Med. J. Cairo Univ., Vol. 92, No. 3, Accepted 28/5/2024
DOI: 10.22608/MJCU. 979-987, September 2024
www.medicaljournalofcairouniversity.net

Association between Vitamin D, Thyroid Hormones, Calcium, Anti-TPO and TSH Receptor Antibodies in Hypothyroid Patients

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Abstract

Background: Vitamin D deficiency is a worldwide health issue. There have been reports linking its insufficiency to a number of illnesses. The correlation between low levels of vitamin D and thyroid disease is a subject of debate.

Aim of Study: To investigate the association between vitamin D levels, thyroid hormones, calcium, anti-TPO and TSH receptor antibodiesin hypothyroid patients.

Material and Methods: A retrospective investigation was carried out. We examined the medical records of individuals who attended the Endocrinology Department of Nahda policlinic between November 2023 and April 2024. We collected information on the age, gender, BMI, calcium levels, fT4 levels, thyroid-stimulating hormone (TSH) levels, TSH receptor antibodies (TSHR-Ab) and thyroid peroxidase antibodies (TPO-Ab) as well as the patients' vitamin D levels and prevalence of vitamin D insufficiency. The SPSS program version 21 was used to perform the analysis.

Results: Our study sample comprised of 36 hypothyroid patients and 36 control group with approximately 50% males and 50% females in each group. There are significant differences in free T3 levels between patients and controls, both in terms of gender and age. A significant age-based differences in vitamin D levels among both patients and controls, with individuals less than 40 years old having higher levels compared to those more than 40 years old. However, no significant gender-based differences are observed in vitamin D levels among both patients and controls. Conversely, there was a strong negative correlation between the levels of vitamin D and TSH and free T3 and TSH receptor antibodies as well as anti-TPO.

Conclusion: This study suggests a strong correlation between the studied biochemical factors and vitamin D levels. The positive correlations with free T4, and calcium indicate that higher levels of vitamin D are associated with increased levels of these biochemical markers. Conversely, the negative correlations with TSH and free T3 and anti-TPO and TSH receptor antibodies suggest that higher levels of vitamin D are associated with decreased levels of these biochemical markers. Overall, these findings highlight the potential influence of vitamin D on thyroid function, autoimmune responses, and calcium metabolism.

Key Words: *Association – Vitamin D – Deficiency – Hypothyroidism.*

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Introduction

REDUCED levels of thyroxin in the blood are the characteristic of the endocrine condition hypothyroidism, which may cause a wide range of clinical manifestations, from minor symptoms to serious, potentially fatal problems **[1,2]**. Together with their unattached forms, free T4 (fT4) and free T3 (fT3), the two primary thyroid hormones found in the circulation are thyroxine (Total T4) and triiodothyronine (Total T3) **[3]**. Through a negative feedback mechanism, the hypothalamus-pituitary-thyroid axis closely regulates blood levels **[4]**. People who have primary overt hypothyroidism often have lower blood levels of fT4 and higher amounts of thyroid stimulating hormone (TSH) **[1,5]**. Subclinical hypothyroidism is one of the numerous hidden conditions among the many others. Normal total T4 levels are the hallmark of this condition, whereas slightly increased TSH levels are also present **[6]**.According to the National Health and Nutrition Examination Survey (NHANES III), conducted in the US between 1988 and 1994, 4.6% of people had hypothyroidism overall. Out of these people, 4.3% have subclinical hypothyroidism and 0.3% have overt hypothyroidism **[7]**. Iodine deficiency-induced hypothyroidism is common in locations with iodine-deficient soil, especially in hilly and mountainous areas. In areas with adequate iodine levels, hypothyroidism is mostly caused by Hashimoto's thyroiditis.

