SYSTEMATIC REVIEW

Effect of vitamin D supplementation on thyroid hormones in hypothyroid females of child-bearing age: a systematic review

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Abstract

Objective: To assess the impact of vitamin D supplementation on thyroid function and autoimmunity in hypothyroid females of child-bearing age.

Method: The systematic review was conducted from October 2024 to May 2025, and comprised search on PubMed, Cochrane Library, Google Scholar and the International Clinical Trials Registry Platform databases using predefined key words and medical subject heading terms, with no date restrictions, up to May 2025. The studies included were randomised controlled and clinical trials in hypothyroid females receiving vitamin D supplementation, and reporting thyroid-stimulating hormone and anti-thyroid peroxidase antibody values. Three reviewers independently screened records, extracted data, and assessed bias using the Cochrane Risk of Bias tool.

Results: : Of the 384 identified records, 11(2.86%) were analysed in detail. Dosages of vitamin D administered ranged from 800 IU/day to 60,000 IU/week, over 2-24 weeks. Of the total, 9(81.81%) studies reported significant thyroid-stimulating hormone reduction, particularly with ≥50,000 IU/week dose and baseline deficiency correction, whereas anti-thyroid peroxidase antibodies declined in eight autoimmune hypothyroidism studies with three documented more than 50% reduction from baseline.

Conclusion: Vitamin D supplementation, especially at higher doses and longer durations, could lower thyroid-stimulating hormone and thyroid autoantibodies in hypothyroid females of reproductive age.

PROSPERO Registration No: CRD42023469980.

Keywords: Vitamin D, Hypothyroidism, Thyroid hormones, Anti-TPO antibodies, Reproductive age, Randomised controlled trials, Clinical trials.

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Submission complete: 28-08-2025 **First Revision received:** 07-10-2025
Acceptance: 28-02-2026 **Last Revision received:** 27-02-2026

DOI: https://doi.org/10.47391/JPMA.32661

Introduction

Thyroid disorders, particularly hypothyroidism, rank among the most prevalent endocrine conditions in women of reproductive age worldwide.[1] Hypothyroidism is primarily identified by elevated levels of thyroid-stimulating hormone (TSH), which indicate reduced thyroid function. Clinically, it is associated with symptoms, such as fatigue, menstrual irregularities, infertility, weight gain and mood changes.[2] Its burden is disproportionately higher in females, with autoimmune thyroiditis being the primary cause in iodine-sufficient populations.[3] In women of child-bearing age, untreated hypothyroidism can profoundly impact overall health, impair fertility, complicate pregnancy, and jeopardise foetal neurodevelopment.[1]

Vitamin D deficiency (VDD) is a major public health concern, affecting more than one billion people globally, with a particularly high prevalence in South Asian populations.[4] This fat-soluble vitamin plays a vital role in calcium-phosphorus homeostasis, but its extra-skeletal actions, including immunomodulatory and anti-inflammatory effects, have increasingly been highlighted.[5] A growing body of evidence has linked vitamin D insufficiency with autoimmune diseases, including Hashimoto's thyroiditis, a primary cause of hypothyroidism. The proposed mechanisms involve vitamin D's role in regulating the immune response, modulating T-cell activity, and influencing cytokine profiles that may affect thyroid function.[6]

Multiple observational and interventional studies around the world have explored the relationship between vitamin D supplementation and thyroid function.[7,8] However, their findings remain inconsistent. Some randomised trials suggest that restoring vitamin D sufficiency may reduce thyroid autoantibodies and improve thyroid hormone levels, while others report no significant effect.[9] These discrepancies could be attributed to variations in study design, dosage and duration of supplementation, baseline vitamin D status, and population characteristics.

