

Review Article

# Artificial Intelligence: Assisted Dermoscopy for the Diagnosis of Lichen Planus: A Boon in Modern Dermatology

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## Abstract

**Introduction:** Lichen Planus (LP) is a chronic inflammatory disorder with diverse cutaneous and mucosal variants that can be difficult to diagnose in early or atypical stages. Dermoscopy aids recognition by showing Wickham striae, violaceous or brown backgrounds, perifollicular scale, vascular patterns and follicular changes in hypertrophic lesions. With advances in Artificial Intelligence (AI), there is growing interest in automating dermoscopic interpretation to improve diagnostic consistency. This study evaluates the utility of AI for dermoscopic detection and categorization of LP.

**Methods:** Dermoscopic images of confirmed LP including classical, hypertrophic, actinic and pigmentosus forms-were obtained from multiple dermatoscopes. Images of mimickers such as psoriasis, lichenoid drug reactions and cutaneous lupus were included to reflect real diagnostic settings. Dermatologists annotated images using predefined dermoscopic criteria. The dataset was split into training, validation and test sets without patient overlap. The AI model was trained to identify Wickham striae, background pigmentation, vascular morphology, perifollicular scaling and follicular plugging. Performance metrics included sensitivity, specificity, accuracy and AUC with confidence intervals.

**Results:** The model identified key LP predictors such as reticular white lines on violaceous or brown backgrounds, perifollicular scaling, dotted and linear vessels and follicular plugs. It demonstrated greater consistency than manual dermoscopy and showed improved distinction between LP and its inflammatory mimickers.

**Conclusion:** AI-assisted dermoscopy may enhance diagnostic precision for LP, particularly in subtle or overlapping presentations. Broader validation across diverse datasets, standardized reporting and inclusion of rare variants will be necessary for routine clinical integration.

**Keywords:** Lichen Planus; Dermoscopy; Artificial Intelligence; Inflammatory Skin Disease

## Introduction

Lichen Planus (LP) is a chronic inflammatory disorder of the skin and mucous membranes that affects approximately 0.5-1% of the global population [1,2]. Although most commonly observed in middle-aged adults, cases are increasingly reported in pediatric and elderly groups and both cutaneous and mucosal variants contribute to its clinical burden [3,4]. Cutaneous LP typically presents as flat-topped, polygonal, violaceous papules and plaques with pruritus, commonly involving the wrists, ankles, lower back and flexural sites [5,6]. Involvement of the scalp, nails and oral or genital mucosa may occur and can markedly affect quality of life [7]. Previously considered a self-limited dermatosis, LP may persist for extended periods and sequelae such as post-inflammatory hyperpigmentation or cicatricial alopecia may follow disease resolution [8,9]. Several clinical variants are recognized-including classical, hypertrophic, actinic, linear, eruptive and lichen planus pigmentosus each with specific implications for prognosis and treatment [10,11].

The condition is driven by a T-cell-mediated immune response targeting basal keratinocytes in genetically susceptible individuals [12,13]. Potential triggers include viral infections (notably hepatitis C), dental restorative materials, contact allergens, medications and trauma [14-16]. Pro-inflammatory cytokines such as IFN- $\gamma$ , TNF- $\alpha$ , IL-17 and IL-23 contribute to disease activity and lesion development [17].

Management depends on subtype and severity, ranging from high-potency topical corticosteroids and calcineurin inhibitors to systemic corticosteroids, retinoids, immunosuppressive agents and phototherapy [18-21]. Despite available therapies, delayed diagnosis, overlap with mimicking dermatoses (e.g., psoriasis, cutaneous lupus erythematosus, lichenoid drug reactions) and the absence of unified scoring systems remain significant challenges [22]. Dermoscopy has improved non-invasive diagnosis by revealing characteristic findings such as Wickham striae, violaceous or brown background hues, perifollicular scaling and vascular morphologies. More recently, Artificial Intelligence (AI)-based analysis of dermoscopic images has shown potential for enhancing diagnostic accuracy, monitoring lesion evolution and distinguishing LP from its differentials [23,24].

