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Evaluation of vitamin D status and its effectiveness among patients with Hashimoto's thyroiditis in Basrah city of Iraq

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Abstract
Background: Vitamin D plays a crucial role in immune regulation and hormonal functions, with its deficiency linked to the development of autoimmune diseases, including Hashimoto's thyroiditis.
Aims of the study: Evaluate Vitamin D levels among patients with Hashimoto's thyroiditis in Basrah City, Iraq, and assess its impact on disease progression and treatment response.
Methodology: This case-control study was conducted at Faiha Specialized Diabetes, Endocrine and Metabolism Center, Basrah, in 2024 to assess the relationship between vitamin D, TSH, and anti-TPO Ab in Hashimoto's thyroiditis patients. Sixty-two patients and 62 controls were included. Patients with low vitamin D received supplementation or no treatment. Blood samples were analyzed using ECLIA before and after an 8-week intervention.
Result: Clinical characteristics of 62 Hashimoto's patients and 62 controls showed no significant differences in age, BMI, gender, or smoking. Vitamin D levels were significantly lower in Hashimoto's patients (15.1±0.3 ng/mL) vs. controls (36.4±0.6 ng/mL, $p<0.001$). After eight weeks, vitamin D supplementation significantly increased 25(OH)D levels ($p<0.001$) and reduced TSH (23.4±2.9 to 6.3±0.98 µIU/mL, $p<0.001$) and anti-TPO Ab (302.9±34.1 to 198.6±28.3 IU/mL, p=0.005). Non-supplemented patients showed minimal anti-TPO Ab reduction (p=0.246).
Conclusions: Vitamin D supplementation significantly improved serum 25(OH)D levels, reduced TSH, and lowered anti-TPO Ab in Hashimoto's patients. This suggests that vitamin D modulates immune responses, reducing thyroid autoimmunity by suppressing inflammatory cytokines and regulating T-regulatory cell function, potentially improving disease outcomes.

Keywords: Vitamin D supplementation, Hashimoto's thyroiditis, thyroid autoimmunity, T-regulatory cells, Inflammatory cytokines, anti-TPO antibodies

Introduction

It is an autoimmune disease, which together with Graves' disease represents examples of autoimmune diseases specifically affecting thyroid gland tissue [1]. First described in 1912 by Hakaru Hashimoto, a Japanese physician, as an autoimmune disease characterized by chronic leucocytic (lymphocytic) infiltration of the thyroid gland associated with destructive effects. The chronic infiltration of the gland with lymphocytes is the main characteristic and appears on ultrasound as moth-eaten [2]. The pathophysiology of Hashimoto's thyroiditis (HT) is attributed to intrathyroidal infiltration of both B and T lymphocytes, the most important is CD4+ Th1, with antithyroid antibodies production. This produces a chronic inflammatory process within the thyroid gland which leads to fibrosis and atrophy of the gland. There are various states of thyroid function includes; subclinical hypothyroidism, euthyroid state and overt hypothyroidism [3]. The next step in the disease process is the breakdown of immune tolerance both central and peripheral. Immune tolerance breakdown occurs as a result of a lack of certain types of lymphocytes called regulatory T cells which are responsible for the inhibition of exaggerated immune response. Subsequently, CD8+ lymphocytes are activated together with activation of B lymphocytes which eventually convert to plasma cells that produce antibodies against thyroid gland antigens mainly thyroid peroxidase (TPO), thyroglobulin (Tg) and the thyroid stimulating hormone (TSH) receptor. Th1 lymphocytes represent the largest cellular contribution in the pathogenesis and are

