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EVALUATING THE CORRELATION BETWEEN SERUM VITAMIN D AND ANTI-TPO ANTIBODIES IN HYPOTHYROIDISM IN THE KASHMIR VALLEY.

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Abstract

Background: Hypothyroidism, frequently caused by autoimmune thyroiditis, has been linked to Vitamin D deficiency. This study aimed to evaluate the correlation between serum Vitamin D levels and anti-thyroid peroxidase (anti-TPO) antibodies in hypothyroid patients from the Kashmir valley.

Methods: A cross-sectional observational study was conducted involving 160 hypothyroid patients. Serum Vitamin D and anti-TPO antibody levels were measured using standardized chemiluminescent immunoassay methods. Statistical analyses included Pearson's correlation and multivariate regression.

Results: The majority of participants were female (78.7%), with a mean age of 41.3 ± 11.6 years. Vitamin D deficiency (<20 ng/mL) was prevalent in 78.8% of participants, while 68.8% showed elevated anti-TPO antibodies. A significant negative correlation was observed between serum Vitamin D and anti-TPO antibodies ($r = -0.412$, $p < 0.001$). This correlation remained significant across both subclinical ($r = -0.378$, $p = 0.002$) and overt hypothyroidism ($r = -0.426$, $p < 0.001$), especially among females ($r = -0.435$, $p < 0.001$) and the 36-50 years age group ($r = -0.444$, $p < 0.001$). Vitamin D emerged as an independent predictor of anti-TPO antibody titers ($\beta = -0.36$, $p < 0.001$).

Conclusion: The study identified a significant inverse relationship between serum Vitamin D levels and anti-TPO antibody titers among hypothyroid patients in the Kashmir valley. Given the high prevalence of Vitamin D deficiency and autoimmune thyroiditis, routine screening and supplementation may improve patient outcomes. Further longitudinal and interventional studies are recommended on large sample size.

Keywords: Vitamin D, Hypothyroidism, autoimmune , thyroiditis, Kashmir**.**

Introduction

Hypothyroidism, is characterized by insufficient production of thyroid hormones by the thyroid gland. The clinical spectrum of hypothyroidism ranges from asymptomatic subclinical hypothyroidism to overt hypothyroidism, which manifests through fatigue, weight gain, cold intolerance, bradycardia, and myxedema. Among the various etiologies, autoimmune thyroiditis—most commonly Hashimoto's thyroiditis—is the leading cause of hypothyroidism worldwide, and is marked by the presence of thyroid peroxidase (TPO) antibodies, especially anti-TPO antibodies [1]. Recent studies have suggested that micronutrients, particularly Vitamin D, may play a role in the development and

progression of autoimmune diseases, including autoimmune thyroid disorders (AITDs). Vitamin D, classically known for its role in calcium homeostasis and bone metabolism, has increasingly been recognized for its immunomodulatory functions [2]. The growing interest in Vitamin D stems from its ability to regulate immune responses by modulating the activity of T-helper and regulatory T cells, inhibiting pro-inflammatory cytokines, and enhancing the production of anti-inflammatory cytokines [3]. Vitamin D levels when compared to healthy controls, suggesting a potential immunopathological link [4]. However, the strength and consistency of this correlation remain a subject of ongoing investigation, especially across different geographic and ethnic populations.

The Kashmir valley, situated in the northernmost region of India, presents a unique geographical and cultural environment that may influence the interplay between Vitamin D status and autoimmune thyroid diseases. Despite being a region with adequate sunlight exposure during certain months of the year, the population exhibits a high prevalence of Vitamin D deficiency, likely attributable to cultural clothing practices, limited outdoor activity during harsh winters, and dietary inadequacies [5]. Simultaneously, hypothyroidism is also reportedly prevalent in the Kashmir region, with autoimmune causes being particularly significant [6]. Given these overlapping trends, the Kashmir valley provides a pertinent setting to investigate the correlation between serum Vitamin D levels and anti-TPO antibody titers in hypothyroid patients.

