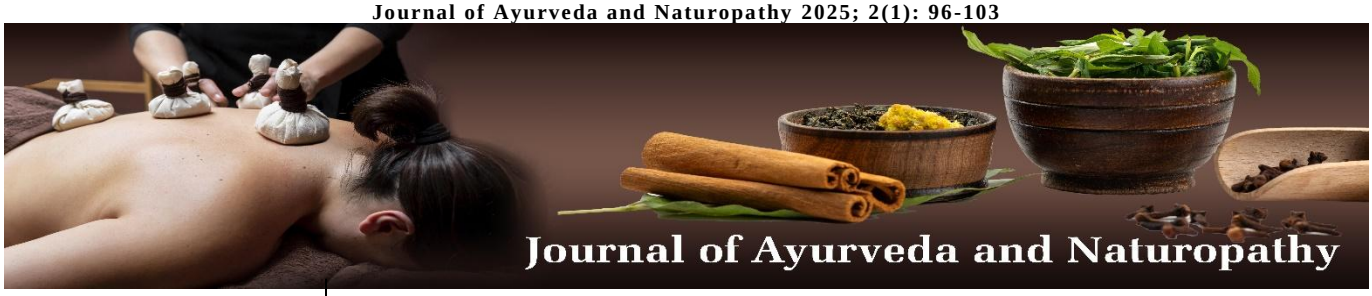

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Use of artificial intelligence in Ayurvedic dermatology: Diagnosis and management of skin disorders

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Abstract
Background: Artificial Intelligence (AI) is increasingly transforming dermatology by improving diagnostic accuracy and efficiency. Concurrently, Ayurveda-the ancient Indian medical system-offers a personalized, holistic approach to skin disorders (Twak Vikara). However, integration of AI with Ayurvedic dermatology remains nascent.
Objectives: We systematically reviewed recent literature (2020-2025) on applications of AI in skin disease diagnosis and management, with a focus on intersections between modern dermatology and Ayurvedic principles.
Methods: A systematic search was conducted in PubMed, Scopus, Google Scholar, the AYUSH research portal, and DHARA using keywords combining "Artificial Intelligence" or "Machine Learning" with "Ayurveda" and "Dermatology" or specific skin conditions (e.g., "Twak Vikara," "psoriasis," "acne"). Inclusion was limited to peer-reviewed articles from January 2020 to July 2025. Relevant studies on AI in dermatology, Ayurvedic approaches to skin diseases, and especially those bridging both fields were analyzed per PRISMA guidelines.
Results: Out of 62 records identified, 18 articles met inclusion criteria (5 on AI in modern dermatology, 7 on Ayurvedic dermatology, 6 directly integrating AI with Ayurveda). AI has demonstrated dermatologist-level performance in detecting skin lesions (e.g., melanoma) and improved teledermatology outcomes in primary care. Ayurveda literature describes skin diseases like eczema (Vicharchika), psoriasis (Kitibha), and acne (Yuvan Pidika) in terms of doshic imbalance, with individualized treatments showing efficacy in case reports. A few pioneering studies combined these domains: one 2023 study using deep learning to classify skin diseases and then provide Ayurvedic treatment suggestions achieved high accuracy (>95%) in disease identification and recommendation success. Nonetheless, no large clinical trials were found. Key themes include AI's strength in image-based diagnosis, Ayurveda's holistic treatment protocols, and early attempts at AI-driven Ayurvedic diagnostic tools.
Conclusion: AI holds promise to enhance Ayurvedic dermatology by objectively diagnosing skin conditions and personalizing therapy recommendations, while Ayurveda's rich clinical knowledge can broaden AI's scope in holistic skincare. Robust interdisciplinary research and clinical validation are needed to realize an integrative model that leverages AI's precision and Ayurveda's personalization for improved skin health outcomes.

Keywords: Ayurveda, artificial intelligence, dermatology, machine learning, Twak Vikara, personalized medicine, skin disorders

Introduction

Modern dermatology is experiencing a paradigm shift with the advent of artificial intelligence. AI-driven image analysis can now detect certain skin diseases with accuracy on par with expert dermatologists. Notably, AI algorithms have even surpassed dermatologists in identifying malignant skin lesions in some studies, demonstrating capabilities for early skin cancer detection and diagnosis at scale [1]. AI applications in dermatology range from classifying skin tumors and analyzing dermoscopic images to aiding in chronic disease monitoring and teledermatology consultations. For example, machine learning tools have been shown to improve diagnostic agreement among primary care providers in teledermatology settings, thereby enhancing accuracy and access to specialist-level skin care in remote areas [6]. Despite these advances, dermatology has lagged behind fields like radiology in AI adoption, due in part to challenges such as image standardization, data privacy, and the need for clinical validation [1].

