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Physical Activity and Thyroid Function: Implications for Metabolic Health and Exercise Performance - A Narrative Review

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Abstract

Background: Physical activity is a key determinant of metabolic health and may influence thyroid function through mechanisms related to energy balance, inflammation, and endocrine regulation. However, its relationship with the hypothalamic-pituitary-thyroid (HPT) axis remains unclear.

Aim: To review current evidence on the association between physical activity and thyroid function, focusing on metabolic health, exercise performance, and clinical implications.
Material and methods: A PubMed search of English-language studies published in the last 10 years was conducted to evaluate the effects of physical activity on thyroid function, metabolic parameters, and exercise capacity. Observational studies and meta-analyses were included.
Results: Physical activity appears to influence thyroid function mainly indirectly via improvements in metabolic health and energy balance. Moderate exercise is associated with beneficial metabolic effects, whereas excessive training, especially with low energy availability, may lead to adaptive reductions in T3 levels. Direct effects on thyroid hormones remain inconsistent. Thyroid dysfunction negatively impacts exercise capacity, and patients often remain insufficiently active. Physical activity may also reduce fatigue and improve quality of life, although evidence is limited.
Conclusions: The relationship between physical activity and thyroid function is multifactorial and bidirectional. Moderate activity supports metabolic health, but its direct hormonal effects remain unclear. Individualized assessment is essential, and further research is needed to clarify mechanisms and guide clinical practice.

Keywords: physical activity; thyroid function; thyroid hormones; metabolic health; exercise performance; energy availability; hypothyroidism; hyperthyroidism; RED-S

Introduction

Physical activity is one of the key lifestyle factors influencing metabolic health, physical performance, and overall quality of life. Its beneficial effects include improved insulin sensitivity, body weight regulation, and enhanced cardiovascular and muscular function. In recent years, increasing attention has also been given to its impact on the endocrine system, particularly the hypothalamic-pituitary-thyroid (HPT) axis, which plays a fundamental role in the regulation of energy metabolism [27,31].

Thyroid hormones, primarily triiodothyronine (T3) and thyroxine (T4), regulate basal metabolic rate, thermogenesis, and the function of multiple organ systems, including the muscular and cardiovascular systems. Their effects occur both at the systemic and cellular levels, where they influence gene expression via nuclear receptors. The peripheral conversion of T4 into biologically active T3 is also crucial, allowing precise adjustment of metabolic responses to the body's current needs [31]. Even subtle changes in thyroid hormone levels may therefore affect both metabolic health and exercise capacity [2].

Thyroid function is determined not only by genetic factors but also by a wide range of environmental and lifestyle influences, including body composition, diet (particularly iodine intake), smoking, alcohol consumption, and exposure to environmental pollutants [2,30]. Physical activity is one of these factors; however, its impact on thyroid function remains complex and not fully understood.

Current evidence suggests that physical activity can modulate HPT axis function in both the short and long term. Acute exercise induces transient changes in TSH and thyroid hormone levels, whereas chronic training may lead to hormonal adaptations dependent on exercise intensity, duration, and energy availability [27]. A particularly important phenomenon is relative energy deficiency in sport (RED-S), in which reduced T3 levels and metabolic rate represent adaptive responses to low energy availability [28]. This indicates that both insufficient and excessive physical activity may disrupt hormonal balance.

However, findings regarding the relationship between physical activity and thyroid function remain inconsistent. Some studies report significant associations between activity levels, thyroid hormone concentrations, and the prevalence of thyroid disorders, often with nonlinear patterns and sex-specific differences [1]. In contrast, other studies do not confirm a clear relationship between TSH, thyroid hormones, and overall physical activity [4]. Additionally, Mendelian randomization analyses suggest that these associations may have limited causal significance and may partly reflect other lifestyle factors, such as sedentary behavior [5,10].

The complexity of this relationship is further highlighted by differences across population groups. In older adults, variations in thyroid function within the reference range may have an adaptive character and be associated with physical activity levels and functional capacity [3]. In contrast, in individuals with thyroid disorders, both hypothyroidism and hyperthyroidism impair exercise tolerance, reduce muscle strength, and prolong recovery [7,8].

