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The Role of Vitamin D in Acne Vulgaris:

A Comprehensive Review of Recent Advances

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Abstract

Acne vulgaris is a common dermatological condition affecting millions worldwide, particularly adolescents and young adults. Recent research suggests a potential link between vitamin D levels and acne severity, highlighting the role of vitamin D in immune regulation and inflammation. This review analyzes studies published from 2020 onward, focusing on the relationship between vitamin D deficiency and acne, as well as the therapeutic potential of vitamin D supplementation.

A systematic search on PubMed identified 10 significant studies, including 7 original research articles and 3 systematic reviews or meta-analyses. The findings indicate a notable prevalence of vitamin D deficiency among acne patients, with several studies showing significantly lower serum 25-hydroxyvitamin D levels compared to healthy controls. Furthermore, clinical trials demonstrated that topical vitamin D can effectively reduce inflammatory markers, suggesting its therapeutic potential.

Despite these findings, the relationship between vitamin D levels and acne severity is complex, with some studies showing no significant correlation. This inconsistency underscores the need for further investigation into the mechanisms linking vitamin D deficiency to acne. Overall, this review emphasizes the potential of vitamin D as a therapeutic target in acne management and calls for more robust studies to clarify its role in mitigating acne-related inflammation and improving patient outcomes.

Keywords: acne vulgaris, vitamin D deficiency, IL-1β, acne severity

Introduction

Acne vulgaris (AV) is a chronic inflammatory skin condition and one of the most prevalent dermatological disorders worldwide, affecting approximately 9.4% of the global population (Tan et al., 2015). It predominantly impacts adolescents, with boys often experiencing more severe cases, but also persists into adulthood. Acne's effects extend beyond the physical, as it can significantly impair quality of life (QoL) and mental health. Studies show that individuals with chronic skin conditions like acne face a heightened risk of depression and even suicidality (Barlow et al., 2023). Given these profound impacts, there is a pressing need for safe and effective therapeutic interventions.

Emerging evidence highlights the potential role of lifestyle factors, including diet, in acne management. Diets with a high glycemic index and glycemic load have been associated with increased acne severity, suggesting that dietary modifications may play a role in reducing acne symptoms (Meixiong et al., 2022). Additionally, adherence to a diet rich in antioxidants has been shown to improve QoL and reduce depressive symptoms in young women with acne, emphasizing the importance of nutritional approaches in holistic acne treatment (Zujko-Kowalska et al., 2024).

Recently, vitamin D has garnered significant attention for its therapeutic potential across various diseases. Traditionally known for its role in bone health, vitamin D is now recognized as a critical regulator of immune, nervous, and dermatological functions (Mostafa & Hegazy, 2015). Deficiencies in vitamin D are widespread and have been linked to a spectrum of conditions, including autoimmune diseases, neurological disorders, and cancers (Zhang & Naughton, 2010). In dermatology, evidence suggests that serum vitamin D levels inversely correlate with the severity of hidradenitis suppurativa, a chronic inflammatory skin disorder, and that supplementation may reduce disease progression (Lackner et al., 2024).

Moreover, vitamin D's impact extends to systemic health issues. For instance, it has been shown to alleviate asthma exacerbations in children (Fedora et al., 2024), improve glycemic control in type 2 diabetes (Sim et al., 2024), and reduce symptoms of depression and anxiety, particularly in vulnerable populations like ante- and postnatal women (Centeno et al., 2024). Moreover, a recent meta-analysis revealed a correlation between vitamin D levels and systemic sclerosis, suggesting that its deficiency may exacerbate clinical features of this autoimmune condition (Dhaouadi et al., 2024). Such findings underscore the broad-reaching effects of vitamin D on

immune regulation, systemic health and suggest that vitamin D may influence pathways integral to both physical and mental health.

