QUALITY IN SPORT
eISSN 2450-3118 · Open Access · Peer-reviewed
apcz.umk.pl/QS Nicolaus Copernicus University in Toruń

Cite as: MURASZEWSKI, Łukasz, MURASZEWSKA, Emilia, KWITOWSKA, Patrycja, UBYSZ, Eryk, NIERADKA, Kornelia and KRAKOWIAK, Dominika. The Relationship Between Thyroid Function, Mental Health and Physical Activity - A Narrative Review. Quality in Sport. 2026;61:73001. https://doi.org/10.12775/QS.2026.61.73001

ARTICLE TIMELINE
Received: 02.06.2026. Revised: 03.07.2026. Accepted: 04.07.2026. Published: 08.07.2026.

The journal has been awarded 20 points in the parametric evaluation by the Polish Ministry of Higher Education and Science (Annex to the announcement of 05.01.2024, No. 32553). Unique Journal Identifier: 201398. Scientific disciplines assigned: Economics and finance (Field of social sciences); Management and Quality Sciences (Field of social sciences).
Punkty Ministerialne z 2019 – aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

The Relationship Between Thyroid Function, Mental Health and Physical Activity - A Narrative Review

Łukasz Muraszewski [ŁM]
University Clinical Hospital in Poznań
Przybyszewskiego 49, 60-355 Poznań, Poland
https://orcid.org/0009-0000-0331-9701
lukaszmuraszewski@outlook.com

Emilia Muraszewska [EM]
University Clinical Hospital in Poznań
Przybyszewskiego 49, 60-355 Poznań, Poland
https://orcid.org/0009-0005-4534-1014
muraszewskaemilia@gmail.com

Patrycja Kwitowska [PK]
Provincial Hospital in Poznań
Juraszów 7/19, 60-479 Poznań, Poland
https://orcid.org/0009-0006-7297-2871
patrycjakwitowska@gmail.com

Eryk Ubysz [EU]
Provincial Polyclinical Hospital in Płock of Marcina Kacprzaka
Medyczna 19, 09-400 Płock, Poland
https://orcid.org/0009-0004-9099-7648
eryk.ubysz123@gmail.com

Kornelia Nieradka [KN]
District Specialist Hospital in Stalowa Wola
Staszica 4, 37-450 Stalowa Wola
https://orcid.org/0009-0006-0770-8425
kornelianieradka@gmail.com

Dominika Krakowiak [DK]
Provincial Specialist Hospital in Częstochowa
Bialska 104/118, 42-202 Częstochowa
https://orcid.org/0009-0007-8627-7332
dkrakowiak55@gmail.com

Corresponding Author: Łukasz Muraszewski, lukaszmuraszewski@outlook.com

Abstract

Background: Thyroid hormones play a key role in metabolic, cardiovascular, neuromuscular, and central nervous system regulation. Consequently, thyroid dysfunction may impair physical performance, mental health, and overall quality of life. Physical activity has been proposed as a supportive strategy that may beneficially influence both thyroid-related outcomes and psychological well-being.

Aim: This narrative review aimed to summarize current evidence regarding the interrelationships between thyroid function, mental health, and physical activity, with emphasis on potential mechanisms and clinical implications.

Materials and Methods: A narrative review of the literature was conducted using recent clinical studies, cohort studies, randomized trials, and meta-analyses addressing thyroid disorders, exercise, depression, anxiety, and related endocrine mechanisms.

Results: Both hypothyroidism and hyperthyroidism are associated with reduced exercise tolerance, fatigue, mood disturbances, and lower quality of life, with autoimmune thyroid diseases adding further psychological burden. Moderate physical activity improves mood, functional capacity, and metabolic health, while excessive exercise and low energy availability may disrupt hormonal balance. These relationships are multidirectional and involve hormonal, inflammatory, and behavioral mechanisms.

Conclusions: Thyroid function, mental health, and physical activity are closely interconnected. Moderate, individualized exercise may represent an important adjunctive strategy in patients with thyroid disorders. Integrated multidisciplinary care and further prospective studies are needed to clarify causal mechanisms and optimize management strategies.

Keywords

Thyroid function, Hypothyroidism, Hyperthyroidism, Autoimmune thyroid disease, Physical activity, Exercise, Mental health,

1. Introduction

Thyroid hormones play a fundamental role in the regulation of multiple physiological systems, including metabolic, cardiovascular, musculoskeletal, and central nervous system function. Consequently, disturbances in thyroid function may have wide-ranging clinical consequences, significantly affecting both physical and mental health as well as the ability to engage in regular physical activity [1]. Both hypothyroidism and hyperthyroidism are associated with reduced exercise tolerance, muscle weakness, and an increased risk of complications such as cardiac arrhythmias and musculoskeletal injuries, which may further limit physical performance and overall functional capacity [1,3].

At the same time, physical activity has been recognized as an important non-pharmacological intervention that may support the management of thyroid disorders. Regular exercise has been shown to improve quality of life, reduce fatigue, and enhance metabolic and muscular function in patients with thyroid dysfunction [1,9]. However, the effects of physical activity

on thyroid hormone levels remain inconsistent and appear to depend on factors such as exercise intensity, duration, and individual characteristics. Acute and chronic exercise may lead to changes in thyroid-stimulating hormone (TSH) and thyroxine (T4) levels, while the response of triiodothyronine (T3) remains variable, reflecting the complex and multifactorial nature of this relationship [1,24].

Emerging evidence suggests that the relationship between physical activity and thyroid function may be non-linear. Moderate levels of physical activity appear to be associated with a more favorable hormonal profile, including higher free thyroxine (fT4) concentrations and lower TSH and thyroid peroxidase antibody (TPOAb) levels, indicating potential benefits for hormonal homeostasis and reduced autoimmune activity [2]. In contrast, both low and very high levels of physical activity may be less beneficial or even detrimental, highlighting the importance of appropriate exercise prescription [2,13,23]. Additionally, the effects of physical activity may vary depending on sex, body composition, and metabolic status, with particularly favorable associations observed in women and individuals with overweight or obesity [2].

