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Collegiate Athletic Trainers' Knowledge of the Female Athlete Triad and Relative Energy Deficiency in Sport

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Context: The female athlete triad (Triad) and relative energy deficiency in sport (RED-S) specify the consequences of energy imbalance. Athletic trainers (ATs) are positioned to identify athletes who are fueling themselves inadequately and experiencing related health and performance consequences.

Objective: To assess the knowledge of collegiate ATs about the Triad and RED-S and to examine variability in related screening and referral behaviors among National Collegiate Athletic Association divisions.

Design: Cross-sectional study.

Setting: Collegiate athletic training departments.

Patients or Other Participants: Head ATs at National Collegiate Athletic Association member institutions (n = 285, response rate = 33%).

Main Outcome Measure(s): An electronic survey was administered. The number of Triad components that were correctly identified and screening and referral behaviors related to Triad components were measured.

Results: Nearly all respondents (98.61% [n = 281]) had heard of the Triad; a smaller proportion (32.98% [n = 94]) had heard of RED-S. On average, respondents correctly identified 2 components of the Triad. We observed differences by sex, with women correctly identifying more components than men ($U = 12.426$, $P = .003$). More than half (59.93% [n = 163]) indicated that athletes at their institutions were screened for eating disorders. Nearly three-quarters (70.55% [n = 115]) of respondents indicated that all female athletes at their institutions were screened annually for menstrual dysfunction. More comprehensive referral behaviors for athletes identified as experiencing menstrual dysfunction or a bone injury (eg, athlete referred to a nutritionist, dietitian, or counselor) occurred at Division I institutions than at Division II and III institutions.

Conclusions: Continuing education for ATs about the Triad and RED-S may encourage a more comprehensive approach to referral and screening after a diagnosis of menstrual dysfunction or bone-stress injury. Using institutional opportunities, such as preparticipation screening, for identifying components of the Triad or RED-S and specifying protocols for referring athletes who screen positive for 1 of these components should also be explored.

Key Words: disordered eating, menstrual dysfunction, bone injury, referral

Key Points

- Most athletic trainers (ATs) were aware of some elements of the female athlete triad.
- Continuing education is needed to ensure that ATs are aware of how energy deficiency can lead to bone injury and other negative health and performance outcomes in male and female athletes.
- It may be useful for ATs to take a more comprehensive approach to screening and referral in athletes with menstrual dysfunction or bone-stress injury.

Adequate energy intake relative to energy expenditure is necessary for optimal physiologic functioning; when athletes are in an energy deficit, they may experience negative health and performance outcomes.[1] One pathway through which this can occur is disruption of endocrine function, often marked by amenorrhea. This can also result in suppression of the hormones that promote bone formation,[2] which increases the likelihood of sustaining bone-stress injuries.[3] The term *female athlete triad* (Triad) was first used to describe this pathway, delineating the 3 interrelated conditions of disordered eating, menstrual dysfunction, and osteoporosis.[4] More recently, energy deficiency with or without disordered eating has been identified as the component of the Triad that precipitates menstrual dysfunction and loss of bone mineral density.[2] Energy deficits sometimes but not always result from a clinical or subclinical pathologic eating condition.[5] Estimates of low energy availability among female adolescent and young adult athletes, operationalized as $\leq$45 kcal/kg of lean body mass, have included 36% of a sample of female high school varsity athletes,[6] 20.8% of a sample of female adolescent swimmers,[7] and 26.3% during preseason and 33.3% during midseason of a sample of female collegiate soccer players.[8]

In 2014, an expert panel convened by the International Olympic Committee proposed an expanded conceptualization of the Triad under the term *relative energy deficiency in sport* (RED-S).[9] This conceptualization identified 10 areas in which the health consequences of relative energy deficiency are found (menstrual function, bone health, and endocrine, metabolic, hematologic, growth and development, psychological, cardiovascular, gastrointestinal, and

immunologic function) and 10 performance-related consequences of relative energy deficiency (decreased endurance, increased injury risk, decreased training response, impaired judgment, decreased coordination, decreased concentration, irritability, depression, decreased glycogen stores, and decreased muscle strength).[9] Importantly, it did not focus solely on women, as researchers[10] have indicated that men can also experience physiologic impairments due to insufficient energy intake. Given that this updated conceptualization is relatively recent, it may not be incorporated into instruction for athletic training students and continuing education for current athletic trainers (ATs).