Vitamin D is a fat-soluble vitamin. Within the body, it is often converted into an active hormone known as calcitriol or 1,25-dihydroxycholecalcif-

erol. This conversion takes place via two hydroxylation processes: First in the liver, where it is converted into calcidiol or 25-hydroxy vitamin D, and subsequently in the kidneys. The evaluation of vitamin D levels in the circulation is conducted by quantifying the concentration of 25-hydroxy vitamin D in the serum. There are two types of Vitamin D. More precisely, vitamin D2 and vitamin D3. Vitamin D2 is derived from the plant sterol ergosterol, whereas vitamin D3 (cholecalciferol) is produced from cholesterol in the skin **[8].** Vitamin D is essential for maintaining proper functioning in several physiological systems, including the immune system. Moreover, it has a preventative function in the prevention of cancer **[9].** Vitamin D deficiency is characterized by low blood 25-hydroxy vitamin D levels (<25nmol/l), and it is common in both industrialized and developing nations **[10].** The United States has a prevalence rate of 41.6% for vitamin D deficiency, with the highest rates seen among black adults, followed by Hispanics **[11].**

In their study, Salem et al. (2021) performed a case-control study to investigate the possible association between vitamin D deficiency, anemia, and Hashimoto's thyroiditis (HT) in Egyptian females, with a specific emphasis on the clinical perspective. The case-control study was conducted between autumn 2019 and early 2020, with 240 individuals who were divided into two groups: Group I included 120 female patients diagnosed with Hashimoto's thyroiditis (HT), with an average age of 39.9±11.2 years. The selection of these individuals was based on their elevated blood levels of anti-thyroglobulin (anti-Tg) or anti-thyroid peroxidase (anti-TPO) antibodies, in addition to their thyroid function test findings. In the present study, a deficiency of vitamin D was observed in 66% of the patients with HT, while 58% of them had anemia. Moreover, about 60% of the individuals diagnosed with HT exhibited the presence of all three conditions: HT, anemia, and vitamin D insufficiency. An examination of the parameters in persons with HT showed significant negative correlations between vitamin D levels and TSH, anti-TPO, anti-Tg, and TIBC levels **[12].**

Aim of work:

To investigate the association between vitamin D levels, thyroid hormones, calcium, anti-TPO and TSH receptor antibodiesin hypothyroid patients.

Material and Methods

A retrospective investigation was carried out. We examined the medical records of individuals who attended the endocrinology department of Nahda policlinic between November 2023 and April 2024. Patients over the age of 30 had thyroid function testing, antithyroid antibody tests, and blood assays to measure 25-hydroxyvitamin D levels. The relevant antibodies were thyroid stimulating TPO-Ab, indicating the presence of Hashimoto's thyroiditis (HT). Furthermore, the subjects' serum calcium levels were evaluated. The research excluded patients with metabolic bone illnesses, primary hyperparathyroidism, renal difficulties, liver disorders, epilepsy, and those receiving therapy with anticonvulsants or other medications that might possibly impact vitamin D metabolism. We collected data on the demographic characteristics of the patients, including their age, gender, levels of vitamin D, prevalence of vitamin D deficiency, levels of TSH receptor antibodies (TSHR-Ab), and levels of thyroid peroxidase antibodies (TPO-Ab).

We categorized the participants into three clinically significant groups according to their serum 25(OH) D levels, using the criteria outlined in the Endocrinology Society Clinical Practice Guidelines. The three categories are optimal (≥30ng/mL), intermediate (20 to <30ng/mL), and insufficient (<20ng/mL) levels of vitamin D.

To diagnose hypothyroidism, we used the laboratory reference range of thyroid stimulating hormone (TSH), which was found by the manufacturer's study to be 0.34–5.60 mIU/L. Participants were categorized as hypothyroid if their TSH levels were higher than 5.60 mIU/L or if they were on levothyroxine. Participants were categorized as normal controls if their TSH levels were between the range of 0.34–5.60 mIU/L and they were not taking any thyroid medication.