Autoimmune thyroid diseases, such as Hashimoto's thyroiditis, further complicate this relationship. These conditions are characterized by immune system dysregulation and progressive thyroid gland damage, leading to impaired physical performance and reduced exercise capacity [3]. Moderate physical activity may exert beneficial immunomodulatory and anti-inflammatory effects, including increased regulatory T-cell activity and reduced pro-inflammatory responses, which may help mitigate autoimmune processes and improve thyroid function [3]. Conversely, excessive physical exertion may induce oxidative stress and transient immune suppression, potentially exacerbating disease activity [3,24].

In parallel, a substantial body of evidence highlights a strong association between thyroid dysfunction and mental health. Both hypothyroidism and hyperthyroidism have been linked to an increased risk of psychiatric symptoms, including depression, anxiety, cognitive impairment, and reduced treatment responsiveness in psychiatric disorders [4-6]. This relationship is bidirectional, as alterations in thyroid function may influence central nervous system activity, while chronic stress, neuroendocrine dysregulation, and psychiatric treatments may disrupt the hypothalamic–pituitary–thyroid (HPT) axis [4,20,30].

Particular attention has been given to autoimmune mechanisms, as the presence of thyroid autoantibodies has been associated with an increased risk of depressive and anxiety symptoms, even in the absence of overt hormonal abnormalities [4,7]. Meta-analyses indicate that individuals with autoimmune thyroid diseases have significantly higher rates of depression and anxiety compared to healthy populations, underscoring the importance of immunological

pathways in the interaction between thyroid function and mental health [7]. Furthermore, hypothyroidism has been identified as a potential contributor to treatment-resistant depression, and appropriate thyroid hormone replacement may improve psychiatric outcomes in selected patients [5].

Importantly, physical activity is also well established as an effective intervention for improving mental health. Numerous meta-analyses have demonstrated that regular exercise exerts significant antidepressant effects, particularly in individuals with major depressive disorder, with benefits comparable to pharmacological and psychotherapeutic interventions in some cases [14,15]. These effects are mediated through a combination of biological mechanisms, including improved neuroplasticity, reduced inflammation, and modulation of neuroendocrine function, as well as psychosocial factors such as enhanced self-efficacy and social interaction [16].

Taken together, these findings suggest the existence of a complex and multidirectional relationship between thyroid function, mental health, and physical activity. Thyroid dysfunction may impair both physical and psychological functioning, reducing the capacity and motivation for exercise, while physical activity may, in turn, influence hormonal balance, immune processes, and mental well-being. Additionally, psychological stress and mental health disorders may further modulate thyroid function through neuroendocrine and immunological pathways [20,30].

Despite growing interest in this area, the available evidence remains fragmented and, in some cases, inconsistent. The heterogeneity of study designs, populations, and outcome measures, as well as the lack of longitudinal and mechanistic studies, limit the ability to draw definitive conclusions regarding causality and optimal clinical recommendations.

Therefore, the aim of this narrative review is to synthesize current evidence on the interrelationships between thyroid function, mental health, and physical activity, with particular emphasis on underlying mechanisms, clinical implications, and potential directions for future research.

2. Epidemiology of Thyroid Disorders and Mental Health

Thyroid disorders are among the most common endocrine diseases worldwide and constitute a major public health concern due to their high prevalence, chronic course, and broad systemic consequences. Both hypothyroidism and hyperthyroidism affect millions of individuals globally, with women being disproportionately burdened, particularly in the case of

autoimmune thyroid diseases such as Hashimoto's thyroiditis [4,7,25]. In addition to their metabolic and somatic manifestations, thyroid disorders are increasingly recognized as important contributors to impaired mental health, reduced quality of life, and diminished functional capacity [4-7].

Hypothyroidism, including its subclinical form, is especially prevalent in adult and older populations. Epidemiological studies indicate that subclinical hypothyroidism occurs relatively frequently in the general population, although prevalence estimates vary depending on age, sex, iodine status, and diagnostic criteria [8,23,27]. Importantly, the burden of thyroid dysfunction is not limited to overt endocrine disease. Even mild abnormalities in thyroid hormone regulation may be associated with fatigue, reduced exercise tolerance, cognitive complaints, and mood disturbances, all of which may impair everyday functioning and well-being [1,5,21].

A growing body of population-based evidence suggests that thyroid disorders are closely linked to mental health problems, particularly depression and anxiety [4,6,7,19,20]. Untreated hypothyroidism has been associated with higher levels of depressive symptoms and anxiety, while untreated hyperthyroidism has also been linked to an increased risk of major depressive episodes [6]. Meta-analytic evidence further indicates that autoimmune thyroiditis is associated with a markedly increased risk of both depression and anxiety disorders, with affected individuals more frequently reporting clinically significant psychological symptoms than healthy controls [7]. Similarly, subclinical hypothyroidism has been associated with an elevated risk of depression in some studies, although this relationship appears to be influenced by age and may be more pronounced in younger adults than in older populations [8,27].

The epidemiology of thyroid dysfunction and mental health is further complicated by the apparent bidirectionality of this relationship. While thyroid disease may contribute to the development or exacerbation of psychiatric symptoms, mental health disorders may also increase the risk of subsequent thyroid dysfunction [4,20,30]. In a large prospective cohort study based on UK Biobank data, symptoms of depression and anxiety were associated with a higher long-term risk of developing both hypothyroidism and hyperthyroidism, with risk increasing alongside symptom severity [20]. These findings suggest that mental disorders may not only coexist with thyroid disease but may also precede and potentially contribute to its onset.

Sex differences also play an important epidemiological role. Women are more likely to develop both thyroid disorders and depression, which may partly explain the frequent overlap of these conditions in clinical populations [19,20,25]. Some studies additionally suggest that

the association between thyroid function and depressive symptoms may be stronger in women, although sex-specific patterns may vary depending on the type of thyroid disorder and the psychiatric outcome analyzed [19,20]. Age is another important modifying factor. For example, while subclinical hypothyroidism has been associated with depression in younger adults, this relationship appears less consistent in older individuals, in whom mild TSH elevation may more often reflect physiological aging rather than clinically meaningful thyroid pathology [8,28].