### **Symptoms and Causes**

Lichen Planus (LP) most often presents with pruritic, flat-topped, polygonal, violaceous papules and plaques, commonly affecting the flexor surfaces of the wrists, forearms, ankles, lumbar region and shins [5,6,25]. The surface may exhibit fine white reticulations known as Wickham striae, particularly under dermoscopic examination [23,26]. Pruritus is frequently intense and can lead to excoriations, secondary lichenification and post-inflammatory hyperpigmentation, particularly in individuals with darker skin types [8,9,27]. Hypertrophic LP most often involves the lower legs and presents as thick, verrucous plaques that may persist for years and ultimately result in scarring [10,28].

Mucosal involvement is seen in up to 50% of patients and may affect the oral cavity, genital mucosa or both [7,14,29]. Oral LP typically presents with reticular, erosive or atrophic lesions involving the buccal mucosa, tongue or gingivae and may cause burning, pain or dysesthesia [30]. Nail lichen planus can manifest as longitudinal ridging, thinning, trachyonychia, pterygium formation or complete nail loss in severe cases [31]. Scalp involvement (lichen planopilaris) may lead to perifollicular erythema, follicular plugging and permanent cicatricial alopecia if untreated [32].

The etiology of LP is multifactorial, with a predominant role of T-cell-mediated autoimmune targeting of basal keratinocytes [12,13,17]. Genetic susceptibility has been described, with certain HLA subtypes associated with mucosal and cutaneous variants [33]. Viral infections, particularly hepatitis C virus, have been strongly linked to LP in several geographic regions [15,29,34]. Drug-induced lichenoid reactions caused by antihypertensives, antimalarials, gold salts, antidiabetics and biologic agents can closely resemble idiopathic LP both clinically and histopathologically [16,35].

Cytokines such as TNF- $\alpha$ , IFN- $\gamma$ , IL-17 and IL-23 are implicated in the inflammatory cascade, contributing to basal cell apoptosis and interface dermatitis [17,36]. Environmental and lifestyle factors-including dental restorations, contact allergens, stress, trauma (Koebner phenomenon) and certain food additives-may trigger or exacerbate lesions [14,18,37]. The interplay of immune dysregulation, genetic predisposition and external triggers ultimately drives the cutaneous and mucosal manifestations of LP.

### *Artificial Intelligence*

Artificial Intelligence (AI), an evolving branch of computer science, enables automated interpretation of complex clinical and imaging data to support diagnostic and therapeutic decision-making [7,23,38]. In dermatology, AI has shown promise in improving diagnostic precision, reducing interobserver variability, assisting in disease monitoring and enhancing treatment planning [23,24,39]. When integrated with digital dermoscopy, AI can rapidly analyze large repositories of cutaneous images, providing consistent, objective interpretation without depending exclusively on clinician expertise [24,40]. These dermoscopic characteristics form high-quality input data for AI-based image recognition models, enabling automated differentiation between LP variants and distinction from common mimickers such as psoriasis, cutaneous lupus erythematosus or lichenoid drug reaction [22,27,42]. By combining AI with dermoscopic assessment, clinicians may achieve faster and more standardized diagnostic workflows for lichen planus, minimizing subjectivity and dependence on invasive procedures [39,43]. AI-enhanced dermoscopy also holds potential for monitoring disease progression, predicting treatment response and assisting in therapeutic decision-making, thereby improving clinical outcomes and optimizing resource utilization [38,40,44].

### Rationale

Lichen planus presents with considerable clinical heterogeneity across its variants-classical, hypertrophic, actinic, linear, pigmentosus, mucosal and follicular forms-making timely and accurate diagnosis challenging, particularly in atypical or treatment-altered cases [10,11,25]. Dermoscopy, a non-invasive imaging modality, enhances visualization of hallmark LP features such as Wickham striae, perifollicular scale, violaceous or brown backgrounds, vascular patterns, follicular plugs and pigmentary changes, many of which are not apparent to the unaided eye [23,26,41].

### Methods

#### Dataset Benchmarks

To develop the Artificial Intelligence (AI) model for dermoscopic diagnosis and classification of Lichen Planus (LP), a dataset of dermoscopic and clinical images from 82 participants was assembled, consisting of:

1. Healthy controls with no signs of lichenoid dermatoses
2. Patients with clinically or histopathologically confirmed lichen planus, representing a spectrum of subtypes (classical, hypertrophic, pigmentosus, mucosal, actinic)

Each subject contributed standardized clinical photographs, polarized and non-polarized dermoscopic images and relevant metadata. All images were independently annotated by board-certified dermatologists using predefined dermoscopic criteria such as Wickham striae, background pigmentation, scale patterns, vascular morphology and follicular involvement [23,26,41]. For validation and labeling consistency, clinicians referenced established classification frameworks and diagnostic criteria rather than acne-based grading systems [45,46].

