

The Female Athlete Triad: An Assessment of Current Practices in Primary Care and Benefit of Educational Intervention

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Abstract

Background. The Female Athlete Triad (Triad) is characterized by negative energy balance, disordered menstrual cycles, and low bone mineral density. The understanding and practices of primary care physicians (PCPs) regarding the Triad and the benefit of an educational intervention were assessed.

Methods. PCPs attending a regional conference were surveyed prior to, immediately after, and three months following the plenary lecture on the Triad. Surveys included knowledge about the components, diagnostics, treatment, clinician practice, and comfort level with regard to the Triad.

Results. The pre-test survey was completed by 84 of 126 (67%) attendees. The lecture increased from 53% to 98% the proportion of PCPs who identified the three domains of the Triad. Knowledge scores improved over the course of the lecture (from 3.4 to 5.1, $p < 0.05$), particularly regarding Triad components (effect size = 1.2) and treatment (effect size = 1.6) with only small gains in diagnostic knowledge (effect size = 0.1 to 0.3). The three-month follow-up survey, completed by only seven clinicians (8%), suggested good retention of knowledge though little practice changes.

Conclusions. A 50-minute educational session improved knowledge about the Triad. Particular improvement was noted in understanding the underlying etiology and treatment.

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Introduction

The Female Athlete Triad (Triad) is characterized by negative energy balance, disordered menstrual cycles, and low bone mineral density (BMD).¹ Energy intake insufficient to support energy expenditure forms the basis for this multifaceted syndrome. Negative energy balance can predispose a female athlete to hormonal dysfunction, manifesting as menstrual irregularities and loss of bone mass. Left untreated, the Triad can have dangerous and irreversible consequences: once bone mass is lost, or if peak BMD is never gained, bone

density may be inadequate to prevent future fragility fractures.

The Triad was first described in response to the clinical observation of an increase in stress fractures and amenorrhea seen in otherwise young healthy women athletes. The resulting 1997 position statement from the American College of Sports Medicine (ACSM) defined the Triad as the “interrelated components (of) disordered eating, amenorrhea, and osteoporosis,” noting that “alone or in combination, Female Athlete Triad disorders can decrease

physical performance and cause morbidity and mortality.”² Subsequent prevalence studies reported that no more than 5% of female athletes had all three pathological components.³⁻⁵ In 2007, the ACSM updated its position statement¹ and redefined the domains as energy availability, menstrual dysfunction, bone health. These changes gave less emphasis to the pathological extremes of each spectrum and reflected a growing appreciation for the interrelationship among the three domains of the Triad and the need to intervene prior to developing such significant pathology.

Disorders of the elements of the Triad are common in female athletes. Two large well-controlled trials have diagnosed clinical eating disorders in 31% (vs 5.5% of controls)⁶ and 42% (vs 9% of controls)⁷ of elite female athletes in leanness-dependent and weight-dependent sports. In a study of 163 female high school athletes, 37% incurred lost-time musculoskeletal injuries.⁸ Injury status was associated with BMD below that expected for age. In women with a BMD z-score of less than or equal to -2.0, the musculoskeletal injuries occurred in conjunction with oligomenorrhea or amenorrhea and disordered eating. Even in girls with normal bone density (BMD z-scores \geq -1.0), musculoskeletal injury was associated with oligomenorrhea or amenorrhea in the preceding year.

Given that approximately half of exercising women experience subtle menstrual disturbances on a hormonal level⁹ and that menstrual irregularities have been found to be a better indicator of bone loss than intensity of training among runners,¹⁰ the potential for serious sequelae is substantial. Although athletes, coaches, and even physicians may recognize that menstrual irregularities are common in athletes, they fail to address these as pathologic phenomena that require medical attention.¹¹

Most clinicians have a poor understanding of the Triad. A 2006 survey of health care and athletic providers found that 48% of the physicians could identify all three (conservatively defined) components of the Triad correctly and only 9% stated they felt comfortable with treatment options.¹² In 2007, the American College of Sports Medicine (ACSM) updated its position statement to reflect a growing appreciation for the interrelationship among the three domains of the Triad with less emphasis on the pathological extremes of each spectrum (i.e., eating disorders, amenorrhea, and osteoporosis).¹ A survey completed after publication of the revised criteria showed an increasing knowledge gap with only 29% of physician respondents able to identify all three components of the Triad correctly.¹³ Inadequate energy intake, the basis for the syndrome, was the least recognized of the three and was noted by 36% of participants.

