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Hypothyroidism in Female Athletes: Differentiation from Overtraining Syndrome and Implications for Athletic Performance – A Narrative Review

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ABSTRACT

Introduction. Hypothyroidism and overtraining syndrome (OTS) may present with similar symptoms in female athletes, including fatigue, reduced exercise tolerance, mood disturbances, sleep problems, and impaired performance, which may complicate differential diagnosis.

Aim of the study. To review the overlap between hypothyroidism and OTS in female athletes, identify key elements of differential diagnosis and discuss implications for treatment and return to sport.

Material and Methods. A narrative literature review was conducted using PubMed, Scopus, and Google Scholar for studies published between 1990 and 2025, with emphasis on review articles, consensus statements, clinical guidelines, and papers addressing symptom overlap, laboratory evaluation, and athletic performance.

Results. Both hypothyroidism and OTS are associated with persistent fatigue, delayed recovery, sleep disturbances, mood changes, and reduced training capacity. However, hypothyroidism is more often linked to cold intolerance, weight gain, cognitive complaints, and other features of endocrine dysfunction. Thyroid-stimulating hormone (TSH) and free thyroxine (fT4) are the most useful laboratory markers in differential diagnosis, whereas biochemical abnormalities in OTS remain nonspecific. Coexisting low energy availability and relative energy deficiency in sport (RED-S) may further complicate clinical assessment.

Conclusions. In female athletes with fatigue and declining performance, hypothyroidism should be considered alongside OTS, especially when symptoms persist despite training modification. Early recognition of thyroid dysfunction may support appropriate treatment and safer return-to-sport decisions.

Keywords: hypothyroidism; overtraining syndrome; female athletes; fatigue; thyroid function; return to sport

1. Introduction

Elite female athletes are frequently exposed to high training loads and dense competition schedules. When persistent fatigue, reduced exercise tolerance, mood disturbances, and declining athletic performance occur, these complaints are often interpreted in the context of overtraining syndrome (OTS), a condition associated with prolonged underperformance and maladaptation to training stress [1,2]. However, a similar clinical picture may also accompany endocrine disorders, including hypothyroidism, whose gradual onset and nonspecific presentation can delay recognition [3,6]. Previous sports medicine reviews have shown that thyroid disorders may impair performance and complicate clinical assessment in athletes [7,8]. The diagnostic challenge is further increased by the fact that fatigue and underperformance in athletes are often multifactorial rather than purely training-related [14,15]. More recent reviews have likewise emphasized that persistent symptoms should not automatically be interpreted as evidence of OTS alone [17,21,23].

Hypothyroidism is one of the most common endocrine disorders in women, and autoimmune thyroiditis is its leading cause in iodine-sufficient populations [5,6]. Its manifestations, including chronic fatigue, impaired concentration, depressed mood, weight change, reduced exercise tolerance, and delayed recovery, overlap with complaints commonly reported during periods of intensified training [3,6]. As a result, thyroid dysfunction may be mistaken for a training-related condition, particularly in highly active women who continue training despite persistent symptoms [3,12].

In female athletes, the differential diagnosis of persistent fatigue and performance decline is especially important because these symptoms may reflect several overlapping processes, including OTS, low energy availability, relative energy deficiency in sport (RED-S), and endocrine dysfunction [9,10]. The relevance of RED-S in this context has been reinforced by the 2023 IOC consensus statement, which highlighted the broad physiological consequences of low energy availability [11]. Recent reviews have further emphasized the need to consider disordered eating, endocrine consequences, and athlete health more broadly in women with ongoing fatigue and underperformance [18,19]. This broader perspective is also supported by newer sport-related reviews addressing RED-S, endocrine manifestations, and eating disorders in athletes [20,24,25].

Early recognition of hypothyroidism is clinically important because appropriate treatment may improve general health, recovery, and the ability to return safely to training and competition [3,6]. Failure to identify thyroid dysfunction may prolong symptoms and lead to unnecessary interruption of training and suboptimal clinical decision-making [2,3].

The aim of this narrative review was to examine the overlap in clinical presentation between hypothyroidism and overtraining syndrome in female athletes, with particular emphasis on diagnostic differentiation and implications for athletic performance. It also discusses the role of thyroid function testing in athletes presenting with persistent fatigue and reduced exercise tolerance and outlines practical considerations for return to sport after diagnosis and treatment.

