













Nutrological care for athletes in overtraining: a brief systematic review

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Abstract

Introduction: Training can cause stress to an athlete, changing their physical and psychological well-being, and progressing from acute to chronic fatigue (overtraining). Athletes must be monitored closely to ensure training can deliver the desired effects on the athlete's well-being and performance. In this sense, physiological, biochemical, metabolic, and subjective performance measures are all options for monitoring the athlete, including prioritizing the relationship between metabolism and functional nutrition.

Objective: It was to carry out a systematic review to elucidate and describe the importance of metabolic tracking and nutrological care in athletes. **Methods:** The PRISMA Platform systematic review rules were followed. The research was carried out from October to November 2025 in the Scopus, PubMed, Science Direct, Scielo, and Google Scholar databases. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** A total of 127 articles were found, and 46 articles were evaluated, and 34 were

included in this systematic review. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 14 studies with a high risk of bias and 33 studies that did not meet GRADE. Most studies showed homogeneity in their results, with $X^2 = 69.5\% > 50\%$. The biases did not compromise the scientific basis of the studies. It was concluded that subjective well-being responded consistently to training stress, deteriorating with increased and chronic training and improving with reduced training. Athletes need to consume adequate energy in the quantity and timing of intake during periods of high-intensity and/or long-duration training to maintain health and maximize training outcomes. Low energy availability can result in unwanted loss of muscle mass, menstrual dysfunction, hormonal disturbances, suboptimal bone density, an increased risk of fatigue, injury and illness, impaired adaptation, and a prolonged recovery process.

Keywords: Metabolism. Stress. athletes. Body composition. Nutrients.

Introduction

Training can cause stress to an athlete, altering their physical and psychological well-being, evolving from acute to chronic fatigue (overtraining) [1,2]. Although overreaching can be carefully incorporated into a periodized training plan, progression to overtraining syndrome is undesirable. Athletes should be closely monitored to ensure training can deliver desired effects on athlete well-being and performance [3-11].

In this sense, physiological, biochemical, metabolic, and subjective performance measures are all options for athlete monitoring, including prioritizing the relationship between metabolism and functional nutrition [8]. Performance is the ultimate indicator of physical and psychological well-being and the athlete's readiness to compete, but it is impractical to test athletes daily through performance tests [17].

In this context, potential physiological mechanisms underlying progression to overtraining syndrome can be observed [18-22]. Hormonal, immunological, inflammatory, and hematological parameters, along with responses, have been proposed as markers of these mechanisms; however, the results have been inconsistent. This has been attributed to factors such as intra- and inter-assay variability, intra-individual and inter-individual variability, the influence of circadian and pulsatile rhythms, nutritional and hydration status, climate, psychosocial factors, and particular characteristics of the exercise [18,20,23-25].

Thus, whether the markers are elevated or depressed also depends on the athlete's position along the wellness continuum, with proposed physiological mechanisms involving an increase in the initial response that later depletes [19-22]. Although there is debate about the specific physiological mechanisms underlying the progression to overtraining syndrome, progression is associated with psychological signs such as mood disorders and symptoms similar to clinical depression [11,26]. The signs and symptoms can be self-reported by athletes as perceived physical and psychological well-being, collectively termed subjective measures. Subjective measures for routine athlete monitoring are also relatively inexpensive and simple to implement compared to objective measures. However, it is not known whether subjective measures accurately reflect changes in athletes' well-being and how they can be effectively integrated into applied practice [9].

Therefore, the present study aimed to conduct a systematic review to elucidate and describe the importance of metabolic tracking, web, and functional

nutrition in athletes, pointing out the main nutritional elements to establish body and functional balance for better sports performance.

Methods

Study Design

This study followed an international model for systematic review, following the PRISMA (preferred reporting items for systematic reviews and meta-analysis) guidelines. Available at: <http://www.prisma-statement.org/?AspxAutoDetectCookieSupport=1>. Accessed on: 11/28/2025. The methodological quality standards of AMSTAR 2 (Assessing the methodological quality of systematic reviews) were also followed. Available at: <https://amstar.ca/>. Accessed on: 11/28/2025.

Research Strategy and Search Sources

The search strategy was carried out in the PubMed, Cochrane Library, Web of Science, and Scopus, and Google Scholar databases, using the descriptors (DeCS/MeSH Terms): Metabolism. Stress. athletes. Body composition. Nutrients), and using the Boolean operator "and" between MeSH terms and "or" between historical findings.

Study Quality and Risk of Bias

Quality was classified as high, moderate, low, or very low regarding the risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident highlight was for systematic review articles or meta-analyses of randomized clinical trials, followed by randomized clinical trials. Low-quality evidence was attributed to case reports, editorials, and brief communications, according to the GRADE instrument. The risk of bias was analyzed according to the Cochrane instrument.

Results

Summary of Findings

As a corollary to the literature search system, 127 studies were analyzed and submitted to eligibility analysis, and subsequently, 34 studies of high to medium quality were selected (Figure 1), considering in the first instance the level of scientific evidence of studies such as meta-analyses, consensus, randomized clinical trials, prospective and observational studies. Biases did not compromise the scientific basis of the studies. Most studies showed homogeneity in their results, with $X^2=69.5\% >50\%$. Biases did not compromise the scientific basis of the studies.