associated with cell-mediated response. It can produce various cytokines that activate macrophages .Th2 cells associated with humeral-mediated response, it can stimulate B lymphocytes for antibody production. Anti-TPO antibodies are considered a sensitive marker in the immune process and are found in all patients while anti-Tg antibodies is a less significant determinant. Thyroid gland destruction and fibrosis represent the final stage in the disease process which is the result of extensive infiltration of T and B lymphocytes with macrophages [4]. A variety of thyroid disorders including hyperthyroidism, hypothyroidism and goiter were mentioned in different studies, with variation in the prevalence of different forms of thyroid disorders among the studies [5]. Information about the epidemiology of thyroid disorders is scanty in the Middle East region. Through an observational study of the retrieved databases in a tertiary center in Basrah including all men and non-pregnant women ≥ 18 years old, it was found that the prevalence of hypothyroidism was twice that of hyperthyroidism (12.5% vs 6.1%) respectively. Also, thyroid nodularity was observed in 5.2% of patients and thyroid cancer in 0.4% [6]. The prevalence of Hashimoto's thyroiditis ranges from 0.9-7.9% in men to 4.8-25.8% in women (about four-fold higher in adult females). A significant variation of the prevalence was found depending on socioeconomic status and geographical location with the highest prevalence in Africa, in countries with low and middle income. The prevalence was found to be as high as 22.8% in Tunisia, 18.8% in Denmark and as low as 0.1% in South Korea and 0.4% in Russia [7]. Vitamin D is a fat-soluble vitamin that has a crucial role in the metabolism of calcium and phosphate thus maintaining normal development of the bone, through its action in the enhancement of calcium intestinal absorption and mobilization from the bone by stimulation of osteoclasts activity [8]. In addition to that, it has an important role in the modulation of immune function and its deficient state has been studied concerning many health problems including autoimmune diseases [9]. Calcitriol which is the active metabolite of the vitamin can positively affect insulin secretion and action, and has a role in blood pressure regulation through its effect on renin and modulate the inflammatory response combining atherosclerosis [10]. In adults, several risk factors have been recognized to be involved in the etiology of vitamin D deficiency: female sex especially those with certain clothing styles (concealed style), multi-parity, socio-economic status, residency in urban areas and advanced age. While delayed weaning with the absence of vitamin D intake was recognized as the main risk factor in children [11]. Vitamin D deficiency is higher in winter than in other seasons, this gives a clue that the season of sampling is an important risk factor in developing vitamin D deficiency [12]. Daily exposure to sunlight is crucial in the process of cutaneous synthesis of vitamin D. Practicing indoor occupation was one the risk factor which implicated in the development of vitamin D deficiency [13]. Women during pregnancy manifested an extremely high prevalence of vitamin D deficiency which is associated with adverse outcomes. The main risk factors were: a reduced level of physical activity, high body mass index, low sunlight exposure and vitamin D intake [14]. Vitamin D is one of the most important subjects in research. Vitamin D deficiency was found to have a negative influence not only on bone health but also has a role in the development of many other diseases including cardiovascular diseases, cancer and autoimmune diseases [15]. The finding of inverse relationship between levels of vitamin D and anti-thyroid antibodies levels by Unal *et al*. suggested a potential role of vitamin D deficiency in the development of the autoimmune disease of the thyroid gland [16]. Similarly, the contribution of vitamin D deficiency in the pathogenesis of autoimmune thyroid diseases (AITD) and the advisability of vitamin D supplementation had been suggested by Kivity *et al*. [17]. Furthermore, a positive correlation was found by Bozkurt *et al*. between the severity of vitamin D deficiency and the disease duration and anti-thyroid antibody levels [18]. The association between Hashimoto's thyroiditis and hypovitaminosis D has been investigated in many studies, some studies revealed a positive association while others did not. According to Taheriniya *et al*., vitamin D levels were lower among patients with Hashimoto's thyroiditis compared with healthy individuals [19]. The prevalence of Hashimoto's thyroiditis was twice among those with vitamin D level of < 20 ng/mL with a significant difference in the mean level of vitamin D between patients and controls (71.1% vs 51.9%) respectively. This pointed to the presence of an association between low vitamin D levels and Hashimoto's thyroiditis disease [20]. Differences in the relationship between Hashimoto's thyroiditis and the level of vitamin D are still unresolved and it remains unclear whether vitamin D deficiency is the consequence of the disease process or is implicated in its etiology. A similar concentration of vitamin D was demonstrated in both Hashimoto's thyroiditis patients and controls and this brought attention to the absence of a relationship between vitamin D deficiency and the occurrence of Hashimoto's thyroiditis +. Likewise, there was no significant difference in the mean level of vitamin D among Hashimoto's thyroiditis patients and their controls whom matched them for the season of blood sampling and in all stages of the disease (mild and severe cases). This might exclude any association between vitamin D deficiency which is widely spread among all study participants and Hashimoto's thyroiditis disease. However, a significant difference in the level of vitamin D was found between the mild and the severe groups which might suggest an association between vitamin D level and the severity of the disease [22]. The aim of the study was assess vitamin D status in patients with Hashimoto's thyroiditis in Basrah City, Iraq, and evaluate its effect on disease progression and treatment outcomes.

