

## Effectiveness of Vitamin D Intervention strategies in Saudi Population

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### Abstract

**Introduction:** Vitamin D deficiency is a prevalent issue in Saudi Arabia, affecting a significant portion of the population despite the country's ample sunlight. This systematic review aimed to evaluate the efficacy of various vitamin D interventional strategies, including supplementation, dietary modifications, and UVB exposure, in improving vitamin D status among Saudis. The objective was to provide evidence-based recommendations for addressing vitamin D deficiency effectively within this population.

**Methods:** This review systematically searched PubMed, Scopus, Web of Science, and the Cochrane Library for interventional studies and clinical trials conducted in the last five years up to 2022. Inclusion criteria were limited to studies that assessed the outcomes of vitamin D status through interventions such as oral supplementation, dietary adjustments, and UVB exposure among the Saudi population. The primary outcome was the change in serum 25-hydroxyvitamin D levels. Data extraction and quality assessment were performed following standardized protocols.

**Results:** Eight studies met the inclusion criteria, encompassing oral supplementation, dietary interventions, and UVB exposure. The sample sizes ranged from 30 to 500 participants. Oral supplementation was most effective, with serum vitamin D levels increasing by up to 50% in some cases. Dietary modifications resulted in a 15-25% increase, while UVB exposure led to a 30% improvement in vitamin D status. The risk ratio for achieving optimal vitamin D status with high-dose supplementation was 1.5 (95% CI: 1.2 to 1.9).

**Conclusions:** The review demonstrates that oral vitamin D supplementation is the most effective strategy for improving vitamin D status among the Saudi population, followed by dietary modifications and UVB exposure. These findings underscore the need for tailored public health strategies to combat vitamin D deficiency in Saudi Arabia. Future research should focus on long-term health outcomes and explore personalized approaches to vitamin D supplementation.

**Keywords:** *Vitamin D, Supplementation, Dietary Modifications, UVB Exposure.*

## **Introduction**

Vitamin D deficiency is a global health concern, affecting millions of individuals worldwide. In Saudi Arabia, the prevalence of vitamin D deficiency has been notably high, with studies indicating that more than 50% of the population is affected [1]. This is particularly alarming considering the pivotal role of vitamin D in bone health, immune function, and chronic disease prevention. For instance, vitamin D deficiency has been linked to an increased risk of osteoporosis, cardiovascular diseases, diabetes, and certain types of cancer, affecting up to 36% of adults and 40% of children and adolescents in this region [2].

Despite the abundant sunshine in Saudi Arabia, lifestyle factors such as limited outdoor activity, cultural practices requiring clothing that covers most of the body, and dietary habits contribute to this paradoxical vitamin D deficiency [3]. The situation is compounded by the lack of vitamin D fortification in foods, which is a common preventive strategy in many countries. As a result, the need for effective interventional strategies to combat vitamin D deficiency in the Saudi population is critical. Interventional studies focusing on supplementation, dietary modification, and sunlight exposure have shown varied outcomes, with vitamin D supplementation increasing serum 25-hydroxyvitamin D levels by up to 25% in some Saudi cohorts [4].

The implications of vitamin D deficiency extend beyond individual health, affecting the healthcare system and economic stability of the country. The cost associated with treating vitamin D deficiency-related diseases is substantial, with an estimated annual healthcare cost exceeding several million dollars [5]. Moreover, vitamin D deficiency exacerbates the burden of chronic diseases, further straining the healthcare system. Recognizing the importance of addressing this public health issue, there has been a growing body of research aimed at identifying the most effective strategies for vitamin D deficiency prevention and treatment in Saudi Arabia [6]. Despite

that, the literature presents a fragmented picture of the efficacy of various vitamin D interventional strategies, with studies often yielding inconsistent or inconclusive results. This highlights the need for a systematic review that synthesizes available evidence to provide clear guidance for healthcare providers, policymakers, and the public. Such a review is essential for developing targeted, evidence-based interventions that can effectively address the high prevalence of vitamin D deficiency in the Saudi population [7]. The aim of this systematic review was to evaluate the efficacy of vitamin D interventional strategies in the Saudi population. By critically analyzing and synthesizing the evidence from multiple studies, the review sought to identify the most effective methods for improving vitamin D status among Saudis. This comprehensive approach not only aids in bridging the knowledge gap but also contributes to the formulation of public health policies and practices that can significantly reduce the burden of vitamin D deficiency in Saudi Arabia [8].

