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Role of the Yoga Prana Vidya (YPV) Healing Technique as an Adjunct Therapy in Atopic Dermatitis: A Prospective Case-Control Study

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Abstract

Introduction: Atopic dermatitis (AD) is chronic inflammatory illness and one of the most commonly occurring and debilitating skin condition affecting 15-30% of the paediatric and 10% of adult population globally. [1,2] The pathogenesis of AD, involves the upregulation of the Type II immune mechanism through the activation of Type II helper T cells. Environmental factors like cold, dry weather, sudden climate changes, and excessive heat and sweating aggravate atopic dermatitis. This study evaluates the use of the YPV system as an adjuvant therapy in the management of moderate to severe atopic dermatitis.

Methods: This is the case study method with detailed clinical analysis and available photos of affected parts for patients' health condition pre and post Yoga Prana Vidya (YPV) Healing treatment applied as complementary & alternative medicine (CAM) system. These are the cases of 15 patients clinically diagnosed with Atopic Dermatitis with different level of severity, out of which 8 were treated using YPV Healing System and 7 were not.

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Results: Analysis of these patients' clinical parameters, available photos of affected parts pre and post treatment show that their disease was well controlled with Yoga Prana Vidya (YPV) healing method for Atopic Dermatitis.

Conclusion: This controlled case study documents the evidence on the effective use of Yoga Prana Vidya (YPV) in treating Atopic Dermatitis. There is ample scope to conduct further research on the application of YPV as Complementary & Alternatively Medicine (CAM), effective and low-cost treatment for various medical conditions.

Keywords: Atopic Dermatitis, Skin Diseases, Inflammatory Conditions, Yoga Prana Vidya System®, YPV Healing

1. Introduction:

Atopic dermatitis (AD) is chronic inflammatory illness and one of the most commonly occurring and debilitating skin condition affecting 15-30% of the paediatric and 10% of adult population globally. [1,2] The pathogenesis of AD, involves the upregulation of the Type II immune mechanism through the activation of Type II helper T cells. Environmental factors like cold, dry weather, sudden climate changes, and excessive heat and sweating aggravate atopic dermatitis.
Persistent and recurrent lesions, dry skin, and pruritus are noted in AD. However, atypical morphologies such as prurigo nodularis and follicular/papular dermatitis may also occur. [3] These lesions are characterized by profound and persistent pruritus that may lead to sleep disorders and psychological issues ultimately impacting the individual's quality of life (QoL). [4] Epidemiological studies have examined the link between psychological stress and AD, revealing that stress exacerbates the condition. Additionally, patients with AD are reported to experience higher levels of psychological stress compared to those without AD [5]. Disrupted sleep patterns, fatigue, social isolation, systemic treatments, and poor QoL may increase the likelihood of depression and anxiety among individuals with AD. Both depression and anxiety are commonly observed in AD patients, possibly due to shared pathological triggers and mechanisms [6,7]. Meanwhile, psychological factors have also been shown to aggravate skin symptoms

In cases of moderate to severe AD, topical treatments are often less effective, while systemic medications may carry risk of significant toxicity [8]. Hence, adoption of holistic approach can potentially minimize the use of systemic therapy while facilitating remission in patients. This study evaluates the use of the YPV system as an adjuvant therapy in the management of moderate to severe atopic dermatitis.

Yoga Prana Vidya (YPV) System as a Complementary & Alternative Medicine (CAM*)*

Yoga Prana Vidya (YPV) system is an integrated and holistic energy healing system of complementary and alternative medicine. It integrates the science of breathing, healing, and meditation in the treatment of physical and mental health conditions. It is based on Pranic energy, also known as bio-plasmic energy principle. It deals with healing the energy body, and in turn heals the physical body through systematic healing protocols and techniques.

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YPV system uses ancient techniques of energy healing and its protocols are structured for systematic healing of patients for treating various illnesses. More than 166 published research articles show consistent results of recovery for patients. For example, Atopic Dermatitis (Eczema): Successful Energy Healing [9], Energy healing of contact dermatitis caused by Holigarna ferruginea Marchand [10], Four cases of Gangrene treated using YPV Healing [11], speedy recovery of skin ailments: A multiple case study [12].

2. Material and Methods:

Study Design

This was a case–control study conducted among patients with a clinical diagnosis of moderate to severe atopic dermatitis.

Study Population

A total of **15 patients** aged **2–50 years** who were clinically diagnosed with moderate to severe atopic dermatitis were enrolled in the study during the study period of 1 year (February 2025 to January 2026).

Case and Control Definition

Of the 15 enrolled patients, **8 patients who provided informed consent for YPV intervention** were included in the **case group**. The remaining **7 patients who did not provide consent for YPV intervention** served as the **control group** and did not receive YPV intervention.

Inclusion Criteria

- Clinically diagnosed moderate to severe atopic dermatitis
- Age between 2 and 50 years

Exclusion Criteria

- Mild atopic dermatitis
- Age <2 years or >50 years
- Pregnant and lactating females

Written informed consent was obtained from all participants or from parents/guardians in the case of paediatric patients.