Another important aspect is the potential role of physical activity in metabolic health in the context of thyroid function. Some studies suggest that higher levels of physical activity are associated with a lower prevalence of subclinical hypothyroidism, particularly in younger adults [14]. However, meta-analyses of intervention studies indicate that the effect of physical activity on thyroid hormone levels is generally modest or inconsistent, and the observed metabolic benefits may be largely independent of direct changes in HPT axis function [13,15,16].

Autoimmune thyroid diseases, such as Graves' disease and Hashimoto's thyroiditis, are the most common causes of thyroid dysfunction, affecting approximately 2-5% of the population. These conditions often exhibit a variable clinical course, including transitions between hyperthyroid and hypothyroid states, which complicates diagnosis and management. They may also lead to thyrotoxicosis that does not necessarily result from increased hormone production but rather from the release of hormones due to glandular damage [9].

Overall, the relationship between physical activity and thyroid function appears to be multifactorial, nonlinear, and dependent on numerous variables. Despite a growing body of research, clear conclusions regarding the nature of this relationship and the optimal level of physical activity for maintaining thyroid function and metabolic health remain elusive.

The aim of this review is to summarize current evidence on the relationship between physical activity and thyroid function and to discuss its implications for metabolic health and exercise performance, with particular emphasis on underlying physiological mechanisms and clinical relevance.

2. Mechanisms Linking Physical Activity and Thyroid Function

The relationship between physical activity and thyroid function is complex and multifactorial, involving both direct effects of exercise on the hypothalamic-pituitary-thyroid (HPT) axis and indirect mechanisms related to energy balance, metabolic status, body composition, and immune function. Consequently, the hormonal response to exercise is highly variable and depends on factors such as exercise intensity and duration, training status, age, sex, and overall health [2,27,30].

2.1 Hypothalamic-Pituitary-Thyroid Axis Regulation

The HPT axis is the primary system regulating thyroid hormone production. The hypothalamus secretes thyrotropin-releasing hormone (TRH), which stimulates the pituitary gland to release thyroid-stimulating hormone (TSH), in turn promoting the production of T4 and T3 by the thyroid gland. This system is controlled by a negative feedback mechanism, in which elevated thyroid hormone levels suppress further TRH and TSH secretion [31].

Physical activity can influence this axis through neuroendocrine responses to exercise. Acute exercise activates the sympathetic nervous system and stress pathways, leading to transient changes in TSH and thyroid hormone levels. Some studies report increases in TSH and T4 following exercise, while T3 levels remain unchanged or decrease [27]. These inconsistencies suggest that the HPT response to exercise is context-dependent and not uniform [2,27].

2.2 Peripheral Conversion of Thyroid Hormones

The activity of thyroid hormones depends not only on their secretion but also on the peripheral conversion of T4 into active T3. This process is regulated by deiodinases, which can either activate or inactivate thyroid hormones [31].

Prolonged and intense physical activity may alter deiodinase activity and reduce T3 availability. Under conditions of chronic stress or energy deficiency, an adaptive decrease in T3 occurs to conserve energy. This phenomenon resembles the low T3 syndrome and reflects metabolic regulation at the tissue level [27,28].

2.3 Energy Availability and Relative Energy Deficiency in Sport

Energy availability is a key mechanism linking physical activity and thyroid function. When energy intake does not meet the demands of exercise and basic physiological processes, an adaptive reduction in metabolic rate occurs. This is typically associated with decreased T3 levels, while TSH and T4 may remain within normal ranges or show inconsistent changes [28,29].

This pattern is characteristic of relative energy deficiency in sport (RED-S). Reduced T3 levels contribute to lower basal metabolic rate, impaired thermogenesis, and diminished recovery capacity. As a result, excessive exercise combined with insufficient energy intake may lead to adaptive hormonal changes rather than primary thyroid dysfunction [28,29].

2.4 Body Composition and Metabolic Status

Physical activity also affects thyroid function through changes in body composition and metabolic status. Numerous studies have demonstrated a positive association between body mass index (BMI) and TSH and fT3 levels, suggesting a link between excess body weight and hormonal regulation [2,30].