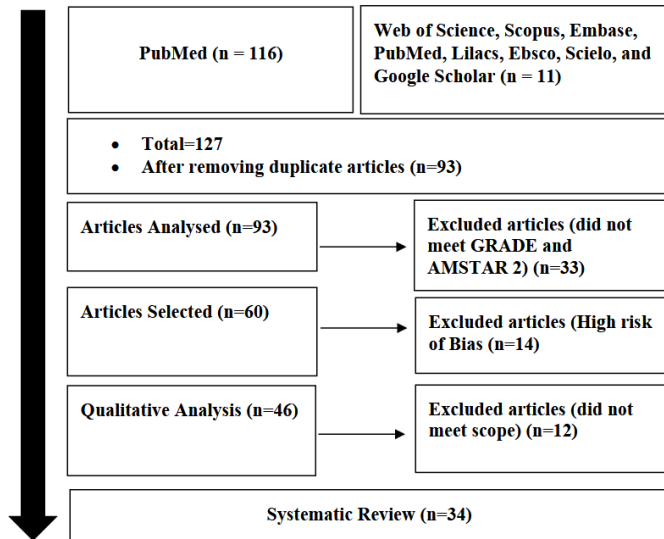


Figure 1. Selection of articles. Source: Own authorship.

Major Clinical Findings

Based on the literature findings of the present study, moderate evidence of a negative association between stress and cortisol and a positive association between vigor and leukocytes was observed. There was moderate evidence for a positive association between four RESTQ-S stress subscales and creatine kinase (CQ), but the evidence was conflicting for total stress. Between POMS and maximum oxygen consumption (VO₂max), there was strong evidence of an association with the vigor subscale and moderate evidence of a negative association with the fatigue subscale, which was also reflected by strong evidence of a negative association with total mood disturbance. There was strong evidence of a negative association between stress symptoms (measured by DALDA) and sustained performance [8,9,22].

In the studies, subjective measures were more sensitive and consistent than objective measures in most studies. Objective measures were generally unresponsive to acute changes in training load, with moderate evidence of a typical response in three measures (CQ, short-term, and sustained performance) to increasing and decreasing training. With continuous training, there was moderate to strong evidence of responsiveness for five objective measures, including impairment of epinephrine/noradrenaline and leukocytes [22-31].

Subjective well-being responded consistently to the stress imposed by training, deteriorating with increased and chronic training and improving with reduced training. There was negligible evidence for an association between subjective and objective measures. This was likely due to the superior responsiveness of subjective measures over objective measures. Given that subjective measures reflect changes in athlete well-being and provide a practical method for monitoring,

coaches and athlete support staff can confidently employ self-report measures [23-34].

Body Composition Assessment

Techniques used to assess athlete body composition include dual-energy X-ray absorptiometry (DXA), hydrodensitometry, air displacement plethysmography, skinfold measurements, and single- and multi-frequency bioelectrical impedance analysis [27]. Although DXA is fast and non-invasive, issues regarding cost, accessibility, and exposure to a small dose of radiation limit its usefulness, especially for certain populations [28].

When performed according to standardized protocols, DXA has the lowest standard error of estimate, considering that skinfolds are the highest. Air displacement plethysmography (Bod-Pod, Life Measurement, Inc.) provides an alternative method that is fast and reliable, but may underestimate body fat by 2% to 3% [28].

Skinfold measurements and other anthropometric data serve as an excellent substitute (certainty of adiposity and muscularity when profile composition changes in response to training interventions) [25]. However, it should be noted that the standardization of skinfold sites, measurement techniques, and calipers varies worldwide. Despite some limitations, this technique remains a popular method of choice due to its convenience and cost, with information being provided in absolute measures and compared with sequential data from each individual athlete or, more generally, with normative data collected in the same way from athlete populations [28,29].

All body composition assessment techniques should be vetted to ensure accuracy and reliability. Tests should be performed with the same calibrated equipment, with a standardized protocol, and by technicians with proven reliability in testing. In cases where population-specific prediction equations are used, they should be cross-validated and reliable. Athletes should be informed of the limitations associated with body composition assessment and strictly follow pre-assessment protocols. These instructions, which include maintaining a consistent training volume, fasting status, and hydration from test to test, should be applied to avoid compromising the accuracy and reliability of body composition measurements [28].

Body composition should be determined within a sports program according to a schedule appropriate to the event's performance, the practicality of conducting assessments, and the athlete's sensitivity. There are technical errors associated with all body composition techniques that limit the usefulness of the

measurement for athlete selection and performance prediction. Instead of establishing absolute body composition goals or applying absolute criteria to categorize groups of athletes, it is preferable that normative data be provided in terms of ranges [24]. As an individual athlete's body fat content varies throughout the season and over time, in an athlete's career, goals for body composition should be defined in terms of ranges that can be adequately tracked at critical times.

When conducting such monitoring programs, it is important that the communication of results with coaches, training staff, and athletes is carried out sensitively, that limitations in the measurement technique are recognized, and that care is taken to avoid promoting an obsession with body composition [25,26]. Thus, sports dietitians have important opportunities to work with these athletes to help promote healthy body composition and minimize their reliance on quick weight loss techniques and other dangerous practices that can result in decreased performance.

Many issues need to be addressed, including creating a culture and environment that values safe, long-term approaches to body composition management, modifying rules or practices around selection and qualification for weight classes [27-29], and programs that identify disordered eating practices at an early stage for intervention [26].

Conclusion

It was concluded that subjective well-being responded consistently to the stress imposed by training, deteriorating with increased and chronic training and improving with reduced training. Athletes need to consume adequate energy in the amount and timing of intake during periods of high-intensity and/or long-duration training to maintain health and maximize training outcomes. Low energy availability can result in unwanted muscle mass loss, menstrual dysfunction, hormonal disorders, suboptimal bone density, an increased risk of fatigue, injuries and illnesses, impaired adaptation, and a prolonged recovery process.

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