



Research Article

Integrating Artificial Intelligence and Ayurvedic Diagnostic Methods in Dermatology: A Narrative Review of Current Evidence and Future Directions

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Abstract

Background: Skin disorders continue to present significant healthcare challenge due to their diverse clinical manifestations and need for precise identification. The field of dermatology is seen significantly influenced with recent advancement of Artificial Intelligence (AI) by aiding in image interpretation, pattern recognition, and clinical decision-making. Unlike standardized diagnostic models, Ayurveda focuses on the individual, combining the evaluation of clinical characteristics with patient-specific factors to arrive at a comprehensive diagnosis. **Aims and objectives:** This review aims to provide an overview of AI-based and Ayurvedic diagnostic methods used in dermatology, emphasizing their strengths and examining their potential to complement each other for more accurate skin disease diagnosis. **Materials and Methods:** A comprehensive review of literature was conducted using electronic databases such as PubMed and Google Scholar, incorporating relevant peer-reviewed publications. Articles published between 2017 and 2023 were identified using various keywords as artificial intelligence, dermatology, Ayurveda, skin disorders, and diagnostic methods. The selected studies were then reviewed to assess existing evidences and identify the recent advancements and emerging trends. **Results:** Existing evidences suggest that AI has significantly advanced dermatology by supporting image-based diagnosis, lesion classification, and disease prognosis. In contrast, Ayurvedic diagnostic methods emphasize comprehensive clinical assessment and individualized patient evaluation. Despite the potential of combining these approaches, the integration of AI with Ayurvedic Dermatology remains unexplored. **Conclusion:** The synergy between AI technologies and Ayurvedic diagnostic principles has the potential to provide more comprehensive approach to dermatological assessment. Further research is needed to develop standardized frameworks and evaluate the feasibility and effectiveness of applying these integrated methods in clinical dermatology practice.

Keywords: Skin Disease, *Twak Rogas*, *Dosh Vikalpa*, *Gunas*, AI Diagnostic Tools, Dermatology, Diagnostic Methods

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Introduction

Skin disorders are a major global health concern because of their high prevalence, diverse clinical manifestations, and significant impact on physical, psychological, and social well-being.

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Accurate diagnosis plays crucial role for effective management. Many dermatological conditions share similar clinical features, vary in severity, and present differently among individuals, which makes diagnosis challenging.

Recent advances in artificial intelligence (AI) have transformed various areas of healthcare, including dermatology. AI-driven technologies such as image analysis, machine learning (1), and clinical decision support systems have demonstrated encouraging potential in improving diagnostic accuracy, classifying skin lesions and facilitating early detection of dermatological diseases. These developments of AI in the field of dermatology offer more

objective and evidence based approach to skin disease diagnosis and assessment.

Ayurveda offers holistic and individualized approach in diagnosing skin disorders. Ayurvedic diagnosis is not solely limited to visible symptoms but takes into account multiple underlying factors such as *Hetu* (Causative factors), *dosha* imbalance, *dosh pradhanya*, *vikalpa samprapti*, *dushya*, *lakshana* (2) (clinical features), disease progression, *upashay* and *anupahsay*, and patient's unique constitution. *Twak Roga* assessment is based on established diagnostic principles of *Roga Pariksha* and *Rogi Pariksha*, including *Trividha Pariksha*—*Darshana* (inspection), *Sparshana* (palpation), and *Prashna* (history taking)—along with *Panchanidana* and other individualized clinical evaluations, as *Dashavidha* (3) and *Ashtavidha Pariksha*, to achieve comprehensive understanding of the condition.

Although AI and Ayurveda rely on different diagnostic approaches, both aim to strengthen clinical understanding and enhance treatment outcomes. AI contributes advanced analytical capabilities and pattern recognition, whereas Ayurveda provides a personalized and multidimensional perspective on disease evaluation. Combining these complementary approaches may create new opportunities to improve dermatological diagnosis without compromising core principles of individualized patient care.

