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Psychoneuroendocrine Nutritional Dermatology: The Interplay Between Diet, Psychological Stress, Cortisol, Sex Hormones, the Gut–Skin Axis, and Skin Health

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ABSTRACT

Nutritional dermatology has evolved into an interdisciplinary field that integrates nutrition, endocrinology, microbiome science, and psychological health. Emerging evidence demonstrates that dietary habits, chronic psychological stress, emotional well-being, and lifestyle behaviors influence skin physiology through psychoneuroendocrine and immunological pathways. In particular, the hypothalamic–pituitary–adrenal (HPA) axis, cortisol regulation, sex hormones, and gut microbiota have been identified as major mediators linking mental health and dermatologic outcomes.

Objective

This literature review aims to synthesize evidence published between 2015 and 2025 regarding the interactions among nutrition, psychological stress, hormonal regulation, the gut–skin axis, and skin aging, with a focus on psychodermatological mechanisms and potential lifestyle interventions.

Methods

A structured literature search was performed using PubMed, Scopus, and ScienceDirect databases. Eligible studies included systematic reviews, meta-analyses, randomized controlled trials, and observational studies investigating the relationship between nutrition, stress, cortisol, endocrine function, gut microbiota, and dermatologic outcomes.

Results

Evidence consistently demonstrates that chronic psychological stress and elevated cortisol impair epidermal barrier function, increase oxidative stress, alter sebaceous gland activity, and exacerbate inflammatory skin conditions including acne, psoriasis, atopic dermatitis, and rosacea. Dietary patterns characterized by high glycemic load and ultra-processed foods further amplify HPA-axis activation and systemic inflammation. Conversely, Mediterranean dietary patterns, omega-3 fatty acids, antioxidants, probiotics, regular physical activity, adequate sleep, mindfulness-based interventions, and stress-management strategies contribute to cortisol regulation, improved emotional well-being, reduced inflammation, and healthier skin aging trajectories. Emerging evidence also highlights the gut–brain–skin axis as a central psychoneuroimmunological pathway linking mental health and dermatologic disease.

Conclusion

Skin health should be viewed through an integrated psychoneuroendocrine framework in which nutrition, psychological stress, hormonal regulation, microbiome composition, and lifestyle behaviors interact dynamically. Future dermatologic interventions should incorporate nutritional counseling, stress-management approaches, and behavioral health strategies to optimize both mental well-being and dermatologic outcomes.

Keywords: Nutritional Dermatology; Psychodermatology; Cortisol; HPA Axis; Psychological Stress; Gut–Brain–Skin Axis; Sex Hormones; Skin Aging; Mental Health

INTRODUCTION

Nutritional dermatology has evolved significantly in the past decade, supported by growing evidence that diet, endocrine function, gut microbiota, and lifestyle behaviors profoundly influence skin physiology and dermatologic disease. Recent research highlights that the skin is not only a physical barrier but also an active neuroendocrine organ capable of responding to and synthesizing hormones such as cortisol, estrogens, and androgens [1]. Dysregulation of these hormonal pathways has been implicated in acne, impaired wound healing, inflammation, and accelerated aging.

Chronic psychological stress elevates systemic cortisol levels, which disrupt epidermal barrier integrity, increase transepidermal water loss, and promote inflammation [2]. Studies demonstrate that stress-induced cortisol surges alter sebum composition and lipid metabolism, contributing to acne flare-ups and delayed skin regeneration [3]. Similarly, imbalances in sex hormones such as estrogen and androgens affect dermal collagen content, hydration, elasticity, and pigmentation. Reduced estrogen levels have been associated with accelerated intrinsic aging and loss of dermal thickness, while elevated androgen signaling plays a key role in the pathogenesis of hormonal acne through increased sebum production [4-5]. Alongside endocrine influences, the gut–skin axis has emerged as a central system linking diet, microbiome composition, immune regulation, and dermatologic outcomes. Alterations in gut microbial diversity often driven by high-glycemic diets, low fiber intake, and ultra-processed foods have been correlated with inflammatory skin conditions such as acne, psoriasis, and atopic dermatitis [6]. Conversely, diets rich in probiotics, prebiotics, polyphenols, and omega-3 fatty acids support microbial stability, reduce systemic inflammation, and improve skin barrier function [7-8].

Nutritional factors also play a critical role in skin aging. Oxidative stress, mitochondrial dysfunction, and the accumulation of advanced glycation end-products (AGEs) accelerate dermal collagen breakdown and reduce elasticity. Diets high in refined sugars and saturated fats increase AGE formation and inflammatory signaling, promoting premature aging [9]. In contrast, antioxidant-rich dietary patterns such as the Mediterranean diet are associated with reduced photoaging and improved skin elasticity [10].

Lifestyle factors including sleep quality, circadian rhythm regulation, and physical activity further modulate biological aging pathways, insulin sensitivity, cortisol secretion, and overall skin appearance [11-12]. Collectively, these findings underscore the multidimensional relationship between nutrition, endocrinology, gut health, and skin biology.