The epidemiological burden of coexisting thyroid dysfunction and mental health symptoms is particularly relevant in patients with autoimmune thyroid diseases. Hashimoto's thyroiditis, the most common cause of hypothyroidism in iodine-sufficient regions, has been repeatedly associated with depressive symptoms, reduced quality of life, and impaired psychological well-being [7,25]. In women with Hashimoto's disease, depressive symptoms appear to be relatively common, and their severity may be associated not only with endocrine disturbances but also with lifestyle-related factors such as low physical activity and suboptimal diet quality [25]. This highlights the importance of considering thyroid disease not solely as an endocrine disorder, but as a multidimensional condition involving metabolic, immunological, and psychological components.

At the same time, not all epidemiological findings support a simple linear association between thyroid hormone levels and mental health. Some studies have shown that both low and high TSH levels may be associated with increased depressive symptoms, suggesting a U-shaped relationship [19]. In contrast, Mendelian randomization analyses have not confirmed a clear causal relationship between small variations in TSH or free thyroxine within the reference range and major depression, indicating that some observed associations may reflect confounding factors rather than direct causality [22]. Likewise, interventional studies in patients treated with levothyroxine have shown that minor dose adjustments leading to different TSH levels within or near the normal range do not necessarily improve mood, cognition, or quality of life [21,28]. These observations underscore the complexity of the epidemiological relationship between thyroid function and mental health.

Overall, current evidence indicates that thyroid disorders and mental health problems frequently coexist and may influence each other through endocrine, immunological, and psychosocial pathways [4,7,20,30]. Their high prevalence, especially among women and individuals with autoimmune thyroid disease, emphasizes the need for integrated clinical assessment and early recognition of psychiatric symptoms in patients with thyroid dysfunction. At the population level, these findings also support the importance of preventive

strategies and multidisciplinary care aimed at addressing both endocrine and psychological aspects of health.

3. Thyroid Function and Mental Health

Thyroid hormones play a critical role in the regulation of central nervous system function, influencing neurodevelopment, neurotransmission, and overall brain homeostasis. Triiodothyronine (T3), the biologically active form of thyroid hormone, exerts its effects through nuclear receptors widely distributed in the brain, including regions responsible for mood regulation, cognition, and emotional processing, such as the hippocampus and prefrontal cortex [4,5]. Consequently, even subtle disturbances in thyroid function may contribute to significant neuropsychiatric manifestations.

Both hypothyroidism and hyperthyroidism have been consistently associated with a broad spectrum of mental health disorders, particularly depression and anxiety [4-6]. Hypothyroidism is commonly linked to symptoms such as low mood, fatigue, cognitive slowing, and decreased motivation, which may resemble or overlap with major depressive disorder [5]. In more severe cases, it may lead to clinically significant depression, and in rare instances, psychotic symptoms. Importantly, hypothyroidism has also been identified as a potential contributing factor in treatment-resistant depression, with some patients demonstrating improvement following appropriate thyroid hormone replacement [5].

In contrast, hyperthyroidism is typically associated with symptoms of increased psychological arousal, including anxiety, irritability, restlessness, and emotional instability [6]. Patients with excess thyroid hormone levels may also experience sleep disturbances, impaired concentration, and, in severe cases, mood disorders or psychosis. Although the clinical presentations of hypo- and hyperthyroidism differ, both conditions are associated with impaired quality of life and reduced psychological well-being.

The relationship between thyroid function and mental health is complex and appears to involve multiple neurobiological mechanisms. One key pathway is the modulation of neurotransmitter systems. Thyroid hormones influence serotonergic, dopaminergic, and noradrenergic signaling, all of which play essential roles in mood regulation and emotional

processing [4,5]. Alterations in thyroid hormone levels may therefore disrupt neurotransmitter balance, contributing to the development of depressive and anxiety symptoms.

Another important mechanism involves the hypothalamic-pituitary-thyroid (HPT) axis and its interaction with the hypothalamic-pituitary-adrenal (HPA) axis, which regulates the stress response. Chronic stress and elevated cortisol levels may suppress thyroid function by inhibiting thyrotropin-releasing hormone (TRH) and thyroid-stimulating hormone (TSH) secretion, leading to a state of relative hypothyroidism [4,20]. Conversely, thyroid dysfunction may alter stress reactivity and increase vulnerability to psychiatric disorders, highlighting the bidirectional nature of this relationship.

Autoimmune processes also play a significant role in linking thyroid function with mental health. The presence of thyroid autoantibodies, such as thyroid peroxidase antibodies (TPOAb), has been associated with an increased risk of depressive and anxiety symptoms, even in individuals with normal thyroid hormone levels [4,7]. This suggests that immune-mediated mechanisms, including chronic low-grade inflammation and altered cytokine profiles, may contribute to neuropsychiatric manifestations independently of overt hormonal abnormalities.

In recent years, increasing attention has been given to the concept of “brain hypothyroidism,” in which normal peripheral thyroid hormone levels do not necessarily reflect adequate hormone availability or activity within the central nervous system [5]. This phenomenon may help explain why some patients continue to experience depressive symptoms despite achieving biochemical euthyroidism with standard levothyroxine therapy. It also underscores the limitations of relying solely on serum thyroid markers in the assessment of neuropsychiatric outcomes.

Despite strong observational associations, the causal relationship between thyroid function and mental health remains a subject of ongoing debate. While many studies demonstrate correlations between thyroid hormone levels and psychiatric symptoms, others suggest that these associations may be influenced by confounding factors such as comorbid conditions, medication use, and lifestyle variables [21,22]. Furthermore, interventional studies indicate that small variations in thyroid hormone levels within the normal range do not consistently translate into clinically meaningful improvements in mood or cognition [21,28].

Nevertheless, from a clinical perspective, the interaction between thyroid function and mental health has important implications. Screening for thyroid dysfunction is recommended in patients presenting with depressive or anxiety symptoms, particularly in cases of treatment resistance or atypical clinical features [5]. Similarly, clinicians managing patients with thyroid disorders should be aware of the increased risk of psychiatric comorbidities and consider integrated approaches that address both endocrine and psychological aspects of care.

Overall, current evidence supports a multidimensional and bidirectional relationship between thyroid function and mental health, involving endocrine, neurobiological, and immunological mechanisms. Further research is needed to clarify causal pathways and to identify optimal strategies for diagnosis and treatment in patients with coexisting thyroid and psychiatric disorders.