Methodology

This study is a case-control interventional research conducted at the Faiha Specialized Diabetes, Endocrine and Metabolism Center in Basrah, Iraq, from January to December 2024. It aimed to assess the relationship between vitamin D levels, thyroid stimulating hormone (TSH), and anti-thyroid peroxidase antibody (anti-TPO Ab) levels in patients with Hashimoto's thyroiditis. The study population consisted of 62 patients diagnosed with Hashimoto's thyroiditis and 62 healthy controls, matched for age, gender, smoking status, BMI, and sampling season. Patients with Hashimoto's thyroiditis were included based on criteria of TSH levels greater than 10 µIU/mL and positive anti-TPO Ab. Exclusion criteria included individuals on medications that may interfere with vitamin D or thyroid hormone levels (such as corticosteroids, anticonvulsants, and anti-tuberculosis drugs), those with chronic diseases like

liver/kidney disease, diabetes, or hypertension, and pregnant or lactating women. Informed consent was obtained from all participants, and the study was approved by the relevant ethical committees. The diagnosis of Hashimoto's thyroiditis was established previously and the patients were kept on 1.6 µg/kg/day of thyroxin at the time of participating in the study. Clinical assessments were conducted by a consultant endocrinologist, and BMI was calculated according to WHO standards. The study was designed to compare Hashimoto's thyroiditis patients' levels of vitamin D, TSH, and anti-TPO Ab with those of healthy controls. Patients with low vitamin D levels (25(OH)D < 20 ng/mL) were divided into two groups: one group received vitamin D supplementation (Cholecalciferol 50,000 IU per week for 8 weeks), while the other group did not. Blood samples were collected from all participants at baseline and after 8 weeks of intervention, with serum analysis for vitamin D, TSH, and anti-TPO Ab. The biochemical assessments were conducted using Electrochemiluminescence Immunoassay (ECLIA) on the Cobas e411 Immunoanalyzer.

Statistical analysis

Statistical analysis was performed using SPSS software, with a p-value of less than 0.05 considered significant. Independent sample t-tests were used to assess baseline differences in 25(OH)D, TSH, and anti-TPO Ab levels between the Hashimoto's thyroiditis patients and healthy controls. Paired t-tests were utilized to compare the changes in these markers before and after vitamin D supplementation within both groups. Categorical data were analyzed using chi-square and Fisher's exact tests. Data are expressed as mean±Standard Error, number and proportion of participants. This study aimed to investigate the effects of vitamin D supplementation on thyroid function and immune markers in patients with Hashimoto's thyroiditis.

Ethical approval

An approval from research ethics committee/institute review board, in addition to, an approval from the Basrah health directorate was obtained. Everyone who took part in the study was told about it and asked to sign a consent form. The patient was also guaranteed that his information would be kept private.

Results

Demographic characteristics of Hashimoto's thyroiditis patients and their healthy controls.

Clinical characteristics were compared between Hashimoto's disease patients and healthy controls (n=62 each). The results showed no significant differences in mean age (38.2±1.5 years vs. 39±1.6 years, p=0.721) or body mass index (32.3±0.9 kg/m² vs. 31.9±0.8 kg/m², p=0.736). Regarding gender, 90% of participants were female in both groups, while the percentage was 10% male in each. No significant differences were found in smoking status, with 95% of participants being non-smokers in both groups. Regarding the sampling season, the highest proportion of Hashimoto's disease patients was taken in the summer (38.7%), while the lowest was in the fall. Regarding vitamin D supplementation, 50% of Hashimoto's patients were receiving supplements, while none of the healthy controls were receiving vitamin D supplements (p<0.0001).

Table 1: Demographic characteristics of Hashimoto's thyroiditis patients and their healthy controls

Characteristics		Hashimoto's thyroiditis patients (n=62)	Healthy controls (n=62)	*P* value
Age (years)		38.2±1.5	39±1.6	0.721
Gender	Male	6 (10%)	6 (10%)	1
	Female	56 (90%)	56 (90%)	
BMI (Kg/m^2)		32.3±0.9	31.9±0.8	0.736
	Normal 18.5-24.9	10 (16%)	8 (12.9%)	0.742
	Overweight 25-29.9	11 (17.7%)	14 (22.5%)	
	Obese ≥30	41 (66.1%)	40 (64.5%)	
Smoking status	Smokers	3 (5%)	3 (5%)	1
	Non-smokers	59 (95%)	59 (95%)	
Season of sampling	Winter	17 (27.4%)	20 (32.3%)	0.462
	Spring	14 (22.5%)	12 (19.4%)	
	Summer	24 (38.7%)	18 (29%)	
	Autumn	7 (11.3%)	12 (19.4%)	
Vitamin D supplementation	Yes	31 (50%)	0	<0.0001*
	No	31 (50%)	62 (100%)	

Data are expressed as mean ± SE and number of patients (proportion).
*A statistically significant difference between patients and healthy controls. P value < 0.05

Baseline laboratory parameters of Hashimoto's thyroiditis patients and their healthy controls.

