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# BENEFICIAL IMPACT OF NUTRITIONAL AND SUPPLEMENTAL CHANGES ON THE THYROID GLAND HEALTH

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**Abstract**

Diseases associated with hypothyroidism and autoimmune Hashimoto's thyroiditis have been increasing at a significant rate in recent decades, affecting mainly women of mature age. The study aims to assess the beneficial impact of nutritional and supplemental changes on the overall thyroid gland health. The research was conducted in 2022 and 2023 in Bulgarian women. The effect of 90 days lasting changes in nutritional plan on thyroid gland function were estimated by serum levels of thyroid-stimulating hormone (TSH) and free thyroxine (FT4) in 40 women aged from 25 to 45 years, diagnosed with Hashimoto's thyroiditis and was compared to a control group of 40 women of the same age. Restriction of pro-inflammatory and use of anti-inflammatory foods as well as the supplementation with important nutritional components significantly decreased average serum levels of TSH from 4.41 mIU/ml to 2.59 mIU/ml and increased FT4 from 14.17 pmol/L to 15.88 pmol/L at the output date, i.e. after 90 days. It is concluded that adequate changes in the nutritional plan, including compensation of nutritional deficiencies crucial for thyroid gland function together with avoidance of proinflammatory foods have a beneficial influence on TSH and FT4 levels in Bulgarian women with Hashimoto's thyroiditis.

**Key words:** Hashimoto's thyroiditis, thyroid hormones, thyroid-stimulating hormone, nutritional deficiencies, diet

**Introduction.** The thyroid gland secretes the iodine-containing hormones thyroxine (T4) and triiodothyronine (T3). These hormones affect directly oxygen

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consumption of all tissues in the human body with the exception of the uterus, brain, spleen, gonads, adenohypophysis and lymph nodes [1]. T3 and T4 increase also heat production due to stimulated aerobic metabolism [2].

Hashimoto's thyroiditis (HT) is an autoimmune disorder and a common cause for hypothyroidism [3]. Diet is the main factor, which can significantly affect the thyroid gland in health and disease. Unbalanced diets are one of the risk factors for the onset and worsening of hypothyroidism, a clinical condition responsible for the occurrence of dyslipidemia and inflammation status, and of a number of non-contagious chronic diseases such as obesity and diabetes mellitus [4]. Some trace elements, such as zinc, selenium, and iodine, are required for the synthesis and proper functioning of thyroid hormones [5]. Dysfunction of the thyroid gland (including hypothyroidism) can be induced not only by iodine deficiency, but also by its excessive intake [3]. Chronic inadequate intake of micronutrients has extremely negative health effects on the thyroid gland and on the body as a whole. Other substances in the diet that affect the functioning of the thyroid gland are gluten, glucosinolates, isoflavones and flavonoids [3, 6]. Nutrients called "functional foods", in addition to macronutrients and micronutrients, have the potential to improve physical conditions through their advantage over the benefits of conventional nutrients. Products such as bread, cereals, vitamin- and elements-enriched drinks, nutritional supplements, herbs, and many others can contain functional foods [7]. In vivo studies indicate that some flavonoids have the potential to activate or inhibit the conversion of T4 to T3 while others – to activate sodium-iodide symporter in thyrocytes [8]. Also, it is reported that the effect of gluten free diet is still ambiguous in patients with HT [9]. Vitamin D has a significant role in the development of autoimmune diseases of the endocrine system, including HT. Deficiencies of vitamin D, as well as of iron, copper, unsaturated fatty acids, inadequate intake of proteins and dietary fibres may also facilitate HT [3, 10].

The aim of the present study is to investigate the effect of changes in the diet and compensation of nutritional deficiencies on thyroid gland by measuring the serum levels of generally accepted markers of thyroid function – thyroid stimulating hormone (TSH) and thyroxine (FT4) in Bulgarian women with HT.

**Materials and methods.** The observational study was conducted among a group of 80 women aged from 25 to 45 years diagnosed with HT, and divided into two groups of 40. They were Bulgarian citizens living in big cities and leading an active lifestyle. The participants had been diagnosed with Hashimoto's thyroiditis. They signed informed consent for participation, as well as consent within the framework and the use of their data for the purposes of the project. The research was conducted in 2022 and 2023. TSH and FT4 were used as markers for assessment the diet and supplementation effect on overall thyroid health. The thyroid biomarkers were evaluated at the beginning of dietary regime and at the end of the study after 90 days.

The control group included 40 women aged from 25 to 45 years who expressed unwillingness to follow a strict diet and inability to stop consuming foods with goitrogenic, thyroid function-inhibiting and autoimmune-aggressive effects. During the study period, the women in the control group continued with their usual life habits and diet, and supplementation was not applied to compensate their nutritional deficiencies. Each participant continued to adhere to the therapy prescribed by their attending endocrinologist.