Method

Diagnosis and severity assessment were made based on clinical evaluation by a dermatologist. Severity assessment score included EASI (Eczema Area and Severity Index) and DLQI (Dermatology life Quality Index). For children (4-16 years) the Children's Dermatology Life Quality Index (CDLQI) was used.

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After clinical and laboratory evaluation, standard medical treatment was given to both the groups, while YPV healing care was additionally given to all 8 cases. All patients were evaluated every month and assessed for severity and flare of the condition.

YPV Healing by Healers

YPV Psychotherapy, Internal organ and blood cleansing techniques of YPV Healing.
Affected parts were treated with greater focus by the use of specific combinations of colour pranas of YPV Healing.

Healing was done 3 times a day for first 8 months from February 2025 to September 2025
Then twice a day for another 2 months from October 2025 to November 2025
Then once a day for 1 month in December 2025
Alternate day for 1 month in January 2026

3. Results:

Table 1. Demographic characteristics of cases and controls (n = 15)

Variable	Cases (n = 8) n (%)	Controls (n = 7) n (%)	Total (n = 15) n (%)
Age (years)			
2–12	3 (37.5)	1 (14.3)	5 (33.3)
13–30	2 (25.0)	2 (28.6)	4 (26.7)
31–50	3 (37.5)	4 (57.1)	6 (40.0)
Gender			
Male	4 (50.0)	4 (57.1)	8 (53.3)
Female	4 (50.0)	3 (42.9)	7 (46.7)

Duration of Disease
All 15 patients had duration of disease more than 1 year with minimum in a 3-year-old (female) case while maximum in a control group in a 50-year-old female having history of atopic dermatitis for 40 years.

Table 2. Severity assessment scores at Baseline

EASI severity grade	Cases (n = 8) n (%)	Controls (n = 7) n (%)
Moderate (7.1–21.0)	3 (37.5)	3 (42.9)
Severe (21.1–50.0)	5 (62.5)	4 (57.1)

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Table 3. DLQI/CDLQI scores at baseline

DLQI/CDLQI score range	Interpretation	Cases (n = 8) n (%)	Controls (n = 7) n (%)	Total (n = 15) n (%)
0–1	**No effect on QoL**	0 (0.0)	0 (0.0)	0 (0.0)
2–5	**Small effect**	1 (12.5)	0 (0.0)	1 (6.7)
6–10	**Moderate effect**	3 (37.5)	3 (42.9)	6 (40.0)
11–20	**Very large effect**	3 (37.5)	4 (57.1)	7 (46.66)
21–30	**Extremely large effect**	1 (12.5)	0 (0.0)	1 (6.7)

Table 4. Baseline Treatment Profile (Systemic therapy)

Baseline Treatment	Cases (n = 8) n (%)	Controls (n = 7) n (%)	Total (n = 15) n (%)
Steroid only	1 (12.5%)	1 (14.3%)	2 (13.3%)
Cyclosporine	2 (25.0%)	1 (14.3%)	3 (20.0%)
***Tofacitinib**	3 (37.5%)	3 (42.9%)	6 (40.0%)
***Azathioprine**	2 (25.0%)	2 (28.6%)	4 (26.7%)
Total	8 (100%)	7 (100%)	15 (100%)

**Oral prednisolone was given in tapering dose along with tofacitinib and azathioprine.*

Table 5. Comparison of EASI Scores at Follow-up

Time Point	Cases – EASI (Mean ± SD)	Controls – EASI (Mean ± SD)	p-value	Significance
Baseline	21.0 ± 6.2	20.3 ± 6.4	0.83	Not significant
3 months	14.8 ± 6.3	15.7 ± 3.1	0.73	Not significant
6 months	13.1 ± 7.6	12.8 ± 3.2	0.92	Not significant
9 months	8.25 ± 6.3	12.9 ± 3.0	0.092	Trend toward significance
1 year	5.38 ± 4.8	10.3 ± 1.8	0.024	Significant

No significant difference in EASI scores was observed between cases and controls at baseline, 3 months, or 6 months. By 9 months, cases showed a trend toward lower EASI scores compared to controls (p = 0.09), and at 1 year, the reduction was statistically significant (p = 0.024), indicating greater improvement in the cases group.

Table 6. Comparison of DLQI/CDLQI Scores at Follow-up

Time Point	Cases – DLQI	Controls – DLQI	p-value	Significance
Baseline	10.5 ± 6.4	10.1 ± 3.1	0.88	Not significant
3 months	9.1 ± 5.5	9.4 ± 2.6	0.89	Not significant
6 months	7.4 ± 6.1	7.6 ± 1.5	0.93	Not significant
9 months	5.3 ± 3.2	9.0 ± 2.6	0.037	Significant
1 year	5.0 ± 3.1	8.7 ± 2.4	0.027	Significant

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No significant differences in DLQI scores were observed between cases and controls at baseline, 3 months, or 6 months. By 9 months and 1 year, cases showed significantly lower DLQI scores compared to controls (p = 0.037 and p = 0.027, respectively), indicating improved quality of life in the cases group.

