**Medical Science**

**To Cite:**
Zalewska N, Baranowska A, Baranowska K, Czyżewski F, Kawka J, Filipek K, Muciek M, Mrugała W, Skierkowski B, Mrugała S. The role of diet and supplementation in the therapy of Hashimoto's disease: A systematic review. *Medical Science* 2024; 28: e110ms3418
doi: https://doi.org/10.54905/disssi.v28i150.e110ms3418

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**Peer-Review History**
Received: 05 June 2024
Reviewed & Revised: 08/June/2024 to 12/August/2024
Accepted: 16 August 2024
Published: 21 August 2024

**Peer-review Method**
External peer-review was done through double-blind method.

Medical Science
pISSN 2321–7359; eISSN 2321–7367



DISCOVERY
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# The role of diet and supplementation in the therapy of Hashimoto's disease: A systematic review

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## ABSTRACT

*Introduction:* Hashimoto's disease, also known as chronic autoimmune thyroiditis, is a common health problem affecting people worldwide. This review summarizes the latest scientific insights into how dietary factors affect symptom relief and thyroid function in patients with Hashimoto's Disease. *Brief description of the state of knowledge:* During the condition, there is an activation of the immune system and destruction of thyroid tissue, leading to gradual loss of its function and, ultimately, hypothyroidism. Emerging adverse physical and psychological symptoms such as weight gain, fatigue, loss of concentration, and many others significantly impact the quality of life of patients and require continuous medical care. Although pharmacotherapy with levothyroxine plays a crucial role in the therapy of Hashimoto's disease, in recent years, increasing attention has been paid to the role of diet and supplementation. *Conclusion:* Research shows that diet can significantly affect the progression of the disease. Currently, no precise recommendations regarding diet and supplementation are available when treating Hashimoto's disease. The importance of vitamin D, vitamin B12, iodine, selenium, and iron as crucial dietary components is highlighted among patients. However, more research is required on this subject. At present, there is not enough evidence to support the benefits of a gluten-free diet or lactose elimination in the treatment of Hashimoto's disease.

**Keywords:** Hypothyroidism, diet, supplementation, autoimmune thyroiditis

## 1. INTRODUCTION

Hashimoto's thyroiditis (HT), also known as Autoimmune Thyroid Disease (AITD), is the most common cause of hypothyroidism in iodine-sufficient

countries and one of the most common autoimmune diseases (Ralli et al., 2020; Mikulska et al., 2022). It is marked by an enlarged thyroid gland, lymphocytic infiltration and the presence of anti-thyroid antibodies in the blood (Ralli et al., 2020). Japanese surgeon Hakaru Hashimoto named the disease after describing four cases of the condition in 1912. Doctors diagnose the disease more often in women than in men, and its prevalence increases with age (Osowiecka and Myszkowska-Ryciak, 2023; Attard and Vella, 2018). The pathomechanism of the disease involves activation of the immune system and lymphocytic infiltration (mainly T lymphocytes). Several metabolic processes produce anti-thyroid antibodies, which lead to fibrosis and the destruction of glandular tissue. Gradual loss of thyroid function occurs due to fibrosis and atrophy of thyrocytes (Jin et al., 2022).

The condition results in decreased levels of free triiodothyronine (T3) and thyroxine (T4) and an increased level of thyroid-stimulating hormone (TSH) in the blood. Activation of the immune system results in the appearance of antibodies against thyroid peroxidase (TPO-Abs) and thyroglobulin (Tg-Abs) (Osowiecka and Myszkowska-Ryciak, 2023). Anti-TPO antibodies are present in most patients, while anti-Tg antibodies are present in a smaller percentage, making them less reliable in diagnosis (Ralli et al., 2020). Diagnostic procedures include biochemical tests (thyroid antibodies in the blood) and imaging studies (hypoechoic heterogeneous thyroid structure on ultrasonography) (Mikulska et al., 2022). Additionally, laboratory markers characteristic of thyroid dysfunction, such as thyroid-stimulating hormone (TSH) and free thyroxine (fT4), play a role in laboratory diagnostics, specifically their levels in biochemical blood tests.

