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THE ROLE OF DIET IN THE DEVELOPMENT OF ACNE VULGARIS: A REVIEW OF THE LITERATURE

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ABSTRACT

Background: Acne vulgaris is a chronic inflammatory skin disorder influenced by genetic, hormonal and environmental factors. In recent years, the role of diet in acne development and severity has received increasing attention.

Objective: The aim of this review was to summarise and evaluate the current evidence regarding the association between dietary patterns and acne vulgaris. The review focused on key nutritional factors, such as the glycemic index, dairy products, omega-3 fatty acids, probiotics and micronutrients.

Methods: A literature search was conducted using the databases PubMed, Scopus, Web of Science and Google Scholar to identify studies published between 2010 and 2025. Twenty-six peer-reviewed articles, including clinical trials, observational studies and reviews, were included in the analysis. The data were synthesised qualitatively based on dietary categories and reported acne outcomes.

Results: Diets with a high glycemic load, dairy consumption and whey protein supplementation were associated with acne prevalence and severity. By contrast, omega-3 fatty acids, adherence to the Mediterranean diet and probiotic supplementation demonstrated anti-inflammatory and protective effects. Micronutrients such as vitamins A, D and E, as well as zinc, also contributed to improved skin health and reduced lesion counts. However, despite these consistent trends, the heterogeneity of study design and dietary assessment limited the possibility of making direct comparisons between studies.

Conclusion: Diet plays a significant role in modulating acne vulgaris. Low-glycaemic, anti-inflammatory and nutrient-rich diets may complement conventional acne therapies. Further randomised controlled trials are needed to confirm causal relationships and establish evidence-based dietary recommendations for managing acne.

1. Introduction

Acne vulgaris is the most common chronic inflammatory skin condition. It affects around 85% of teenagers and young adults worldwide (Heng & Chew, 2020). It presents as comedones, papules, pustules and, in severe cases, nodules and cysts, primarily on the face, chest and back. The development of acne is influenced by various factors, including increased sebum production, excessive keratinisation of hair follicles, Cutibacterium acnes proliferation, and complex inflammatory and hormonal processes (Baldwin & Tan, 2021). In recent years, particular attention has focused on modifiable environmental and lifestyle factors, particularly diet, as these may contribute to the development and severity of acne (Davidovici & Wolf, 2010).

Historically, the link between acne and diet has been overlooked; however, mounting evidence suggests that dietary factors can significantly influence the biological pathways implicated in acne development. Diets with a high glycemic index (GI) and glycemic load (GL) have been shown to increase circulating insulin and insulin-like growth factor-1 (IGF-1) levels, stimulating sebocyte proliferation and androgen synthesis (Burris et al., 2018; Gruszczyńska et al., 2023). Similarly, consuming dairy products, especially skimmed milk and whey protein, has been associated with acne flare-ups via hormonal mechanisms involving IGF-1 and mammalian target of rapamycin complex 1 (mTORC1) activation (Juhl et al., 2018; Muhaidat et al., 2024; Cava et al., 2024).

On the other hand, the Mediterranean diet, which has anti-inflammatory and antioxidant properties, may have a protective effect by regulating inflammatory pathways and improving metabolic balance (Taha et al., 2024; Aryanian et al., 2025; Annunziata et al., 2025). Furthermore, increasing evidence highlights the role of the gut-skin axis, suggesting that probiotics and plant-based foods influence systemic inflammation and the skin microbiome, thereby improving outcomes in the treatment of acne (Aryanian et al., 2025; Gowda et al., 2024; Sutema et al., 2025; Dessinioti & Katsambas, 2024).

In light of the results, diet is currently recognised as an important and modifiable factor in the prevention and treatment of acne. However, the evidence is inconsistent and sometimes contradictory, necessitating a comprehensive synthesis of the available literature. The objective of this review is therefore to evaluate and summarise the current evidence on the impact of dietary factors, including glycemic load, dairy and whey protein intake, omega-3 fatty acids, probiotics and overall dietary patterns, on the development and severity of acne vulgaris.

2. Materials and Methods

A literature search was conducted in the databases PubMed, Scopus, Web of Science and Google Scholar for studies published between 2010 and 2025 investigating the relationship between diet and acne vulgaris. Combinations of the following keywords were used in the search: 'acne vulgaris', 'diet', 'nutrition', 'glycemic index', 'dairy', 'omega-3 fatty acids' and 'probiotics'.

