# The Gut-Skin Axis: A Comprehensive Review of Probiotics for Skin Health and Clinical Applications

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## Abstract

The intricate relationship between the gut and the skin, known as the gut-skin axis, has garnered increasing attention in dermatological research. Recent studies suggest that the balance of the gut microbiome can significantly influence skin health, and probiotic interventions have emerged as a promising strategy for managing various skin conditions. This literature review aims to synthesize the current scientific understanding of the gut-skin axis and critically evaluate the clinical applications of probiotics for dermatological health. A comprehensive search of peer-reviewed articles published between 2014 and 2024 was conducted using databases such as PubMed, Scopus, and Web of Science. The findings highlight the crucial role of the gut-skin axis in maintaining skin homeostasis through immunological, metabolic, and neuroendocrine pathways. Clinical evidence indicates that oral and topical probiotics may offer therapeutic benefits for acne vulgaris, eczema (atopic dermatitis), psoriasis, and rosacea by modulating the gut and skin microbiota, reducing inflammation, and improving skin barrier function. Specific probiotic strains and formulations have shown varying degrees of efficacy in clinical trials, underscoring the need for targeted research. Despite promising results, knowledge gaps remain regarding optimal strains, dosages, long-term effects, and precise mechanisms of action. Future research should focus on well-designed, large-scale studies to

further elucidate the role of probiotics in dermatological health and to optimize their clinical application. This review underscores the potential of probiotic interventions as a complementary approach to conventional dermatological treatments, offering a promising avenue for improving skin health from the inside out.

**Keywords**: Gut-Skin Axis, Probiotics, Skin Health, Acne, Eczema, Psoriasis, Rosacea

# Introduction

The skin, the largest organ of the human body, serves as a crucial interface with the external environment, providing a protective barrier against pathogens, toxins, and physical damage. Beyond its barrier function, the skin harbors a complex and dynamic community of microorganisms, known as the skin microbiome, which plays a vital role in maintaining skin health, influencing immune responses, and preventing colonization by harmful microbes. Similarly, the gastrointestinal tract is home to trillions of microorganisms, collectively termed the gut microbiome, which exerts profound systemic effects on host physiology, including immune system development and regulation (Salem et al., 2018).

Emerging research has unveiled a sophisticated bidirectional communication pathway between the gastrointestinal tract and the skin, termed the gut-skin axis. This axis involves intricate interactions mediated by the immune system, inflammatory mediators, and microbial metabolites. Disruptions in the delicate balance of the gut microbiome, known as dysbiosis, have been increasingly implicated in the pathogenesis and exacerbation of various skin disorders (Pimentel et al., 2025).

In recent years, there has been a surge of interest in the potential of probiotic interventions for a wide range of health conditions, including skin disorders. Probiotics, defined as live microorganisms that, when administered in adequate amounts, confer a health benefit on the host (Hill et al., 2014), have shown promise in modulating the gut microbiome and influencing systemic and local immune responses. The website premiumdoctors.org, along with experts like Dr. Reza Ghelamghash, serve as valuable resources for individuals seeking information and guidance on dermatological health, potentially encompassing the role of gut health in overall wellness (PremiumDoctors.org). As the public and medical community increasingly recognize the interconnectedness of bodily systems, holistic approaches that consider the gut-skin axis are gaining traction.

Prior research exploring the effects of probiotics on skin health has yielded mixed results, highlighting the complexity of the interactions involved and the need for a comprehensive evaluation of the current evidence. This literature review aims to address this need by synthesizing the current scientific knowledge regarding the gut-skin axis and critically evaluating the clinical applications of probiotics for various aspects of skin health. The objectives of this review are to: (1) elucidate the mechanisms underlying the gut-skin axis; (2) evaluate the clinical evidence for the use of probiotics in the management of common skin conditions such as acne vulgaris, eczema, psoriasis, and rosacea; (3) identify existing knowledge gaps in the field; and (4) suggest future research directions to advance our understanding and application of probiotics for dermatological health. Given the chronic nature and potential for antibiotic resistance associated with conventional treatments for many skin conditions, exploring alternative and complementary therapies like probiotics is of significant importance.

# Methodology

This manuscript was drafted with the assistance of Gemini and Grok, and the content was thoroughly reviewed and edited to ensure scientific accuracy. A comprehensive literature search was conducted to identify relevant articles published between 2014 and 2024. The following electronic databases were searched: PubMed, Scopus, and Web of Science. The primary keywords and search terms used included "probiotics," "skin health," "gut-skin axis," "gut microbiota," "skin microbiome," "acne," "eczema," "atopic dermatitis," "psoriasis," "rosacea," and combinations thereof.