This indicates a need for collaborative efforts to integrate AI into routine dermatological practice safely and effectively. Ayurvedic medicine, an ancient holistic system of health care, offers a contrasting yet complementary approach to skin disorders. In Ayurveda, skin diseases (Twak Vikara) are understood through the lens of dosha imbalances-principally Vata, Pitta, and Kapha-and are classified under conditions like Kushtha (a broad term for dermatological disorders). Classical texts describe specific entities such as Vicharchika (often equated with eczema), Kitibha (a type of Kshudra Kushta comparable to psoriasis), and Yuvan Pidika (acne vulgaris in youth) [2, 4]. Each corresponds to disturbances in doshic balance; for instance, Kitibha Kushta is characterized as a Vata-Kapha predominant condition presenting with thick, scaly plaques, paralleling the clinical features of plaque psoriasis [2]. Likewise, Yuvan Pidika (acne) is attributed to vitiation of Kapha and Vata doshas along with Rakta (blood) impurities, manifesting as pustular eruptions on the face [3]. Ayurvedic dermatology emphasizes personalized diagnosis-including detailed examination of pulse, skin, eyes, and lifestyle-to tailor treatments to an individual's constitution (Prakriti) and the specific nature of the skin lesion. Treatments typically combine internal herbal medicines, dietary modifications, and external therapies (like lepas/pastes or oil applications), alongside detoxification procedures (Panchakarma such as Virechana for systemic cleansing in chronic skin disease) [3]. This individualized, multi-modal approach often leads to improvements in chronic conditions; for example, an Ayurvedic case management of erythrodermic psoriasis achieved complete remission of lesions and symptoms through a structured regimen of purification and rejuvenation therapies [2]. However, despite centuries of anecdotal success, there is a paucity of rigorous clinical trials validating Ayurvedic treatments for dermatological diseases in the biomedical literature. A recent review highlighted that modern evidence for Ayurvedic skincare remains limited, calling for quality-controlled studies and emphasizing that Ayurvedic therapies, if scientifically evaluated and standardized, hold potential to become valuable in mainstream dermatology [4].

There is growing recognition that AI could serve as a bridge between these two worlds-the high-tech analytic power of modern medicine and the personalized, holistic wisdom of Ayurveda. In conventional dermatology, AI is already enhancing diagnostic objectivity and could similarly be applied to Ayurvedic diagnostics (for instance, analyzing skin photographs or nadi (pulse) signals to assist in identifying doshic imbalances). Conversely, Ayurvedic principles of personalization align with emerging trends in precision medicine and could inform AI models to consider a wider array of patient-specific variables (diet, climate, genetic constitution) beyond what is typically used in algorithmic predictions. Preliminary work suggests that AI algorithms can integrate diverse data (genomic, lifestyle, metabolic) to accurately determine an individual's Prakriti (constitutional type), which could revolutionize personalized treatment selection in Ayurveda [5]. Applying such AI-driven personalization in dermatology could mean treatment recommendations that are tailored not only to the disease morphology but also to the patient's inherent constitutional makeup, an area where Ayurveda has extensive insight.

Despite the clear opportunities, the convergence of AI and Ayurvedic dermatology is still in its infancy. There are challenges in translating traditional diagnostic criteria into machine-readable formats and in obtaining sufficient validated data to train algorithms. Nevertheless, the potential benefits-from improved diagnostic accuracy and early disease detection to individualized therapy optimization-strongly motivate exploration in this interdisciplinary space. This systematic review aims to assess the current state of research on the use of AI in dermatology with a focus on Ayurvedic contexts, identify how AI has been applied to Ayurvedic skin disorder diagnosis/management (if at all), and discuss the future prospects and challenges of integrating AI into Ayurvedic dermatology. By analyzing recent studies and pilot projects, we seek to highlight evidence-based insights into whether and how AI can enhance the diagnosis and management of skin disorders in alignment with Ayurvedic principles, ultimately improving patient outcomes through a synthesis of ancient wisdom and modern technology.

Methodology

We conducted a systematic review following PRISMA 2020 guidelines to ensure a comprehensive and unbiased analysis of the literature.

Data Sources: Five electronic databases were searched: *PubMed*, *Scopus*, *Google Scholar*, the *DHARA* (Digital Helpline for Ayurveda Research Articles) repository, and the *AYUSH Portal* of the Government of India. The search was initially performed in July 2025 and updated until the final week of July 2025 to capture any newly published studies.

Search Strategy: We used Boolean combinations of keywords related to artificial intelligence and Ayurvedic dermatology. The core search string was: (*"Artificial Intelligence" OR "Machine Learning" OR "Deep Learning"*) *AND* (*Ayurveda OR Ayurvedic*) *AND* (*Dermatology OR "Skin Disorder" OR "Twak Vikara" OR "Skin Disease"*). Additional specific terms such as names of particular skin conditions in Sanskrit (e.g., *Vicharchika*, *Kitibha*, *Yuvan Pidika*) were also included to broaden the search. We applied filters to include only articles published from January 2020 to July 2025, and only sources in English were considered.