These potential effects of vitamin D are highly promising and may also extend to acne, a widespread societal concern. The increasing body of research exploring this connection offers exciting possibilities for better understanding and management of acne through vitamin D interventions. In this review, we focus on the problem of acne and analyze the association between vitamin D deficiency and acne severity. By synthesizing and critically examining the latest studies, this review aims to provide a comprehensive understanding of how vitamin D might influence this prevalent condition and its broader implications for public health.

Methods

This review analyzes studies found exclusively on PubMed, focusing on original research published from 2020 onward. A total of 10 significant studies were identified after a thorough examination of all search results, ensuring the creation of the most accurate and valuable review regarding the impact of vitamin D on acne vulgaris, based on the latest research. This collection comprises 7 original research articles and 3 systematic reviews or meta-analyses. The search was conducted using keywords such as "acne vulgaris," "vitamin D deficiency," and "IL-1β", to ensure comprehensive coverage of relevant literature. Each of the original studies was thoroughly examined to assess the relationship between vitamin D levels and acne vulgaris, with a particular emphasis on their findings regarding the efficacy of vitamin D supplementation or treatment in acne management. The results of these original studies were subsequently compared with the larger-scale analyses provided by the systematic reviews and meta-analyses to gain a more comprehensive understanding of the current landscape of research on this topic.

Standardized evaluation tools were employed to assess the quality and reliability of the included studies, ensuring that the findings of this review are based on robust scientific methodology.

Results

The investigation into the relationship between vitamin D levels and acne vulgaris has yielded a spectrum of findings, illustrating both the prevalence of vitamin D deficiency among acne patients and its potential implications for acne severity. A notable double-blind, randomized clinical trial conducted by Dahlan et al. (2024) evaluated the effects of topical vitamin D on

inflammatory acne vulgaris (AV) lesions. This study focused particularly on the modulation of pro-inflammatory cytokines such as IL-1β. With 64 participants divided into two groups—one receiving topical vitamin D and the other a placebo, both also using adapalene—the results revealed a significant reduction in IL-1β levels within acne lesions ($p = 0.028$). This reduction correlated with a decrease in both the number and severity of moderate to severe inflammatory lesions ($p = 0.045$). Importantly, no significant adverse effects were reported, supporting the safety of topical vitamin D as a treatment option. These findings underscore the potential of vitamin D in mitigating inflammatory processes associated with acne.

In a different context, a study by Iqbal et al. (2023) investigated the relationship between vitamin D levels and acne severity among 150 participants categorized into groups of moderate acne, severe acne, and healthy controls. The results indicated that individuals with acne exhibited significantly lower vitamin D levels compared to healthy controls ($p < 0.001$), with median concentrations of 7.09 ng/mL in severe AV cases, 13.7 ng/mL in moderate cases, and 21.6 ng/mL in the control group. However, despite the observed deficiency, no direct correlation was found between the severity of acne and the degree of vitamin D deficiency (Iqbal et al., 2023). This highlights a complex relationship that requires further exploration, suggesting that while vitamin D deficiency is prevalent among acne patients, it may not serve as a direct exacerbating factor.

Complementing these findings, Shrestha et al. (2022) conducted a comparative analysis of serum vitamin D levels between patients with moderate-to-severe acne and healthy controls. Their findings indicated that a staggering 90.5% of acne patients had insufficient or deficient vitamin D levels, compared to only 43.33% in the control group ($p = 0.001$). Additionally, there was an inverse correlation between vitamin D levels and acne severity, suggesting that lower vitamin D levels were associated with more severe cases. Interestingly, after three months of oral isotretinoin treatment, no significant changes in vitamin D levels were observed ($p = 0.127$) (Shrestha et al., 2022). This raises important questions about the interplay between established acne therapies and vitamin D levels, indicating that current treatments may not address underlying deficiencies.