Despite these advancements, limited research has explored the integration of AI with Ayurvedic diagnostic methods in dermatology. Therefore for collaborative diagnostic approaches in dermatological practice, a comprehensive review of available literature is needed to evaluate current developments, identify existing knowledge gaps, and explore future directions. Therefore a study was planned with the objective to provide an overview of AI-based and Ayurvedic diagnostic methods used in dermatology, highlight their strengths, explore their potential to complement each other for more accurate skin disease diagnosis and to identify current limitations, challenges, and future research opportunities in this emerging field.

Materials and Methodology

An extensive literature search was conducted to address the study objectives.

Literature Search Approach

A comprehensive literature search was conducted using databases such as PubMed and Google Scholar to identify relevant studies. Additionally, a targeted search of reputable open-access journals including *International Journal of Ayurveda Research (IJAR)*, *Journal of Indian System of Medicine (JISM)*, *Indian Journal of Dermatology (IJD)*, and *Journal of Clinical Medicine (JCM)* specializing in dermatology, digital health, and Ayurveda was conducted to ensure detailed coverage of available evidences. The literature search included articles from January 2017 to December 2023. Search strategy was developed using combination of various keywords and Boolean operators like: (“Artificial Intelligence” OR “Machine Learning” OR “Deep Learning”) AND (“Dermatology” OR “Skin Diseases” OR “Skin Diagnosis”), and (“Ayurveda” OR “Ayurvedic Diagnosis” OR “*Twak Roga*”) AND (“Artificial Intelligence” OR “Digital Health”).

Selection Criteria

Inclusion Criteria

Studies discussing Ayurvedic diagnostic approaches in skin diseases were included. Studies exploring the use of digital technologies or AI-based tools in relation to diagnosis or assessment of Ayurvedic skin disease were also considered. Additionally, articles published in English language and available as full text publications were included.

Exclusion Criteria

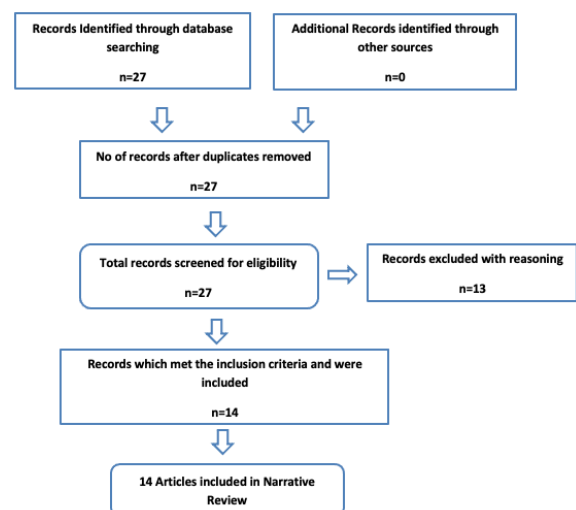
Articles focused exclusively on treatment protocols without addressing diagnostic aspects were excluded. Conference abstracts, editorials, duplicate publications were also excluded. Articles published in languages other than English were not considered. Additionally, studies that did not provide sufficient methodological details for evaluation were excluded from the review.

Data Extraction and Synthesis

Relevant data, including study characteristics, diagnostic approaches, AI methods, skin conditions evaluated, and insights into integration of Ayurvedic principles, was extracted and summarized descriptively. Evidence gathered was then organized into key themes, including current applications of AI in dermatology, the fundamental concepts of Ayurvedic diagnosis, opportunities for integrating the two approaches, and the major challenges associated with their implementation.

Observation and Results

This narrative review included 14 articles. Among them, 3 review articles addressed the scope and current applications of Artificial Intelligence (AI) in Ayurveda, whereas 4 articles focused on recent developments and applications of AI in dermatology. The remaining 7 studies assessed use of AI in specific dermatological conditions including psoriasis, lesion analysis, skin cancer diagnosis, classification of benign and malignant skin tumors, algorithms for atopic dermatitis, and image-based dermatological assessment. The selected literature consisted of systematic reviews and meta-analyses, narrative/review articles, original research studies, and methodological studies focusing on application of AI in dermatology and Ayurveda. Although the literature demonstrates considerable progress in AI applications across both Ayurveda and dermatology, no study specifically investigated application of AI in Ayurvedic dermatology or its integration with classical Ayurvedic diagnostic methods for *Twak Roga*. This finding reveals a significant gap in existing literature and emphasizes the need for further research in this emerging field.



