.2	1.5 ± 2.5
Ball and team	3.6 ± 3.3	1.3 ± 2.3	1.0 ± 1.1	1.3 ± 1.7
Technical	3.9 ± 3.2	1.1 ± 1.8	1.2 ± 1.2	1.5 ± 1.5

[a] $P < .05$.

Exercise Dependence

We used the EDS-21 to examine EXD in a sample of collegiate student-athletes across the United States. Our main result was that 4.9% of student-athletes presented with EXD across 5 sport categories and 16 sports, as follows: endurance (eg, cross-country, swimming, and track middle

Table 4. Eating Disorder Risk in Collegiate Student-Athletes by Using the EAT-26 and Pathogenic Behaviors

	% (No.)				
	Eating Disorder Risk Type			Overall Risk	
Student-Athletes	Eating Attitudes Test-26 Only	Behavior Only	Both	At Risk	*P* Value[a]
All	1.3 (24)	17.1 (322)	4.4 (82)	22.7 (428)	.039
Endurance	1.1 (8)	17.3 (122)	5.3 (37)	23.7 (167)	<.001
Aesthetic	1.7 (6)	19.4 (68)	3.7 (13)	24.8 (87)	.830
Power	2.3 (4)	17.2 (30)	5.7 (10)	25.3 (44)	.050
Ball and team	0.6 (3)	14.0 (67)	2.9 (14)	17.6 (84)	.099
Technical	1.7 (3)	20.2 (36)	4.5 (8)	25.8 (46)	.135
Females	1.6 (21)	17.9 (235)	5.9 (78)	25.5 (334)	.038
Endurance	1.3 (6)	19.1 (85)	7.6 (34)	28.1 (125)	
Aesthetic	2.0 (6)	18.6 (55)	4.4 (13)	35.0 (74)	
Power	2.8 (3)	19.3 (21)	8.3 (9)	30.3 (33)	
Ball and team	0.9 (3)	14.4 (48)	4.2 (14)	19.5 (65)	
Technical	2.3 (3)	20.3 (26)	6.3 (8)	28.9 (37)	
Males	0.5 (3)	15.2 (87)	0.7 (4)	16.4 (94)	.510
Endurance	0.8 (2)	14.3 (37)	1.3 (3)	16.2 (42)	
Aesthetic	0 (0)	23.6 (13)	0 (0)	23.6 (13)	
Power	1.5 (1)	3.8 (9)	1.5 (1)	16.9 (11)	
Ball and team	0 (0)	13.2 (19)	0 (0)	13.2 (19)	
Technical	0 (0)	18.0 (9)	0 (0)	18.0 (9)	

[a] $P < .05$.

Table 6. Logistic Regression Analysis for the Presence of Eating Disorder Risk

	Exp (B)	95% CI	*P* Value
Total			
Exercise dependence	5.1	3.2, 8.1	<.001
Nondependent symptomatic	2.1	1.7, 2.7	<.001
Females (n = 1312)			
Exercise dependence	7.2	4.1, 12.4	<.001
Nondependent symptomatic	2.4	1.8, 3.1	<.001
Males (n = 573)			
Exercise dependence	2.3	0.9, 5.9	.083
Nondependent symptomatic	1.7	1.0, 2.7	.004

and long distance), aesthetic (eg, cheerleading, dance, diving, and equestrian), power (eg, football, track and field, and track sprints), ball and team (eg, baseball, basketball, soccer, softball, volleyball, and beach volleyball), and technical sports (eg, golf, tennis, and track and field lean events [high jump, javelin]). Moreover, males had a higher prevalence (5.1%) than females (4.8%) but the difference was not statistically significant. Our findings were consistent with those of previous studies (1.44%–18.3%)[25–29] in which researchers assessed EXD in athletes using the EDS-21. However, they differed from the outcomes of more recent studies in which the authors suggested that females engaged in compulsive exercise and presented with a greater EXD prevalence than males, perhaps because females in general felt more comfortable disclosing their problems.[30,31] Furthermore, the mean total score on the EDS-21 (54.4) for our sample size was similar to the scores of other male endurance athletes (54.7)[32] and female inpatients with EDs (55.8).[11]

