



Contents lists available at [Journal ELORA](#)

JRTI (Jurnal Riset Tindakan Indonesia)

ISSN: 2502-079X (Print) ISSN: 2503-1619 (Electronic)

Journal homepage: <https://jrti.eloracenter.org/jrti>



From detection to management: the gap between screening tool validity and health-care provider preparedness for female athlete triad and red-s: a systematic review

Dally Rahman¹, Jeki Haryanto^{*2}

¹ Universitas Andalas

² Universitas Negeri Padang

Article Info

Article history:

Received Jul 07th, 2026

Revised Aug 17th, 2026

Accepted Sept 18th, 2026

Keyword:

Female athlete triad,
Relative energy deficiency in sport,
Low energy availability,
Screening tools,
Screening tools

ABSTRACT

The female athlete triad and its broader conceptualisation as relative energy deficiency in sport (RED-S) describe the interrelated health and performance consequences of low energy availability, encompassing menstrual dysfunction, impaired bone health, and disordered eating. Despite growing recognition, questions persist regarding how female athletes are screened, how frequently the condition occurs, and how prepared health-care and support staff are to manage it. This systematic literature review synthesised evidence on the screening, prevalence, and health-care management of the triad and RED-S in female athletes. The review followed the PRISMA 2020 framework, searching Scopus, PubMed, and Science Direct for English-language research articles published between 2017 and 2026. The searches identified 1,093 records; after the removal of duplicates and records excluded by eligibility limiters and screening, 15 studies were included in the final synthesis. Three themes were derived: the development and validation of screening instruments, the prevalence of and factors associated with triad and RED-S components, and the knowledge and preparedness of health-care providers. Findings indicate that self-report screening tools such as the Low Energy Availability in Females Questionnaire are widely used yet perform inconsistently across sports, that risk indicators are highly prevalent, and that awareness among providers remains limited. The review underscores the need for context-specific screening protocols and structured, nursing-inclusive education. Future research should prioritise longitudinal and interventional designs and standardised health-care pathways.



© 2026 The Authors.

This is an open access article under the CC BY-NC-SA license
(<https://creativecommons.org/licenses/by-nc-sa/4.0>)

Corresponding Author:

Jeki Haryanto,
Universitas Negeri Padang
Email: jekiharyanto@fik.unp.ac.id

Introduction

The participation of women and girls in competitive and recreational sport has expanded markedly over recent decades, and with it, attention to the specific physiological demands and health vulnerabilities of female athletes has intensified within sports science, sports medicine, and allied health disciplines (Maya & Misra, 2022; Marzuki et al., 2023). Optimal athletic health depends on an adequate balance between the energy an athlete consumes and the energy expended through training and daily living. When this balance is disrupted, a cascade of physiological consequences can follow that threatens not only performance but long-term reproductive, skeletal, and cardiovascular health (Coelho et al., 2021; Sozaeva et al., 2026). The female athlete triad, and its

more comprehensive successor concept, relative energy deficiency in sport (RED-S), have therefore become central concerns for clinicians, coaches, nutritionists, and nursing professionals who support sporting populations (Sims et al., 2023; Heikura et al., 2022).

The female athlete triad was originally defined as the interrelationship among energy availability, menstrual function, and bone mineral density, spanning a spectrum from optimal health to clinically significant low energy availability, functional hypothalamic amenorrhoea, and osteoporosis (Amoruso et al., 2024; Torres Dos Ramos et al., 2025). The RED-S model expanded this framework to acknowledge that low energy availability affects a far wider range of physiological systems, including metabolic, haematological, immunological, endocrine, and psychological function, in both female and male athletes (Angelidi et al., 2024; Grabia et al., 2024). Low energy availability is now understood as the primary upstream driver of the syndrome, making its early identification a clinical priority. Because menstrual disturbance is frequently one of the earliest observable manifestations, it often serves as a sentinel indicator for underlying energy deficiency in female athletes (Amoruso et al., 2024).

A substantial body of research has sought to quantify the burden of the triad and RED-S and to develop practical means of detecting at-risk athletes. Prevalence studies conducted across diverse national contexts and sporting disciplines have reported that indicators such as menstrual irregularity, disordered eating, and suboptimal bone health are common, particularly among endurance and aesthetic athletes (Skorseth et al., 2020; Sharps et al., 2022; Marzuki et al., 2023). In parallel, self-report screening instruments, most prominently the Low Energy Availability in Females Questionnaire (LEAF-Q) and the Female Athlete Screening Tool, have been introduced to enable rapid, low-cost identification of athletes who warrant fuller clinical assessment (Torres Dos Ramos et al., 2025; von Rosen et al., 2022). These tools are appealing because they can be administered by a range of practitioners, including nurses and support staff, in field settings.

Recent advances have refined and extended these approaches. Screening instruments have been culturally adapted and validated in additional languages and populations, proxy indicators derived from resting metabolic rate have been proposed as objective adjuncts, and nutritional management strategies have been articulated in greater detail (Ferraris et al., 2025; Liu et al., 2026; Larrosa et al., 2025). The incorporation of the LEAF-Q into international clinical assessment frameworks has reinforced its role in both research and practice (Ferraris et al., 2025). At the same time, the growing interest in the menstrual cycle as a modifiable and monitorable dimension of female athlete health has stimulated work on symptom burden and its perceived effect on performance (Carmichael et al., 2021; Oester et al., 2026).

Despite this progress, important gaps remain. The measurement performance of widely used screening tools appears to vary considerably across sporting contexts, and evidence suggests that instruments validated in endurance athletes may not transfer reliably to team-sport populations (Dasa et al., 2023; Łuszczki et al., 2021; Witkoś et al., 2022). Reliance on self-reported symptoms, heterogeneous cut-off thresholds, and inconsistent reference standards complicate comparison across studies and may lead to both under-detection and over-detection. Without a clear understanding of where and for whom these tools function well, practitioners cannot confidently translate screening results into appropriate referral and care decisions.

A second, and arguably more consequential, gap concerns the health-care system that surrounds the athlete. Athletes experiencing symptoms of low energy availability frequently present first to physiotherapists, general practitioners, nurses, athletic trainers, and gynaecologists rather than to specialist sports physicians, yet several studies report limited awareness and confidence among these providers, and even the inappropriate use of hormonal contraception to mask amenorrhoea rather than to address its underlying cause (Verhoef et al., 2024; Tenforde et al., 2020; Kroshus et al., 2018; Lodge et al., 2022). This mismatch between where athletes seek help and where expertise resides represents a critical weakness in the care pathway, and it is one that a nursing-inclusive, education-focused perspective is well placed to address.

Although narrative reviews and topic-specific analyses of the triad and RED-S exist, comparatively few syntheses integrate the three interconnected dimensions of screening tool performance, epidemiological burden, and provider preparedness within a single, health-care-oriented framework. Addressing this omission is timely given the rapid growth of female sport participation and the accompanying demand for scalable, practitioner-delivered detection and management. Accordingly, this systematic literature review synthesises recent evidence on the female athlete triad and RED-S in female athletes, and is guided by the following research questions. RQ1: What screening tools and assessment approaches are used to identify female athletes at risk of the triad or RED-S, and how valid and applicable are they across sporting populations? RQ2: What is the prevalence of, and which factors are associated with, the components of the triad or RED-S among female athletes? RQ3: What is the level of knowledge, awareness, and preparedness among health-care providers and support staff to detect and manage the triad or RED-S in female athletes?

Method

Research Design and Framework

This study was conducted as a systematic literature review, a structured and transparent method for identifying, appraising, and synthesising the available evidence on a defined question. The review process was designed and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement, which provides an established checklist and flow framework for documenting the identification, screening, and inclusion of studies (Page et al., 2021). A systematic approach was chosen because the questions addressed here concern the state of knowledge across multiple populations, instruments, and health-care settings, and therefore require a reproducible synthesis rather than a selective narrative account. The review protocol specified the research questions, eligibility criteria, information sources, search strategy, selection procedure, appraisal approach, and synthesis method in advance of data extraction.

