

**THYROID HORMONE DEFICIENCY: CLINICAL MANIFESTATIONS,  
PATHOGENESIS, AND CONSEQUENCES**

**Boyxonova R. S Kurbanova N.S**

Students of the Faculty of Treatment, Samarkand State Medical University.

Assistant of the Department of Endocrinology SamDTU.

Samarkand State Medical University, Samarkand, Uzbekistan

**Abstract:** Thyroid hormone deficiency, or hypothyroidism, is one of the most prevalent endocrine disorders, affecting millions of people worldwide. Thyroid hormones play a vital role in regulating metabolism, oxygen consumption, and the functioning of almost all organ systems. Insufficient secretion of thyroxine (T4) and triiodothyronine (T3) leads to systemic disturbances including cardiovascular, hematological, neurological, and reproductive dysfunctions. This article reviews the pathophysiological mechanisms of thyroid hormone deficiency, the types of anemia associated with hypothyroidism, and its impact on patients' quality of life. The study also analyzes clinical findings from international literature and provides insights into the importance of early diagnosis and lifelong hormone replacement therapy for improving outcomes.

**Key words:** Thyroid hormone deficiency; Hypothyroidism; Pathophysiology; Clinical features; Anemia; Normochromic anemia; Microcytic anemia; Macrocytic anemia; Hematological consequences; Quality of life; Endocrine disorders; Hormone replacement therapy.

**Introduction:** The thyroid gland is one of the central regulators of metabolic balance in the human body. Its hormones—thyroxine (T4) and triiodothyronine (T3)—influence nearly every organ system by modulating oxygen consumption, thermogenesis, protein synthesis, and energy metabolism. Thyroid hormone deficiency, clinically defined as hypothyroidism, can arise from autoimmune thyroiditis (Hashimoto's disease), iodine deficiency, iatrogenic causes (thyroidectomy, radioactive iodine therapy), or drug-induced suppression. Epidemiological studies show that hypothyroidism is significantly more common in women and in older individuals. According to recent reports, its prevalence in the adult population is approximately 4–10%, with subclinical hypothyroidism being even higher. Importantly, hypothyroidism is not only a metabolic disorder but also a systemic disease, as it affects cardiovascular health, hematopoiesis, neurocognitive function, and reproductive capacity.

The relationship between thyroid dysfunction and anemia has recently gained significant attention. Normochromic anemia due to reduced erythropoiesis, hypochromic anemia due to impaired iron absorption, and macrocytic anemia caused by vitamin B12 or folate deficiency are all documented in hypothyroid patients.

#### Main Part

##### 1. Pathophysiology of Thyroid Hormone Deficiency

- Metabolism slows down, leading to weight gain, fatigue, cold intolerance.
- Mitochondrial activity decreases, resulting in reduced ATP production.
- Hematopoiesis is impaired, lowering red blood cell production.
- Cardiac output decreases, causing bradycardia and in severe cases, heart failure.
- Neuropsychiatric effects include depression, memory impairment, and slowed reflexes.

##### 2. Clinical Aspects

- General symptoms: fatigue, dry skin, hair loss, constipation, sensitivity to cold.
- Cardiovascular system: bradycardia, hypertension, reduced ejection fraction.
- Hematological system: anemia in up to 30–40% of patients.
- Reproductive health: menstrual irregularities, infertility, complications during pregnancy.
- Severe forms: Myxedema coma, a life-threatening complication.

##### 3. Types of Anemia in Hypothyroidism

- Normochromic normocytic anemia: reduced erythropoietin response and bone marrow suppression.
- Hypochromic microcytic anemia: impaired iron absorption due to low thyroid hormone activity.
- Hyperchromic macrocytic anemia: vitamin B12 and folate deficiency linked to autoimmune thyroiditis.

#### Research Findings

A comparative analysis was conducted on 125 patients with hypothyroidism and 54 healthy women in a control group. The results demonstrated:

- Quality of life scores were significantly lower in hypothyroid patients.
- Anemia prevalence was markedly higher, especially normochromic anemia.
- Age and severity of hypothyroidism correlated with reduced health indicators.
- Psychological well-being and emotional stability were more impaired in hypothyroid patients compared to controls.

Other international studies (Nature Reviews, JAMA, Frontiers in Endocrinology) confirm these findings, emphasizing the systemic nature of thyroid hormone deficiency and its impact on hematological health.

### Discussion

The collected evidence shows that thyroid hormone deficiency disrupts multiple physiological systems. The connection between hypothyroidism and anemia is multifactorial: impaired erythropoiesis, decreased erythropoietin secretion, iron malabsorption, and autoimmune associations. Furthermore, the reduced metabolic rate worsens oxygen delivery, exacerbating symptoms of fatigue and weakness. An important clinical aspect is the quality of life. Patients with hypothyroidism experience not only physical but also emotional and cognitive impairments. This highlights the importance of holistic treatment approaches, including hormone replacement therapy (levothyroxine), correction of nutritional deficiencies, and psychological support.

### Conclusion:

Thyroid hormone deficiency is a widespread endocrine disorder with profound consequences on nearly all organ systems. One of the most significant manifestations is anemia, which occurs through multiple mechanisms including impaired erythropoiesis, iron metabolism disturbances, and vitamin deficiencies. Early diagnosis and timely initiation of hormonal replacement therapy are critical to prevent complications, improve patient outcomes, and enhance quality of life. Future research should focus on understanding the molecular mechanisms of thyroid-hematopoietic interactions and developing integrated treatment strategies.

### Clinical Features

The clinical manifestations of thyroid hormone deficiency are diverse and can affect multiple organ systems. The severity of symptoms often correlates with the duration and extent of hormone deficiency.

- General symptoms: persistent fatigue, lethargy, cold intolerance, weight gain.
- Skin and hair: dry skin, brittle nails, hair thinning and loss of the outer third of eyebrows.
- Gastrointestinal: constipation, reduced appetite, slowed digestion.
- Cardiovascular: bradycardia, low cardiac output, pericardial effusion in severe cases.
- Neurological: slow reflexes, cognitive decline, memory impairment, depression.
- Reproductive: menstrual irregularities, infertility, complications during pregnancy.
- Severe cases: Myxedema coma, characterized by hypothermia, altered mental status, and multi-organ failure.

### Pathogenesis

The pathogenesis of hypothyroidism is multifactorial and depends on the underlying cause:

1. Autoimmune destruction (Hashimoto's thyroiditis): chronic lymphocytic infiltration damages thyroid tissue, leading to reduced hormone synthesis.
2. Iodine deficiency: insufficient iodine intake limits thyroxine (T4) and triiodothyronine (T3) production.
3. Iatrogenic causes: surgical removal of the thyroid gland, radioactive iodine therapy, or medications (amiodarone, lithium).
4. Central hypothyroidism: pituitary or hypothalamic disorders reduce TSH secretion, lowering thyroid hormone output.

Pathophysiological consequences include:

- Reduced mitochondrial oxidative phosphorylation and ATP generation.
- Decreased erythropoietin production and impaired bone marrow activity (leading to anemia).
- Altered lipid and carbohydrate metabolism, contributing to hypercholesterolemia and weight gain.
- Impaired thermogenesis, resulting in cold intolerance.
- Neurological dysfunction due to decreased synaptic activity and slowed conduction.

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