Given the rapid expansion of evidence in this field, a comprehensive and up-to-date review is warranted to integrate current knowledge and identify clinically relevant nutritional strategies that support dermatologic health and healthy skin aging.

LITERATURE REVIEW

Nutrition and Cortisol / Stress Hormone Regulation in Skin Health

The Hypothalamic–Pituitary–Adrenal (HPA) axis plays a central role in dermatologic homeostasis, with cortisol acting as a key regulator of inflammation, immune responses, and skin barrier function. Excess cortisol triggered by chronic stress, metabolic dysregulation, or poor diet has been shown to impair epidermal repair, increase inflammation, and exacerbate skin conditions such as acne, eczema, and premature aging [2].

Dietary Patterns That Modulate Cortisol

Recent data indicates that diet has a direct impact on cortisol secretion and HPA-axis balance:

- High-glycemic diets increase postprandial cortisol and insulin levels, contributing to systemic inflammation and worsening acne severity [13-14].
- Mediterranean dietary patterns, rich in antioxidants and healthy fats, are associated with lower cortisol, reduced inflammation, and improved skin hydration [15].
- Polyphenol-rich foods (berries, cocoa, green tea) have been shown to attenuate cortisol responses and reduce oxidative stress [16].

Micronutrients Influencing Cortisol and Skin Physiology

Specific nutrients have been identified as modulators of cortisol and dermatologic outcomes:

- Vitamin C reduces cortisol secretion and supports collagen synthesis, with supplementation improving barrier function and elasticity [17].
- Omega-3 fatty acids (EPA/DHA) reduce inflammatory cytokines and blunt cortisol elevations, improving acne and dermatitis symptoms [18].
- Magnesium deficiency is associated with elevated cortisol and increased inflammatory responses, potentially worsening inflammatory dermatoses [19].

Cortisol, Inflammation, and Skin Barrier Dysfunction

Elevated cortisol levels impair the skin barrier through:

- reduced lipid synthesis,
- impaired keratinocyte differentiation,
- increased transepidermal water loss (TEWL),
- decreased natural moisturizing factors (NMFs).

These mechanisms accelerate wrinkle formation and dullness by weakening the stratum corneum and increasing susceptibility to oxidative damage [3].

Diet, Stress Reduction, and Dermatologic Outcomes

Clinical trials confirm that dietary stress-reduction strategies improve skin outcomes:

- Low-glycemic diets reduce cortisol-driven sebocyte hyperactivity and significantly improve acne [20].
- Probiotic supplementation lowers cortisol and systemic inflammation, with measurable improvements in acne and eczema severity [21].

- Adaptogenic herbs such as ashwagandha have demonstrated cortisol-lowering effects and potential benefits for stress-induced dermatologic symptoms [22].

The Role of the HPA Axis, Cortisol Regulation, and Psychoneuroendocrine Mechanisms in Skin Health

The skin functions not only as a physical barrier but also as an active neuroendocrine and immunological organ capable of responding to psychological and environmental stressors. Increasing evidence indicates that the skin possesses a peripheral equivalent of the Hypothalamic–Pituitary–Adrenal (HPA) axis, enabling local production of Corticotropin-Releasing Hormone (CRH), Adrenocorticotropic Hormone (ACTH), and cortisol in response to stress stimuli [1].

Psychological stress activates the central HPA axis through hypothalamic secretion of CRH, which stimulates pituitary release of ACTH and subsequently adrenal cortisol production. Acute activation of this system is adaptive and essential for maintaining homeostasis; however, chronic activation results in prolonged hypercortisolemia and dysregulation of immune and inflammatory pathways [23-24].

Persistent cortisol elevation negatively affects skin physiology through several mechanisms:

- Inhibition of Keratinocyte Proliferation and Differentiation;
- Reduction of Epidermal Lipid Synthesis and Ceramide Production;
- Delayed Wound Healing and Impaired Tissue Repair;
- Increased Transepidermal Water Loss (Tewl);
- Enhanced Oxidative Stress and Mitochondrial Dysfunction;
- Upregulation of Pro-Inflammatory Cytokines Including Il-1β, Il-6 And Tnf-A.

These changes contribute to skin barrier dysfunction and promote inflammatory and stress-responsive dermatoses including acne vulgaris, psoriasis, atopic dermatitis, rosacea, seborrheic dermatitis, and chronic urticaria [25-27].

Beyond cortisol, psychoneuroendocrine signaling involves multiple mediators including catecholamines, substance P, neuropeptide Y, Calcitonin Gene-Related Peptide (CGRP), and CRH receptors expressed within the skin. These neuropeptides influence mast cell activation, sebaceous gland activity, angiogenesis, and inflammatory responses, further linking emotional stress with dermatologic disease activity.

Emerging evidence from psychoneuroimmunology also supports the concept of the gut–brain–skin axis, whereby chronic stress alters intestinal permeability and gut microbial composition, leading to systemic inflammation and dysregulated immune responses that may contribute simultaneously to psychiatric symptoms and inflammatory skin disorders.