4. Physical Activity and Thyroid Function

Physical activity and thyroid function are closely interconnected, with thyroid disorders exerting significant effects on exercise capacity and, conversely, physical activity influencing endocrine regulation. Thyroid dysfunction affects multiple physiological systems, including cardiovascular, metabolic, and musculoskeletal function, which may substantially limit the ability to engage in regular physical activity [1,3]. Both hypothyroidism and hyperthyroidism are associated with reduced exercise tolerance, muscle weakness, and an increased risk of complications such as cardiac arrhythmias and musculoskeletal injuries, ultimately impairing physical performance and functional capacity [1].

Despite these limitations, physical activity is increasingly recognized as an important supportive intervention in the management of thyroid disorders. Regular exercise has been shown to improve quality of life, reduce fatigue, and enhance metabolic and muscular function in affected individuals [1,9,26]. However, the direct effects of physical activity on thyroid hormone levels remain inconsistent and appear to depend on factors such as exercise intensity, duration, training status, and individual characteristics [1,24]. Acute exercise may lead to transient increases in thyroid-stimulating hormone (TSH) and thyroxine (T4), while triiodothyronine (T3) responses are more variable, reflecting the complexity of endocrine adaptations to physical stress [24].

A growing body of evidence suggests that the relationship between physical activity and thyroid function may be non-linear. Moderate levels of physical activity appear to be associated with a more favorable hormonal profile, including higher free thyroxine (fT4) concentrations and lower TSH and thyroid peroxidase antibody (TPOAb) levels, indicating potential benefits for hormonal homeostasis and reduced autoimmune activity [2]. In contrast, both insufficient and excessive levels of physical activity may be less beneficial or even detrimental. Population-based analyses have demonstrated U-shaped or L-shaped associations between physical activity and thyroid parameters, suggesting the existence of an optimal range of exercise intensity and volume [13,23].

These associations may be further modified by individual factors such as sex, age, and body composition. For example, beneficial relationships between moderate physical activity and thyroid function have been observed particularly in women and individuals with overweight or obesity [2]. Age also appears to play a role, as the protective association between physical activity and subclinical hypothyroidism is more pronounced in individuals under 60 years of age [23]. Such findings highlight the importance of individualized exercise recommendations in clinical practice.

In patients with autoimmune thyroid diseases, including Hashimoto's thyroiditis, physical activity may exert additional immunomodulatory effects. Moderate exercise has been associated with increased regulatory T-cell activity and reduced inflammatory responses, potentially contributing to decreased autoimmune activity and lower levels of thyroid autoantibodies [3,12]. Moreover, recreational physical activity appears to have more favorable effects on hormonal and immunological parameters than occupational physical activity, which may be associated with chronic stress and insufficient recovery [12]. These observations support the concept of a "physical activity paradox," in which the health effects of exercise depend not only on its intensity but also on its context and psychosocial characteristics.

Conversely, excessive physical activity, particularly when combined with inadequate energy availability, may negatively affect thyroid function. Conditions such as relative energy deficiency in sport (RED-S) are associated with disruptions in endocrine function, including suppression of the hypothalamic-pituitary-thyroid (HPT) axis and reduced levels of thyroid hormones [18]. Similarly, prolonged or high-intensity exercise may induce a "low T3

syndrome," reflecting an adaptive response aimed at conserving energy under conditions of metabolic stress [24]. These findings indicate that excessive training loads, especially without adequate nutritional support, may impair hormonal balance and overall health.

Interventional studies provide further insight into the potential benefits of structured exercise programs. Meta-analyses of randomized controlled trials suggest that long-term exercise interventions, particularly those combining aerobic and resistance training, may lead to reductions in TSH and increases in T4 levels in individuals with hypothyroidism [9,26]. At the same time, some studies report improvements in cardiovascular fitness, metabolic parameters, and quality of life without significant changes in thyroid hormone levels, indicating that functional benefits of exercise may occur independently of direct endocrine modulation [11].

Additionally, experimental studies suggest that physical activity may influence thyroid function indirectly through its effects on stress regulation and neuroendocrine balance. Exercise has been shown to modulate the interaction between the hypothalamic-pituitary-adrenal (HPA) and HPT axes, potentially counteracting the negative effects of chronic stress on thyroid function [10,24,30]. This interaction is particularly relevant given the established links between stress, mental health, and thyroid dysfunction.

Overall, current evidence indicates that physical activity exerts a complex and multidirectional influence on thyroid function. While moderate, well-balanced exercise appears to support hormonal homeostasis, immune regulation, and overall health, both insufficient and excessive physical activity may have unfavorable effects. The heterogeneity of study findings, however, highlights the need for further well-designed longitudinal and interventional studies to establish clear recommendations regarding the optimal type, intensity, and duration of physical activity for individuals with thyroid disorders.

5. Physical Activity and Mental Health

Physical activity is widely recognized as an effective non-pharmacological intervention for improving mental health across diverse populations. A substantial body of evidence, including meta-analyses of randomized controlled trials, demonstrates that regular exercise significantly reduces symptoms of depression and anxiety, with effects comparable to

pharmacological and psychotherapeutic interventions in some cases [14,15]. These findings highlight the important role of physical activity as both a preventive and therapeutic strategy in mental health care.

The antidepressant effects of physical activity are particularly well documented in individuals with major depressive disorder (MDD). Exercise interventions, especially those involving aerobic training of moderate to high intensity, have been shown to produce clinically meaningful reductions in depressive symptoms [14]. The effectiveness of such interventions appears to be enhanced when they are supervised and structured, suggesting that adherence, guidance, and social support may play a key role in achieving optimal outcomes [14,15]. In addition to depression, physical activity has also been associated with improvements in anxiety, stress-related disorders, and overall psychological well-being [15].

The mechanisms underlying the beneficial effects of physical activity on mental health are complex and multifactorial, involving both biological and psychosocial pathways. From a biological perspective, exercise promotes neuroplasticity and neurogenesis, particularly in brain regions such as the hippocampus, which are closely linked to mood regulation [16]. Physical activity also influences neurotransmitter systems, including serotonin, dopamine, and norepinephrine, thereby contributing to improved emotional regulation and reduced depressive symptoms [16].