The meal plan assigned to participants in the active group was not associated with caloric restriction for weight reduction. The recommendations given to the participants were related only to the exclusion or inclusion of certain foods from the daily diet. Participants in the active group were advised to follow strictly the prescribed diet plan, with some basic nutritional guidelines, such as increased intake of probiotic foods, seasonal vegetables rich in fibres, and herbal teas low in tannins and caffeine. Their daily consumption included fruits such as wild blueberries, green apples, bananas and salads at each meal, along with foods, cooked over low heat, without overcooking or baking without burning.

***Anti-autoimmune food protocol.*** The participants in the active group had to follow some basic rules for eating:

- To avoid the consumption of wheat and all gluten containing food, eggs, soy and any soy products, white rice, dairy products, ghee, refined and brown sugar, molasses, corn syrup, fructose syrup, artificial sweeteners, millet, corn, trans fats (margarine, palm oil), vegetable oils (sunflower oil, grape seed oil, corn oil, canola, peanut oil, mayonnaise), coffee and alcohol, tobacco products, canned food, grapefruit, meat of non-organic origin, processed meat (salami, sausages, meat semi-finished products, not wild fish – farmed), bone broth, peanuts and peanut butter, roasted/fried nuts, soft drinks with or without sugar, refined table salt, sauces, monosodium glutamate.
- To consume daily raw fruits and vegetables, especially apples, bananas, oranges, all berries (blueberries, strawberries, raspberries, blackberries), papaya, avocado, grapes, kiwi, mango, in season – peaches, apricots, cherries, artichokes, asparagus, broccoli, cabbage, cauliflower, beets, fennel, kale, mushrooms, peppers, potatoes – never fried, zucchini, radishes, sweet potatoes.
- To consume regularly seaweeds (wakame, dulse, nori, spirulina), garlic and onions, ginger, turmeric, cinnamon, probiotic foods, nuts and seeds, pulses, meat and fish from organic farming.

Nutritional deficiencies and deviations in the values of micronutrients, specific for hypothyroidism and HT in the studied participants were observed. They were established through laboratory tests at the beginning of the study. According

to the results of the personal blood tests and the observed nutritional deficiencies, the participants in the active group were recommended some of the following nutritional supplements: biologically active $B_{12}$ sublingual form of methylcobalamin – 1 to 5 µg daily depending on the severity of the deficiency; bio coenzyme B complex in cases of elevated homocysteine levels; selenium – (L-selenomethionine) – 200 µg preferably with food; zinc chelate 30 mg per day, preferably with food; Iron SunActive® (iron pyrophosphate) – 5 mg per day daily before or during meals, a few hours before or after taking medication; magnesium citrate – 300 mg; the following nutritional supplements were recommended to optimize thyroid function – L-tyrosine – 250 mg; Ashwagandha extract (root), (1.5% withanolides)/Withania somnifera – 75 mg; Guggul extract (resin oleoresin), 2.5% guggulsterone/Commiphora mukul/ – 60 mg; Pantothenic acid (calcium d-pantothenate) – 50 mg; copper (copper gluconate) – 250 µg or biotin – 300 µg.

***Statistical analysis.*** Data are expressed as mean ± standard error of the mean (SEM). The difference between control group and diet restricted group was tested by independent samples Student's $t$-test. The serum level changes at the beginning and at the end of the observational study were tested by paired samples Student's $t$-test. A value of $p < 0.05$ was considered significant.

**Results and discussion.** TSH values of the diet-restricted group (active group) at the beginning of the study were 4.41±0.49 mIU/ml and a significant drop to $2.59 \pm 0.28$ mIU/ml was observed at the end of the study (Fig. 1B; $p < 0.001$). TSH level decreased by an average of 1.82 mIU/ml or about 41.3%. On the other hand, TSH in the control group at the input date was $4.20 \pm 0.31$ mIU/ml and increased to $5.25 \pm 0.64$ mIU/ml at the end of the monitored period (Fig. 1A; $p < 0.001$). Thus, TSH serum level in control group increased by 1.05 mIU/ml or by 25%.

FT4 serum level in the active group at the starting date was 14.17±0.48 pmol/L and significantly increased to $15.88 \pm 0.50$ pmol/L at the output date after 90 days (Fig. 1B; $p < 0.001$). FT4 in the control group at the input date was $13.69 \pm 0.46$ pmol/L and significantly dropped to $12.42 \pm 0.49$ pmol/L at the final date (Fig. 1A; $p < 0.001$).