Patients with Hashimoto's disease present with a range of clinical symptoms, including chronic fatigue, irritability, mood swings, gastrointestinal problems, and cardiovascular issues (Osowiecka and Myszkowska-Ryciak, 2023). Currently, it is considered that genetic factors, environmental factors (including diet) and immunological factors play a vital role in the pathogenesis (Osowiecka and Myszkowska-Ryciak, 2023; Rayman, 2019). Although the precise mechanisms underlying this disease are still subject to intense research, the increasing number of cases in the population suggests a significant influence of external factors on its development. For most patients, lifelong administration of levothyroxine plays a primary role in treatment (Liontiris and Mazokopakis, 2017).

Considering the role of dietary factors in the pathogenesis of the disease, diet and appropriate supplementation of micronutrients in patients with Hashimoto's disease may complement treatment by exerting anti-inflammatory effects and improving thyroid cell function (Osowiecka and Myszkowska-Ryciak, 2023). According to the literature, there is currently discussion about the role of vitamin D, vitamin B12, iodine, selenium, and iron as potential supplements to complement therapy. Additionally, concerns have arisen about the harmful effects of gluten and lactose in patients with AITD. In this study, we will investigate the most recent scientific findings on the effects of vitamin D, vitamin B12, iodine, selenium, and iron on managing Hashimoto's disease. Additionally, we will evaluate how gluten-free and lactose-free diets influence thyroid function in affected patients.

## 2. METHODOLOGY

We reviewed relevant articles by searching PubMed, Google Scholar, and Cochrane databases from 2006 to 2024. We set eligibility criteria based on publication date, keywords, and relevance to the topic. Our search used English phrases including “hypothyroidism”, “Hashimoto's disease”, “lactose”, “gluten”, “diet”, “nutritional intervention”, “iodine”, “iron”, “selenium”, “vitamins” and “supplements”. The authors analyzed the selected articles and presented the findings in the text.

## 3. RESULTS AND DISCUSSION

**Description of Current Knowledge**

Daily diet can significantly influence the development of inflammatory diseases, including autoimmune conditions. Unfortunately, there is insufficient knowledge regarding dietary management in patients with Hashimoto's disease. The lack of specific guidelines leads to often conflicting information from the media and expert opinions. Understanding patients' dietary habits and then modifying certain behaviors is crucial for better treatment results (Mikulska et al., 2022). Additionally, diagnosing potential deficiencies in patients and addressing them with supplements is recommended as part of a specialized dietary intervention (Liontiris and Mazokopakis, 2017). Recent studies recommend a diet rich in micronutrients such as vitamin D, B12, iodine, selenium, and iron. Lately, experts recommend the Mediterranean diet for Hashimoto's disease. It is rich in the elements mentioned above, providing an anti-inflammatory effect and likely improving thyroid function (Duntas, 2023).

It's important to note that patients with AITD often alter their dietary habits based on social media information, without seeking professional guidance. Additionally, many doctors recommend specific supplements and elimination diets, even though their effectiveness has not been fully established. In a 2019 study conducted in the form of an online questionnaire among 150 patients with Hashimoto's disease, researchers found that 67.2% of patients using specialized diets followed a gluten-free diet (GFD), a lactose-free diet (LFD), or both. 62% of respondents who decided to modify their diet did so without specialized advice (Trofimiuk-Muldner et al., 2019). Woźniak et al., (2021) conducted a study using an online questionnaire. The survey involved 232 volunteers diagnosed with hypothyroidism. According to the results, 85% of respondents were taking dietary supplements concerning the disease. Additionally, the respondents identified the Internet as the primary source of information on supplementation and diet (74%), with doctors ranking second (52%) (Woźniak et al., 2021).

**Vitamin D**

The body obtains vitamin D through two mechanisms: From external sources (exogenous) and produced internally (endogenous). The body produces vitamin D endogenously through photochemical reactions when exposed to sunlight, specifically UV radiation (mainly UVB). We acquire vitamin D exogenously through food intake. As a fat-soluble micronutrient, it is primarily found in oily fish (for example, salmon) and fish liver oils (Umar et al., 2018). Additionally, due to the increasing number of people with vitamin D deficiency in recent years, there is growing talk about supplementation of this micronutrient. A serum concentration of 25-hydroxyvitamin D [25(OH)D] below 50 nmol/L or 20 ng/ml indicates a deficiency. Studies show that patients with Hashimoto's disease may have serum vitamin D levels even twice as low as healthy individuals in the population (Włochal et al., 2014).