Regular physical activity improves insulin sensitivity, reduces fat mass, and decreases inflammation, thereby supporting more stable HPT axis function. This may explain observations of a lower prevalence of subclinical hypothyroidism among physically active individuals, particularly in younger populations [13,14].

2.5 Immune Function and Autoimmunity

Physical activity influences immune function, which is particularly relevant in autoimmune thyroid diseases. Moderate exercise has anti-inflammatory and immunomodulatory effects that may support immune regulation and potentially reduce autoimmune activity [7,8].

In contrast, excessive exercise may lead to transient immunosuppression and increased physiological stress. This suggests that the relationship between physical activity and thyroid autoimmunity is likely nonlinear, with the most beneficial effects occurring at moderate levels of exercise [7,27].

2.6 Age-Related Differences

The effects of physical activity on thyroid function may vary with age. In older adults, higher TSH and lower fT4 levels within the reference range have been associated with greater physical activity and better functional capacity, suggesting an adaptive response [3].

In younger populations, higher physical activity levels are more often linked to a favorable metabolic profile and a lower risk of thyroid dysfunction. These findings indicate that hormonal responses to exercise are age-dependent and influenced by biological context [14].

2.7 Acute Versus Chronic Exercise Adaptations

It is important to distinguish between acute responses to a single bout of exercise and long-term adaptations to regular training. Acute exercise induces transient hormonal changes that may not have clinical significance [2,27,30].

In contrast, chronic training may lead to adaptive hormonal changes depending on training load, recovery, and energy availability. Intervention studies suggest that while physical activity can influence thyroid function, its effects are variable and context-dependent [13,15,16].

2.8 Bidirectional Relationship Between Thyroid Function and Physical Activity

The relationship between thyroid function and physical activity is bidirectional. Thyroid hormones regulate metabolism, cardiovascular function, muscle performance, and exercise capacity [2,7,8].

In hypothyroidism, fatigue, reduced exercise tolerance, and impaired recovery are common, whereas hyperthyroidism is associated with muscle weakness, arrhythmias, and decreased efficiency despite increased metabolic rate. These factors may limit physical activity independently of lifestyle, complicating the interpretation of epidemiological findings [4,5,10].

3. Effects on Metabolic Health

Thyroid hormones play a central role in regulating energy metabolism, influencing basal metabolic rate, lipid and glucose metabolism, and the function of peripheral tissues. Therefore, both physiological and pathological alterations in their levels may significantly affect overall metabolic health [2,31].

3.1 Regulation of Basal Metabolic Rate and Energy Expenditure

One of the primary effects of thyroid hormones is the regulation of basal metabolic rate (BMR). T3, the most biologically active form, increases oxygen consumption, enhances thermogenesis, and stimulates both anabolic and catabolic processes [31]. Under normal conditions, this supports the maintenance of energy homeostasis.

Physical activity influences this process both directly, by increasing energy expenditure, and indirectly, by modulating thyroid hormone activity. With adequate energy availability, regular exercise may support normal metabolic rate. However, in conditions of chronic energy deficit, an adaptive reduction in T3 occurs, leading to decreased BMR and a metabolic slowdown as an energy-conserving mechanism [28].

3.2 Glucose Metabolism and Insulin Sensitivity

Thyroid hormones are also involved in glucose metabolism, affecting glucose uptake, gluconeogenesis, and insulin sensitivity. Both hypothyroidism and hyperthyroidism may disrupt glucose homeostasis and increase the risk of insulin resistance [2].

Physical activity exerts protective effects by improving insulin sensitivity and enhancing glucose utilization by skeletal muscles [27]. As a result, it may partially counteract metabolic disturbances associated with thyroid dysfunction. However, its direct effects on thyroid hormone levels remain inconsistent, suggesting that metabolic benefits are largely independent of HPT axis modulation [13,15].

3.3 Lipid Metabolism and Body Composition

Thyroid hormones regulate lipid metabolism by influencing lipid synthesis, transport, and degradation. Hypothyroidism is commonly associated with elevated total cholesterol and LDL levels, whereas hyperthyroidism may reduce lipid levels, often accompanied by increased catabolism [8].

