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Influence of gut microbiota on skin rejuvenation in adult women.

Influence of the gut microbiota on skin rejuvenation in adult women.

Influence of the intestinal microbiota on skin rejuvenation in adult women.

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SUMMARY

Introduction: Skin aging is a multifactorial process associated with structural, inflammatory, and hormonal changes that compromise skin integrity. Recent evidence indicates that the gut microbiota plays a relevant role in modulating systemic homeostasis and skin health through the gut-skin axis. In this context, the present study aimed to analyze the influence of the gut microbiota on skin rejuvenation in adult women. **Methodology:** This is an integrative literature review, primarily conducted in the PubMed database, supplemented by Google Scholar, encompassing studies published between 2018 and 2025.

The descriptors "Gastrointestinal Microbiome", "Gut-Skin Axis", "Skin Aging", "Probiotics", and "Estrogen" were used. After applying the eligibility criteria, 19 articles were selected for analysis. **Results:** The studies demonstrated that intestinal dysbiosis is associated with increased systemic inflammation, oxidative stress, and extracellular matrix degradation, contributing to skin aging. Conversely, microbiota metabolites exhibit antioxidant, immunomodulatory, and estrogen signaling regulatory effects. Interventions with probiotics, prebiotics, and postbiotics demonstrated benefits in relation to hydration, elasticity, and skin integrity. **Discussion:** The findings reinforce that inflammatory, metabolic, and hormonal mechanisms act in an integrated way in female skin aging, with emphasis on the stroboloma. However, there are still limitations regarding the confirmation of causality and the standardization of interventions.

Final considerations: The gut microbiota represents a potential therapeutic target for integrative skin rejuvenation strategies in adult women, although more robust clinical studies are still needed.

Descriptors: Gastrointestinal Microbiome; Gut-Skin Axis; Skin Aging; Probiotics; Estrogen.

INTRODUCTION

Skin aging is a multifactorial biological process resulting from the interaction between intrinsic factors, such as genetic predisposition and cellular senescence, and factors extrinsic factors, including sun exposure, pollution, inadequate diet, and oxidative stress. (Khmaladze et al., 2020). This process is associated with the progressive reduction of the synthesis of collagen and elastin, compromising the firmness, elasticity, and functionality of the skin. Clinically, skin aging manifests as wrinkles, loss of radiance, Reduced hydration and decreased regenerative capacity of the skin, impacting significantly impacts quality of life and aesthetic perception, especially in women.

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adult women are more susceptible to hormonal changes associated with aging (Lee; Kim, 2022; Mahmud et al., 2022).

In recent decades, advances in research on the human microbiome have broadened the Understanding the systemic factors involved in skin health. In this context, the microbiota The gut, composed of trillions of microorganisms, plays essential roles in digestion, vitamin synthesis, immune modulation, and maintenance of homeostasis. Systemic (De Pessemier et al., 2021). Changes in its composition and functionality, known as intestinal dysbiosis, they have been associated with increased systemic inflammation. of oxidative stress and dysfunction of different peripheral tissues, including the skin (Boyajian et al., 2021).

The interaction between the gut microbiota and the skin underlies the concept of the axis. The gut-skin axis is characterized as a bidirectional communication network. mediated by immunological, metabolic, hormonal and neuroendocrine pathways (Lee; Kim, 2022; Jimenez-Sanchez et al., 2025). Under dysbiosis conditions, increased permeability occurs. intestinal and systemic release of lipopolysaccharides (LPS) and pro-inflammatory cytokines, favoring inflammatory processes related to tissue aging and compromising the function of the epidermal barrier (De Pessemier et al., 2021; Woo and Kim, 2024). This chronic, low-grade inflammatory state, known as inflammaging, has been associated with the degradation of the extracellular matrix and the reduction of cutaneous homeostasis (Ghosh; Shanahan; O'Toole, 2022).

In addition to inflammatory mechanisms, the gut microbiota participates in the production of bioactive metabolites, such as short-chain fatty acids (SCFAs), which exhibit immunomodulatory and antioxidant properties related to the preservation of homeostasis dermal (Boyajian et al., 2021; Gao et al., 2023). In addition, the gut microbiome influences neuroendocrine communication via the hypothalamic-pituitary-adrenal (HPA) axis modulating responses associated with systemic stress and tissue regeneration (Woo; Kim, 2024). In aging women, these interactions take on added relevance due to progressive reduction of estrogen levels, directly related to loss of elasticity, of hydration and dermal thickness (Lephart; Naftolin, 2022).