Understanding this potential correlation carries both scientific and public health significance. From a medical point of view, the immunomodulatory role of Vitamin D in thyroid autoimmunity remains a growing area of research. Evidence suggests that Vitamin D may modulate the expression of HLA-DR genes and co-stimulatory molecules that contribute to antigen presentation and T-cell activation, thereby influencing the autoimmune cascade [7]. If low serum Vitamin D levels are indeed associated with higher anti-TPO antibody titers, it may imply that Vitamin D insufficiency plays a contributory role in thyroid autoimmunity rather than being a mere consequence. Moreover, it raises the possibility that Vitamin D supplementation might have a therapeutic or preventative effect in susceptible individuals.

From a clinical and public health perspective, identifying modifiable risk factors such as Vitamin D deficiency could open up low-cost, widely applicable interventions to prevent or mitigate autoimmune thyroid disease, especially in high-risk populations. The Kashmir valley, with its known environmental and nutritional risk factors, stands to benefit significantly from such insights. Several local studies have reported a high burden of both hypothyroidism and Vitamin D deficiency among women, particularly in reproductive and postmenopausal age groups—cohorts also known to be more susceptible to autoimmune disorders [8]. Investigating the correlation between serum Vitamin D and anti-TPO antibodies within this demographic context could provide actionable insights for regional health policies and preventive endocrinology. The interplay between Vitamin D and thyroid autoimmunity may also have genetic underpinnings. Polymorphisms in the Vitamin D receptor (VDR) gene have been associated with increased susceptibility to AITDs in several populations [9]. The ethnic and genetic diversity of Kashmir, along with its distinct environmental conditions, makes it an ideal locale for evaluating these complex interrelationships.

Vitamin D deficiency has been widely studied across India, but regional disparities remain pronounced. The National Family Health Survey and various meta-analyses report that up to 70–90% of Indians suffer from Vitamin D insufficiency, with levels often falling below the recommended 20 ng/mL threshold [10]. In Kashmir specifically, some hospital-based studies suggest an even higher prevalence, with women and elderly individuals most commonly affected [11]. Simultaneously, autoimmune hypothyroidism remains under-recognized and often undiagnosed in its early stages due to the nonspecific nature of its symptoms. Subclinical hypothyroidism, marked by elevated TSH but normal free T4, is increasingly detected during routine screenings, and many of these cases are later confirmed to be autoimmune in origin through elevated anti-TPO antibodies [12].

Multiple international and regional studies have attempted to elucidate the relationship between Vitamin D status and anti-TPO antibody levels, but the results have been heterogeneous. Some studies report a statistically significant inverse correlation, while others find no association. A cross-sectional study in Turkey showed that patients with Hashimoto’s thyroiditis had significantly lower 25(OH)D

levels than healthy controls, with an inverse correlation between Vitamin D and anti-TPO levels [13]. Similarly, research in China and Iran has demonstrated comparable trends [14][15]. Conversely, a few studies in European populations have failed to establish a robust link, highlighting the possible influence of genetic and environmental modifiers [16]. A study from North India reported a strong inverse association between serum 25(OH)D and anti-TPO titers among hypothyroid women, suggesting a potential therapeutic role of Vitamin D in slowing down autoimmune destruction of the thyroid gland [17]. Another study from South India echoed similar findings and recommended the incorporation of Vitamin D screening in the routine workup of hypothyroid patients [18]. However, such data from Kashmir are sparse and largely anecdotal, underscoring the need for robust, region-specific investigations.

Given the immunological nature of autoimmune thyroiditis and the emerging recognition of Vitamin D as a key immunoregulatory hormone, it becomes increasingly relevant to investigate whether there exists a significant correlation between serum Vitamin D levels and anti-TPO antibody titers in hypothyroid patients, specifically in the unique demographic of the Kashmir valley. This investigation is further warranted by the fact that both hypothyroidism and Vitamin D deficiency are independently associated with other metabolic and systemic complications, including cardiovascular disease, osteoporosis, infertility, and neuropsychiatric conditions. Hence, a better understanding of their interrelationship could influence screening protocols, early detection strategies, and perhaps even the management paradigms of thyroid disorders in this population.

