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Risk of Low Energy Availability, Disordered Eating, and Menstrual Dysfunction in Female Collegiate Runners

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Context: Collegiate female distance runners may be at risk for low energy availability (LEA) due to increased exercise energy expenditure with or without decreased energy intake. Furthermore, this population has an increased risk of disordered eating (DE), which can lead to LEA and negative health consequences, such as menstrual dysfunction (MD).

Objective: To (1) investigate risk of LEA, DE, and MD; (2) compare DE, training volume, and weight dissatisfaction between female collegiate runners at risk and those not at risk for LEA; and (3) compare the risk for LEA between National Collegiate Athletic Association Division I, II, and III female collegiate runners.

Design: Cross-sectional study.

Setting: Free-living conditions.

Patients or Other Participants: A total of 287 female runners who competed on a National Collegiate Athletic Association Division I, II, or III cross-country team, track team, or both.

Main Outcome Measure(s): Participants completed a 45-item questionnaire that included the Low Energy Availability in Females Questionnaire (LEAF-Q) and the Disordered Eating Screen for Athletes (DESA-6).

Results: We observed that 54.4% (n = 156) of runners were at risk for LEA (LEAF-Q score $\geq$ 8), 40.8% (n = 117) were at risk for DE (DESA-6 score $\geq$ 3), and 56.5% (n = 162) reported MD (LEAF-Q menstrual function subsection score $\geq$ 4). Athletes at risk for LEA had higher DESA-6 scores than athletes not at risk for LEA ($P < .001$). Athletes at risk for LEA had greater weight dissatisfaction than those not at risk for LEA ($\chi^2_{3,156} = 15.92$, $P = .001$). Higher weekly training volume was not associated with risk for LEA ($\chi^2_{2,156} = 4.20$, $P = .11$).

Conclusions: A substantial percentage of collegiate female runners were found to be at risk for LEA and DE and to report MD. These findings demonstrate that the risks for DE, MD, and weight dissatisfaction are associated with risk for LEA.

Key Words: relative energy deficiency in sport (RED-S), eating disorder, female runner nutrition, weight dissatisfaction

Key Points

- More than half of female collegiate cross-country and track runners were at risk for low energy availability (LEA), and more than 40% were at risk for disordered eating.
- Disordered eating, menstrual dysfunction, and weight dissatisfaction increased the risk for LEA.
- Athletes can be screened for LEA by assessing warning signs, such as disordered eating, menstrual dysfunction, and weight dissatisfaction.

Endurance athletes, such as distance runners, have a high risk for disordered eating (DE) habits and low energy availability (LEA).[1] Researchers have shown that LEA has negative health and performance consequences for endurance athletes.[2,3] Chronic energy restriction and increased exercise energy expenditure (EEE) result in impaired energy availability (EA). Energy availability is the energy left over to support normal health and physiological function (eg, regular menses, endocrine production, and bone remodeling) after energy expenditure from exercise has been accounted for in relation to fat-free mass (FFM).[4,5] The *LEA threshold* in female athletes is defined as <30 kcal/kg of FFM per day, with *subclinical LEA* typically defined as 30 to 45 kcal/kg^{-1} of FFM per day.[4] Among college-aged female athletes, a substantial risk exists for the negative effects of intentional or unintentional energy deficits.[6] Specifically, disordered behaviors can lead to LEA in these athletes.[7]

In competitive athletes, DE habits can persist due to the emphasis placed on body size or composition for perceived advantages in performance and sociocultural pressure. Furthermore, DE can progress to a diagnosable eating disorder (ED), with a multitude of health consequences relating to the potential for relative energy deficiency in sport (RED-S), a syndrome of health and performance impairments.[7] Female endurance athletes are known to have a higher rate of DE behaviors and a higher risk for developing diagnosed EDs than the general population and male endurance athletes.[8] In addition, endurance athletes are at greater risk for DE, as leanness is often emphasized and idealized in sports such as running.[8] Disordered eating behaviors and caloric restriction can stem from poor body image and the heightened risk for weight dissatisfaction in pursuit of an idealized body weight and composition.[9] Female elite endurance athletes have a higher incidence of DE compared with other athletes, and college-aged runners may experience among the highest prevalence of DE habits even in the absence of a clinical ED diagnosis.[10] Although they are sometimes independent of one another, LEA often occurs in conjunction with DE, EDs, or both, and each condition poses substantial health risks.[7]