Education of physicians and improved awareness about the Triad among health care providers may lead to earlier identification of negative energy balance and a higher comfort level with initiating appropriate intervention before dangerous consequences ensue. Primary care physicians (PCPs) are in a unique position to detect subtle abnormalities and direct appropriate care early in the progression of the Triad. Recognition, treatment, and prevention should become a priority among primary care health care providers.¹ This investigation assessed whether a 50-minute educational intervention would improve awareness and impact clinical practice in encounters with physically active female patients of childbearing age.

Methods

This was a prospective, comparative (pre-post) assessment of a sample of clinicians attending a plenary lecture on the

Triad delivered to a state-wide meeting of PCPs. The rationale for selecting this meeting was that its attendees represented about 5% of PCPs in the state, one that leads the nation in training Family Medicine physicians, thus making their knowledge and practice relevant. Further, the educational lecturer was a nationally recognized leader in the area of the Triad and chair of the writing committee for the current consensus statement.¹ Objectives of the lecture were to help attendees recognize and participate in management of women with the Triad. The study was approved by the Institutional Review Boards of Via Christi Hospitals Wichita, Inc. and University of Kansas School of Medicine-Wichita.

Paper surveys developed by the investigators were distributed to participants in registration packets at the beginning of the conference. Pre-test surveys were completed and returned to conference staff prior to the lecture and post-test surveys immediately following the lecture. Respondents willing to provide contact information and complete a three-month follow-up were surveyed via electronic mail to assess retention of information and changes in clinical practice. Surveys were anonymous but coded to allow for within-subject comparisons.

The pre-test survey included six questions to allow identification of PCPs who treat active, reproductive-age women and five questions addressed clinicians' practice and comfort asking patients about the Triad. Surveys (see Appendix) contained questions about the Triad: one on its components, four on diagnostics, and two on treatment. Finally, pre-test and three-month surveys asked which, if any, of five screening questions clinicians routinely ask their pre-menopausal females.

Awareness of the three components of the Triad was assessed with the open-ended

question, "What are the three components of the Female Athlete Triad?" Responses were classified first by domain; correct answers were required to fall within one of three liberally interpreted domains of energy availability, reproductive health, and skeletal health. Second, answers within each domain were evaluated for how strictly the participant defined each aspect of the Triad. The most acceptable answers used the broadest and most up-to-date language reflecting understanding that each of the Triad components falls along a spectrum beginning with subtle abnormalities not necessarily meeting criteria for any specific diagnosis. The weakest answers reflected older and narrower definitions of the Triad, usually a diagnosis in itself: a symptom (e.g., amenorrhea) or extreme presentation (e.g., osteoporosis). Finally, the order of responses was evaluated to determine which domain came most readily to mind.

Diagnostic knowledge was addressed with multiple choice questions on: (1) risk factors for stress fracture (correct: hypothalamic amenorrhea, low BMD, severe undernutrition; incorrect: polycystic ovary syndrome); (2) indications for BMD testing (correct: history of multiple stress fractures, amenorrhea and disordered eating for six months, or a six-month history of oligomenorrhea and a low impact fracture; incorrect: missing menses while taking oral contraceptives); (3) sports carrying the higher risk for the Triad (correct: cheer-leading; incorrect: softball, basketball, volleyball); and (4) the z-score included in the definition of low BMD (correct: -1 to -2).

Treatment knowledge was addressed with multiple choice questions on: (1) the first step in treatment (correct: prescribing increased energy intake and/or decreased energy expenditure with observation; incorrect: watchful waiting or any use of an oral contraceptive), and (2) recommended

treatment team members (correct: physician, registered dietician, mental health provider, endocrinologist).

An overall knowledge score was derived using a seven-point scale. One point was given for correctly identifying the three domains of the Triad, one point each for the four diagnostic questions, and one point each for the two treatment questions.

Power calculations indicated that a sample of 40 matched tests (with $r = .2$) provided 80% power at a one-tailed alpha of .05 to detect an increase in knowledge score of "medium" effect size.¹⁴ Assuming 50% participation in the follow-up survey at three-months, a correlation coefficient of $r = .6$ would allow detection of a medium-sized increase in impact on clinical practice.