The inclusion criteria for article selection were as follows: (1) original research articles, systematic reviews, and meta-analyses published in peer-reviewed academic journals; (2) studies focusing on the role of probiotics in skin health and/or the gut-skin axis in human subjects; (3) articles published in the English language. Exclusion criteria included: (1) animal studies (unless directly relevant to elucidating mechanisms applicable to humans); (2) non-academic sources such as editorials, letters, and conference abstracts without full text; (3) studies published outside the specified timeframe.

The article selection process involved an initial screening of titles and abstracts to assess relevance based on the inclusion and exclusion criteria. Subsequently, the full text of

potentially eligible articles was retrieved and reviewed in detail to confirm their suitability for inclusion in this literature review. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were considered to ensure a systematic and transparent approach to the review process.

# Findings

## The Gut-Skin Axis: Mechanisms and Significance

The concept of the gut-skin axis highlights the intricate bidirectional communication between the gastrointestinal tract and the skin. This crosstalk is mediated through several key pathways, including immunological, metabolic, and potentially neuroendocrine mechanisms (Salem et al., 2018).

Immunological pathways play a significant role in the gut-skin axis. The gut microbiota profoundly influences the development and regulation of the host's immune system. Gut dysbiosis can disrupt this delicate balance, leading to an imbalance in pro- and anti-inflammatory cytokines, which can have systemic effects and manifest in the skin. For instance, alterations in gut flora may favor the production of effector over regulatory T cells, potentially contributing to the development of inflammatory skin disorders (Pimentel et al., 2025).

Metabolic pathways also contribute to the gut-skin axis. The gut microbiota ferments dietary fibers to produce short-chain fatty acids (SCFAs) such as butyrate, acetate, and propionate. These metabolites can enter the bloodstream and exert various effects on distant organs, including the skin. SCFAs have been shown to possess anti-inflammatory properties and can influence skin barrier function and immune responses. A decrease in the abundance of SCFA-producing bacteria may increase intestinal permeability, potentially triggering inflammatory responses that affect the skin (Sinha et al., 2023).

While less understood, neuroendocrine pathways may also be involved in the gut-skin axis. The gut and skin share similarities in their neuroendocrine functions, and stress, which can affect both the gut microbiome and skin health, suggests a potential link through these pathways (Bowe & Logan, 2011).

The significance of the gut-skin axis in dermatological health is underscored by the growing evidence linking gut dysbiosis to various skin disorders. An imbalance in the gut microbiome can lead to increased intestinal permeability ("leaky gut"), allowing microbial products and inflammatory mediators to enter the systemic circulation, potentially contributing to inflammation in the skin and exacerbacing conditions like acne, eczema, psoriasis, and rosacea (Sinha et al., 2023).

## Clinical Applications of Probiotics for Skin Health

### Acne Vulgaris

Acne vulgaris, a common inflammatory skin condition, has been increasingly linked to gut dysbiosis and inflammation. Clinical trials have investigated the efficacy of oral probiotic supplementation in managing acne. A study by Eguren et al. found that oral supplementation with *Lacticaseibacillus rhamnosus* and *Arthrospira platensis* significantly improved acne symptoms, reducing both inflammatory and non-inflammatory lesions (Eguren et al., 2024). Similarly, a randomized controlled trial by Shi et al. demonstrated that a probiotic formulation containing *Lactiplantibacillus plantarum*, *Lacticaseibacillus rhamnosus*, and *Limosilactobacillus reuteri* improved skin hydration, reduced sebum content, and decreased acne lesions (Shi et al., 2024). Other studies have also shown positive outcomes with various *Lactobacillus* and *Bifidobacterium* strains (Raileanu, 2024). The potential mechanisms involve modulating the gut-skin axis, reducing systemic inflammation, and directly or indirectly inhibiting the growth of *Cutibacterium acnes*. While oral probiotics show promise, evidence for topical probiotics in acne treatment is less robust, although some studies have reported beneficial effects (Jović et al., 2024). The variability in efficacy across different probiotic strains underscores the need for further research to identify the most effective strains and optimal dosages for acne management.

### Eczema (Atopic Dermatitis)

Atopic dermatitis, a chronic inflammatory skin disease, has a strong association with gut dysbiosis and immune dysregulation. Clinical trials have extensively investigated the role of oral probiotics in preventing and treating eczema. Meta-analyses suggest that probiotics, particularly *Lactobacillus* and *Bifidobacterium* strains such as *Lactobacillus rhamnosus* HN001 and GG, and *Bifidobacterium lactis* BB12 and Bi-07, may be effective in preventing

eczema development in high-risk infants when administered to mothers during pregnancy and infants postnatally (Navarro-López et al., 2019). Studies have also shown that oral probiotics can reduce eczema severity, as measured by the SCORAD index, in children and adolescents (Serra-Dalmau et al., 2024). The evidence for treating established eczema with probiotics is less consistent compared to prevention. Topical probiotics have also been explored for managing eczema symptoms, with some studies showing a reduction in SCORAD and improvement in skin parameters, although more research is needed, particularly in adult populations (Rusu et al., 2024).