Baseline laboratory parameters were compared between Hashimoto's disease patients and healthy controls (n=62 each). The results showed that vitamin D (25(OH)D) levels were significantly lower in Hashimoto's disease patients (15.1±0.3 ng/mL) compared to healthy controls (36.4±0.6 ng/mL), with a significant difference (p<0.001). Thyroid-stimulating hormone (TSH) levels were also significantly higher in Hashimoto's disease patients (27.8±2.9 µIU/mL) compared to healthy controls (2.6±0.1 µIU/mL), with a significant difference (p<0.001). As for the levels of thyroid peroxidase antibodies (Anti-TPO Ab), they were significantly elevated in Hashimoto's patients (358.7±26.6 IU/mL) compared to healthy controls (12.2±0.8 IU/mL), with a significant difference (p<0.001).

Table 2: Baseline laboratory parameters of Hashimoto's thyroiditis patients and their healthy controls.

Parameters	Hashimoto's thyroiditis patients (n=62)	Healthy controls (n=62)	*P* value
25 (OH)D ng/mL	15.1±0.3	36.4±0.6	<0.001
TSH (µIU/mL)	27.8±2.9	2.6±0.1	<0.001
Anti-TPO Ab (IU/mL)	358.7±26.6	12.2±0.8	<0.001

Data are expressed as mean ± SE and number of patients (proportion).

Demographic and laboratory Characteristics of Hashimoto's thyroiditis patients at baseline.

Demographic and laboratory characteristics of Hashimoto's disease patients at baseline were compared between the group of patients treated with vitamin D (n=31) and those not treated with vitamin D (n=31). The results showed that the mean age was similar between the two groups (37±2.1 years vs. 39±2.2 years, p=0.432). The male-to-female ratio was also equal in the two groups (10% male and 90% female, p=1.000). Regarding body mass index (BMI), the result was slightly higher in the group of patients treated with vitamin D (33.8±1.1 kg/m²) compared to those not treated (30.8±1.4 kg/m²), but there was no significant difference (p=0.083). Vitamin D (25(OH)D) levels were also similar in both groups (14.9±0.5 ng/mL vs. 15.2±0.5 ng/mL, p=0.644). TSH results showed slight differences between the two groups (23.4±2.9 µIU/mL vs. 32.2±5.1 µIU/mL, p=0.140). However, anti-thyroid peroxidase antibody (anti-TPO Ab) levels were significantly lower in patients treated with vitamin D (302±34.1 IU/mL) compared to those not treated (414.4±38.9 IU/mL, p=0.035).

Table 3: Demographic and laboratory characteristics of Hashimoto's thyroiditis patients at baseline.

Characteristics		Hashimoto's thyroiditis patients (n=62)		*P* value
		Vitamin D-treated HT patients (n=31)	Vitamin D non-treated HT patients (n=31)	
Age (years)		37±2.1	39±2.2	0.432
Gender	Male	3 (10%)	3 (10%)	1.000
	Female	28 (90%)	28 (90%)	
BMI (Kg/m^2)		33.8±1.1	30.8±1.4	0.083
25(OH)D (ng/mL)		14.9±0.5	15.2±0.5	0.644
TSH (µIU/mL)		23.4±2.9	32.2±5.1	0.140
Anti-TPO Ab (IU/mL)		302±34.1	414.4±38.9	0.035

Data are expressed as mean ± SE and number of patients (proportion).

Measurement of serum 25(OH)D level in Hashimoto's thyroiditis patients, eight weeks after initiation of vitamin D supplementation compared to their baseline level.