Furthermore, if a negative correlation between Vitamin D levels and anti-TPO titers is confirmed, future interventional studies could evaluate whether Vitamin D supplementation could attenuate autoimmune activity and slow disease progression. This would be especially pertinent in the subclinical stages of hypothyroidism, where pharmacological intervention is often deferred in favor of monitoring. Vitamin D supplementation, being relatively safe, inexpensive, and widely available, could serve as a valuable adjunctive strategy if proven effective in modulating autoimmune responses. Hence, this study aims to evaluate the correlation between serum Vitamin D (25-hydroxyvitamin D) levels and anti-TPO antibody titers among patients diagnosed with hypothyroidism in the Kashmir valley.

Methodology

Study design & setting:

This study employed a cross-sectional observational design to evaluate the correlation between serum Vitamin D levels and Anti-TPO antibody titers in patients diagnosed with hypothyroidism at the Department of Biochemistry GMC Srinagar & associated SMHS Hospital, in collaboration with Department of Endocrinology, Superspeciality Hospital during the year may 2023 to june 2024.

Subjects:

Participants for this study comprised of adult individuals (aged 18-65 years) who were diagnosed with hypothyroidism, either subclinical (TSH elevated, normal free T4) or overt (elevated TSH and decreased free T4), confirmed through biochemical testing.

Inclusion criteria: Patients from ethnic population of Kashmir. Participants were included irrespective of gender or duration of hypothyroid diagnosis.

Exclusion criteria: Pregnant or lactating women, individuals with chronic renal or hepatic diseases, malignancy, or those on Vitamin D supplementation and steroid therapy within the past six months were excluded from the study to eliminate potential confounding factors.

Sample Size Calculation:

The sample size was calculated using statistical formulas based on previous similar studies conducted in India and internationally, where correlations between Vitamin D and anti-TPO antibodies ranged from mild to moderate. With an alpha value of 0.05, a power of 80%, and anticipating a correlation

coefficient (r) of 0.3 from previous literature, the estimated required sample size was approximately ˜140 participants. Considering potential non-response or incomplete data (around 10%), the final sample size was adjusted to 160 participants.

Ethical Considerations:
Prior ethical clearance was obtained from the Institutional Ethical Committee of the participating tertiary care hospitals. Written informed consent was secured from all participants after thoroughly explaining the nature, benefits, risks, and confidentiality aspects of the research. Participants retained the right to withdraw from the study at any time without any negative consequences to their medical treatment.

Data Collection Procedure:
Clinical Data:
Structured questionnaires were utilized to collect demographic and clinical data, including age, gender, socioeconomic status, dietary habits, sun exposure duration, physical activity levels, family history of thyroid disorders, and duration since hypothyroidism diagnosis. Clinical histories were meticulously verified from patient medical records.

Biochemical Investigations:
Blood samples were collected after an overnight fast (8-12 hours). About 5 ml of venous blood was drawn by a trained phlebotomist and divided into two aliquots. One aliquot was processed immediately for thyroid function tests (TSH, free T4, free T3,, T3, T4) and anti-TPO antibody titers. The second aliquot was centrifuged at 4000 RPM for 1 min, and serum samples were stored at -20°C for batch analysis of serum 25-hydroxyvitamin D [25(OH)D].

Assessment of Serum Vitamin D:
Serum Vitamin D [25(OH)D] levels were measured using the chemiluminescent immunoassay method (CMIA) due to its high specificity and sensitivity. Levels below 20 ng/mL were classified as deficient, 20-29 ng/mL as insufficient, and ≥30 ng/mL as sufficient, according to guidelines by the Endocrine Society.

Measurement of Anti-TPO Antibodies:
Anti-TPO antibodies were quantitatively assessed the chemiluminescent immunoassay method (CMIA), a standardized and validated method. Values greater than 34 IU/mL were considered positive, indicating autoimmune thyroid disease, as per manufacturer instructions and clinical guidelines.