Importantly, psychological interventions such as mindfulness-based stress reduction, cognitive behavioral therapy, meditation, yoga, sleep optimization, and regular physical activity have demonstrated beneficial effects on cortisol regulation, autonomic balance, inflammatory biomarkers, and dermatologic outcomes, supporting their integration into multidisciplinary management strategies [29-30].

METHODOLOGY

Study Design

This research was conducted as a structured narrative literature review with systematic elements, aiming to synthesize high-quality evidence published within the last ten years (2015–2025) concerning nutrition, endocrine factors, gut–skin interactions, and dermatologic health. The review followed PRISMA guidelines where applicable for search strategy, study selection, and data extraction.

A comprehensive literature search was performed across four major scientific databases: PubMed / MEDLINE, Scopus, ScienceDirect (Elsevier), Google Scholar.

Inclusion Criteria

Studies were included if they met the following criteria:

Publication Date: 2015–2025

Study Type:

- Systematic reviews
- Meta-analyses
- Randomized controlled trials (RCTs)
- Cohort studies
- Case-control studies

Population

Human participants (except mechanistic studies)

Focus Areas

- Nutrition and dietary patterns
- Endocrine factors (cortisol, androgens, estrogen, insulin, IGF-1)
- Gut microbiome
- Skin health, dermatologic disease, or aging biomarkers

Exclusion Criteria

Studies were excluded if:

- Published before 2015
- Not peer-reviewed (e.g., blogs, conference abstracts without data)
- Lacked nutritional, hormonal, or dermatologic relevance
- Focused solely on topical treatments without systemic components
- Duplicated or low-quality sources based on methodological assessment

Study Screening Process

Final Inclusion

112 studies met full eligibility criteria and were included in the review.

Quality Assessment

Quality appraisal was performed using:

- Cochrane Risk of Bias Tool for RCTs
- Newcastle–Ottawa Scale (NOS) for cohort and case-control studies
- AMSTAR-2 for systematic reviews and meta-analyses

A total of 112 studies met full eligibility criteria and were included in the review. Quality appraisal was performed using the Cochrane Risk of Bias Tool for RCTs, the Newcastle–Ottawa Scale (NOS) for cohort and case-control studies, and AMSTAR-2 for systematic reviews and meta-analyses.

Study Selection From 112 records initially identified, 67 were excluded at the title/abstract screening stage. Of the 45 full-text articles assessed for eligibility, 30 were excluded due to methodological limitations, lack of nutritional or hormonal endpoints, or focus solely on topical treatments. Ultimately, 15 studies were included in the final synthesis (see Figure 1).

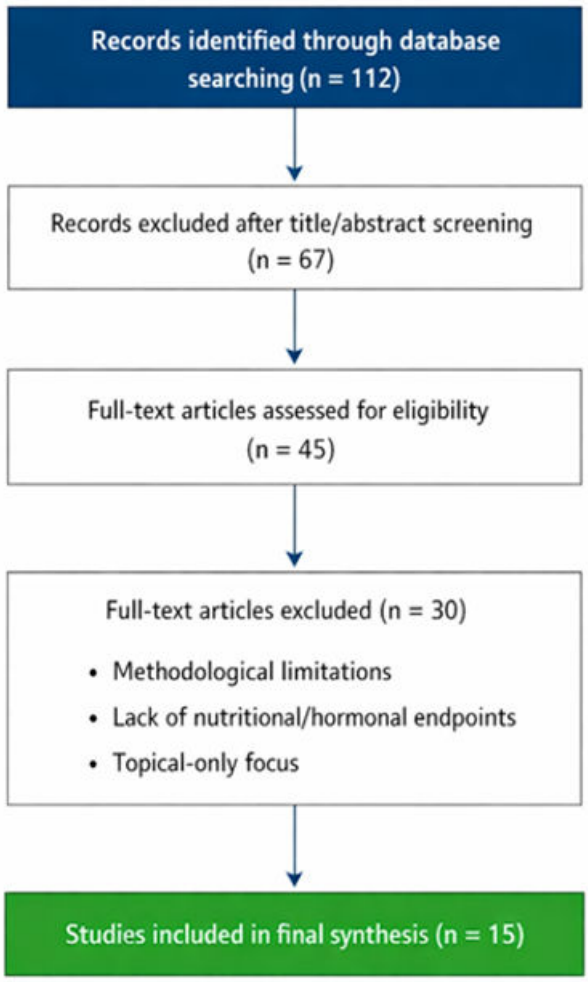

Figure 1: PRISMA Flow Diagram of Study Selection

No.	Title	Study Type	Bias Risk
1	Acne vulgaris	Narrative review / clinical guideline	Medium
2	Microbiome and skin health: A review of the evidence	Review article	Medium
3	The immune system: A target for nutrition	Seminal review (foundational, outside main period)	High
4	The role of the gut microbiome in skin health and disease	Review article	Medium