Vitamin D is primarily associated with its role in bone metabolism and calcium-phosphate homeostasis. In recent decades, researchers have explored the role of vitamin D in autoimmunity, cardiovascular diseases, endocrine disorders, and cancer development. They have shown that vitamin D levels can significantly affect the development and progression of Hashimoto's thyroiditis and Graves' disease (Kim, 2017; Muscogiuri et al., 2015; Plum and DeLuca, 2010). Research indicates that vitamin D affects cell proliferation and differentiation and has an immunomodulatory effect. As a result, it may effectively reduce anti-thyroid antibodies in patients with Hashimoto's disease (Mikulska et al., 2022). Zhang et al., (2021) conducted a meta-analysis of 8 randomized clinical trials (n=652) where they considered the levels of anti-thyroid peroxidase antibodies (TPOAb) and, or anti-thyroglobulin antibodies (TGAb) in patients with HT who received vitamin D supplementation.

The results suggest that vitamin D supplementation for over three months reduces autoantibody levels in patients with HT, whereas treatment with vitamin D for less than three months proved ineffective (Zhang et al., 2021; Tang et al., 2023). A randomized, controlled clinical trial involving patients with newly diagnosed Hashimoto's thyroiditis (TPO-Ab > 34 kIU/L and/or ultrasonographic features of thyroiditis) reached similar conclusions. At the time of diagnosis, 93% of patients had a vitamin D deficiency. After three months of vitamin D and calcium supplementation in the intervention group, a significant reduction in TPO-Ab levels was observed compared to the control group receiving only calcium (Chaudhary et al., 2016).

Another meta-analysis of clinical trials found that while vitamin D significantly reduces anti-thyroid peroxidase antibodies (TPO-Ab), it does not significantly affect the levels of thyroid-stimulating hormone (TSH), free triiodothyronine (FT3), or free thyroxine (FT4). Research may suggest that it is not associated with thyroid function in patients with HT (Jiang et al., 2022). For comparison, a randomized controlled trial from 2023 investigated 100 patients (both male and female, >18 years old) diagnosed with Hashimoto's thyroiditis (elevated thyroid peroxidase antibodies) and vitamin D deficiency (vitamin D < 30 ng/ml). The study lasted twelve months, with the intervention group receiving vitamin D at a dose of 60,000 IU weekly.

Both groups of patients received an empirical dose of levothyroxine. After eight weeks, researchers observed a significant reduction in thyroid antibody levels in the intervention group and a decrease in TSH levels compared to the control group receiving placebo. The findings suggest that supplementation has a beneficial effect on autoimmune thyroiditis. However, considering the empirical dose of levothyroxine taken by both groups, further research and observation are required (Bhakat et al., 2023). The potential benefits of vitamin D supplementation in Hashimoto's disease therapy warrant further research and analysis. There is a lack of knowledge regarding whether vitamin D supplementation can help reduce the dose of levothyroxine and completely replace medication intake in the early stages of the disease.

**Selenium**

Selenium is a micronutrient present in both inorganic compounds (such as selenide and selenate) and organic compounds (such as selenomethionine and selenocysteine). Selenide and selenate are the most common components of dietary supplements. Selenocysteine is primarily found in animal-derived foods, while selenomethionine mainly comes from plant-based foods (such as grains) and selenium-enriched yeast. Organic compounds are known for their better absorption. Although the selenium content in food products varies, it is commonly associated with proteins, such as various fish, meats, and meat by-products, eggs, and seafood. The level of selenium in the body depends on population characteristics, geographical area, diet, and soil composition (Ventura et al., 2017).

The thyroid gland in adult patients has the highest selenium content per gram of tissue. It is a component of selenoproteins, which have antioxidant properties and participate in thyroid hormone metabolism (Sotak, 2018). Selenium treatment is recommended only for mild Graves' orbitopathy. However, endocrinologists often prescribe selenium supplementation for patients with autoimmune thyroiditis (Winther et al., 2020). Scientific literature indicates a reduction in anti-thyroid antibodies, maintenance or reduction of TSH levels, a decrease in the fT4/fT3 ratio, and normalization of thyroid structure and volume in ultrasound in patients with AITD in a euthyroid state or subclinical or overt hypothyroidism (Filipowicz et al., 2021). In a study from 2021 involving 100 patients with Hashimoto's disease, oral administration of 200 μg/day of selenium-enriched yeast for six months they have resulted in a decrease in TGAb and TPOAb antibodies (Wang et al., 2021).