Comparing sport categories, we noted that our endurance-sport athletes had the highest prevalence of EXD at 8.0% and accounted for 60.9% of all athletes with EXD (n = 56/92). Earlier examinations of endurance athletes typically focused on long-distance runners and ultramarathoners, with prevalences of 1.44% and 3.2%, respectively.[26,27] However, Maselli et al[33] also used the EDS-21 and reported rates as high at 12.9% across endurance athletes (cycling, running, swimming, and triathlon). The higher prevalence may be associated with triathlons, as this competitive sport requires time-intensive training across 3 disciplines, namely, swimming, cycling, and running. Moreover, the second highest prevalence of EXD was in ball and team sports at 4.4%, which was lower than that in previous studies (8.1%–18.3%).[8,28,33] Differences between our findings and those of others can be attributed to the study populations; we looked specifically at collegiate student-athletes who had structured training schedules, whereas other researchers evaluated members of fitness clubs. Additionally, the earlier investigations were conducted in Italy, and training and expectations may have differed. Here, we categorized football, track and field, and track nonlean events (discus, hammer, and shot put) as power sports categories. Yet other authors who explored EXD in power sports looked primarily at bodybuilders and weightlifters. We demonstrated that EXD in our power sport category was 4%, which was significantly lower than that of bodybuilders and weightlifters, which ranged from 13.5% to 15.1%.[25,34] An additional novel finding of our work was the increased EXD prevalence of nondependent-symptomatic athletes. More than half of the student-athletes (53.9%) displayed symptoms of EXD without dependence, which was similar to the result among Hungarian runners in 2019.[35] Student-athletes are an important population for implementing EXD prevention strategies as symptoms arise and are recognized.

Risk for EDs

Using the EAT-26 or pathogenic behavior or both to determine the risk for EDs, we observed an overall prevalence of 22.7%. Previous researchers characterized the ED risk across physically active populations as ranging from 11% to 45%, which is consistent with our findings.[18,36–38] By sex, typically, we detect higher prevalence rates in females than in males; our results were similar, with 25.5% of females at risk compared with 16.4% of males. Males are often understudied in regard to EDs, and a possible explanation is that before the diagnostic criteria were established in the *Diagnostic and Statistical Manual of Mental Disorders*, loss of menses was a criterion for an ED diagnosis.[4] Investigators[18,19,37,39] who examined EDs in male athletes identified similar rates ranging from 3.2% to 19.2%.

Moreover, differences for ED risk were evident across sport categories: 23.7%, endurance; 24.8%, aesthetic; 25.3%, power; 17.6%, ball and team; and 25.8%, technical. Interestingly, technical sports (golf, tennis, and track and field lean events [high jump and javelin]) had the highest prevalence. Typically, lean sport categories, such as endurance and aesthetic sports, have an increased risk for EDs. Aesthetic sports emphasize leanness primarily because athletes are being graded or judged on various factors; on the other hand, a common belief is that a lean figure will improve performance in endurance sports. Researchers[39] have suggested that athletes in these sports are susceptible to body image dissatisfaction and EDs. However, we should not negate the idea that athletes participating in ball and team, power, and technical sports are also at elevated risk for EDs. Technical sports are commonly individual sports; although they are part of a team, these athletes usually compete individually in their sport. Individual athletes scored higher on the EAT-26 subscales for bulimia and food preoccupation.[40]

Furthermore, these athletes were also cognizant of their appearance and weight as compared with team athletes.[40] Performing individually and receiving all the attention from spectators, including judges and other coaches, may offer valid reasons as to why they may be at risk for EDs or body image dissatisfaction.

Associations Between EXD and the Risk for EDs

Exercise continues to be one of the behaviors often associated with controlling or losing weight. A primary finding by Dalle Grave et al,[10] who assessed inpatients with EDs, was that nearly 50% reported compulsive exercising to control their weight or shape. In our study, individuals with EXD had significantly increased odds for being at risk for EDs compared with both nondependent-asymptomatic and nondependent-symptomatic athletes. Researchers[41] proposed that EXD mediates the relationship between exercise and EDs by 14.3% and that intervening in psychological factors such as EXD may be as beneficial as interventions for patients with EDs who exercise excessively. A positive correlation ($r = 0.41$) has been established between scores on the EDS-21 and other ED risk assessment tools.[32] We should additionally acknowledge that 53.9% of student-athletes were nondependent symptomatic based on the EDS-21, meaning that although they were not at risk, symptoms were present. This population also had increased odds (5 times higher) of being at risk for EDs compared with those without risk or symptoms of EXD, which was nearly identical to the finding of 5 times higher odds among those at risk for EXD versus nondependent-asymptomatic athletes. Perhaps our focus should also be on this population when observing and preventing behaviors associated with both EXD and EDs.