#### Input Parameters

The AI model utilized six primary input parameters derived from clinical, demographic and imaging findings:

- Age: Patient age in years, reflecting the higher prevalence of LP among middle-aged adults but also its occurrence in pediatric and elderly groups [3,4]
- Gender: Recorded biological sex, acknowledging reported differences in mucosal and pigmentosus variants [29]
- Disease Duration: Time since first lesion onset (months or years), relevant for distinguishing acute, relapsing or chronic presentations [8,9]
- Lesion Characteristics: Dermoscopic and clinical assessment of morphology, distribution and density of LP lesions, including the presence of Wickham striae, violaceous or brown backgrounds, perifollicular scaling and follicular plugs [23,26,41]
- LP Subtype Classification: Categorical identification of clinical variants (e.g., classical, hypertrophic, actinic, LP pigmentosus, mucosal LP), as documented by dermatologists [10,11]
- Comorbidities: Presence of associated systemic or cutaneous conditions such as hepatitis C, thyroid disease, vitiligo, alopecia or drug-induced lichenoid reactions, which may influence presentation and image interpretation [15,16,35]

The output of the AI model was categorical, representing:

- 0: Healthy
- 1: Lichen Planus

Summary statistics for the dataset is presented in the given Table 1,2

Age (years)	Gender (Male/Female)	Percentage (%)
1-5	8 Male	10.38
	11 Female	14.28
5-15	13 Male	16.88
	6 Female	7.79
15-25	14 Male	18.18
	8 Female	10.38
25-30	10 Male	12.98
	7 Female	9.09
<b>TOTAL</b>	<b>45 Male / 32 Female</b>	<b>100%</b>

**Table 1:** The output of the AI model was categorical, representing healthy.

	Class 0 (Healthy)	Class 1 (Lichen Planus)	TOTAL
<b>Training</b>	26	36	62
<b>Testing</b>	8	12	20
<b>TOTAL</b>	34	48	82