These results were obtained under conditions when no changes in endocrinologist-prescribed hormone replacement therapy have been made for any of the participants in both groups. The absence of improvement achieved in thyroid gland function, as measured by serum TSH levels and despite prescribed hormone treatment, confirms the hypothesis that hormone replacement therapy alone could not lead to regeneration of thyroid tissue and remission of the autoimmune process. Quite the opposite is observed in control group – the regression of thyroid gland continues and this would require soon increase in the replacement hormonal doses.

On the other hand, the values of the two markers of the active group, where the participants changed their nutrition and compensated nutritional deficiencies

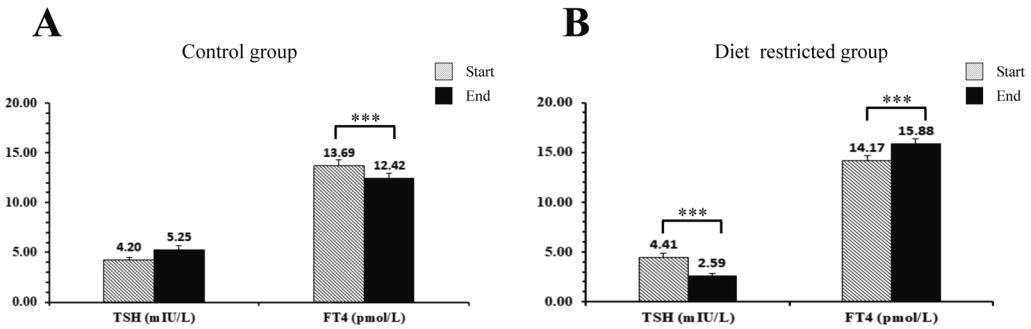


Fig. 1. TSH and FT4 serum levels at the beginning and at the end of observation. A: In the control group, TSH concentration increases insignificantly ($p = 0.083$) during the research by $1.05 \pm 0.59$ mIU/L. The FT4 levels decrease by $1.27 \pm 0.26$ pmol/L. This change is statistically significant ($p = 0.000013$). B: Opposite effects were observed in the diet restricted group. The serum levels of TSH decreased significantly ($p = 0.000057$) by $1.82 \pm 0.4$ mIU/L and FT4 increased significantly ($p = 0.0000000084$) by $1.71 \pm 0.02$ pmol/L

that were proven by personal laboratory blood tests, reported significant decrease in TSH level and increase of FT4 at the end of the study period (Fig. 2). Both parameters confirm improvement of thyroid gland function.

The data obtained support the importance and beneficial influence of changes in the nutritional plan, including compensation of nutritional deficiencies on TSH and FT4 levels in Bulgarian women with HT. These results support the hypothesis that changes in nutrition decrease the harmful effect of chronic inflammation of the thyrod gland and even support a partial recovery of thyrocytes' endocrine function. The importance of thyroxine for whole body functions suggests that appropriate changes in nutritional habbits can generate suitable conditions for the restoration of homeostasis in middle aged women with HT.

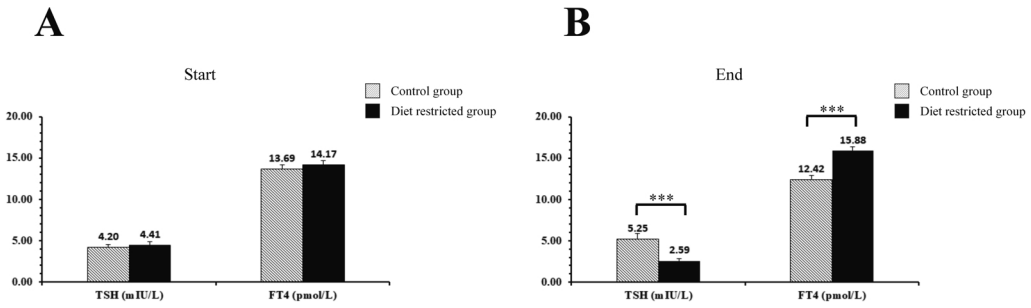


Fig. 2. TSH and FT4 serum levels in the control and the diet restricted group. A: At the beginning of observation both groups have approximately the same levels of TSH ($0.21 \pm 0.49$ mIU/L, $p = 0.72$) and FT4 ($0.48 \pm 0.48$ pmol/L, $p = 0.47$). B: At the end of observation the diet restricted group shows statistically significant decrease in TSH concentrations ($2.66 \pm 0.28$ mIU/L, $p = 0.00026$) and decrease in FT4 concentrations ($3.46 \pm 0.5$ pmol/L, $p = 0.0000043$) compared to the controls