In Pakistan and other South Asian countries, both VDD

and hypothyroidism are highly prevalent, especially among women.[10,11] Despite this, vitamin D status is not routinely assessed in patients with thyroid dysfunction, and its therapeutic role in hypothyroidism management remains underexplored in clinical practice. Furthermore, previous systematic reviews have largely focused on mixed adult populations, have not specifically addressed females of child-bearing age, and often examined either thyroid hormones or autoimmunity in isolation rather than in combination. Evidence from South Asia is particularly scarce despite the region's high disease burden. Addressing these gaps through a rigorous synthesis of global clinical trial data is bound to provide context-specific insights and may inform future recommendations for integrated endocrine care. The current systematic review was planned to fill the gaps in literature by assessing the impact of vitamin D supplementation on thyroid function and autoimmunity in hypothyroid females of child-bearing age.

Materials and Methods

The systematic review was conducted from October 2024 to May 2025 at the University College of Medicine and Dentistry, affiliated with the University of Lahore, Pakistan, and comprised search on PubMed, Cochrane Library, Google Scholar and the International Clinical Trials Registry Platform databases using predefined key words and medical subject heading (MeSH) terms, with no date restrictions, up to May 2025. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, and the review protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO Registration No.: CRD42023469980) in October 2023.[12]

Studies were eligible for inclusion if they involved females aged 15-65 years diagnosed with any form of hypothyroidism, confirmed by standard biochemical criteria, elevated TSH with or without thyroid autoimmunity. If both males and females were enrolled in a study, it was included only if the proportion of female participants substantially exceeded that of males, reflecting the higher prevalence of hypothyroidism in females. Eligible trials assessed vitamin D supplementation (D2 or D3) administered in pharmacological forms with a clearly specified dosage and duration of at least two weeks. Comparators consisted of hypothyroid females who did not receive vitamin D supplementation, along with thyroid hormones. Predefined primary outcome included serum TSH, and in studies done on Hashimoto's thyroiditis, anti-thyroid peroxidase (anti-TPO) antibodies, also called thyroid autoantibodies, were included. Baseline serum 25-hydroxyvitamin D (25[OH]D) levels were recorded in all the included studies to assess initial vitamin D status before intervention. Only randomised controlled trials (RCTs) and clinical trials published in English were considered. Preference was given to studies that included a comparison group, but, recognising that many clinical trials lack such a group, this criterion was applied with some flexibility. Keeping this into account, two single-arm trials without a comparator group were included, as they provided relevant within-group data on the effects of vitamin D supplementation in hypothyroid patients, thereby broadening the evidence base. Studies were excluded if they were observational in design, review articles, editorials, or commentaries. In addition, grey literature and unpublished or non-peer-reviewed material were also excluded. Trials were also excluded if they lacked full-text access, were published only as abstracts, were non-human experimental studies, or failed to specify vitamin D dosage. Studies without proper thyroid function assessment were likewise excluded. Studies in which participants were receiving additional micronutrient supplementation or medications known to influence thyroid function were excluded unless such interventions were equally distributed between study groups.

The search strategy combined both key words and MeSH terms. Intervention-related terms included "Vitamin D," "cholecalciferol," "ergocalciferol," and "25-hydroxyvitamin D," while outcome-related terms covered "thyroid hormones," "hypothyroidism," "TSH," "thyrotropin," "thyroxine," "triiodothyronine," and "autoantibodies." The population was defined using terms such as "women of reproductive age," "women of childbearing age," "fertile women," and "premenopausal." To capture study design, the terms "randomized," "randomised," and "clinical trial" were used. The final Boolean search string applied was: ("Vitamin D" OR cholecalciferol OR ergocalciferol OR "25-hydroxyvitamin D") AND (hypothyroidism OR "thyroid hormone" OR TSH OR thyrotropin OR thyroxine OR triiodothyronine) AND ("reproductive age" OR "women of childbearing age" OR "fertile women" OR premenopausal) AND (randomized OR randomised OR "clinical trial").

The search results were independently screened by three reviewers. Screening was performed in duplicate using Microsoft Excel, to minimise selection bias. Titles and abstracts were assessed for relevance, followed by full-text review to confirm eligibility. Disagreements were resolved through discussion, and when consensus could not be reached, a third reviewer provided the final decision.