Ackerman et al reported that female athletes with LEA are more likely to exhibit the negative health consequences of RED-S than those with adequate EA.[2] Long-term LEA is characterized by metabolic adaptations and changes in physiological functions, important for several body systems.[4] As EA decreases, whether intentionally or unintentionally, female athletes can experience amenorrhea and osteoporosis as long-term consequences.[2,11] In a study examining the risk of LEA among elite cross-country runners, 79.5% of female athletes were considered to be at high risk for LEA, and 41.3% of female runners reported menstrual dysfunction (MD).[12] Similarly, Beermann et al reported that 41% of female collegiate cross-country runners had clinical LEA as determined using 2 measures of EA.[6] Finally, Rogers et al found that 55% of female athletes were at risk for LEA, 80% demonstrated symptoms of RED-S, and that a strong relationship existed between the two.[13] Low EA, whether inadvertent or intentional, can result from the high energy demands consequent to substantial training loads.[9,10] Training behaviors that exceed energy intake (EI) can be the unintentional result of a high-volume training program, such as distance running at a collegiate level or the unhealthy manipulation of exercise load, as seen with DE behaviors.[10]

In recent research, the relationship between DE and LEA and substantial health concerns such as MD in female athletes has been highlighted. Menstrual function is sensitive to EA, which can be affected by training volume, weight periodization, and the presence of DE.[3,5] Understanding the relationship between the risk of LEA, DE, and MD is crucial for health and performance outcomes, but research in which investigators have examined these variables among female collegiate endurance athletes is lacking. Therefore, the purposes of our study were to examine (1) the risks for DE, LEA, and reported MD; (2) the relationship between risk for LEA and DE, MD, training volume, and weight dissatisfaction among female collegiate runners; and (3) differences in risk for LEA between National Collegiate Athletic Association (NCAA) Division I, II, and III female collegiate runners.

METHODS

Participants

College-aged (age range, 18–30 years) female athletes who run competitively (NCAA Division I, II, and III cross-country and track athletes) were eligible to participate in this study. The first 200 participants were offered the opportunity to receive a $20 Amazon gift card for participating in and completing the online questionnaire. The questionnaire was advertised via Instagram requesting participation in the research study, and collegiate athletes were contacted via email. The first question of the survey informed participants of the nature of the study and asked for anonymous informed consent via answering the first question with *yes*. All participants provided informed consent, and the study was approved by the Human Subjects Review Committee of Central Washington University.

Instruments

We implemented a cross-sectional study in which participants completed a questionnaire with 45 questions. Questions covered the following topics: type of runner (NCAA Division I, II, or III cross country, track, or both), running mileage per week (*low*, $\leq$30 miles [$\leq$48 km]; *moderate*, 31–60 miles [49.6–96.0 km]; and *high*, $>$60 miles [$>$96.0 km]), incidence of stress fracture, weight control methods, weight dissatisfaction, history or presence of an ED or DE, occurrence and frequency of menstrual cycles within the 12 months before the study, contraceptive use, and gastrointestinal (GI) function. The survey was created using the Qualtrics (Qualtrics LLC) platform. Participants completed questions embedded from the Low Energy Availability in Females Questionnaire (LEAF-Q). The questionnaire has been validated for use in identifying athletes at risk for LEA with a Cronbach α of 0.62 to 0.79, a sensitivity of 78%, and a specificity of 90%.[14] The LEAF-Q gathers information regarding injury frequency in the past year, current and past menstrual function, and current GI function. Participants who scored $\geq$8 were considered to be at risk for LEA, and participants scoring $<$8 were considered to be not at risk.[14] Those with subsection scores of $\geq$2 for GI function, $\geq$2 for injuries, or $\geq$4 for menstrual function were considered at risk for that category.[12,14] Disordered eating behaviors were assessed using questions from the Disordered Eating Screen for Athletes (DESA-6), which is used to assess the frequency and severity of injuries, the fear of weight gain, happiness with current weight, the intensity of dissatisfaction with current weight, the presence of dieting, and the presence of pressure to lose weight. Participants who scored $\geq$3 were considered to be at risk for DE, and those who scored $<$3 were considered to be not at risk.[15] The DESA-6 has been validated to effectively identify DE among athletes of all sports with a sensitivity of 92% and specificity of 85.96%.[15] Higher DESA-6 scores are associated with risk for EDs in female athletes when compared with the Eating Disorder Examination Questionnaire (EDE-Q; $r = 0.80$, $P < .001$).[15]

Procedures

Data collection was performed online between November 2, 2021, and June 1, 2022. Athletes who chose to participate were directed to the Qualtrics survey via a link and, after entering the Qualtrics website, were given participation information regarding estimated time requirements, assurance of confidentiality, nature of the questions, and directions to a second survey to receive an Amazon gift card if qualified. Participants then could either agree to the terms outlined in the informed consent or close their browser window. All collected data were anonymous. After completing the survey, the initial 200 participants were directed to another Qualtrics survey to enter their first and last names and email address to receive the Amazon gift card. Email addresses could not be traced back to any of the original survey responses.