2. Methods

This narrative review synthesizes clinical, physiological, and epidemiological evidence concerning hypothyroidism and overtraining syndrome (OTS) in female athletes. Relevant peer-reviewed literature published between 1990 and 2025 was identified through searches of PubMed, Scopus, and Google Scholar using combinations of the following terms: "hypothyroidism athletes," "overtraining syndrome female," "thyroid dysfunction sport," and "OTS differential diagnosis."

Particular attention was given to studies addressing symptom overlap, diagnostic differentiation, and performance-related consequences in athletic populations, especially in female athletes. The review drew on consensus statements [10,11], review articles [1,2], clinical guidelines [6], and selected original studies considered relevant to the topic.

Articles were included on the basis of their relevance to the aims of the review, clinical applicability, and overall methodological value. The analysis focused on three main areas: clinical presentation, laboratory approaches to differential diagnosis, and practical considerations related to return to training and competition. As this was a narrative review, no formal risk-of-bias assessment or meta-analysis was performed.

3. Clinical presentation

Both overtraining syndrome (OTS) and hypothyroidism in female athletes may present with nonspecific symptoms, which makes clinical differentiation difficult [1-3]. Common manifestations include persistent fatigue, mood disturbances, reduced exercise capacity, sleep problems, and delayed recovery between training sessions [2,4,10]. Because these complaints are common in athletes exposed to high training loads, they may initially be interpreted as a consequence of training maladaptation rather than an underlying endocrine disorder [2,3,12]. The main overlapping and differentiating clinical features are summarized in Table 1.

Table 1. Clinical features that may overlap between overtraining syndrome and hypothyroidism in female athletes

Clinical feature	**Overtraining syndrome (OTS)**	Hypothyroidism	**Diagnostic relevance**
Persistent fatigue	Common	Common	Nonspecific; requires further evaluation
Reduced performance	Common	Common	Present in both conditions
Mood disturbances	Common	Common	May include low mood, irritability, or reduced motivation
Sleep problems	Common	Possible	More often linked to impaired recovery in OTS
Delayed recovery	Common	Common	Persistent symptoms despite reduced training load should raise suspicion
Weight gain	Less common	More common	More suggestive of hypothyroidism
Cold intolerance	Uncommon	More common	Supports suspicion of hypothyroidism, but is not diagnostic alone
Dry skin / constipation	Uncommon	More common	Favors hypothyroidism
Menstrual disturbances	Possible	Possible	May also be related to RED-S / low energy availability
Cognitive complaints	Possible	More common	May include impaired concentration and memory difficulties

Despite the overlap in symptoms, some features may support the differential diagnosis. OTS is usually associated with excessive training load, insufficient recovery, and prolonged underperformance [2,10]. Hypothyroidism, in contrast, typically develops more gradually and may be accompanied by metabolic symptoms such as cold intolerance, constipation, dry skin, and weight gain [3,6]. Female athletes with hypothyroidism may also report impaired concentration, memory difficulties, and menstrual disturbances [5,12]. However, some of these complaints may also occur in athletes with low energy availability or relative energy deficiency in sport (RED-S) [9,11].

The time course of symptoms may also be informative. In OTS, complaints are more often related to recent changes in training volume, intensity, or recovery [2,10]. Hypothyroidism usually follows a more persistent and progressive course that is not clearly linked to training load [3,12]. At the same time, low energy availability may further obscure the clinical picture and make thyroid dysfunction more difficult to recognize, particularly in female athletes [9,11]. For this reason, symptoms alone are often insufficient for a reliable diagnosis. When fatigue, performance decline, and recovery problems persist despite training modification, clinical assessment should be supported by laboratory testing [3,6,10,12].

4. Laboratory diagnosis

Laboratory evaluation becomes particularly important when fatigue, performance decline, and delayed recovery persist despite training modification, as biochemical testing may help distinguish thyroid dysfunction from overtraining syndrome (OTS) [3,6,10]. In athletes with suspected hypothyroidism, the initial assessment should include serum thyroid-stimulating hormone (TSH) and free thyroxine (fT4), which remain the basic tests used to evaluate thyroid function [6]. In primary hypothyroidism, the typical pattern is elevated TSH with low fT4, whereas subclinical hypothyroidism is characterized by elevated TSH with normal fT4 [6,12]. By contrast, low fT4 with low or inappropriately normal TSH should raise suspicion of central hypothyroidism, although this is uncommon in athletic populations [3,6].