LIMITATIONS AND FUTURE RESEARCH

We must acknowledge several limitations to our work. Both the EAT-26 and EDS-21 have been validated, but they are self-reported measures. Therefore, participants may not be truthful and honest when responding to all questions. The clinical diagnosis of EDs is performed through medical assessment and interviews by mental health providers and physicians. The EAT-26 is a risk assessment tool detailing eating attitudes and behaviors and should not be used to diagnose patients with clinical EDs. Also, our sample was predominately female, which could have altered the prevalence of EXD and the ED risk. Student-athletes are an at-risk population for EXD and EDs; thus, future authors should address the implementation of prevention programs across various levels of collegiate athletics.

CONCLUSIONS

The risk of EDs continues to be prevalent across student-athletes, and EXD may be associated with this increased risk, specifically across individuals in endurance sports. Although physical activity has become a public health intervention to improve overall health in populations, excessive exercise can pose additional risk factors to the athletic population. Eating disorders can be affected by EXD, as exercise can be a compensatory behavior for weight loss. However, as athletic trainers working with an at-risk population, we should consider the potential effects of EXD on injuries, especially chronic and bone stress injuries. The literature supports the increased risk for EDs among athletes in sports with a leanness focus, yet we noted that athletes in nonlean sports were also at risk. Particular attention should be given to student-athletes and to females who display signs of EXD; additional education and awareness are needed to minimize the overall risk of EDs in student-athletes. Initiatives associated with nutrition interventions and education programs should be provided to student-athletes as prevention tools. A reduction in stigma, a healthy relationship with food, and a positive image should be the foci of educational programs. Also, we must educate patients on the potential health and performance consequences, specifically illnesses and long-term injuries, associated with increased exercise and abnormal eating behaviors or EDs. Lastly, allied health care professionals, such as athletic trainers, dietitians, and mental health providers, should be supplied with comprehensive and continuing education regarding EXD and EDs so that they can assist athletes, regardless of their sex or sport category. Athletic trainers should consider screening all athletes for disordered eating behaviors and their risk for EDs during preparticipation examinations. Furthermore, those working specifically with endurance athletes (cross-country, swimming, and track and field) can implement screening tools for EXD and educate athletes on adequate recovery and nutrition practices as well as other leisure activities that will not increase the training load already implemented by coaches.