The relationship between vitamin D levels and inflammatory markers was further elucidated by Singh et al. (2022), who investigated 50 acne patients and their vitamin D status in conjunction with levels of interleukin-17 (IL-17). Their results revealed that 28% of acne patients had vitamin D deficiency, a rate significantly higher than the 6.7% observed in healthy controls (p

= 0.022). Notably, serum 25-hydroxyvitamin D levels showed an inverse correlation with acne severity ($p < 0.001$), while IL-17 levels were significantly elevated in acne patients, increasing in accordance with the severity of acne. The strong negative correlation between IL-17 and vitamin D levels (correlation coefficient: -0.668) indicates that higher IL-17 levels are associated with lower vitamin D levels and more severe acne, suggesting an inflammatory mechanism that warrants further exploration (Singh et al., 2022).

A meta-analysis by Hasamoh et al. (2022) synthesized data from 13 studies, revealing that circulating 25-hydroxyvitamin D levels were significantly lower in acne patients compared to healthy controls, with a pooled mean difference of -9.02 ng/mL (95% CI = -13.22 to -4.81, $p < 0.0001$). This analysis also demonstrated that vitamin D deficiency was nearly three times more prevalent among acne patients than in controls (pooled OR = 2.97, 95% CI = 1.68–5.23), reinforcing the association between low vitamin D levels and the presence of acne (Hasamoh et al., 2022). Such findings highlight the potential role of vitamin D in the pathogenesis of acne, supporting the hypothesis that addressing vitamin D deficiency could play a critical role in managing acne symptoms effectively.

A systematic review by Rasti et al. (2022) analyzed 10 studies, of which eight demonstrated an inverse relationship between serum vitamin D levels and acne severity. However, two studies did not find this correlation to be statistically significant, suggesting that while vitamin D deficiency is linked to worsening acne, the relationship is not universally consistent across all studies (Rasti et al., 2022). This inconsistency emphasizes the need for further research to elucidate the mechanisms involved.

Finally, a systematic review conducted by Wang et al. (2022) confirmed that acne patients have significantly lower serum 25-hydroxyvitamin D levels compared to healthy individuals (SMD = -7.66 ng/mL, 95% CI = -10.92 to -4.40) (Wang et al., 2022). This review highlighted potential therapeutic benefits of vitamin D supplementation in managing acne, suggesting that vitamin D could serve as a promising adjunct in acne treatment and prevention strategies.

While the cumulative evidence from the clinical trials and cohort studies presented above indicates a notable prevalence of vitamin D deficiency in patients with acne vulgaris, it also reveals a complex interplay between vitamin D levels and acne severity. Some studies, such as Alhetheli et al. (2020), found no significant correlation between serum vitamin D levels and acne severity, indicating that while low vitamin D levels are common in this population, they

may not directly exacerbate acne. Furthermore, in a larger cohort study by Kemeriz et al. (2020), a strong negative correlation was identified between serum 25-hydroxyvitamin D levels and Global Acne Grading Scale (GAGS) scores ($p < 0.001$; $r = -0.910$), suggesting that lower vitamin D levels are indeed associated with more severe acne lesions.

Moreover, the findings from Ahmed Mohamed et al. (2021) added further depth to this discussion by demonstrating that treatment with alfacalcidol led to significant increases in serum 25-hydroxyvitamin D levels ($p < 0.05$) and a notable decrease in pro-inflammatory cytokines ($p < 0.05$) in acne patients. This suggests that vitamin D supplementation may provide a beneficial therapeutic option for managing acne vulgaris without adverse effects.

In summary, the results from this analysis collectively indicate a significant prevalence of vitamin D deficiency in individuals with acne vulgaris and suggest an association between low vitamin D levels and increased severity of acne. However, the complexity of this relationship, as indicated by certain studies that found no direct correlation, underscores the need for caution in interpreting these results.