Search Strategy

The search strategy was structured using the PICOS framework to ensure that each conceptual element of the review question was represented. The population of interest was female athletes and physically active women across competitive levels. The exposure or phenomenon of interest was low energy availability and the female athlete triad or RED-S, together with the screening, assessment, education, and health-care or nursing management approaches applied to them. The comparison, where relevant, was drawn between athletes classified as at risk and those not at risk, or across competitive levels and sporting disciplines. The outcomes of interest included risk classification and detection, menstrual function, energy availability, bone health, disordered eating, and provider knowledge or management behaviour. The study designs sought were original research articles published in peer-reviewed journals.

Boolean search strings were constructed for each database by combining population terms, condition terms, and health-care or screening terms with the operators AND and OR, and by applying truncation to capture lexical variants. The specific strings applied in each database are presented below.

Scopus

(TITLE-ABS-KEY ("female athlete*" OR "female athlete triad" OR "relative energy deficiency in sport" OR "RED-S" OR "low energy availability") AND TITLE-ABS-KEY (menstrua* OR amenorrh* OR "bone mineral density" OR "disordered eating" OR "energy availability") AND TITLE-ABS-KEY (screening OR nurs* OR "health care" OR management OR awareness OR education))

PubMed

("Female Athletes"[Mesh] OR "female athlete*" OR sportswomen) AND (nurs* OR "health care" OR "health education" OR screening OR management) AND (menstru* OR amenorrhea OR "Female Athlete Triad" OR RED-S OR "Relative Energy Deficiency in Sport" OR "low energy availability")

Science Direct

("female athlete" OR "female athletes") AND (nursing OR nurse) AND ("Female Athlete Triad" OR RED-S OR menstruation OR amenorrhea)

Database and Information Sources

Three electronic bibliographic databases were searched: Scopus, PubMed, and Science Direct. These sources were selected because, in combination, they provide broad coverage of the sports science, sports medicine, nursing, and allied health literature, spanning both indexed multidisciplinary content and clinically oriented biomedical publications. The searches were executed for records published between 2017 and 2026 and were completed in September 2026. The initial database searches returned 1,093 records in total, comprising 493 records from Scopus, 228 records from PubMed, and 372 records from Science Direct. Database-level eligibility limiters were then applied during retrieval, restricting results to the specified publication window, to the English language, to journal research articles at the final stage of publication, and to open-access availability, which yielded the set of records exported for de-duplication and screening.

Eligibility Criteria

Explicit inclusion and exclusion criteria were defined prior to screening to ensure that decisions about study eligibility were consistent and reproducible. Studies were eligible if they reported original research on female athletes or physically active women, addressed the screening, prevalence, or health-care management of the female athlete triad or RED-S or their components, were published as peer-reviewed journal articles in English between 2017 and 2026, and were available in open-access full text. Studies were excluded if their outcomes did not align with the components of the triad or RED-S, if they were not primary research, or if their populations were not female athletes or could not be disaggregated by sex. The full criteria are summarised in Table 1.

Table 1. Inclusion and exclusion criteria

Criterion	Inclusion	Exclusion
Publication period	Published between 2017 and 2026	Published before 2017
Language	Written in English	Written in a language other than English
Publication type	Peer-reviewed journal research article at final publication stage	Reviews, editorials, conference abstracts, theses, book chapters, and grey literature
Access	Open-access full text available	Full text not retrievable or behind restricted access
Population	Female athletes or physically active women	Non-athlete populations, male-only samples, or mixed samples not disaggregated by sex
Topic and outcome	Screening, prevalence, or health-care management of the triad or RED-S or their components	Outcomes not aligned with triad or RED-S components
Study design	Original empirical research	Non-primary research and non-empirical commentary

Study Selection Process

The records exported from the three databases were compiled and de-duplicated, with 15 duplicate records removed. The remaining records were then screened in two sequential stages. In the first stage, titles and abstracts were examined against the eligibility criteria, and records that were clearly irrelevant to the review question were removed. In the second stage, the full texts of the potentially eligible reports were retrieved and assessed in detail. Reports that did not satisfy every inclusion criterion were excluded, and the reasons for exclusion were recorded. The number of records identified, screened, assessed, and included at each stage, together with the reasons for exclusion, is depicted in the PRISMA flow diagram in Figure 1. Screening and eligibility decisions were conducted by two independent reviewers at both the title-and-abstract and full-text stages. Inter-rater agreement was calculated using Cohen's kappa (Cohen, 1960) and yielded $\kappa = 0.82$ for title-and-abstract screening and $\kappa = 0.85$ for full-text eligibility assessment, indicating strong concordance by the benchmarks of Landis and Koch (1977). Disagreements were resolved through discussion with reference to the pre-specified eligibility criteria; where consensus could not be reached, a third reviewer provided a deciding opinion. This review was not prospectively registered; eligibility criteria, information sources, search strategy, appraisal approach, and synthesis method were specified in the review protocol prior to data extraction and applied without modification.

Quality Appraisal

The methodological quality of the included studies was appraised to gauge the trustworthiness of their findings and to inform the weight given to them during synthesis. Because the included studies were predominantly observational and cross-sectional in design, appraisal was guided by the Joanna Briggs Institute Analytical Cross-Sectional Studies Checklist, which evaluates the clarity of inclusion criteria, the description of study subjects and settings, the validity and reliability of exposure and outcome measurement, the identification and handling of confounding factors, and the appropriateness of the statistical analysis. Validation and diagnostic-accuracy studies were additionally considered against the relevant psychometric and accuracy standards. Each study was rated on the individual criteria and assigned an overall judgement of high or moderate methodological quality. No study was excluded solely on the basis of appraisal; instead, appraisal informed the interpretation of the evidence. A summary of the appraisal is presented in Table 2.

Table 2. Summary of methodological quality appraisal of included studies

Author(s), Year	Design	Appraisal tool	Key appraisal observations	Overall
Ferraris et al. (2025)	Cross-sectional validation	JBIC; psychometric standards	Clear criteria and measures; robust reliability and factor analysis; confounding not a focus	High
Skorseth et al. (2020)	Descriptive epidemiology	JBIC cross-sectional	Valid objective measures (DXA, blood); small sample; limited confounder control	Moderate
Łuszczki et al. (2021)	Cross-sectional	JBIC cross-sectional	Validated tool with objective measures; modest sample; some confounders unaddressed	Moderate
Koltun et al. (2020)	Cross-sectional (methodological)	JBIC cross-sectional	Clear methods; objective measures; confounders and proxies explicitly examined	High
Amoruso et al. (2024)	Cross-sectional survey	JBIC cross-sectional	Clear criteria; adjusted analysis with odds ratios; confounders considered	High

Author(s), Year	Design	Appraisal tool	Key appraisal observations	Overall
Torres Dos Ramos et al. (2025)	Descriptive cross-sectional	JBİ cross-sectional	Large sample; validated questionnaires; self-report exposure	High
Vardardottir et al. (2023)	Cross-sectional	JBİ cross-sectional	Multiple validated instruments and objective measures; small sample	Moderate
Lodge et al. (2022)	Cross-sectional survey	JBİ cross-sectional	Clear groups and analysis; self-report knowledge; limited confounder control	Moderate
Dasa et al. (2023)	Cross-sectional diagnostic accuracy	JBİ; accuracy standards	Reference standards and ROC analysis; small single-cohort sample	High
Witkoř et al. (2022)	Cross-sectional	JBİ cross-sectional	Objective measures; very small national-team sample	Moderate
Kroshus et al. (2018)	Cross-sectional survey	JBİ cross-sectional	National sample; clear analysis; self-report and 33% response rate	Moderate
Marzuki et al. (2023)	Cross-sectional survey	JBİ cross-sectional	Clear methods; online self-report; no clinical confirmation	Moderate
Sharps et al. (2022)	Cross-sectional	JBİ cross-sectional	Two validated tools; predictors modelled; self-report exposure	High
Verhoef et al. (2024)	Cross-sectional survey	JBİ cross-sectional	Large multi-professional sample; clear analysis; self-report knowledge	High
Tenforde et al. (2020)	Cross-sectional survey	JBİ cross-sectional	Clear methods; conference sample and 42% response rate limit generalisability	Moderate

Data Extraction

A structured data-extraction form was used to capture consistent information from each included study. The extracted fields comprised the authors and year of publication, the country in which data were collected, the study design, the sample and sporting population, the screening instruments or assessment methods employed, the outcomes measured, and the principal findings. Extracting these fields in a uniform manner allowed the studies to be compared systematically and provided the raw material for both the descriptive summary and the thematic synthesis. The extracted characteristics of the included studies are presented in Table 3, and their classification by theme and method is presented in Table 4.