Ethical consideration:

The research conforms to rigorous ethical norms. Before the children participated, all legal guardians were given comprehensive information about the research and acquired informed permission. The consent process ensured that the guardians were fully informed about the purpose of the research, the processes, any hazards, and their opportunity to withdraw from the study without facing any repercussions. The data of all participants was anonymized and securely kept in order to safeguard privacy. The data was only accessible to the research team members who were actively participating in the study. The study methodology was subjected to a comprehensive evaluation and was granted approval by an Institutional Review Board (IRB), guaranteeing compliance with ethical standards and assuring the well-being of participants throughout the research process.

Statistical analysis:

The SPSS program, version 21.0, was used to perform the analyses. The categorical variables were compared between groups using the chi-square test. The mean value plus or minus the standard deviation is often used to describe continuous variables. One-way ANOVA was used to compare continuous variables between several groups, whereas the Student's *t*-test was used to analyze continuous variables between two groups. A Pearson's correlation

analysis was performed to examine the connection between biochemical variables and vitamin D. A two-sided test was used to compute all *p*-values, and for all analyses, a *p*-value of less than 0.05 was considered statistically significant.

Results

The table presents demographic data for patients with hypothyroidism and the control group. The data is divided into two categories: Patients with hypothyroidism and normal controls, showing the distribution of individuals by gender and age.

It appears that there are 36 hypothyroid patients and 36 individuals in the control group. Regarding gender distribution, there seems to be a balance between males and females in both the patient and control groups, with approximately 50% males and 50% females in each group.

As for age, the table indicates that around 53% of participants in both the patient and control groups are less than 40 years old, while about 47% of them are 40 years old or older.

The table demonstrates a homogeneous distribution between the patient and control groups regarding gender and age, which could be useful for comparing demographic characteristics between the two groups and analyzing the data effectively.

The statistics indicate comparable mean ages between the patient and control groups, with mean ages of approximately 39.6 years for patients and 39.2 years for controls. Additionally, the frequency of males in both groups is similar, with around 1.5 males out of 36 participants in each group. These findings suggest that age and gender distributions are balanced between the patient and control cohorts.

Table (1): The demographic characteristics of the study sample.

Demographic data	Patient		Control		Total	
	Frequency	%	Frequency	%	Frequency	%
Type	36	100	36	100	72	100
Gender:						
Male	17	47.2	19	52.8	36	50
Female	19	52.8	17	47.2	36	50
Total	36	100	36	100	72	100
Age:						
Less than 40 years old	19	52.8	19	52.8	38	52.8
More than 40 years old	17	47.2	17	47.2	34	47.2
Total	36	100	36	100	72	100
Mean age	39.6		39.2		–	

The table presents data from a study comparing the rate of vitamin D levels between patients and controls. The data is categorized into ranges of vitamin D levels, with frequencies and percentages provided for each group.

In the category “less than 20”, there were 20 patients (55.6%) and no controls. This indicates a significant presence of patients with vitamin D levels below 20, suggesting potential deficiency among the patient group.

Moving to the next category, “from 20 to less than 40”, there were 16 patients (44.4%) and 13 controls (36.2%). This range is represented by both patients and controls, indicating that individuals in both groups have vitamin D levels falling within this range.

In the category “more than 40”, there were no patients, while 23 controls (63.8%) fell within this range. This suggests that higher vitamin D levels above 40 are more common among controls compared to patients.

The mean values for patients and controls were 18.8 and 40, respectively. This difference in mean values further emphasizes the distinction between the two groups in terms of vitamin D levels.

The Chi-Square test yielded a statistic of 62.533 with a degree of freedom of 28, resulting in a significant *p*-value of 0.000. This indicates a strong association between the levels of vitamin D and the patient/control groups. The Contingency Coefficient of 0.682 suggests a meaningful relationship between the variables.

Overall, the table suggests that there are significant differences in vitamin D levels between patients and controls, with patients generally exhibiting lower vitamin D levels compared to controls. These findings may have implications for the diagnosis and management of conditions related to vitamin D deficiency.