Early identification of inadequate energy intake is important to avoid lasting harm through worsened symptoms and other health-related or performance-related impairments.[11] Athletic trainers tend to be the health professionals who interact most closely with athletes each day, meaning that they are positioned to observe changes in health or performance that could indicate inadequate energy intake or related disorders.[12,13] However, whereas observation and interpersonal interactions may help this identification process, they are likely not sufficient. Vaughan et al[14] reported that only 1 in 4 collegiate ATs indicated that they were confident in their ability to identify whether an athlete had an eating disorder. Preparticipation examinations present an important opportunity for ATs to gather information related to the Triad and RED-S.[15] Data collected via validated written scales, interviews, and physical assessments can help identify athletes at risk for disorders related to insufficient energy intake. For example, athletes who score higher on indices of disordered eating are more likely to sustain stress fractures than athletes with healthy fueling behaviors.[16] Conceptualizing a bone-stress injury or menstrual dysfunction within the framework of the Triad or RED-S can provide direction for subsequent referral and care by linking 1 red flag with potentially related disorders. For example, determining whether a stress fracture is related to low bone mineral density, menstrual dysfunction in female athletes, and insufficient energy intake can help ATs identify strategies for preventing future injury.

Given the role that ATs can play in early detection and care coordination for disorders related to insufficient energy intake, exploring what they know about this topic is an important first step in identifying whether educational programming related to this topic is needed. Differences between male and female ATs may exist for specific facets of these conditions and may be rooted in experiences specific to their sex. For example, researchers[17] have reported that male coaches are less knowledgeable and comfortable communicating about menstrual dysfunction than female coaches. Assessing whether differences exist between male and female ATs in their knowledge about conditions related to insufficient energy intake can provide insight into whether sex-targeted educational approaches are appropriate for this population.

Therefore, the purpose of our study was to assess knowledge about the TRIAD and RED-S and examine variability in screening and referral behaviors related to energy deficiency, menstrual dysfunction, and bone injury in a sample of US collegiate ATs. Researchers have observed that National Collegiate Athletic Association (NCAA) Division I institutions are more likely than Division II and III institutions to screen for mental health concerns, with some of this difference explained by greater staffing in the sports medicine departments of Division I institutions.[18] Consequently, we also made comparisons by division of competition, testing the hypothesis that Division I institutions would engage in more extensive screening than Division II and III institutions.

METHODS

Sample

Head ATs at all NCAA member institutions (N = 863) were contacted using an e-mail distribution service of the NCAA Sport Science Institute and invited to participate in a Web-based survey. Two reminder e-mails were sent at intervals of approximately 10 days. A total of 285 ATs (response rate = 33%) participated in the survey. Participants provided informed consent by completing the survey, and the study was approved by the Harvard School of Public Health Institutional Review Board.

Instrument

Data were collected during May 2014. We drew questionnaire content from surveys of college coaches,[19] high school coaches,[17] and school nurses[20] that focused on knowledge of and screening and referral behaviors related to the Triad. Additional content was added about RED-S and to reflect the AT's role. The survey was pilot tested in a small sample of ATs, and slight modifications were made based on their feedback.

Measures

General Knowledge About the Triad and RED-S. Participants indicated whether they had heard the terms *female athlete triad* and *relative energy deficiency in sport* with response options of *yes*, *no*, and *I don't know*. Responses were dichotomized into *yes* and *no/I don't know*. Participants who had heard of the Triad were prompted to identify what they believed were its 3 components with an open-ended response. These responses were coded as *correct* for each component based on whether they named or described each of the 3 groupings: (1) menstrual function or dysfunction; (2) bone health or bone density; and (3) disordered eating, nutrition, or energy imbalance. A fourth grouping for responses that referred specifically to energy imbalance and not to disordered eating or nutrition was added to reflect the updated RED-S conceptualization. Responses that did not fall within these categories (eg, *burnout*) were coded as *incorrect*.

Screening for Disordered Eating. Participants indicated whether their institutions screened student-athletes for eating disorders with response options of *yes*, *no*, and *I don't know*. They reported when screening occurred, with response options including *as part of an annual preparticipation exam*, *as part of a 1-time preparticipation exam*, *when there is concern about a specific athlete*, and *other*. Finally, participants indicated which athletes were screened for eating disorders with response options of *all athletes*, *all female athletes*, *all female athletes in sports considered as high risk for eating disorders*, and *specific athletes when there is a concern*.

Screening for Menstrual Dysfunction. Participants indicated whether female student-athletes were asked about their menstrual cycles as part of screening activities. Response options were *all athletes on an annual basis*, *all athletes at the beginning of their collegiate sports career*, *only in sports considered high risk of eating disorders (on an annual basis)*, *only in sports considered at high risk for eating disorders (at the beginning of their collegiate sports career)*, *no*, and *I don't know*.

Referral for Menstrual Dysfunction. The ATs reported the frequency with which each of the following occurred at their institutions if student-athletes indicated that they were not having regular menstrual cycles: the athlete was referred to a dietitian or nutritionist, the athlete was referred to a sports medicine physician, the athlete was referred to a counselor or psychologist, the athlete was screened for disordered eating, the athlete's caloric intake relative to energy expenditure was assessed, the athlete's bone density was assessed, and the athlete was prescribed hormonal contraceptives. Response options were *never*, *sometimes*, *often*, *always*, and *I don't know*.