Data Analysis and Synthesis

Given the heterogeneity of the included studies in terms of populations, instruments, and outcomes, a meta-analysis was not appropriate, and the evidence was instead combined using a narrative thematic synthesis. In this approach, findings were first examined study by study and then grouped according to recurring conceptual foci that mapped onto the review questions. Three analytical themes were derived: the development, validation, and applicability of screening and assessment tools; the prevalence of and factors associated with the components of the triad and RED-S; and the knowledge, awareness, and preparedness of health-care providers and support staff. Within each theme, findings were compared and contrasted, points of convergence and divergence were identified, and the results were interpreted in relation to the wider literature. Descriptive patterns across the corpus, including publication trends, geographic distribution, and keyword frequency, were also summarised to contextualise the synthesis.

Reporting

The review is reported in line with the PRISMA 2020 recommendations, and the flow of studies through the identification, screening, eligibility, and inclusion stages is documented in Figure 1 (Page et al., 2021). Reporting the process transparently allows readers to evaluate the comprehensiveness of the search, the rigour of the selection decisions, and the extent to which the conclusions are supported by the included evidence.

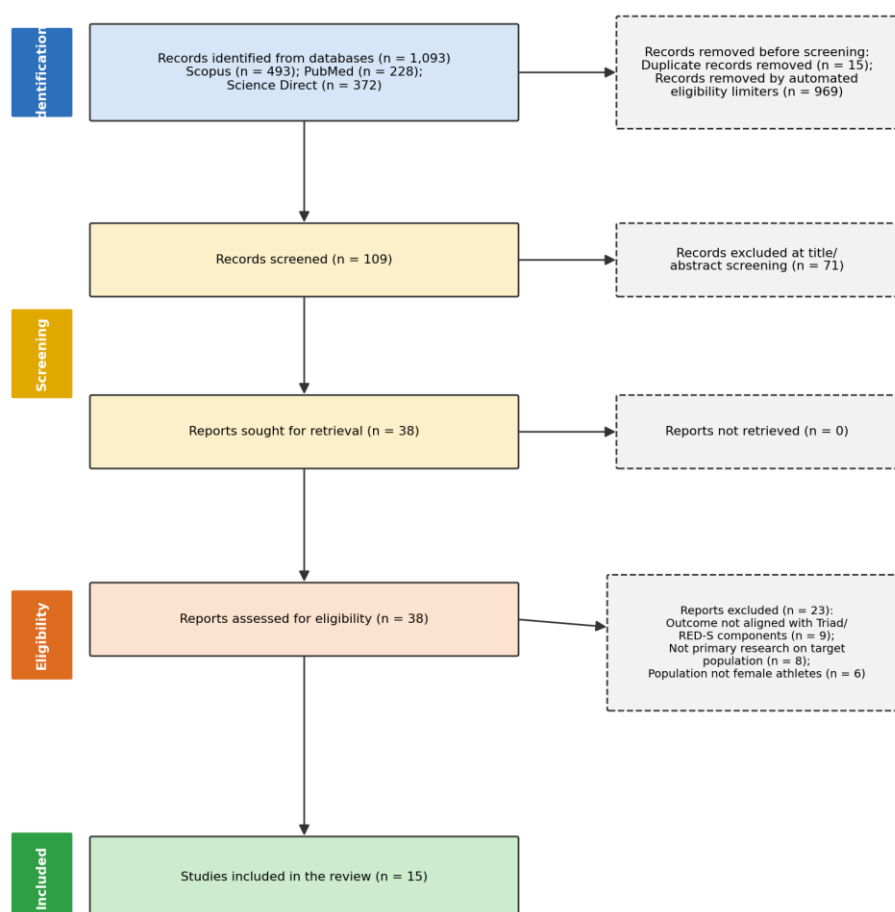


Figure 1. PRISMA 2020 flow diagram of the study identification and selection process

Results and Discussions

Study Selection Results

The database searches identified 1,093 records in total, comprising 493 from Scopus, 228 from PubMed, and 372 from Science Direct. After the removal of 15 duplicate records and 969 records that did not satisfy the automated eligibility limiters, 109 records proceeded to title and abstract screening. Of these, 71 records were excluded as clearly irrelevant to the review question, leaving 38 reports that were retrieved and assessed in full text. A further 23 reports were excluded, of which 9 reported outcomes not aligned with the components of the triad or RED-S, 8 were not primary research on the target population, and 6 involved populations that were not female athletes or could not be disaggregated by sex. Fifteen studies met all eligibility criteria and were included in the final synthesis, as illustrated in Figure 1.

Descriptive Characteristics of Included Studies

The fifteen included studies were published between 2018 and 2025 and were conducted across a range of national contexts, reflecting the international relevance of the topic. Studies originated from the United States, Italy, Poland, Spain, Iceland, Norway, Malaysia, the United Kingdom, and the Netherlands, with the United States contributing the largest number. All of the included studies used cross-sectional or descriptive observational designs, including survey-based, validation, and diagnostic-accuracy variants, which is consistent with a field oriented towards screening, prevalence estimation, and provider assessment rather than experimental intervention. The full characteristics of each study are presented in Table 3, and their classification by analytical theme and method is presented in Table 4. The temporal distribution of the wider retrieved corpus

is shown in Figure 2, the geographic distribution of the included studies in Figure 3, and the most frequent keywords across the corpus in Figure 4.

Table 3. Characteristics of the included studies

Title	Author(s)	Country	Design	Key findings
Screening tool for the identification of relative energy deficiency in Sport risk: validation of the low energy availability in female questionnaire - Italian version (LEAFQ-ITA)	Ferraris et al.	Italy	Cross-sectional validation	The Italian LEAF-Q (LEAFQ-ITA) showed high test-retest reliability (ICC = 0.832) and acceptable internal consistency; 37.6% of participants were classified at risk of low energy availability. Triad risk factors were highly prevalent (76.3% disordered eating, 45.9% menstrual dysfunction, 42.1% low bone mineral density); low free triiodothyronine was associated with higher Triad risk.
Prevalence of Female Athlete Triad Risk Factors and Iron Supplementation Among High School Distance Runners: Results from a Triad Risk Screening Tool	Skorseth et al.	United States	Descriptive epidemiology	64.7% of youth female football players were at risk according to the LEAF-Q, and inadequate energy intake was associated with roughly a tenfold increase in risk.
The LEAF questionnaire is a good screening tool for the identification of the Female Athlete Triad/Relative Energy Deficiency in Sport among young football players	Łuszczki et al.	Poland	Cross-sectional	Alternative scoring for the Triad cumulative risk assessment tool was proposed; delayed menarche could substitute for low bone mineral density and low energy availability for oligomenorrhoea or amenorrhoea.
Female athlete triad coalition cumulative risk assessment tool: Proposed alternative scoring strategies	Koltun et al.	United States	Cross-sectional (methodological)	Menstrual irregularity affected 33.0% of athletes; lean-sport participation and overestimation of body image were significant determinants of menstrual dysfunction (AOR 2.02 and 3.83). Among 1,154 physically active women, 40.0% were at risk for the Triad and 24.3% for subclinical eating disorder; menstrual dysfunction correlated with the LEAF-Q score.
Determinants of menstrual dysfunction in the female athlete triad: A cross-sectional study in Italian athletes	Amoruso et al.	Italy	Cross-sectional survey	Female athletes at risk of low energy availability had higher disordered-eating, exercise-addiction, and muscle-dysmorphia scores, suggesting muscle-dysmorphia screening may aid early detection.
Prevalence of physically active females at risk for the female athlete triad in Spain	Torres Dos Ramos et al.	Spain	Descriptive cross-sectional	Knowledge, confidence, and educational-impact scores were lowest among athletes and highest among athletic trainers, supporting education as the primary preventive tool. The LEAF-Q showed poor accuracy for most components
Body dissatisfaction, disordered eating and exercise behaviours: associations with symptoms of REDs in male and female athletes	Vardardottir et al.	Iceland	Cross-sectional	
Knowledge of the Female Athlete Triad and Relative Energy Deficiency in Sport Among Female Cross-Country Athletes and Support Staff	Lodge et al.	United States	Cross-sectional survey	
Evaluating the Suitability of the Low Energy Availability	Dasa et al.	Norway	Cross-sectional diagnostic accuracy	