Serum 25(OH)D levels were measured in Hashimoto's disease patients eight weeks after starting vitamin D supplementation compared to baseline levels. The results showed that patients treated with vitamin D experienced a significant increase in 25(OH)D levels from 14.9±0.5 ng/mL at baseline to 34.1±0.7 ng/mL after eight weeks (p<0.001). In contrast, there was no significant change in 25(OH)D levels in patients not treated with vitamin D, remaining unchanged at 15.2±0.5 ng/mL at baseline and 15.2±0.4 ng/mL after eight weeks (p=0.820). When comparing the two groups, there were significant differences in 25(OH)D levels after eight weeks (p<0.001), while there were no significant differences at baseline (p=0.644).

Table 4: Measurement of serum 25(OH)D level in Hashimoto's thyroiditis patients, eight weeks after initiation of vitamin D supplementation compared to their baseline level.

Hashimoto's thyroiditis patients (n=62)	Serum level of 25(OH)D (ng/mL)		*P* value (within the same group)
	At baseline	Eight weeks after starting vitamin D supplementation	
Vitamin D-treated HT patients (n=31)	14.9±0.5	34.1±0.7	<0.001
Vitamin D non-treated HT patients (n=31)	15.2±0.5	15.2±0.4	0.820
P value (between the two group)	0.644	<0.001	

Data are expressed as mean ± SE.

Laboratory parameters (TSH and anti-TPO Ab) measurement in Hashimoto's thyroiditis patients, eight weeks after initiation of vitamin D supplementation compared to their baseline level.

Laboratory parameters (TSH and anti-TPO Ab) were measured in Hashimoto's patients eight weeks after initiating vitamin D supplementation compared to baseline levels. The results showed that patients treated with vitamin D experienced a significant decrease in TSH levels from 23.4±2.9 µIU/mL to 6.3±0.98 µIU/mL, reflecting a 73% reduction (p<0.001). Anti-TPO Ab levels also decreased from 302.95±34.1 IU/mL to 198.6±28.3 IU/mL, a 34% reduction (p=0.005). In patients not treated with vitamin D, TSH levels decreased from 32.2±5.1 µIU/mL to 11.3±3.5 µIU/mL, reflecting a 65% decrease (p<0.001), while Anti-TPO Ab levels decreased slightly from 414.4±38.91 IU/mL to 386.8±40.5 IU/mL, representing a 7% decrease (p=0.246).

Table 5: Laboratory parameters (TSH and anti-TPO Ab) measurement in Hashimoto's thyroiditis patients, eight weeks after initiation of vitamin D supplementation compared to their baseline level.

HT patients (n=62)	Laboratory parameters	At baseline	After eight weeks	Percent reduction	*P* value
Vitamin D-treated HT patients (n=31)	TSH (μIU/mL)	23.4±2.9	6.3±0.98	73%	<0.001
	Anti-TPO Ab (IU/mL)	302.95±34.1	198.6±28.3	34%	0.005
Vitamin D non-treated HT patients (n=31)	TSH (μIU/mL)	32.2±5.1	11.3±3.5	65%	<0.001
	Anti-TPO Ab (IU/mL)	414.4±38.91	386.8±40.5	7%	0.246

Data are expressed as mean ± SE and percentage.

Effect of eight weeks of vitamin D supplementation on serum level of TSH and anti-TPO Ab in vitamin D-treated Hashimoto's thyroiditis patients compared to vitamin D non-treated Hashimoto's thyroiditis patients.

Results of measuring serum anti-TPO Ab and TSH levels in Hashimoto's disease patients treated with vitamin D compared to those not treated with vitamin D after eight weeks of treatment showed a significant difference in anti-TPO Ab levels between the two groups. Anti-TPO Ab levels in patients receiving vitamin D supplements were 198.6±28.3 IU/mL, compared to 386.8±40.5 IU/mL in patients not treated with vitamin D (p<0.001). As for TSH levels, there was no significant difference between the two groups, with TSH levels in patients receiving supplements being 6.3±0.98 μIU/mL, compared to 11.3±3.5 μIU/mL in untreated patients (p=0.170).

Table 6: Effect of eight weeks vitamin D supplementation on serum level of anti-TPO Ab and TSH in vitamin D-treated Hashimoto's thyroiditis patients compared to vitamin D non-treated Hashimoto's thyroiditis patients.

Serum level at eight weeks	Hashimoto's thyroiditis patients (n=62)		*P* value
	Vitamin D-treated HT patients (n=31)	Vitamin D non-treated HT patients (n=31)	
TSH (μIU/mL)	6.3±0.98	11.3±3.5	0.170
Anti-TPO Ab (IU/mL)	198.6±28.3	386.8±40.5	<0.001

Data are expressed as mean ± SE.