Referral for Bone Injury. Participants reported the frequency with which each of the following occurred at their institution if a student-athlete sustained a bone injury: the athlete was referred to a dietitian or nutritionist, the athlete was referred to a sports medicine physician, the athlete was referred to a counselor or psychologist, the athlete was screened for disordered eating, the athlete's caloric intake relative to energy expenditure was assessed, the athlete's bone density was assessed, and the athlete's menstrual function was assessed. Response options were *never*, *sometimes*, *often*, *always*, and *I don't know*.

Demographic Characteristics. Athletic trainers reported their sex and the number of years of experience working as an AT in any setting and at their present job or institution. They also reported their current institution, from which the division of competition was determined.

Statistical Analyses

Two levels of stringency were used to classify written responses about the components of the Triad as correct or incorrect. For the least stringent classification, responses were scored as *correct* if they referred to (1) menstrual function or dysfunction; (2) bone health or bone density; and (3) disordered eating, nutrition, or energy imbalance. A more stringent classification was subsequently applied, with responses that referred only to energy imbalance scored as *correct*. For both levels, the percentage of respondents who correctly identified each component and the mean number of correctly identified components was calculated.

For subsequent analyses, the dependent variables were Triad knowledge and screening and referral practices and the independent variables were AT sex and division of competition. Specifically, we used χ^2 tests or, if warranted by the small cell sizes ($n \leq 5$), the Fisher exact test to compare male and female respondents for the proportions who had heard of the Triad and correctly identified each component. For these comparisons, only respondents who indicated that they had heard of the Triad were included in the analyses. A similar comparison was also conducted for the proportion of male and female respondents who had heard of RED-S. The Mann-Whitney test was used to compare the number of components correctly identified (range, 0 to 3) between male and female respondents.

Descriptive statistics are reported for disordered-eating and menstrual function–related screening practices, with comparisons by division of competition using the Fisher exact test. We also report descriptive statistics for screening and referral practices for athletes who sustained a bone injury and who indicated that they were not having regular menstrual cycles; comparisons among responses on the ordinal Likert-type scale were made using the Kruskal-Wallis test. For post hoc pairwise comparisons by division for responses that were different, we used the Mann-Whitney test. Analyses were conducted in Stata software (version 12.1; StataCorp LP, College Station, TX). To account for the large number of comparisons by sex and division, we set the α level at .01 for all analyses.

Table 1. Participant Characteristics (N = 285)

Variable	% (n)[a]
Sex	
Male	43.86 (125)
Female	35.79 (102)
Missing	20.35 (58)
National Collegiate Athletic Association division	
I	44.91 (128)
II	22.11 (63)
III	29.12 (83)
Missing	3.86 (11)
Years certified as an athletic trainer	
<1	0.00 (0)
1–2	0.70 (2)
3–5	3.16 (9)
6–10	14.39 (41)
11–20	31.23 (89)
>20	30.88 (88)
Missing	19.65 (56)
Years employed at present institution as an athletic trainer	
<1	0.00 (0)
1–2	8.07 (23)
3–5	16.49 (47)
6–10	21.05 (60)
11–20	25.61 (73)
>20	9.47 (27)
Missing	19.30 (55)

[a] Percentages were rounded.

RESULTS

Sample Characteristics

More than half (55.07% [n = 125]) of the 227 participants who provided their sex were men. On average, participants had been certified as an AT for 18.31 ± 9.02 years and employed at their present institution for 10.62 ± 7.51 years. Additional sample characteristics are reported in Table 1.

Knowledge About the Triad and RED-S

As shown in Table 2, nearly all respondents (n = 281 [98.61%]) had heard of the Triad. The 4 (1.40%) respondents who had not heard of the Triad were men. A smaller proportion of respondents (32.98% [n = 94]) had

Table 2. General Knowledge of the Female Athlete Triad and Relative Energy Deficiency in Sport (N = 285)