Our data are in an agreement with other studies using changes in nutrition for treatment of HT [5, 11, 12]. The impact of this research is a detailed nutritional plan (strategy) given in Materials and methods section that combines precise combination of pro-inflammatory foods elimination, their replacement with anti-inflammatory products and supplies the body with necessary amounts of vitamins, other micronutrients and nutritional additives using their Bio adaptive forms. On the other hand, in women after menopause or those with comorbidity, underlying clinical conditions like metabolic disorders, insulin resistance, dyslipidemia, compromised microbiota, small intestinal bacterial overgrowth, intestinal permeability, obesity, and others, the results achieved by following the nutritional plan on HT were significantly lower, close to negligible [13, 14]. In women with comorbidity, all clinical conditions should be addressed in order to achieve an overall health improvement and longer periods of diet modifications should be followed to analyze adequately the beneficial effect of nutrition and supplementation [13].

**Conclusion.** The reported results support the view for the beneficial influence of changes in the nutritional plan, including compensation of nutritional deficiencies, on TSH and FT4 levels in Bulgarian women with Hashimoto's thyroiditis. The research proves the importance of food and nutritional supplements as key determinants of human health that are effective means of prevention, prophylaxis and supporting conventional therapy of autoimmune processes of thyroid gland. On the other hand, participants in the passive group, who did not make any changes to their dietary plan and did not compensate any deficiencies or low serum levels of thyroid-stimulating nutrients over the same period, had a significant increase in TSH levels and decrease of FT4. This result supports the view that Hashimoto's thyroiditis is a chronic autoimmune disease that may progresses over time, unless adequate changes in nutrition are undertaken.

## REFERENCES


[1] Hong N., Y. Lin, Z. Ye et al. (2022) The relationship between dyslipidemia and inflammation among adults in east coast China: A cross-sectional study, Front. Immunol., **13**, 937201, https://doi.org/10.3389/fimmu.2022.937201.

[2] Bursuk E. (2012) Introduction to Thyroid: Anatomy and Functions. In: Thyroid and Parathyroid Diseases – New Insights into Some Old and Some New Issues (ed. L. S. Ward), Rijeka, IntechOpen Publ., (Ch. 1), 17, https://doi.org/10.5772/37942.

[3] Danailova Y., T. Velikova, G. Nikolaev et al. (2022) Nutritional management of thyroiditis of Hashimoto, Int. J. Mol. Sci., **23**, 5144, https://doi.org/10.3390/ijms23095144.

[4] Silva J. E. (2001) The multiple contributions of thyroid hormone to heat production, J. Clin. Invest., **108**, 35–37, https://doi.org/10.1172/JCI13397.

[5] Mezzomo T., J. Nadal (2016) Effect of nutrients and dietary substances on thyroid function and hypothyroidism, Demetra, **11**(2), 427–443, https://doi.org/10.12957/demetra.2016.18304.

[6] Maleki S. J., J. F. Crespo, B. Cabanillas (2019) Anti-inflammatory effects of flavonoids, Food Chem., **299**, 125124.
[7] Granato D., F. J. Barba, D. Bursać Kovačević et al. (2020) Functional foods: product development, technological trends, efficacy testing, and safety, Annu. Rev. Food Sci. Technol., **11**, 93–118, https://doi.org/10.1146/annurev-food-032519-051708.
[8] Gonçalves C. F. L., M. L. de Freitas, A. C. F. Ferreira (2017) Flavonoids, thyroid iodide uptake and thyroid cancer – a review, Int. J. Mol. Sci., **18**(6), 1247, https://doi.org/10.3390/ijms18061247.
[9] Szczuko M., A. Syrenicz, K. Szymkowiak et al. (2022) Doubtful justification of the gluten-free diet in the course of Hashimoto's disease, Nutrients, **14**(9), 1727, https://doi.org/10.3390/nu14091727.
[10] Kim D. (2017) The role of vitamin D in thyroid diseases, Int. J. Mol. Sci., **18**(9), 1949, https://doi.org/10.3390/ijms18091949.
[11] Hu S., M. P. Rayman (2017) Multiple nutritional factors and the risk of Hashimoto's thyroiditis, Thyroid, **27**(5), 597–610, https://doi.org/10.1089/thy.2016.0635.
[12] Harris C. (2012) Thyroid disease and diet-nutrition plays a part in maintaining thyroid health, Todays Diet, **14**, 40.
[13] Ostrowska L., D. Gier, B. Zyśk (2021) The influence of reducing diets on changes in thyroid parameters in women suffering from obesity and Hashimoto's disease, Nutrients, **13**, 862, https://doi.org/10.3390/nu13030862.
[14] Biondi B. (2023) Subclinical hypothyroidism in patients with obesity and metabolic syndrome: a narrative review, Nutrients, **16**, 87, https://doi.org/10.3390/nu16010087.

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