Statistical Analysis

Participant characteristics were calculated as mean $\pm$ SD for age, height, and mass. The χ^2 test was used to analyze nominal data, including weight dissatisfaction and training

Table 1. Characteristics for the Sample Population by National Collegiate Athletic Association Division

Characteristic	Sample Population (N = 287)	Division I (n = 135)	Division II (n = 88)	Division III (n = 64)
Age, mean ± SD, y	21.30 ± 2.86	21.25 ± 2.61	22.30 ± 3.48	20.10 ± 1.76
Height, mean ± SD, cm	165.75 ± 6.94	165.79 ± 7.10	166.64 ± 7.06	164.42 ± 6.29
Mass, mean ± SD, kg	57.07 ± 6.92	55.62 ± 5.88	58.95 ± 8.24	57.57 ± 6.39
Body mass index, mean ± SD	20.75 ± 2.49	20.23 ± 2.24	21.24 ± 3.08	21.20 ± 1.81
Training volume range, mi/wk (km/wk)[a]	31–60 (49.6–96.0)	31–60 (49.6–96.0)	31–60 (49.6–96.0)	31–60 (49.6–96.0)

[a] Most frequently reported range.

volume. An independent *t* test was used to identify differences in risk of DE (DESA-6 score), GI function, injuries, and menstrual function subsection scores between those at risk and those not at risk for LEA. One-way analysis of variance was used to determine differences in LEA risk, DE risk, GI function subsection scores, injuries subsection scores, and menstrual function subsection scores between Divisions I, II, and III. Post hoc Bonferroni correction was applied to examine pairwise comparisons when differences were found. The Pearson correlation coefficient was used to examine the relationship between the risk of LEA (LEAF-Q score ≥8) and risk of DE (DESA-6 score ≥3). Results from the Qualtrics survey were analyzed using Excel (version 16.88 [24081116]; Microsoft Corp) and SPSS (version 28.0; IBM Corp). A *P* value of <.05 was considered statistically significant.

RESULTS

Descriptive characteristics for the sample population (N = 287) and each NCAA division are presented in Table 1.

Low Energy Availability in Females Questionnaire

The mean LEAF-Q score for all participants was 9.2 ± 5.8, with no differences found between Division I, II, and III athletes (9.0 ± 6.0, 7.2 ± 4.9, and 8.5 ± 5.5, respectively; $F_{2,284} = 1.1$, $P = .32$). We identified 54.4% (n = 156) of female collegiate runners as being at risk for LEA. Of runners at risk for LEA, 58.5% (n = 79 of 135) were Division I, 50.0% (n = 44 of 88) were Division II, and 51.6% (n = 33 of 64) were Division III runners (Table 2). We observed no difference in risk for LEA among runners categorized as having low, moderate, and high weekly running mileage ($\chi^2_{2,156} = 4.20$, $P = .11$). No difference was found between the total LEAF-Q score and Division I, II, and III athletes ($P = .31$). Furthermore, no differences were detected for NCAA division and LEAF-Q categorical scores, including menstrual function ($F_{2,284} = 1.89$, $P = .15$), injury ($F_{2,284} = 0.001$, $P = .98$), and GI function ($F_{2,281} = 2.1$, $P = .12$).

GI Function Subsection. Of all athletes, 69.3% (n = 199) reported a GI function subsection score of ≥2, indicating risk for GI symptoms. The mean GI subsection score among all runners was 3.5 ± 2.2, but no differences were found in GI function subsection scores between Division I, II, and III runners ($F_{2,281} = 2.1$, $P = .12$).