Item	All, % (n)[a]	Sex Comparisons[a,b]			Statistical Test Values[c]		
		Female, % (n)	Male, % (n)	*P* Value	χ^2	Fisher Exact Test	*U*
Heard of female athlete triad?							
Yes	98.61 (281)	100.00 (102)	96.80 (121)	.13		3.323	
No or I don't know	1.40 (4)	0.00 (0)	3.20 (4)				
Heard of relative energy deficiency in sport?							
Yes	32.98 (94)	36.27 (37)	32.00 (40)	.50	0.458		
No or I don't know	67.02 (191)	63.73 (65)	68.00 (85)				
Correctly identified components of female athlete triad or relative energy deficiency in sport							
Bone-density issues							
Yes	93.33 (266)	99.02 (101)	86.40 (108)	<.001[f]		12.251	
No	6.67 (19)	0.98 (1)	13.60 (17)				
Menstrual function							
Yes	95.09 (271)	99.02 (101)	90.40 (113)	.007[f]		7.730	
No	4.91 (14)	0.98 (1)	9.60 (12)				
Energy imbalance							
Yes	13.33 (38)	11.76 (12)	11.20 (14)	>.99	0.018		
No	86.67 (247)	88.24 (90)	88.80 (111)				
Energy imbalance, disordered eating, or nutrition							
Yes	94.74 (270)	96.08 (98)	92.00 (115)	.27		1.614	
No	5.26 (15)	3.92 (4)	8.00 (10)				
No. of components correctly identified (more stringent)[d]							
0	3.86 (11)	0.98 (1)	8.00 (10)	.003[f]			12.426
1	3.16 (9)	0.00 (0)	5.60 (7)				
2	80.35 (229)	87.25 (89)	76.80 (96)				
3	12.63 (36)	11.76 (12)	9.60 (12)				
No. of components correctly identified (less stringent)[e]							
0	2.46 (7)	0.98 (1)	4.80 (6)	.006[f]			11.691
1	1.40 (4)	0.00 (0)	3.20 (4)				
2	6.67 (19)	2.94 (3)	10.40 (13)				
3	89.47 (255)	96.08 (98)	81.60 (102)				

[a] Percentages were rounded.
[b] Some participants did not report their sex.
[c] Comparisons were conducted using the χ^2 test or the Fisher exact test (if cell frequencies <5) for binary response options (*yes* or *no*) and using the Mann-Whitney test for questions about the number of components correctly identified.
[d] Correct responses refer to bone health or bone density, menstrual function or dysfunction, and energy imbalance.
[e] Correct responses refer to bone health or bone density; menstrual function or dysfunction; and energy imbalance, disordered eating, or nutrition.
[f] Indicates difference ($P < .01$).

heard of RED-S, with no difference between men and women ($\chi^2 = 0.458$, $P = .50$). Most respondents (93.33% [n = 266]) correctly identified 1 component of the Triad as involving bone health or bone injury, with women more likely than men to correctly identify this component (Fisher exact test value = 12.251, $P < .001$). Most respondents (95.09% [n = 271]) also correctly identified 1 component as involving menstrual function, again with women more likely than men to correctly identify this component (Fisher exact test value = 7.730, $P = .007$). Very few respondents (13.33% [n = 38]) correctly identified 1 of the components as involving energy imbalance or energy deficiency, with no differences between men and women ($\chi^2 = 0.018$, $P > .99$). Most respondents (94.74% [n = 270]) indicated that a component involved energy imbalance, disordered eating, or adequate nutrition in some capacity, with no differences between men and women (Fisher exact test value = 1.614, $P = .27$). On average, respondents correctly identified 2.02 ± 0.56 components under the more stringent energy-imbalance criteria and 2.83 ± 0.56 under the less stringent criteria. We observed differences by sex, with women correctly identifying more components, on average, than men across the more stringent ($U = 12.426$, $P = .003$) and less stringent ($U = 11.691$, $P = .006$) conditions.

Screening Practices Related to Triad Components

As presented in Table 3, 59.93% of respondents (n = 163) indicated that athletes at their institutions were screened for eating disorders. Screening most frequently occurred as part of the annual preparticipation examination (69.94% [n = 114]). At most institutions that screened for eating disorders, all athletes were screened (76.43% [n = 120]); 17.20% (n = 27) of respondents indicated that their institutions only screened female athletes. We observed a trend toward statistical differences by division of competition only in whether screening occurred (Fisher exact test value = 12.994, $P = .01$), with screening occurring at 70.16% (n = 87) of Division I, 48.28% (n = 28) of Division II, and 49.37% (n = 39) of Division III institutions.

Nearly three-fourths of respondents (70.55% [n = 115]) indicated that all female athletes at their institutions were screened annually for menstrual dysfunction. We observed