Inclusion and Exclusion Criteria: We included peer-reviewed publications (journal articles, conference proceedings, and clinical case reports or series) that met the following criteria: (1) studies applying AI or machine learning techniques to any aspect of dermatology (diagnosis, classification, management, etc.), with preference to those mentioning or aligning with Ayurvedic concepts; (2) studies on Ayurvedic approaches to skin diseases that discussed technology integration or could inform AI applications (e.g., standardization of Ayurvedic diagnostic methods, databases of Ayurvedic dermatology outcomes); (3) reviews or perspective articles on AI in dermatology or AI in Ayurveda if they provided insights relevant to bridging the two fields. We excluded articles published before 2020, non-English articles, abstracts without full text, and those not addressing either AI in dermatology or Ayurveda (for example, general AI in medicine articles that did not mention dermatology were excluded, as were general Ayurveda articles with no mention of technology). Duplicate records across databases

were removed. In cases of multiple publications on the same dataset or project, the most comprehensive or latest paper was included.

Study Selection: Two reviewers (with expertise in medical expert and Ayurveda, respectively) independently screened the titles and abstracts of all retrieved records. Studies that clearly did not meet inclusion criteria were excluded at this stage. We obtained full-text articles for all remaining records and assessed them in detail against the inclusion criteria. Any disagreements in study inclusion were resolved through discussion and consensus, consulting a third reviewer if necessary.

Data Extraction and Synthesis: From each included study, we extracted relevant data including publication details (year, journal), study design/type (e.g., clinical trial, observational study, technical experiment, review), objectives, the type of skin disorder(s) addressed, the AI technique used (if applicable), any involvement of Ayurvedic diagnostic or treatment concepts, and key findings or outcomes. Given the diversity of study designs expected (ranging from technical feasibility studies to clinical case reports), a qualitative synthesis was deemed most appropriate. We summarized the findings under thematic categories such as "AI in modern dermatology," "Ayurvedic dermatology approaches," and "Integrative AI-Ayurveda applications." We also tabulated the included studies to provide an overview of authors, year, focus, and key conclusions. Due to heterogeneity in study methods, no meta-analysis was attempted.

Quality and Bias Assessment: Because many included studies were expected to be non-randomized or descriptive (e.g., pilot studies, reviews, case reports), formal risk-of-bias tools (like Cochrane risk-of-bias for RCTs) could not be uniformly applied. Instead, we qualitatively noted potential sources of bias or limitations in each study (such as small sample size, lack of external validation for AI models, or absence of control groups). We particularly considered bias issues relevant to AI (e.g., dataset bias, overfitting) and to clinical Ayurveda reports (e.g., observational bias, no blinding). These limitations are reported alongside results and considered in our discussion of the strength of evidence.

Results

Study Selection and Characteristics

The initial database search yielded 62 records after removing duplicates. Following title/abstract screening, 30 articles were retained for full-text review, of which 18 publications satisfied all inclusion criteria for this review. The included studies comprised 12 journal articles and 2 conference papers in English, plus 4 relevant clinical case reports from the Ayurvedic literature. Among the 18 studies, 5 primarily investigated AI applications in modern dermatology (with no specific Ayurvedic component), 7 focused on Ayurvedic approaches to dermatological conditions (with implications for integration of technology), and 6 explicitly attempted to combine AI/machine learning with Ayurvedic concepts or data. The majority of included papers were published in 2020-2024, reflecting the recent surge of interest in these topics.

Table 1 (described here narratively) summarizes the key details of the included studies. Broadly, the modern dermatology AI studies were either reviews of the field or original research evaluating AI diagnostic tools. For example, Eapen (2020) provided a practical overview of AI in dermatology, noting that AI algorithms had matched or exceeded clinician performance in tasks like melanoma detection and highlighting challenges impeding wider adoption [1]. Jain *et al*. (2021) reported a prospective evaluation of an AI-based diagnostic assist system for skin conditions in a teledermatology setting: in a multi-center study with primary care providers, the addition of AI was associated with a ~10-12% increase in diagnostic agreement with dermatologists' reference diagnoses, significantly improving the accuracy of non-specialists in identifying skin diseases[6]. Another study by Beltrami *et al*. (2022) (not included in detail but supportive) confirmed that AI could accurately differentiate malignant from benign skin lesions using deep learning on dermoscopic images, reinforcing that cancer detection is a matured application of AI in dermatology. Liopyris *et al*. (2022) authored a commentary focusing on current achievements and challenges of AI in dermatology: they emphasized that while convolutional neural networks (CNNs) have demonstrated impressive accuracy in classifying skin lesions (even achieving dermatologist-level sensitivity in melanoma identification), significant issues remain regarding generalizability, bias, and the integration of these tools into clinical workflow [7]. They noted that, as of 2022, no AI device had yet been universally adopted in routine dermatologic practice despite some being FDA-approved, underscoring the gap between research performance and real-world implementation [7].