REFERENCES

1. Hales CM, Carroll MD, Fryar CD, Ogden CL. Prevalence of obesity and severe obesity among adults: United States, 2017–2018. *NCHS Data Brief*. 2020;360:1–8.
2. Stierman B, Afful J, Carroll MD, et al. National Health and Nutrition Examination Survey 2017–March 2020 prepandemic data files—development of files and prevalence estimates for selected health outcomes. National Health Statistics Reports. Published June 14, 2021. Accessed September 2022. https://stacks.cdc.gov/view/cdc/106273
3. Zmijewski CF, Howard MO. Exercise dependence and attitudes toward eating among young adults. *Eat Behav*. 2003;4(2):181–195. doi:10.1016/S1471-0153(03)00022-9
4. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 5th ed. American Psychiatric Publishing; 2013.
5. Hausenblas HA, Downs DS. Exercise dependence: a systematic review. *Psychol Sport Exerc*. 2002;3(2):89–123. doi:10.1016/S1469-0292(00)00015-7
6. de Coverley Veale DM. Exercise dependence. *Br J Addict*. 1987; 82(7):735–740. doi:10.1111/j.1360-0443.1987.tb01539.x
7. Currie-McGhee LK. *Exercise Addiction*. Greenhaven Publishing LLC; 2011.
8. Di Lodovico L, Poulnais S, Gorwood P. Which sports are more at risk of physical exercise addiction: a systematic review. *Addict Behav*. 2019;93:257–262. doi:10.1016/j.addbeh.2018.12.030
9. Marques A, Peralta M, Sarmento H, Loureiro V, Gouveia ÉR, Gaspar de Matos M. Prevalence of risk for exercise dependence: a systematic review. *Sports Med*. 2019;49(2):319–330. doi:10.1007/s40279-018-1011-4
10. Dalle Grave R, Calugi S, Marchesini G. Compulsive exercise to control shape or weight in eating disorders: prevalence, associated features, and treatment outcome. *Compr Psychiatry*. 2008;49(4):346–352. doi:10.1016/j.comppsych.2007.12.007
11. Bratland-Sanda S, Martinsen EW, Rosenvinge JH, Rø O, Hoffart A, Sundgot-Borgen J. Exercise dependence score in patients with longstanding eating disorders and controls: the importance of affect regulation and physical activity intensity. *Eur Eat Disord Rev*. 2011; 19(3):249–255. doi:10.1002/erv.971
12. Bamber D, Cockerill I, Rodgers S, Carroll D. "It's exercise or nothing": a qualitative analysis of exercise dependence. *Br J Sports Med*. 2000;34(6):423–430. doi:10.1136/bjsm.34.6.423
13. Kostrzewa E, Eijkemans MJC, Kas MJ. The expression of excessive exercise co-segregates with the risk of developing an eating disorder in females. *Psychiatry Res*. 2013;210(3):1123–1128. doi:10.1016/j.psychres.2013.08.050
14. Lichtenstein MB, Hinze CJ, Emborg B, Thomsen F, Hemmingsen SD. Compulsive exercise: links, risks and challenges faced. *Psychol Res Behav Manag*. 2017;10:85–95. doi:10.2147/PRBM.S113093
15. Meyer C, Taranis L, Goodwin H, Haycraft E. Compulsive exercise and eating disorders. *Eur Eat Disord Rev*. 2011;19(3):174–189. doi:10.1002/erv.1122
16. Godoy-Izquierdo D, Ramírez MJ, Díaz I, López-Mora C. A systematic review on exercise addiction and the disordered eating-eating disorders continuum in the competitive sport context. *Int J Ment Health Addict*. 2023;21:529–561. doi:10.1007/s11469-021-00610-2
17. Fitzsimmons-Craft EE, Balantekin KN, Eichen DM, et al. Screening and offering online programs for eating disorders: reach, pathology, and differences across eating disorder status groups at 28 US