Data extraction was conducted in duplicate using a structured proforma developed in advance. The extracted data included study identification (ID), title, authors, year of publication, study setting, study design, population age range, dosage of vitamin D supplementation, baseline and post-intervention levels of TSH, assessment of thyroid autoimmunity (if available), and parameters related to risk of bias. Each data item was systematically coded and entered into a central Microsoft Excel spreadsheet, with consistency checks performed by separate reviewers to ensure accuracy.

The risk of bias was assessed for each study using the Cochrane Risk of Bias tool (RoB 1.0), evaluating seven domains: random sequence generation, allocation concealment, blinding of participants, blinding of outcome assessors, completeness of outcome data, selective reporting, and other potential sources of bias. Each domain was rated as low, high or unclear risk of bias based on the criteria outlined in the Cochrane Handbook for Systematic Reviews of Interventions version 5 (2008, updated through 2011).[14] The overall risk of bias was classified as low if all domains were rated low risk; unclear, if one or more domains had unclear risk but none had high risk; and high if at least one domain had high risk. Three reviewers independently assessed each study, resolving disagreements through discussion with a third reviewer, when necessary.

Additionally, other potential sources of bias were considered, such as whether the baseline vitamin D status of participants was reported and accounted for, and whether ethical clearance was obtained and documented, and the route of Vitamin D administration. Each study was independently assessed for risk of bias by two reviewers, and any discrepancies in judgments were discussed and resolved through consensus to ensure reliability and objectivity in the risk-of-bias evaluation.

The findings were synthesised narratively due to variability in participant characteristics, interventions, comparators, outcome measures, and two different study designs across the included studies. This approach allowed integration and interpretation of results within a structured descriptive framework.

Data on thyroid function parameters (TSH and anti-TPO antibodies) was extracted from all the included studies. To ensure consistency and comparability, all hormone concentrations were converted into standard international (SI) units using established conversion factors.

Results

Of the 384 identified records, 11(2.86%) were analysed in

Table -1: Risk of bias assessment of the studies analysed.

Author (Year)	Random Sequence Generation	Allocation Concealment	Blinding (Participants/ Personnel)	Blinding (Outcome Assessors)	Incomplete Outcome Data	Selective Reporting	Other Bias	Overall Risk
Chahardoli et al. (2019)[15]	Low	Low	Low	Low	Low	Low	Low	Low
Al Johani et al. (2018)[16]	Low	Unclear	No randomization done. No control group. It was a clinical trial	No randomization done. No control group. It was a clinical trial.	Low	Low	Low	Unclear
Safari et al. (2023)[17]	Low	Low	Low	Low	Low	Low	Low	Low
Bhakat et al. (2023)[18]	Low	Low	Low	Low	Low	Low	Low	Low
Pezeshki et al. (2020)[19]	Low	Low	No randomization done. No control group	No randomization done. No control group	Low	Low	Low	Low
Chaudhary et al. (2016)[20]	Low	Unclear	Low	Unclear	Low	Low	HighOpen labelled design*	Unclear
Talaei et al. (2018)[21]	Low	Low	Low	Low	Low	Low	Vitamin D sponsored**	unclear
Robat-Jazi et al. (2022)[22]	Low	Low	Low	Low	Low	Low	Low	Low
Jiang et al. (2023)[23]	Low	Low	Low	Low	Low	Low	Low	Low
Anaraki et al. (2017)[24]	Low	Low	Low	Low	Low	Low	Low	Low
Dabbaghmanesh et al. (2019)[25]	Low	Low	Low	Low	Low	Low	Low	Low

Note: *The name of the drug was not concealed from either the investigators or the participants. **The drugs administered were sponsored by pharmaceutical companies.