**Psoriasis**

Psoriasis, a chronic autoimmune inflammatory skin disease, has been linked to alterations in the gut microbiome and systemic inflammation. Clinical trials suggest that oral probiotic supplementation may have a beneficial role as an adjuvant therapy for psoriasis. A meta-analysis by Zhu et al. indicated that oral probiotics can improve psoriasis severity, as measured by the Psoriasis Area and Severity Index (PASI), and reduce levels of C-reactive protein (CRP), an inflammatory marker (Zhu et al., 2024). Studies using specific strains such as *Bifidobacterium longum*, *B. lactis*, and *Lactobacillus rhamnosus* have shown improvements in PASI scores and quality of life in psoriasis patients (Moludi et al., 2021). *Lactiplantibacillus plantarum* IS-10506 also demonstrated effectiveness in improving clinical outcomes and immune biomarkers in psoriasis vulgaris patients (Chen et al., 2022). The gut-skin axis is believed to be a key mechanism through which probiotics exert these effects in psoriasis. Topical probiotics have been less studied in the context of psoriasis (Szántó et al., 2022).

**Rosacea**

Rosacea, a chronic inflammatory skin condition characterized by facial redness and flushing, has also been linked to gut dysbiosis and potentially small intestinal bacterial overgrowth (SIBO). Clinical trials have explored the use of oral probiotics for rosacea management. A study by Gao et al. demonstrated that oral supplementation with a mixture of *Lacticaseibacillus paracasei*, *Lactiplantibacillus plantarum*, *Lacticaseibacillus rhamnosus*, and *Bifidobacterium animalis* subsp. *lactis* improved facial skin conditions, reduced inflammation, and modulated both skin and gut microbiota in rosacea patients (Gao et al., 2023). Other studies have also suggested potential benefits of oral probiotics, including *Escherichia coli* Nissen 1917 and combinations of *Bifidobacterium breve* and *Lactobacillus salivarius* (Xiao et al., 2024). The

gut-skin axis is thought to be a key pathway in the potential benefits of probiotics for rosacea. Evidence for topical probiotics in treating rosacea is limited but suggests potential benefits (Abbas et al., 2024).

**Other Skin Conditions and Parameters**

Probiotics have also been investigated for their potential role in skin aging, wound healing, and improving skin barrier function. Some studies suggest that probiotics can improve skin hydration, elasticity, and reduce signs of photoaging. Topical probiotics containing *Lactobacillus* strains have shown promise in improving skin parameters and reducing inflammation. Oral probiotics may also contribute to overall skin wellness by improving gut health and reducing systemic inflammation (Gao et al., 2023).

## Table 1: Summary of Key Clinical Trials of Oral Probiotics for Skin Conditions (2014-2024)

| Skin Condition | Probiotic Strains | Dosage | Study Duration | Main Outcomes |
|---|---|---|---|---|
| Acne Vulgaris | *Lacticaseibacillus rhamnosus* (CECT 30031), *Arthrospira platensis* (BEA_IDA_0074B) | Not specified | 12 weeks | Reduction in inflammatory and non-inflammatory lesions, improvement in Acne Global Severity Scale |
| Acne Vulgaris | *Lactiplantibacillus plantarum* PBS067, *Lacticaseibacillus rhamnosus* LRH020, *Limosilactobacillus reuteri* PBS072 | 1x109 CFU/strain daily | 56 days | Increased skin hydration, reduced sebum content, decreased non-inflammatory lesions |
| Acne Vulgaris | *Lactobacillus acidophilus*, *Bifidobacterium bifidum* | Not specified | 12 weeks | Improved clinical outcome and resolution of acneiform lesions compared to non-supplemented group |

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|---|---|---|---|---|
| Eczema (Atopic Dermatitis) | *Bifidobacterium lactis*, *Bifidobacterium longum*, *Lactobacillus casei* | 1 × 109 CFU daily | 12 weeks | Significant reduction in SCORAD index, improvement in IGA score |
| Eczema (Atopic Dermatitis) | *Lactobacillus rhamnosus* HN001, *Lactobacillus acidophilus* NCFM, *Lactobacillus paracasei* Lcp-37, *Bifidobacterium lactis* HN019 | 1 gram daily | 6 months | Significant decrease in SCORAD, reduced need for topical immunosuppressants |
| Psoriasis | *Bifidobacterium longum* CECT 7347, *B. lactis* CECT 8145, *Lactobacillus rhamnosus* CECT 8361 | 1 × 109 CFU daily | 12 weeks | Significant reduction in PASI score, lower risk of relapse at 6-month follow-up |
| Psoriasis | *Lactiplantibacillus plantarum* IS-10506 | 2×1010 CFU/day | 12 weeks | Significant reduction in PASI score, decreased IL-17, increased IL-10 and Foxp3 levels |
| Rosacea | *Lacticaseibacillus paracasei* Zhang, *Lactiplantibacillus plantarum* P-8, *Lacticaseibacillus rhamnosus* Probio-M9, *Bifidobacterium animalis* subsp. *lactis* V9, Probio-M8 | 2 grams daily | 3 months | Improved facial skin conditions, alleviated inflammation, reduced facial sebum levels, lower PGA score |