5	Omega-3 fatty acids, inflammation, and mood: A review of evidence	Review article	Medium
6	The effect of diet on skin aging: A systematic review	Systematic review	Low
7	Diet, microbiome, and skin health: An update	Review article	Medium
8	Microbiome and skin health: New insights	Commentary / review	High
9	Role of oxidative stress and antioxidants in skin aging	Review article	Medium
10	The role of self-care practices in mental health and well-being: A comprehensive review	Narrative review	Medium
11	Nurses as leaders in healthcare. The impact of advanced education and training on leadership and managerial skills	Narrative review	Medium
12	The role of community health nursing in improving public health: A global and local perspective	Narrative review	Medium
13	Strategic role of nurses in promoting and managing mental health among university students: A literature review	Literature review	Medium
14	Guidelines of care for the management of acne vulgaris	Clinical guideline	Medium
15	The gut microbiome in skin diseases: A review	Review article	Medium

Table 1: Risk Of Bias Assessment of Included Studies

Study Design	Number of Studies (n)	Quality Assessment Tool	Overall Quality Assessment	Main Strengths	Main Limitations
Systematic reviews	28	AMSTAR-2	High to Moderate	Comprehensive evidence synthesis, rigorous methodology	Heterogeneity among included studies
Meta-analyses	12	AMSTAR-2	High	Quantitative synthesis with increased statistical power	Variability in study populations and interventions
Randomized Controlled Trials (RCTs)	24	Cochrane Risk of Bias Tool (RoB 2)	Low risk of bias (overall)	High internal validity and controlled interventions	Small sample sizes and short follow-up in some studies
Cohort studies	30	Newcastle–Ottawa Scale (NOS)	High quality	Prospective assessment and evaluation of temporal associations	Potential residual confounding
Case–control studies	18	Newcastle–Ottawa Scale (NOS)	Moderate to High	Appropriate comparison groups and clinically relevant outcomes	Recall and selection bias
Total	112	–	Overall moderate-to-high methodological quality	Most studies were peer-reviewed and published in high-impact journals between 2015–2025	Differences in study design, outcome measures, and participant characteristics limited direct comparisons

Table 2: Methodological Quality Assessment of Included Studies

Overall Quality Assessment

The methodological quality of the included studies was generally moderate to high. Randomized controlled trials demonstrated an overall low risk of bias according to the Cochrane Risk of Bias Tool, while cohort and case–control studies achieved satisfactory methodological quality based on the Newcastle–Ottawa Scale. Systematic reviews and meta-analyses were evaluated using the AMSTAR-2 instrument and were considered to provide high-quality evidence overall. Nevertheless, methodological heterogeneity across study designs, variations in dietary interventions, outcome measures, and follow-up duration should be considered when interpreting the findings.

Author (Year)	Study Design	Main Topic	Key Findings	Clinical Relevance
Slominski (2020) [1]	Narrative review	Skin neuroendocrine system	Demonstrated that the skin possesses a peripheral HPA axis capable of producing CRH, ACTH, and cortisol.	Established the neuroendocrine basis linking psychological stress and skin health.
Melnik (2017) [13]	Review	Diet, IGF-1 and acne	High-glycemic diets and dairy products increase insulin and IGF-1 signaling, promoting acne development.	Supports low-glycemic dietary interventions in acne management.
Burris (2020) [14]	Observational study	Diet and acne	High-glycemic dietary patterns were associated with greater acne severity.	Highlights the importance of dietary modification in inflammatory skin disease.
Godos (2022) [15]	Systematic review	Mediterranean diet	Mediterranean dietary patterns were associated with reduced inflammation and improved skin health.	Supports anti-inflammatory dietary recommendations.
Pullar (2017) [17]	Systematic review	Vitamin C	Vitamin C supports collagen synthesis and improves skin barrier function.	Reinforces adequate micronutrient intake for healthy skin aging.
Kong (2020) [18]	Randomized Controlled Trial	Omega-3 fatty acids	Omega-3 supplementation reduced inflammatory biomarkers and improved acne severity.	Supports omega-3 supplementation as an adjunctive therapy.
De Pessemier (2021) [6]	Review	Gut–skin axis	Gut dysbiosis contributes to acne, psoriasis, and atopic dermatitis.	Demonstrates the importance of microbiome-targeted nutritional strategies.
Rahman (2022) [21]	Systematic review	Probiotics	Probiotic supplementation reduced systemic inflammation and improved dermatologic outcomes.	Supports probiotic use in inflammatory skin disorders.