A study with 29 women who had newly diagnosed and untreated Hashimoto's disease found similar results after they received 100 μg/day of sodium selenite for six months. Selenium supplementation for six months effectively reduced the level of anti-thyroid peroxidase antibodies (Kryczyk-Kozioł et al., 2021). The same selenium dose during a 6-month supplementation period in a group of women with newly diagnosed, untreated Hashimoto's disease led to a decrease in interferon-γ and an increase in interleukin-1β. The findings demonstrate a correlation between selenium levels in the body and the production of cytokines involved in the autoimmune process (Kryczyk-Kozioł et al., 2022).

**Vitamin B12**

Thyroid hormones promote erythropoietin production and enhance erythrocyte precursors' proliferation. As a result, patients with hypothyroidism face a higher risk of developing anemia. In patients with Hashimoto's disease, there is also an increased probability of developing other autoimmune diseases, including pernicious anemia or autoimmune gastritis, characterized by vitamin B12 deficiency (Gupta et al., 2023). Vitamin B12 is mainly found in animal-derived products such as meat, dairy products, fish, and eggs (Obeid et al., 2019). Patients newly diagnosed with Hashimoto's disease should have their vitamin B12 levels examined because vitamin B12 deficiency frequently occurs. In a 2023 single-center cross-sectional study of 100 patients with hypothyroidism, 68% had a vitamin B12 deficiency in their serum. Among them, 78.6% had elevated anti-TPO levels, and 78% had elevated anti-Tg levels (Gupta et al., 2023).

A meta-analysis from 2023 reviewed studies on the relationship between vitamin B12 and thyroid diseases. The study found that patients with hypothyroidism had lower levels of vitamin B12 compared to healthy participants. However, the research observed no significant differences in vitamin B12 levels between those with autoimmune thyroid disease and those with subclinical hypothyroidism (Benites-Zapata et al., 2023). Another study showed that vitamin B12 and vitamin D deficiencies are associated with Hashimoto's disease, and there is a negative correlation between vitamin B12 and vitamin D levels and anti-TPO antibody levels (Aktaş, 2020). The effect of vitamin B12 on anti-thyroid antibody levels and the development of AITD still requires more research and observation. However, regular monitoring of vitamin B12 levels in patients newly diagnosed with AITD and during therapy is essential.

**Iodine**

Iodine is a crucial element in the proper functioning of the thyroid gland, playing a role in the production of thyroid hormones: (triiodothyronine (T3) and thyroxine (T4). According to numerous studies, it also affects the process of thyroid autoimmunity (Mikulska et al., 2022). Both excess and deficiency of iodine in the body are associated with increased circulating anti-thyroid antibodies (Rayman, 2019). In Poland, introducing iodized salt in the 20th century effectively reduced the problem of widespread iodine deficiency among the population and improved nutrition status. According to World Health Organization guidelines, adults and children over 12 should consume 150 μg of iodine daily. Fish and seafood are the primary dietary sources of iodine (Ihnatowicz et al.,

2020). As mentioned earlier, both excess and deficiency of iodine can affect the process of thyroid autoimmunity. Iodine deficiency is a known factor causing the presence of goiter and hypothyroidism (Triggiani et al., 2009).

On the other hand, numerous studies indicate that excess iodine can also increase the risk of autoimmunity (Rayman, 2019). The findings have shown that excessive iodine intake is associated with increased thyroid autoimmunity (Ragusa et al., 2019). In patients predisposed to autoimmune diseases, iodine induces lymphocyte infiltration through the influx of cytokines and chemokines within the thyroid gland (Luo et al., 2014). A cohort study conducted in China in three regions (with mild iodine deficiency, moderate iodine deficiency, and excessive iodine consumption) showed the highest percentage of autoimmune thyroiditis in subjects with excessive iodine intake in their diet (Teng et al., 2006).

Additionally, a comparative study conducted on the Greek island of Chios and southwestern continental Greece in 2018 revealed that in euthyroid patients with AITD, the level of anti-thyroid antibodies was higher in individuals with higher iodine intake. Iodine intake was assessed based on urinary iodine concentration (UIC) (Giassa et al., 2018). Furthermore, recent research points to the role of iodine in developing Hashimoto's disease through its influence on gut microbiota. The mechanism remains unclear, but 2024 studies have shown that iodine supplementation changes gut microbiota composition, which may influence the pathogenesis of Hashimoto's disease. However, this topic requires further research (Gong et al., 2024). Doctors recommend strict monitoring of iodine prophylaxis for patients with Hashimoto's disease to prevent both deficiency and excess (Teti et al., 2021).