Artificial Intelligence in Dermatology: Current Evidences**AI Techniques currently used in Dermatology-**

1. Deep learning (DL)(4): Automated detection, Classification, Segmentation, Severity assessment and treatment monitoring

2. Machine learning (ML) (5): Analysis of electronic health records, disease prediction and clinical decision support

3. Convolutional Neural Networks (CNNs)(6): Classification of skin cancers(7), inflammatory dermatoses, dermoscopic image analysis

4. Bayesian Image Segmentation: Lesion Segmentation (8), severity assessment of psoriatic lesions

5. Computer Vision: Recognition of Lesion morphology, texture, color, and vascular patterns from clinical images

6. Predictive Analytics (9): Clinical decision support by combining imaging findings with patient data

7. Tele dermatology (10): Remote evaluation of skin conditions, access to specialist care, particularly in underserved areas.

Table 1. 1. Current AI Applications in Dermatology

Sr. No	Dermatological Application	What is Analyzed?	AI Technique Used	Major Limitations
1	Skin cancer detection (Melanoma, Basal cell carcinoma)	Analyzing a dermoscopic image of pigmented lesions to identify features suggestive of melanoma	Deep Learning, Convolutional Neural Networks (CNNs)	Requires large annotated datasets; Poor performance in darker skin types Limited interpretability ("black-box" nature) External validation required.
2	Benign and Malignant Lesion Classification in skin cancers	Differentiating a benign nevus from suspicious malignant lesion based on color, border, asymmetry	Convolutional Neural Networks (CNNs), Deep Neural Networks	Reduced accuracy for rare tumors; Results affected by image quality and lighting, Risk of false positives or false negatives.
3	Lesion Segmentation	Automatically outlining lesion boundaries to calculate its size, shape, affected area	Image Segmentation Algorithms, Bayesian Segmentation, Convolutional Neural Networks (CNN)-based segmentation	Difficulty if poorly defined lesion borders, hair artifacts, shadows and varying illumination.
4	Assessment of Psoriasis	Analyzing Plaque size, scaling, erythema, to support assessment of psoriasis severity	Bayesian Image Analysis, Machine Learning, Deep Learning	Unable in assessing symptoms like itching or pain; Influenced by image quality and skin pigmentation.
5	Detection of Atopic Dermatitis	Analyzing Electronic Health Records (diagnosis, medications, clinical notes) to identify patients with dermatitis	Machine Learning Algorithms	Dependent on complete and standardized Electronic records; May not be generalized across healthcare systems.
6	Assessment of Disease Severity	Comparing extent of lesions, erythema, scaling to estimate disease severity	Deep Learning, Image Analysis, Computer Vision	Lack of universally accepted severity standards; Serial images need consistent imaging conditions.
7	Treatment Response Monitoring	Comparing Sequential clinical images pre and post treatment to identify reduction in lesion size	Image Comparison Algorithms, Convolutional Neural Networks (CNNs)	Camera angle and lighting variations, Patient positioning reduce reliability.
8	Clinical Decision Support	Combining Clinical images combined with patient data to support diagnostic decision making	Machine Learning, Deep Learning Decision Support Systems	Should complement and not replace the clinician judgment Medico-legal and ethical concerns remain.
9	Tele dermatology	Analyzing Images submitted remotely to support screening and initial assessment	Deep Learning, AI mobile Applications	Variable image quality, Internet dependence, Privacy concerns, Inability in conducting physical examination.
10	Pattern Recognition	Identifying Texture, color distribution, vascular patterns, and lesion morphology from clinical images	Convolutional Neural Networks (CNNs), Computer Vision, Pattern Recognition	Dataset bias and limited interpretability may reduce clinician trust.

Despite these advances, several challenges continue to hinder integration of AI into routine clinical practice. Several Factors like availability of diverse and high-quality datasets (11), differences in image quality, skin tone, disease prevalence, and clinical settings are seen affecting performance of AI. Limited

transparency of AI models, concerns regarding privacy and data security restricts its widespread adoption.

Emerging research in the field is focused on developing transparent and clinically validated AI systems through explainable AI (12), multimodal data integration, personalized

dermatology, workflow automation, and larger, more representative datasets (13).