The role of laboratory testing in OTS is different. OTS has no single diagnostic biochemical marker [1,2,10]. Instead, laboratory assessment is used mainly to exclude other causes of fatigue and underperformance rather than to confirm the diagnosis directly [14,17]. This approach has also been supported by more recent review papers [21,22]. For this reason, thyroid function testing is especially useful in female athletes whose symptoms seem disproportionate to recent training changes or are accompanied by features suggestive of endocrine dysfunction.

Table 2. Laboratory findings that may assist in the differential diagnosis of OTS and hypothyroidism

Parameter	Overtraining syndrome (OTS)	Hypothyroidism	Diagnostic relevance
TSH	Usually within reference range	Often elevated in primary hypothyroidism	Main screening test for primary thyroid dysfunction
Free T4 (fT4)	Usually normal	Low in overt hypothyroidism; normal in subclinical hypothyroidism	Helps confirm hypothyroidism together with TSH
Free T3 (fT3)	May vary	May be low, but is not routinely required for diagnosis	Limited value in routine assessment
Anti-TPO antibodies	Not characteristic	May be elevated in autoimmune thyroiditis	Supports autoimmune etiology
CK (creatine kinase)	May increase after heavy training or muscle stress	May also be elevated, especially in hypothyroid myopathy	Nonspecific; should be interpreted with caution
Cortisol	Variable	Usually not diagnostic	Limited value as an isolated marker
CRP / ESR	Usually normal or mildly nonspecific	Usually normal unless another condition coexists	Mainly useful to exclude inflammatory or infectious causes
CBC / ferritin / iron status	May reveal other contributors to fatigue	May reveal comorbid causes of fatigue	Important in the broader differential diagnosis

Anti-thyroid peroxidase antibodies (anti-TPO) may be helpful when autoimmune thyroiditis is suspected, as they support an autoimmune cause of hypothyroidism, although they do not replace assessment of TSH and fT4 [5,6]. Additional laboratory tests, such as complete blood count, ferritin, inflammatory markers, and creatine kinase, may support the broader differential diagnosis, but they are not specific for either OTS or hypothyroidism [2,6,10].

Interpretation should always take clinical context into account. In OTS, laboratory abnormalities are often absent or nonspecific [1,2]. Persistent thyroid test abnormalities, in contrast, are more consistent with thyroid disease than with training maladaptation alone [3,10]. In athletes with mildly elevated TSH and normal fT4, repeat testing and clinical correlation are needed before establishing a diagnosis or considering treatment [6,12]. This is particularly important because transient abnormalities may occur and symptoms may also reflect low energy availability, RED-S, or other non-thyroidal causes [9,11].

For this reason, laboratory findings should not be interpreted in isolation. Recent case evidence suggests that relative energy deficiency may also complicate interpretation of thyroid-related findings in athletes [13]. The most useful approach combines thyroid function testing with clinical history, training context, symptom duration, and assessment of other common contributors to fatigue in female athletes [3,6,10].

Table 3. Proposed diagnostic approach to persistent fatigue in female athletes

Step	**Clinical focus**	**Suggested next step**
1	Persistent fatigue, reduced performance, delayed recovery, mood or sleep disturbances in a female athlete	Begin structured clinical assessment
2	Clinical assessment: training load, recent changes in intensity or volume, symptom duration, recovery, sleep, nutrition, body mass changes, menstrual history, symptoms suggestive of hypothyroidism	Consider the most likely causes of persistent symptoms

Step	Clinical focus	Suggested next step
3	Initial differential diagnosis	Consider OTS, hypothyroidism, low energy availability / RED-S, and other medical causes of fatigue
4	Initial laboratory assessment	Measure TSH and fT4; consider CBC, ferritin, CRP / ESR, CK, and other tests if clinically indicated
5	Abnormal thyroid function tests	Consider hypothyroidism and proceed with endocrine evaluation and management
6	Normal thyroid function tests	Hypothyroidism becomes less likely; consider OTS, RED-S, iron deficiency, infection, inflammation, or other causes
7	Management and follow-up	Apply targeted treatment, reassess symptoms, recovery, and exercise tolerance before full return to competition