In this context, the strobolome stands out, a collection of intestinal microorganisms. involved in the metabolism and recirculation of estrogens, capable of influencing the systemic hormonal bioavailability and, consequently, skin physiology (Park; Kim; Kim, 2025). In addition, certain metabolites derived from microbial activity, such as

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equol exhibits antioxidant and estrogen signaling modulating potential, contributing for the maintenance of cutaneous homeostasis (Lee et al., 2021). These findings reinforce the Understanding female skin aging as a multifactorial systemic process. influenced by the functional dynamics of the gut microbiome.

The growing interest in modulating the gut microbiome reflects the search for Integrative approaches aimed at promoting healthy aging and skin health. In this context, strategies for modulating the gut microbiota are being investigated. as promising approaches for promoting skin health and rejuvenation. Interventions with probiotics, prebiotics, synbiotics, and postbiotics show potential. to restore microbial balance, reduce systemic inflammatory processes and promote the integrity of the skin barrier (Gao et al., 2023; Gowda et al., 2024). However, still There are gaps in the literature regarding the mechanisms involved in this interaction and... Consolidation of clinical evidence specifically focused on skin rejuvenation in adult women. In this sense, the present study aims to analyze the influence of Intestinal microbiota in skin rejuvenation in adult women, considering the physiological, immunological, metabolic and hormonal mechanisms involved in the gut-brain axis skin.

METHODOLOGY

This study is characterized as an integrative literature review, of A qualitative approach, developed with the aim of analyzing the influence of the microbiota. Intestinal function in skin rejuvenation in adult women, considering mechanisms physiological, immunological, metabolic, and hormonal factors related to the gut-skin axis.

The literature search was conducted primarily in the PubMed database, with supplementing the search on Google Scholar, using scientific articles published between 2018 and 2025. The selection of descriptors was based on the Health Sciences Descriptors. (DeCS) and its English equivalents. The following were adopted as the main descriptors: "Gastrointestinal Microbiome", "Gut-Skin Axis", "Skin Aging", "Probiotics" and "Estrogen". To To refine the search, the descriptors were combined with complementary terms. related to skin aging and gut-skin communication, such as "Strobolome", "Skin Health", "Skin Barrier", and "Cellular Senescence", using Boolean operators. AND and OR.

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The search strategy applied was:
("Gut Microbiota" OR "Intestinal Microbiota" OR "Dysbiosis") AND
("Skin Aging" OR "Skin Rejuvenation" OR "Skin Health") AND
("Gut-Skin Axis" OR "Skin Barrier") AND
("Probiotics" OR "Prebiotics" OR "Estrogen" OR "Estrobolome").

Articles published between 2018 and 2025, written in Portuguese and English, were included. that directly addressed the relationship between gut microbiota, aging, or Skin rejuvenation and mechanisms associated with the gut-skin axis were considered. Eligible studies include observational studies, experimental studies, clinical trials, narrative reviews, and reviews. systematic and molecular and translational approach studies, provided they are available in complete text and relevant to the purpose of the review.

As exclusion criteria, studies outside the time frame were disregarded. established, articles without access to the full text, productions not directly related to the objective. from research, as well as editorials, letters to the editor, opinion pieces and reviews without consistent scientific basis.

After the initial screening, the selected studies were analyzed qualitatively and quantitatively in terms of thematic relevance, scientific importance, and adequacy methodological. After applying the eligibility criteria and removing duplicates, the following were... XX articles were selected to compose the integrative review. For systematization of Based on the information gathered, the extracted data was organized into a synoptic table containing: author and year. publication type, study type, objective, mechanism related to the gut-skin axis, Main results and contributions to the understanding of skin rejuvenation.

Subsequently, the findings were grouped into thematic categories for analysis and Integrative interpretation of the results, including: modulation of inflammatory cytokines and of Gut-skin axis; effects of the gut microbiota on skin elasticity and hydration; gut microbiota, oxidative stress and cellular senescence; hormonal influence, stroboloma and female skin aging; and therapeutic strategies for modulating gut microbiota. These categories allowed for an integrative and systematic analysis of the scientific evidence related to the biological mechanisms involved in the influence of The role of gut microbiota in skin health and rejuvenation in adult women.