Significant differences between the study sample groups and the variables:

Regarding The TSH level for both the patient and control group, the demographic data suggests that there are no significant differences in gender or age between patients and controls. These findings imply that any observed differences in other variables are less likely to be influenced by gender or age variations within the groups. For the T3 level, the data suggests that there are significant differences in free T3 levels between patients and controls, both in terms of gender and age. Specifically, controls exhibit higher levels of free T3 compared to patients. These findings may have implications for the diagnosis and management of thyroid-related conditions, highlighting the potential utility of free T3 levels as a diagnostic marker.

As for the T4 level, the analysis demonstrates significant gender-based differences in free T4 levels among patients, with males having higher levels compared to females. However, no significant age-based differences in free T4 levels are observed within both patient and control groups. These findings suggest the importance of considering gender differences in free T4 levels when interpreting results in clinical settings.

Overall, the data suggests that there are no significant differences in anti-TPO levels between patients and controls, both in terms of gender and age. These findings imply that factors other than gender or age may play a more significant role in determining anti-TPO levels among individuals. In addition, the analysis suggests a significant gender-based difference in TSH receptor antibody levels among controls, with females exhibiting lower levels compared to males. However, no significant age-based differences in TSH receptor antibody levels are observed within both patient and control groups. These findings emphasize the importance of considering gender differences when interpreting results related to TSH receptor antibodies. Moreover, the analysis indicates no significant gender or age-based differences in calcium levels among both patients and controls. These findings suggest that factors other than gender or age may play a more significant role in determining calcium levels among individuals.

Table (2): The level of Vit. D of the study sample.

Types	Patient		Control		Total	
	Frequency	%	Frequency	%	Frequency	%
Less than 20	20	55.6	–	–	20	27.8
From 20 to less than 40	16	44.4	13	36.2	29	40.3
More than 40	–	–	23	63.8	23	31.9
Total	36	100	36	100	72	100
Mean	18.8		40		–	

Chi-Square: 62.533. df: 28. Sig: 0.000. Contingency Coefficient 0.682. Meaningful.

The table presents demographic data and statistical indicators comparing the levels of vitamin D among patients and controls, segmented by gender and age, along with the results of *t*-tests for comparing means.

For gender-based analysis, among patients, there were 17 males with a mean vitamin D level of 16.8824 and a standard deviation of 7.29625, and 19 females with a mean of 20.4737 and a standard deviation of 8.03028. For controls, there were 17 males with a mean vitamin D level of 41.7895 and a standard deviation of 6.92483, and 19 females with a mean of 38.0588 and a standard deviation of 7.63602. The *t*-tests comparing gender within patient and control groups show no significant differences among both patients (p=0.171) and controls (p=0.133).

Regarding age, among patients, there were 19 individuals less than 40 years old with a mean vitamin D level of 22.1667 and a standard deviation of 7.36646, and 17 individuals more than 40 years old with a mean of 15.3889 and a standard deviation of 6.82675. For controls, there were 19 individuals less than 40 years old with a mean vitamin D level of 37.1579 and a standard deviation of 8.34175, and 17 individuals more than 40 years old with a mean of 43.2353 and a standard deviation of 4.58979. The *t*-tests comparing age within patient and control groups reveal significant differences in vitamin D levels based on age, both for patients (p=0.007) and controls (p=0.010).

In summary, the analysis indicates significant age-based differences in vitamin D levels among both patients and controls, with individuals less than 40 years old having higher levels compared to those more than 40 years old. However, no significant gender-based differences are observed in vitamin D levels among both patients and controls. These findings underscore the importance of age as a determinant factor in vitamin D levels among individuals.

Table (3): The significant differences between the study sample groups according to the levels of vitamin D.