Studies were included if they were original articles, reviews or meta-analyses, written in English, and focusing on human populations. Those excluded were in vitro studies, case reports, conference abstracts and papers unrelated to the influence of diet on acne.

Following the screening of titles, abstracts and full texts, a total of 26 studies were found to meet the inclusion criteria. These included observational studies, randomised controlled trials and systematic reviews. The extracted data covered the following categories: study design; dietary factors; and main outcomes. These were then summarised thematically into the following six categories: glycemic index; dairy; omega-3 and the Mediterranean diet; probiotics; chocolate; and micronutrients.

A qualitative synthesis was performed given the heterogeneity of methods and results, and study quality was assessed using established bias evaluation tools.

3. Results

3.1. High-Glycaemic-Index and High-Glycaemic-Load Diets

Several studies have demonstrated a strong association between the severity of acne and diets with a high glycaemic index (GI) and load (GL). Such diets elevate plasma insulin and IGF-1 levels, thereby stimulating sebaceous gland activity, androgen production and keratinocyte proliferation — key processes in the pathogenesis of acne (Melnik, 2012; Gruszczyńska et al., 2023).

Clinical studies have shown that reducing the glycaemic load of a person's diet can alleviate the symptoms of acne. For example, one study found that a low GI/GL diet over a period of two weeks significantly reduced serum IGF-1 levels and inflammation in acne lesions (Burris et al., 2018). Similarly, a large

prospective cohort analysis found that the frequent consumption of high-GI foods, including sweetened beverages and processed cereals, was associated with a higher incidence of acne (Penso et al., 2020).

Evidence suggests that this relationship may be mediated by the mTORC1 signalling pathway, which regulates sebocyte proliferation and lipid synthesis (Baldwin & Tan, 2021). It is believed that a diet that causes hyperinsulinemia activates mTORC1, resulting in increased sebum production and clogged hair follicles (Melnik, 2015). Furthermore, a low glycaemic index diet can reduce systemic inflammation and the severity of acne by lowering insulin and IGF-1 levels, as well as improving insulin sensitivity (Burris et al., 2018; Melnik, 2015).

In summary, the quality of carbohydrates significantly impacts the pathogenesis of acne. A diet based on low glycaemic index foods, such as whole grains, pulses and vegetables, may contribute to better metabolic control and consequently reduce the number of acne lesions.

3.2. Dairy Products and Whey Protein

Dairy products have long been associated with the development of acne vulgaris. Numerous studies have confirmed the negative impact of milk, particularly skimmed milk, on acne severity (Juhl et al., 2018; Melnik, 2015). Dairy products contain bioactive molecules, such as IGF-1 and bovine hormones, that can stimulate sebaceous gland activity and keratinocyte proliferation, as well as activating inflammatory pathways (Melnik, 2012; Baldwin & Tan, 2021). Increased sebum production and hair follicle blockages may activate the mTORC1 signalling cascade resulting from elevated IGF-1 levels caused by milk consumption (Melnik, 2015).

There is epidemiological evidence to support this relationship. A meta-analysis of over 78,000 participants found a significant association between total dairy consumption, especially skimmed milk, and acne prevalence in children, adolescents and young adults (Juhl et al., 2018). This effect appears to be more pronounced in individuals who consume large quantities of milk.

Recent studies have demonstrated that whey protein supplementation may be a contributing factor to the development of acne. The consumption of whey protein by young men has been linked to a higher prevalence of acne lesions, likely due to its potent insulinotropic and IGF-1 stimulating properties (Muhaidat et al., 2024). Furthermore, narrative reviews have suggested that excessive protein supplementation may contribute to hormonal imbalances and excessive stimulation of the sebaceous glands (Cava et al., 2024).

Overall, the evidence suggests that increased consumption of dairy products and whey protein supplements may exacerbate acne by influencing insulin and IGF-1 pathways, enhancing androgenic activity and stimulating mTORC1 signalling (Melnik, 2015; Muhaidat et al., 2024).