Table 3. Screening for Disordered Eating and Menstrual Dysfunction

Item	All, % (n)	National Collegiate Athletic Association Division Comparisons			*P* Value	Kruskal-Wallis Test Value
		I, % (n)	II, % (n)	III, % (n)		
Do you screen for eating disorders?						
Yes[a]	59.93 (163)	70.16 (87)	48.28 (28)	49.37 (39)	.01[e]	12.994
No[a]	37.50 (102)	27.42 (34)	50.00 (29)	46.84 (37)		
I don't know[a]	2.57 (7)	2.42 (3)	1.72 (1)	3.80 (3)		
Missing	4.56 (13)	3.13 (4)	7.94 (5)	4.82 (4)		
When do you screen for eating disorders?[b,c]						
Annual preparticipation examination	69.94 (114)	71.26 (62)	57.14 (16)	79.49 (31)	.03	14.47
One-time preparticipation examination	39.26 (64)	42.53 (37)	50.00 (14)	25.64 (10)		
When concerned about a specific athlete	48.47 (79)	54.02 (47)	39.29 (11)	41.03 (16)		
Other	6.13 (10)	5.75 (5)	7.14 (2)	2.56 (1)		
Which athletes are screened for an eating disorder?						
All athletes[a]	76.43 (120)	72.29 (60)	75.00 (21)	83.78 (31)	.67	4.033
All female athletes[a]	17.20 (27)	19.28 (16)	17.86 (5)	16.22 (6)		
All athletes in sports considered high risk for eating disorders[a]	0.64 (1)	1.20 (1)	0.00 (0)	0.00 (0)		
Specific athletes about whom there is concern[a]	5.73 (9)	7.23 (6)	7.14 (2)	0.00 (0)		
Missing[c]	3.68 (6)	4.60 (4)	0.00 (0)	5.13 (2)		
Who do you screen for menstrual dysfunction and how often?						
All female athletes on an annual basis	70.55 (115)[c]	69.88 (58)[d]	78.57 (22)[d]	78.38 (29)[d]	.46	1.547
All female athletes at the beginning of their collegiate sports career	22.09 (36)[c]	26.51 (22)[d]	21.43 (6)[d]	16.22 (6)[d]		
Missing	7.36 (12)[c]	8.05 (7)[e]	0.00 (0)[e]	10.26 (4)[e]		

[a] Percentages were calculated excluding missing data.
[b] Respondents were allowed to select more than 1 option, so percentages do not total 100%; comparisons among divisions were made for whether the institution screened annually as part of the preparticipation examination (conditional on any screening occurring).
[c] Percentages were calculated based on the number of respondents who indicated that screening for eating disorders occurred.
[d] Percentage was calculated based on the total number of responses in the division to the question, "Which athletes are screened for an eating disorder?"
[e] Post hoc pairwise comparisons showed differences between Divisions I and II and Divisions I and III ($P < .01$).

no differences by division of competition in when screening for menstrual dysfunction occurred (Fisher exact test value = 1.547, $P = .46$).

Follow-Up and Referral Practices Related to Menstrual Dysfunction and Bone Injury

Follow-up and referral practices for athletes who indicated that they were not having regular menstrual cycles are reported in Table 4. Almost half (47.85% [n = 78]) of respondents indicated that athletes would always be referred to a sports medicine physician, and about one-third (29.45% [n = 48]) indicated that athletes would always be screened for disordered eating. We observed differences by division of competition, with Division I institutions tending to be more likely than Division II and III institutions to refer athletes to a dietitian or nutritionist (Kruskal-Wallis test value = 14.354, $P = .001$) or to prescribe hormonal contraceptives (Kruskal-Wallis test value = 11.464, $P = .003$) and Division II being more likely to refer athletes to a sports medicine physician (Kruskal-Wallis test value = 9.930, $P = .007$).

Follow-up and referral practices for athletes who sustained a bone injury are reported in Table 5. The most frequent action was referral to a sports medicine physician, which 76.84% (n = 219) of respondents indicated always occurred. The next most frequent action was assessing the female athlete's menstrual function, which 28.07% (n = 80) of respondents indicated always occurred. We observed differences by division of competition, with Division I institutions most likely to refer athletes with bone injury to a nutritionist or dietitian (Kruskal-Wallis test value = 36.170, $P = .001$) or engage in additional follow-up screening for disordered eating (Kruskal-Wallis test value = 12.587, $P = .002$).

DISCUSSION

Nearly all participants had heard of the Triad, suggesting that the level of general awareness about the topic was high. However, most ATs indicated that disordered eating was 1 of the 3 interrelated conditions, suggesting that their knowledge of the Triad was rooted in the pre-2007 definition. On average, participants had been certified as ATs for more than 18 years, meaning that they may have received most of their formal education on this topic before the expanded conceptualization of the Triad. Similarly, only one-third had heard of the term *relative energy deficiency in sport*. Regardless of whether one subscribes more strongly to the RED-S framework[9] or the updated Triad conceptualization,[2] it is clear that energy balance is a critical element of athlete health and performance. Athletic trainers who view the Triad within the more restrictive pre-2007 conceptualization may be missing opportunities to identify athletes who are not engaging in pathologic eating behaviors or who do not fit the profile of someone who is likely engaging in pathologic eating behaviors (eg, participants in sports with aesthetic, gravitational, or

Table 4. Follow-Up and Referrals for Athletes Who Indicated That They Were Not Having Regular Menstrual Cycles