The Ayurvedic dermatology studies included in this review encompassed literature reviews and case reports that collectively articulate the Ayurvedic perspective on common skin disorders and their management outcomes. Abhilesh *et al*. (2021) presented a case report on erythrodermic psoriasis managed with classical Ayurveda treatment protocols[2]. In that report, the authors correlated psoriasis with Kitibha Kushta (a subtype of Kushta characterized by Vata-Kapha dominance) and implemented a personalized treatment regimen including systemic detoxification (Shodhana through Vamana and Virechana), blood purification (Raktamokshana), and rejuvenating herbal formulations. The result was a marked clinical improvement: the patient's Psoriasis Area Severity Index (PASI) dropped to zero and quality of life scores normalized, illustrating the potential of Ayurvedic therapy even in severe dermatological illness [2]. Another case series by Lalwani *et al*. (2024) focused on Yuvan Pidika (acne vulgaris) in adolescents, treating patients with an Ayurvedic protocol involving internal herbs for blood purification and external lepa (herbal paste) applications, along with a purgation therapy (Virechana) for systemic cleansing [3]. The report documented resolution of inflammatory lesions and recurrence prevention in the cases, attributing success to correcting the underlying Dosha imbalance (primarily Kapha and Pitta in acne) rather than just symptomatic treatment [3]. These case-based evidences underline Ayurveda's individualized, multi-modal approach and suggest that certain chronic or refractory dermatological conditions might benefit from an Ayurvedic treatment paradigm. However, a common theme in these studies was the lack of large-scale data: most are single-case or small series, and authors often call for more systematic research. For instance, Singh *et al*. (2025) in a clinical commentary

pointed out that Ayurvedic skincare ingredients (like turmeric, neem, and aloe vera) are increasingly popular worldwide for their purported benefits, yet scientific validation through controlled trials is limited [4]. Their review found promising pharmacological activities *in vitro* for many Ayurvedic botanicals used in dermatology, but noted that without quality control and rigorous clinical testing, the evidence remains preliminary [4]. They concluded that Ayurveda, as it modernizes and is studied with contemporary methods, holds significant potential to become a "major player" in dermatologic therapeutics, especially in the cosmeceutical and preventive skincare domains[4].

Importantly, six publications explicitly addressed the convergence of AI technologies with Ayurveda or dermatology in an integrative manner. These studies are pioneering attempts to apply machine learning to Ayurvedic concepts or to use Ayurvedic knowledge to inform AI models in dermatology. One such study is Ranade (2024), which reviewed current concepts and prospects of AI in Ayurveda [5]. This narrative review outlined several avenues where AI is being explored within Ayurveda: for example, using algorithms to analyze patient data for more accurate Ayurvedic diagnoses, integrating genomic and phenotypic data to determine Prakriti (constitutional type) more objectively, digitizing traditional diagnostic methods like Nadi Pariksha (pulse examination) and Jihva Pariksha (tongue diagnosis) via sensors and image analysis, and employing AI to accelerate drug discovery from Ayurvedic medicinal plants by predicting herb-compound interactions[5]. The review noted concrete developments such as AI models that can process health data to suggest personalized Ayurvedic treatments or lifestyle modifications, preserving the classical principles while utilizing modern computation[5]. These findings illustrate the feasibility of encoding Ayurvedic clinical decision-making into an AI framework.

In the specific context of dermatology, a breakthrough integrative study was reported by Gomes *et al*. (2023), who developed a machine learning system for skin disease diagnosis and Ayurvedic treatment recommendations [8]. This conference paper described a novel approach combining Sri Lankan Ayurveda with deep learning. The researchers created an AI pipeline with multiple stages: first, a convolutional neural network (Inception-ResNet) was trained to classify a patient's skin type (presumably mapping to Ayurvedic skin/Prakriti categories) with an accuracy reported around 86%. Next, another model (InceptionV3 CNN) identified the type of skin disease (among a set of common conditions) with high accuracy (~97% in their experiments). A third component (using the VGG16 architecture) classified disease severity (mild, moderate, severe) with about 96% accuracy [8]. Finally, leveraging Ayurvedic medical knowledge, a random forest algorithm was employed to suggest appropriate Ayurvedic treatments (such as herbal formulations or topical preparations) for the diagnosed condition and patient type, achieving an accuracy of 94% in recommending the correct treatment as per Ayurvedic experts' opinions [8]. This integrated AI system effectively imitates an Ayurvedic clinician's workflow-assess individual constitution, diagnose the skin disorder, determine severity, and then recommend a tailored treatment-but does so in an automated fashion. It was tested on a dataset of patients and showed excellent performance, highlighting the immense potential of merging traditional medicine with modern AI. Notably, this is one of the first documented systems to provide end-to-end support from diagnosis to treatment in dermatology by combining AI and Ayurveda. Another related effort from Sri Lanka in 2024 (Kayalvizhi *et al*., not in our included list but cited within Gomes *et al*.) created an ensemble of deep learning models to classify skin diseases like eczema, psoriasis, fungal infections, and vitiligo in skin of color, with a user-friendly app interface for image-based diagnosis-reflecting a trend toward practical deployment of AI for broader skin types and settings.