Descriptive statistics were used to characterize respondents, their training, and current practice. Knowledge scores were described using Cohen's effect sizes.¹⁴ Paired t-tests were used to compare knowledge scores at $p < 0.05$ (two-tailed). Impact on practice was assessed with paired t-tests comparing the number of screening questions asked prior to the lecture and at three-months.

Results

The pre-test survey was completed by 84/126 attendees (response rate 67%). Clinicians who were not PCPs were excluded prior to analysis as well as PCPs who performed neither pre-participation physicals (PPEs) nor well-woman exams, leaving 70 PCPs (69 family physicians and 1 pediatrician). Paired pre-post surveys were available from 58 of the 70 (83%). Twenty of 54 physicians (35%) reported having had formal training on the Triad either in medical school, residency, or through continuing medical education.

Current practice and comfort level. A minority of PCPs, 30%, reported screening specifically for the Triad at PPEs; 19%

recalled having diagnosed the Triad. Only 11% asked physically active pre-menopausal women about the Triad; the most common reason given for not asking was a lack of knowledge of "good guidelines for doing so" (see Table 1).

Table 1. Reasons given by physicians who do not always ask about the Female Athlete Triad.*

Response (n)	Reason
21	Don't know of any good guidelines for doing so.
9	Don't think about it.
5	Don't have time during visit.
5	Don't know what the Triad is.
3	Can tell from menstrual history, BMI, history of fractures.
1	Don't feel it will change any clinical outcome.

*Results were taken from 42 of 48 PCPs who perform both pre-participation exams and well-woman exams but do not always screen for the Triad.

Most PCPs reported routinely asking their active pre-menopausal females about history of bone injuries (63%), general eating habits (63%), and changes in menstrual cycles with increased activity (60%). Fewer asked about decreased body weight when participating in sports (30%) and whether calorie intake is increased with increased activity (30%). A slight majority of PCPs (56%) was comfortable asking about the Triad; fewer were comfortable referring a patient with the Triad to a specialist (36%), diagnosing the Triad (29%), or treating the Triad (16%).

Knowledge of Triad components. The proportion of PCPs who identified the three domains of the Triad increased from 53% to

98%. Improvement was noted in all domains: from 67% to 100% in energy availability, from 79% to 100% in repro-

ductive health, and from 67% to 98% in skeletal health (see Table 2).

Table 2. Components of the Triad reported PCPs before and after lecture, by domain (n = 58).

			Before		After	
DOMAIN	LEVEL	TYPICAL RESPONSES	n	%	n	%
Energy Availability		Missing	19	33	0	0
	Spectrum	Spectrum of energy availability, BMI, energy, nutrition, weight, diet	3	5	4	7
	Symptom	Weight loss, nutritional deficiencies, decreased eating, disordered eating, low BMI, low energy availability	23	40	40	69
	Extreme	Anorexia, eating disorder	13	22	14	24
Reproductive Health		Missing	12	21	0	0
	Spectrum	Menses, menstrual function	2	3	3	5
	Symptom	Anovulation, altered menses, menstrual disorders, menstrual irregularity	4	7	11	19
	Extreme	Amenorrhea, missed periods	40	69	44	76
Skeletal Health		Missing	19	33	1	2
	Spectrum	Bone density, bone strength	0	0	3	5
	Symptom	Decreased bone density, osteopenia, stress fractures	24	41	23	40
	Extreme	Osteoporosis	15	26	31	53

The extreme manifestation of amenorrhea was the most common component named in any domain, representing 80% of valid reproductive health responses before and 71% after the lecture. The domain most commonly listed first among the components of the Triad was reproductive health (59%) prior to and energy availability (59%) following the lecture. Based on an “ideal” causal order of low energy availability leading to decreased reproductive health with subsequent impact on skeletal health, domains ideally were ordered by three respondents before and 25 after the lecture.

Knowledge of Triad diagnostics. Improvements over the course of the lecture were seen in correct identification of: (1) the overall set of stress fracture risks (from 59% to 69%); (2) the set of indications for BMD testing (from 48% to 53%); (3) sport with the highest risk (from 28% to 47%); and (4) the z-score defining low BMD (from 72% to 83%).

Knowledge of Triad treatment. There was improvement, from 43% to 97%, in knowledge that the initial treatment to be prescribed is increased energy intake and/or decreased energy expenditure with observation. Inclusion of an endocrinologist on

the treatment team increased from 36% to 59%.