Item	All, % (n/163)[a]	National Collegiate Athletic Association Division Comparisons[b] I, % (n/87)	II, % (n/28)	III,% (n/39)	*P* Value	Kruskal-Wallis Test Value
The athlete was referred to a dietitian or nutritionist						
Never	7.36 (12)	2.30 (2)	10.71 (3)	15.38 (6)	.001[c]	14.354
Sometimes	45.40 (74)	37.93 (33)	57.14 (16)	56.41 (22)		
Often	26.38 (43)	35.63 (31)	21.43 (6)	10.26 (4)		
Always	13.50 (22)	17.24 (15)	7.14 (2)	5.13 (2)		
I don't know	3.07 (5)	2.30 (2)	0.00 (0)	7.69 (3)		
Missing	4.29 (7)	4.60 (4)	3.57 (1)	5.13 (2)		
The athlete was referred to a sports medicine physician						
Never	4.91 (8)	2.30 (2)	7.14 (2)	7.69 (3)	.007[d]	9.930
Sometimes	22.09 (36)	13.79 (12)	42.86 (12)	28.21 (11)		
Often	19.02 (31)	21.84 (19)	17.86 (5)	15.38 (6)		
Always	47.85 (78)	56.32 (49)	32.14 (9)	35.90 (14)		
I don't know	2.45 (4)	1.15 (1)	0.00 (0)	7.69 (3)		
Missing	3.68 (6)	4.60 (4)	0.00 (0)	5.13 (2)		
The athlete was referred to a counselor or psychologist						
Never	9.20 (15)	8.05 (7)	14.29 (4)	10.26 (4)	.96	0.074
Sometimes	61.96 (101)	64.37 (56)	53.57 (15)	61.54 (24)		
Often	16.56 (27)	16.09 (14)	17.86 (5)	15.38 (6)		
Always	4.29 (7)	3.45 (3)	7.14 (2)	2.56 (1)		
I don't know	2.45 (4)	1.15 (1)	3.57 (1)	5.13 (2)		
Missing	5.52 (9)	6.90 (6)	3.57 (1)	5.13 (2)		
The athlete was screened for disordered eating						
Never	5.52 (9)	2.30 (2)	10.71 (3)	7.69 (3)	.63	0.941
Sometimes	30.06 (49)	27.59 (24)	32.14 (9)	33.33 (13)		
Often	28.22 (46)	33.33 (29)	21.43 (6)	28.21 (11)		
Always	29.45 (48)	29.89 (26)	32.14 (9)	20.51 (8)		
I don't know	1.84 (3)	1.15 (1)	0.00 (0)	5.13 (2)		
Missing	4.91 (8)	5.75 (5)	3.57 (1)	5.13 (2)		
The athlete's caloric intake relative to energy expenditure is assessed						
Never	11.04 (18)	6.90 (6)	14.29 (4)	17.95 (7)	.53	1.257
Sometimes	31.90 (52)	29.89 (26)	32.14 (9)	33.33 (13)		
Often	24.54 (40)	29.89 (26)	21.43 (6)	17.95 (7)		
Always	22.09 (36)	22.99 (20)	21.43 (6)	17.95 (7)		
I don't know	4.29 (7)	2.30 (2)	7.14 (2)	7.69 (3)		
Missing	6.13 (10)	8.05 (7)	3.57 (1)	5.13 (2)		
The athlete's bone density was assessed						
Never	20.86 (34)	16.09 (14)	28.57 (8)	25.64 (10)	.56	1.149
Sometimes	49.69 (81)	54.02 (47)	46.43 (13)	41.03 (16)		
Often	12.88 (21)	14.94 (13)	7.14 (2)	10.26 (4)		
Always	4.91 (8)	6.90 (6)	3.57 (1)	2.56 (1)		
I don't know	5.52 (9)	1.15 (1)	7.14 (2)	15.38 (6)		
Missing	6.13 (10)	6.90 (6)	7.14 (2)	5.13 (2)		
The athlete was prescribed hormonal contraceptives						
Never	15.95 (26)	5.75 (5)	46.43 (13)	15.38 (6)	.003[e]	11.464
Sometimes	53.99 (88)	65.52 (57)	32.14 (9)	38.46 (15)		
Often	10.43 (17)	11.49 (10)	3.57 (1)	15.38 (6)		
Always	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)		
I don't know	14.72 (24)	11.49 (10)	14.29 (4)	25.64 (10)		
Missing	4.91 (8)	5.75 (5)	3.57 (1)	5.13 (2)		

[a] Percentages were calculated based on the total number of respondents indicating that screening for eating disorders occurred.
[b] Percentages were calculated based on the total number of respondents in each division indicating that screening for eating disorders occurred.
[c] Post hoc pairwise comparisons showed differences between Divisions I and II and Divisions I and III ($P < .01$).
[d] Post hoc pairwise comparisons showed difference between Divisions I and II ($P < .01$).
[e] Post hoc pairwise comparisons showed differences between Divisions I and II, I and III, and II and III ($P < .01$).