Artificial Intelligence in Ayurveda: Current Evidences

Recent researches highlight growing use of AI in Ayurved for **Prakruti assessment**, **Dosha prediction**, Clinical decision support, personalized treatment planning, Medicinal plant identification (14), Drug discovery, and Digitizing classical Ayurvedic literature.

Converting the traditional diagnostic concepts into objective, quantifiable (15), and digitally interpretable parameters remains a major challenge. Inconsistent terminology, subjective interpretation, and lack of standardized diagnostic frameworks reduce consistency and reproducibility. At the same time balancing standardization is essential as excessive standardization may compromise diagnostic depth, whereas insufficient standardization limits effective integration of AI.

Table 2: Current AI Applications in Ayurved

Sr. No	Application in Ayurveda	What is Analyzed?	AI Feature/Technology Used
1	Prakruti Assessment	Analyzing structured responses regarding physical, physiological, behavioral characteristics	Machine learning (ML) Classification Algorithms
2	Dosha Prediction	Analyzing Clinical features and patient responses to estimate dosha	Machine learning Predictive Analytics
3	Clinical Decision Support	Combining Patient specific clinical information with Ayurvedic diagnostic rules	Expert Systems, Decision Support Systems Machine learning
4	Personalized Treatment Planning	Generating patient specific suggestions based on <i>prakruti</i> , <i>dosha dominance</i> , disease characteristics	Predictive Analytics Recommendation Systems
5	Digitization of Classical Ayurvedic Literature	Converting Scanned Sanskrit texts into searchable digital text	Natural Language Processing (NLP), Optical Character Recognition (OCR) Knowledge Graphs
6	Plant Identification (Medicinal)	Identifying plant from photograph of leaves, flowers and morphology	Deep Learning, Computer Vision Image Recognition
7	Formulation Development and Drug Discovery	Analyzing data on medicinal plants and phytoconstituents for formulations	AI-based Data Mining, Predictive Modeling Machine Learning
8	Herb–Drug Interaction Predictions	Predicting potential interactions between herbal ingredients	Machine Learning, network Analysis, Predictive Models
9	Preventive Health and Lifestyle Recommendations	Generating individualized lifestyle or dietary recommendations based on whole patient data	Recommendation Systems, Wearable Analytics
10	Knowledge Discovery and Research Analytics	Analyzing large volumes of Ayurvedic research to identify recurring concepts and trends	Data Mining, Big Data Analytics, Knowledge Graphs
11	Integration with Ayurvedic Digital Resources (TKDL, DHARA, AYUSH Research Portal, AYUSoft)	Using semantic search to retrieve relevant information from digital resources	Natural Language processing, Semantic Search Database Management
12	Multimodal Integration of Clinical Data	Combining clinical history, findings, images, symptoms for comprehensive assessment	AI Data Fusion, Machine Learning Predictive Analytics

Overall, these advancements emphasize growing potential of AI in Ayurvedic practice by improving diagnostic support, enabling personalized healthcare, and by facilitating research and knowledge management. Although AI has seen advanced considerably majority applications are in developmental or validation stage with only limited number of clinically validated tools being available. Future research should focus on developing AI-assisted assessment of observable features of *Twak Roga*, reproducible grading systems, integration of multimodal clinical information, standardized digital documentation, longitudinal disease monitoring, and personalized treatment planning.

Discussion

The present review highlights emerging role of Artificial Intelligence (AI) in dermatology and explores its potential relevance within the context of Ayurvedic diagnosis. The available literature demonstrates that AI has shown considerable diagnostic

efficiency in dermatology, using image analysis, lesion classification (16), disease severity assessment, and clinical decision support. However, most current AI applications depend primarily on visual analysis and structured datasets, with their performance influenced by factors such as image quality, dataset diversity, and clinical validation. In contrast, Ayurvedic diagnosis of *Twak Roga* adopts a broader and more individualized approach. This approach recognizes that patients with similar skin manifestations may differ in their underlying pathology and therefore require individualized clinical interpretation. This comprehensive perspective remains one of the major strengths of Ayurvedic dermatology.