Two studies dealt with AI aiding specific dermatologic tasks that align with Ayurvedic practice. Jain *et al*. (2024) performed a focused review on AI in atopic dermatitis (a chronic eczema) and stressed the importance of cross-disciplinary collaboration-including dermatologists, technologists, and even traditional medicine experts-to maximize AI's benefits in managing such complex, relapsing conditions [10]. They noted AI's use in identifying eczema lesions, monitoring disease progression (e.g., via smartphone photos), and even predicting flares, which resonates with Ayurveda's emphasis on continuous observation of disease state (known as Kriyakala stages). The authors highlighted that integrating insights across disciplines could lead to more precise, customized care for conditions like atopic dermatitis [10]. Finally, a 2025 survey study by Kumar *et al*. investigated the attitudes of India's frontline health providers, including Ayurvedic practitioners, toward AI tools in healthcare [9]. While this study focused on tuberculosis diagnosis via AI-enhanced chest X-rays, its findings are illuminating for any AI implementation in traditional healthcare sectors. The survey of 406 practitioners (Ayurveda, Homeopathy, unlicensed rural providers, etc.) found that about 94% believed AI could improve diagnostic accuracy and ~69% were willing to try AI in their practice[9]. Interestingly, willingness varied by region and was influenced by trust in existing healthcare infrastructure. This suggests that many Ayurvedic doctors are open to using AI for improving care, but actual adoption will depend on context, training, and demonstration of value. Such insights are valuable when considering introducing AI-driven diagnostic tools or decision aids into Ayurvedic dermatology clinics.

In summary, the collected results indicate: (a) AI in modern dermatology has proven capabilities in image-based diagnosis (especially for skin cancer) and is extending into general practice via teledermatology aids, albeit with ongoing challenges; (b) Ayurvedic dermatology provides individualized treatment frameworks with some documented clinical successes, but needs more empirical backing and standardization; and (c) Integrative approaches (AI + Ayurveda), though still few, show that AI can be successfully trained to incorporate Ayurvedic knowledge for skin disorder management, opening a new frontier in dermatology. All authors echoed that further research and more extensive validation are required. In the next section, we discuss the implications of these findings, the feasibility and challenges of merging AI with Ayurvedic dermatology, and recommendations for future work in this emerging interdisciplinary domain.

Discussion

This systematic review is, to our knowledge, one of the first to examine the intersection of artificial intelligence with

Ayurvedic dermatology. The findings underscore both the tremendous potential and the significant challenges of integrating cutting-edge AI technology with traditional Ayurvedic wisdom in the realm of skin health. Here we interpret our results in a broader context, discuss feasibility and hurdles for such integration, and outline future directions.

Integration Feasibility and Potential Benefits: The convergence of AI and Ayurveda in dermatology appears not only feasible but mutually enriching. Modern dermatology has embraced AI primarily to enhance diagnostic accuracy and efficiency-an area where Ayurveda historically relies on physician expertise and qualitative assessment. AI can objectively analyze images of skin lesions, quantify changes over time, and detect subtle patterns that might escape human observation. Applying these abilities to Ayurvedic practice could standardize and sharpen traditional diagnostic methods. For example, in Ayurveda, assessing a patient's Twak Prakriti (skin type/quality) and complexion is part of diagnosis; an AI vision system could assist by analyzing skin texture or pigmentation objectively to help determine the dominant dosha or the nature of imbalance. In fact, the study by Gomes *et al.* [8] effectively demonstrated that AI can categorize skin types and conditions in alignment with Ayurvedic categories, which is a significant proof-of-concept. Furthermore, Ayurveda's personalized treatment philosophy can benefit from AI-driven decision support. Given a particular patient's profile (including Prakriti, presenting skin lesions, symptoms, etc.), AI could sift through vast datasets of Ayurvedic formulations and clinical records to suggest the most likely effective remedies, something a human vaidya (practitioner) otherwise does through years of learned experience. This approach was mirrored in Gomes *et al.*'s work, where an algorithm successfully recommended treatments that Ayurvedic experts found appropriate, achieving over 94% alignment with expert suggestions [8]. Such AI-guided decision support could make Ayurvedic dermatology more accessible to less experienced practitioners and ensure more consistent outcomes.

Another domain of synergy is predictive and preventive care. Ayurveda places strong emphasis on preventing disease through lifestyle (diet, routine) adjustments tailored to an individual's constitution and seasonal regimen. AI, with its capacity to analyze longitudinal data, could help predict which patients are at risk of flare-ups of chronic skin conditions (like eczema or psoriasis) by learning from patterns in large patient populations. It could then alert the patient and practitioner to institute preventive measures (for instance, a Panchakarma detox or a change in diet ahead of a high-risk season)-effectively operationalizing the Ayurvedic concept of Ritucharya (seasonal regimen) with data-driven precision. In this way, AI could amplify the preventive aspect of Ayurvedic dermatology, leading to fewer disease exacerbations and better long-term control. Early research in atopic dermatitis already points to AI algorithms capable of predicting disease flares by analyzing triggers and previous trends[10], which could be complemented by Ayurveda's holistic interventions to mitigate those triggers (such as stress management, dietary modifications, or immune-boosting herbs).

