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Review

An Umbrella Review on the Prevention of Skin Diseases: Do Specific Nutrients Play a Protective Role?

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ABSTRACT: Skin diseases affect a considerable proportion of the population worldwide, with a substantial impact on quality of life. The power of certain foods, beverages, and dietary supplements for the primary prevention of these diseases remains poorly understood and is not widely disseminated. The aim of this umbrella review was to evaluate specific nutrients in the primary prevention of skin diseases. Manuscripts were extracted from four online databases (PubMed, Scopus, Web of Science, and Cochrane) using keywords and MeSH (Medical Subject Headings) terms. The inclusion criteria were general populations and high-risk but disease-free individuals, food and dietary supplementation intake, their effects on the primary prevention of skin diseases, and systematic reviews or meta-analyses. When performing a further search, other studies were included, but manuscripts regarding risk factors and diets were excluded. A total of six studies were included in this umbrella review, which covered a period between 2001 and 2023 and included a total of 9,229 participants, either *in utero* or aged 0 – 80 years old. The preventive effect of green tea catechins on ultraviolet radiation-induced erythema was highlighted, as well as the role of *Lactobacillus* probiotics in infant atopic eczema. Finally, niacinamide supplementation reduced the incidence of basal and squamous cell carcinoma (the major subtypes of non-melanoma skin cancer). Despite the small number of studies identified, the emerging evidence provided some insights into the primary prevention of certain skin diseases and may serve as a foundation for future studies.

Keywords: food, nutrients, primary prevention, probiotics, skin diseases

INTRODUCTION

Skin diseases are among the most common ailments worldwide, representing the fourth leading cause of non-fatal disease burden globally (Karimkhani et al., 2017). Recent estimates indicate that approximately 1.8 billion people suffer from skin conditions at any given time (WHO, 2023). Each year, billions of new cases of skin

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disorders occur, and more than 4.8 billion cases were reported in 2019 alone (Yakupu et al., 2023).

In the United States, approximately one in four people is affected by a skin condition, incurring an estimated $75 billion in direct healthcare costs and $11 billion in lost productivity (Lim et al., 2017). Although most skin conditions are not life-threatening, their chronic and visible nature often leads to substantial disability, stigma, and healthcare costs. Skin diseases can cause long-term physical effects and are frequently associated with psychological distress as well as a reduced quality of life (Yakupu et al., 2023).

Chronic dermatoses, such as atopic dermatitis, rank highest in disability among the various skin disorders and impose substantial costs (Elezbawy et al., 2022). Beyond medical expenses, skin diseases cause considerable psychosocial and financial burdens on patients and even on their families (Karimkhani et al., 2017). This dual impact on physical and mental health (Luck-Sikorski et al., 2022), combined with the high prevalence of dermatological conditions, emphasizes the importance of preventive strategies in dermatology from a public health perspective.

Nutritional interventions have gained increasing interest as a cost-effective approach to reduce the incidence and severity of skin diseases, although their efficacy in the primary prevention thereof remains unknown (Diotallevi et al., 2022). Diet is a modifiable lifestyle factor that influences systemic inflammation and immune function; therefore, it is suggested that it could also play an important role in skin health. However, the relationship between nutrition and skin disease prevention is complex and occasionally controversial, given the multifactorial etiologies of most skin conditions (Diotallevi et al., 2022).

Emerging evidence is beginning to clarify how specific nutrients, foods, and supplements might protect the skin, thereby laying the foundation for dietary guidance as part of skin disease prevention. Previous umbrella reviews have addressed single conditions, such as atopic eczema in children (Foisy et al., 2011), and to the best of our knowledge, this is the first umbrella review to systematically synthesize evidence on selected nutrients in the primary prevention of skin diseases. This review aims to systematically gather the most solid evidence available through an umbrella review procedure.