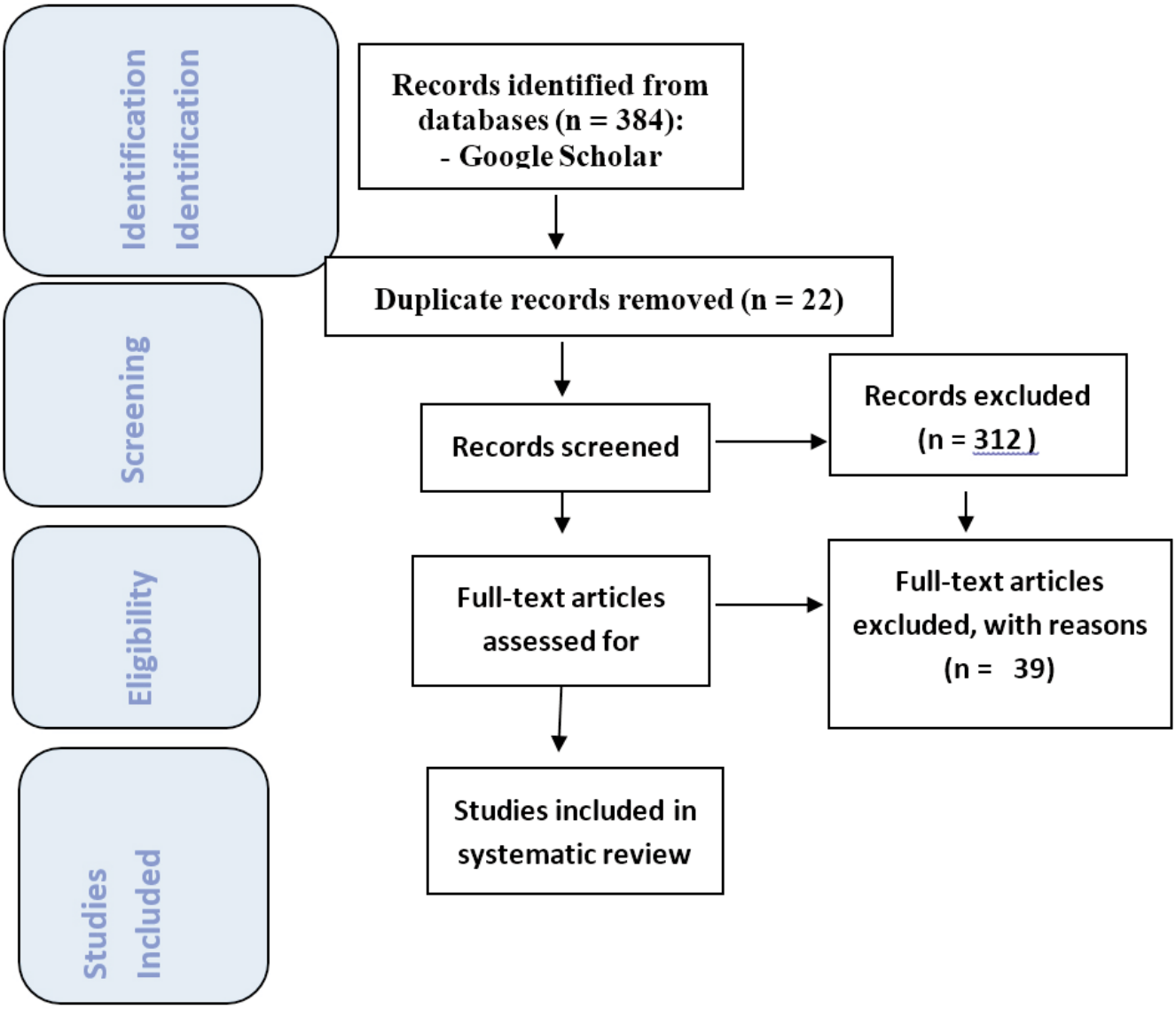

Figure: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 flow diagram.

detail15-25 (Figure); 9(81.81%) RCTs and 2(18.18%) clinical trials. The overall risk of bias was low in 8(63.3%) studies (Table 1).

