FUNCTION OF THYROID GLAND HORMONES, METABOLIC DISORDERS, OVERWEIGHT, OBESITY AND BIOCHEMICAL PARAMETERS

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Abstract

Introduction: The thyroid gland represents a central component of the endocrine system, which through its hormones triiodothyronine (FT_3) and thyroxine (FT_4), regulated by thyroid-stimulating hormone (TSH), plays a key role in the control of basal metabolism and energy homeostasis. Thyroid function disorders are associated with significant neuro-endocrino-metabolic changes, affecting carbohydrate and lipid metabolism as well as the body's energy balance. At the biochemical level, these disorders are reflected in dyslipidemia, hyperglycemia, and alterations in metabolic parameters, which contribute to the development of overweight and obesity. Furthermore, there is a complex interaction between thyroid hormones and body mass index (BMI), where thyroid dysfunction may influence fat tissue accumulation and changes in metabolic profile. In this context, biochemical and hormonal biomarkers represent important indicators for the early assessment of metabolic disorders and for monitoring patients' physiological status.
Aim: This study aims to evaluate the relationship between thyroid gland function, biochemical parameters, and the development of overweight and obesity in the population.
Materials and methods: The study included 200 patients and 30 control individuals, divided according to age groups (18–30, 31–50, and 51–70 years) and gender. Anamnestic data were collected and BMI was measured. Venous blood samples were analyzed for glucose, lipid profile (total cholesterol, triglycerides, HDL, LDL), as well as thyroid hormones (TSH, FT_3, FT_4, ATPO, ATG). Analyses were performed using enzymatic, spectrophotometric, and immunofluorescence methods (ELFA – VIDAS).
Results: It is expected that patients with thyroid dysfunction will show increased TSH levels, disturbances in lipid profile, and elevated glucose levels, accompanied by increased BMI and a higher prevalence of overweight and obesity.
Conclusion: Biochemical and hormonal parameters represent important diagnostic tools for the identification and monitoring of metabolic disorders associated with thyroid dysfunction.

Keywords: thyroid gland, BMI, obesity, dyslipidemia, metabolism.

Introduction

The thyroid arises from a downward outpouching of the floor of the pharynx, and a persisting remnant of this migration is known as a thyroglossal duct. The gland itself consists of two oblong lobes lying on either side of the trachea and connected by a narrow band of tissue called the isthmus. In normal adults the thyroid gland weighs 10 to 15 grams (0.4 to 0.5 ounce), though it has the capacity to grow much larger. The lobes of the gland, as well as the isthmus, contain many small globular sacs called follicles. The follicles are lined with follicular cells and are filled with a fluid known as colloid that contains the prohormone thyroglobulin. The follicular cells contain the enzymes needed to synthesize thyroglobulin, as well as the enzymes needed to release thyroid hormone from thyroglobulin. When thyroid hormones are needed, thyroglobulin is reabsorbed from the colloid in the follicular lumen into the cells, where it is split into its component parts, including the two thyroid hormones thyroxine (T_4) and triiodothyronine (T_3). The hormones are then released, passing from the cells into the circulation. The substances produced in increased quantities in response to triiodothyronine

secretion include many enzymes, cell constituents, and hormones. It also stimulates carbohydrate utilization, lipid production and metabolism (thereby increasing cholesterol utilization), and central and autonomic nervous system activation, resulting in increased contraction of cardiac muscle and increased heart rate. During fetal life and in infancy this stimulatory activity of triiodothyronine is critically important for normal neural and skeletal growth and development; in both the unborn and the newborn, thyroid deficiency is associated with dwarfism and intellectual disability (Britannica Editors, 2026).