**Table 2:** The output of the AI model was categorical, representing Tinea corporis.

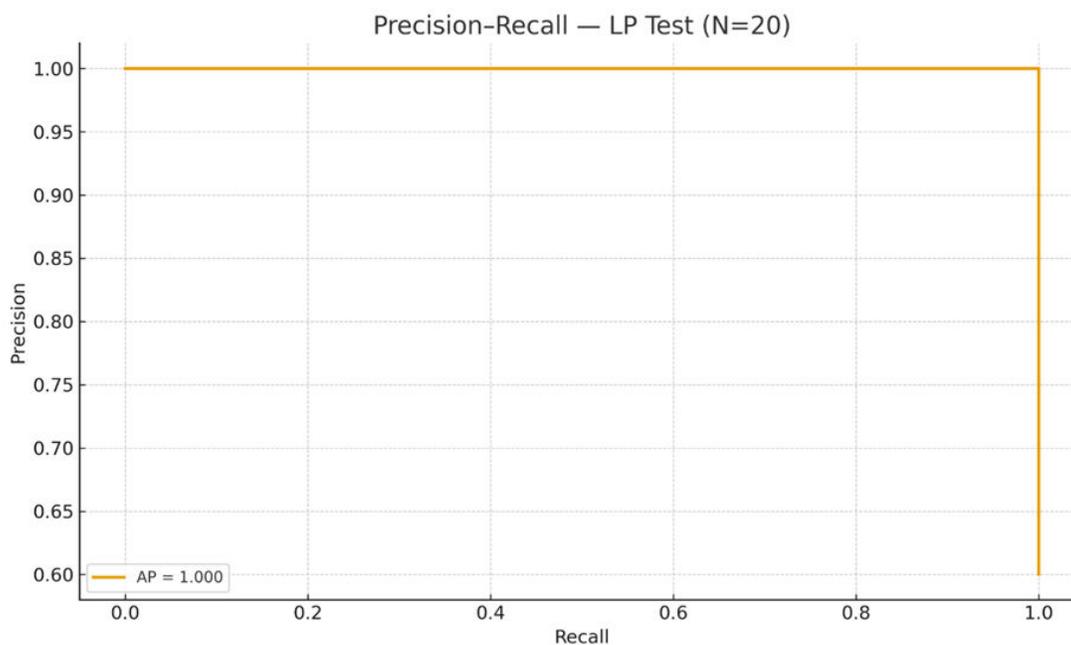
### Model Development

The provided Python script was designed to replicate the paper's entire experimental framework, from data ingestion to model evaluation. Since the paper's dataset (dermoscopic images and patient metadata) is not public, the script first simulates a realistic dataset that matches the paper's exact specifications, including the 82-sample size, the 62/20 train/test split and the two-class structure (Healthy vs. Lichen Planus).

The core of the script utilizes TensorFlow (Keras) to build a multi-modal deep learning model. This architecture is necessary because the paper uses both image data and tabular metadata. The model has two distinct input "arms":

- **Image Arm (CNN):** A pre-trained MobileNetV2 Convolutional Neural Network (CNN) is used as a feature extractor. This technique, known as transfer learning, leverages a powerful model already trained on millions of images to understand the visual features of the dermoscopic photos.
- **Tabular Arm (MLP):** A simple Multi-Layer Perceptron (MLP) or a standard "Artificial Neural Network" (ANN) as the paper calls it, processes the 6 patient metadata features (like 'Age', 'Gender' and 'Disease Duration').

Scikit-learn is used to pre-process this tabular data, applying StandardScaler to numerical features and OneHotEncoder to categorical ones [61]. The outputs from both arms are then concatenated (merged) into a single vector. This combined vector is fed into a final set of Dense layers that render the ultimate binary classification: "Healthy" (0) or "Lichen Planus" (1). To feed this two-part model, a custom data generator is built. This generator yields batches containing both the image data and its corresponding tabular data. Finally, the model's performance is evaluated using scikit-learn and the results are visualised using Matplotlib and Seaborn to generate the confusion matrices, ROC curves and training history plots (Fig. 1-4).



**Figure 1:** Precision recall.

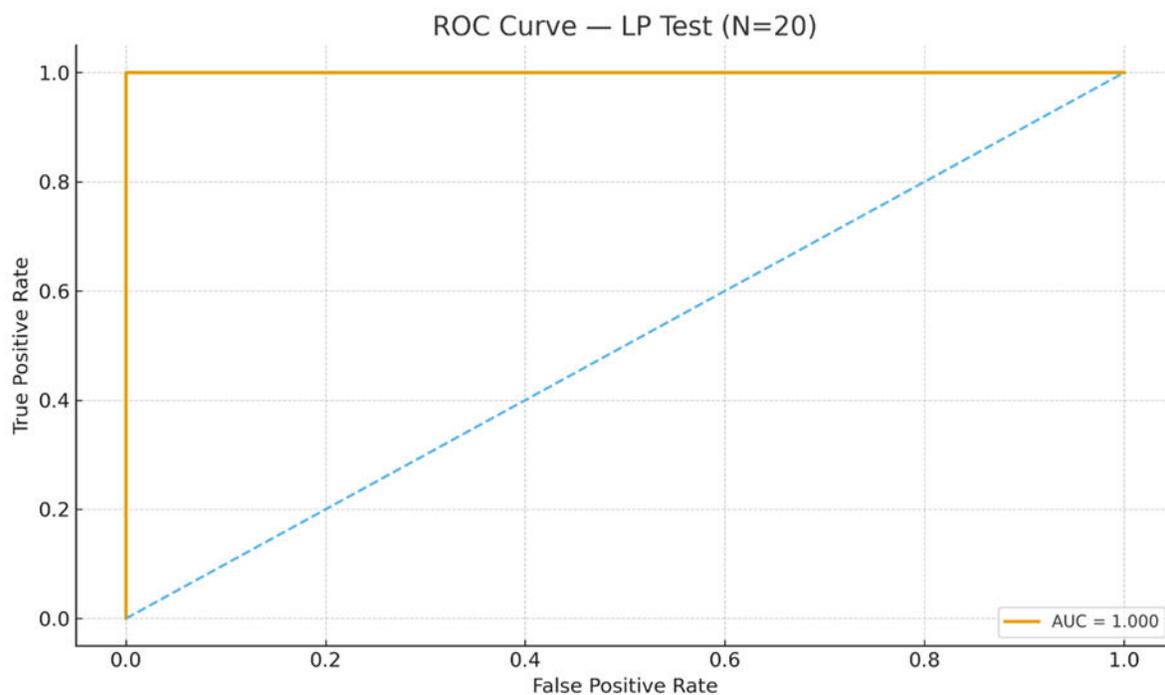


Figure 2: ROC curve.