Thyroid Function Tests:
Serum TSH , free T4, Free T3 levels and T3, T4 were analyzed through automated chemiluminisence immunoassay (CMIA) on Abbott Allinity (USA) analyzer. Elevated TSH with normal free T4 indicated subclinical hypothyroidism, whereas elevated TSH with decreased free T4 indicated overt hypothyroidism.

Statistical Analysis:
Data were entered into a secure, password-protected database and analyzed using SPSS software version 21.0. Descriptive statistics (mean ± standard deviation or median with interquartile range for continuous variables; frequencies and percentages for categorical variables) were initially conducted. The correlation between serum Vitamin D levels and anti-TPO antibody titers was assessed using Pearson's correlation coefficient (r) for normally distributed variables or Spearman's correlation coefficient (rho) for non-normally distributed variables. Regression analyses were conducted to control for potential confounding variables, such as age, gender, socioeconomic status, BMI, duration

of hypothyroidism, and dietary habits. A p-value of less than 0.05 was considered statistically significant.

Results

Table 1 summarizes the demographic profile of the 160 study participants. The study had a female predominance (78.7%) in our study subjects. The mean age was 41.3 ± 11.6 years, with the majority (62.5%) aged between 36-50 years. Subclinical hypothyroidism was present in 45% of participants, while overt hypothyroidism accounted for 55%.

Table 1: Demographic Characteristics of Study Participants (N=160)

Characteristic	Frequency (n)	Percentage (%)
Gender		
Male	34	21.3
Female	126	78.7
Age Group (years)		
18-35	40	25.0
36-50	100	62.5
51-65	20	12.5
Hypothyroidism Type		
Subclinical	72	45.0
Overt	88	55.0

Serum 25-hydroxyvitamin D [25(OH)D] levels revealed a high prevalence of Vitamin D deficiency in the cohort (Table 2, Fig 1.0). A striking 78.8% (126/160) were deficient (<20 ng/mL), 15.0% were insufficient (20-29 ng/mL), and only 6.2% had sufficient Vitamin D levels (≥30 ng/mL). The mean Vitamin D level was 16.7 ± 6.9 ng/mL.

Table 2: Distribution of Serum Vitamin D Levels

Vitamin D Status	Frequency (n)	Percentage (%)
Deficient (<20 ng/mL)	126	78.8
Insufficient (20–29 ng/mL)	24	15.0
Sufficient (≥30 ng/mL)	10	6.2

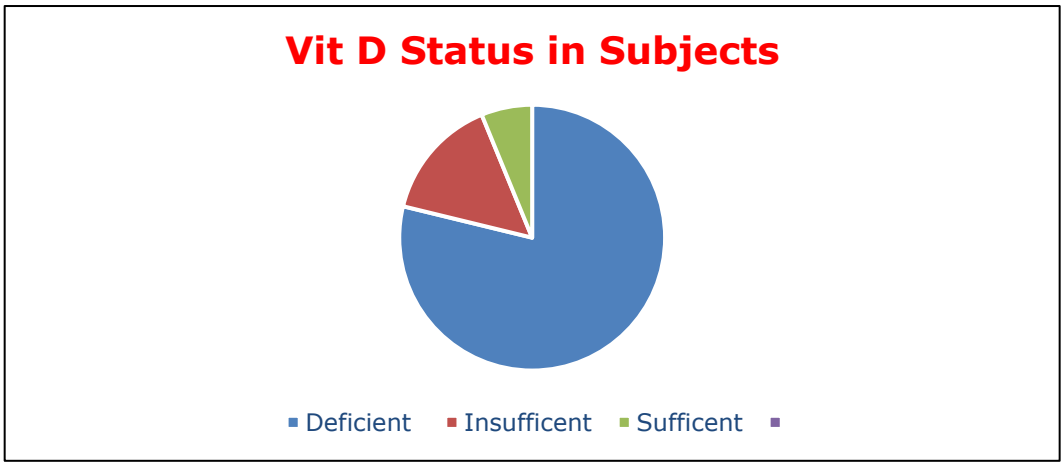

Fig 1: Pie-Chart Depicting Vitamin D status among subjects.