MATERIALS AND METHODS

Study design

This umbrella review was performed by the National Working Group on "Preventive Nutrition" of the Medical Residents' Council of the Italian Society of Hygiene, Preventive Medicine and Public Health (S.It.I.) in the 2024/25 academic year. The study was registered in the International Prospective Register of Systematic Reviews (PROSPERO) (protocol number CRD42024545536). The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) and the Joanna Briggs Institute (JBI) guidelines for umbrella reviews were followed during the study.

Search strategy

A comprehensive search was performed across four electronic databases, namely PubMed, EMBASE, Cochrane Reviews, and Web of Science, to identify systematic reviews and meta-analyses that addressed the role of nutrients in the prevention of skin diseases. The search strategy used a combination of keywords and controlled vocabulary terms, such as "food," "beverages," "protective agents," and "skin diseases," to identify studies related to dietary nutrients and their preventive effects on skin conditions. The search included studies published in English without any restrictions on publication dates.

Eligibility criteria

Studies were included if they focused on specific skin diseases where the skin was the primary site of disease onset, involved general populations or high-risk but disease-free individuals, and investigated the intake of specific nutrients or protective substances through diet. Only systematic reviews and meta-analyses were considered, and no restrictions were placed on age, thereby allowing for studies that addressed specific age groups as well as all-age populations. All other review types were not included in this study.

Studies were excluded if they involved *in vitro* or animal research, focused on diseases that affected multiple organs or systems, addressed dietary patterns or models instead of specific nutrients, or were related to allergies, as their prevention primarily relies on allergen avoidance. In addition, reactions to drugs or external stressors were excluded, as they can often be mitigated by avoidance. Special conditions, such as pregnancy, which complicate the evaluation of the actual effects of nutrients, were also excluded. Studies that analyzed risk factors (such as associations between the avoidance of specific substances and prevention) were not included, nor were observational or experimental studies, case reports, or case series. Finally, studies that were not published in English, gray literature, and articles from non-indexed or non-peer-reviewed journals were excluded.

Study screening process

The search queries extracted from the four databases were uploaded to the online study screening tool Rayyan (Rayyan: AI-Powered Systematic Review Management Platform, 2025). The researchers were divided into three

groups and activated the blind in the online tool. At this point, the automatic duplicate detection function was performed, and each detected duplicate was assessed by Group 1 and Group 2, who could either confirm, deny, or mark it as "maybe." Once the analysis was complete, the blind was removed, and Group 3 assessed the conflicts between Groups 1 and 2 and the "maybes," with the possibility to discuss every single case with the entire research team. The same process was repeated for title and abstract screening, and finally for the full-text screening, which followed the eligibility criteria.

Data extraction

The full texts that were included were further assigned to the researchers, who extracted the following information into a shared online table:

- First author of the review, title, year, and type (systematic review or meta-analysis);
- Risk of bias tools used and the rating;
- Number of studies included and the period covered;
- Total population size and age;
- Exposure(s), dose(s), and duration(s);
- Outcome(s) and number of studies for every outcome (if reported);
- Prevalence of effect frequency: considering the effect occurrence frequency as always (100% of times), almost always (>75%), sometimes (>25%), few (>5%), very few (>0%), and no effect (0%);
- Prevalence of effect entity as very strong (>50%), strong (>25%), medium (>10%), low (>5%), very low (>0%), and no effect (0%);

Furthermore, the most experienced authors double-checked all information extracted by the research team.

Quality assessment

The methodological quality was determined through the application of the JBI Critical Appraisal Checklist. Furthermore, the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) approach was employed, where possible, for the overall assessment of the quality of evidence for the included articles.

RESULTS

Selection of studies

Of the initial 585 studies identified, only 68 were chosen for full-text analysis. Of these, 62 were excluded, mainly because of incorrect outcomes (n=25) or because they were narrative reviews (n=37). Finally, three studies were added following the research update, which included screening of the supplementary texts cited by the already included studies. Fig. 1 shows the identification process for the included studies.