In addition, exercise exerts anti-inflammatory and antioxidative effects, which may counteract biological processes associated with the development of depression and anxiety. Chronic low-grade inflammation and oxidative stress have been implicated in the pathophysiology of mood disorders, and regular physical activity has been shown to reduce inflammatory markers and improve systemic homeostasis [16]. Furthermore, physical activity modulates neuroendocrine function, including the regulation of the hypothalamic-pituitary-adrenal (HPA) axis, leading to improved stress resilience and more adaptive hormonal responses [16,30].

Psychosocial mechanisms also play a crucial role in mediating the mental health benefits of physical activity. Engagement in exercise can enhance self-esteem, increase perceived self-efficacy, and provide a sense of achievement, all of which contribute to improved psychological well-being [16]. Additionally, participation in physical activity-particularly in

group or supervised settings-may promote social interaction and reduce feelings of isolation, which are important factors in the prevention and treatment of mental health disorders.

Importantly, the relationship between physical activity and mental health may also be influenced by the type and context of exercise. Evidence suggests that not all forms of physical activity produce the same psychological benefits. For example, voluntary and recreational activities may be associated with greater improvements in mental well-being compared to obligatory or work-related physical exertion, which may be accompanied by stress and limited recovery opportunities [12]. Similarly, unstructured and enjoyable forms of physical activity may be particularly beneficial for psychological health, as they are more likely to promote intrinsic motivation and long-term adherence [17].

The dose–response relationship between physical activity and mental health outcomes also appears to be non-linear. Moderate levels of physical activity are generally associated with the greatest psychological benefits, whereas both insufficient and excessive exercise may be less effective or even detrimental [14,18]. Excessive training, particularly in the context of low energy availability, may contribute to the development of conditions such as relative energy deficiency in sport (RED-S), which is associated not only with physiological disturbances but also with an increased risk of mood disorders, anxiety, and impaired stress coping [18].

It is also important to consider that mental health can influence physical activity behavior. Individuals experiencing depression or anxiety often report reduced motivation, fatigue, and decreased engagement in physical activity, which may create a negative feedback loop, further exacerbating psychological symptoms [15]. This bidirectional relationship underscores the importance of tailored interventions that address both psychological and physical barriers to exercise participation.

Overall, current evidence supports a strong and multidimensional relationship between physical activity and mental health. Regular, appropriately prescribed exercise can lead to significant improvements in mood, cognitive function, and overall well-being through a combination of biological and psychosocial mechanisms. However, the variability in individual responses and the influence of contextual factors highlight the need for personalized approaches to physical activity interventions, particularly in populations with coexisting physical and mental health conditions.

6. Integrative Perspective: Interactions Between Thyroid Function, Mental Health and Physical Activity

The relationship between thyroid function, mental health, and physical activity is complex, multidirectional, and mediated by overlapping endocrine, neurobiological, and immunological mechanisms. Rather than representing independent domains, these three components form an interconnected system in which alterations in one area may influence the others through multiple feedback pathways.

Thyroid dysfunction may act as a central factor disrupting both physical and psychological functioning. Impaired thyroid hormone regulation can negatively affect metabolic processes, neuromuscular performance, and central nervous system activity, leading to reduced exercise capacity, fatigue, and diminished motivation for physical activity [1,4,5]. At the same time, thyroid disorders are strongly associated with depressive and anxiety symptoms, cognitive impairment, and reduced quality of life, which may further limit engagement in regular physical activity [4-7]. This creates a potential negative cycle in which endocrine dysfunction contributes to both physical inactivity and psychological distress.

Conversely, physical activity may influence both thyroid function and mental health through a range of physiological mechanisms. Regular exercise has been shown to modulate the hypothalamic-pituitary-thyroid (HPT) axis, improve metabolic regulation, and exert anti-inflammatory and immunomodulatory effects, which may be particularly relevant in autoimmune thyroid diseases [3,24]. In parallel, physical activity positively affects mental health by enhancing neuroplasticity, regulating neurotransmitter systems, and improving stress resilience through modulation of the hypothalamic-pituitary-adrenal (HPA) axis [16,30]. These combined effects suggest that physical activity may serve as a key mediating factor linking endocrine and psychological processes.

An important element of this interaction is the role of stress and neuroendocrine regulation. Chronic psychological stress, frequently observed in depression and anxiety disorders, may disrupt thyroid function by altering the activity of the HPT axis and increasing cortisol levels through activation of the HPA axis [20,30]. Elevated cortisol may suppress thyroid hormone production and peripheral conversion, contributing to a state of relative hypothyroidism. At

the same time, thyroid dysfunction may increase vulnerability to stress and impair adaptive responses, reinforcing the bidirectional relationship between endocrine and psychological systems.

Immune mechanisms represent another critical link between thyroid function and mental health. Autoimmune thyroid diseases are associated with chronic low-grade inflammation and altered cytokine profiles, which may contribute to the development of depressive and anxiety symptoms independently of hormonal abnormalities [4,7]. Physical activity may partially counteract these processes by reducing systemic inflammation and promoting immune regulation, including increased regulatory T-cell activity [3]. This highlights the potential role of exercise as a modulator of the immune-endocrine-brain axis.

The concept of energy availability provides further insight into the interaction between physical activity and thyroid function. Both insufficient physical activity and excessive exercise, particularly in the context of low energy availability, may disrupt hormonal balance. Conditions such as relative energy deficiency in sport (RED-S) illustrate how chronic energy imbalance can lead to suppression of endocrine function, including alterations in thyroid hormones, alongside negative effects on mental health, such as increased risk of depression, anxiety, and impaired stress coping [18]. These findings emphasize that not only the presence of physical activity, but also its intensity, volume, and nutritional context, are critical determinants of its overall impact.

Importantly, the relationship between these three domains appears to be non-linear. Moderate levels of physical activity are consistently associated with the most favorable outcomes in terms of hormonal balance, immune function, and psychological well-being, whereas both low and excessive levels may be associated with adverse effects [2,13,23]. This U-shaped pattern underscores the importance of individualized and well-balanced exercise prescriptions, particularly in populations with thyroid disorders or mental health conditions.

From a clinical perspective, the interaction between thyroid function, mental health, and physical activity has important implications for patient management. Individuals with thyroid disorders should be assessed not only in terms of endocrine parameters, but also with regard to psychological well-being and lifestyle factors, including physical activity levels. Similarly, patients presenting with depression or anxiety may benefit from evaluation of thyroid function

and targeted lifestyle interventions that include appropriately tailored exercise programs [5,20]. An integrated, multidisciplinary approach involving endocrinologists, mental health professionals, and exercise specialists may therefore provide the most effective strategy for improving patient outcomes.