Discussion

The findings from this review highlight the intricate relationship between vitamin D levels and acne vulgaris, a common dermatological condition affecting millions globally. The clinical trials and observational studies analyzed indicate a prevalent deficiency of vitamin D among acne patients and suggest that this deficiency may play a role in the inflammatory processes underlying acne. However, the variability in results across different studies warrants a nuanced discussion regarding the strengths and limitations of the current research, as well as the implications for future investigations.

One of the notable strengths of the studies reviewed is the consistent identification of lower serum vitamin D levels in acne patients compared to healthy controls, as observed in multiple trials (e.g., Kemeriz et al. (2020), Ahmed Mohamed et al. (2021)). This finding reinforces the hypothesis that vitamin D deficiency could be a risk factor for developing or exacerbating acne vulgaris. Additionally, several studies, such as those by Dahlan et al. (2024) and Singh et al. (2022), provide evidence for the anti-inflammatory effects of vitamin D, suggesting that it may have therapeutic potential in managing acne through modulation of pro-inflammatory cytokines.

However, the limitations of the studies must be considered. A significant weakness is the

inconsistency in findings regarding the correlation between vitamin D levels and acne severity. While many studies suggest an inverse relationship, others, such as Iqbal et al. (2023) and Alhetheli et al. (2020), have found no significant correlation. This discrepancy may stem from differences in study design, sample sizes, and demographic variations among participants. Moreover, the reliance on cross-sectional designs in some studies limits the ability to establish causal relationships between vitamin D deficiency and acne severity. Future longitudinal studies are needed to elucidate this relationship and determine whether vitamin D supplementation can lead to improved clinical outcomes in acne patients.

Another important consideration is the variability in methodologies used to assess both vitamin D levels and acne severity. The lack of standardization in measurement techniques may contribute to discrepancies across studies, highlighting the need for consensus on these parameters in future research. Furthermore, the role of confounding factors such as age, gender, skin type, and environmental influences, including sun exposure, must be thoroughly examined to better understand their impact on vitamin D levels and acne severity.

While this review underscores the potential role of vitamin D in acne management, it also points to the necessity for further research. Specifically, studies should focus on investigating the mechanisms through which vitamin D influences acne pathogenesis, including its effects on immune response and inflammation. Additionally, exploring the optimal dosage and duration of vitamin D supplementation could provide valuable insights into its therapeutic efficacy for acne patients.

In conclusion, while there is a growing body of evidence suggesting a link between vitamin D deficiency and acne vulgaris, further investigation is warranted to clarify the nature of this relationship. By addressing the existing gaps in the literature and employing more rigorous study designs, researchers can better determine the role of vitamin D in acne pathogenesis and its potential as a therapeutic target in acne management.

Conclusion

This comprehensive review of the literature on vitamin D and acne vulgaris underscores the significant association between vitamin D deficiency and the prevalence and severity of acne among affected individuals. The majority of studies indicate that acne patients tend to have lower serum levels of vitamin D compared to healthy controls, suggesting that vitamin D may play a crucial role in the pathophysiology of acne through its effects on inflammation and

immune response.

Although the evidence supports a potential therapeutic role for vitamin D in acne management, the inconsistencies across various studies highlight the need for further research. Notably, while some studies demonstrate an inverse correlation between vitamin D levels and acne severity, others fail to establish a significant relationship, indicating a complex interplay of factors influencing acne development.

Future investigations should focus on establishing standardized methodologies for measuring vitamin D and acne severity, as well as exploring the underlying mechanisms that link vitamin D deficiency to acne pathogenesis. Additionally, randomized controlled trials assessing the impact of vitamin D supplementation on acne treatment are essential to determine its therapeutic efficacy.

In conclusion, while vitamin D deficiency appears to be prevalent among acne patients, and its supplementation may offer potential benefits, more robust and comprehensive studies are required to clarify its role in acne management and inform clinical practice effectively. Addressing these gaps in research will ultimately enhance our understanding of acne vulgaris and improve therapeutic strategies for those affected by this common skin condition.

Disclosure

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