Title	Author(s)	Country	Design	Key findings
in Females Questionnaire (LEAF-Q) for Female Football Players				except menstrual status in professional female football players, and its use for detecting low energy availability in this group was not supported.
An Assessment of the Early Symptoms of Energy Deficiency as a Female Athlete Triad Risk among the Polish National Kayaking Team Using LEAF-Q	Witkoś et al.	Poland	Cross-sectional	The LEAF-Q proved a useful screening tool for early detection of Triad symptoms in national-team kayakers, among whom about 15% reported menstrual disorders.
Collegiate athletic trainers' knowledge of the female athlete triad and relative energy deficiency in sport	Kroshus et al.	United States	Cross-sectional survey	Nearly all athletic trainers had heard of the Triad (98.6%) but only 33.0% of RED-S; women identified more components, and comprehensive referral was more common at Division I institutions.
Prevalence of Relative Energy Deficiency in Sport (RED-S) among National Athletes in Malaysia	Marzuki et al.	Malaysia	Cross-sectional survey	67.2% of national athletes were at medium or high RED-S risk, with the highest prevalence among female athletes (41.2%), supporting routine RED-S screening.
Prevalence of disordered eating, eating disorders and risk of low energy availability in professional, competitive and recreational female athletes based in the United Kingdom	Sharps et al.	United Kingdom	Cross-sectional	16% of athletes were at risk of an eating disorder, 44% of disordered eating, and 53% of low energy availability; age and competition level predicted risk.
Knowledge on relative energy deficiency in sport among physiotherapists and physicians	Verhoef et al.	Netherlands	Cross-sectional survey	Only 22.0% of 799 health-care providers had heard of RED-S, few felt qualified to treat it, and 46.6% of gynaecologists would prescribe oral contraception, masking rather than treating the condition.
Awareness and comfort treating the female athlete triad and relative energy deficiency in sport among healthcare providers	Tenforde et al.	United States	Cross-sectional survey	76% of providers were aware of the Triad versus 29% of RED-S, and comfort treating both was low, underscoring the need for education in recognition and management.

Note. LEAF-Q = Low Energy Availability in Females Questionnaire; ICC = intraclass correlation coefficient; AOR = adjusted odds ratio; RED-S = relative energy deficiency in sport.

Table 4. Classification of included studies by theme and method

Author(s), Year	Country	Design	Theme	Assessment / instrument	Principal outcome
Ferraris et al. (2025)	Italy	Cross-sectional validation	Screening and assessment tools	LEAF-Q (Italian); Delphi; test-retest	Valid, reliable Italian LEAF-Q; 37.6% at LEA risk
Skorseth et al. (2020)	United States	Descriptive epidemiology	Prevalence and risk factors	Triad risk tool; DXA; free T3	High Triad-risk prevalence; free T3 linked to risk
Łuszczki et al. (2021)	Poland	Cross-sectional	Screening and assessment tools	LEAF-Q; DXA; REE; dietary recall	64.7% at risk; low energy intake raised risk ~10-fold

Author(s), Year	Country	Design	Theme	Assessment / instrument	Principal outcome
Koltun et al. (2020)	United States	Cross-sectional	Screening and assessment tools	Triad CRA tool; DXA; RMR proxies	Validated substitution scoring for the CRA tool
Amoruso et al. (2024)	Italy	Cross-sectional survey	Prevalence and risk factors	Menstrual-dysfunction questionnaire	33.0% menstrual irregularity; lean sport and body image predictive 40.0% at Triad risk; menstrual dysfunction linked to LEAF-Q
Torres Dos Ramos et al. (2025)	Spain	Descriptive cross-sectional	Prevalence and risk factors	LEAF-Q; FAST	At-risk females showed higher DE, exercise-addiction, dysmorphia
Vardardottir et al. (2023)	Iceland	Cross-sectional	Prevalence and risk factors	LEAF-Q/LEAM-Q; EDE-QS; EAI; MDDI	Knowledge lowest in athletes, highest in trainers
Lodge et al. (2022)	United States	Cross-sectional survey	Provider knowledge and management	Knowledge and confidence survey	LEAF-Q poor accuracy except menstrual status
Dasa et al. (2023)	Norway	Diagnostic accuracy	Screening and assessment tools	LEAF-Q; ROC accuracy analysis	LEAF-Q useful for early detection; ~15% menstrual disorders
Witkoś et al. (2022)	Poland	Cross-sectional	Screening and assessment tools	LEAF-Q; body composition; calcium	33% knew RED-S; referral better at Division I
Kroshus et al. (2018)	United States	Cross-sectional survey	Provider knowledge and management	Knowledge and referral survey	67.2% at medium/high RED-S risk; females highest
Marzuki et al. (2023)	Malaysia	Cross-sectional survey	Prevalence and risk factors	RED-S risk online survey	16% ED, 44% DE, 53% LEA risk; age and level predict 22% aware of RED-S; contraceptive masking; education needed
Sharps et al. (2022)	United Kingdom	Cross-sectional	Prevalence and risk factors	FAST; LEAF-Q	76% aware Triad vs 29% RED-S; low treatment comfort
Verhoef et al. (2024)	Netherlands	Cross-sectional survey	Provider knowledge and management	RED-S awareness and knowledge survey	
Tenforde et al. (2020)	United States	Cross-sectional survey	Provider knowledge and management	Triad/RED-S awareness and comfort survey	

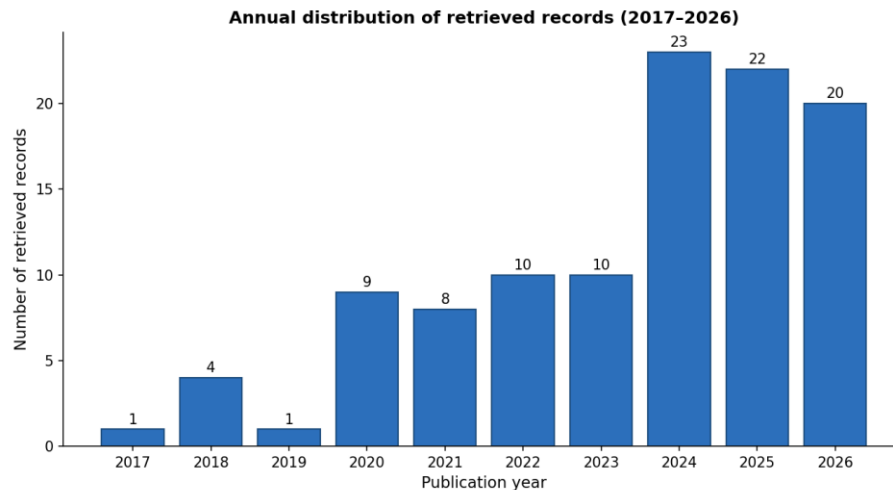


Figure 2. Annual distribution of retrieved records (2017 to 2026)

The temporal distribution of the retrieved corpus indicates a pronounced increase in scholarly attention to the female athlete triad and RED-S over the review window, with the volume of records rising steeply from 2020 onward and peaking in the most recent years. This trajectory signals a maturing and rapidly expanding evidence base and reinforces the timeliness of synthesising current knowledge.