Thyroid hormone (TH) directly regulates metabolic rate, body weight, and cholesterol metabolism. TH regulates the expression of target genes directly through TR binding to specific TREs, as well as nongenomic modification of cell signaling. New evidence highlights the coordinate roles of central and peripheral regulation of TH in modulating metabolic pathways. TH interacts with the SNS in a synergistic and complementary fashion to maintain homeostasis. In addition, adipokine and neuropeptide regulation of the HPT axis and thermogenesis integrates information on energy availability, storage, and utilization to gauge the regulation of appetite, basal metabolic rate, and body weight. TR nuclear hormone crosstalk with other metabolic pathways, especially the nuclear receptors PPARα, LXR, and PGC-1α, is essential for the T_3 regulation of cholesterol metabolism and transcription of lipogenic and lipolytic genes. Bile acid stimulation of D2 and local thyroid hormone activation is another unexpected signaling link. Interference with thyroid hormone signaling is associated with obesity and hepatic steatosis. Finally, emerging evidence identifies a role for TH in glucose metabolism including actions in pancreatic islet development, gluconeogenesis, and insulin signaling (Mullur, R., et al 2014).

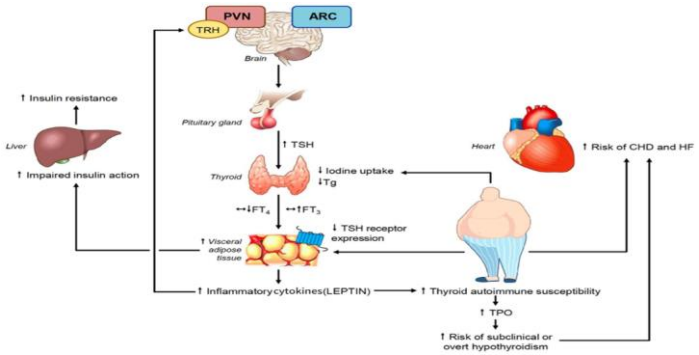


Figure 1: Mechanisms underlying the association between obesity and metabolic syndrome with subclinical hypothyroidism and the potential risk of these associated conditions (Biondi B. Subclinical Hypothyroidism in Patients with Obesity and Metabolic Syndrome: A Narrative Review. Nutrients. 2024; 16(1):87. https://doi.org/10.3390/nu16010087)

Purpose of the study

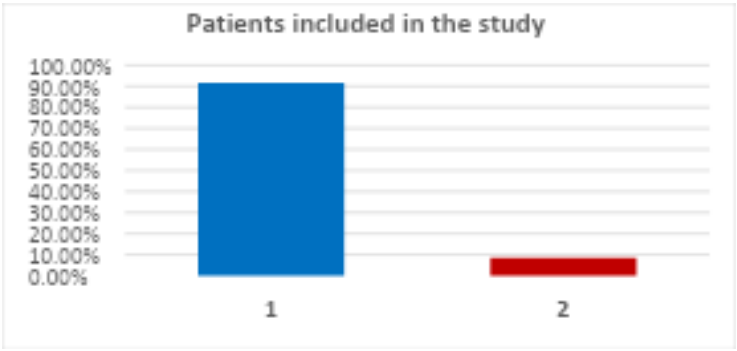
This study aims to comprehensively evaluate the relationship between thyroid gland function, key biochemical parameters, and their potential role in the development of overweight and obesity within the population. By examining these interrelated factors, the research seeks to provide a clearer understanding of how variations in thyroid activity and metabolic markers may contribute to changes in body weight and overall metabolic health. Ultimately, the goal is to generate insights that could support more effective prevention strategies and inform clinical approaches to managing obesity.