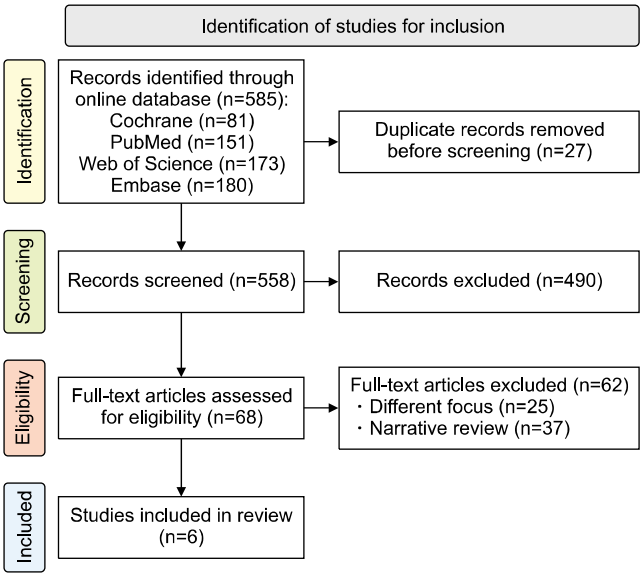

Fig. 1. Identification process of the studies selected for inclusion in the review.

Characteristics of the included studies

Analysis of the included studies highlighted several associations between the intake of specific nutrients and the prevention of certain skin conditions. These provided varying levels of evidence and strength of the preventive effects depending on the intervention employed, as shown in Table 1.

Green tea derivatives, particularly catechins, were evaluated in two systematic reviews, which covered a total of 11 studies (Kapoor et al., 2021; Di Sotto et al., 2022). The oral supplementation thereof revealed a consistent preventive effect in reducing ultraviolet (UV)-induced skin erythema, with the preventive effect being described as occurring "almost always" or "always" and with a "moderate" to "strong" magnitude. However, regarding the impact on pro-inflammatory mediators, although a reduction in 12-hydroxyeicosatetraenoic acid (12-HETE) was observed in one individual study, no statistically significant preventive effect was confirmed in the pooled analysis for either prostaglandin E2 (PGE2) or 12-HETE. An antioxidant activity of green tea catechins on skin integrity was not observe.

The use of niacinamide has been associated with a reduction in the risk of non-melanoma skin cancers, particularly basal and squamous cell carcinoma, in older adult populations (Tosti et al., 2024). The effect was described as "moderate" in magnitude, with an observed frequency between 25% and 75%.

Regarding supplementation with probiotics in pediatric populations, the use of *Lactobacillus rhamnosus*, alone or combined with other strains, exhibited a consistent preventive effect in reducing the incidence of atopic eczema, particularly in early childhood, when combined with *Bifidobacterium* strains (Szajewska and Horvath, 2018; Sun

Table 1. Selected studies investigating the associations between the intake of specific nutrients and the prevention of certain skin conditions

Study	Critical Appraisal Checklist Score	No. of studies	Covered period (year)	Population studied (size; age, years)	Exposure	Dose per day & length	Outcome	No. of studies for this outcome	Preventive effect frequency[1)]	Preventive effect entity[2)]
Kapoor et al., 2021	10	4	2011–2018	170 (age 18–65)	Green tea catechins	540–1,402 mg; 6–12 weeks	UV-induced erythema (pre-/post)	3	Almost always	Strong
							UV-induced erythema (vs. placebo)	2	Always	Strong
							Pro-inflammatory mediators reduction (PGE2)	2	Never	Very low
							Pro-inflammatory mediators reduction (12-HETE)	2	Sometimes	Low
Tosti et al., 2024	8.5	4	Up to Aug 2023	318 (age 62–72) disease-free yet high-risk	Niacinamide	500 mg; 4–12 months	Squamous cell carcinoma	3	Sometimes	Medium
							Basal cell carcinoma	3	Sometimes	Medium
							Non-melanoma skin cancer	5	Almost always	Medium
Szajewska and Horvath, 2018	9	5	2001–2017	889 (age 0–2)	*Lactobacillus rhamnosus*	1–18 CFU ($\times 10^9$); 3–6 months	Risk of eczema		Almost always	Low
Sun et al., 2021	10	9	2008–2019	2,093 (age 0–3)	Mixed strains of *Bifidobacterium*	0.01–50 CFU ($\times 10^9$); 6–24 months	Incidence of infant eczema		Always	Strong
Di Sotto et al., 2022	6	7	2011–2022	322 (age 18–80)	Green tea (beverage and catechins extract)	500–2,700 mg capsule; 12 weeks	UV-induced erythema	5	Almost always	Medium
						600 mL/2 packs; 2–26 weeks	Skin integrity and antioxidant defenses	2	Never	No effect
Voigt and Lele, 2022	7	11	2001–2018	5,437 (age 0–11)	*L. rhamnosus*	5–50 CFU ($\times 10^9$); 2–10 weeks	Incidence of infant atopic eczema ≤2 years	10	Almost always	Strong
							Incidence of infant atopic eczema at 4–5 years	3	Almost always	Strong
							Incidence of infant atopic eczema at 6–7 years	3	Almost always	Strong
							Incidence of infant atopic eczema at 10–11 years	2	Almost always	Strong