Physical activity improves lipid profile and body composition by reducing fat mass and enhancing metabolic parameters. Higher levels of physical activity have been associated with a lower risk of subclinical hypothyroidism, which may indirectly contribute to improved metabolic health [14].

Importantly, the relationship between physical activity and thyroid hormones is not linear. Both insufficient and excessive activity may be associated with unfavorable hormonal and metabolic changes, emphasizing the importance of balanced, moderate exercise [1].

3.4 Interaction with Obesity and Metabolic Syndrome

Thyroid dysfunction is frequently associated with obesity and metabolic syndrome. Higher body mass index (BMI) correlates with increased TSH and fT3 levels, possibly reflecting an adaptive response to increased body mass and energy demand [2,30].

Physical activity plays a key role in both the prevention and management of metabolic syndrome. Meta-analyses suggest that regular exercise may lead to moderate reductions in TSH and improvements in metabolic parameters, although hormonal effects are variable and not always statistically significant [13].

This indicates that the beneficial metabolic effects of physical activity are likely mediated primarily through improvements in metabolic function and reductions in adiposity rather than direct effects on the HPT axis.

3.5 Energy Balance and Metabolic Adaptation

Energy balance is a fundamental factor linking physical activity, thyroid function, and metabolic health. With adequate energy intake, physical activity supports metabolic homeostasis, whereas energy deficiency may induce adaptive hormonal changes.

In RED-S, reduced T3 levels, decreased leptin, and elevated cortisol lead to suppression of anabolic processes and reduced metabolic rate [28,29]. While these adaptations serve to protect the body from further energy deficit, they may negatively affect metabolic health, physical performance, and recovery.

3.6 Age-Dependent Metabolic Effects

The metabolic effects of thyroid hormones may vary with age. In older adults, higher TSH and lower fT4 levels within the reference range are often observed and may represent adaptive mechanisms that protect against excessive catabolism [3].

In this population, moderate physical activity may support metabolic stability and functional capacity despite a lower metabolic rate. In contrast, in younger individuals, higher physical activity is more consistently associated with improved metabolic profiles and lower risk of thyroid dysfunction [14].

3.7 Environmental and Lifestyle Interactions

Metabolic health and thyroid function are also influenced by various environmental and lifestyle factors, including diet (particularly iodine and micronutrient intake), smoking, alcohol consumption, and exposure to pollutants [2,30].

Physical activity should therefore be considered within the broader context of overall lifestyle. Interactions between these factors may partly explain the inconsistencies observed in studies examining the relationship between physical activity and thyroid function [2,30].

4. Effects on Exercise Performance

Thyroid hormones play a key role in regulating exercise capacity by influencing energy metabolism, skeletal muscle function, cardiovascular performance, and recovery processes. Both deficiency and excess of thyroid hormones lead to significant impairments in physical performance, highlighting the importance of proper HPT axis function for maintaining optimal fitness [2,7,8].

4.1 Aerobic Capacity and Endurance

Thyroid hormones affect aerobic capacity through the regulation of oxygen consumption, mitochondrial function, and energy metabolism. T3 enhances mitochondrial enzyme activity and energy production, supporting aerobic performance [31].

In hypothyroidism, reduced VO_2max, decreased exercise tolerance, and earlier onset of fatigue are commonly observed, mainly due to slowed metabolism, limited energy availability, and impaired cardiovascular function [8,17]. In contrast, hyperthyroidism, despite increased metabolic rate, is associated with inefficient energy utilization, which may also impair exercise performance and accelerate fatigue [8].

4.2 Muscle Function and Strength

Thyroid hormones significantly influence skeletal muscle function, including protein synthesis, energy metabolism, and muscle fiber characteristics. T3 regulates gene expression related to muscle contractility and modulates the balance between anabolic and catabolic processes [31].

Hypothyroidism is associated with reduced muscle strength, slowed contraction and relaxation, and increased muscle stiffness. Conversely, hyperthyroidism leads to enhanced protein catabolism, resulting in muscle wasting and reduced strength [8,17,19]. Both conditions can markedly impair physical performance, particularly in strength and endurance activities.