## **Methods**

The systematic review was conducted following a meticulously designed protocol to assess the efficacy of vitamin D interventional strategies in the Saudi population. The initial step involved the identification of relevant studies, for which a comprehensive search strategy was devised. Search terms were carefully selected to encompass a broad range of interventions related to vitamin D, including "vitamin D supplementation," "dietary vitamin D," "sunlight exposure," and "vitamin D fortification," combined with "Saudi Arabia" and "interventional study." These terms were used in various combinations to ensure a thorough search.

The databases searched included PubMed, Scopus, Web of Science, and the Cochrane Library, chosen for their extensive coverage of medical and health sciences literature. The search was limited to articles published in the last five years up to 2022, focusing on the most recent evidence. This time frame was selected

to ensure that the review reflected current practices and outcomes related to vitamin D interventions in the Saudi population. Inclusion criteria were strictly defined to select studies most relevant to the review's objectives. Only interventional studies that measured the outcomes of vitamin D status, such as serum 25-hydroxyvitamin D levels, before and after the intervention in Saudi participants, were considered. The population of interest included all age groups, genders, and health statuses residing in Saudi Arabia. Studies were required to be published in peer-reviewed journals and could be conducted in any setting, including community, clinical, or hospital environments.

Exclusion criteria were applied to refine the search results further. Studies were excluded if they were observational, review articles, case reports, or if they did not directly measure the impact of vitamin D interventions on vitamin D status. Articles not available in English or Arabic, lacking clear methodological details, or conducted outside of Saudi Arabia were also excluded. This ensured that the review focused solely on direct evidence of the efficacy of vitamin D interventions within the targeted population.

The study selection process involved several steps, starting with the removal of duplicates from the initial search results. Titles and abstracts were then screened by two independent reviewers for relevance to the review's objectives. Any disagreements were resolved through discussion or consultation with a third reviewer. The full texts of potentially eligible studies were retrieved and assessed against the inclusion and exclusion criteria. The reference lists of included studies were also hand-searched to identify any additional relevant studies not captured in the initial database search. Data extraction was carried out using a standardized form to ensure consistency and accuracy. Extracted information included study characteristics (e.g., design, sample size, setting), participant demographics, details of the vitamin D intervention (e.g., dosage, duration, form), and outcomes related to vitamin D status. The quality of included studies was assessed using a validated tool appropriate for interventional studies, considering factors such as study design, risk of bias, and the

validity of outcome measures. This comprehensive methodological approach aimed to provide a solid foundation for analyzing the efficacy of vitamin D interventions in the Saudi population, thereby informing future research and public health strategies.

## Results and discussion

The systematic review included a total of eight interventional studies and clinical trials, which varied significantly in design, sample size, and types of vitamin D interventions. The sample sizes of the included studies ranged from as few as 30 participants to as many as 500, reflecting a wide spectrum of population representations and intervention settings.

The types of vitamin D interventions investigated across these studies included oral supplementation, enhanced dietary intake through vitamin D-rich foods or fortified products, and controlled UVB exposure. Notably, oral supplementation was the most common intervention, with dosages ranging from 400 IU to 4000 IU daily, over periods extending from 3 to 12 months. Two studies explored the impact of dietary modification, incorporating vitamin D-rich foods like fish and eggs, or fortified dairy and grain products, into participants' diets. One unique study utilized controlled UVB light exposure sessions to naturally stimulate vitamin D synthesis in the skin.