[1)]Preventive effect frequency: always, 100%; almost always, >75%; sometimes, 25%–75%; few, <25%; never, 0%.
[2)]Preventive effect entity: very strong, >50%; strong, >25%; medium, >10%; low, >5%; very low, <5%; no effect, 0%.
CFU, colony-forming units; UV, ultraviolet; PGE2, prostaglandin E 2; 12-HETE, 12-hydroxyeicosatetraenoic acid.

et al., 2021; Voigt and Lele, 2022).

A detailed overview of the epidemiological measures emerging from the meta-analyses included in the review is provided in Table 2.

High heterogeneity was noted for the outcomes of 12-HETE (I^2=88%), basal cell carcinoma (63%), and some infant atopic eczema subgroups (Voigt and Lele, 2022; Tosti et al., 2024). A heterogeneity equal to or close to zero was highlighted for the prevention of UV-induced erythema and reduction of PGE2 levels through green tea consumption, squamous cell and non-melanoma skin cancer prevention with niacinamide consumption, and eczema risk reduction in the pediatric population with supplementation with *L. rhamnosus* (Szajewska and Horvath, 2018; Kapoor et al., 2021; Voigt and Lele, 2022; Tosti et al., 2024). The lowest *P*-values were found for the UV-induced erythema prevention through green tea consumption and infant atopic eczema prevention through supplementation with *L. rhamnosus* with and without *Bifidobacterium* (Kapoor et al., 2021; Sun et al., 2021).

Methodological quality assessment of the included studies

Based on the JBI Critical Appraisal Checklist, the quality of the included articles was medium to high, with scores between 8 and 10; however, it is necessary to highlight that five out of the six articles have a deficiency in the application of limitations to publication bias (Szajewska and Horvath, 2018; Kapoor et al., 2021; Di Sotto et al., 2022; Sun et al., 2021; Voigt and Lele, 2022) or methods to reduce data extraction errors (Kapoor et al., 2021; Di Sotto et al., 2022; Voigt and Lele, 2022; Tosti et al., 2024). Moreover, in three articles, there are no recom-

Table 2. Detailed overview of the epidemiological measures emerging from the meta-analyses included in the review