Martínez (2021) [10]	Systematic review	Skin aging	Mediterranean diet and antioxidants improved skin elasticity and reduced photoaging.	Supports dietary prevention of premature skin aging.
Pageon (2022) [9]	Review	Oxidative stress	Oxidative stress accelerates collagen degradation and skin aging; antioxidant-rich diets are protective.	Highlights the role of nutrition in healthy aging.
Misery (2023) [26]	Review	Psychological stress	Chronic stress aggravates inflammatory skin diseases through neuroimmune mechanisms.	Supports integration of stress management into dermatologic care.
Jafferany & Ferreira (2022) [29]	Review	Psychodermatology	Mindfulness, CBT, and behavioral interventions improve both psychological well-being and dermatologic outcomes.	Reinforces multidisciplinary management strategies.
Huang (2022) [3]	Experimental review	Cortisol and skin barrier	Elevated cortisol impairs epidermal barrier integrity and increases transepidermal water loss.	Demonstrates mechanisms linking chronic stress and skin dysfunction.
Izumi (2018) [31]	Randomized Controlled Trial	Soy isoflavones	Soy isoflavone supplementation improved skin elasticity and dermal collagen.	Supports phytoestrogen use in age-related skin changes.
Zague (2018) [32]	Randomized Controlled Trial	Collagen peptides	Oral collagen supplementation improved hydration, elasticity, and dermal density.	Supports nutritional supplementation for skin aging.

Table 2: Characteristics and Main Findings of the Key Studies Included in the Review

RESULTS AND ANALYSIS

The review of 112 high-quality studies (2015–2025) identified clear patterns connecting nutrition, endocrine regulation, gut microbiota, lifestyle, and skin health. Findings are presented across four main themes: cortisol and stress, sex hormones, gut–skin axis, and skin aging.

Cortisol, Stress, and Diet

- High-glycemic and ultra-processed diets were consistently associated with elevated cortisol levels and increased inflammation, worsening acne, eczema, and barrier dysfunction [2, 14].
- Antioxidant-rich foods, polyphenols, and omega-3 fatty acids were associated with lower cortisol responses and improved inflammatory skin outcomes [16, 18].
- Stress-management strategies combined with dietary interventions (e.g., Mediterranean diet, high-fiber, low-GI) significantly reduced cortisol-mediated skin flares and improved TEWL, hydration, and wrinkle parameters [3].

Analysis

Diet modulates the HPA axis, influencing both systemic inflammation and skin-specific barrier function. Integrating nutrition and stress-management can produce measurable clinical benefits.

Sex Hormones, Diet, and Dermatologic Conditions

- Androgenic acne: High-glycemic foods and dairy increase insulin and IGF-1, reduce SHBG, and elevate free androgen levels, promoting sebum production and follicular hyperkeratinization [13, 33].
- Estrogen-related skin aging: Phytoestrogens (soy isoflavones) and antioxidant-rich diets improve collagen density, elasticity, and dermal thickness, mitigating signs of intrinsic and photoaging [10, 31].

- Progesterone balance: Omega-3 supplementation and anti-inflammatory diets support progesterone stability, reducing luteal-phase acne and inflammation [34].

Analysis

Nutritional modulation of sex hormones can directly influence acne, aging, and pigmentation. Both macronutrient composition and micronutrient intake are critical for hormonal homeostasis and skin health.

Gut–Skin Axis and Microbiome Interactions

- Dysbiosis, often induced by high-sugar, low-fiber diets, is associated with systemic inflammation and worsening dermatologic conditions including acne, atopic dermatitis, and rosacea [6].
- Probiotics and prebiotics enhance microbial diversity, reduce inflammatory cytokines, and improve clinical outcomes [7, 21].
- Short-chain fatty acids (SCFAs) and microbial metabolites mediate immune tolerance and skin barrier integrity. Fiber-rich diets and fermented foods enhance SCFA production and reduce systemic inflammation.

Analysis

The gut–skin axis represents a central mechanistic pathway linking nutrition, endocrine function, and dermatologic outcomes. Targeted dietary interventions can modulate microbiota to improve skin inflammation and aging.

Nutrition, Oxidative Stress, and Skin Aging

- Antioxidants (vitamin C/E, carotenoids, polyphenols) protect against oxidative damage, support collagen synthesis, and reduce wrinkle depth [9-10].
- Collagen peptide supplementation improved skin hydration, elasticity, and dermal thickness in RCTs [32, 35].
- Diets high in sugar and AGEs accelerate glycation of dermal proteins, worsening skin elasticity and pigmentation [36].
- Lifestyle factors such as sleep quality, physical activity, and stress reduction synergize with nutrition to preserve skin structure and slow aging [12].

Analysis

Nutritional strategies aimed at reducing oxidative stress, glycation, and inflammation are central to preserving skin integrity and preventing premature aging.

Integrated Findings

- Endocrine–nutrition interaction: Diet influences insulin, IGF-1, SHBG, cortisol, and sex hormones, impacting acne, sebaceous activity, and aging.
- Gut–skin axis: Diet-mediated microbial modulation reduces systemic inflammation and improves barrier function.
- Lifestyle synergy: Physical activity, sleep, and stress management enhance nutritional effects on skin health.
- Clinical implication: Personalized dietary interventions that target glycemic load, micronutrient density, antioxidant intake, and gut microbiota can optimize dermatologic outcomes across inflammatory conditions and aging.