Material and method

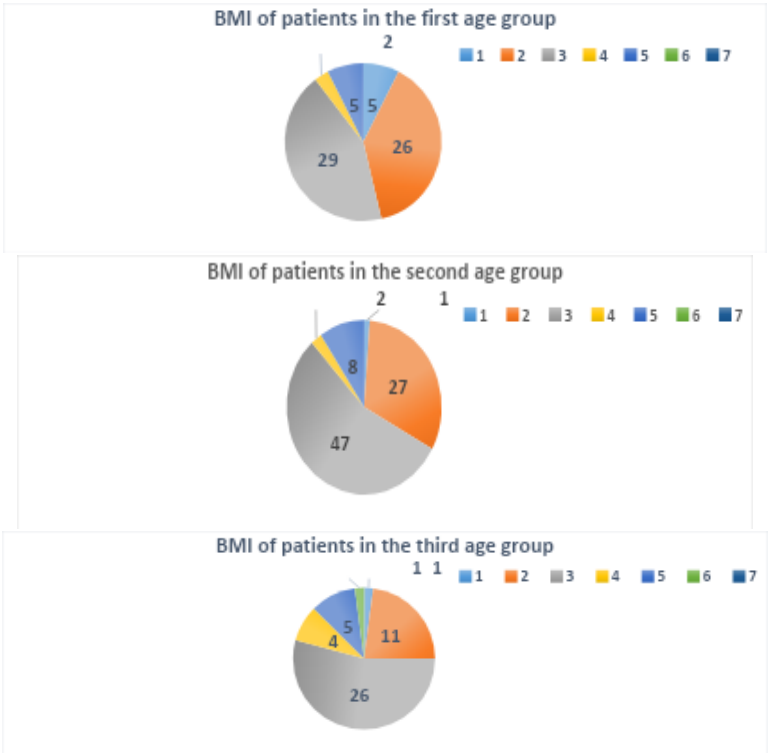
The study included 200 patients and 30 control individuals, divided according to age groups (18–30, 31–50, and 51–70 years) and gender. Anamnestic data were collected and BMI was measured. Venous blood samples were analyzed for glucose, lipid profile (total cholesterol, triglycerides, HDL, LDL), as well as thyroid hormones (TSH, FT_3, FT_4, ATPO, ATG). Analyses were performed using enzymatic, spectrophotometric, and immunofluorescence methods (ELFA – VIDAS).

Results

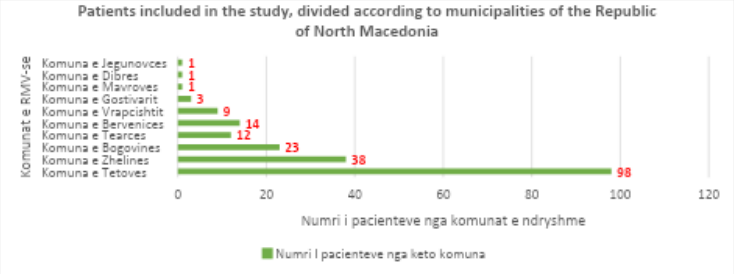
Based on the obtained results regarding thyroid gland hormone function, metabolic disorders, overweight and obesity, as well as associated biochemical parameters across different age groups and genders, the findings are presented in the graphics below:



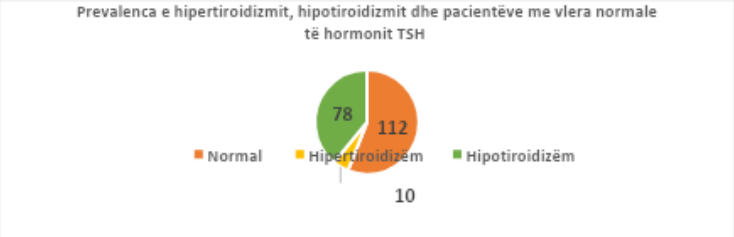
Grafic 1. Patients included in the study by thyroid status, lipid status, blood glucose level, and BMI



Grafic 2,3 and 4. BMI of patients in the first, second, and third age groups included in the study