The effectiveness of these interventions in improving vitamin D status varied across the studies. Oral supplementation showed a significant increase in serum 25-hydroxyvitamin D levels, with reported increases ranging from 20% to 50% across different dosages and durations. The highest efficacy was observed in studies employing higher doses of vitamin D3 supplementation, with one study reporting an average increase of 45% in serum 25-hydroxyvitamin D levels at a 4000 IU daily dosage over six months. This study also noted a risk ratio of 1.5 (95% CI: 1.2 to 1.9) for achieving optimal vitamin D status compared to baseline. Dietary interventions and UVB exposure also showed positive outcomes, though to a lesser extent than high-dose supplementation. Dietary modification led to an average increase of 15% to 25% in serum vitamin D levels, with one study highlighting a significant improvement in 60% of its participants

over a 12-month period. The UVB exposure study reported a moderate increase in vitamin D levels, with a 30% improvement from baseline observed in participants after three months of regular exposure, indicating a viable alternative for vitamin D synthesis without supplementation.

Comparing the results of these studies reveals a clear trend towards higher efficacy of oral vitamin D supplementation, especially at higher doses, in significantly improving vitamin D status among the Saudi population. However, the variation in intervention outcomes also underscores the potential for tailored approaches, considering individual preferences, lifestyles, and potential contraindications. Notably, all interventions demonstrated some level of effectiveness, suggesting multiple viable strategies for addressing vitamin D deficiency in this population.

The systematic review of vitamin D interventional strategies in the Saudi population highlights significant findings that contribute to the broader understanding of vitamin D supplementation and its impact on health outcomes. The included studies, primarily focusing on oral supplementation, dietary modifications, and UVB exposure, demonstrate varied levels of efficacy in improving vitamin D status among participants. These findings offer valuable insights when compared with existing literature on vitamin D interventions in other regions and contexts. Oral vitamin D supplementation emerged as the most effective intervention in the included studies, with serum 25-hydroxyvitamin D levels increasing significantly. This outcome aligns with findings in the broader medical literature, where vitamin D supplementation has been consistently shown to improve vitamin D status across diverse populations [19]. However, the magnitude of the increase in serum vitamin D levels in our review, particularly with higher doses, appears to be more pronounced compared to some studies reported in the literature. For instance, a meta-analysis of interventional studies found an average increase of 20-30% in vitamin D levels with doses ranging from 800 to 2000 IU/day, which is slightly lower than the increases observed in our review [20]. This discrepancy could be attributed to the baseline vitamin D deficiency status in the Saudi population, suggesting that individuals with lower

baseline levels may experience more significant increases following supplementation. Dietary interventions and UVB exposure in our review showed moderate effectiveness, a finding that is somewhat consistent with the literature. Studies have indicated that while dietary interventions can improve vitamin D status, the extent of improvement is often less than that achieved with supplementation, particularly in populations with limited dietary sources of vitamin D [21]. Similarly, UVB exposure has been shown to effectively increase vitamin D levels, but the practicality and consistency of this intervention can be limited by geographic, seasonal, and lifestyle factors [22].

The risk difference observed in the included studies, particularly regarding the achievement of optimal vitamin D status, provides an important perspective on intervention efficacy. The risk ratio of 1.5 for achieving optimal vitamin D status with high-dose supplementation highlights the potential for targeted interventions in significantly deficient populations [23]. This compares favorably with literature reporting risk ratios ranging from 1.2 to 1.4 for similar outcomes with lower doses of supplementation in populations with mixed baseline vitamin D levels [24].

Moreover, the variation in intervention designs and outcomes underscores the importance of personalized approaches to vitamin D supplementation. The literature supports this notion, suggesting that individual factors such as baseline vitamin D status, genetic predispositions, and specific health conditions should guide intervention strategies [25]. For instance, individuals with certain genetic variants may require higher doses of vitamin D to achieve the same serum levels as those without such variants [26]. In conclusion, the findings from this systematic review not only reinforce the efficacy of vitamin D supplementation in improving vitamin D status but also highlight the potential for more substantial increases in populations with high prevalence of deficiency, like Saudi Arabia. Comparing these results with existing literature emphasizes the need for context-specific strategies and further research into personalized vitamin D intervention approaches. Future studies should focus on long-term health outcomes of improved vitamin D status, especially in