3.3. Omega-3 Fatty Acids and Anti-Inflammatory Diets

The anti-inflammatory and immunomodulatory properties of polyunsaturated omega-3 fatty acids (PUFAs), particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), offer special protection in cases of acne vulgaris (Guertler et al., 2022; Melnik, 2015). They reduce inflammation in the sebaceous glands and surrounding tissues by inhibiting the production of pro-inflammatory cytokines, such as interleukin-1β (IL-1β), interleukin-8 (IL-8) and tumour necrosis factor alpha (TNF-α) (Guertler et al., 2024).

The beneficial effects of omega-3 supplementation have been confirmed by numerous clinical and interventional studies. Participants showed a reduction in the number of inflammatory lesions and an improvement in skin structure thanks to daily omega-3 supplementation, which reduced the production of leukotriene B4 (LTB4), a mediator known to stimulate sebaceous gland activity (Guertler et al., 2022; Guertler et al., 2024).

The Mediterranean diet is rich in nutrients with anti-inflammatory properties and has been shown to contribute to a lower incidence and severity of acne (Taha et al., 2024; Aryanian et al., 2025). (Taha et al., 2024; Aryanian et al., 2025). This diet consists of fruit, vegetables, legumes, whole grains, olive oil and fish, all of which are rich in antioxidants, polyphenols and omega-3 fatty acids. Studies have shown that adherence to the Mediterranean diet is associated with improved metabolic health and reduced systemic inflammation, which may indirectly improve acne outcomes (Annunziata et al., 2025).

Evidence from cross-sectional and interventional studies supports the hypothesis that omega-3 fatty acids and a Mediterranean-style diet have a combined anti-inflammatory effect. These dietary approaches appear to reduce oxidative stress and sebum production, and modulate the hormonal and metabolic pathways involved in the pathogenesis of acne (Melnik, 2015; Guertler et al., 2024).

3.4. Probiotics and the Gut–Skin Axis

There is growing evidence to support the existence of a gut–skin axis. This suggests that the composition of intestinal microbiota influences systemic inflammation and skin health, including acne vulgaris (Dessinioti & Katsambas, 2024). Intestinal dysbiosis can promote the development of acne by inducing low-grade inflammation and lipid metabolism disorders, as well as increasing oxidative stress (Melnik, 2015). In this context, probiotics have been suggested as a possible treatment for restoring microbial balance and regulating the immune response.

Clinical studies have demonstrated that probiotic supplementation can reduce the severity of acne and improve the function of the skin barrier. Strains of Lactobacillus and Bifidobacterium present in oral probiotics have been shown to reduce inflammatory changes, sebum production and the activity of Cutibacterium acnes (Alyoussef, 2024; Gowda et al., 2024). The modulation of intestinal permeability, the reduction of pro-inflammatory cytokines, and the increased antioxidant capacity all contribute to the beneficial effects (Gowda et al., 2024; Sutema et al., 2025).

A scoping review of probiotic interventions found consistent improvements in mild-to-moderate acne when probiotics were administered orally or topically, particularly when combined with standard treatments such as benzoyl peroxide or retinoids (Sutema et al., 2025). Probiotic therapy may also complement conventional treatments by mitigating adverse effects and enhancing patient tolerance. Furthermore, diets that are plant-based and fibre-rich, which naturally promote gut microbial diversity, have been associated with better acne outcomes (Alyoussef, 2024).

Collectively, the current body of evidence suggests that probiotics may influence acne via various mechanisms, including reducing systemic inflammation, restoring gut–skin homeostasis and modulating immune and endocrine pathways (Dessinioti & Katsambas, 2024; Aryanian et al., 2025; Gowda et al., 2024).

3.5. Chocolate and Processed Foods

The relationship between chocolate consumption and acne vulgaris is still a matter of debate. Some studies have shown that eating chocolate, especially products containing added sugar and milk, may result in worsening acne through increased inflammation and sebum production (Daszkiewicz et al., 2024). However, other studies suggest that it is the added ingredients, such as sugar, milk solids and saturated fats, that have an adverse effect, and that pure cocoa does not directly worsen acne (Sadhasivamohan & Karthikeyan, 2022).