Injuries Subsection. We observed that 30.3% (n = 87) of all athletes and 25.4% (n = 73) of athletes at risk for LEA had a score of ≥2, indicating risk for injury. The mean injury subsection score was 1.3 ± 2.0, with no differences in scores between Division I, II, and III runners ($F_{2,284} = 0.001$, $P = .98$). Compared with the GI (43.6%, n = 125) and menstrual function (46.3%, n = 133) subsections of the LEAF-Q, fewer athletes scored at risk for LEA due to a score of ≥2 in the injury subsection (25.4%). Of those at risk for LEA, 49.4% (n = 77) reported *yes* when asked, "Have you had 3 or more injuries that have inhibited your ability to train in the past season OR did your past season end early due to injury?"

Menstrual Function Subsection. A menstrual function subsection score of ≥4 indicated MD, which includes both oligomenorrhea and amenorrhea. The mean menstrual function subsection score for the population was 5.0 ± 4.1, with no differences in scores among Division I, II, and III runners ($F_{2,284} = 1.89$, $P = .15$). We observed that 56.4% (n = 162) of all runners were at risk for or reported MD. Among the athletes, 24.0% (n = 69) reported menarche at >15 years of age (indicative of primary amenorrhea), and 1.7% (n = 5) of athletes reported never having menstruated. A total of 29.3% (n = 84) of the female runners reported taking oral contraceptives, with 9.5% (n = 8) of runners reporting oral contraceptive use to prevent or correct amenorrhea; 16.7% (n = 14) of runners reporting use to "regulate their menstrual cycle in relation to performance"; and 48.8% (n = 41) of runners reporting use to reduce menstrual pain (10.7%, n = 9) or menstrual bleeding (8.3%, n = 7).

Further questions from the LEAF-Q and respective answers are displayed in Figure 1.

Table 2. Prevalence of Athletes at Risk for Low Energy Availability, the Low Energy Availability in Females Questionnaire (LEAF-Q), and Subsection Scores by National Collegiate Athletic Association Division (No. [%])

LEAF-Q Score	Sample Population (N = 287)		Division I (n = 135)		Division II (n = 88)		Division III (n = 64)	
	At Risk	Not at Risk	At Risk	Not at Risk	At Risk	Not at Risk	At Risk	Not at Risk
Gastrointestinal function subsection ≥ 2	125 (43.6)	74 (25.8)	65 (48.1)	34 (25.2)	38 (43.2)	25 (28.4)	22 (34.4)	15 (23.4)
Injuries subsection ≥ 2	73 (25.4)	14 (4.9)	33 (24.4)	8 (5.9)	25 (28.4)	3 (3.4)	15 (23.4)	3 (4.7)
Menstrual function subsection ≥ 4	133 (46.3)	29 (10.1)	68 (50.4)	6 (4.4)	37 (42.0)	14 (15.9)	28 (43.8)	9 (14.1)
Total ≥ 8	156 (54.4)	131 (45.6)	79 (58.5)	56 (41.5)	44 (50.0)	44 (50.0)	33 (51.6)	31 (48.4)