The studies were published between 2015 and 2023, and were conducted in Asian countries. All the 11(100%) studies included VDD hypothyroid females aged 12-65 years.

Nine out of eleven studies mentioned generalized term of cholecalciferol, only two specifically mentioned (vitamin D3) usage at varying doses, ranging from 800 IU/day to 60,000 IU/week. The intervention durations ranged 2-24 weeks. All the 11(100%) studies explicitly detailed the vitamin D dose, dosing frequency and participants' baseline vitamin D status, ensuring clarity and comparability although the route of administration was not specified in some studies.[15,16,18,22]

The baseline vitamin D levels ranged from 11.94±5.47ng/mL to 25.29±11.33ng/mL, with six studies participants classified as deficient (<20ng/mL) and in remaining five insufficient (20-<30ng/mL). Baseline TSH levels varied from 2.6±1.4 to 50.8±21.18mIU/L, and post-supplementation values showed a reduction in nine studies following vitamin D supplementation, except in 2(18.18%) studies.[23,24] Baseline anti-TPO antibody levels ranged from 38.26±145.02IU/mL to 820.25±98.^{2} IU/mL across the studies. In studies reporting follow-up data, seven studies demonstrated a reduction after vitamin D supplementation, with decreases ranging from modest

Table-2: Summary of the studies analysed.

Author(Year)	Country	Population	Vitamin D Dosage	Anti-TPO (IU/ml)	TSH (mIU/L)	Key Findings
Chahardoli et al (2019)[15]	Iran	Hashimoto's Thyroiditis	50,000 IU/week	Before131.4 ± 108, after intervention 118.1 ± 97.9	Before 3 ± 2.09, after intervention, 3 ± 1.4	↓Anti-TPO TSH ↓
Al Johani et al(2018)[16]	KSA	Hashimoto's Thyroiditis	50,000 IU/week	Before,343.4 ± 145 after intervention 125 ± 58	Before 6.1 ± 0.3, after4.8 ± 0.2	↓Anti-TPO TSH ↓
Safari et al.(2023)[17]	Iran	Sub clinical hypothyroidism	50,000 IU/week	Not measured	before 7.150 ± 1.107, after intervention 5.681 ± 1.003	TSH ↓
Bhakat et al.(2023)[18]	India	Hashimoto's Thyroiditis	60,000 IU/ week	Before, 545.06±230.8 after intervention 378.60±160.4	Before 50.8±21.18, after intervention 3.70±0.37	↓Anti-TPO TSH↓
Pezeshki et al(2020)[19]	Iran	Sub clinical hypothyroidism	50000 IU	Not measured	Before 6.89 ± 1.48 after intervention 3.34 ± 1.35	TSH↓
Chaudhary et al (2016)[20]	India	Hashimoto's Thyroiditis	60,000 IU/ week	Before 687.8± 25.51, after intervention -16.6 percent change	Before 6.8±1.4 after intervention 3.39± 2.19	↓Anti-TPO TSH ↓
Talaei et al(2018)[21]	Iran	Pre diagnosed cases of hypothyroid were stable for more than one year	50,000 IU/week	Not measured	Before 2.6±1.4, after intervention 2.2±1.4	TSH↓
Robat-Jazi et al(2022)[22]	Iran	Hashimoto's thyroiditis	50000 IU/week	Before 258.1±1.5 after intervention 132.9± 1.8	Before 3.7± 0.8 after intervention was 3.3 ± 0.9	↓Anti-TPO TSH ↓
Jiang et al(2023)[23]	China	Hashimoto'sthyroiditis	800 IU/day	Before 281.24±165.34, after intervention 231.88±147.33	Before 3.35±1.82, after intervention 2.49±1.22	↓ Anti-TPO TSH ↓
Anaraki et al(2017)[24]	Iran	Hashimoto's thyroiditis	50000 IU/week	Before 820.25± 98.2, after intervention 734±102.93	Before 3.3± 0.5 after intervention 3.88±0.82	↓Anti-TPO TSH ↓
Dabbaghmanesh et al (2019)[25]	Iran	Hashimoto'sthyroiditis	2000 IU/day	before 38.26 ± 145.02 after intervention 23.42 ± 73.86	before 2.74 ± 3.06 after intervention 3.78 ± 5.91	↓ Anti-TPO TSH ↓