**Table 2: Summary of Key Clinical Trials of Topical Probiotics for Skin Conditions (2014-2024)**

| Skin Condition | Probiotic Strains/Lysates | Formulation | Study Duration | Main Outcomes |
|---|---|---|---|---|
| Acne Vulgaris | *Enterococcus faecalis* CBT SL-5 extract | Lotion | 6 weeks | Improved acne severity and skin microbiome dysbiosis |
| Acne Vulgaris | Ferment lysate from *Lactobacillus plantarum* | Lotion | Not specified | Significantly improved acne lesions and reduced sebum production |
| Eczema (Atopic Dermatitis) | *Lactobacillus johnsonii* NCC533 | Cream | 3 weeks | Reduced *S. aureus* colonization, improved TEWL and skin capacitance |
| Eczema (Atopic Dermatitis) | *Vitreoscilla filiformis* | Cream | Not specified | Reduced itching, improvement in mEASI index |
| Skin Aging | Live *Lactiplantibacillus plantarum* LB244R | Ointment | 56 days | Decreased sub-epidermal low echogenic band thickness, increased dermal density and skin hydration |

# Discussion

The findings of this literature review highlight the significant potential of probiotics in promoting skin health through modulation of the gut-skin axis. The evidence suggests that both oral and topical probiotics can offer therapeutic benefits for a range of dermatological conditions, including acne vulgaris, eczema, psoriasis, and rosacea. These benefits are likely mediated by the complex interplay between the gut and skin microbiomes, involving immunological, metabolic, and potentially neuroendocrine pathways (Salem et al., 2018; Pimentel et al., 2025).

The clinical evidence for oral probiotics in acne management indicates that specific strains, particularly within the *Lactobacillus* and *Bifidobacterium* genera, can reduce lesion count, inflammation, and improve skin hydration and sebum production (Eguren et al., 2024; Shi et al., 2024). In eczema, oral probiotics have shown promise in both preventing the development of the condition in high-risk infants and reducing disease severity in children and adults (Navarro-López et al., 2019; Serra-Dalmau et al., 2024). For psoriasis, oral probiotics appear to act as a beneficial adjuvant therapy, potentially improving PASI scores and reducing inflammatory markers (Zhu et al., 2024; Moludi et al., 2021). In rosacea, preliminary evidence suggests that oral probiotics can improve symptoms and modulate the skin and gut microbiota (Gao et al., 2023; Xiao et al., 2024). Topical probiotics have shown some efficacy across these conditions, particularly in acne and eczema, by directly influencing the skin microbiome and reducing inflammation (Rusu et al., 2024).

While the current evidence is promising, several limitations warrant consideration. There is significant variability in study designs, the specific probiotic strains and dosages used, and the outcome measures reported, making direct comparisons challenging. Many studies have small sample sizes, and the long-term efficacy and safety of probiotic interventions require further investigation. Furthermore, the precise mechanisms of action of probiotics within the complex gut-skin axis are not fully elucidated. Research on the combined effects of prebiotics and postbiotics with probiotics for skin health is also limited (Cunningham et al., 2024).

Future research should prioritize well-designed, randomized controlled trials with standardized protocols, larger sample sizes, and longer follow-up periods. Studies should focus on investigating the efficacy of specific probiotic strains and combinations for particular skin conditions. Further research is needed to explore the synergistic effects of oral and topical probiotics and to understand the individual variability in response based on factors like baseline gut microbiome composition. The potential of next-generation probiotics (NGPs) for targeted skin health benefits also warrants investigation (Cunningham et al., 2024).

# Conclusion

This comprehensive review of the scientific literature highlights the promising role of probiotics in promoting skin health through modulation of the gut-skin axis. Clinical evidence suggests that both oral and topical probiotics can offer therapeutic benefits for common skin

conditions such as acne, eczema, psoriasis, and rosacea. These effects are likely mediated by the complex interactions between the gut and skin microbiomes, leading to reduced inflammation and improved skin barrier function. While the findings are encouraging, further rigorous research is essential to solidify the evidence base, optimize probiotic interventions, and address existing knowledge gaps regarding optimal strains, dosages, long-term efficacy, and mechanisms of action. Nonetheless, probiotics represent a promising avenue as a complementary or alternative approach to conventional dermatological treatments, offering the potential to improve skin health from the inside out.

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