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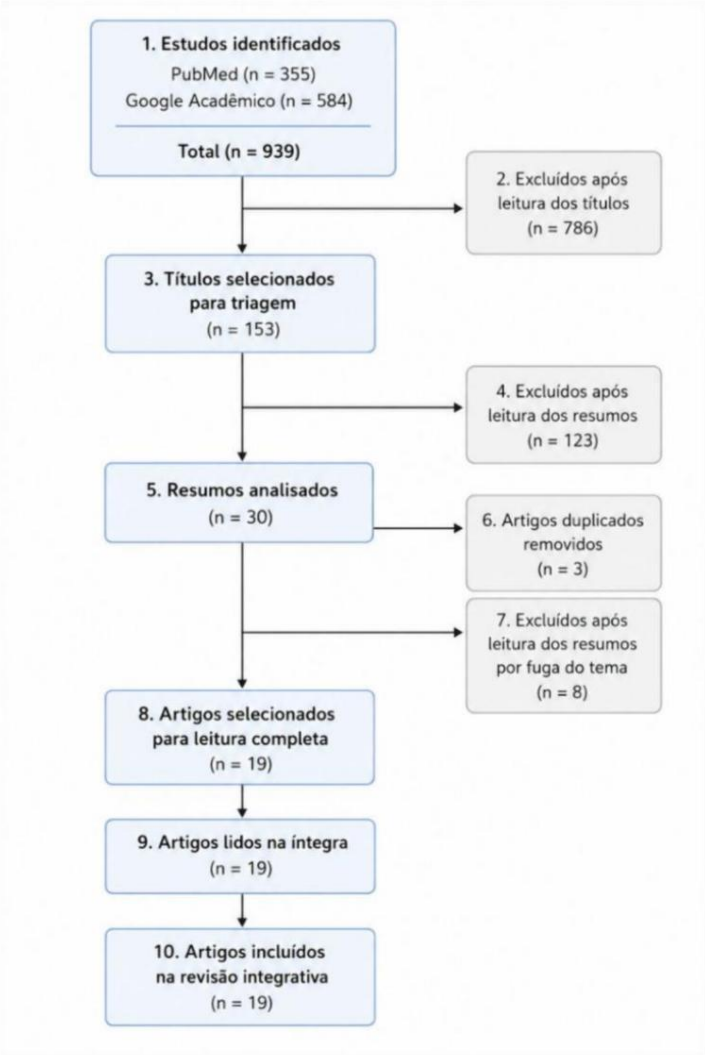
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RESULTS

Based on a structured search conducted in the PubMed and Google databases. Academically, 939 studies were identified. After reading the titles and abstracts, the application of the inclusion and exclusion criteria, as well as the removal of duplicate articles and those that deviated from the topic, resulted in the selection of 19 articles to compose the corpus of analysis of the present integrative review (Figure 1).

Figure 1. Article selection flowchart, 2026.



Source: Author's own work, 2026.

Among the 19 articles selected for the review, studies that addressed were analyzed. The influence of the gut microbiota on skin aging and rejuvenation in adult women, with emphasis on the gut-skin axis, intestinal dysbiosis, and permeability.

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The studies included: intestinal function, systemic inflammation, and modulation of skin health. They primarily investigated the pathophysiological mechanisms related to aging. of the skin, the influence of probiotics, prebiotics and postbiotics on barrier integrity cutaneous, in skin hydration and elasticity, and in reducing oxidative stress, in addition to The relationship between gut microbiota, estrogen, and healthy aging. Details of The articles reviewed are listed in Table 1.

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Table 1. Characteristics of the selected scientific articles, according to authors, year of publication, objectives, mechanism related to the gut-skin axis, main findings and impact on skin rejuvenation 2026.

Author/Year	Type of study Objective		Mechanism related to the gut-skin axis	Key findings	Skin rejuvenation impact
Alagiakrishnan et al., 2024	Revision	Addressing diagnosis and management of dysbiosis	Inflammation systemic and microbial imbalance	Dysbiosis influences inflammatory and metabolic processes.	Indirect relationship with skin aging.
Beaver et al., 2025	Revision	Assessing microbiota and phytochemicals for healthy aging	Antioxidant-inflammatory and modulation	Bioactive compounds contribute to healthy longevity.	Potential action of anti-aging skin
Boyajian et al., 2021	Revision	Investigating probiotics and prebiotics in aging.	Reduction of cellular senescence	Benefits for skin and health cells	Direct relationship with rejuvenation
Chen et al., 2024	Genetic study	Assessing microbiota and risk of facial aging	Genetic influence of the microbiota	Microbiota and skin between and aging association	Direct relationship with skin aging
Of Pessemier et	Revision	Exploring axle the gut-skin	Modulation immune and	Bowel changes impact diseases.	Relationship with integrity and