TSH: Thyroid-stimulating hormone, TPO: Thyroid peroxidase.

declines to substantial drops, while 1(9.09%) study reported a 16.6% reduction instead of absolute values[20] (Table 2).

Discussion

The systematic review consolidates evidence from nine RCTs and two clinical trials investigating the effects of vitamin D supplementation on thyroid hormone profiles in hypothyroid females of reproductive age. The findings indicate that vitamin D supplementation is generally associated with a reduction in TSH levels in several studies, and a noticeable reduction in thyroid autoantibody titers in studies focusing on autoimmune hypothyroidism (Table 2). These results warrant careful consideration in the light of the growing recognition of vitamin D's roles beyond skeletal health, particularly its immunomodulatory influence on endocrine organs, like the thyroid gland. Considering the high global prevalence

of hypothyroidism and VDD, particularly among South Asian women, these findings hold significant public health relevance.

Across the included trials, six were conducted in patients with Hashimoto's thyroiditis, three in those with subclinical hypothyroidism, and two in mixed cohorts. In these studies, vitamin D supplementation consistently led to reductions in TSH levels and, in many cases, also lowered anti-TPO antibody titers (Table 2). For example, some studies[15,16,18,20,22,23] reported improvement in the serum levels of thyroid hormones, along with biochemical evidence of reduced autoimmune activity. Only two trials[24,25] reported slight increases in TSH despite reductions in anti-TPO levels, indicating that the hormonal response to vitamin D supplementation was not uniform across the studies (Table 2). This finding is consistent with broader evidence indicating that vitamin D may influence the hypothalamic-pituitary-thyroid (HPT) axis through immunomodulatory mechanisms, such as reducing pro inflammatory cytokines and curbing antigen presentation, which can impair thyroid hormone synthesis and release.[26] The greatest improvements, seen as larger reductions in TSH and anti-TPO antibody levels, were reported in participants with baseline VDD and autoimmune thyroiditis, suggesting that the immune-related form of hypothyroidism may respond best to supplementation.[15,18] The consistent reduction in TSH across different geographical regions and ethnic groups supports the wider applicability of these findings.

Although the risk of bias assessment indicated that most trials were methodologically sound with low risk across key domains, variability remained in how outcomes were reported (Table 1). In several studies, details regarding intervention protocols, follow-up duration, or completeness of outcome data were not fully described, which may limit the strength and comparability of the evidence even where TSH and anti-TPO were reported (Table 1). After homogenising units across reported thyroid outcomes (Table 2), it was also evident that most studies either did not present all parameters consistently, or showed only minimal changes in hormone concentrations following vitamin D therapy.

Notably, improvements tended to occur in trials with longer intervention durations (>12 weeks) and substantial correction of baseline VDD, supporting the hypothesis that both time and dose adequacy are key determinants of endocrine responsiveness.[15,17,21] This pattern is reflected in studies conducted in Iran where increased vitamin D status was associated with decrease in the levels of serum TSH.[17,25] Conversely, studies with only marginal deficiency at baseline or shorter supplementation periods of vitamin D supplementation showed no meaningful change in the Chinese cohort.[23]