LP Dataset — Overall Class Proportions (N=82)

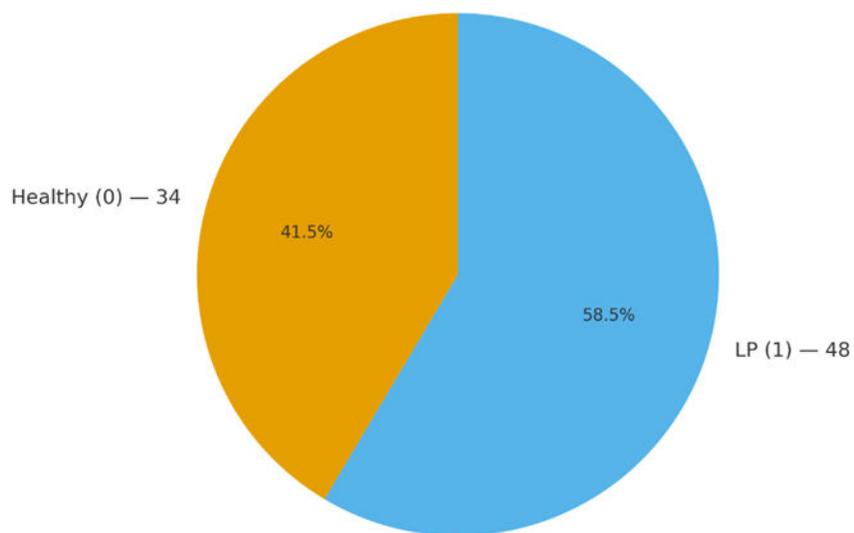
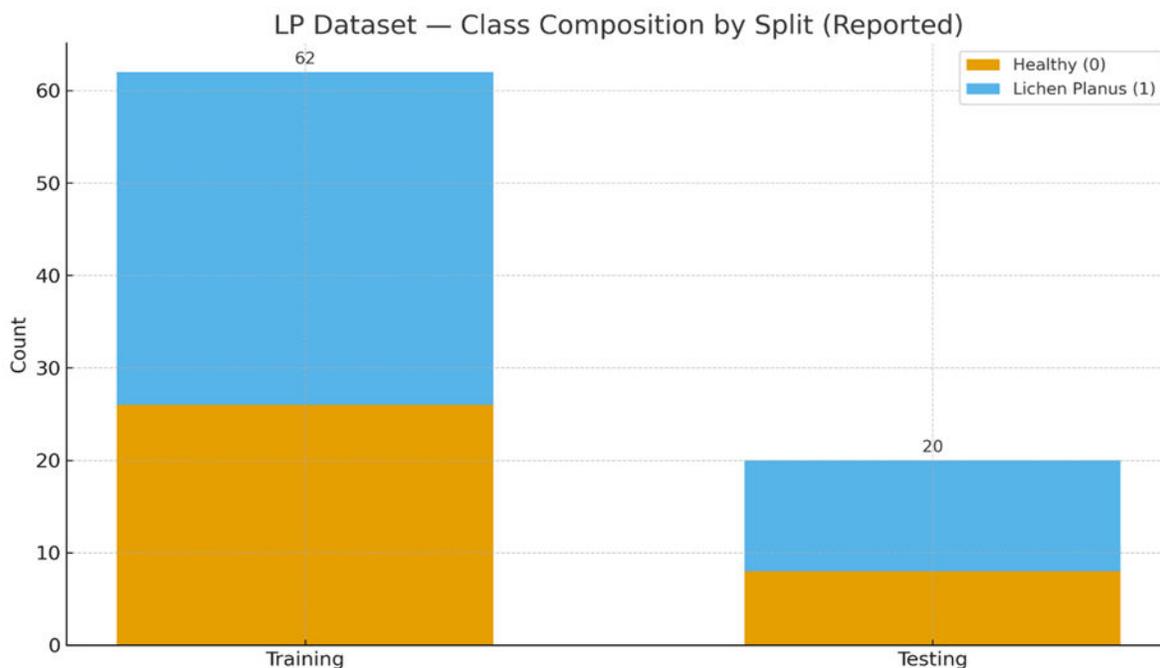


Figure 3: LP dataset.