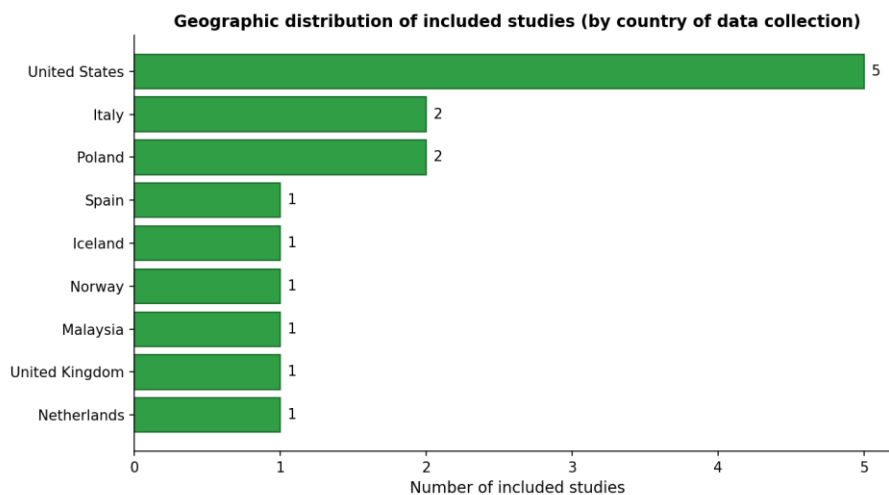


Figure 3. Geographic distribution of the included studies by country of data collection

The geographic distribution shows that the included evidence is concentrated in high-income European and North American settings, with a single study from Southeast Asia. This concentration has implications for the transferability of screening thresholds and prevalence estimates to under-represented regions, where sporting structures, body-image norms, and health-care access may differ.

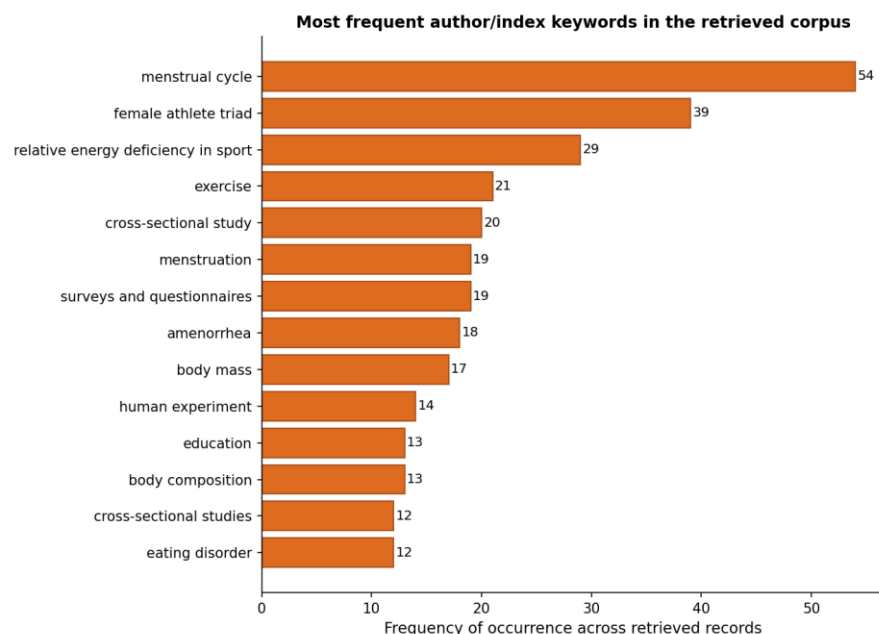


Figure 4. Most frequent author and index keywords across the retrieved corpus

The keyword profile of the corpus is dominated by terms relating to the menstrual cycle, the female athlete triad, relative energy deficiency in sport, and cross-sectional methodology, confirming that menstrual and energy-related outcomes are the conceptual core of the field and that observational designs predominate.

Thematic Synthesis

The synthesis of the fifteen included studies produced three interrelated themes that correspond directly to the review questions: the screening and assessment tools used to identify at-risk athletes, the prevalence of and factors associated with the components of the triad and RED-S, and the knowledge and preparedness of health-care providers. Each theme is considered in turn below.

Findings for RQ1: Screening and Assessment Tools

Across the included studies, the Low Energy Availability in Females Questionnaire (LEAF-Q) emerged as the most frequently applied screening instrument, valued for its brevity and its suitability for administration by a range of practitioners in field settings. Evidence for its measurement properties, however, was mixed. In a rigorous validation study, Ferraris et al. (2025) translated and culturally adapted the instrument into an Italian version and demonstrated high test-retest reliability and acceptable internal consistency, classifying more than a third of participants as at risk of low energy availability. Similarly, Witkoś et al. (2022) found the LEAF-Q useful for the early detection of triad symptoms among national-team kayakers, and Łuszczki et al. (2021) reported that it identified almost two-thirds of youth football players as at risk, with inadequate energy intake sharply increasing the likelihood of risk classification. These studies collectively support the tool as a pragmatic first-line screen when applied in appropriate populations.

Countering this, Dasa et al. (2023) directly evaluated the diagnostic accuracy of the LEAF-Q against clinically defined markers in professional female football players and found that, aside from acceptable performance in determining menstrual status, most components exhibited poor accuracy and predictive value, leading the authors to advise against its use for detecting low energy availability in that population and to propose higher cut-off thresholds. This divergence indicates that the instrument's validity is population-dependent and that thresholds derived from endurance athletes and dancers may not transfer to team-sport athletes. Recognising the limitations of any single self-report tool, Koltun et al. (2020) advanced the methodological basis of screening by proposing alternative scoring strategies for the Female Athlete Triad Coalition cumulative risk assessment tool, showing that delayed menarche could substitute for bone mineral density and that self-reported low energy availability and disordered-eating measures could substitute for menstrual criteria when those data are unavailable. Taken together, the evidence for RQ1 suggests that screening is feasible and increasingly refined, but that instrument selection, cultural adaptation, and context-specific validation are essential to avoid both under-detection and over-detection.

Findings for RQ2: Prevalence and Associated Factors

The prevalence studies consistently demonstrated that indicators of the triad and RED-S are common among female athletes, although the magnitude varied with population, sport, and instrument. In adolescent distance runners, Skorseth et al. (2020) documented strikingly high proportions of disordered eating, menstrual dysfunction, and low bone mineral density, and identified low free triiodothyronine as a biochemical correlate of elevated triad risk. In large community and club samples, Torres Dos Ramos et al. (2025) found that two-fifths of physically active Spanish women were at risk for the triad and a quarter were at risk of subclinical eating disorder, while Sharps et al. (2022) reported that more than half of United Kingdom athletes were at risk of low energy availability and that age and competition level predicted risk. In a national multi-sport survey, Marzuki et al. (2023) classified two-thirds of athletes as at medium or high RED-S risk, with female athletes showing the highest prevalence.

Beyond describing frequency, several studies illuminated the factors that shape risk. Amoruso et al. (2024) identified menstrual irregularity as an early manifestation of energy impairment and showed that participation in lean sports and overestimation of body image were significant determinants of menstrual dysfunction, with adjusted odds ratios of approximately two and four respectively. Vardardottir et al. (2023) extended the risk profile by demonstrating that athletes at risk of low energy availability also exhibited elevated disordered-eating, exercise-addiction, and muscle-dysmorphia scores, suggesting that the psychological dimension of the syndrome is substantial and that a drive for muscularity, not only for thinness, may contribute. The convergence across these studies is that low energy availability, menstrual dysfunction, and disordered eating co-occur and reinforce one another, and that psychological and sport-type factors modulate risk. For RQ2, the evidence therefore establishes a high and multifactorial burden, while also underscoring that self-report prevalence figures require clinical confirmation to avoid misclassification.

Findings for RQ3: Health-Care Provider Knowledge and Management

The third theme addressed the preparedness of the health-care system that surrounds the athlete, and the findings were uniformly concerning. Kroshus et al. (2018) found that while nearly all collegiate athletic trainers had heard of the triad, only a third were familiar with RED-S, and that comprehensive referral behaviour was inconsistent and more developed at higher competitive divisions. Tenforde et al. (2020) reported a comparable awareness gap among physicians and allied health professionals, with far greater awareness of the triad than of RED-S and low self-reported comfort in treating either condition, though fellowship training improved comfort. Lodge et al. (2022) demonstrated that knowledge, confidence, and educational impact were lowest among the athletes themselves and highest among athletic trainers, positioning education as the central lever for improvement.