One of the most compelling findings in this review is the consistent reduction in anti-TPO antibody levels reported in several trials, particularly those involving autoimmune hypothyroidism. Studies from Saudi Arabia,[16] India[18,20] and Iran,[15,17,19,21] demonstrated that high-dose vitamin D supplementation, most commonly 50,000-60,000IU weekly, produced marked declines in antibody titers.[18,16] Such reductions are clinically significant, as anti-TPO antibodies play a central role in the immune-mediated destruction of thyroid follicular cells, and serve as a prognostic marker for disease progression in Hashimoto's thyroiditis. Their presence is associated with a higher annual risk of developing overt hypothyroidism, particularly in individuals with subclinical hypothyroidism, compared to those without detectable antibodies.[27,28] The observed decline aligns with proposed mechanisms whereby vitamin D downregulates cytokine production mediated by T helper 1 (Th1) cells, and promotes regulatory T-cell activity, thereby dampening autoimmune responses.[15,22] In contrast, smaller or absent changes were seen in trials using lower daily doses, such as 800-2,000IU/day,[23,25] or in studies without confirmed baseline deficiency,[24] underscoring the importance of dose adequacy and initial vitamin D status. Notably, in most high-dose trials, antibody reduction paralleled improvements in TSH, suggesting a mechanistic link between immune modulation and thyroid axis regulation.[15,18] These findings are particularly relevant in resource-limited settings, such as Pakistan and India, where antibody testing is not routinely performed, highlighting the potential role of vitamin D optimisation in both biochemical control and attenuation of the autoimmune process, with possible implications for reducing long-term levothyroxine dependence in select patients.

Regarding thyroid autoantibodies, the evidence on changes in thyroid volume or thyroid hormone receptor expression remains limited. One trial from India reported thyroid ultrasound findings, while another trial from Iran evaluated Vitamin D receptor (VDR) expression.[18,21] The Indian study produced inconclusive results, showing no consistent reduction in gland size after supplementation. In contrast, the Iranian study demonstrated a decrease in VDR expression, along with reductions in the inflammatory mediators interferon-gamma (IFNγ)-interferon-gamma-inducible protein 10 (IP10) and tumour necrosis factor-alpha (TNF-α) in the serum of patients with Hashimoto's thyroiditis following vitamin D

supplementation. None of the included studies quantitatively assessed thyroid hormone receptor expression at the molecular level, underscoring a clear gap in mechanistic research. Some authors, however, postulated that improved receptor sensitivity could partially explain observed biochemical improvements in TSH.[15,18]

Methodological appraisal revealed that while most studies implemented randomisation and adequately described intervention protocols (e.g., dosage, frequency, and duration), several lacked blinding or allocation concealment, introducing potential performance and detection bias (Table 1).[24,25]Additionally, marked heterogeneity was evident in supplementation regimens (ranging from daily doses of 800-2000IU to weekly high-dose regimens of 50,000-60,000IU), baseline vitamin D status, and hypothyroidism subtypes (Hashimoto's, subclinical, and long-term treated cases), limiting the feasibility of formal meta-analysis and necessitating a narrative synthesis. Despite these limitations, the consistent directionality of outcomes, particularly TSH reduction and anti-TPO decline, across the region.[15-19]

Overall, the review supports the growing body of literature suggesting that vitamin D plays a supportive role in thyroid hormone regulation and autoimmunity. Its impact appears to be most pronounced in females with subclinical or autoimmune hypothyroidism and pre-existing VDD. While current guidelines do not advocate routine vitamin D supplementation for thyroid management, these findings underscore the potential benefits of an integrated approach that includes vitamin D optimisation as part of hypothyroidism care, particularly in high-risk, low-resource settings, such as Pakistan.

Although this review consolidates evidence from clinical trials conducted in different Asian countries, it has its limitations, with several factors constraining the strength and applicability of the findings. Considerable heterogeneity was observed across studies in terms of vitamin D dosing regimens, intervention durations, baseline serum ^{25}(OH)D levels, and participant age range, which made a formal meta-analysis inappropriate. In addition, blinding and allocation concealment were not consistently reported, introducing the possibility of performance and selection bias.