A key observation from this review is that many of the clinical features commonly assessed in Ayurveda, such as *varna (color)* (17), *sparsha (texture)*, *vedana (associated symptoms)*, *srava (discharge)*, *akruti* (lesion morphology), and disease progression, are observable parameters that could potentially be documented in

a more structured manner. Standardizing the documentation of these clinical observations could enhance consistency between practitioners and establish foundation for future digital documentation and AI-assisted analysis.

Only three studies pertaining to Ayurveda and artificial intelligence were identified. However, none of these studies were published in journals indexed in Scopus or other major bibliographic databases. One of the most important findings of this review is absence of studies exploring direct application of AI in the Ayurvedic diagnosis of *Twak Roga*. While AI has been extensively studied in conventional dermatology and is gradually finding applications in various areas of Ayurveda, its use in conjunction with classical Ayurvedic diagnostic principles for skin diseases remains largely unexplored. This highlights a significant gap in the current literature and provides an important direction for future interdisciplinary research. The review also revealed a clear difference in the maturity of AI applications across the two fields. Although AI is well established in conventional dermatology, its application in Ayurveda is still in early stages of development.

The identified strengths and limitations suggest that AI and Ayurvedic approaches may complement each other in dermatological assessment. AI offers rapid analysis, objective pattern recognition, and the ability to process large amounts of clinical data, but it often lacks individualized clinical interpretation. Conversely, Ayurveda provides a comprehensive understanding of the patient and disease but faces challenges related to standardization, reproducibility (18), and digital representation. Integrating both approaches may enable a more balanced and clinically meaningful framework for dermatological assessment.

Overall, this review suggests that AI and Ayurvedic diagnostic methods should be viewed as complementary. AI has the potential to enhance documentation, analysis, and clinical decision making, while Ayurveda provides individualized and context-based assessment beyond visual findings. Future studies should focus on developing standardized diagnostic frameworks, validating Ayurvedic clinical parameters, and exploring multimodal AI models capable of integrating both image-based findings and patient-specific clinical information. Such interdisciplinary efforts may pave the way for more comprehensive, reproducible, and personalized approaches to the diagnosis of skin diseases.

Table 3: Potential opportunities for Integrating AI with Ayurvedic Diagnostic Methods in *Twak Roga*

Sr. No.	Opportunity	Ayurvedic Component	Potential AI application
1	Digital Assessment of Skin parameters	<i>Varna, Sparsha, Akroti, Srava</i>	Image and Texture Analysis
2	Dosha- Guna grading	<i>Ruksha, Khara, Parusha</i> and other guna features	Classification and grading models
3	Multimodal Diagnosis	<i>Darshan, Sparshan, Prashna</i> + patient factors	Multimodal AI
4	Ayurvedic dermatology Atlas	Clinical Features and Classical descriptions	Image / Knowledge database
5	Diagnostic decision support	Ayurvedic diagnostic principles	Clinical decision support systems
6	Formulation knowledge system	Classical Kalpana and formulations	Search / Recommendation System
7	Tele-Twak Roga	Classical Images+ History	Remote preliminary assessment
8	Longitudinal Monitoring	Disease progression and treatment response	Sequential image analysis
9	Predictive assessment	Disease history + Clinical Parameters	Predictive Modelling

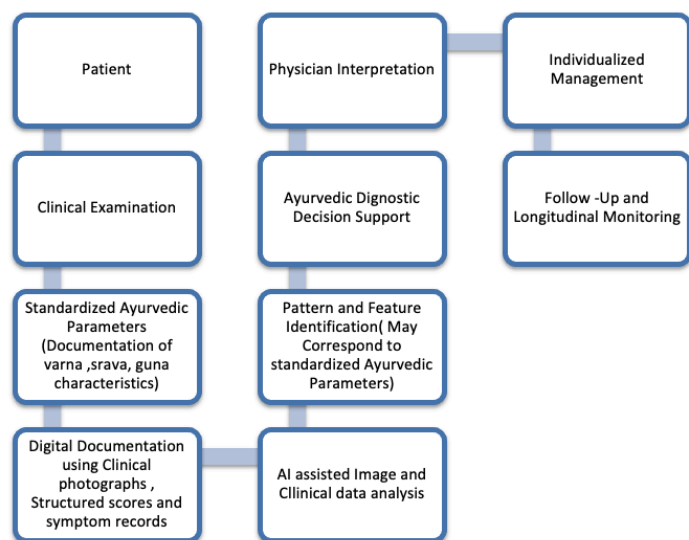
Table 4: Integration of AI with Ayurvedic Diagnostic Methods in *Twak Roga*