Study	Population studied (size; age, years)	Exposure	Outcome	No. of studies for this outcome	Type of metric	95% CI or *P*-value	Heterogeneity (%)
Kapoor et al., 2021	170 (age 18–65)	Green tea catechins	UV-induced erythema (pre-/post)	3	SMD: −0.35	−0.57 to −0.13; *P*=0.002	4
			UV-induced erythema (vs. placebo)	2	SMD: −0.29	−0.53 to −0.05; *P*=0.020	0
			Pro-inflammatory mediators reduction (PGE2)	2	MD: −2.93 pg/μL	−35.61 to 29.75; *P*=0.860	0
			Pro-inflammatory mediators reduction (12-HETE)	2	MD: −7.49 pg/μL	−33.04 to 18.05; *P*=0.080	88
Tosti et al., 2024	318 (age 62–72)	Niacinamide	Squamous cell carcinoma	3	RR: 0.81	0.48–1.37	0
			Basal cell carcinoma	3	RR: 0.88	0.50–1.55	63
			Non-melanoma skin cancer	5	RR: 0.82	0.61–1.12	63
Szajewska and Horvath, 2018	889 (age 0–2)	*Lactobacillus rhamnosus*	Risk of eczema	5	RR: 0.31-2.79	*P*=0.75	0
Sun et al., 2021	2,093 (age 0–3)	Mixed strains of *Lactobacillus* and *Bifidobacterium*	Incidence of infant eczema	9	RR: 0.60	0.47–0.78; *P*<0.001	67
Voigt and Lele, 2022	5,437 (age 0–11)	*L. rhamnosus*	Incidence of infant atopic eczema ≤2 years	10	RR: 0.60	0.47–0.75; *P*<0.001	48
			Incidence of infant atopic eczema at 4–5 years	3	RR: 0.74	0.55–1.00; *P*=0.050	61
			Incidence of infant atopic eczema at 6–7 years	3	RR: 0.62	0.50–0.75; *P*<0.001	0
			Incidence of infant atopic eczema at 10–11 years	2	RR: 0.68	0.37–1.27; *P*=0.230	74

CI, confidence interval; UV, ultraviolet; PGE2, prostaglandin E 2; 12-HETE, 12-hydroxyeicosatetraenoic acid; SMD, standardized mean difference; MD, mean difference; RR, risk ratio.

mendations to support the highlighted data (Szajewska and Horvath, 2018; Di Sotto et al., 2022; Voigt and Lele, 2022).

The use of the GRADE method allowed for the quality of evidence to be defined based on aspects such as the feasibility and transferability of the proposed intervention, the expected benefits and risks, and the various implications. The systematic reviews that were analyzed with this methodology (Voigt and Lele, 2022; Tosti et al., 2024) exhibited a moderate value of the quality of evidence, which correlated with a good methodological quality.

Despite the presence of attrition bias (Szajewska and Horvath, 2018; Sun et al., 2021) related to the characteristics of the samples included in the articles, some less robust methodological choices (Di Sotto et al., 2022; Voigt and Lele, 2022; Tosti et al., 2024), and variable heterogeneity, the quality of the research remained very good.

The risk of bias assessment is visually summarized in Fig. 2, which shows the distribution of the responses for each domain of the JBI Critical Appraisal Checklist.

DISCUSSION

The results are largely consistent with previous knowledge while offering new insights. Regarding the prevention of skin cancers, the effectiveness of niacinamide suggests that dietary supplementation may help prevent certain skin disorders, which has emerged in preclinical and phase II studies. In addition, vitamin B3 protects the skin from UV-induced actinic damage by improving DNA repair mechanisms and barrier function. Furthermore, the 23% reduction in non-melanoma carcinomas observed in the ONTRAC study indicates a promising trend supporting this chemopreventive approach, which aligns with previous evidence that actinic keratoses are reduced via niacinamide (Chen et al., 2015; Allen et al., 2023; Tosti et al., 2024).

In the case of atopic dermatitis, our results support the various studies that link the early modulation of the microbiota with the prevention of allergy-related diseases. The role of probiotics in "educating" the neonatal immune system toward tolerance was confirmed by recent meta-analyses, including those conducted by pediatric scientific societies. This provides evidence that the intake of probiotics during pregnancy and/or in early childhood involves a significant reduction in the risk of eczema, mainly in infants and young children (Szajewska and Horvath, 2018; Sun et al., 2021; Voigt and Lele, 2022).

Furthermore, the role of green tea catechins in preventing UV-induced erythema was confirmed by two studies. This supports the literature that associates certain dietary antioxidants with the skin's defenses against environmental damage, although a direct effect on skin integrity was not found in our review. In particular, the photoprotective effects of green tea polyphenols were confirmed (Kapoor et al., 2021; Di Sotto et al., 2022; Anbualakan et al., 2023).