**Figure 4:** LP dataset class composition by split.

## Results

An Artificial Neural Network (ANN) was developed to automate dermoscopic diagnosis and severity stratification of lichen planus using a curated image dataset labeled by board-certified dermatologists. Each dermoscopic image was annotated according to established diagnostic criteria rather than acne-focused grading systems, allowing the model to learn clinically relevant patterns unique to lichen planus. Through supervised learning, the ANN recognized hallmark dermoscopic features such as Wickham striae, violaceous or brown background hues, perifollicular scale, pigmented dots or blotches and subtle vascular structures with high sensitivity and diagnostic consistency (Fig. 5-7) [47-49].

The growing implementation of deep learning architectures-including ANNs, CNNs and attention-based hybrid models-has enhanced diagnostic reproducibility in inflammatory dermatoses such as lichen planus [50,51]. These systems address longstanding limitations of clinician-dependent interpretation, particularly in distinguishing LP from mimicking disorders like psoriasis, lupus erythematosus, chronic eczema and drug-induced lichenoid reactions. By minimizing interobserver variability and standardizing image-based evaluation, AI has demonstrated promise in improving lesion recognition, subtype classification and early detection of atypical or treatment-modified presentations [52-54].

Given the clinical and dermoscopic heterogeneity of lichen planus, automated image analysis may assist in differentiating classical, hypertrophic, pigmentosus, actinic and mucosal variants. Integrating dermoscopic insights with metadata-such as patient sex, disease duration or associated systemic conditions-can enable more refined classification and help predict chronicity, pigmentation outcomes or relapse tendencies [55,56]. The ability of AI to quantify subtle textural and chromatic changes also supports monitoring of therapeutic response and may reduce the need for invasive biopsies. In addition, by reducing reliance on empirical clinical judgment, AI-assisted interpretation may enhance cost-effectiveness and streamline individualized treatment selection [57,58]. The utility of AI in lichen planus is not limited to identifying isolated dermoscopic features. Newer predictive systems can be designed to monitor treatment response to topical corticosteroids, calcineurin inhibitors, systemic agents or phototherapy by analyzing serial dermoscopic changes. Future AI platforms may also integrate information from mucoscopy, reflectance confocal microscopy, serologic markers and patient-reported outcomes, creating a more comprehensive and fully connected decision-support framework [59,60]. As these technologies mature, incorporation into clinical practice and teledermatology workflows may facilitate earlier diagnosis, guide monitoring strategies and improve access to specialist-level evaluation in underserved regions.



**Figure 5:** Clinical picture of dorsum of leg showing well defined irregularly bordered plaque of lichen planus.



**Figure 6:** Polarised dermoscopy showing whitish background with irregularly distributed yellow-white structureless areas.



**Figure 7:** Ultraviolet dermoscopy showing fluorescent background with irregular, white-blue, fine reticular structures spreading across the surface.

## Discussion

Lichen planus is a chronic, immune-mediated inflammatory dermatosis characterized by T-cell-driven cytotoxicity against basal keratinocytes, influenced by genetic susceptibility, environmental triggers and systemic associations [47-49]. Aberrant cytokine signaling-particularly involving IL-1, TNF- $\alpha$  and interferon- $\gamma$ -contributes to keratinocyte apoptosis and the development of violaceous papules, mucosal erosions and pigmentary alterations [50,51]. Hepatitis C infection, drug exposure and autoimmune comorbidities further modulate disease onset and severity, particularly in mucosal, hypertrophic and pigmentosus variants [52,53]. Genetic predisposition and dysregulation of both innate and adaptive immune responses also influence lesion morphology and chronicity [54,55].

A broader understanding of desquamative inflammatory diseases helps contextualize LP within a spectrum of disorders where epidermal turnover, barrier injury and immune activation intersect. Conditions such as psoriasis, chronic eczema, pityriasis rosea and cutaneous lupus erythematosus share overlapping features of scaling, erythema and interface damage. These disorders often demonstrate similar pathways involving Th1, Th17 or interferon-driven inflammation, leading to accelerated keratinocyte turnover, aberrant differentiation and surface desquamation. Their clinical overlap with LP becomes evident in early or treated lesions where hallmark features diminish, making distinction difficult during routine examination.