Despite growing interest in this field, the current body of evidence remains limited by heterogeneity in study design, population characteristics, and outcome measures. Many studies are cross-sectional, making it difficult to establish causal relationships, and there is a lack of large-scale longitudinal and mechanistic research exploring the interaction between these domains. Future studies should aim to clarify the directionality of these relationships and to identify optimal types and doses of physical activity for different patient populations.

In summary, thyroid function, mental health, and physical activity are closely interconnected through a network of endocrine, neurobiological, and immunological pathways. Physical activity may play a central role in this system, acting as both a mediator and a potential therapeutic tool. A better understanding of these interactions may contribute to the development of more comprehensive and personalized approaches to the prevention and management of both thyroid disorders and mental health conditions.

7. Discussion

The present narrative review highlights the complex and multidirectional relationship between thyroid function, mental health, and physical activity. Current evidence suggests that thyroid dysfunction may negatively influence both psychological well-being and physical performance, while appropriately prescribed physical activity may exert beneficial effects on endocrine regulation, mood, and overall quality of life [1,4,9,14]. At the same time, mental health disorders and chronic stress may further modulate thyroid function through neuroendocrine and immunological pathways, indicating the presence of reciprocal interactions between these domains [20,30].

One of the most clinically relevant findings is the strong association between thyroid disorders and mental health symptoms, particularly depression and anxiety. Both hypothyroidism and hyperthyroidism have been linked to impaired mood, reduced cognitive performance, fatigue, and diminished quality of life [4-7]. These effects are likely mediated

through several mechanisms, including altered neurotransmitter activity, dysregulation of the hypothalamic-pituitary-thyroid (HPT) axis, interactions with the hypothalamic-pituitary-adrenal (HPA) axis, and immune activation [4,5,20]. Autoimmune thyroid diseases appear especially important in this context, as depressive and anxiety symptoms may occur even in the absence of overt hormonal abnormalities, suggesting an independent contribution of inflammatory and autoimmune processes [4,7].

Another important observation concerns the role of physical activity as a potentially valuable adjunctive strategy in patients with thyroid disorders. Regular exercise has been associated with improvements in fatigue, cardiovascular fitness, muscle function, and psychological well-being [1,9,26]. In individuals with hypothyroidism, structured exercise programs may reduce TSH levels, improve functional capacity, and enhance quality of life, although the magnitude of endocrine changes remains inconsistent across studies [9,11,26]. Similarly, moderate physical activity may have favorable immunomodulatory effects in autoimmune thyroid disease, potentially reducing inflammatory burden and improving clinical outcomes [3,12].

However, the relationship between physical activity and thyroid function does not appear to be uniformly beneficial. Several studies suggest a non-linear or U-shaped association, in which moderate levels of exercise are associated with the most favorable hormonal and psychological outcomes, whereas sedentary behavior and excessive training loads may be associated with adverse effects [2,13,23]. This is particularly relevant in athletes and highly active individuals exposed to low energy availability or overtraining, where endocrine suppression, low T3 states, mood disturbances, and impaired recovery may occur [18,24]. These findings emphasize that exercise prescription should be individualized and balanced rather than universally intensified.

The review also underscores the bidirectional role of mental health in thyroid disease. Depression, anxiety, and chronic psychological stress may increase the future risk of thyroid dysfunction, potentially through persistent HPA-axis activation, elevated cortisol levels, immune dysregulation, sleep disturbances, and unhealthy lifestyle behaviors [19,20,29,30]. This suggests that mental health disorders should not only be viewed as consequences of thyroid disease, but also as possible contributors to its development and progression [20].

From a practical perspective, these findings support a more integrated clinical model. Patients presenting with thyroid disorders may benefit from routine screening for depressive and anxiety symptoms, fatigue, sleep problems, and physical inactivity [5,7]. Likewise, individuals with persistent mood disorders, reduced motivation, or treatment-resistant depression may warrant evaluation of thyroid function [5]. Multidisciplinary management involving endocrinologists, mental health professionals, dietitians, and exercise specialists may offer the greatest potential for improving long-term outcomes [4,15].

Despite growing interest in this field, the available evidence has several limitations. Many studies are cross-sectional, preventing causal inference [2,12,23]. Considerable heterogeneity exists regarding study populations, diagnostic criteria, exercise protocols, and psychological outcome measures [9,14]. In addition, many studies rely on self-reported physical activity or symptom questionnaires, which may introduce bias [17,23]. There is also a lack of large longitudinal studies and mechanistic trials examining how exercise modifies thyroid-related psychological symptoms or how thyroid treatment influences exercise behavior over time [20,22].

Future research should focus on prospective and randomized studies evaluating the optimal type, intensity, and duration of physical activity in patients with specific thyroid disorders [9,26]. Further investigation is also needed into sex differences, age-related effects, autoimmune mechanisms, and the role of stress biology in thyroid–brain interactions [7,8,19,30]. Personalized lifestyle interventions combining exercise, nutrition, sleep optimization, and psychological support may represent a promising direction for future clinical care [15,25].

Overall, the current evidence indicates that thyroid function, mental health, and physical activity are deeply interconnected. Recognizing these relationships may improve prevention strategies, clinical assessment, and therapeutic outcomes in individuals affected by thyroid disease or mental health disorders [1,4,14,20].

8. Conclusions

Current evidence indicates that thyroid function, mental health, and physical activity are closely interconnected through endocrine, neurobiological, immunological, and behavioral

pathways. Both hypothyroidism and hyperthyroidism may negatively affect psychological well-being, cognitive performance, exercise tolerance, and overall quality of life, while mental health disorders may also contribute to the development or progression of thyroid dysfunction.

Regular physical activity appears to be a valuable non-pharmacological strategy that may improve mood, physical functioning, metabolic health, and selected thyroid-related outcomes. The most favorable effects are generally observed with moderate and appropriately prescribed exercise, whereas both sedentary behavior and excessive training loads may be associated with adverse endocrine and psychological consequences.