The evidence that emerged could have relevant repercussions on public health policies by suggesting relatively simple and low-cost nutritional interventions that may be effective in preventing certain skin diseases with a strong influence on the population and health system economics. Oral niacinamide intake has exhibited potential as a preventive strategy against cutaneous oncological diseases in high-risk individuals, although its large-scale implementation requires confirmation from further high-quality randomized controlled trials.

Similarly, newborns with a familial predisposition for

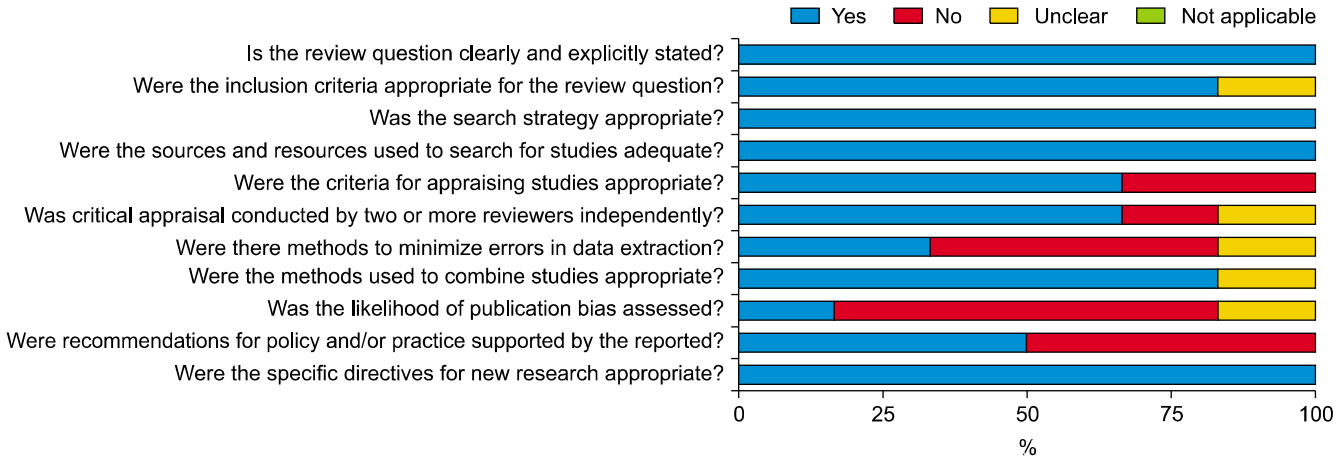

Fig. 2. The risk of bias for the included studies according to the JBI (Joanna Briggs Institute) Critical Appraisal Checklist, expressed as a percentage. The answer for each question was categorized as "yes" (blue), "unclear" (yellow), "no" (red), or "not applicable" (green).

atopic dermatitis may potentially benefit from probiotic supplementation during pregnancy and early infancy. However, current findings remain preliminary, and additional rigorous studies are required for confirmation before they are translated into public health recommendations.

Finally, the consumption of green tea or its extracts, which are easy to purchase and implement, might provide benefits for individuals exposed to high levels of solar radiation (e.g., for work-related reasons), but the evidence remains limited and heterogeneous.

Nevertheless, these potential benefits should be interpreted with caution, given the variability and heterogeneity of the underlying evidence.

A collaboration between dermatologists, nutritionists, and epidemiologists on this evidence could generate joint information for health promotion campaigns. In the future, official recommendations could be made for the general population and health operators, such as dermatologists and pediatricians. Secondarily, the results of our review could also address prevention policies in health services; for example, a routine nutritional assessment (e.g., weight and eating habits) could be included in dermatological follow-ups of patients, with brief counselling interventions to correct their risky lifestyle habits.