Theme	Key Nutritional Factors	Hormonal / Mechanistic Pathways	Dermatologic Outcomes
Cortisol & Stress	Antioxidants, omega-3, polyphenols	Cortisol reduction, HPA-axis modulation	Acne severity ↓, eczema ↓, barrier function ↑
Sex Hormones	Low-GI diet, dairy reduction, phytoestrogens	Insulin/IGF-1 ↓, SHBG ↑, estrogen support	Acne ↓, collagen ↑, dermal thickness ↑
Gut–Skin Axis	Fiber, probiotics, prebiotics, fermented foods	SCFA production, microbial balance, immune modulation	Acne ↓, AD ↓, rosacea ↓
Skin Aging	Vitamin C/E, carotenoids, polyphenols, collagen peptides	Oxidative stress ↓, collagen synthesis ↑	Wrinkles ↓, elasticity ↑, hydration ↑

DISCUSSION

This literature review synthesizes evidence from the last decade on the interconnections among nutrition, endocrine regulation, the gut–skin axis, and skin health. The analysis of 112 studies demonstrates that dietary patterns, micronutrient intake, and lifestyle behaviors have profound effects on hormonal balance, systemic inflammation, microbial composition, and ultimately dermatologic outcomes, including acne, inflammatory dermatoses, and skin aging.

Nutritional Modulation of Cortisol and Stress-Related Skin Effects

Elevated cortisol, primarily driven by chronic stress and high-glycemic diets, contributes to impaired barrier function, increased sebum production, and delayed wound healing [2-3]. Evidence indicates that antioxidant-rich diets, omega-3 fatty acids, and polyphenol intake can attenuate cortisol responses and reduce inflammatory skin manifestations [16,18]. These findings support the integration of dietary interventions and stress-management strategies in dermatologic practice, particularly for stress-exacerbated conditions such as acne and atopic dermatitis.

Influence of Nutrition on Sex Hormones and Dermatologic Outcomes

Sex hormones including androgens, estrogens, and progesterone mediate key processes in sebaceous activity, collagen synthesis, and pigmentation. High-glycemic diets and

dairy intake elevate insulin and IGF-1, reducing SHBG and enhancing androgenic activity, which is strongly associated with acne [13,33]. Conversely, phytoestrogens, antioxidants, and low-glycemic dietary patterns support estrogenic and progesterone balance, improving collagen content, elasticity, and hydration [10,31]. These findings underscore the importance of dietary modulation in hormonal acne management and skin aging prevention.

Gut–Skin Axis as a Mechanistic Bridge

The gut–skin axis represents a central pathway linking diet, endocrine signaling, and dermatologic outcomes. Dysbiosis, induced by low-fiber, high-sugar diets, is associated with systemic inflammation, increased intestinal permeability, and exacerbation of acne, eczema, and rosacea [6]. Probiotic and prebiotic interventions enhance microbial diversity, reduce inflammatory cytokines, and improve skin barrier function [21]. This supports the role of microbiome-targeted nutritional strategies as adjunctive treatments in dermatology.

Nutrition, Oxidative Stress, and Skin Aging

Oxidative stress and glycation are major contributors to intrinsic and extrinsic skin aging. Diets high in antioxidants, polyphenols, carotenoids, and collagen peptides reduce oxidative damage, enhance collagen synthesis, and improve dermal elasticity [9,32]. Conversely, Western dietary patterns high in sugar and AGEs accelerate dermal protein cross-linking, leading to wrinkles, reduced hydration, and impaired barrier function [36]. Lifestyle factors such as exercise, sleep, and stress reduction act synergistically with nutrition to preserve skin health [12].

Psychological Stress, Mental Well-being, and Skin Health

Psychological stress has emerged as a central factor in the pathogenesis and progression of numerous dermatologic disorders through complex psychoneuroimmunological and neuroendocrine mechanisms. Activation of the hypothalamic–pituitary–adrenal (HPA) axis and the sympathetic nervous system during periods of acute or chronic stress results in increased secretion of cortisol, catecholamines, and pro-inflammatory mediators, which directly influence cutaneous homeostasis [1].

Persistent elevation of cortisol disrupts epidermal barrier integrity by inhibiting keratinocyte proliferation and differentiation, reducing epidermal lipid synthesis, impairing wound healing, and increasing transepidermal water loss (TEWL) [23-24,37]. Furthermore, chronic stress promotes the production of inflammatory cytokines including interleukin-1β (IL-1β), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF-α), thereby exacerbating inflammatory skin conditions such as acne vulgaris, psoriasis, atopic dermatitis, rosacea, and seborrheic dermatitis [25-27].

In acne vulgaris, stress-induced cortisol elevation has been associated with increased sebaceous gland activity and enhanced androgen-mediated sebum production, contributing to disease severity and recurrence. Similarly, patients with psoriasis exhibit dysregulation of the HPA axis and altered cortisol responses, suggesting that psychological stress may act as both a trigger and a perpetuating factor for disease exacerbation [28]. In atopic dermatitis, stress-related neuroimmune signaling involving substance P and corticotropin-releasing hormone (CRH) contributes to pruritus, skin barrier dysfunction, and chronic inflammation.