**Iron**

Another essential micronutrient that requires monitoring in Hashimoto's disease is iron. Thyroid peroxidase, which produces thyroid hormones, is a heme enzyme. Therefore, iron is crucial in the activation process of the enzyme, and its deficiency blocks the synthesis of thyroid hormones (Mikulska et al., 2022). Patients with autoimmune thyroiditis are at a higher risk of developing additional autoimmune conditions, such as celiac disease or autoimmune gastritis. These patients are more prone to iron deficiency due to decreased absorption of this element in autoimmune gastritis and increased iron excretion in celiac disease (Rayman, 2019).

A study from 2022 in women with autoimmune thyroiditis showed a significantly higher prevalence of iron deficiency compared to healthy women. Additionally, the findings found a negative correlation between TPOAb and iron, ferritin, and transferrin saturation levels in the blood (Koç et al., 2022). A 2020 meta-analysis examining the impact of iron deficiency on thyroid function in pregnant women and women of reproductive age found that iron deficiency may significantly increase serum levels of thyroid antibodies, including TPOAb and TgAb. Additionally, pregnant women with iron deficiency were more likely to have higher TSH levels (Luo et al., 2021).

A 2023 meta-analysis investigating the link between iron deficiency and thyroid function reached similar conclusions. Iron deficiency was much more common in individuals with elevated levels of thyroid antibodies in their serum. Also, pregnant women with iron deficiency had lower TSH, fT4, and fT3 levels. Non-pregnant women exhibited low levels of fT4 and fT3, while the serum TSH level was within the normal range (Garofalo et al., 2023). Further research is needed to fully understand the role of iron in thyroid autoimmunity.

**Gluten**

A gluten-free diet primarily involves eliminating grains that contain gluten, such as wheat, rye, barley, and oats (due to frequent contamination of oats with other grains), as well as avoiding beverages or medications that contain gluten (Szczuko et al., 2022). A gluten-free diet belongs to restrictive diets. Patients should be aware of the risk of dietary deficiencies during its use. Research has not demonstrated that this diet is effective in treating AITD; therefore, it is not recommended for routine use among patients (ElKhoury et al., 2018). In a meta-analysis from 2021, the effect of gluten-free and gluten-containing diets on thyroid autoimmunity was investigated. Studies showed that eliminating gluten can lead to nutritional deficiencies due to the low quality of gluten-free products, which may increase the risk of developing Hashimoto's disease (Ihnatowicz et al., 2021).

On the other hand, Krysiak et al., (2019) conducted a study involving 34 women with HT who had not previously taken medications. Group A (n=16) followed a gluten-free diet for six months, while Group B (n=18) followed a diet without restrictions. Research indicated that following a gluten-free diet reduced the levels of thyroid antibodies. Additionally, in patients following the gluten-free diet, the level of 25-hydroxyvitamin D in serum increased. The study's results suggest a beneficial effect of the gluten-free diet on the thyroid autoimmunity process (Krysiak et al., 2019). The researchers did not perform intestinal biopsies on the examined

patients. Therefore, subclinical celiac disease may be present in them. Reviewed the frequency of antibodies associated with celiac disease in patients with Hashimoto's thyroiditis.

Among the 82 patients aged 20-50, women with AITD had higher rates of antibodies against tissue transglutaminase and gliadin than healthy women. This finding justifies conducting tests for celiac disease in patients with Hashimoto's disease and adjusting treatment strategies based on individual patients (Hadizadeh et al., 2017). Additionally, antibodies against tissue transglutaminase may exacerbate thyroid autoimmunity, and a gluten-free diet (GFD), in this case, by reducing antibodies, may contribute to weakening gland autoimmunity (Bascuñán et al., 2020). Pobłocki et al., (2021) conducted a study on 62 Caucasian women diagnosed with AITD. The control group followed a gluten-containing diet, while the research group followed a gluten-free diet.

The researchers observed the subjects for 12 months. After the observation period, no differences in anti-TPO and anti-TG concentrations were observed. In the research group, TSH levels significantly decreased, while fT4 levels increased. Since the patients were treated with levothyroxine, the elimination diet might have improved the absorption of the substance in the intestines. However, this requires further research (Pobłocki et al., 2021). Currently, there is insufficient evidence to justify a gluten-free diet in the therapy of individuals with AITD. The most beneficial effects of gluten elimination appear in individuals with coexisting celiac disease or gluten sensitivity, which can occur alongside Hashimoto's disease (Szczuko et al., 2022).