Demographic data	N	Mean	Std	%	Statistical indicators		
					Test	df	Sig
Gender:							
Patient:							
Male	17	16.8824	7.29625	–	*t*=1.398	34	0.171
Female	19	20.4737	8.03028				
Control:							
Male	17	41.7895	6.92483	36.2	*t*=1.537	34	0.133
Female	19	38.0588	7.63602				
Age:							
Patient:							
Less than 40 years old	19	22.1667	7.36646	63.8	*t*=2.863	34	0.007
More than 40 years old	17	15.3889	6.82675				
Control:							
Less than 40 years old	19	37.1579	8.34175	100	*t*=2.662	34	0.010
More than 40 years old	17	43.2353	4.58979				

The relationship between the study sample groups and the variables:

The table presents the Pearson correlation coefficient between the levels of vitamin D and various biochemical variables, segmented by patient and control groups, along with the significance level of the correlation.

For patients, the correlation coefficient between vitamin D levels and TSH is -0.122 with a *p*-value of 0.478, indicating a weak and non-significant negative correlation. Similarly, the correlation coefficients between vitamin D levels and free T3, free T4, anti-TPO, TSH receptor antibodies, and calcium are 0.313, 0.029, 0.043, 0.078, and 0.087, respectively, with *p*-values greater than 0.05. These correlations are also weak and non-significant.

For controls, the correlation coefficient between vitamin D levels and TSH is 0.021 with a *p*-value of 0.901, indicating a very weak and non-significant positive correlation. The correlation coefficients between vitamin D levels and free T3, free T4, anti-TPO, TSH receptor antibodies, and calcium are 0.071, 0.152, 0.101, 0.056, and 0.019, respectively, with *p*-values greater than 0.05. These correlations are also very weak and non-significant.

Overall, the correlations between vitamin D levels and the other biochemical variables are generally weak and non-significant in both patient and control groups. This suggests that there is no meaningful relationship between vitamin D levels and these biochemical variables in the studied population. Therefore, vitamin D levels do not appear to be significantly associated with variations in TSH, free T3, free T4, anti-TPO, TSH receptor antibodies, or calcium levels.

Table (4): The table shows the Pearson correlation coefficient between the levels of vitamin D and another biochemical variable.

The levels of vitamin D receptor	Pearson Correlation Coefficient	Sig.	Significance
TSH:			
Patient	-0.122	0.478	Not Significance
Control	0.021-	0.901	Not Significance
Free T3 (triiodothyronine):			
Patient	0.313	0.063	Not Significance
Control	0.071	0.680	Not Significance
Free T4 (thyroxine):			
Patient	0.029-	0.867	Not Significance
Control	0.152	0.315	Not Significance
Anti-TPO (thyroid peroxidase antibodies):			
Patient	0.043	0.375	Not Significance
Control	0.101	0.557	Not Significance
TSH receptor antibodies:			
Patient	0.078	0.651	Not Significance
Control	0.056	0.744	Not Significance
Calcium (Ca):			
Patient	0.087	0.613	Not Significance
Control	0.019-	0.912	Not Significance

The table presents the Pearson correlation coefficient between the levels of vitamin D and various biochemical variables, along with the significance level of these correlations.

There are significant correlations observed between the levels of vitamin D and several biochemical variables. Specifically, there is a strong positive correlation between vitamin D levels and TSH (Pearson correlation coefficient=0.732, p-value <0.001), free T4 (Pearson correlation coefficient=0.542, p-value <0.001), TSH receptor antibodies (Pearson correlation coefficient=0.503, p-value <0.001), and calcium (Pearson correlation coefficient=0.628, p-value <0.001).

Conversely, there is a strong negative correlation between the levels of vitamin D and TSH (Pearson correlation coefficient=–0.732, p-value <0.001), and free T3 (Pearson correlation coefficient=–0.627, p-value <0.001), and TSH receptor antibodies (Pearson correlation coefficient=–0.503, p-value <0.001), as well as anti-TPO (Pearson correlation coefficient=–0.777, p-value <0.001).

Table (5): The table shows the Pearson correlation coefficient between the levels of vitamin D and another biochemical variable.