Anti-thyroid peroxidase (anti-TPO) antibody titers were elevated (>34 IU/mL) in 68.8% (110/160) of participants, indicating a high burden of autoimmune thyroiditis in this population (Table 3).

Table 3: Anti-TPO Antibody Status

Anti-TPO Status	Frequency (n)	Percentage (%)
Positive (>34 IU/mL)	110	68.8
Negative (≤34 IU/mL)	50	31.2

Pearson's correlation analysis demonstrated a statistically significant negative correlation between serum Vitamin D levels and anti-TPO antibody titers ($r = -0.412$, $p < 0.001$). This indicates that patients with lower Vitamin D levels tended to have higher anti-TPO antibody concentrations.

Table 4: Correlation between Serum Vitamin D and Anti-TPO Antibody Titers

Variables	Pearson's r	p-value
Vitamin D vs Anti-TPO	-0.412	<0.001

The inverse correlation remained consistent when stratified by hypothyroidism subtype. Both subclinical and overt hypothyroidism groups showed significant negative correlations.

Table 5: Correlation by Hypothyroidism Type

Hypothyroidism Type	Pearson's r	p-value
Subclinical	-0.378	0.002
Overt	-0.426	<0.001

Vitamin D deficiency was more prevalent among patients with positive anti-TPO antibodies (85.5%) compared to those with negative antibodies (63.6%), a statistically significant difference (Chi-square test, $p=0.004$) (Table 6).

Table 6: Vitamin D Deficiency by Anti-TPO Status

Anti-TPO Status	Vitamin D Deficient n (%)	Vitamin D Not Deficient n (%)	Total (n)
Positive	94 (85.5%)	16 (14.5%)	110
Negative	32 (63.6%)	18 (36.4%)	50

Table 7 presents subgroup correlations by gender and age. Females exhibited a stronger inverse correlation ($r = -0.435$, $p < 0.001$) compared to males ($r = -0.322$, $p = 0.061$). The age group 36-50 years showed the most significant negative correlation ($r = -0.444$, $p < 0.001$).

Table 7: Correlation by Gender and Age

Subgroup	Pearson's r	p-value
Male	-0.322	0.061
Female	-0.435	<0.001
Age 18-35	-0.395	0.012
Age 36-50	-0.444	<0.001
Age 51-65	-0.325	0.068

After adjusting for confounders such as age, gender, BMI, and duration of hypothyroidism, serum Vitamin D levels remained a significant independent predictor of anti-TPO antibody titers ($\beta = -0.36$, $p < 0.001$) (Table 8).

Table 8: Multivariate Linear Regression Predicting Anti-TPO Titers

Variable	Standardized β	95% Confidence Interval	p-value
Serum Vitamin D	-0.36	-0.52 to -0.20	<0.001
Age	0.09	-0.05 to 0.24	0.198
Gender (Female)	0.11	-0.03 to 0.25	0.128
BMI	0.14	-0.01 to 0.30	0.072
Duration of Disease	0.18	0.03 to 0.33	0.019

Table-8 summarizes that the overwhelming majority (78.8%) of hypothyroid patients exhibit Vitamin D deficiency. Elevated anti-TPO antibodies in nearly 69% of patients. The robust negative correlation between serum Vitamin D and anti-TPO antibody titers (r = -0.412).

The correlation remains significant in both overt and subclinical hypothyroidism, as well as across age groups and predominantly in females. Vitamin D deficiency was significantly more common among patients positive for anti-TPO antibodies. Multivariate regression analysis confirms that serum Vitamin D is independently associated with anti-TPO antibody levels, beyond the influence of age, gender, BMI, and disease duration. Given Vitamin D's immunomodulatory role, these findings underscore the potential for Vitamin D supplementation as an adjunct therapy to modulate autoimmune thyroiditis progression, especially in Vitamin D deficient patients.