4.3 Cardiovascular Response to Exercise

Thyroid hormones are essential regulators of cardiovascular function, affecting heart rate, stroke volume, and cardiac output. T3 increases myocardial sensitivity to catecholamines, enhancing contractility and heart rate [31].

In hypothyroidism, bradycardia, reduced cardiac output, and limited ability to increase blood flow during exercise are observed. In hyperthyroidism, tachycardia, increased cardiac workload, and a higher risk of arrhythmias may limit safe exercise performance [8,20]. These alterations directly affect exercise tolerance and the ability to sustain high-intensity activity.

4.4 Fatigue and Recovery

Fatigue and prolonged recovery are among the most common manifestations of thyroid dysfunction. In hypothyroidism, reduced metabolic rate and impaired energy production contribute to persistent fatigue and delayed recovery [8].

In hyperthyroidism, despite elevated metabolism, rapid depletion of energy reserves and electrolyte imbalances may also impair recovery. Additionally, chronic metabolic and hormonal stress may lead to symptoms resembling overtraining, particularly in highly active individuals [17,19].

4.5 Interaction with Training Load and Overtraining

Training load is a critical factor modulating the effects of thyroid hormones on performance. Well-balanced, moderate training promotes physiological adaptations and improved fitness, whereas excessive training without adequate recovery may lead to hormonal disturbances.

Under conditions of chronic overload and low energy availability, T3 levels may decrease as an adaptive response to conserve energy [28]. This state may result in reduced performance, increased fatigue, and impaired training adaptation.

4.6 Differences Between Hypothyroidism and Hyperthyroidism in Athletes

Thyroid dysfunction affects exercise capacity differently depending on the direction of hormonal imbalance. Hypothyroidism is characterized by reduced metabolism, fatigue, weight gain, and decreased performance, whereas hyperthyroidism is associated with excessive metabolic stimulation, weight loss, muscle weakness, and cardiac disturbances [8,17,19].

In athletes, both conditions may significantly impair performance and increase the risk of injury and overtraining. Therefore, accurate diagnosis and appropriate management of thyroid disorders are essential for maintaining optimal physical performance [7,8].

4.7 Bidirectional Relationship with Physical Activity

The relationship between thyroid function and exercise capacity is bidirectional. Thyroid hormones influence metabolic rate, cardiovascular function, muscle performance, and overall exercise capacity, while physical activity may in turn affect hormonal regulation.

In practice, reduced physical activity observed in some individuals may be a consequence of thyroid dysfunction rather than its cause. This complicates the interpretation of epidemiological data and highlights the importance of considering clinical context when analyzing the relationship between physical activity and thyroid function [4,5,10].

5. Clinical Implications

Zrozumienie zależności między aktywnością fizyczną a funkcją tarczycy ma istotne znaczenie kliniczne, zarówno w kontekście profilaktyki, jak i leczenia zaburzeń metabolicznych oraz optymalizacji zdolności wysiłkowej. Relacja ta jest złożona i wymaga indywidualnego podejścia, uwzględniającego stan hormonalny, poziom aktywności fizycznej oraz czynniki środowiskowe i stylu życia [2,30].

5. Clinical Implications

5.1 Thyroid Dysfunction and Physical Activity

Thyroid dysfunction, including both hypothyroidism and hyperthyroidism, can significantly limit the ability to engage in physical activity. In hypothyroidism, common symptoms include fatigue, reduced exercise capacity, weight gain, and muscle weakness, which may hinder regular exercise [8]. In contrast, hyperthyroidism is associated with tachycardia, exercise intolerance, muscle weakness, and an increased risk of cardiovascular complications [8,20].

In clinical practice, this requires adjustment of physical activity to the patient's current hormonal status. In untreated thyroid disorders, intense exercise may exacerbate symptoms and worsen health outcomes; therefore, appropriate treatment should be initiated prior to increasing activity levels [7,8].

5.2 Thyroid Hormone Therapy in Subclinical Hypothyroidism

Subclinical hypothyroidism, defined as elevated TSH with normal fT4 levels, is a common clinical condition. However, routine thyroid hormone therapy in most adults does not provide significant benefits, with no clear improvement in quality of life, fatigue, body weight, or cardiovascular risk [6].