Table 5. Follow-Up and Referrals for Athletes Who Sustained a Bone Injury

Item	All, % (n/285)[a]	National Collegiate Athletic Association Division Comparisons[b]			*P* Value	Kruskal-Wallis Test Value
		I, % (n/128)	II, % (n/63)	III, % (n/83)		
The athlete was referred to a dietitian or nutritionist						
Never	17.89 (51)	8.59 (11)	28.57 (18)	25.30 (21)	.001[c]	36.170
Sometimes	47.02 (134)	40.63 (52)	47.62 (30)	56.63 (47)		
Often	15.79 (45)	24.22 (31)	9.52 (6)	4.82 (4)		
Always	9.82 (28)	18.75 (24)	4.76 (3)	1.20 (1)		
I don't know	1.75 (5)	0.78 (1)	1.59 (1)	3.61 (3)		
Missing	7.72 (22)	7.03 (9)	7.94 (5)	8.43 (7)		
The athlete was referred to a sports medicine physician						
Never	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	.02	7.468
Sometimes	5.26 (15)	2.34 (3)	6.35 (4)	9.64 (8)		
Often	10.18 (29)	7.03 (9)	12.70 (8)	12.05 (10)		
Always	76.84 (219)	83.59 (107)	73.02 (46)	69.88 (58)		
I don't know	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)		
Missing	7.72 (22)	7.03 (9)	7.94 (5)	8.43 (7)		
The athlete was referred to a counselor or psychologist						
Never	19.65 (56)	13.28 (17)	28.57 (18)	22.89 (19)	.046	6.159
Sometimes	58.95 (168)	63.28 (81)	53.97 (34)	56.63 (47)		
Often	8.77 (25)	12.50 (16)	3.17 (2)	6.02 (5)		
Always	0.70 (2)	0.78 (1)	1.59 (1)	0.00 (0)		
I don't know	3.86 (11)	2.34 (3)	4.76 (3)	6.02 (5)		
Missing	8.07 (23)	7.81 (10)	7.94 (5)	8.43 (7)		
The athlete was screened for disordered eating						
Never	16.84 (48)	10.16 (13)	25.40 (16)	21.69 (18)	.002[d]	12.587
Sometimes	44.21 (126)	41.41 (53)	41.27 (26)	50.60 (42)		
Often	20.70 (59)	28.91 (37)	12.70 (8)	12.05 (10)		
Always	8.07 (23)	10.94 (14)	9.52 (6)	3.61 (3)		
I don't know	2.11 (6)	0.78 (1)	3.17 (2)	3.61 (3)		
Missing	8.07 (23)	7.81 (10)	7.94 (5)	8.43 (7)		
The athlete's caloric intake relative to energy expenditure was assessed						
Never	17.54 (50)	8.59 (11)	26.98 (17)	24.10 (20)	.02	8.186
Sometimes	38.25 (109)	42.19 (54)	31.75 (20)	37.35 (31)		
Often	19.30 (55)	21.88 (28)	17.46 (11)	16.87 (14)		
Always	14.04 (40)	17.97 (23)	12.70 (8)	8.43 (7)		
I don't know	3.16 (9)	2.34 (3)	3.17 (2)	4.82 (4)		
Missing	7.72 (22)	7.03 (9)	7.94 (5)	8.43 (7)		
The athlete's bone density was assessed						
Never	14.74 (42)	8.59 (11)	22.22 (14)	18.07 (15)	.03	7.244
Sometimes	48.07 (137)	47.66 (61)	44.44 (28)	53.01 (44)		
Often	16.49 (47)	21.88 (28)	12.70 (8)	8.43 (7)		
Always	7.37 (21)	11.72 (15)	3.17 (2)	4.82 (4)		
I don't know	5.26 (15)	2.34 (3)	9.52 (6)	7.23 (6)		
Missing	8.07 (23)	7.81 (10)	7.94 (5)	8.43 (7)		
The athlete's menstrual function was assessed						
Never	10.53 (30)	4.69 (6)	14.29 (9)	16.87 (14)	.04	6.731
Sometimes	30.18 (86)	26.56 (34)	33.33 (21)	32.53 (27)		
Often	19.65 (56)	25.78 (33)	12.70 (8)	15.66 (13)		
Always	28.07 (80)	34.38 (44)	25.40 (16)	20.48 (17)		
I don't know	3.86 (11)	1.56 (2)	6.35 (4)	6.02 (5)		
Missing	7.72 (22)	7.03 (9)	7.94 (5)	8.43 (7)		

[a] Percentages were calculated based on the total number of study participants.
[b] Percentages were calculated based on the total number of study participants in each division.
[c] Post hoc pairwise comparisons showed differences between Divisions I and II and Divisions I and III ($P < .01$).
[d] Post hoc pairwise comparisons showed a difference between Divisions I and III ($P < .01$).

weight-class demands) but who are fueling inadequately. Communicating with athletes and coaches about RED-S in addition to the Triad may have 2 important benefits. First, it does not restrict the conversation to female athletes. Male athletes can also experience negative health and performance consequences from insufficient energy intake,[10] and using a more inclusive framework engages them in this topic and underscores its relevance to their experience. Second, given that RED-S specifies a larger number of possible negative consequences associated with insufficient

energy intake than the Triad, it is more likely that an athlete or coach will notice a change in markers of health or performance that could signal the need for further evaluation.