5. Treatment and return-to-sport considerations

Once hypothyroidism is biochemically confirmed, oral levothyroxine is the standard treatment and usually leads to gradual clinical improvement after restoration of euthyroidism [6]. In adults with overt hypothyroidism, the replacement dose should be individualized according to body weight, age, severity of hormone deficiency, and comorbidities [6]. Lower starting doses may be appropriate in milder cases or when cautious titration is needed. In female athletes, dose adjustment requires particular care to avoid both undertreatment and over-replacement, as excessive thyroid hormone exposure may adversely affect cardiovascular and bone health [3,6]. In athletes with subclinical hypothyroidism, management should be individualized. Treatment may be considered in symptomatic patients, particularly when thyroid peroxidase antibodies are present or when biochemical abnormalities persist on repeat testing [5,6]. Clinical decision-

making should also take into account symptom burden, the effect on training and performance, the degree of TSH elevation, and the likelihood of autoimmune thyroid disease [5,12].

Because improvement in symptoms and performance may lag behind biochemical normalization, return to sport should be gradual and guided by clinical recovery rather than by a fixed timeline alone [3,6]. Athletes may resume light to moderate training once symptoms begin to improve and thyroid hormone replacement has been initiated [3,6]. Progression toward full training load should depend on exercise tolerance, recovery, sleep quality, and follow-up thyroid function tests [6,10]. Persistent fatigue, exercise intolerance, or worsening symptoms despite treatment should prompt reassessment of the diagnosis, treatment adherence, dose adequacy, and coexisting conditions such as low energy availability or relative energy deficiency in sport (RED-S) [9,11,12].

In contrast, management of overtraining syndrome focuses primarily on reduction of training load, restoration of recovery, nutritional support, and correction of contributing stressors rather than on pharmacological therapy [2,10]. Since no specific laboratory marker confirms OTS, clinical follow-up and exclusion of other medical causes remain central to management [1,2]. If symptoms persist despite appropriate recovery strategies, repeat endocrine evaluation may be warranted, particularly in female athletes with clinical features suggestive of thyroid dysfunction [3,6].

Athletes with coexisting low energy availability or RED-S require integrated management addressing nutrition, training load, and endocrine health [9,11]. In female athletes, this assessment should also consider eating-related problems and the broader health consequences of low energy availability [18-20,25]. For this reason, collaboration between sports medicine physicians, endocrinologists, dietitians, and, where appropriate, coaches or physiotherapists may improve recovery and reduce the risk of recurrent symptoms [3,10,11]. Long-term follow-up should include periodic reassessment of thyroid status in athletes with previous thyroid dysfunction, especially if symptoms recur during periods of intensified training, weight loss, or dietary restriction [6,12].

Table 4. Practical considerations for return to sport after diagnosis and treatment of hypothyroidism

Stage	Clinical focus	Training approach	Monitoring
Early treatment phase	Symptom reduction and treatment initiation	Light activity or reduced training load as tolerated	TSH/fT4 follow-up according to treatment plan
Early return phase	Improving fatigue, sleep, and recovery	Gradual increase in volume and intensity	Clinical reassessment of tolerance to training
Full return phase	Stable symptoms and satisfactory exercise tolerance	Progressive return to usual training and competition	Follow-up thyroid monitoring, especially if symptoms recur

6. Conclusions

Overtraining syndrome and hypothyroidism in female athletes share many nonspecific manifestations, particularly persistent fatigue, reduced performance, and delayed recovery [1-3]. This overlap may contribute to diagnostic uncertainty and delayed management [6]. For this reason, such symptoms should not be attributed solely to training maladaptation without broader clinical evaluation [2,10].

Thyroid function testing, particularly measurement of TSH and fT4, remains an important component of the differential diagnosis, as hypothyroidism is a potentially treatable cause of prolonged fatigue and underperformance [3,6]. In contrast, overtraining syndrome has no single specific biochemical marker [1,2]. As a result, exclusion of endocrine and other medical causes is especially important in symptomatic female athletes [10].

Diagnostic assessment should consider not only training history and symptom duration, but also clinical features suggestive of thyroid dysfunction, such as cold intolerance, cognitive complaints, weight change, and menstrual disturbances [5,6,12]. Attention should also be paid to coexisting low energy availability and relative energy deficiency in sport (RED-S), which may further complicate the clinical picture and influence both recovery and performance [9,11]. Early recognition of hypothyroidism may reduce unnecessary interruptions in training and support a safer return to sport after appropriate treatment [3,6]. In female athletes with persistent or recurrent fatigue, especially when symptoms are disproportionate to training load or fail to

improve with adequate recovery, thyroid dysfunction should remain part of the differential diagnosis [3,12].

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