Discussion

This study assessed baseline vitamin D levels in 62 patients with Hashimoto's thyroiditis and 62 healthy controls from Basrah. Vitamin D deficiency was defined as a level < 20 ng/mL, while sufficiency was > 30 ng/mL. The mean vitamin D level in Hashimoto's thyroiditis patients was 15.1±0.3 ng/mL, significantly lower than the control group's mean of 36.4±0.6 ng/mL. While some studies, including this one, suggest an association between low vitamin D levels and Hashimoto's thyroiditis, others have shown conflicting results. Taheriniya *et al*. found lower vitamin D levels in Hashimoto's thyroiditis patients compared to healthy individuals [19], while Botelho *et al*. observed no such association [21]. Studies like Bozkurt *et al*. suggest that vitamin D may play a role in Hashimoto's thyroiditis progression by correlating with anti-TPO and anti-Tg antibodies and Mansournia *et al*. found that increased vitamin D levels could reduce the risk of Hashimoto's thyroiditis [18, 23]. However, it has been proposed that vitamin D deficiency in autoimmune diseases is a result of chronic infection causing vitamin D receptor dysfunction, rather than the cause of the disease [24]. In our study, the vitamin D-treated group showed a 34% reduction in anti-TPO Ab levels after 8 weeks of supplementation, while the non-treated group only showed a 7% reduction. This significant difference highlights the impact of vitamin D supplementation on improving autoimmune aspects of Hashimoto's thyroiditis. Previous studies by Bhakat *et al*. and Chaudhary *et al*. support this finding, showing similar reductions in anti-thyroid antibodies with vitamin D treatment [25, 26]. Further studies, such as those by Jiang *et al*. and Tang *et al*., confirm that vitamin D supplementation reduces anti-TPO Ab and Tg Ab levels [27, 28]. However, a trial in Isfahan found no significant change despite adequate vitamin D levels, and Knutsen *et al*. also observed no significant change in anti-TPO Ab levels despite increased vitamin D [29, 30]. Calcitriol, the active form of vitamin D, showed the most significant reduction in anti-TPO Ab levels when supplemented for more than 12 weeks. Vitamin D suppresses immune responses by reducing cytokine production, inhibiting T cell activation, and decreasing antibody production [28, 31]. A serum vitamin D level >50 ng/mL is necessary for maintaining optimal thyroid function, with supplementation shown to reduce hypothyroidism from 2% to 0.4% [32]. Chahardoli *et al*. found that 12 weeks of 50,000 IU vitamin D supplementation significantly impacted Tg Ab and TSH levels, suggesting vitamin D's role in reducing disease activity [33]. Vitamin D receptors mimic TSH receptors, and by binding to these sites, vitamin D regulates TSH secretion and inhibits thyrocyte growth, influencing thyroid function [34]. Zhang *et al*. and Chailurkit *et al*. found a negative association between vitamin D levels and TSH in different age groups, while Mackawy *et al*. linked hypothyroidism severity with vitamin D deficiency [35-37]. In our study, both vitamin D-treated and non-treated Hashimoto's thyroiditis patients showed a reduction in TSH levels after 8 weeks, but no significant difference between the groups suggests that vitamin D may not significantly alter TSH levels. These results align with studies by Jiang *et al*., VahabiAnaraki *et al*., and Knutsen *et al*., where vitamin D supplementation did not change thyroid function in Hashimoto's thyroiditis patients [27, 29, 30]. A systemic review also found no significant association between vitamin D and thyroid function, indicating that the effect may depend on baseline vitamin D levels, thyroid function, and medications used [34]. Thus, while vitamin D deficiency is linked to Hashimoto's thyroiditis, it primarily affects thyroid autoimmunity rather than TSH levels.

Conclusion

Vitamin D supplementation significantly increased serum 25(OH)D levels, reduced TSH, and lowered anti-TPO Ab in Hashimoto's patients, suggesting its role in modulating immune responses. Vitamin D inhibits T cell activation, suppresses cytokines production, and reduces autoantibody

production, thereby decreasing thyroid autoimmunity. The significant reduction in TSH and anti-TPO Ab levels in supplemented patients indicates improved thyroid function and reduced autoimmune activity. These findings highlight vitamin D's potential as an adjunct therapy for Hashimoto's thyroiditis.

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