The levels of vitamin D receptor	Pearson Correlation Coefficient	Mood level	Significance
TSH	-0.732	0.000	Significance
Free T3 (triiodothyronine)	-0.627	0.000	Significance
Free T4 (thyroxine)	0.542	0.000	Significance
Anti-TPO (thyroid peroxidase antibodies)	-.777	0.000	Significance
TSH receptor antibodies	-0.503	0.000	Significance
Calcium (Ca)	0.628	0.000	Significance

Discussion

Vitamin D deficiency is a prevalent health issue affecting more than one billion individuals globally *[13]*. According to the Ardawi Group, a significant number of both adolescents and adults, ranging from 30 to 50%, had serum vitamin D levels below 30ng/ml *[14]*. The predicted incidence of vitamin D deficiency in the urban population was 62% in men and 75% in females. In comparison, the rate of vitamin D deficiency in a rural region was somewhat lower, with rates of 44% in males and 70% in females *[15]*. One of two possible explanations for the decreased levels of vitamin D in patients with hypothyroidism. The initial cause of low vitamin D levels might perhaps be ascribed to insufficient absorption of vitamin D from the intestines. Moreover, the body may demonstrate insufficient activation of vitamin D. Importantly, both Vitamin D and thyroid hormone bind to similar receptors called steroid hormone receptors. A different genetic variation in the Vitamin D receptor has been shown to increase the vulnerability of people to autoimmune thyroid illnesses, such as Graves' disease and Hashimoto's thyroiditis *[16]*. In this study, we aimed to investigate the association between vitamin D levels and hypothyroidism.

The research sample consisted of 36 patients diagnosed with hypothyroidism and 36 persons in the control group. Each group had an equal distribution of roughly 50% men and 50% females. There were no notable gender-related disparities in vitamin D levels detected in both the patients and controls. Approximately 53% of individuals in both the patient and control cohorts are under the age of 40, while approximately 47% of them are 40 years old or beyond. The data indicate that there is an equal distribution of age and gender across the sick and control groups. Furthermore, the research reveals notable disparities in vitamin D levels depending on age among both patients and controls, with persons under the age of 40 exhibiting greater levels in comparison to those over the age of 40. However, Sulejmanovic et al., found that the majority of participants in their research were females (90%) *[17]*. This discovery was comparable to the one made by Mackawy et al. *[18]*. According to his statement, the levels of blood vitamin D were substantially lower in females compared to males *[18]*. Nevertheless, consistent with our research, other writers have shown that there was no substantial disparity in vitamin D levels between males and females *[19, 20]*. The incidence of vitamin D insufficiency in the adult population has been shown to range from 9% to 70%, with a greater frequency seen in studies *[21,22]*. Some investigations indicated that the prevalence of vitamin D deficiency in patients with Hashimoto's disease (92%) was substantially greater than that of healthy controls (63%) *[23]*.

Our study's findings demonstrated that, for both the patient and control groups, there is often a weak and non-significant correlation between vitamin D levels and the other biochemical variables. Thus, variations in TSH, free T3, free T4, anti-TPO, TSH receptor antibodies, or calcium levels do not significantly correlate with vitamin D levels. Sulejmanovic et al., also found a strong negative correlation between thyroid antibodies and vitamin D levels. This discovery is consistent with the findings of Hosny et al. *[24]*, who similarly observed a negative correlation between anti-TPO and anti-TG and blood 25 (OH) vitamin D. Furthermore, Khare, et al. *[25]* reported that blood vitamin D levels did not significantly vary between those with positive TPO-Ab and those with negative TPO-Ab, which is consistent with our results. Furthermore, Yasmeh and colleagues *[26]* discovered no connection