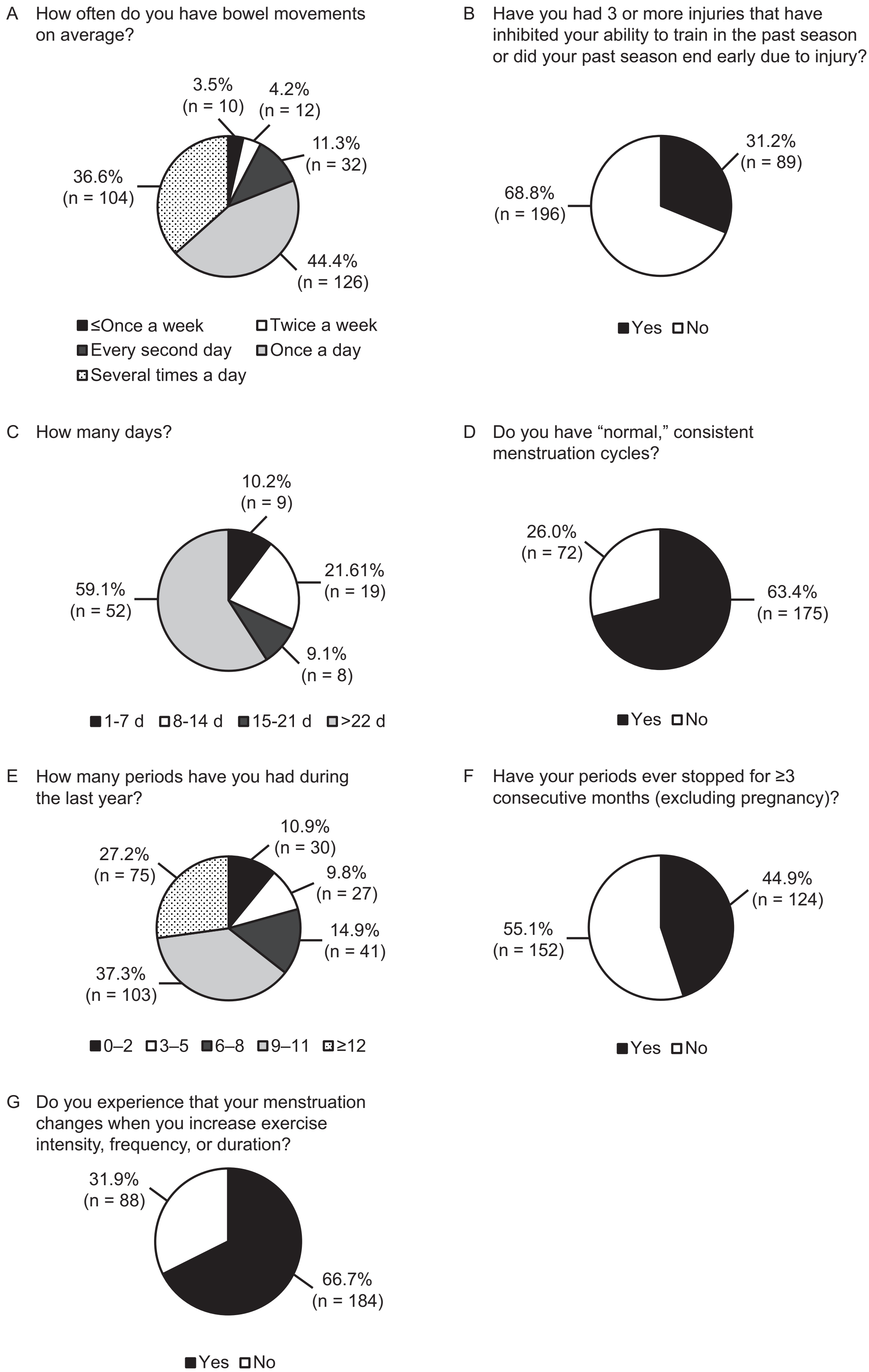

Figure 1. Graphical representation of the Low Energy Availability in Females Questionnaire: A, gastrointestinal function; B and C, injuries; and D–G, menstrual function subsection questions and answers provided.

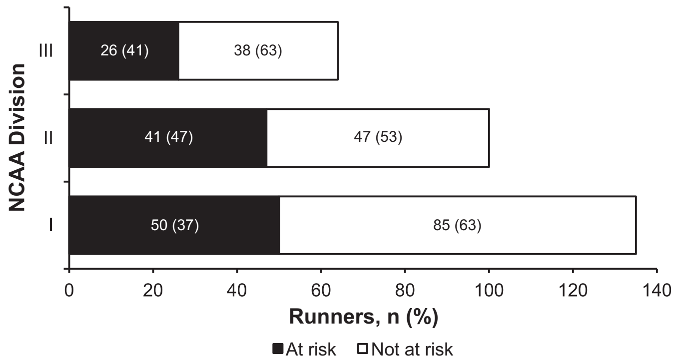

Figure 2. The number and percentage of athletes at risk (≥3 Disordered Eating Screen for Athletes [DESA-6]) and not at risk (<3 DESA-6) for disordered eating by National Collegiate Athletic Association division.

Disordered Eating Screen for Athletes

A total of 59.2% (n = 170) of runners scored <3 on the DESA-6, indicating they were not at risk for DE, and 40.8% (n = 117) of runners scored ≥3, indicating they were at risk for DE. Figure 2 displays the number and percentage of athletes at risk for DE based on NCAA division. We observed no differences in total DESA-6 score among Division I, II, and III athletes ($F_{2,284} = 0.53$, $P = .58$). Furthermore, risk for DE was not associated with weekly training volume among those running low, moderate, or high weekly mileage ($\chi^2_{3,117} = 1.31$, $P = .52$). Questions from the DESA-6 and the respective answers are displayed in Figure 3.