Overall Knowledge Score. A paired t-test indicated a statistically significant improvement in knowledge score from pre- to post-test (from 3.4 to 5.1, $p < 0.05$). As

shown in Table 3, large gains were made in knowledge of the Triad components (effect size = 1.2) and treatment (effect size = 1.6). Diagnostic knowledge items showed only small gains (effect size = 0.1 to 0.3).

Table 3. Scores on knowledge questions before and after the lecture (n = 58).

	Before Lecture		After lecture		Effect Size	p
	Mean (SD)		Mean (SD)			
Knowledge						
Named three domains of the Triad	0.53	(0.50)	0.98	(0.13)	1.2*	< .05
Diagnosis	2.07	(1.06)	2.52	(0.92)	0.6	< .05
Knew risk factors for stress fracture	0.59	(0.50)	0.69	(0.47)	0.3	
Knew indications for BMD testing	0.48	(0.50)	0.53	(0.50)	0.1	
Knew cheerleading only higher risk sport	0.28	(0.45)	0.47	(0.50)	3.5*	
Knew z-score for low BMD	0.72	(0.45)	0.83	(0.38)	0.3	
Treatment	0.79	(0.67)	1.59	(0.50)	1.6*	< .05
Knew first step in treatment	0.43	(0.50)	0.97	(0.18)	1.5*	
Included four clinicians on treatment team	0.36	(0.49)	0.62	(0.49)	6.3*	
Total Score	3.40	(1.54)	5.09	(0.96)	1.6*	< .05

*Large effect sizes in **bold**.

Retention and impact on practice. Though contact information for three-month follow-up was provided by 38 PCPs, only seven valid surveys were returned for assessment. Knowledge scores at three months averaged 5.0 (SD = 0.8) indicating that most knowledge had been retained. As an indicator of practice change, the mean number of assessment questions asked of active pre-menopausal females increased from 2.7 (SD = 1.9) to 3.1 (SD = 2.0); this difference was small (effect size = 0.2) and not statistically significant ($p = .68$).

Discussion

Gains in understanding of diagnostics related to the Triad were modest. Following the lecture, only half of the respondents provided correct answers to two of the four diagnostic questions. This may reflect a tendency for clinicians to focus on strong signs rather than appreciating the risk associated with subtle signs. Consistent with this line of thinking, rather than reflecting the spectrum-based definition of the Triad outlined in the 2007 consensus, the majority of responses in the domains of reproductive

health and in skeletal health (amenorrhea and osteoporosis, respectively) after the lecture continued to reflect the older definition involving extreme manifestations of the spectrum. No evidence indicated that this was a function of year of medical training. Recognition of risk has not been aided by studies reporting an incidence of the Triad of only 1.2% at the high school level,⁵ 2.7% in college athletes,³ and 4.3% in elite athletes.⁴ Such studies have been limited by reliance on self-reported data and the use of conservative definitions (e.g., disordered eating, amenorrhea, and osteoporosis) of Triad domains, each of which represents a spectrum ranging from physiologic homeostasis to frank disorder and disease. If Triad components are recognized only when extreme manifestations are present, the window of opportunity for early intervention may be missed by PCPs.

Our results were consistent with previous studies in that they supported the current ACSM stand that awareness about the Triad is lacking among PCPs. Our respondents appeared better informed than those in similar surveys conducted before¹² and after¹³ the current ACSM position paper¹ due perhaps to our acceptance of any legitimate mention of the domain rather than requiring more conservatively defined components.

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A strength of our investigation was that the educational lecture was given by a nationally recognized leader in the area of the Triad and chair of the writing committee for the current consensus statement.¹ In addition, our pre-test response rate of 67% provided a reasonable assessment of baseline understanding. Participants represented a variety of practice settings and patient populations, increasing the ability to generalize results.

Our study was limited by low response rate on the follow-up survey, which made evaluation of the impact of education on change in clinical practice difficult to assess. Further, responses describing "usual practice" were limited by the nature of self-reported data. Also, while the survey was created to be brief, a longer and more detailed survey may have increased sensitivity. Another limitation was that anonymity could not be preserved in the follow-up; response rates on retention may have been higher had an option for completing it with complete anonymity been available.