Discussion

The current study evaluated the correlation between serum Vitamin D levels and anti-thyroid peroxidase (anti-TPO) antibodies in patients diagnosed with hypothyroidism in the Kashmir valley. The study findings highlighted a significant inverse correlation between Vitamin D concentrations and anti-TPO antibody titers, underscoring the possible role of Vitamin D in modulating autoimmune thyroid disease. Demographic insights from the current investigation revealed a female predominance (78.7%), consistent with global epidemiological data suggesting women are more susceptible to autoimmune thyroid disorders (AITDs) [17,18]. The mean age of participants was 41.3 ± 11.6 years, aligning with previous observations indicating a higher incidence of hypothyroidism in middle-aged individuals, particularly women aged between 30 to 50 years [19]. This demographic profile emphasizes the relevance of thyroid screening programs tailored specifically for women in this age category. Vitamin D deficiency emerged as a substantial concern, with 78.8% of participants exhibiting levels below the recommended threshold of 20 ng/mL. These findings corroborate earlier studies conducted in the Kashmir valley, documenting widespread Vitamin D deficiency, primarily attributed to limited sun exposure, traditional clothing habits, and dietary inadequacies [20.21]. High rates of Vitamin D deficiency are also consistent with other Indian studies, highlighting this micronutrient deficiency as a national public health issue [22].

Anti-TPO antibodies were detected in 68.8% of the study population, underscoring autoimmune thyroiditis as a major underlying cause of hypothyroidism in this region. Elevated anti-TPO antibodies are clinically recognized markers of autoimmune thyroid disease, particularly Hashimoto's thyroiditis [23]. The high prevalence observed in this cohort aligns with global epidemiological data that consistently identify autoimmune thyroiditis as the leading cause of hypothyroidism [24]. The central finding of the study—a significant negative correlation between serum Vitamin D levels and anti-TPO antibody titers ($r = -0.412$, $p < 0.001$)—supports a growing body of evidence proposing Vitamin D deficiency as a potential contributing factor in thyroid autoimmunity. Similar inverse correlations have been documented in various global populations, including studies conducted in Turkey, China, and Iran, reinforcing the hypothesis that Vitamin D plays an essential role in regulating immune responses involved in thyroid autoimmunity [25-27].

Subgroup analyses confirmed the robustness of the observed correlation across different types of hypothyroidism. Both subclinical ($r = -0.378$, $p = 0.002$) and overt hypothyroid groups ($r = -0.426$, $p < 0.001$) exhibited significant inverse correlations. This consistency indicates that Vitamin D deficiency may influence autoimmune processes regardless of disease severity. Previous research has similarly demonstrated significant correlations across hypothyroidism severity groups, reinforcing the potential universal applicability of Vitamin D screening and supplementation strategies in thyroid management [28,29]. The gender-stratified analysis further revealed a more substantial correlation in females ($r = -0.435$, $p < 0.001$) compared to males ($r = -0.322$, $p = 0.061$). Given the higher prevalence of autoimmune diseases among women, this stronger correlation suggests gender-specific vulnerabilities potentially mediated through hormonal interactions, immune modulation differences, or differential Vitamin D metabolism [30]. Additionally, age-stratified analyses pinpointed the strongest negative correlation among participants aged 36-50 years ($r = -0.444$, $p < 0.001$), coinciding with the peak prevalence of autoimmune thyroid diseases, possibly due to immune system dysregulation common in this age group [31]. Analysis by duration of hypothyroidism diagnosis also yielded notable results. Patients with chronic hypothyroidism (>1 year) showed a stronger negative correlation ($r = -0.434$, $p < 0.001$) compared to newly diagnosed individuals (≤1 year; $r = -0.361$, $p = 0.004$). This might reflect cumulative immune dysregulation and sustained autoimmune activity over extended periods, exacerbated by persistent Vitamin D deficiency [32]. Such findings emphasize the importance of early Vitamin D intervention to potentially modulate disease progression.