Perhaps the most clinically significant finding came from Verhoef et al., 2024, who surveyed a large and diverse group of health-care providers and found that only a fifth had heard of RED-S, that very few felt qualified to treat it, and that almost half of gynaecologists would respond to a presentation of RED-S symptoms by prescribing oral contraception, an intervention that masks amenorrhoea without addressing the underlying low energy availability. Because athletes frequently present first to physiotherapists, general practitioners, gynaecologists, and nurses rather than to sports physicians, this knowledge deficit at the point of first contact represents a critical vulnerability in the care pathway. The evidence for RQ3 thus indicates that awareness, confidence, and appropriate management are limited across professions, and that structured, multidisciplinary, and nursing-inclusive education is required to ensure that first-contact providers recognise the syndrome and respond with cause-directed rather than symptom-masking care.

Comparative and Critical Analysis

Viewing the three themes together reveals a field that has become adept at detecting and quantifying the female athlete triad and RED-S but has not yet translated that capacity into reliable, system-wide management. The screening literature and the prevalence literature are mutually reinforcing: the same self-report instruments that enable large prevalence surveys also determine who is flagged for care, which means that the population dependence of tools such as the LEAF-Q, evident in the contrast between the supportive findings of Ferraris et al. (2025) and Witkoś et al. (2022) and the cautionary findings of Dasa et al., 2023, propagates directly into prevalence estimates. A tool that over-identifies risk in one sport and under-identifies it in another will distort both the epidemiological picture and the allocation of clinical attention. The methodological quality of the included studies, summarised in Table 2, was generally moderate to high, but the near-universal reliance on cross-sectional self-report designs limits causal inference and clinical confirmation.

The provider-knowledge theme exposes the weakest link in the chain. Even where screening is accurate and prevalence is well characterised, the benefit to athletes depends on providers who can interpret a positive screen and respond appropriately. The finding that a substantial proportion of first-contact clinicians would mask symptoms with hormonal contraception rather than address energy availability Verhoef et al. (2024) demonstrates that detection without provider competence can be not merely unhelpful but actively

counterproductive. This is the central critical insight of the review: screening, prevalence surveillance, and provider education are not independent workstreams but sequential components of a single care pathway, and a weakness in any one undermines the others.

This systematic review synthesised fifteen recent studies on the screening, prevalence, and health-care management of the female athlete triad and RED-S in female athletes. The overarching interpretation is that the field has developed practical screening instruments and has generated consistent evidence of a high and multifactorial risk burden, yet remains constrained by inconsistent instrument performance across sports and by limited provider preparedness at the point of first contact. These findings align with and extend the broader literature, in which low energy availability is positioned as the upstream driver of a syndrome that spans reproductive, skeletal, metabolic, and psychological domains (Angelidi et al., 2024; Heikura et al., 2022). The prominence of menstrual dysfunction as an early and observable marker, seen across the prevalence studies, is consistent with wider evidence that menstrual health is a practical entry point for monitoring energy status in female athletes (Carmichael et al., 2021; von Rosen et al., 2022).

From a theoretical standpoint, the review reinforces the shift from the narrower triad model towards the more comprehensive RED-S framework, while also showing that clinical and research practice has not fully caught up with this conceptual expansion. Awareness of RED-S consistently lagged behind awareness of the triad among both athletes and providers, indicating that the diffusion of the newer model into everyday practice is incomplete. The evidence also supports a biopsychosocial reading of the syndrome, in which sport-type, body-image, and psychological factors such as disordered eating, exercise addiction, and muscle dysmorphia interact with physiological energy deficiency (Vardardottir et al., 2023; Amoruso et al., 2024). This complexity argues against reliance on any single indicator and in favour of multidimensional assessment.

The practical implications are substantial and are especially relevant to nursing and allied health. Because athletes commonly present first to physiotherapists, general practitioners, nurses, and gynaecologists, these professionals are strategically positioned to detect early warning signs, provided they possess the requisite knowledge and clear referral protocols (Vargas et al., 2026; Schulz et al., 2026). The repeated call across studies for structured education points to a concrete intervention: embedding triad and RED-S content into continuing professional development and preparticipation examination pathways, and pairing screening tools with explicit, cause-directed management algorithms that discourage the reflexive prescription of hormonal contraception as a substitute for restoring energy availability (Verhoef et al., 2024; Kroshus et al., 2018). Engagement-focused and athlete-centred educational approaches may further improve help-seeking, which is known to be low among symptomatic athletes (Roche et al., 2024; Verhoef et al., 2021).

When compared with prior narrative and topic-specific reviews, which have tended to address either the pathophysiology and nutritional management of the syndrome or the performance of individual screening tools in isolation (Maya & Misra, 2022; Grabia et al., 2024; Larrosa et al., 2025), the present synthesis contributes an integrated, care-pathway perspective that connects detection, burden, and provider response. This integration surfaces a contradiction that single-theme reviews can obscure: the literature simultaneously endorses the widespread use of self-report screening and documents that such screening performs unreliably in some of the very populations to which it is applied. Resolving this tension requires not the abandonment of screening but its calibration to context and its coupling with confirmatory assessment.

Several gaps in the evidence base warrant emphasis. First, the near-total absence of longitudinal and interventional designs means that the natural history of risk and the effectiveness of management strategies remain poorly quantified, a gap only partially addressed by emerging intervention protocols (Williams et al., 2019). Second, the geographic concentration of the evidence in high-income European and North American settings leaves the prevalence, presentation, and care of the syndrome in other regions largely unknown. Third, the heterogeneity of instruments, thresholds, and reference standards impedes comparison and pooled estimation, and standardised, sport-specific screening protocols are lacking.

This review is subject to limitations that qualify its conclusions. The eligibility criteria restricted inclusion to open-access, English-language journal articles from three databases published within a defined window, which may have excluded relevant evidence published in other languages, formats, or sources and may have introduced selection and language bias. The included studies were almost exclusively cross-sectional and reliant on self-report, so the synthesis inherits their susceptibility to recall and social-desirability bias and cannot support causal claims. Finally, because a meta-analysis was not feasible given the heterogeneity of the evidence, the synthesis is narrative and interpretive rather than quantitative.

Future research should prioritise prospective cohort and randomised or controlled intervention designs that track energy availability, menstrual function, and bone health over time and that test the effectiveness of education and management pathways on athlete outcomes. Screening instruments should be validated and,

where necessary, re-calibrated within specific sports and cultural contexts, and objective adjuncts such as resting-metabolic-rate proxies and biomarkers should be evaluated alongside self-report (Liu et al., 2026; Sharp et al., 2025). Research should also extend to under-represented regions and populations and should develop and trial standardised, multidisciplinary, nursing-inclusive care pathways that connect a positive screen to appropriate, cause-directed management.

In direct response to the research questions, the review reaches the following conclusions. For RQ1, a small number of self-report screening tools, principally the LEAF-Q and the Female Athlete Screening Tool, alongside the cumulative risk assessment approach, are used to identify at-risk female athletes; these tools are practical and, when culturally adapted, can be reliable, but their diagnostic accuracy is population-dependent and cannot be assumed to transfer across sports. For RQ2, the components of the triad and RED-S, particularly low energy availability, menstrual dysfunction, and disordered eating, are highly prevalent among female athletes and are shaped by sport-type, body-image, psychological, and competitive-level factors. For RQ3, knowledge, awareness, and preparedness among health-care providers and support staff are limited, awareness of RED-S consistently trails awareness of the triad, and inappropriate symptom-masking management occurs, indicating an urgent need for structured, multidisciplinary education.

Conclusions

This systematic review of fifteen studies shows that the female athlete triad and relative energy deficiency in sport are frequent and multifactorial among female athletes, yet remain inconsistently detected and inadequately managed. Self-report screening tools such as the Low Energy Availability in Females Questionnaire enable practical, field-based identification of at-risk athletes, but their accuracy depends on the sporting population and requires context-specific validation and confirmatory assessment. Indicators of low energy availability, menstrual dysfunction, and disordered eating are highly prevalent and are shaped by sport-type, psychological, and body-image factors. Most critically, knowledge and preparedness among the health-care providers who athletes consult first are limited, and symptom-masking rather than cause-directed care is common. Strengthening the pathway from accurate screening to competent, nursing-inclusive management, supported by structured education and longitudinal and interventional research, is essential to protect the long-term health of female athletes.