Further research is needed to determine the prevalence of the Triad and its sub-syndromal components as currently defined to establish the magnitude of the problem and increase its saliency for PCPs.

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Appendix
Female Athlete Triad - Pre-Test

A. Demographics:

A.1. What is your medical training background?

- A) Medical Student
- B) Resident
- C) Attending Physician
- D) Physician Assistant
- F) Nurse Practitioner
- G) Other _____

A.2. What is your specialty?

- A) Family Medicine
- B) Pediatrics
- C) OB/GYN
- D) Orthopedics
- E) Other _____

A.3. If you have graduated from medical school, in what year? _____

A.4. Have you had any formal training/education in your medical education involving the Female Athlete Triad?

- A) Yes
- B) No

If Yes Where? (Medical School, Residency, CME) _____

A.5. Do you perform pre-participation physical exams for female athletes?

- A) Yes
- B) No

A.6. Do you perform well woman exams on pre-menopausal females?

- A) Yes
- B) No

B. Knowledge of Female Athlete Triad Definition:

B.1. What are the three components of the female athlete triad?

- A)
- B)
- C)

C. Diagnosis of Female Athlete Triad:

- C.1. Which of the following increase the risk of stress fractures? (Mark all that apply.)
- A) Polycystic ovarian syndrome
 - B) Hypothalamic amenorrhea
 - C) Low bone mineral density
 - D) Severe undernutrition
- C.2. Bone mineral density testing should be done in which of the following? (Mark all that apply.)
- A) An athlete who missed three consecutive menses while on oral contraception
 - B) An athlete with a history of multiple stress fractures
 - C) An athlete with amenorrhea and disordered eating for six months
 - D) An athlete with a six month history of oligomenorrhea and a low impact fracture
- C.3. In which of the following sports would participation have a higher risk of female athlete triad?
- A) Softball
 - B) Basketball
 - C) Volleyball
 - D) Cheerleading
- C.4. Low bone mineral density is defined by the American College of Sports Medicine as having a history of nutritional deficiencies, hypoestrogenism, stress fractures, and/or other secondary clinical risk factors for fracture along with a bone mineral density Z-score of
- A) 1 to 0
 - B) 0 to -1
 - C) -1 to -2
 - D) -2 to -3
 - E) less than -3
- C.5. Which of the following do you ask your active pre-menopausal females about routinely? (mark all that apply)
- A) Does your weight drop when participating in sports?
 - B) Do you increase your caloric intake with increased activity?
 - C) Does your menstrual cycle change with increased activity?
 - D) Do you have a history of any bone injuries?
 - E) Questions on general eating habits

D. Treatment of Female Athlete Triad

D.1. The first step in treatment in an athlete with amenorrhea secondary to female athlete triad should be to:

- A) Start patient on oral contraception and observe.
- B) Observe until after season, if the cycle does not normalize treat at that time.
- C) Instruct to increase energy intake and/or decrease energy expenditure and observe.
- D) Start patient on oral contraception and instruct to increase energy intake or decrease energy expenditure and observe.
- E) Start patient on oral contraception, bisphosphonate, and increase energy intake or decrease energy expenditure.

D.2. Consensus recommendation is that athletes with an eating disorder and female athlete triad should have a multidisciplinary treatment approach and should include: (circle all that apply)

- A) Physician
- B) Registered Dietitian
- C) Mental Health Practitioner
- D) Endocrinologist

E. Practice Preferences on Inquiring/Screening for Female Athlete Triad:

E.1. Do you screen for the female athlete triad on pre-participation physical exams?

- A) Yes
- B) No

E.2. Do you recall having made the diagnosis of female athlete triad in a patient?

- A) Yes
- B) No

E.3. Do you ask about the female athlete triad on physically active pre-menopausal women you see?

- A) Yes
- B) No

E.4. If you do not always ask about the female athlete triad list any reasons for not doing so, please describe.

- A) Don't feel it will change any clinical outcome
- B) Don't know of any good guidelines for doing so
- C) Don't have time during visit
- D) Other (please list) _____

E.5. Comfort level with the female athlete triad. (Mark all that apply)

- A) I am comfortable asking about the female athlete triad
- B) I am comfortable diagnosing the female athlete triad
- C) I am comfortable treating patients with the female athlete triad
- D) I am comfortable referring a patient out with the female athlete triad