Beyond chocolate, processed foods commonly found in Western diets, such as fast food, refined carbohydrates and foods high in saturated or trans fats, have been consistently linked to more severe acne (Ryguła et al., 2024). They promote insulin resistance, systemic inflammation and oxidative stress, which can elevate IGF-1 levels and enhance sebaceous gland activity (Gruszczyńska et al., 2023; Melnik, 2015). In contrast, a diet rich in fresh, unprocessed foods and low in simple sugars improves metabolic balance and reduces the severity of acne.

Overall, the evidence suggests that the excessive consumption of high-glycaemic, processed and fatty foods contributes to the pathogenesis of acne through hormonal and inflammatory pathways. However, due to the heterogeneity of study methodologies and dietary reporting, further controlled studies are needed to establish causation.

3.6. Micronutrients and Vitamins

Micronutrients play a key role in maintaining skin homeostasis and regulating inflammation in cases of acne vulgaris. More severe acne and higher levels of inflammation are associated with vitamin D deficiency (Hasamoh et al., 2022). Adequate vitamin D levels can reduce the expression of inflammatory cytokines and promote the production of antimicrobial peptides, thereby improving the skin's immune function.

Antioxidant vitamins, such as vitamins A and E, have also been linked to better outcomes for people with acne. They are involved in key mechanisms of blackhead formation, such as reducing lipid peroxidation and oxidative stress in the sebaceous glands (Fiedler et al., 2017). Another important micronutrient is zinc, which has anti-inflammatory and antibacterial properties that help to regulate sebum production and speed up wound healing (Ryguła et al., 2024). (Ryguła et al., 2024).

A diet rich in fruit, vegetables, whole grains and nuts naturally provides these micronutrients and may therefore help to improve acne. If you have a deficiency, taking supplements containing specific vitamins or minerals may help; however, taking too much can have adverse effects. Current evidence suggests that maintaining adequate levels of essential micronutrients through a balanced diet promotes healthy skin and reduces the severity of acne (Hasamoh et al., 2022).

Table 1. Summary of Dietary Factors Associated with Acne Vulgaris and Proposed Mechanisms

Dietary Factor	Main Findings	Proposed Mechanisms	Key References
High-Glycemic Diet	Associated with increased acne severity; improvement observed with low-GI diet	↑ Insulin and IGF-1 → mTORC1 activation → sebocyte proliferation and inflammation	Burris et al. (2018); Melnik (2012); Gruszczyńska et al. (2023)
Dairy Products	Positive association, especially with skim milk	IGF-1 stimulation and hormonal activity promoting sebaceous gland proliferation	Juhl et al. (2018); Melnik (2015)
Whey Protein	Linked to new acne outbreaks in young males	↑ Insulin and IGF-1; androgenic and anabolic effects	Muhaidat et al. (2024); Cava et al. (2024)
Omega-3 Fatty Acids / Mediterranean Diet	Reduction in inflammatory lesions and improved skin condition	↓ Cytokines (IL-1β, TNF-α), antioxidant activity, regulation of lipid metabolism	Guertler et al. (2024); Aryanian et al. (2025); Annunziata et al. (2025)
Probiotics	Decrease in inflammatory acne and improved gut balance	Modulation of gut–skin axis; ↓ systemic inflammation	Alyoussef (2024); Gowda et al. (2024); Sutema et al. (2025)
Chocolate / Processed Foods	May worsen acne; effect stronger with high sugar and milk content	↑ Insulin, ↑ oxidative stress, ↑ inflammation	Daszkiewicz et al. (2024); Sadhasivamohan & Karthikeyan (2022)
Micronutrients (A, D, E, Zinc)	Deficiencies associated with more severe acne	Antioxidant and anti-inflammatory effects; regulation of keratinization and immune response	Hasamoh et al. (2022); Ryguła et al. (2024)

Note. The table summarizes the main dietary factors reported to influence acne vulgaris, their proposed biological mechanisms, and representative references supporting each relationship.

4. Discussion

The findings of this review suggest that diet plays a significant and multifactorial role in the development and severity of acne vulgaris. The analysed evidence confirms that the composition of a person's diet can modulate biological pathways related to sebum production, inflammation and keratinisation. This suggests that acne is influenced not only by hormonal, genetic and microbiological factors (Baldwin & Tan, 2021; Melnik, 2015), but also by diet. A Western diet characterised by a high glycaemic index, dairy products and processed foods is associated with the severity of acne, while an anti-inflammatory and plant-based diet may have a protective effect (Penso et al., 2020; Aryanian et al., 2025; Annunziata et al., 2025). (Penso et al., 2020; Aryanian et al., 2025; Annunziata et al., 2025).