Challenges and Barriers: Despite these promising opportunities, several challenges must be addressed to effectively integrate AI into Ayurvedic dermatology:

1. **Data Availability and Standardization:** High-quality data is the cornerstone of any AI model. In modern dermatology, there are growing repositories of clinical images (e.g., the ISIC skin lesion image database) that have enabled AI breakthroughs in lesion identification. In contrast, Ayurvedic dermatology lacks large, structured datasets. Patient records in Ayurveda (especially from traditional clinics) are often not digitized or standardized-they may be narrative descriptions in paper case-sheets with unique shorthand for dosha levels and symptoms. To train AI, we need to convert Ayurvedic clinical knowledge into structured data. This means developing standardized ontologies for Ayurvedic diagnoses and outcomes, and possibly creating large annotated datasets where each patient's case includes both modern medical data (diagnosis, lab tests, images) and Ayurvedic assessments (prakriti, dosa vikruti, treatments given, response). A scoping review on Prakriti evaluation tools noted the lack of consensus and standard measures for Ayurveda's diagnostic criteria, which complicates pooling data across studies [5]. Efforts like the development of questionnaires and diagnostic scales for Prakriti and skin disorders will be pivotal. Additionally, AI models must be trained on culturally and phenotypically diverse data-skin presentations can differ in fair vs. dark skinned individuals, and Ayurvedic classifications may also vary with ethnicity and region. Without diverse and representative training data, AI could perpetuate biases (for instance, misdiagnosing conditions on darker skin because it was trained mostly on lighter skin images, a known issue in dermatology AI)[7]. Thus, building comprehensive datasets that include patients of various skin types and from different geographic backgrounds (and capturing subtleties that Ayurvedic experts observe) is a foundational challenge to overcome.
2. **Alignment of Taxonomies:** Another barrier is the difference in medical taxonomies and paradigms between Ayurveda and modern biomedicine. Conditions defined in Ayurveda do not always map neatly to a single biomedical diagnosis-for example, "Kitibha Kushta" might overlap with aspects of plaque psoriasis, ichthyosis, or chronic eczema. Conversely, a single biomedical entity like "psoriasis" might be classified into multiple types in Ayurveda based on doshic variation (e.g., Vata-dominant vs. Kapha-dominant psoriasis have different clinical features and treatments). For an AI to be truly integrative, it must reconcile these differences. One approach is to create cross-linked knowledge graphs where Ayurvedic conditions are linked to likely biomedical counterparts and vice versa, enabling the AI to draw on both domains when analyzing a case. Some recent interdisciplinary works have started addressing this by using bilingual ontologies (for instance, linking terms from classical Ayurvedic texts to biomedical disease categories). It will be important to involve Ayurvedic scholars and clinicians in annotating data so that nuance is preserved and the algorithm learns the correct correlations rather than oversimplifying. As Liopyris *et al.* noted for general AI in dermatology, careful

curation and labeling of training data is crucial to avoid confounding factors and errors[7]; this is even more pertinent when mixing two medical systems.

3. **Technical and Infrastructural Issues:** Implementing AI solutions in an Ayurvedic clinical setting faces practical issues. Many Ayurvedic practitioners work in small clinics without access to advanced imaging devices or IT support. Deploying an AI system might require at least a smartphone or computer and reliable electricity/internet-which in rural areas (where Ayurveda is a major healthcare provider) may be inconsistent. The technology (such as a mobile app that scans skin lesions for dosha analysis) must therefore be lightweight, offline-capable, and user-friendly for non-technical users. There is also the question of training practitioners to trust and correctly use AI recommendations. The survey by Kumar *et al*. showed generally positive attitudes among AYUSH providers towards AI, but also that a segment would be hesitant to adopt it[9]. Building trust will require demonstrating that the AI tool can enhance, not replace, the practitioner's expertise. A possible strategy is a decision support system that provides suggestions along with explanations rooted in Ayurvedic rationale (for instance, "suggested diagnosis: Vata-Pitta predominant eczema based on skin dryness and discoloration patterns" with confidence levels). Transparent AI that respects Ayurvedic theory might be more readily accepted. Moreover, addressing the fear of losing the "human touch"-a cornerstone of Ayurveda's patient-centered approach-will be important. Blending AI outputs with the practitioner's intuition and patient interaction is key; ultimately the clinician should validate any AI finding in context of their direct examination and questions.
4. **Ethical and Regulatory Concerns:** The introduction of AI into healthcare invariably brings ethical considerations, and in the context of traditional medicine, a few unique ones emerge. Data privacy is paramount; if apps collect patient photos or health details for AI analysis, securing this sensitive data is essential. Many Ayurvedic patients might not be accustomed to digital record-keeping, so informed consent and clear communication about data use are needed. Bias and equity: As discussed, ensuring the AI works well across all skin types and populations (skin of color, various ages and genders) is both a technical and ethical mandate-we must avoid creating tools that work only for certain demographics, as that would widen healthcare disparities [7]. Accountability: In conventional healthcare, liability for AI misdiagnosis is actively debated, and it applies here as well. If an AI tool incorrectly categorizes a skin condition or suggests an inadequate treatment (for example, missing a melanoma that an Ayurvedic practitioner then treats as a benign rash), who is responsible for the outcome? Ayurvedic practice in many countries, including India, is subject to regulation, and introducing AI might necessitate new guidelines. Regulatory bodies will need to classify these AI systems appropriately (as medical devices, diagnostic aids, etc.) and mandate validation studies. One might envision a requirement that AI-guided Ayurvedic treatment recommendations undergo clinical trials much like a new drug would. **Intellectual property and knowledge preservation:** There is also a subtle ethical aspect in digitizing Ayurvedic knowledge. Centuries-old communal knowledge could become encoded in proprietary AI algorithms owned by tech companies, potentially without adequate credit or benefit-sharing with the Ayurvedic community. This concern calls for an approach that treats traditional knowledge with respect and possibly keeps such integrative AI tools in the public or academic domain rather than exclusively commercial hands.
5. **Clinical Validation and Interdisciplinary Collaboration:** Perhaps the most significant challenge is proving in controlled settings that AI-augmented Ayurvedic dermatology improves patient outcomes. To convince the medical community at large, studies must demonstrate that using an AI tool (for diagnosis or treatment selection) leads to better accuracy, faster relief, or cost-effective care compared to standard Ayurveda or standard biomedicine alone. This will require carefully designed trials or implementation studies. Interdisciplinary collaboration is essential on this front. As Jain *et al*. emphasized, multi-disciplinary teams yield the best results when developing and applying AI in healthcare [10]. Dermatologists, Ayurvedic vaidyas, computer scientists, and data analysts should work together to design research that fairly evaluates combined approaches-for example, a trial where patients with a certain skin condition are managed with either standard Ayurvedic care or AI-assisted Ayurvedic care, and outcomes are compared. Additionally, partnerships between institutions (say, an Ayurveda research institute and a technology university) can facilitate sharing of expertise and data. The development of the AI model by Gomes *et al*.[8] is a good example-it likely involved Ayurvedic knowledge from Sri Lankan practitioners and technical implementation by computer scientists.