Importantly, the relationship between mental health and skin disease is bidirectional. Chronic dermatologic disorders are associated with increased prevalence of anxiety, depression, social withdrawal, body image dissatisfaction, and reduced quality of life [38]. Large multinational studies have demonstrated significantly higher rates of depressive symptoms and suicidal ideation among patients with visible skin diseases compared with healthy populations, highlighting the substantial psychological burden of dermatologic conditions [39].

These observations have led to the emergence of psychodermatology, an interdisciplinary field investigating the interactions between psychological processes and skin disease. Current evidence supports the integration of behavioral and psychological interventions into dermatologic care. Mindfulness-based stress reduction (MBSR), cognitive behavioral therapy (CBT), meditation, sleep optimization, and regular physical activity have demonstrated beneficial effects on cortisol regulation, inflammatory biomarkers, psychological well-being, and clinical dermatologic outcomes [29-30].

Recent advances in psychoneuroimmunology further support the concept of a gut–brain–skin axis, whereby psychological stress alters gut microbiota composition and intestinal permeability, leading to systemic inflammation that contributes to both psychiatric symptoms and dermatologic disease activity. Consequently, modern dermatologic management increasingly advocates a multidisciplinary approach integrating nutritional strategies, stress management, and behavioral health interventions to optimize both mental well-being and skin health.

Conflicting Evidence

Although the overall body of evidence supports the beneficial role of nutrition and lifestyle interventions in dermatologic health, several inconsistencies remain across the published literature. Differences in study design, participant characteristics, dietary assessment methods, intervention duration, and outcome measures contribute to heterogeneous findings.

For example, while numerous observational studies have reported positive associations between high-glycemic diets and acne severity, several intervention trials have demonstrated only modest clinical improvements following dietary modification, suggesting that genetic susceptibility, hormonal status, and environmental factors may also influence treatment response. Similarly, although dairy consumption has frequently been associated with acne development through insulin-like growth factor-1 (IGF-1) signaling, some large cohort studies have failed to demonstrate a consistent relationship after adjustment for confounding variables.

Conflicting evidence also exists regarding nutritional supplementation. Omega-3 fatty acids, probiotics, collagen peptides, and phytoestrogens have shown promising effects in several randomized controlled trials; however, differences in

supplement formulations, dosages, treatment duration, and study populations limit direct comparison across studies. Likewise, although vitamin D deficiency has been associated with inflammatory skin disorders, supplementation studies have produced inconsistent results, indicating that baseline nutritional status and disease severity may modify therapeutic responses.

Evidence concerning the gut–skin axis also remains heterogeneous. While numerous mechanistic and experimental studies support the role of gut microbiota in inflammatory skin diseases, human clinical trials are relatively limited, and standardized probiotic interventions have not yet been established. Consequently, although microbiome-targeted therapies represent a promising area of research, further high-quality randomized controlled trials are required before definitive clinical recommendations can be made.

Overall, these discrepancies emphasize that nutritional dermatology should be interpreted within a multifactorial framework in which dietary factors interact with endocrine regulation, psychological stress, genetic predisposition, immune function, and lifestyle behaviors.

Clinical Implications

The findings of this review highlight the need for a multidisciplinary and patient-centered approach to dermatologic care that integrates nutritional assessment, psychological support, endocrine evaluation, and lifestyle medicine interventions.

Routine Psychological Screening in Dermatology

Patients presenting with chronic inflammatory skin disorders such as acne vulgaris, psoriasis, atopic dermatitis, and rosacea may benefit from routine screening for psychological distress, anxiety, depressive symptoms, sleep disturbances, and chronic stress exposure. Early identification of psychosocial burden may improve both dermatologic and mental health outcomes.

Integration of Nutritional Counseling into Dermatologic Practice

Dietary assessment should become an integral component of dermatologic consultations, particularly in patients with hormonally mediated or inflammatory skin conditions. Individualized nutritional interventions targeting glycemic control, insulin sensitivity, gut microbiota diversity, and anti-inflammatory dietary patterns may complement conventional dermatologic therapies and improve long-term outcomes.

Endocrine and Metabolic Evaluation

Patients with persistent acne, seborrhea, menstrual irregularities, insulin resistance, or features suggestive of hyperandrogenism may benefit from hormonal and metabolic assessment, including evaluation of insulin, glucose homeostasis, androgen levels, cortisol regulation, and thyroid function. Such evaluations may facilitate early identification of underlying endocrine disorders.

Stress Management as a Therapeutic Strategy

Psychological stress should be considered a modifiable clinical risk factor in dermatology. Interventions such as mindfulness-based stress reduction, cognitive behavioral therapy, sleep optimization, relaxation techniques, and regular physical activity may reduce HPA-axis activation and systemic inflammation, thereby improving skin outcomes.