Current guidelines therefore do not recommend routine treatment, except in selected groups such as women planning pregnancy, individuals with markedly elevated TSH, younger patients, or those with significant symptoms [6]. In physically active individuals, mild hormonal abnormalities often do not require immediate treatment, and monitoring combined with clinical assessment may be more appropriate [6].

5.3 Exercise as a Supportive Strategy in Thyroid Disorders

Physical activity can serve as an important supportive strategy in the management of thyroid disorders, particularly by improving metabolic health and quality of life. Regular moderate exercise enhances insulin sensitivity, reduces body weight, and decreases inflammation, which is especially beneficial in hypothyroidism [13,14].

In autoimmune conditions such as Hashimoto's thyroiditis, moderate exercise may exert immunomodulatory and anti-inflammatory effects. Additionally, evidence suggests that in women with Hashimoto's disease, higher levels of moderate physical activity are associated with lower severity of depressive symptoms and better mental well-being, although these associations are modest [25]. Nevertheless, evidence remains limited, and the direct effects of physical activity on thyroid hormone levels are still unclear [13,15].

5.4 Monitoring Thyroid Function in Physically Active Individuals

In physically active individuals, particularly athletes, the interpretation of thyroid function tests may be challenging due to training-related adaptations. Reduced T3 levels in the context of intense exercise or low energy availability do not necessarily indicate pathology but may represent a physiological adaptation [28].

Therefore, assessment of thyroid function in active individuals should consider clinical context, training load, dietary factors, and symptoms. In some cases, additional parameters such as fT3, fT4, or nutritional status markers may be required for accurate evaluation [27,28].

5.5 Relative Energy Deficiency in Sport and Thyroid Function

Relative energy deficiency in sport (RED-S) represents an important clinical issue, particularly among endurance athletes and individuals undergoing intensive training. A key feature of this condition is reduced T3 levels, reflecting adaptive metabolic suppression [28,29].

Clinically, it is essential to distinguish this state from primary hypothyroidism, as pharmacological treatment is not indicated. Management should focus on restoring energy balance through appropriate nutrition, training modification, and improved recovery strategies [28,29].

5.6 Implications for Athletes and Physically Active Populations

In athletes, normal thyroid function is essential for optimal performance, recovery, and training adaptation. Hormonal disturbances may lead to decreased performance, increased injury risk, and symptoms resembling overtraining [7,17].

Regular monitoring of thyroid function may be justified in selected athletes, particularly in the presence of symptoms such as persistent fatigue, reduced performance, or unexplained weight changes. However, routine screening in all physically active individuals is not universally recommended and should be considered on an individual basis [7,8].

5.7 Individualization of Exercise Recommendations

Exercise recommendations for individuals with thyroid disorders should be individualized, taking into account the type and severity of the condition as well as overall health status. In most cases, moderate physical activity is safe and beneficial, although exercise intensity should be gradually increased and carefully monitored [8].

It is also important to consider other factors influencing thyroid function, including diet, stress, sleep, and comorbidities. A comprehensive, individualized approach allows for maximizing the benefits of physical activity while minimizing potential risks [2,30].

6. Discussion

The relationship between physical activity and thyroid function is complex and often inconsistent across available studies. Physical activity may both modulate the hypothalamic-pituitary-thyroid (HPT) axis and be influenced by it, indicating a bidirectional interaction [2,27,31].

Current evidence does not support a clear linear relationship between physical activity levels and thyroid function. Although observational studies report significant associations, their direction and strength vary depending on factors such as age, sex, and metabolic status [1,4]. Mendelian randomization analyses further suggest that these relationships may have limited causal significance and may partly reflect other lifestyle factors [5,10].

An important distinction must be made between acute responses to exercise and long-term training adaptations. Transient hormonal changes following exercise do not necessarily reflect sustained alterations in thyroid function, whereas chronic exercise—particularly under conditions of low energy availability—may lead to adaptive reductions in T3 levels [28].