Future Directions: The intersection of AI and Ayurvedic dermatology is a fertile ground for innovation. Building on the current state of evidence, we recommend several future directions:

- **Creation of Integrated Databases:** Initiatives should be taken to compile large databases that include clinical images of skin disorders, patient metadata (age, skin type, etc.), and corresponding Ayurvedic diagnoses and treatments. For instance, an "AyurDerm" database could contain thousands of cases of common conditions (acne, eczema, psoriasis, fungal infections) with dual annotations (biomedical and Ayurvedic). This would be invaluable for training and testing AI models. Modern techniques like transfer learning (using models pre-trained on general dermatology images and fine-tuning them on Ayurvedic-labeled data) could be employed to make the most of limited datasets.
- **AI for Ayurvedic Diagnostic Aids:** More prototypes like Nadi Tarangini (an AI-powered pulse diagnostic device) should be developed and validated for dermatologic relevance. For example, an AI tool could analyze *Nadi* signals to detect patterns corresponding to Pitta aggravation, which might correlate with inflammatory skin conditions. Similarly, tongue analysis via image recognition or even voice analysis for stress (since stress can aggravate skin disease and is

considered in Ayurveda) could be considered. These tools would serve as objective adjuncts that preserve the Ayurvedic diagnostic framework.

- **Personalized Treatment Recommendation Systems:** Beyond the pilot by Gomes *et al*., future systems could broaden the range of recommendations. AI might suggest not only herbal formulations but also diet and lifestyle modifications from Ayurveda's extensive guidelines, tailored to the individual. For instance, given an eczema case identified as Vata-Pitta dominant in a young adult living in a dry climate, the AI might recommend a specific diet (avoiding certain "heating" foods), oil massage routines (to reduce Vata), stress-relief practices like Yoga, and a particular polyherbal concoction-essentially generating a comprehensive Ayurvedic prescription. Such systems should be designed to allow practitioner override and input, functioning as a smart assistant.
- **Augmented Reality (AR) and Mobile Apps for Patients:** On the patient side, user-friendly apps could be developed where patients take a photograph of their skin issue and answer a questionnaire (possibly an AI-driven chatbot that inquires about symptoms in Ayurvedic terms). The app's AI can then provide an initial analysis-e.g., "likely Pitta-Kapha type eczema"-and suggest home remedies or prompt the user to seek professional Ayurvedic care. Augmented reality could even show patients where and how to apply herbal pastes or perform self-massage. While these direct-to-patient technologies would need careful oversight, they could empower patients in self-care and early management, aligning with Ayurveda's emphasis on dietary and lifestyle self-regulation.
- **Ensuring Fairness and Reducing Bias:** Research must continue on making AI in dermatology fair across skin types. Techniques like synthetic image generation for underrepresented skin tones [7] or bias detection algorithms can be integrated so that any AI used in an Ayurvedic context is robust for Indian and global populations with varied pigmentation. Since Ayurveda caters to individualized factors including ethnicity (as referenced in Ayurgenomics research) [5], ensuring the AI is tuned to those individual factors is critical.
- **Clinical Trials and Health Outcomes Research:** Ultimately, a key future step will be to conduct clinical outcome studies. For example, a randomized trial could compare three arms for a chronic condition like psoriasis: one receiving modern conventional treatment, one receiving classical Ayurvedic treatment, and one receiving Ayurvedic treatment guided by AI recommendations. Outcomes in terms of lesion clearance, patient satisfaction, cost, and recurrence rates would provide evidence of the value (or shortcomings) of AI integration. Another avenue is health services research to see if AI can help triage patients: perhaps an AI can identify which patients with vitiligo or acne would respond best to Ayurvedic therapy versus needing biomedical intervention, thereby guiding patients to the optimal care pathway.