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al., 2021			inflammatory	cutaneous	skin aging
Gao et al., Revision	2023	Assessing the role of of the probiotics in the skin	Inflammatory regulation	Benefits for skin barrier and hydration.	rejuvenating effect potential
Ghosh et al., 2022	Revision	Investigating microbiota for and healthy aging	Modulation metabolic and immune	Microbiota healthy promotes skin aging healthy	Indirect relationship with aging,
Gowda et al., 2024	Revision	Evaluate probiotics in in dermatology.	Reducing from the skin inflammation	Benefits in diseases and health	Relationship with improved skin skin quality
Jimenez-Sanchez et al., 2025	Revision	Explore relationship bidirectional gut–skin	Microbiota-immunity-skin communication	Strong interaction between gut and skin	Direct relationship with skin rejuvenation
Kapoor et al., 2025	Clinical trial	Evaluate prebiotics in skin hydration	Modulation intestinal and health	Improves skin elasticity and hydration.	Direct relationship with rejuvenation
Khmaladze et al., 2020	Revisão	Understanding factors integrated health cutaneous	Microbiome-skin barrier interaction	Global influence on skin node aging.	Direct link to skin aging

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Lee HJ; Kim M., 2022	Revision	Assess skin barrier and microbiota/ microbiome	Barrier integrity and	Microbiota influences skin function.	Relationship to skin aging with
Lee K et al., 2021	Experimental study	Evaluate Lactobacillus plantarum HY7714	Gut-skin communication	Protection against skin aging	Direct relationship with rejuvenation
Lephart; Naftolin, 2022	Revision	Investigate hormonal factors relationship skin aging	Microbiota-health estrogen	Hormones influence women skin aging	Direct relationship with to aging
Mahmud et [author's name], 2022	Revised by	Exploring the microbiome therapy and skin health	Immune modulation Intestinal and	Relationship between microbiota and with skin diseases	Indirect relationship with rejuvenation
Nagpal et al., 2018	Revision	Investigate microbiota and aging	Immunological physiological processes and	Microbial changes influence aging.	Indirect relationship with skin aging
Park et al., 2025	Revision	Evaluate microbiota and estrogen	Gut strobolome axis	Microbiota influences female hormonal metabolism	Relationship to aging with
Sawashita et al., 2025	Clinical trial	Assessing postbiotics on the skin of women	Intestinal modulation and cutaneous	Clinical improvement in from the skin condition	Direct relationship with rejuvenation

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Woo; Kim, 2024	Revision	Exploring microbiota and skin barrier in aging	Skin barrier integrity	Relationship between microbiota and skin aging	Direct relationship with to rejuvenation of skin

Source: Author's own work, 2026.

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DISCUSSION

The gut microbiota constitutes a complex ecosystem made up of trillions of microorganisms capable of performing functions essential to maintaining systemic homeostasis, including immune modulation, energy metabolism and neuroendocrine communication (From (Pessemier et al., 2021; Ghosh; Shanahan; O'Toole, 2022). Qualitative and functional changes The evolution of this ecosystem throughout aging has been associated with the development of Low-grade chronic inflammation, known as inflammaging, is a phenomenon related to Cellular senescence and structural changes are observed in different tissues, including the skin. (Nagpal et al., 2018; Ghosh; Shanahan; O'Toole, 2022).

In the female context, this interaction takes on additional relevance due to the changes hormonal changes associated with aging, especially the progressive reduction in levels of estrogen, directly related to collagen loss, reduced elasticity and decreased skin hydration (Lephart; Naftolin, 2022). In this scenario, the microbiome The intestinal tract emerges as a potential modulator not only of the pathophysiology of skin aging, but also mechanisms related to its maintenance. Dermal integrity and skin rejuvenation for women.

Recent evidence suggests that the gut microbiome may directly influence mechanisms associated with senescence and skin regeneration. Chen et al. (2024), in a study Using Mendelian randomization, they observed an association between certain signatures. gut microbiota and reduction of facial biological age, suggesting a possible relationship. There is no causal link between the gut microbiota and skin aging. Unlike previous studies... Based on observational data, the genetic approach adopted by the authors strengthens the hypothesis of participation. The direct influence of the gut microbiome on the modulation of skin physiology, although the mechanisms The circumstances surrounding those involved are not yet fully clarified.