Interventional and mechanistic studies provide strong evidence for the influence of high-glycaemic-index and high-glycaemic-load diets on acne. These diets promote sebocyte proliferation and androgen synthesis by raising blood insulin and IGF-1 levels and activating mTORC1 signalling (Melnik, 2012; Gruszczyńska et al., 2023). Conversely, low-GI diets have been shown to improve insulin sensitivity and reduce inflammatory acne lesions (Burris et al., 2018). These findings reinforce the concept that the quality of dietary carbohydrates can directly influence cutaneous inflammation and lipid metabolism.

Similarly, the severity of acne is probably associated with hormonal mechanisms and mechanisms mediated by IGF-1, and is linked to the consumption of dairy products, especially skimmed milk, and whey protein supplementation (Juhl et al., 2018; Muhaidat et al., 2024). (Juhl et al., 2018; Muhaidat et al., 2024). However, some inconsistencies remain, as several studies have not controlled for confounding factors such as total calorie intake or overall dietary quality. Therefore, while the evidence does not support the complete exclusion of all dairy products, limiting dairy consumption may be beneficial for people prone to acne.

Conversely, omega-3 fatty acids and a Mediterranean diet have a protective effect against acne. These dietary patterns downregulate proinflammatory cytokines, decrease sebum production and support oxidative balance (Gürler et al., 2024; Taha et al., 2024). As acne is a chronic inflammatory disease, anti-inflammatory mechanisms are consistent with the potential of dietary interventions as a supportive therapy.

Emerging data on probiotics and the gut–skin axis is providing additional insights into the management of acne. Evidence suggests that probiotic supplementation and modulation of the gut microbiome can reduce systemic inflammation and alleviate acne symptoms (Alyoussef, 2024; Gowda et al., 2024; Sutema et al., 2025).

The role of micronutrients remains important, too. Deficiencies in vitamins A, D and E, as well as minerals such as zinc, have been linked to the severity of acne. Adequate intake of these nutrients supports antioxidant protection and epidermal regeneration (Hasamoh et al., 2022; Ryguła et al., 2024).

Despite the growing body of evidence linking diet and acne, there is still significant heterogeneity among studies. Variations in dietary assessment methods, population demographics and acne grading systems make it difficult to establish causality. Therefore, while current findings strongly suggest that diet influences the pathogenesis of acne, further well-designed randomised controlled trials are needed to confirm these associations and determine specific dietary recommendations.

5. Conclusions

This paper reviews evidence that highlights the significant yet complex relationship between diet and acne vulgaris. However, acne is a multifactorial condition influenced by genetic, hormonal, and microbiological factors. Nevertheless, dietary habits clearly modulate the biological pathways involved in its pathogenesis (Melnik, 2015; Baldwin & Tan, 2021). A diet high in glycaemic index and with excessive dairy and processed food consumption leads to worsening acne through mechanisms related to insulin resistance, increased IGF-1 signalling and mTORC1 activation (Penso et al., 2020; Juhl et al., 2018; Gruszczyńska et al., 2023). Conversely, diets rich in omega-3 fatty acids, plant-based foods, probiotics, and essential micronutrients appear to exert anti-inflammatory and antioxidant effects, thereby reducing lesion number and overall disease severity (Guertler et al., 2024; Annunziata et al., 2025; Alyoussef, 2024).

Current data suggests that a balanced diet with anti-inflammatory properties and a low glycaemic index, modelled on the Mediterranean diet, could be a valuable addition to acne treatment strategies. Clinicians should consider incorporating basic nutritional counselling into dermatological care, emphasising moderation, whole foods and nutrient diversity, rather than advocating restrictive elimination diets (Taha et al., 2024; Aryanian et al., 2025).

However, due to the heterogeneity of existing studies, definitive causal conclusions cannot yet be drawn. To clarify specific nutritional mechanisms and establish evidence-based nutritional recommendations for the treatment of acne, large-scale, long-term randomised controlled trials must be conducted in future.

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