Associations Among Risk of LEA, DE, and Weight Dissatisfaction

We observed a positive correlation between LEAF-Q scores and DESA-6 scores ($r = 0.51$, $P < .001$). Athletes who were considered at risk for DE had higher LEAF-Q scores for each category than athletes not at risk for DE ($P < .001$). Of athletes at risk for DE (n = 117), 77.8% (n = 91) were also at risk for LEA. Runners at risk for LEA had higher DESA-6 scores and were more likely to report greater weight dissatisfaction than runners not at risk for LEA ($\chi^2_{3,156} = 15.92$, $P = .001$). A total of 18% (n = 52) of athletes reported the absence of a menstrual cycle to be "a normal part of training and/or NOT harmful." Total LEAF-Q and subsection scores of those at risk and not at risk for DE are presented in Table 3.

DISCUSSION

The aim of our study was to investigate the risk for LEA, DE, and MD and compare the risk for DE, training volume, and weight dissatisfaction between female collegiate runners at risk and those not at risk for LEA. Over half of female collegiate runners were identified as being at risk for LEA (54.4%), and those at risk for LEA had higher DESA-6 scores and were more likely to have greater weight dissatisfaction. Therefore, DE, MD, and weight dissatisfaction may increase the risk for LEA development and may be used as warning signs when screening athletes for LEA.

Based on the LEAF-Q, we found 54.4% of the collegiate runners in our sample were at risk for LEA, which is lower than the 62.2% of female endurance athletes reported by Melin et al[14] but comparable to previous findings in competitive and recreational female endurance runners (47.3%, n = 248).[16] Other researchers using the LEAF-Q to identify LEA risk in female endurance athletes have suggested that 65% to 79.5% were at risk for LEA.[12,17] Although these researchers used the LEAF-Q to determine risk for LEA, the discrepancies between risk prevalence may be due to a difference in sample size or specific population of athletes examined (ie, collegiate and recreational versus elite athletes). As noted by Beermann

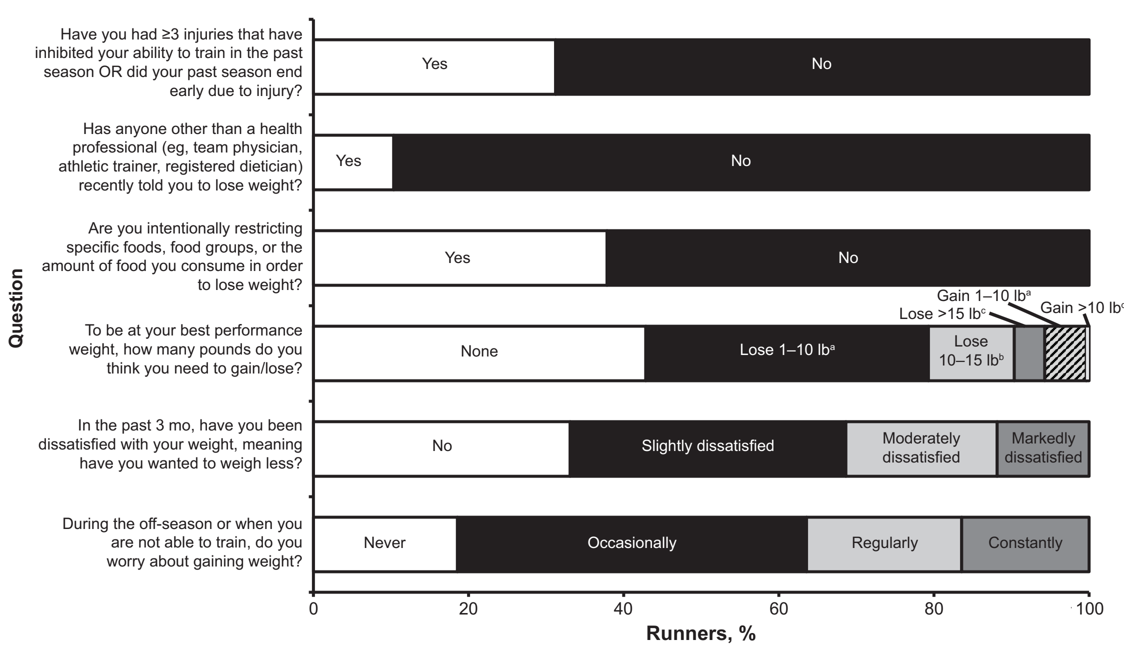

Figure 3. Participant responses to the Disordered Eating Screen for Athletes questions (n = 287). Questions are adapted from Kennedy et al.[15] [a] 0.45–4.50 kg. [b] 4.50–6.75 kg. [c] 6.75 kg. [d] 4.50 kg.