The relationship between the gut and skin is currently described by the concept of the gut-skin axis. skin, defined as a bidirectional network, mediated by immunological mechanisms, metabolic, hormonal and neuroendocrine (De Pessemier et al., 2021; Jimenez-Sanchez et al., 2025). In this context, intestinal dysbiosis, characterized by an imbalance in the composition Microbial activity promotes increased intestinal permeability and systemic translocation of lipopolysaccharides (LPS) and pro-inflammatory cytokines (Alagiakrishnan; Morgadinho; Halverson, 2024). According to Woo and Kim (2024), this inflammatory environment compromises the It acts as a barrier to the epidermal barrier and promotes structural changes associated with aging.

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of the skin.

These pathophysiological mechanisms can be visualized in an integrated way in Figure 1, which summarizes the relationship between intestinal dysbiosis and skin aging.

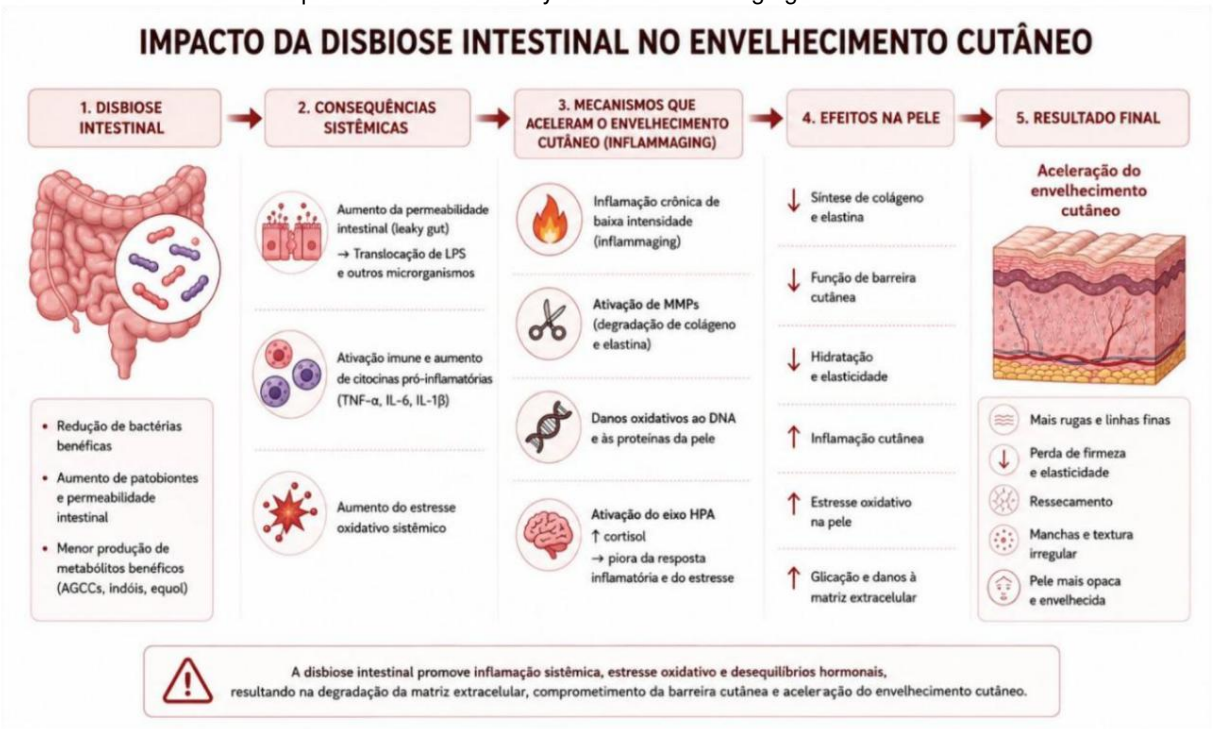


Figure 1 – Impact of intestinal dysbiosis on female skin aging.

Source: Prepared by the author based on De Pessemier et al. (2021), Ghosh, Shanahan and O'Toole (2022), Woo and Kim (2024), Gao et al. (2023) and Kapoor et al. (2025).