Both male and female ATs were similarly likely to have heard of the Triad or RED-S, but women were more likely to correctly identify more components, driven largely by a greater likelihood of correctly identifying menstrual function and bone health. Female ATs may be more likely than their male colleagues to work with female athletes and, in this capacity, may have been exposed to the interrelationship between menstrual function and bone health. They may also have experienced these interrelated conditions themselves as athletes, observed the experiences of teammates, or received educational materials from coaches or medical personnel. Regardless, given that male and female ATs work closely with athletes of both sexes, ensuring that all ATs are aware of the full nature of the Triad and RED-S is important for providing optimal athlete care. Accordingly, the utility of educational modules designed specifically for male ATs working with female athletes should be explored.

Whereas not all individuals who have energy imbalance engage in disordered-eating behaviors,[2] screening for disordered eating is a feasible way to identify at least some individuals who may require further evaluation related to the Triad or RED-S. Our results indicated that 60% of institutions screened for disordered eating, and of those institutions, fewer than three-quarters engaged in annual screening. Institutions should consider adding to their annual preparticipation examinations brief written screening instruments, such as the 4-item SCOFF (Sick, Control, One stone, Fat, Food) questionnaire[21] or the 11-question index proposed by the Female Athlete Triad coalition (or both).[22] The NCAA recommended screening for disordered eating in a recent interassociation consensus document.[23]

We observed that Division I institutions were more likely to engage in screening and referral activities related to the Triad than were Division II and III institutions. Researchers[15] have suggested that this may be a function of institutional resources; screening requires staff to administer and interpret the tool, and referral requires personnel to be available to meet with the symptomatic athlete. Critically, the US Preventive Services Task Force[24] cautioned that screening should not occur in the absence of a plan and resources to facilitate referral and care for an individual who is flagged in the screening process. Recommendations that institutions screen for disordered eating should be matched with support or guidelines for ensuring that adequate staff is available to address the results of the screening process. Partnerships with campus health services may help facilitate greater access to care, particularly at schools with fewer resources devoted to sports medicine.

Our results further suggest that opportunities may be available to apply the Triad or RED-S framework to referral behaviors after a positive screening or diagnosis for a disorder or condition. For example, irregular menstrual cycles indicate that the athlete has inadequate energy intake relative to energy expenditure that is potentially but not necessarily related to disordered eating. Screening for disordered eating, and possibly further evaluation by a dietitian or nutritionist, may help suggest potential pathways through which the menstrual dysfunction may have arisen. Similarly, assessing the bone density of an athlete who is having irregular menstrual cycles may help underscore the severity of the physical sequelae to the athlete and allow the athlete and her medical team to begin engaging in behaviors that can reduce the risk of a potential performance-disrupting bone-stress injury. Continuing education of ATs about the expanded conceptualization of the Triad and RED-S may encourage a more comprehensive approach to screening and referral after a diagnosis of menstrual dysfunction or bone-stress injury. The most appropriate strategies for providing this education to ATs should be explored. Beyond ATs' education, having institutions establish formal protocols to evaluate athletes who screen positive for Triad components may be useful.

Limitations

Our study had limitations. One important limitation was the response rate. Only one-third of the head ATs responded to the survey, and these individuals were possibly more interested in and aware of the Triad than nonrespondents. Consequently, our results are not necessarily generalizable to all ATs in the NCAA and likely overestimate AT awareness of the topic. In addition, the findings may also not be generalizable to ATs working in other settings, such as high schools and professional sports or sports medicine clinics not affiliated with specific schools or teams.

Around one-fifth of respondents (n = 58 [20.35%]) did not report their sex. Post hoc analyses compared Triad knowledge for sex nonreporters. Results of a Kruskal-Wallis test revealed differences in the number of components correctly identified under the less stringent criteria ($P = .001$). A visual inspection of the frequencies indicated that the primary way in which the sex nonresponders diverged was that they correctly identified all 3 components of the Triad under the more stringent criteria almost twice as often (20.70%) as men (9.60%) and women (11.76%). Consequently, values for both men and women may underestimate the Triad and RED-S knowledge of ATs.

CONCLUSIONS

Athletic trainers are well positioned to identify and help coordinate the care of athletes who have disorders related to inadequate energy intake. Whereas most participants were aware of some elements of the Triad, all ATs need to be aware of the role of energy deficiency, and not just disordered eating, in the endocrinologic dysfunction that can result in bone injury and other negative health and performance outcomes. Augmenting the AT curriculum may be necessary to ensure that this important aspect of athlete health and performance is covered. Continuing education may particularly benefit individuals who were formally trained before the RED-S concept was recognized, taught, and addressed clinically.

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