Table 3. Low Energy Availability in Females Questionnaire (LEAF-Q) Total and Subsection Scores and Prevalence of Athletes at Risk for Low Energy Availability Among Athletes at Risk and Not at Risk for Disordered Eating

	Whole Sample (N = 287)		At Risk (n = 117)		Not at Risk (n = 170)		
LEAF-Q	No. (%)	Mean ± SD	No. (%)	Mean ± SD	No. (%)	Mean ± SD	*P*
Gastrointestinal function subsection ≥ 2	199 (69.3)	3.5 ± 2.2	92 (78.6)	3.5 ± 2.2	107 (62.9)	2.5 ± 2.1	<.001[a]
Injuries subsection ≥ 2	87 (30.3)	2.4 ± 2.2	69 (58.9)	2.4 ± 2.2	18 (10.6)	0.5 ± 1.4	<.001[a]
Menstrual function subsection ≥ 4	162 (56.5)	6.2 ± 3.9	87 (74.4)	6.2 ± 3.9	75 (44.1)	4.2 ± 4.0	<.001[a]
Total ≥ 8	156 (54.4)	12.2 ± 5.6	91 (77.8)	12.2 ± 5.6	65 (38.2)	7.2 ± 4.9	<.001[a]

[a] Indicates a significant difference in LEAF-Q or subsection scores between those at risk for DE versus those not at risk for disordered eating.

et al, collegiate athletes face specific barriers to meeting adequate EI and nutritional requirements.[6] Furthermore, the nature of collegiate endurance sports increases the risk of LEA due to demanding training volumes, changing environments with travel, challenging schedules, potentially limited access to food, and increased nutrient requirements.[6,18–20] These factors are concerning, as short-, medium-, and predominantly long-term LEA can lead to many indirect and direct decrements to health and athletic performance.[18]

Of note, we did not use a direct measurement of EA, given the cumbersome nature and difficulty of using self-reported food and activity logs to accurately assess and identify LEA. Direct evaluation of EA may be beneficial for short-term identification of LEA, but this method requires an accurate assessment of body composition, EI, and EEE.[21] Furthermore, researchers have noted difficulties accurately assessing EI and EEE due to a lack of universal protocol for assessment and errors in estimation that may stem from a lack of necessary resources.[22] The calculations of EI and EEE are subject to limitations such as recall biases, underreporting, not capturing long-term intake when using food records, and errors in estimation of energy expenditure during complex activities even when using training records and heart-rate data.[22–24] Therefore, the LEAF-Q offered a more practical assessment tool to examine LEA risk and MD in our large cross-sectional study. The LEAF-Q has been validated to effectively screen the at-risk population of elite female endurance athletes with a sensitivity of 78% and specificity of 90%.[14] Nevertheless, this questionnaire cannot be used as a diagnostic tool, and it is vulnerable to both false-positive and false-negative screenings when used to identify LEA risk.[5,14] Compared with the prevalence of athletes at risk for LEA (54.4%) in our study, authors of other studies using measured EA have suggested a wide prevalence of LEA (29% to 66%) among female collegiate runners.[6,25–27]

In addition to identifying LEA risk, the LEAF-Q can be used to identify MD in female athletes, and more than half of the runners in the current study reported MD.[23] The use of oral contraceptives poses a risk for masking underlying MD, which could potentially lead to a false-negative screening of LEA via the LEAF-Q.[17] Furthermore, this population may be unaware of the negative health consequences associated with MD due to LEA.[17] Despite the well-known link between LEA and MD seen in both the female athlete triad and the RED-S model, 18% of athletes reported the absence of a menstrual cycle to be "a normal part of training and/or NOT harmful."[1,14,23] Thus, this lack of awareness necessitates educational interventions for athletes, coaches, and medical professionals regarding reproductive function as a marker of health.[17]

In our study, 40.8% of surveyed athletes were at risk for DE, supporting the findings of Dervish et al, who reported that 40% (n = 209) of competitive and recreational female endurance runners were at risk for DE when the Female Athlete Screening Tool was used.[16] In contrast, Fahrenholtz et al found that 21.3% of athletes reported DE behaviors when the EDE-Q was used.[17] The discrepancy between the results reported in the aforementioned study and our results may be, in part, due to the recall timeline and nature of questions presented. For example, the EDE-Q measures symptoms of EDs only within the past 28 days, and the DESA-6 assesses DE risk based on both current and typical behaviors, as well as those within the past 3 months, potentially detecting a greater prevalence of DE risk.