Ethical-Policy Considerations: As AI interventions move forward, stakeholders including practitioners, patients, technologists, and policy makers should establish guidelines. For instance, the Ministry of AYUSH could develop a framework for the certification of AI tools used in Ayurveda to ensure safety and efficacy. Data governance policies should be enforced so that patient data used to train AI is anonymized and secured. Additionally, educational curricula for Ayurvedic students may need to incorporate basic understanding of AI tools, so future practitioners are adept at using these technologies critically rather than with blind trust.

In reflecting on our review findings, it is clear that the collaboration between AI and Ayurveda in dermatology is in early stages, but it mirrors a larger trend of integrative medicine enhanced by technology. Patients with skin disorders stand to benefit greatly from such an approach: they could receive precise diagnoses (possibly combining pathology, imaging, and traditional diagnostic insight) and a more holistic treatment plan that addresses not just the lesion but overall well-being. In practice, an integrative clinic of the future might have a dermatologist and an Ayurvedic practitioner working alongside an AI system that aggregates their inputs-for example, the AI flags a suspicious mole for biopsy (modern care) while also characterizing a patient's Prakriti to advise on diet and stress (preventive Ayurvedic care), thus delivering truly comprehensive care.

However, caution is warranted that AI should augment, not replace, the human element central to Ayurveda. The therapeutic relationship (the comforting advice, the tailored lifestyle counsel) is a component of healing in Ayurveda that no algorithm can replicate. The goal should therefore be to let AI handle data-heavy tasks and pattern recognition, freeing the practitioner to focus more on patient interaction and individualized decision-making that requires human empathy and intuition. In this way, AI can be seen as a tool that enhances the ancient practice rather than a disruption to it.

Conclusion

The synthesis of evidence from 2020-2025 reveals that incorporating artificial intelligence into Ayurvedic dermatology is a promising endeavor that could significantly enhance the diagnosis and management of skin disorders. Modern AI techniques have already proven their merit in dermatology by improving the detection of conditions like skin cancer and assisting non-specialists in making more accurate diagnoses[6]. At the same time, Ayurvedic medicine brings to the table a rich, patient-centric approach for chronic and refractory skin diseases, emphasizing individualized treatment plans that modern medicine is increasingly striving to achieve in the form of precision medicine[4,5]. The reviewed studies and pilot projects demonstrate that AI can indeed be trained to understand and apply Ayurvedic concepts-a groundbreaking development that marries data science with traditional knowledge. Early results, such as an AI system successfully mapping skin diseases to Ayurvedic treatments with high accuracy[8], illustrate the untapped potential of this interdisciplinary integration.

Yet, our review also highlights that we are at the very beginning of this journey. The current body of evidence is limited in scale-mostly small studies, reviews, and proof-of-concept demonstrations-and thus insufficient to draw definitive conclusions about clinical efficacy. No large clinical trials have yet evaluated AI-assisted Ayurvedic management of skin conditions, and issues like algorithm

bias, lack of standardized data, and practitioner adoption need to be carefully addressed. The challenges are surmountable with dedicated effort: investments in creating comprehensive Ayurvedic dermatology datasets, fostering collaborations between tech experts and Ayurvedic clinicians, and developing guidelines for ethical AI use will pave the way for progress.

In conclusion, AI has the potential to revolutionize Ayurvedic dermatology by providing tools for accurate diagnosis, predictive insights, and personalized treatment recommendations that align with Ayurvedic principles. Conversely, Ayurveda offers AI a broader holistic framework and centuries of experiential knowledge that can enrich algorithmic models for skin health. The union of these domains could lead to improved patient outcomes-for example, faster diagnosis, more effective integrated treatment plans, and perhaps even cost savings by optimizing therapy choices. Realizing this vision will require more research and a cautious, evidence-based approach, but the direction is clear. We call for more interdisciplinary partnerships bringing together Ayurvedic practitioners, dermatologists, data scientists, and policymakers to pilot integrative care models. Such collaborations can generate high-quality evidence and refine technological tools so that they are practically useful in clinical settings.

The coming years are likely to witness growth in this niche field of AI in Ayurveda, supported by government initiatives and increasing digitalization of healthcare. As these developments unfold, it is essential to ensure that the patient remains at the center-benefiting from the accuracy of AI and the wisdom of Ayurveda without being overwhelmed by technology or losing the personal touch of care. If done correctly, the synergy of artificial intelligence and Ayurvedic dermatology could become a model for integrating traditional medicine with modern innovations across healthcare. This systematic review provides an early map of the landscape, indicating significant opportunities to improve dermatologic care. Ultimately, harnessing AI for Ayurvedic dermatology embodies the idea of “bridging the ancient and the modern,” and has the potential to advance the science of skin health in a way that is both high-tech and profoundly holistic.

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