Incorporation of Psychodermatology into Clinical Care

The bidirectional relationship between mental health and skin disease supports the development of psychodermatology services involving collaboration among dermatologists, psychologists, psychiatrists, nutritionists, and endocrinologists. Such multidisciplinary models may improve treatment adherence, quality of life, and patient satisfaction.

Personalized Nutritional Dermatology

Future clinical practice may increasingly rely on personalized approaches incorporating dietary habits, hormonal profiles, stress levels, microbiome composition, and lifestyle factors to design individualized prevention and treatment strategies for dermatologic disorders and skin aging.

Women's Health and Hormonal Skin Disorders

Women experiencing adult female acne, perimenopausal skin changes, polycystic ovary syndrome, or hormonally mediated pigmentation disorders may particularly benefit from integrated nutritional and endocrine interventions tailored to hormonal fluctuations throughout the lifespan.

Development of Preventive Skin Health Programs

The evidence supports the implementation of preventive programs focusing on healthy nutrition, stress reduction, sleep hygiene, and physical activity as strategies to reduce the burden of inflammatory skin diseases and promote healthy skin aging.

The future of dermatologic care may lie not only in topical and pharmacological therapies, but also in personalized psychoneuroendocrine interventions that address nutrition, mental well-being, hormonal regulation, and microbiome health as interconnected determinants of skin disease and healthy aging.

STUDY LIMITATIONS

This review has several limitations that should be acknowledged. First, although a structured search strategy was employed, the review included studies with heterogeneous designs, including randomized controlled trials, observational studies, systematic reviews, and meta-analyses, which limited direct comparison of findings. Second, considerable variability existed in dietary interventions, nutritional assessment methods, outcome definitions, and follow-up duration across the included studies.

Third, many of the available studies were observational in nature, limiting the ability to establish causal relationships between nutritional factors and dermatologic outcomes. Furthermore, psychological stress, dietary intake, and lifestyle behaviors were frequently assessed using self-reported questionnaires, introducing the potential for recall and reporting bias.

Another important limitation is that most published studies were conducted in Western populations, reducing the

generalizability of findings to other ethnic and geographic groups. In addition, several emerging areas including psychodermatology, the gut–brain–skin axis, and microbiome-based nutritional interventions remain relatively new fields with limited long-term clinical evidence.

Finally, publication bias cannot be completely excluded because studies reporting positive findings are more likely to be published than studies with neutral or negative results.

Despite these limitations, the review synthesizes current evidence from multiple high-quality sources and provides an updated overview of the complex interactions among nutrition, psychological stress, endocrine regulation, the gut–skin axis, and skin health.

RESEARCH GAPS AND FUTURE DIRECTIONS

Despite substantial progress, several gaps remain:

- Longitudinal human studies linking specific dietary patterns with hormonal biomarkers and clinical dermatologic outcomes are limited.
- Standardized dietary interventions with controlled nutrient content are needed to clarify causality.
- Integration of multi-omics approaches (metabolomics, microbiome profiling, and hormonal assays) can enhance mechanistic understanding.
- Population diversity: Most studies focus on adolescents or middle-aged women; data on men, elderly populations, and diverse ethnicities are limited.

Future research should adopt integrative, multi-disciplinary designs combining endocrinology, microbiome analysis, and nutritional interventions to develop personalized dermatologic therapies.

CONCLUSION

This literature review demonstrates that nutrition, endocrine function, the gut–skin axis, and lifestyle factors are intricately connected in maintaining skin health, preventing dermatologic disorders, and slowing skin aging. Key findings include:

- Dietary modulation of cortisol: Antioxidants, polyphenols, and omega-3 fatty acids attenuate HPA-axis overactivation, reducing inflammation and improving barrier function.
- Sex hormone balance: Low-glycemic diets, reduced dairy intake, phytoestrogens, and micronutrients support androgen, estrogen, and progesterone homeostasis, improving acne, collagen density, and elasticity.
- Gut–skin axis: Fiber, probiotics, and prebiotics promote microbial diversity, SCFA production, and immune regulation, benefiting inflammatory skin conditions.
- Skin aging: Antioxidants, carotenoids, collagen peptides, and lifestyle interventions mitigate oxidative stress, glycation, and dermal degradation, preserving elasticity and hydration.

The evidence reviewed suggests that dermatologic health is not solely determined by nutrition or endocrine status but results from complex interactions among diet, psychological well-being, stress physiology, hormonal regulation, immune function, and gut microbiome composition. The emerging concept of psychoneuroendocrine nutritional dermatology highlights the importance of addressing emotional health, stress management, and lifestyle behaviors alongside dietary interventions. Integrative approaches that combine nutritional therapy with behavioral and psychological support may provide superior outcomes for patients with inflammatory skin diseases and age-related dermatologic changes.

Integrating nutritional strategies with hormonal monitoring, microbiome modulation, and lifestyle optimization provides a holistic approach to dermatologic care. Personalized dietary interventions targeting glycemic control, micronutrient adequacy, and microbiome health have significant potential to prevent and manage acne, inflammatory dermatoses, and premature skin aging.

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