Grafic 5. Number of patients included in the study, by municipalities of the RMV



Grafic 6. Number of patients with hyperthyroidism and hypothyroidism

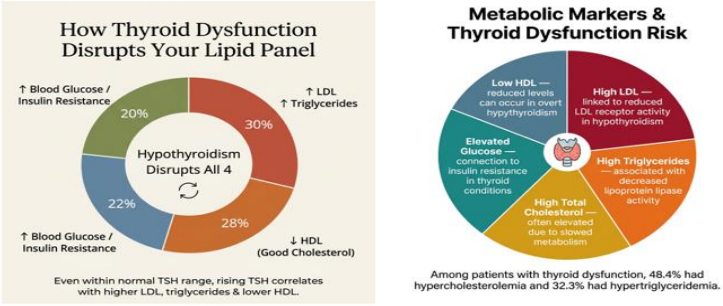
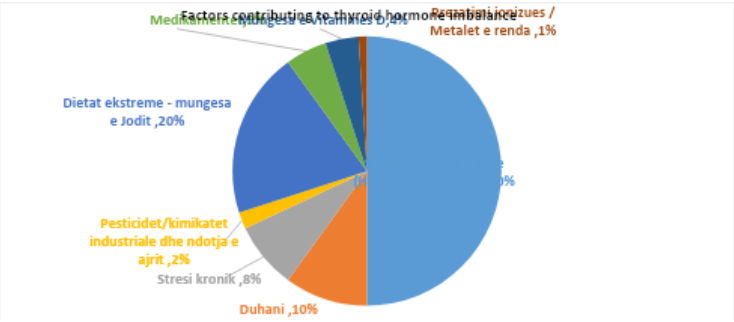


Fig.2: Association of Lipid Profile Parameters (Cholesterol, Triglycerides, HDL, LDL) with Thyroid Dysfunction



Grafic 7. Factors contributing to thyroid hormone imbalance

Fig. 3: Ultrasound images of patients with hypothyroidism: The two images show thyroid gland ultrasound with a heterogeneous and hypoechoic structure, characteristic of hypothyroidism, indicating chronic inflammation and reduced thyroid gland function (Performed by Dr. Spec. Irfan Ahmeti at Albimedica Polyclinic, Tetovo, 2025).

Fig. 4: Ultrasound images of patients with hyperthyroidism: The two images show an enlarged thyroid gland with a hypoechoic structure and increased vascularization, reflecting heightened functional activity of the thyroid gland (Performed by Dr. Spec. Irfan Ahmeti at Albimedica Polyclinic, Tetovo, 2025).

Discussion

The thyroid gland is particularly susceptible to environmental influences and, therefore, is unique among the endocrine glands as far as direct environmental impact. The thyroid gland becomes hyperplastic and a goiter develops when there is severe nutritional iodine deficiency. This is the reverse of the usual meaning of toxic effects of a substance on an organ. In fact, the abnormality occurs when there is an insufficient amount rather than an excess of one of the important chemicals needed for that particular gland. Another aspect of toxicology of the thyroid is the fact that when the normal regulatory mechanisms with the usual feedback control of thyroxin secretion fail, very high levels of thyroxin develop with resultant hyperthyroidism or, more appropriately for this conference, thyrotoxicosis (Edmund B. Flink, 1981). Body mass index (BMI), a measurement based on a person's height and weight, allows the classification of individuals into categories such as obese or overweight. With these classifications, we can assess risk for hypertension, diabetes, cancer, hypercholesterolemia, and other chronic diseases (Deepesh Khanna, et al 2022). Lucyna Ostrowska et al., also stated that their research shows improvement of thyroid parameters in patients suffering from obesity and Hashimoto's disease is possible through effective weight reduction. Concurrently, an individually adjusted elimination diet may lead to better therapeutic results (Ostrowska et al., 2021).

Conclusion

Thyroid hormone function and basal metabolism are essential for maintaining metabolic balance and overall health. This study demonstrates a clear relationship between thyroid dysfunction, biochemical parameters, and the development of overweight and obesity, with significant associations between altered TSH levels and increased BMI.

Variations in FT_3 and FT_4, along with abnormal prolactin and thyroid antibody levels, further indicate a link between thyroid disorders and metabolic imbalance. Overall, the findings highlight the importance of early detection, regular biochemical monitoring, and healthy lifestyle practices to support optimal thyroid function and metabolic health.

Beyond these established associations, the findings also suggest the potential value of integrating thyroid related biomarkers into broader metabolic risk prediction models. Emerging evidence indicates that subtle variations within the "normal" range of TSH, FT_3, and FT_4 may still carry metabolic significance, particularly when assessed in combination with inflammatory and adipokine profiles. This supports a more personalized, systems based approach to thyroid evaluation, where multi parameter biochemical profiling and digital tools

could improve early identification of individuals at risk for metabolic syndrome and obesity-related complications.

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