Complementing this perspective, Khmaladze et al. (2020) proposed the concept of "cutaneous interactome," a model that integrates genome, microbiome, and exposome as factors Interdependent factors in modulating skin health. This approach reinforces the multifactorial nature of the skin. of skin aging and broadens the understanding of the gut-skin axis as a potential A modulator of dermal integrity and maintenance of skin function.

From an inflammatory standpoint, evidence shows that changes in composition Intestinal microbiota favor increased production of pro-inflammatory cytokines, such as TNF-ÿ, IL-6 and IL-1ÿ, contributing to inflammation (Ghosh; Shanahan; O'Toole, 2022). In agreement, Woo and Kim (2024) highlight that this inflammatory state stimulates activation. of matrix metalloproteinases (MMPs), enzymes involved in the degradation of collagen and elastin. These alterations compromise the dermal architecture and favor manifestations. Clinical signs of skin aging, such as loss of firmness and elasticity.

In addition to inflammatory pathways, the gut microbiome influences the skin through... production of bioactive metabolites. Among the main ones are the long-chain fatty acids.

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Short-chain fatty acids (SCFAs), such as butyrate, acetate, and propionate, are produced by bacterial fermentation. of dietary fiber. Boyajian et al. (2021) demonstrate that these compounds have anti-inflammatory and immunomodulatory properties, while Gao et al. (2023) highlight its antioxidant potential in reducing cell damage induced by reactive oxygen species oxygen. In addition to these properties, butyrate also exerts epigenetic effects through modulation of acetylation histones, influencing pathways related to homeostasis. dermal and extracellular matrix preservation (Boyajian et al., 2021). These mechanisms Studies suggest that intestinal microbial balance may contribute to the preservation of structural and functional integrity of the skin.

Tryptophan-derived metabolites, such as indoles produced by the gut microbiota, They can also activate the aryl hydrocarbon receptor (AHR), an important regulator of epidermal differentiation, skin barrier integrity, and skin immune response (Ratanapokasatit et al., 2022). Under dysbiosis conditions, pro-oxidant metabolites can to intensify the cellular damage associated with skin aging.

Another relevant mechanism involves neuroendocrine communication mediated by the axis. hypothalamic-pituitary-adrenal (HPA) axis. According to Woo and Kim (2024), alterations in the microbiota Intestinal factors can promote hyperactivation of this axis and increase cortisol levels. hormone associated with reduced collagen synthesis and impaired regeneration of the skin. These findings reinforce the idea that the influence of the microbiome on the skin will in addition to exclusively immunological mechanisms, also involving pathways related to systemic stress.

In aging women, these interactions become even more relevant because to hormonal changes associated with perimenopause and menopause. Park, Kim and Kim (2025) They describe the concept of the strobolome, defined as the collection of intestinal bacteria. involved in the metabolism and recirculation of estrogens. Alterations in this system can compromise hormone bioavailability and intensify skin manifestations associated with female aging. In addition, Mahmud et al. (2022) highlight that Hormonal changes also directly influence the composition of the microbiota. intestinal, highlighting a bidirectional relationship between the microbiome and metabolism. estrogenic.

The gut microbiota also participates in the metabolism of bioactive compounds. derived from food. Lee et al. (2021) demonstrate that certain bacteria The intestines convert soy-derived isoflavones into equol, a metabolite with properties.

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antioxidants and estrogenic activity, associated with improved elasticity and hydration of the skin. The interaction between the gut microbiota and phytochemicals is bidirectional, since Metabolites derived from these compounds may exhibit greater bioavailability and activity. antioxidant, contributing to the reduction of oxidative stress and the preservation of the matrix. extracellular dermal (Beaver et al., 2025). In parallel, polyphenols and flavonoids exert antioxidant action and modulation of the intestinal microbiota, contributing to the maintenance of Skin functionality and healthy aging (Beaver et al., 2025). These findings They reinforce the growing integration between nutrition, microbiology, and dermatology in understanding... of the mechanisms of skin aging.