### *Histopathology*

Histopathologically, lichen planus demonstrates a band-like lymphocytic infiltrate at the dermoepidermal junction, basal cell degeneration, wedge-shaped hypergranulosis, hyperkeratosis and the presence of Civatte bodies. Saw-toothing of rete ridges and pigment incontinence are common, especially in chronic or pigmentary variants. These features may vary in hypertrophic, actinic or mucosal forms and overlap with findings seen in lichenoid drug reactions, lupus erythematosus or chronic eczema, contributing to diagnostic complexity.

Clinical diagnosis of lichen planus may be challenging in presentations that overlap with psoriasis, chronic eczema, lupus erythematosus or lichenoid drug reactions [49,52]. In such instances, misinterpretation may delay appropriate therapy, prompt unnecessary biopsies or result in prolonged corticosteroid exposure [51,56]. Pigmentary sequelae and chronic relapsing disease courses-particularly in darker skin types-are often underrecognized without dermoscopic evaluation and longitudinal monitoring [53,57].

Artificial intelligence and deep learning frameworks, including convolutional and hybrid attention-based models, provide emerging diagnostic support by enhancing the interpretation of dermoscopic images [50,54]. Automated detection of Wickham striae, pigment networks, vascular structures, perifollicular scaling and background hue variations allows differentiation of subtle or early lesions that may be missed under routine examination [47,48]. The application of AI-based models may also facilitate diagnostic consistency in distinguishing classical LP from its pigmentary, actinic, mucosal or hypertrophic forms [55,58]. By mitigating interobserver variability and standardizing image-based assessment, AI-driven dermoscopy improves clinical confidence and supports earlier intervention. Beyond lesion identification, combining dermoscopic data with patient metadata such as disease duration, comorbidities or treatment history has the potential to enhance predictions of chronicity, pigmentation risk, response to immunomodulatory therapies and relapse tendencies [56,57]. Such integration may allow clinicians to tailor treatment intensity, reduce overtreatment and identify high-risk subgroups proactively. In resource-limited settings and teledermatology platforms, AI-enabled dermoscopic analysis could expand access to specialist-level care and optimize triage strategies [58-60].

In summary, lichen planus is a multifactorial inflammatory disorder driven by immune dysregulation, environmental cofactors and individual susceptibility [47,49,51]. AI-assisted dermoscopic analysis represents a pragmatic approach to improving diagnostic precision, reducing variability and enhancing long-term outcomes in the management of lichen planus [50,54,57,60].

### *Strengths*

AI offers several strengths, including consistent pattern recognition, reduced interobserver variation, rapid image processing and the ability to detect subtle features that may be overlooked during routine examination. It also supports longitudinal monitoring by identifying small dermoscopic changes during treatment.

### *Limitations*

However, most current models rely on relatively small or homogeneous datasets, which restricts generalizability across diverse skin tones and clinical variants. Image quality, device differences and lack of standardized dermoscopic protocols can affect performance. AI systems may also struggle with rare variants, mucosal lesions and heavily modified or treated presentations. Broader validation and clearer clinical integration pathways are needed before these tools can be adopted in routine practice.

### **Conclusion**

Lichen planus is a chronic inflammatory dermatosis with substantial clinical variability, often complicating timely diagnosis and consistent severity assessment. This study shows that attention-based Artificial Neural Networks can reliably interpret dermoscopic images to distinguish LP from non-LP skin while reducing interobserver variability and enhancing diagnostic confidence. However, the model's binary classification framework limits its clinical utility. Future systems should incorporate multiclass differentiation of LP variants, integrate lesion-specific dermoscopic markers and include patient-level data to improve predictive depth and personalized management. Overall, expanding AI-driven dermoscopic analysis to encompass variant classification and longitudinal monitoring may streamline diagnostic workflows, reduce delays in treatment and improve patient outcomes, particularly in settings with high dermatology burden or limited specialist access.

### **Conflict of Interest**

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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### **Consent To Participate**

The authors certify that they have obtained all appropriate patient consent.

### **Data Availability and Consent of Patient**

Data is available for the journal. Informed consents were not necessary for this paper.

### **Author's Contribution**

All authors contributed equally in this paper.

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