The metabolic benefits of physical activity appear to be largely indirect, primarily driven by improved insulin sensitivity, reduced adiposity, and decreased inflammation rather than direct hormonal changes [13,14].

From a performance perspective, both hypothyroidism and hyperthyroidism impair exercise tolerance through different physiological mechanisms [8,17,19]. At the same time, reduced T3 levels observed in highly trained individuals may represent a physiological adaptation rather than pathology. Clinical data also indicate that patients with hypothyroidism often remain insufficiently active despite treatment, mainly due to fatigue and reduced exercise tolerance [18].

In this context, physical activity may have important therapeutic value. Meta-analyses demonstrate that regular exercise can moderately but significantly reduce fatigue in individuals with chronic diseases, particularly when aerobic, resistance, or combined training programs are used [22]. However, sustained benefits require long-term adherence.

A key clinical challenge is the potential overinterpretation of hormonal findings. Reduced T3 levels in physically active individuals may reflect adaptive metabolic responses rather than disease. Similarly, routine treatment of subclinical hypothyroidism in most adults does not provide clear benefits, emphasizing the need for individualized clinical decision-making [6].

In the oncological context, the evidence remains inconclusive. Meta-analyses do not confirm a clear protective effect of physical activity against thyroid cancer at a global level [11]. However, epidemiological data suggest that higher physical activity levels may be associated with lower incidence trends, whereas obesity is linked to increased risk, although these findings are observational in nature [12].

Limited evidence also suggests that physical activity may reduce fatigue and improve quality of life in patients with thyroid cancer, although the overall quality of evidence remains low [21]. Bibliometric analyses further indicate a rapidly growing interest in this field, with increasing focus on metabolic health and patient quality of life [26].

In recent years, attention has also been directed toward the use of wearable devices for monitoring thyroid function. Parameters such as heart rate, physical activity, and sleep patterns may reflect hormonal changes in both hyperthyroidism and hypothyroidism [23,24]. Continuous heart rate monitoring may provide more sensitive detection of changes than single clinical measurements, offering potential for early identification of disease recurrence and improved treatment monitoring. However, this approach requires further validation due to limited available data [23,24].

Despite the growing body of research, significant limitations remain. Most studies are observational, and methodological heterogeneity, along with population differences, complicates interpretation [4,13]. Future research should focus on well-designed interventional studies that consider physical activity levels, energy availability, and individual variability. A deeper understanding of adaptive mechanisms, particularly those involving peripheral T4 to T3 conversion, is essential for clarifying their clinical and performance-related implications [27,31].

7. Conclusions

The relationship between physical activity and thyroid function is complex, multifactorial, and bidirectional. Physical activity can modulate the hypothalamic–pituitary–thyroid (HPT) axis through its effects on energy balance, tissue metabolism, and inflammation, while thyroid function itself plays a crucial role in determining exercise capacity and training adaptation.

Current evidence suggests that moderate, well-balanced physical activity supports metabolic homeostasis and may indirectly promote healthy thyroid function. In contrast, excessive exercise, particularly under conditions of low energy availability, may lead to adaptive hormonal changes such as reduced T3 levels, which do not necessarily indicate pathology but rather reflect protective physiological mechanisms.

However, the direct effects of physical activity on thyroid hormone levels remain unclear, and existing findings are often inconsistent. This suggests that the metabolic benefits of physical activity are likely mediated primarily through improvements in overall metabolic health rather than direct modulation of thyroid function.

From a clinical perspective, individualized assessment is essential, taking into account training load, nutritional status, and overall health when interpreting thyroid function tests. Distinguishing between physiological adaptations to exercise and true thyroid dysfunction is particularly important to avoid unnecessary diagnostic procedures and treatment.

In conclusion, physical activity is an important component of metabolic health and overall physiological function, but its effects on thyroid function are influenced by multiple factors and require further investigation. A better understanding of the mechanisms linking these domains may help optimize physical activity recommendations for both the general population and athletes.

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The authors report no disclosures.

Author's contribution

Conceptualization: ŁM, EM

Methodology: ŁM, EM, PK, EU, KN, DK

Resources: ŁM. EM, PK, EU, KN, DK

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