Ultimately, all the evidence supports a "healthy lifestyle, healthy skin" approach, where investing in nutritional improvements at the population and individual level may potentially translate into a reduction in dermatological morbidity. Furthermore, this supports cross-sectoral public health interventions that embrace nutrition as an essential component of primary and secondary dermatological prevention.

The use of an umbrella review approach in this study integrated and synthesized evidence from numerous high-quality studies, thereby offering a comprehensive and critical overview of nutritional interventions. The diversity of study designs included could be considered a weakness, but it is also a strength of the umbrella review, as it is able to compare and integrate results from different levels of evidence. Furthermore, the literature search covered the entire spectrum of available knowledge, thereby ensuring that the discussion considers consolidated historical evidence and contemporary updates.

In addition, a qualifying methodological point was the systematic assessment of the bias risk of the included studies, taking into account the internal soundness of each study when synthesizing the results. For example, randomized, double-blind, and low-risk-bias studies received more interpretative weight than observational studies with possible confounding effects.

However, some studies exhibited limitations in their methodological quality, thereby influencing the overall interpretation of the data and making it challenging to assess the long-term effects of the nutritional interventions because of their limited duration. As the umbrella review collected previously published evidence, the quality of the umbrella review depends, in part, on the quality of the secondary sources. Thus, any conclusions need to be considered in the context of the diversity and sometimes the fragility of the underlying evidence.

Another limitation is that, despite their potential role in skin health, nutrients such as vitamin D, omega-3 fatty acids, and carotenoids could not be assessed in this study, as no systematic reviews or meta-analyses were available that met our inclusion criteria. This gap highlights the need for future evaluations of these nutrients.

An additional limitation is the exclusion of dietary patterns and observational studies. While this was necessary to ensure methodological rigor and preserve causal inference, it may reduce the generalizability of our findings. Many nutrients can act synergistically within overall dietary patterns, and excluding this body of evidence may have limited the potentially relevant associations.

Finally, high heterogeneity can be considered a strength (wide overview) or a weakness (less specificity), and the external validity of the results may vary, as not all recommendations are ready for large-scale implementation. In particular, the high heterogeneity observed in certain outcomes, such as infant eczema prevention with probiotic supplementation but at older ages, and basal cell carcinoma incidence with niacinamide, limits the robustness of the conclusions and emphasizes the need for cautious interpretation.

The evidence gathered highlights several priority areas that require further investigation, with particular emphasis on the need for longitudinal studies that can effectively assess the long-term effects and safety profiles of the proposed nutritional interventions. Particular attention should be given to methodological rigor, standardized protocols, and careful monitoring to control for potential biases and confounding factors.

Further high-quality research, including large, randomized trials and cost-effectiveness studies, is required to strengthen the evidence base. If future studies conclusively demonstrate that certain nutritional supplements safely reduce skin disease incidence, they will contribute to tailored public health prevention programs, thereby improving the general population's level of skin health.

This umbrella review underscores the potential of nutritional interventions, when appropriately structured and personalized, as promising strategies for the primary prevention of skin diseases. The available evidence supports the use of specific nutrients, such as green tea catechins, niacinamide, and probiotics, in mitigating skin damage induced by environmental and inflammatory factors in various populations.

When integrated into prevention and health promo-

tion programs, these low-cost nutritional supplements could significantly contribute to improving skin health and reducing the worldwide burden of high-impact dermatological conditions. In particular, green tea catechins demonstrated consistent photoprotective effects, while oral niacinamide supplementation was shown to be a protective agent against non-melanoma skin cancers, and probiotic intake of *L. rhamnosus* with or without *Bifidobacterium* was found to be effective in preventing atopic eczema, specifically in the first years of life.

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AUTHOR DISCLOSURE STATEMENT

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Analysis and interpretation: GG, MM, AV, GM, CL, PS, MC, MP, GLB, GS, FL, TU, AL. Writing the article: GG, MM, AV, GM, CL, PS, MC, MP, GLB, GS, FL, TU, AL. Critical revision of the article: GG, MM, AL. Final approval of the article: All authors. Overall responsibility: GG, AL.

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