universities. *Int J Eat Disord*. 2019;52(10):1125–1136. doi:10.1002/eat.23134
18. Martinsen M, Sundgot-Borgen J. Higher prevalence of eating disorders among adolescent elite athletes than controls. *Med Sci Sports Exerc*. 2013;45(6):1188–1197. doi:10.1249/MSS.0b013e318281a939
19. Sundgot-Borgen J, Torstveit MK. Prevalence of eating disorders in elite athletes is higher than in the general population. *Clin J Sport Med*. 2004;14(1):25–32. doi:10.1097/00042752-200401000-00005
20. Thompson R. Dissecting the disorders: eating disorders. In: Brown GT, ed. *Mind, Body, and Sport: Understanding and Supporting Student-Athlete Mental Wellness*. National Collegiate Athletic Association; 2014:25–28.
21. Sundgot-Borgen J. Prevalence of eating disorders in elite female athletes. *Int J Sport Nutr*. 1993;3(1):29–40. doi:10.1123/ijsn.3.1.29
22. Hausenblas HA, Downs DS. How much is too much? The development and validation of the Exercise Dependence Scale. *Psychol Health*. 2002;17(4):387–404. doi:10.1080/0887044022000004894
23. Downs DS, Hausenblas HA, Nigg CR. Factorial validity and psychometric examination of the Exercise Dependence Scale-Revised. *Meas Phys Educ Exerc Sci*. 2004;8(4):183–201. doi:10.1207/s15327841mpee0804_1
24. Garner DM, Olmsted MP, Bohr Y, Garfinkel PE. The Eating Attitudes Test: psychometric features and clinical correlates. *Psychol Med*. 1982;12(4):871–878. doi:10.1017/s0033291700049163
25. Hale BD, Roth AD, DeLong RE, Briggs MS. Exercise dependence and the drive for muscularity in male bodybuilders, power lifters, and fitness lifters. *Body Image*. 2010;7(3):234–239. doi:10.1016/j.bodyim.2010.02.001
26. Allegre B, Therme P, Griffiths M. Individual factors and the context of physical activity in exercise dependence: a prospective study of “ultra-marathoners.” *Int J Ment Health Addict*. 2007;5(3):233–243. doi:10.1007/s11469-007-9081-9
27. Cook B, Karr TM, Zunker C, et al. Primary and secondary exercise dependence in a community-based sample of road race runners. *J Sport Exerc Psychol*. 2013;35(5):464–469. doi:10.1123/jsep.35.5.464
28. Costa S, Hausenblas HA, Oliva P, Cuzzocrea F, Larcan R. Perceived parental psychological control and exercise dependence symptoms in competitive athletes. *Int J Ment Health Addict*. 2015;13(1):59–72. doi:10.1007/s11469-014-9512-3
29. Reche C, De Francisco C, Martínez-Rodríguez A, Ros-Martínez A. Relationship among sociodemographic and sport variables, exercise dependence, and burnout: a preliminary study in athletes. *An Psicol*. 2018;34(2):398–404. doi:10.6018/analesps.34.2.289861
30. Gorrell S, Scharmer C, Kinasz K, Anderson D. Compulsive exercise and weight suppression: associations with eating pathology in distance runners. *Eat Behav*. 2020;36:101358. doi:10.1016/j.eatbeh.2019.101358
31. Juwono ID, Szabo A. 100 Cases of exercise addiction: more evidence for a widely researched but rarely identified dysfunction. *Int J Ment Health Addict*. 2021;19(5):1799–1811. doi:10.1007/s11469-020-00264-6
32. Torstveit MK, Fahrenholtz IL, Lichtenstein MB, Stenqvist TB, Melin AK. Exercise dependence, eating disorder symptoms and biomarkers of Relative Energy Deficiency in Sports (RED-S) among male endurance athletes. *BMJ Open Sport Exerc Med*. 2019;5(1):e000439. doi:10.1136/bmjsem-2018-000439
33. Maselli M, Gobbi E, Probst M, Carraro A. Prevalence of primary and secondary exercise dependence and its correlation with drive for thinness in practitioners of different sports and physical activities. *Int J Ment Health Addict*. 2019;17(1):89–101. doi:10.1007/s11469-017-9867-3
34. Hale BD, Diehl D, Weaver K, Briggs M. Exercise dependence and muscle dysmorphia in novice and experienced female bodybuilders. *J Behav Addict*. 2013;2(4):244–248. doi:10.1556/JBA.2.2013.4.8
35. Lukács A, Sasvári P, Varga B, Mayer K. Exercise addiction and its related factors in amateur runners. *J Behav Addict*. 2019;8(2):343–349. doi:10.1556/2006.8.2019.28
36. Uriegas NA, Emerson DM, Smith AB, Kelly MR, Torres-McGehee TM. Examination of eating disorder risk among university marching band artists. *J Eat Disord*. 2021;9(1):35. doi:10.1186/s40337-021-00388-7
37. Abbott W, Brett A, Brownlee TE, et al. The prevalence of disordered eating in elite male and female soccer players. *Eat Weight Disord*. 2021;26(2):491–498. doi:10.1007/s40519-020-00872-0
38. Ravi S, Ihalainen JK, Taipale-Mikkonen RS, et al. Self-reported restrictive eating, eating disorders, menstrual dysfunction, and injuries in athletes competing at different levels and sports. *Nutrients*. 2021;13(9):3275. doi:10.3390/nu13093275
39. Bratland-Sanda S, Sundgot-Borgen J. Eating disorders in athletes: overview of prevalence, risk factors and recommendations for prevention and treatment. *Eur J Sport Sci*. 2013;13(5):499–508. doi:10.1080/17461391.2012.740504
40. Firoozjah MH, Shahrbanian S, Homayouni A, Hower H. Comparison of eating disorders symptoms and body image between individual and team sport adolescent athletes during the COVID-19 pandemic. *J Eat Disord*. 2022;10(1):119. doi:10.1186/s40337-022-00644-4
41. Cook B, Hausenblas H, Crosby RD, Cao L, Wonderlich SA. Exercise dependence as a mediator of the exercise and eating disorders relationship: a pilot study. *Eat Behav*. 2015;16:9–12. doi:10.1016/j.eatbeh.2014.10.012

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