From a clinical perspective, patients with thyroid disorders should be assessed not only for biochemical abnormalities, but also for mental health symptoms, lifestyle behaviors, and physical activity patterns. Likewise, individuals with persistent depression, anxiety, fatigue, or reduced functional capacity may benefit from evaluation of thyroid status as part of a comprehensive diagnostic approach.

Despite growing interest in this topic, the available literature remains limited by heterogeneity of study designs and a lack of longitudinal and mechanistic research. Further well-designed prospective studies are needed to determine causal pathways and to identify the optimal type, intensity, and duration of physical activity for individuals with different thyroid disorders.

In summary, a multidisciplinary and personalized approach integrating endocrinology, mental health care, and lifestyle medicine may offer the greatest potential for improving long-term outcomes in patients affected by thyroid dysfunction and related psychological or functional impairments.

Disclosure

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

Data curation: ŁM, EM, KN, DK

Formal analysis: EM, PK, EU

Investigation: KN, DK

Supervision: ŁM, EM

Writing-rough preparation: KN, DK, PK, EU

Writing-review and editing: EM, ŁM

All authors have read and agreed with the published version of the manuscript.

Funding Statement:

This research received no external funding.

Institutional Review Board Statement:

Not applicable.

Informed Consent Statement:

Not applicable.

Data Availability Statement:

Not applicable.

Acknowledgments:

Not applicable.

Conflict of Interest Statement:

The authors declare no conflict of interest.

References:

1. Gavriilidou, M., Chorti, A., Psomiadou, A., Koidou, E., Papaioannou, M., & Papavramidis, T. (2025). Thyroid Gland Disorders and Physical Activity: Can They Affect Each Other?. Cureus, 17(3), e81489. https://doi.org/10.7759/cureus.81489
2. Lee, J., Baek, H. S., Jo, K., Kim, M. H., Lee, J. M., Chang, S. A., & Lim, D. J. (2025). The Impact of Physical Activity on Thyroid Health: Insights From Representative

Data in Korea. The Journal of clinical endocrinology and metabolism, 110(3), e717–e727. https://doi.org/10.1210/clinem/dgae178

3. Skrzypiec-Spring, M., Pokrywka, A., Szeląg, A., & Zembroń-Łacny, A. (2025). Autoimmune Thyroid Diseases and Physical Activity and Sports-More Unknowns than Facts. Biomedicines, 13(10), 2352. https://doi.org/10.3390/biomedicines13102352
4. Al Qaderi, A. H., Osman, A. A., Manasrah, H., Ali, M. Z., & Al Qaderi, N. (2026). Exploring the Connection Between Thyroid Health and Psychiatric Disorders: A Comprehensive Review With a Focus on Schizophrenia and Bipolar Disorder. Cureus, 18(1), e102146. https://doi.org/10.7759/cureus.102146
5. Nuguru, S. P., Rachakonda, S., Sripathi, S., Khan, M. I., Patel, N., & Meda, R. T. (2022). Hypothyroidism and Depression: A Narrative Review. Cureus, 14(8), e28201. https://doi.org/10.7759/cureus.28201
6. Ittermann, T., Völzke, H., Baumeister, S. E., Appel, K., & Grabe, H. J. (2015). Diagnosed thyroid disorders are associated with depression and anxiety. Social psychiatry and psychiatric epidemiology, 50(9), 1417–1425. https://doi.org/10.1007/s00127-015-1043-0
7. Siegmann, E. M., Müller, H. H. O., Luecke, C., Philipsen, A., Kornhuber, J., & Grömer, T. W. (2018). Association of Depression and Anxiety Disorders With Autoimmune Thyroiditis: A Systematic Review and Meta-analysis. JAMA psychiatry, 75(6), 577–584. https://doi.org/10.1001/jamapsychiatry.2018.0190
8. Zhao, T., Chen, B. M., Zhao, X. M., & Shan, Z. Y. (2018). Subclinical hypothyroidism and depression: a meta-analysis. Translational psychiatry, 8(1), 239. https://doi.org/10.1038/s41398-018-0283-7
9. Sundus, H., Khan, S. A., Zaidi, S., Chhabra, C., Ahmad, I., & Khan, H. (2025). Effect of long-term exercise-based interventions on thyroid function in hypothyroidism: A systematic review and meta-analysis of randomized controlled trials. Complementary therapies in medicine, 92, 103196. https://doi.org/10.1016/j.ctim.2025.103196
10. Oumali, N. A., Abrari, K., Shafia, S., Hosseini, S. H., & Akhoundzadeh, K. (2026). Comparative effects of voluntary and forced exercise on cognitive performance, thyroid function, and hippocampal integrity in a rat model of post-traumatic stress disorder. IBRO neuroscience reports, 20, 391–398. https://doi.org/10.1016/j.ibneur.2026.02.015

11. Almas, S. P., Werneck, F. Z., Coelho, E. F., Teixeira, P. F. S., & Vaisman, M. (2023). Endurance training improves heart rate on-kinetics in women with subclinical hypothyroidism: a preliminary study. Journal of endocrinological investigation, 46(1), 51–57. https://doi.org/10.1007/s40618-022-01882-8
12. Vuletić, M., Kaličanin, D., Barić Žižić, A., Cvek, M., Sladić, S., Škrabić, V., Punda, A., & Boraska Perica, V. (2024). Occupational Physical Activity and Regular Exercise Are Inversely Correlated with Thyroid Function in Patients with Hashimoto's Thyroiditis. Diseases (Basel, Switzerland), 12(11), 281. https://doi.org/10.3390/diseases12110281
13. Tian, L., Lu, C., & Teng, W. (2024). Association between physical activity and thyroid function in American adults: a survey from the NHANES database. BMC public health, 24(1), 1277. https://doi.org/10.1186/s12889-024-18768-4
14. Schuch, F. B., Vancampfort, D., Richards, J., Rosenbaum, S., Ward, P. B., & Stubbs, B. (2016). Exercise as a treatment for depression: A meta-analysis adjusting for publication bias. Journal of psychiatric research, 77, 42–51. https://doi.org/10.1016/j.jpsychires.2016.02.023
15. Stubbs, B., Vancampfort, D., Hallgren, M., Firth, J., Veronese, N., Solmi, M., Brand, S., Cordes, J., Malchow, B., Gerber, M., Schmitt, A., Correll, C. U., De Hert, M., Gaughran, F., Schneider, F., Kinnafick, F., Falkai, P., Möller, H. J., & Kahl, K. G. (2018). EPA guidance on physical activity as a treatment for severe mental illness: a meta-review of the evidence and Position Statement from the European Psychiatric Association (EPA), supported by the International Organization of Physical Therapists in Mental Health (IOPTMH). European psychiatry : the journal of the Association of European Psychiatrists, 54, 124–144. https://doi.org/10.1016/j.eurpsy.2018.07.004
16. Kandola, A., Ashdown-Franks, G., Hendrikse, J., Sabiston, C. M., & Stubbs, B. (2019). Physical activity and depression: Towards understanding the antidepressant mechanisms of physical activity. Neuroscience and biobehavioral reviews, 107, 525–539. https://doi.org/10.1016/j.neubiorev.2019.09.040
17. Yang, W., Wong, S. H., Sum, R. K., & Sit, C. H. (2021). The association between physical activity and mental health in children with special educational needs: A systematic review. Preventive medicine reports, 23, 101419. https://doi.org/10.1016/j.pmedr.2021.101419
18. Mountjoy, M., Sundgot-Borgen, J. K., Burke, L. M., Ackerman, K. E., Blauwet, C., Constantini, N., Lebrun, C., Lundy, B., Melin, A. K., Meyer, N. L., Sherman, R. T.,