All the included studies emphasised biochemical outcomes, such as TSH and anti-TPO antibodies, rather than clinical endpoints, like symptom improvement, fertility outcomes, or quality of life, limiting the ability to translate these results into patient-centred care. None of the included studies reported major adverse effects from vitamin D supplementation. However, since most trials did not systematically evaluate or report safety outcomes, it is difficult to draw firm conclusions about the overall tolerability of vitamin D supplementation.

Since all the included studies were conducted in Asian populations, the evidence highlights a region-specific burden, and suggests that vitamin D optimisation may serve as a useful adjunct in managing thyroid dysfunction in this demographic group. However, none of the trials were carried out in Pakistan, a country with a particularly high prevalence of both VDD and thyroid disorders, which limits the direct applicability of these findings to the local context. In addition, publication bias cannot be ruled out, as smaller trials with positive results are more likely to be published, and the limited number of available studies did not allow for a formal assessment of reporting bias.

Given the widespread VDD among women in Asia, particularly in Pakistan, the current results carry important public health implications. Vitamin D optimisation may not only improve endocrine outcomes, but also contribute to broader reproductive, metabolic and immunological health. However, current evidence is limited by variability in intervention protocols and methodological heterogeneity across trials.

Future research should prioritise large-scale, well-designed RCTs that standardise vitamin D dosing, account for baseline vitamin D status, and explore long-term clinical outcomes. Until then, clinicians may consider evaluating vitamin D levels as part of routine hypothyroidism management and initiate supplementation when deficiency is identified.

The results of this review highlight the need for a paradigm shift in how nutritional factors are integrated into endocrine care, particularly for women of reproductive age. In low- and middle-income countries (LMICs), like Pakistan, where access to regular endocrinological evaluations may be limited, ensuring optimal vitamin D levels could serve as a simple and cost-effective strategy to support thyroid health and immune regulation.

In addition to guiding biochemical outcomes, future research should explore the long-term effects of vitamin D supplementation on clinical endpoints, such as menstrual regularity, fertility outcomes, pregnancy success rates, cognitive function, and patient-reported thyroid symptom scores. Molecular studies investigating the modulation of thyroid hormone receptor sensitivity or downstream signalling pathways in response to vitamin D

would also deepen understanding of underlying mechanisms.

Clinicians managing hypothyroid females, particularly those with subclinical or autoimmune aetiologies, should routinely assess serum vitamin D levels, and address deficiencies as part of integrated care. In regions with high deficiency rates, such as Pakistan, public health frameworks should incorporate awareness and prevention campaigns highlighting vitamin D's role in thyroid and reproductive health. Although not a replacement for standard therapies like levothyroxine, vitamin D may be used adjunctively in cases of poor biochemical control, persistent symptoms, or coexisting autoimmunity. Large, multicentre RCTs with standardised dosing and robust methodology are needed to confirm and expand the current findings.

For future primary studies and stronger evidence syntheses, pre-specification and consistent measurement of both total and free thyroid hormones, with clear descriptions of assay methods, is recommended. Standardised reporting of units (or dual reporting) and transparent documentation of baseline vitamin D and thyroid status is also recommended. Consistent reporting of intervention details, including dose, formulation, duration and adherence, as well as adequately powered sample sizes to detect small but clinically meaningful changes in thyroid function are also recommended.

Conclusion

Vitamin D supplementation may have a beneficial effect on thyroid function in hypothyroid females of reproductive age, particularly by lowering serum TSH levels, and reducing thyroid autoantibody titers in autoimmune thyroiditis. These findings suggest a potential adjunctive role for vitamin D in managing hypothyroidism, especially in populations where both conditions coexist at high prevalence.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

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AUTHORS' CONTRIBUTIONS:

GI & NK: Literature search, data analysis, interpretation, revision, review, final approval and agreement to be accountable for all aspects of the work.

MH: Literature search, took primary responsibility, drafting, review, final approval and agreement to be accountable for all aspects of the work.