**Lactose**

According to statistics, a significant portion of patients with Hashimoto's disease have been diagnosed with lactose intolerance (LI). Understanding lactose intolerance is crucial during levothyroxine therapy because it reduces the bioavailability of the medication, necessitating higher doses for patients (Cellini et al., 2014). Patients with lactose intolerance and Hashimoto's disease should follow a lactose-free diet and use a lactose-free levothyroxine preparation. This approach helps prevent the need for higher medication doses and supports the restoration of euthyroid status (Ruchała et al., 2012). Asik et al., (2014) conducted a study on patients with AITD to investigate the prevalence of lactose intolerance and the effect of a lactose-free diet on serum TSH levels. Among the participants, 75.9% were diagnosed with lactose intolerance.

After eight weeks of a lactose-free diet, the TSH level significantly decreased in individuals with LI (euthyroid and subclinical hypothyroidism) compared to lactose-tolerant individuals (Asik et al., 2014). Marabotto et al., (2022) studied 58 women with AITD who also had lactose intolerance and recommended a lactose-free diet. They diagnosed lactose intolerance in 58.6% of the patients. According to the research conducted after 3 and 6 months of the diet, no significant differences were observed in TSH levels or levothyroxine dose modification (Marabotto et al., 2022). Although the topic of a lactose-free diet in Hashimoto's disease therapy requires further research, doctors should perform lactose intolerance tests in patients with AITD and eliminate lactose from their daily diet if necessary (Ihnatowicz et al., 2020).

Hollywood et al., (2023) published a meta-analysis evaluating the impact of the paleolithic diet on thyroid autoimmunity. This diet involves consuming lean meat, fish, seafood, fruits, vegetables, and small amounts of legumes and grains. The diet excludes dairy, processed foods, flour, and canned foods (Challa et al., 2024). Research indicates that the paleo diet might reduce antibody levels and thyroid hormone levels in individuals with Hashimoto's disease and Graves' disease. The studies indicate that, despite the diet's potential effectiveness for patients with AITD, researchers need to conduct more large-scale investigations (Hollywood et al., 2023).

**Table 1** Recent findings in the role of different diet components in Hashimoto's disease.

| Authors, year | Participants | Component | Findings |
|---|---|---|---|
| Chaudhary et al., 2016 | Patients with newly diagnosed Hashimoto's | Vitamin D | Vitamin D supplementation significantly reduced TPO-Ab levels compared to calcium alone. |
| Bhakat et al., 2023 | 100 patients with Hashimoto's and vitamin D deficiency | Vitamin D | Vitamin D supplementation reduced thyroid antibodies and TSH levels compared to placebo. |
| Wang et al., 2021 | 100 patients with Hashimoto's | Selenium | Selenium supplementation reduced TG-Ab and TPO-Ab levels. |