Similar to the findings of Kuikman et al, DE risk in our study was positively correlated with LEA risk, suggesting that female collegiate runners with LEA are more likely to show DE tendencies.[28] To our knowledge, this is the first study to implement the LEAF-Q and DESA-6 concurrently to determine the prevalence of LEA and DE risk in a sample of female athletes.[15] Furthermore, Folscher et al found that 27% and 44% of ultramarathon runners were at risk for DE and LEA, respectively, whereas we demonstrated a higher prevalence of DE (40.8%) and LEA (54.4%) in female collegiate runners.[1] In a similar study examining LEA and DE in competitive and recreational female runners, Dervish et al reported that 47.3% of athletes were at risk for LEA per the LEAF-Q and 40% were at risk for subclinical DE per the Female Athlete Screening Tool.[16] Comparable with our findings, Fahrenholtz et al reported that higher LEAF-Q scores were associated with higher DE scores among competitive female endurance athletes per the EDE-Q.[17] Some of the differences in the presence of DE and LEA reported in the literature may be due to varying assessment instruments used, specifically when considering measured EA versus quantifying the risk for LEA.[22,23] Although the cause of LEA is multifactorial and can stem from overtraining, weight periodization, unintentional energy deficits, or a combination, DE behaviors often lead to the problematic physiological adaptations seen with LEA.[7,9,18]

Weekly reported running volume was not found to be associated with risk for LEA, which may be a result of the relative homogeneity of the sample, similar training programs across NCAA divisions, the large range of mileage within each category, or a combination. Although the phase of training was not accounted for, these athletes may have been in varying phases of their training because the survey was open between November and June, which covers different stages of cross-country and track seasons. Even though we did not find a difference in training volume between athletes at risk and those not at risk for LEA, future assessment of exercise dependence in collegiate athletes may be a beneficial metric because it can contribute to excess energy expenditure and potentially LEA, with or without concurrent DE.[28]

Weight dissatisfaction was found to be associated with a greater risk for LEA, potentially indicating that preoccupation with and the desire to decrease body weight can contribute to this risk. Similarly, Berg et al found that elite female runners with a self-reported history of an ED reported a higher prevalence of weight dissatisfaction (62.5%).[29] These factors indicate that, along with the risk for LEA and DE, the collegiate female runner population is particularly vulnerable to body weight dissatisfaction. High levels of body weight dissatisfaction concurrent with DE tendencies may influence energy restriction and progression to clinical EDs and LEA.[29]

This study is one of the first to examine risk of LEA and DE and potential differences between NCAA Divisions I, II, and III female collegiate runners. Other researchers examining risk of LEA and DE have focused primarily on Division I runners[6,25,27,30] or other Division I female athletes,[31,32] with only 1 sampling Division II athletes.[33] We found no differences in the prevalence of LEA or DE risk between NCAA Division I, II, and III athletes, although differences in access to health and nutrition resources may exist among NCAA divisions.[34]

Our study had limitations. It was based on self-reported data, which are susceptible to response bias. The LEAF-Q is vulnerable to both false-negative and false-positive screenings, especially regarding MD and the implications of oral contraceptive use. Furthermore, the survey was completed during a single time point and may not account for differences in LEA risk and weekly training volume that could be observed between phases of training (ie, preseason, competition, or off-season). Lastly, although the DESA-6 has been validated for use in identifying DE behaviors among all levels of athletes, it has not been widely used to detect individuals at risk for DE, and literature detailing its use in female runners is limited.

CONCLUSIONS

Our study confirmed that a large proportion of female collegiate runners are at high risk for LEA (54.4%) and DE (40.8%); however, we observed no difference in risk between NCAA divisions, and the risk of LEA was not related to weekly running volume. Furthermore, athletes at risk for LEA were more likely to be at risk for DE and to report MD and greater body weight dissatisfaction. Coaches and practitioners should be educated on the signs of DE, MD, and weight dissatisfaction, as they may be warning signs for the development of LEA, and the potential associated health and performance effects if left untreated. Therefore, our findings support the importance of LEA and DE prevention, early identification, education, and early intervention strategies to support health and athletic performance. Understanding and awareness around reproductive health, injury history, signs of unhealthy eating behaviors, and negative physiological and performance consequences due to LEA are fundamental in the prevention of LEA. Runners at risk for LEA or DE should be referred to a registered dietician who is a Certified Specialist in Sports Dietetics for a comprehensive dietary assessment and dietary plan, as an increase in EI, a decrease in EEE, or both are necessary to treat LEA.

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