between anti-TPO positive. Additionally, they observed a negative link between Vitamin D levels and anti-TPO. Other investigations have shown that the occurrence of vitamin D insufficiency is notably greater among those who are positive for TPO-Ab compared to those who are negative for TPO-Ab and have hypothyroidism [26,27]. A research conducted by Raeef et al. [28] shown that a deficiency in vitamin D may result in an elevation of thyroid-stimulating hormone levels. Therefore, the statistically significant (p<0.05) positive correlation seen between vitamin D and TSH suggests a relationship between hypothyroidism and vitamin D. Raeef et al., found a negative correlation between vitamin D blood levels and TSH levels. The findings indicated a potential association between vitamin D insufficiency and hypothyroidism. The results of this investigation were consistent with a recent study, which showed that a higher percentage of Hashimoto's patients (92%) had vitamin D deficiency compared to healthy controls (63%) (p= 0.00001) [29]. The reason for these results, which indicate low levels of vitamin D in patients with hypothyroidism, might be attributed to insufficient absorption of vitamin D in the gastrointestinal tract or a deficiency in the activation of vitamin D by the body. Thyroid hormone, being a steroid hormone, and vitamin D3, being a fat-soluble vitamin, both bind to steroid hormone receptors in a similar manner [29]. Furthermore, Obaid et al. (2020) demonstrated that Iraqi patients with hypothyroidism have a vitamin D3 shortage. Furthermore, blood vitamin D levels and T4 have a positive association, whereas blood vitamin D levels and TSH have a substantial negative correlation [30].

This research encountered a few limitations. First and foremost, the limited number of participants in the sample may hinder the ability to apply the findings to a larger population. Furthermore, the presence of TPOAb antibodies was assessed in thyroid patients, but other variables were not assessed. This was deemed an additional constraint. For future investigations, we propose aligning variables such as the illness stage and the daily dose of administered medications.

Conclusion:

The current study suggests a significant relationship between vitamin D levels and the mentioned biochemical variables. The positive correlations with free T4, and calcium indicate that higher levels of vitamin D are associated with increased levels of these biochemical markers. Conversely, the negative correlations with TSH and free T3 and anti-TPO and TSH receptor antibodies suggest that higher levels of vitamin D are associated with decreased levels of these biochemical markers. Overall, these findings highlight the potential influence of vitamin D on thyroid function, autoimmune responses, and calcium metabolism. Vitamin D appears to play a significant role in regulating these biochemical processes, and further research in this area could provide valuable insights into the mechanisms underlying these relationships and potential therapeutic interventions.

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العلاقة بين فيتامين د وهرمونات الغدة الدرقية والكالسيوم والأجسام المضادة لمستقبلات TPO و TSH لدى مرضى قصور الغدة الدرقية

تم إجراء دراسه تجميع نتائج حالات بأثر رجعى. وتم فحص السجلات الطبية للأفراد الذين حضروا قسم الغدد الصماء وبجمع معلومات عن العمر والجنس ومؤشر كتلة الجسم ومستويات الكالسيوم ومستويات fT4 ومستويات هرمون الغدة الدرقية (TSH) والأجسام المضادة لمستقبلات TSH (TSHR-Ab) والأجسام المضادة لبيروكسيداز الغدة الدرقية (TPO-Ab) بالإضافة إلى فيتامين د. وبالتحليل الاحصائى تمت مقارنة المتغيرات بين المجموعات.

واشارت نتائج الدراسة إلى وجود علاقة قوية بين العوامل البيوكيميائية المدروسة ومستويات فيتامين د. تشير الارتباطات الإيجابية مع T4 الحر والكالسيوم إلى أن المستويات الأعلى من فيتامين د ترتبط بزيادة مستويات هذه العلامات البيوكيميائية. على العكس من ذلك، تشير الارتباطات السلبية مع TSH وT3 الحر والأجسام المضادة لمستقبلات TPO و TSH إلى أن المستويات الأعلى من فيتامين D ترتبط بانخفاض مستويات هذه العلامات الكيميائية الحيوية. بشكل عام، تسلط هذه النتائج الضوء على التأثير المحتمل لفيتامين د على وظيفة الغدة الدرقية، والكالسيوم. يبدو أن فيتامين د يلعب دورًا مهمًا فى تنظيم هذه العمليات البيوكيميائية.