Tenforde, A. S., Klungland Torstveit, M., & Budgett, R. (2018). IOC consensus statement on relative energy deficiency in sport (RED-S): 2018 update. British journal of sports medicine, 52(11), 687–697. https://doi.org/10.1136/bjsports-2018-099193

19. Baweja, R., Eisele, C., Breitzig, M. T., Free, M. F., Kalyoncu, A., Singh, B., Frye, M. A., Waschbusch, D. A., Liao, D., & Saunders, E. F. H. (2026). Thyroid and depression: Insights from a retrospective real world clinical cohort. Psychoneuroendocrinology, 188, 107809. Advance online publication. https://doi.org/10.1016/j.psyneuen.2026.107809
20. Fan, T., Luo, X., Li, X., Shen, Y., & Zhou, J. (2024). The Association between Depression, Anxiety, and Thyroid Disease: A UK Biobank Prospective Cohort Study. Depression and anxiety, 2024, 8000359. https://doi.org/10.1155/2024/8000359
21. Samuels, M. H., Kolobova, I., Niederhausen, M., Janowsky, J. S., & Schuff, K. G. (2018). Effects of Altering Levothyroxine (L-T4) Doses on Quality of Life, Mood, and Cognition in L-T4 Treated Subjects. The Journal of clinical endocrinology and metabolism, 103(5), 1997–2008. https://doi.org/10.1210/jc.2017-02668
22. Kuś, A., Kjaergaard, A. D., Marouli, E., Del Greco M, F., Sterenborg, R. B. T. M., Chaker, L., Peeters, R. P., Bednarczuk, T., Åsvold, B. O., Burgess, S., Deloukas, P., Teumer, A., Ellervik, C., & Medici, M. (2021). Thyroid Function and Mood Disorders: A Mendelian Randomization Study. Thyroid : official journal of the American Thyroid Association, 31(8), 1171–1181. https://doi.org/10.1089/thy.2020.0884
23. Li, Z., Mao, Y., Wen, X., Chen, G., & Zhou, S. (2025). Associations of physical activity type, intensity, and frequency with subclinical hypothyroidism: a cross-sectional analysis of NHANES 2007-2012. Frontiers in public health, 13, 1499070. https://doi.org/10.3389/fpubh.2025.1499070
24. Mennitti, C., Farina, G., Imperatore, A., De Fonzo, G., Gentile, A., La Civita, E., Carbone, G., De Simone, R. R., Di Iorio, M. R., Tinto, N., Frisso, G., D'Argenio, V., Lombardo, B., Terracciano, D., Crescioli, C., & Scudiero, O. (2024). How Does Physical Activity Modulate Hormone Responses?. Biomolecules, 14(11), 1418. https://doi.org/10.3390/biom14111418
25. Gacek, M., Wojtowicz, A., & Kędzior, J. (2025). Physical Activity, Nutritional Behaviours and Depressive Symptoms in Women with Hashimoto's Disease. Healthcare (Basel, Switzerland), 13(6), 620. https://doi.org/10.3390/healthcare13060620

26. Ahmad, A. M., Serry, Z. H., Abd Elghaffar, H. A., Ghazi, H. A., & El Gayar, S. L. (2023). Effects of aerobic, resistance, and combined training on thyroid function and quality of life in hypothyroidism. A randomized controlled trial. Complementary therapies in clinical practice, 53, 101795. https://doi.org/10.1016/j.ctcp.2023.101795
27. Loh, H. H., Lim, L. L., Yee, A., & Loh, H. S. (2019). Association between subclinical hypothyroidism and depression: an updated systematic review and meta-analysis. BMC psychiatry, 19(1), 12. https://doi.org/10.1186/s12888-018-2006-2
28. Wildisen, L., Feller, M., Del Giovane, C., Moutzouri, E., Du Puy, R. S., Mooijaart, S. P., Collet, T. H., Poortvliet, R. K. E., Kearney, P., Quinn, T. J., Klöppel, S., Bauer, D. C., Peeters, R. P., Westendorp, R., Aujesky, D., Gussekloo, J., & Rodondi, N. (2021). Effect of Levothyroxine Therapy on the Development of Depressive Symptoms in Older Adults With Subclinical Hypothyroidism: An Ancillary Study of a Randomized Clinical Trial. JAMA network open, 4(2), e2036645. https://doi.org/10.1001/jamanetworkopen.2020.36645
29. Milo, T., Maimon, L., Cohen, B., Haran, D., Segman, D., Danon, T., Bren, A., Mayo, A., Cohen Rappaport, G., McInnis, M., & Alon, U. (2024). Longitudinal hair cortisol in bipolar disorder and a mechanism based on HPA dynamics. iScience, 27(3), 109234. https://doi.org/10.1016/j.isci.2024.109234
30. Petrowski, K., & Kahaly, G. J. (2025). Stress and Thyroid Function-From Bench to Bedside. Endocrine reviews, 46(5), 709–735. https://doi.org/10.1210/endrev/bnaf015