Acknowledgments

The authors would like to express their sincere gratitude to everyone who provided support and encouragement throughout the completion of this Systematic Literature Review. We also appreciate the researchers whose published works served as valuable references for this study. Their contributions have been essential in enriching the findings and discussions presented in this article.

References

- Amoruso, I., Fonzo, M., Barro, A., Scardina, C., Titton, F., Bertoncello, C., & Baldovin, T. (2024). Determinants of menstrual dysfunction in the female athlete triad: A cross-sectional study in Italian athletes. *Psychology of Sport and Exercise*, 73. <https://doi.org/10.1016/j.psychsport.2024.102653>
- Angelidi, A. M., Stefanakis, K., Chou, S. H., Valenzuela-Vallejo, L., Dipla, K., Boutari, C., Ntoskas, K., Tokmakidis, P., Kokkinos, A., Goulis, D. G., Papadaki, H. A., & Mantzoros, C. S. (2024). Relative Energy Deficiency in Sport (REDs): Endocrine Manifestations, Pathophysiology and Treatments. *Endocr Rev*, 45(5). <https://doi.org/10.1210/endrev/bnae011>
- Armento, A., Brna, M., Seehusen, C., Hagman, J., McCarthy, A., VanBaak, K., & Howell, D. (2026). Health-Related Quality of Life in Adolescent Athletes: Correlations with Energy Availability, Disordered Eating, and Compulsive Exercise Behaviors. *Journal of athletic training*, 61(2), 132–138. <https://doi.org/10.4085/1062-6050-0016.25>
- Carmichael, M. A., Thomson, R. L., Moran, L. J., & Wycherley, T. P. (2021). The Impact of Menstrual Cycle Phase on Athletes' Performance: A Narrative Review. *Int J Environ Res Public Health*, 18(4). <https://doi.org/10.3390/ijerph18041667>
- Carmichael, M., Roberts, A., Perry, K., & Clarke, A. (2026). Tailoring support to the female athlete: A cross-sectional online survey to observe current practices in high performance sport. *International Journal of Sports Science and Coaching*, 21(1), 109–120. <https://doi.org/10.1177/17479541251361218>

- Coelho, A. R., Cardoso, G., Brito, M. E., Gomes, I. N., & Cascais, M. J. (2021). The Female Athlete Triad/Relative Energy Deficiency in Sports (RED-S). *Rev Bras Ginecol Obstet*, 43(5). <https://doi.org/10.1055/s-0041-1730289>
- Dasa, M. S., Friborg, O., Kristoffersen, M., Pettersen, G., Sagen, J. V., Sundgot-Borgen, J., & Rosenvinge, J. H. (2023). Evaluating the Suitability of the Low Energy Availability in Females Questionnaire (LEAF-Q) for Female Football Players. *Sports Medicine - Open*, 9(1). <https://doi.org/10.1186/s40798-023-00605-4>
- Ferraris, C., de Cassya Lopes Neri, L., Amoroso, A. P., Bosio, F., Fiorini, S., Guglielmetti, M., Nappi, R. E., & Tagliabue, A. (2025). Screening tool for the identification of relative energy deficiency in Sport risk: validation of the low energy availability in female questionnaire - Italian version (LEAFQ-ITA). *Journal of the International Society of Sports Nutrition*, 22(1). <https://doi.org/10.1080/15502783.2025.2550317>
- Grabia, M., Perkowski, J., Socha, K., & Markiewicz-Żukowska, R. (2024). Female Athlete Triad and Relative Energy Deficiency in Sport (REDs): Nutritional Management. *Nutrients*, 16(3). <https://doi.org/10.3390/nu16030359>
- Heikura, I. A., Stellingwerff, T., & Areta, J. L. (2022). Low energy availability in female athletes: From the lab to the field. *Eur J Sport Sci*, 22(5). <https://doi.org/10.1080/17461391.2021.1915391>
- Iida, M., Ideno, Y., Nagai, K., Miyazaki, Y., Toki, R., Sato, Y., Iwasa, T., Arata, N., Kurabayashi, T., & Hayashi, K. (2025). Being underweight or obese in adolescence may increase the risk of female infertility later in life: The Japan Nurses' Health Study. *Maturitas*, 193, 108172. <https://doi.org/10.1016/j.maturitas.2024.108172>
- Jugenheimer, A., Lohse, K., Müller, H., & Winnisch, M. (2026). Perceived Impact of Menstrual Cycle Symptoms on Soccer Performance in Elite Female Athletes: A Cross-Sectional Study. *Deutsche Zeitschrift für Sportmedizin*, 77(2), 65–68. <https://doi.org/10.5960/dzsm.2025.653>
- Kirschbaum, E. M., Fischer, K., Speiser, D., Lautenbach, F., Schwenkreis, F., Dathan-Stumpf, A., & Legerlotz, K. (2025). Prevalence of Menstrual Dysfunction and Hormonal Contraceptive Use Among Elite Female Athletes from Different Sports in Germany. *Sports Medicine - Open*, 11(1). <https://doi.org/10.1186/s40798-025-00845-6>
- Koltun, K. J., Williams, N. I., & De Souza, M. J. (2020). Female athlete triad coalition cumulative risk assessment tool: Proposed alternative scoring strategies. *Applied Physiology, Nutrition and Metabolism*, 45(12), 1324–1331. <https://doi.org/10.1139/apnm-2020-0131>
- Kroshus, E., DeFreese, J. D., & Kerr, Z. Y. (2018). Collegiate athletic trainers' knowledge of the female athlete triad and relative energy deficiency in sport. *Journal of Athletic Training*, 53(1), 51–59. <https://doi.org/10.4085/1062-6050-52.11.29>
- Larrosa, M., Gil-Izquierdo, A., González-Rodríguez, L. G., Alférez, M. J. M., San Juan, A. F., Sánchez-Gómez, Á., Calvo-Ayuso, N., Ramos-Álvarez, J. J., Fernández-Lázaro, D., Lopez-Grueso, R., López-León, I., Moreno-Lara, J., Domínguez-Balmaseda, D., Illescas-Quiroga, R., Cuenca, E., López, T., Montoya, J. J., Rodrigues-de-Souza, D. P., Carrillo-Alvarez, E., ... Domínguez, R. (2025). Nutritional Strategies for Optimizing Health, Sports Performance, and Recovery for Female Athletes and Other Physically Active Women: A Systematic Review. *Nutr Rev*, 83(3). <https://doi.org/10.1093/nutrit/nuae082>
- Liu, Z. Y., Lee, W. S., Sohi, S. K., Tan, X. R., & Huang, L. (2026). Comparing RMR-Derived Proxy Indicators and LEAF-Q for Detecting Low Energy Availability Risk in Mixed-Sport Female Athletes. *Sports*, 14(8). <https://doi.org/10.3390/sports14080319>
- Lodge, M. T., Ackerman, K. E., & Garay, J. (2022). Knowledge of the Female Athlete Triad and Relative Energy Deficiency in Sport Among Female Cross-Country Athletes and Support Staff. *Journal of Athletic Training*, 57(4), 385–392. <https://doi.org/10.4085/1062-6050-0175.21>
- Łuszczki, E., Jagielski, P., Bartosiewicz, A., Kuchciak, M., Dereń, K., Stolarczyk, A., Pakosz, P., & Oleksy, L. (2021). The LEAF questionnaire is a good screening tool for the identification of the Female Athlete Triad/Relative Energy Deficiency in Sport among young football players. *PeerJ*, 9. <https://doi.org/10.7717/peerj.12118>
- Marzuki, M. I. H., Mohamad, M. I., Chai, W. J., Farah, N. M. F., Safii, N. S., Jasme, J. K., & Jamil, N. A. (2023). Prevalence of Relative Energy Deficiency in Sport (RED-S) among National Athletes in Malaysia. *Nutrients*, 15(7). <https://doi.org/10.3390/nu15071697>
- Maya, J., & Misra, M. (2022). The female athlete triad: review of current literature. *Curr Opin Endocrinol Diabetes Obes*, 29(1). <https://doi.org/10.1097/med.0000000000000690>
- Oester, C., Lovell, R., Pedlar, C., Bruinvels, G., Wilson, B., & Norris, D. (2026). Knowing isn't enough: Menstrual symptoms drive perceived performance impacts in women's football. *Journal of Science and Medicine in Sport*, 29(4), 425–431. <https://doi.org/10.1016/j.jsams.2025.11.007>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A.,

- Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, n71. <https://doi.org/10.1136/bmj.n71>
- Parnell, S., Graybeal, A. J., Renna, M. E., & Stavres, J. (2024). Preliminary Evaluation of Self-Reported Training Volume as an Adjunct Measure of Female Athlete Triad Risk in Division 1 Collegiate Female Runners. *Journal of Functional Morphology and Kinesiology*, 9(4). <https://doi.org/10.3390/jfmk9040179>
- Recacha-Ponce, P., Suárez-Alcázar, P., Hernando, C., Salas-Medina, P., Muriach, M., Baliño, P., Guisado-Cuadrado, I., & Collado-Boira, E. (2025). Hormonal balance, anovulatory cycles and luteal phase deficiency: exploring relationships between hematological variables, sex hormones and VO2max in athletes. *Reproduction and Fertility*, 6(2). <https://doi.org/10.1530/raf-24-0119>
- Roche, M., McIntyre, A., Oliver, C., Sainani, K., Boyd, T., Stoner, A., & Kraus, E. (2024). How can we better engage female athletes? A novel approach to health and performance education in adolescent athletes. *BMJ Open Sport and Exercise Medicine*, 10(3). <https://doi.org/10.1136/bmjsem-2024-001901>
- Schulz, J. M., Adler, S. J., Dart, H., Khaled, M., Tannous, T., & Thornton, J. S. (2026). Preparticipation examinations for varsity female athletes: The Canadian healthcare practitioners' perspectives. *Journal of Science and Medicine in Sport*. <https://doi.org/10.1016/j.jsams.2026.06.013>
- Sharp, S., Mashlach-Fransis, R., Keay, N., & Slee, A. (2025). Assessment of relative energy deficiency in sport and malnutrition prevalence in female endurance runners by energy availability questionnaire, bioelectrical impedance analysis and relationship with ovulation status. *Clinical Nutrition Open Science*, 59, 171–183. <https://doi.org/10.1016/j.nutos.2024.12.010>
- Sharps, F. R. J., Wilson, L. J., Graham, C. A.-M., & Curtis, C. (2022). Prevalence of disordered eating, eating disorders and risk of low energy availability in professional, competitive and recreational female athletes based in the United Kingdom. *European Journal of Sport Science*, 22(9), 1445–1451. <https://doi.org/10.1080/17461391.2021.1943712>
- Sims, S. T., Kerkick, C. M., Smith-Ryan, A. E., Janse de Jonge, X. A. K., Hirsch, K. R., Arent, S. M., Hewlings, S. J., Kleiner, S. M., Bustillo, E., Tartar, J. L., Starratt, V. G., Kreider, R. B., Greenwalt, C., Rentería, L. I., Ormsbee, M. J., VanDusseldorp, T. A., Campbell, B. I., Kalman, D. S., & Antonio, J. (2023). International society of sports nutrition position stand: nutritional concerns of the female athlete. *J Int Soc Sports Nutr*, 20(1). <https://doi.org/10.1080/15502783.2023.2204066>
- Skorseth, P., Segovia, N., Hastings, K., & Kraus, E. (2020). Prevalence of Female Athlete Triad Risk Factors and Iron Supplementation Among High School Distance Runners: Results from a Triad Risk Screening Tool. *Orthopaedic Journal of Sports Medicine*, 8(10). <https://doi.org/10.1177/2325967120959725>
- Sozaeva, Z. Y., Atayeva, M. V., Rozhkova, Y. V., Khubezhov, I. Y., Bagaeva, K. R., Bdaitseva, E. S., Khozieva, A. I., Dzigoeva, A. O., Yashurkaeva, R. M., & Umarova, E. R. (2026). Cardiovascular and Reproductive Disorders Associated with Relative Energy Deficiency in Adolescent Aesthetic Athletes. *Journal of Biochemical Technology*, 17(1), 68–78. <https://doi.org/10.51847/in6tocscuc>
- Stangerup, I., Melin, A. K., Lichtenstein, M., Friis-Hansen, L., Jørgensen, N. R., Schjerling, P., Kjaer, M., & Mertz, K. H. (2025). Lower Bone Mineral Density in Female Elite Athletes with Menstrual Dysfunction From Mixed Sports. *Translational Sports Medicine*, 2025(1). <https://doi.org/10.1155/tsm2/4969624>
- Tenforde, A. S., Beauchesne, A. R., Borg-Stein, J., Hollander, K., McInnis, K., Kotler, D., & Ackerman, K. E. (2020). Awareness and comfort treating the female athlete triad and relative energy deficiency in sport among healthcare providers. *Deutsche Zeitschrift für Sportmedizin*, 71(3), 76–80. <https://doi.org/10.5960/dzsm.2020.422>
- Torres Dos Ramos, A., Bellver, M., Esquius, L., Martínez Pastor, I., Barea Montes, A., & Andrés, A. (2025). Prevalence of physically active females at risk for the female athlete triad in Spain. *Journal of the International Society of Sports Nutrition*, 22(1). <https://doi.org/10.1080/15502783.2025.2590641>
- van Niekirk, M., Matzkin, E., & Christino, M. A. (2023). Psychological Aspects of Return to Sport for the Female Athlete. *Arthroscopy, Sports Medicine, and Rehabilitation*, 5(4), 100738. <https://doi.org/10.1016/j.asmr.2023.04.021>
- Vardardottir, B., Olafsdottir, A. S., & Gudmundsdottir, S. L. (2023). Body dissatisfaction, disordered eating and exercise behaviours: associations with symptoms of REDs in male and female athletes. *BMJ Open Sport and Exercise Medicine*, 9(4). <https://doi.org/10.1136/bmjsem-2023-001731>
- Vargas, P., Cerussi, N., & Odgers, K. (2026). Stress Fracture in an Adolescent Female Athlete: A Case Report. *Journal for Nurse Practitioners*, 22(4). <https://doi.org/10.1016/j.nurpra.2026.105727>
- Verhoef, S. J., Wielink, M. C., Achterberg, E. A., Bongers, M. Y., & Goossens, S. M. T. A. (2021). Absence of menstruation in female athletes: why they do not seek help. *BMC Sports Science, Medicine and Rehabilitation*, 13(1). <https://doi.org/10.1186/s13102-021-00372-3>

- Verhoef, S. J., Wielink, M. C., Achterberg, E. A., Bongers, M. Y., & Goossens, S. M. T. A. (2024). Knowledge on relative energy deficiency in sport among physiotherapists and physicians. *European Journal of Sport Science*, 24(1), 156–163. <https://doi.org/10.1002/ejsc.12026>
- von Rosen, P., Ekenros, L., Solli, G. S., Sandbakk, Ø., Holmberg, H.-C., Hirschberg, A. L., & Fridén, C. (2022). Offered Support and Knowledge about the Menstrual Cycle in the Athletic Community: A Cross-Sectional Study of 1086 Female Athletes. *International Journal of Environmental Research and Public Health*, 19(19). <https://doi.org/10.3390/ijerph191911932>
- Walsh, M., Crowell, N., & Merenstein, D. (2020). Exploring health demographics of female collegiate rowers. *Journal of Athletic Training*, 55(6), 636–643. <https://doi.org/10.4085/1062-6050-132-19>
- Williams, N. I., Mallinson, R. J., & De Souza, M. J. (2019). Rationale and study design of an intervention of increased energy intake in women with exercise-associated menstrual disturbances to improve menstrual function and bone health: The REFUEL study. *Contemporary Clinical Trials Communications*, 14, 100325. <https://doi.org/10.1016/j.conctc.2019.100325>
- Witkoś, J., Błażejowski, G., & Gierach, M. (2022). An Assessment of the Early Symptoms of Energy Deficiency as a Female Athlete Triad Risk among the Polish National Kayaking Team Using LEAF-Q. *International Journal of Environmental Research and Public Health*, 19(10). <https://doi.org/10.3390/ijerph19105965>