In the therapeutic field, different strategies for modulating the gut microbiome. These have been investigated as potential approaches for promoting health and well-being. skin rejuvenation. Gao et al. (2023) and Gowda et al. (2024) report that probiotics, Prebiotics, postbiotics, and synbiotics have the potential to restore microbial balance. intestinal function and promote skin barrier homeostasis. Clinical studies also demonstrate that strains such as Lactobacillus rhamnosus, Lactobacillus paracasei and Bifidobacterium breve They can contribute to improved hydration, barrier function, and skin elasticity. in addition to reducing sensitivity and signs associated with skin aging (Gao et al., 2023; Lee and Kim, 2022). Lee et al. (2021) also demonstrated that metabolites derived from Lactobacillus plantarum HY7714 showed protective effects against aging. Cutaneous transmission occurs through communication between the gut-skin axes. Unlike probiotics Unlike traditional products, postbiotics offer greater physicochemical stability and lower risk. microbiological characteristics that enhance its therapeutic potential in rejuvenation. cutaneous (Sawashita et al., 2025). Kapoor et al. (2025), in a randomized clinical trial, They observed improved hydration of the stratum corneum, increased skin viscoelasticity, and... Reduction of transepidermal water loss after prebiotic intervention. Similarly, Sawashita et al. (2025) reported benefits of oral postbiotics on skin parameters. in middle-aged women, reinforcing the translational potential of gut modulation in Rejuvenating women's skin.

Despite recent advances, the available evidence still has limitations. Methodological aspects are important. Experimental studies, narrative reviews, and analyses predominate. Observational studies are prevalent, while standardized clinical trials remain scarce. Furthermore, Differences in microbial sequencing methods and diagnostic criteria for dysbiosis. and the parameters for skin assessment make direct comparisons between studies difficult.

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(Alagiakrishnan; Morgadinho; Halverson, 2024). Added to this is the high variability.
interindividual gut microbiome, influenced by dietary and hormonal factors,
genetic and environmental (Nagpal et al., 2018; Ghosh et al., 2022; Shanahan et al., 2022).

Thus, the evidence suggests that the gut microbiota plays a role.
relevant in modulating aging and female skin rejuvenation through
of immunological, metabolic, hormonal and neuroendocrine pathways (De Pessemier et al., 2021;
Mahmud et al., 2022; Woo and Kim, 2024). Among the recent advances, evidence stands out.
genetic findings that suggest a possible causal relationship between gut microbial signatures and
facial skin aging (Chen et al., 2024). Although promising, this evidence
They still depend on standardized clinical trials capable of validating biomarkers.
microbial and confirm the therapeutic effectiveness of gut modulation in rejuvenation
female skin (Chen et al., 2024; Gowda et al., 2024; Jimenez-Sanchez et al., 2025).

FINAL CONSIDERATIONS

This literature review shows that the gut microbiota plays a role.
relevant in modulating aging and skin rejuvenation in women
In adults, it acts as an important link between the immune, metabolic, and endocrine systems.
The evidence analyzed demonstrates that changes in the composition and functionality of
The gut microbiota are associated with systemic processes capable of directly influencing
cutaneous homeostasis, extracellular matrix integrity, and the dynamics of aging
skin.

Consistently, the literature demonstrates that intestinal dysbiosis is associated with
increased oxidative stress and the establishment of a systemic pro-inflammatory state.
which promotes collagen degradation, compromises elasticity, and reduces...
skin hydration. Conversely, intestinal microbial balance appears to contribute to
Maintaining skin function through the production of bioactive metabolites and...
regulation of immunometabolism.

In the context of female aging, the relevance of the interaction between the
gut microbiota and estrogen metabolism, especially through the strobolome,
functional component associated with the regulation of hormone bioavailability. Furthermore,
Metabolites derived from microbial activity, such as equol, show potential.
antioxidant and estrogen signaling modulator, contributing to the maintenance of

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integrity and functionality of the skin.

The findings of this review indicate that the gut microbiota plays a role.
significant in the mechanisms related to female skin rejuvenation, through
Immunological, metabolic, and hormonal pathways are interconnected. Therefore, aging...
Cutaneous disease is now understood as a multifactorial systemic process influenced not by other factors.
not only due to chronological and hormonal factors, but also due to the functional dynamics of
gut microbiome.

However, although the current results are promising, there are still limitations.
important for confirming causality in human studies, especially due
due to the methodological heterogeneity observed among the available research. In this sense, it becomes
if necessary to conduct controlled, longitudinally structured clinical studies and
with greater methodological robustness, capable of validating specific biomarkers and establishing
more standardized therapeutic protocols.

Finally, it is concluded that modulation of the gut microbiota emerges as a
a promising strategy in the context of skin health and integrative approaches focused on
Healthy aging in women. The growing understanding of the gut-skin axis expands the
perspectives for the development of therapeutic interventions aimed at promoting
dermal homeostasis, maintaining skin function and mitigating processes
Biological factors associated with female skin aging.

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