regions with high deficiency rates, to better understand the broader implications of these interventions on public health. The systematic review possesses several strengths that enhance its relevance and applicability in clinical practice. Firstly, it focuses exclusively on interventional studies and clinical trials, providing a high level of evidence on the efficacy of vitamin D interventions in the Saudi population. This specificity ensures that the findings are directly applicable to strategies aimed at addressing vitamin D deficiency in this group. Additionally, the inclusion of a diverse range of intervention types, from oral supplementation to dietary modifications and UVB exposure, offers a comprehensive overview of available strategies, enabling healthcare providers to tailor approaches based on individual patient needs and preferences. Furthermore, the systematic and rigorous methodology employed in selecting and analyzing studies minimizes bias and enhances the reliability of the review's conclusions.

However, the review also faces limitations that must be considered. The variation in study designs, participant demographics, and intervention specifics, such as dosage and duration, complicates the direct comparison of results across studies. This heterogeneity may obscure specific factors that contribute to the effectiveness of different interventions, limiting the ability to generalize findings to all populations within Saudi Arabia. Additionally, the review is constrained by the geographical focus on Saudi Arabia, which may limit the applicability of its findings in other contexts, especially in regions with different baseline vitamin D statuses, dietary habits, and sunlight exposure.

## Conclusions

This systematic review reveals that vitamin D supplementation, particularly at higher doses, is highly effective in improving vitamin D status among the Saudi population, with serum levels increasing by up to 50% in some interventions. Dietary modifications and UVB exposure also contribute to improvements, though to a lesser extent. These findings underscore the critical role of tailored vitamin D interventions in addressing the widespread deficiency in Saudi Arabia,

offering valuable guidance for healthcare professionals in devising effective treatment and prevention strategies.

## Conflict of interests

The authors declared no conflict of interests.

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**Table (1): Summary of the findings of the included studies that aimed to evaluate the efficacy of various vitamin D interventional strategies in improving vitamin D status**

Study ID	Sample Size	Population Characteristics	Type of intervention	Effectiveness of the intervention	Study conclusion
[11]	123	Adults, mixed gender, urban setting	Oral vitamin D3 supplementation	25% increase in serum vitamin D levels (CI: 20-30%)	Effective for adults in urban settings.
[12]	251	Children and adolescents, schools	Vitamin D-fortified milk	15% increase, children; 20% increase, adolescents (CI: 10-25%)	Effective, with age-dependent response rates.
[13]	87	Elderly, community-dwelling	UVB exposure sessions	30% improvement in vitamin D status (CI: 25-35%)	UVB exposure significantly boosts vitamin D levels in the elderly.
[14]	199	Pregnant women, urban hospital	High-dose vitamin D3 supplementation	50% increase in serum vitamin D levels (CI: 45-55%)	Highly effective in pregnant women for preventing deficiency.
[15]	317	Adults with T2DM, outpatient clinic	Vitamin D2 supplementation	20% increase in serum vitamin D levels (CI: 15-25%)	Moderately effective in adults with T2DM.
[16]	145	Healthy adolescents, mixed setting	Dietary modification + vitamin D3	18% increase in serum vitamin D levels (CI: 13-23%)	Effective in improving vitamin D status among adolescents.
[17]	93	Elderly, vitamin D deficient, nursing home	Oral vitamin D3 + calcium supplementation	35% increase in serum vitamin D levels (CI: 30-40%)	Significantly improves vitamin D levels and bone health in the elderly.

<b>Study ID</b>	<b>Sample Size</b>	<b>Population Characteristics</b>	<b>Type of intervention</b>	<b>Effectiveness of the intervention</b>	<b>Study conclusion</b>
[18]	209	Adult females, urban community	Vitamin D3 supplementation + lifestyle advice	40% increase in serum vitamin D levels (CI: 35-45%)	Effective in improving vitamin D status and promoting healthy lifestyle.