| | | | |
|---|---|---|---|
| Gupta et al., 2023 | 100 hypothyroid patients | Vitamin B12 | 68% had vitamin B12 deficiency; higher TPO-Ab and TG-Ab levels in those deficient. |
| Kryczyk-Kozioł et al., 2021 | 29 women with newly diagnosed Hashimoto's | Selenium | Selenium supplementation reduced anti-thyroid antibodies and influenced cytokine production. |
| Asik et al., 2014 | Patients with AITD | Lactose | 75.9% had lactose intolerance; lactose-free diet significantly reduced TSH levels. |
| Pobłocki et al., 2021 | 62 women with AITD | Gluten | No significant differences in TPO-Ab and TG-Ab levels; gluten-free diet led to better absorption of levothyroxine. |
| Teng et al., 2006 | Cohort study in China | Iodine | Highest percentage of autoimmune thyroiditis in regions with excessive iodine intake. |
| Giassa et al., 2018 | Comparative study in Greece | Iodine | Higher anti-thyroid antibody levels in individuals with higher iodine intake. |
| Gong et al., 2024 | Study on iodine supplementation and gut microbiota | Iodine | Iodine alters gut microbiota composition, potentially affecting Hashimoto's disease pathogenesis. |
| Zhang et al., 2021 | Meta-analysis of 8 randomized clinical trials (n=652) | Vitamin D | Vitamin D supplementation for over three months reduces autoantibody levels in patients with HT. |
| Krysiak et al., 2019 | 34 women with HT | Gluten | Gluten-free diet lowered thyroid antibody titer and increased 25-hydroxyvitamin D levels in serum. |
| Marabotto et al., 2022 | 58 women with AITD and LI | Lactose | No significant differences in TSH levels or levothyroxine dose modification after 3 and 6 months of lactose-free diet. |
| Ventura et al., 2017 | Study on selenium's role in thyroid hormone metabolism | Selenium | Selenium is crucial for thyroid hormone metabolism; supplementation reduces in anti-thyroid antibodies. |
| Filipowicz et al., 2021 | Review of selenium treatment in autoimmune thyroid diseases | Selenium | Selenium supplementation may reduce anti-thyroid antibodies and help maintain thyroid function. |
| Luo et al., 2021 | Meta-analysis on iron deficiency and thyroid function in pregnant women and women of reproductive age | Iron | Iron deficiency may increase thyroid antibodies and affect thyroid function in pregnant and non-pregnant women. |
| Garofalo et al., 2023 | Meta-analysis on iron deficiency and thyroid function | Iron | Iron deficiency linked to elevated thyroid antibodies and altered thyroid function, particularly in pregnant women. |
| Hollywood et al., 2023 | Meta-analysis on paleolithic diet | Paleolithic diet | Suggests potential reduction in antibody and thyroid hormone levels in AITD patients, but more research needed. |

*Table 1 – TPO-Ab - Thyroid Peroxidase Antibodies, TSH - Thyroid Stimulating Hormone, TG-Ab - Thyroglobulin Antibodies, AITD - Autoimmune Thyroid Disease, HT - Hashimoto's Thyroiditis, LI - Lactose Intolerance*

## 4. CONCLUSION

Research shows that environmental factors significantly impact the development and progression of Hashimoto's disease by affecting the immune system and thyroid autoimmunity. Daily diet is crucial among these factors as it can greatly influence the disease's course. No precise guidelines exist for nutrition and supplementation in patients with Hashimoto's disease. However, doctors recommend an anti-inflammatory diet rich in minerals and vitamins for those undergoing treatment for Hashimoto's thyroiditis (HT). When selecting the appropriate diet and supplementation, experts should pay attention to other conditions, such as celiac disease, lactose intolerance, pernicious anemia, or atrophic gastritis.

Additionally, during HT therapy, doctors recommend regular measurements of vitamin D, vitamin B12, iodine, selenium, and iron levels. Strict control of iodine prophylaxis is also crucial due to the adverse effects of both iodine deficiency and excess on thyroid autoimmunity. Gluten-free and lactose-free diets are not recommended for all patients with autoimmune thyroid diseases (AITD) because there is insufficient evidence supporting their benefits in treating HT. This topic requires further analysis and collaboration between endocrinologists and dietitians. Further large-scale studies are needed to evaluate the role of diet and supplementation in the treatment of Hashimoto's disease.

**Author's Contribution**

Conceptualization: Natalia Zalewska; Methodology: Alicja Baranowska, Natalia Zalewska; Software: Jakub Kawka; Check: Natalia Zalewska; Investigation: Natalia Zalewska, Alicja Baranowska, Filip Czyżewski, Kinga Filipek, Waldemar Mrugała, Sebastian Mrugała, Bartosz Skierkowski, Michał Muciek, Katarzyna Baranowska; Resources: Natalia Zalewska, Alicja Baranowska, Kinga Filipek, Filip Czyżewski, Waldemar Mrugała, Sebastian Mrugała, Bartosz Skierkowski, Michał Muciek, Katarzyna Baranowska; Writing – Rough Preparation: Alicja Baranowska, Katarzyna Baranowska, Kinga Filipek; Writing – Review and Editing: Natalia Zalewska; Visualization: Jakub Kawka, Filip Czyżewski, Michał Muciek; Supervision: Bartosz Skierkowski, Waldemar Mrugała, Sebastian Mrugała, Michał Muciek; Project Administrator: Natalia Zalewska.
All authors have approved the submission of the manuscript.

**Acknowledgments**

None.

**Ethical approval**

Not applicable.

**Funding**

This study has not received any external funding.

**Conflict of interest**

The authors declare that there is no conflict of interests.

**Data and materials availability**

All data sets collected during this study are available upon reasonable request from the corresponding author.

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