Ayurvedic Parameter	Clinical Observations	Possible digital representation	Relevance into Structured AI Assessment	Potential AI Application
<i>Varna</i> (Color)	- Blackish brown - Crimson red - Coppery - Black, White - Bluish hue, Yellow - Bright red - Violet black	Standardized Color features	Observation of color changes Supports assessment of pigmentation, erythema, lesion appearance	Color pattern classification
<i>Sparsha</i> (Texture)	- Dry, Extremely dry - Rough - Coarse - Thickened - Scaly - Resembling Scar tissue - Thin - Compact - Wrinkled, Crusted, Creased	Image + Structured Tactile score	Supports assessment of scaling, roughness, consistency (Evaluation of texture and tactile characteristics)	Texture Assessment

Vedana (Pain)	• Extreme, Moderate, Mild or no pain • With or without bleeding • With or without burning • With or without discharge • Any specific type of pain as pricking, Splitting, cutting • Any other associated symptoms as burning, itching	Patient Reported score	Contributes to symptom characterization (Assessment of Pain, itching burning and discomfort)	Multimodal symptom Analysis
Srava (Discharge)	• Thick or slimy • Profuse or less • Watery or copious • Pus • Bloody discharge • Yellowish discharge	Structured Clinical record / image	Supports evaluation of exudative lesions (Observation of discharge characteristics)	Lesion Characterization
Akruti (lesion morphology)	• Unevenly spread • Elevated round with smooth margins • Centre elevated with thin margins and rough papules • Matted patches • Moistened lesion • Slow or fast progressive • Slow or rapid onset • Fissures, Cracks, wounds, Blisters, Ulcerated • Vesicles, Pustules, • Nodules, Eruptions • Congested, Inflamed lesion • Putrefied, Pruritus	Image Features	Supports lesion classification and pattern interpretation (Assessment of morphology and distribution)	Morphological classification
Dosha predominance	• Ekdoshaj • Dwandwaj • Sannipaat	Structured Clinical Variables	Supports individualized diagnostic interpretation (Understanding disease variability)	Decision Support model
Vyadhi Avastha	• New or chronic • Specific Dhatugat kushtha		Supports longitudinal assessment , Body mapping Evaluation of temporal changes (Disease progression)	

Table 5: Research Gap and Future Directions

Domain	Current Evidence	Limitations	Future Direction
Artificial Intelligence in Dermatology	Strong evidence for image analysis and diagnostic support	Dataset variability and explainability	• Explainable AI for transparency • Multimodal data integration • Personalized dermatology • Workflow automation • Large, diverse datasets • AI-assisted clinical decision support
Ayurvedic Diagnostic Methods	Individualized and multidimensional assessment	Limited standardization	Structured documentation
AI in Ayurveda	Emerging conceptual exploration	Limited clinical validation	• Predictive and preventive healthcare • Translational research • Standardized Ayurvedic diagnosis and Personalized treatment planning
AI-assisted Twak Roga Diagnosis	Very limited direct evidence	Lack of integrated frameworks	Interdisciplinary model development

Figure 1.1: Proposed Framework for AI -assisted Ayurvedic *Twak Roga* assessment

Conclusion

Artificial Intelligence has demonstrated significant potential in improving dermatological diagnosis through image analysis, pattern recognition, and clinical decision support. In contrast, Ayurveda offers comprehensive and individualized approach to diagnosis of *Twak Roga*, taking into account both disease-related and patient-specific factors. This review identified limited evidence regarding direct application of AI in Ayurvedic dermatology, highlighting a significant research gap in current literature. Standardizing observable Ayurvedic diagnostic parameters could support their digital documentation and their future AI-assisted analysis. Integrating AI with Ayurvedic diagnostic principles has the potential to enhance clinical decision-making while preserving the holistic nature of Ayurveda. Further interdisciplinary research is required to develop validated frameworks for the meaningful application of AI in Ayurvedic dermatological practice.

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