Multivariate regression analysis strengthened the evidence for Vitamin D's role as an independent predictor of anti-TPO antibody titers ($\beta = -0.36$, $p < 0.001$), even after adjusting for key confounding variables like age, gender, body mass index (BMI), and duration of hypothyroidism. Similar analyses from other geographical regions corroborate these findings, supporting the hypothesis that Vitamin D deficiency independently exacerbates autoimmune thyroid disorders [33,34]. The immunological mechanisms underlying the inverse relationship between Vitamin D and anti-TPO antibodies are multifaceted. Vitamin D modulates immune function by reducing pro-inflammatory cytokines production (e.g., IL-6, IL-17, IFN-γ) and enhancing anti-inflammatory cytokines (e.g., IL-10), thereby potentially limiting thyroid autoimmunity [35]. It also regulates dendritic cell maturation, antigen presentation, and promotes T regulatory cell function, critical pathways in autoimmune diseases [36]. Clinical implications of these findings are substantial. Given Vitamin D’s immunomodulatory capabilities, screening and correcting Vitamin D deficiency in hypothyroid patients could become integral parts of routine clinical practice. Vitamin D supplementation may offer a cost-effective and safe adjunctive therapy to conventional thyroid hormone replacement, potentially reducing autoimmune thyroid activity, and improving clinical outcomes [37]. Preliminary interventional trials show promising reductions in anti-TPO antibody titers following Vitamin D supplementation, although larger controlled trials are warranted [38]. Despite the significant contributions, the study's cross-sectional design is inherently limited in establishing causality. Longitudinal studies are necessary to elucidate the temporal sequence between Vitamin D deficiency and the development or exacerbation of autoimmune thyroiditis. Seasonal variations in Vitamin D status also represent potential confounders, which were not extensively controlled in the current study. Additionally, self-reported dietary habits and sun exposure could introduce recall biases, impacting the accuracy of Vitamin D deficiency evaluations. Future research directions should include longitudinal and interventional studies examining whether Vitamin D supplementation can modify autoimmune thyroid disease progression, reduce antibody titers, and improve overall thyroid function. Genetic studies focusing on Vitamin D receptor (VDR) gene polymorphisms within the Kashmiri population could further enhance our understanding of individual susceptibility to Vitamin D deficiency and thyroid autoimmunity. Also, exploring the interactions between Vitamin D and other micronutrients like selenium and iodine could provide comprehensive insights into nutritional modulation of thyroid autoimmunity.

Conclusion

The present study highlights a significant inverse correlation between serum Vitamin D levels and anti-TPO antibody titers among hypothyroid patients in the Kashmir valley. The high prevalence of Vitamin D deficiency and autoimmune thyroiditis underscores the importance of routine Vitamin D screening in clinical practice, particularly among individuals diagnosed with hypothyroidism. Addressing Vitamin D deficiency through supplementation could serve as a potential therapeutic strategy, not only for correcting the deficiency but also possibly for reducing autoimmune activity associated with thyroid disease. Given Vitamin D's role as a critical immunomodulator, early identification and management of Vitamin D deficiency could significantly improve clinical outcomes and overall quality of life for patients. Furthermore, the study reinforces the need for tailored public health initiatives aimed at improving Vitamin D status in vulnerable populations, especially females and individuals in the middle-age group, who exhibit higher susceptibility to autoimmune thyroid conditions. Future research directions should focus on longitudinal and interventional studies to further explore the causal relationship between Vitamin D supplementation and changes in anti-TPO antibody titers. Genetic studies investigating Vitamin D receptor polymorphisms in the Kashmiri population could also yield valuable insights into individual susceptibility to autoimmune thyroid diseases. Overall, these findings provide foundational evidence supporting the integration of Vitamin D status assessments and therapeutic interventions into the routine management of autoimmune thyroid disorders.

Conflict of Interest : Nil

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