Table 7. Comparison of Number of Flares in a period of 1 year in Cases and Controls

Parameter	**Cases (n = 8)**	**Controls (n = 7)**	**p-value**	**Significance**
Number of flares (mean ± SD)	*0.75 ± 0.66*	*2.29 ± 0.90*	*0.005*	*Significant*
Patients with no flare, n (%)	*3 (37.5%)*	*0 (0%)*	—	—
Patients with 1–2 flares, n (%)	*4 (50%)*	*1 (14.3%)*	—	—
Patients with >2 flares, n (%)	*1 (12.5%)*	*6 (85.7%)*	*0.02*	*Significant*

A flare is defined as a temporary worsening or exacerbation of atopic dermatitis symptoms beyond the patient's usual baseline often requiring temporary increase in therapy.

The mean number of flares was significantly lower in cases compared to controls (0.75 ± 0.66 vs 2.29 ± 0.90, p = 0.005). Among cases, 37.5% had no flares, 50% had 1–2 flares, and 12.5% had more than 2 flares. In controls, none had zero flares, 14.3% had 1–2 flares, and 85.7% had more than 2 flares. The difference in patients experiencing more than 2 flares between cases and controls was statistically significant (p = 0.02), indicating a higher flare frequency in the control group.

The available photos of the result are as below:

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Fig 1 (a)

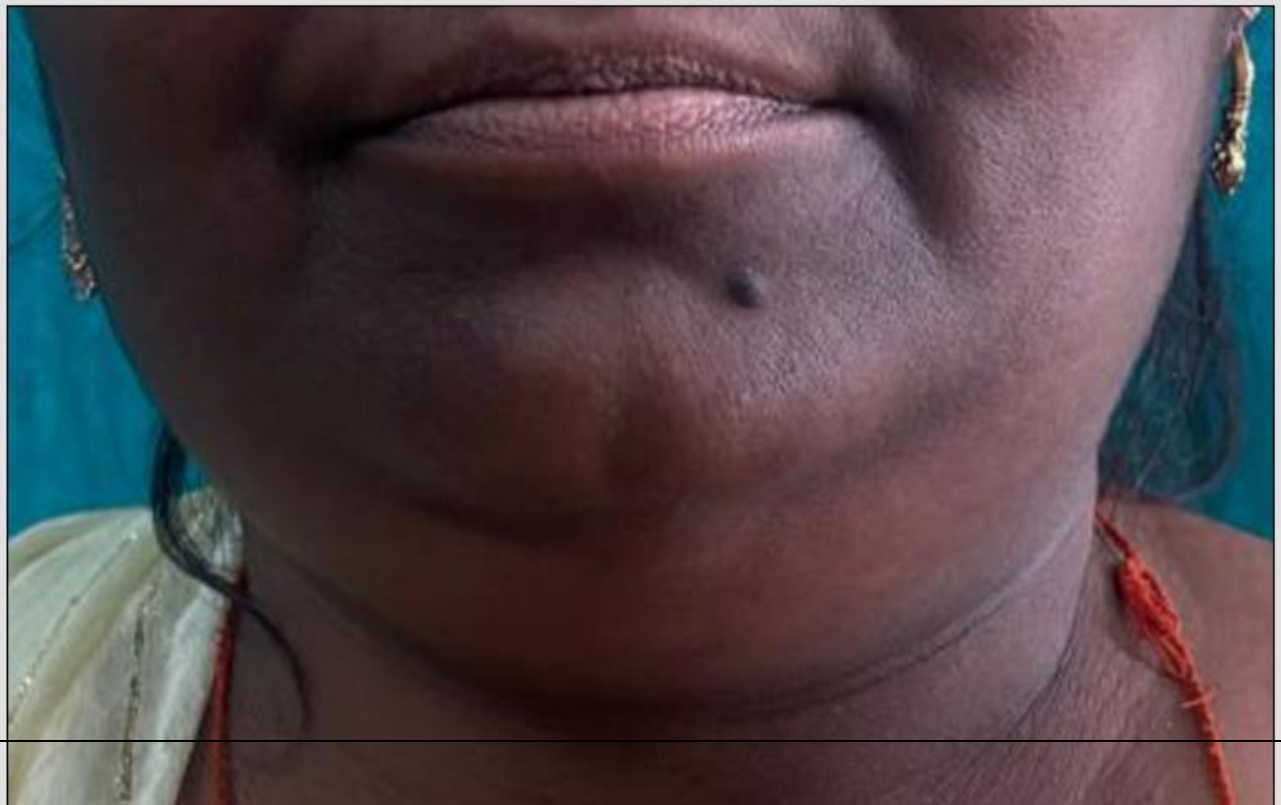
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Fig 1 (b) Pre and Post images of 40 year old female showing decreased peri orbital and peri oral lichenification and erosions after 9 months of YPV intervention.



Fig 2 Pre and post images showing cleared erythema and pustules over neck, axilla, lower abdomen and groin in a 11-year-old male after 3 months of YPV intervention.

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Fig 3 Pre and Post images of a 13-year-old female showing resolution of erythema and exudation over face and neck after 6 months of YPV intervention.

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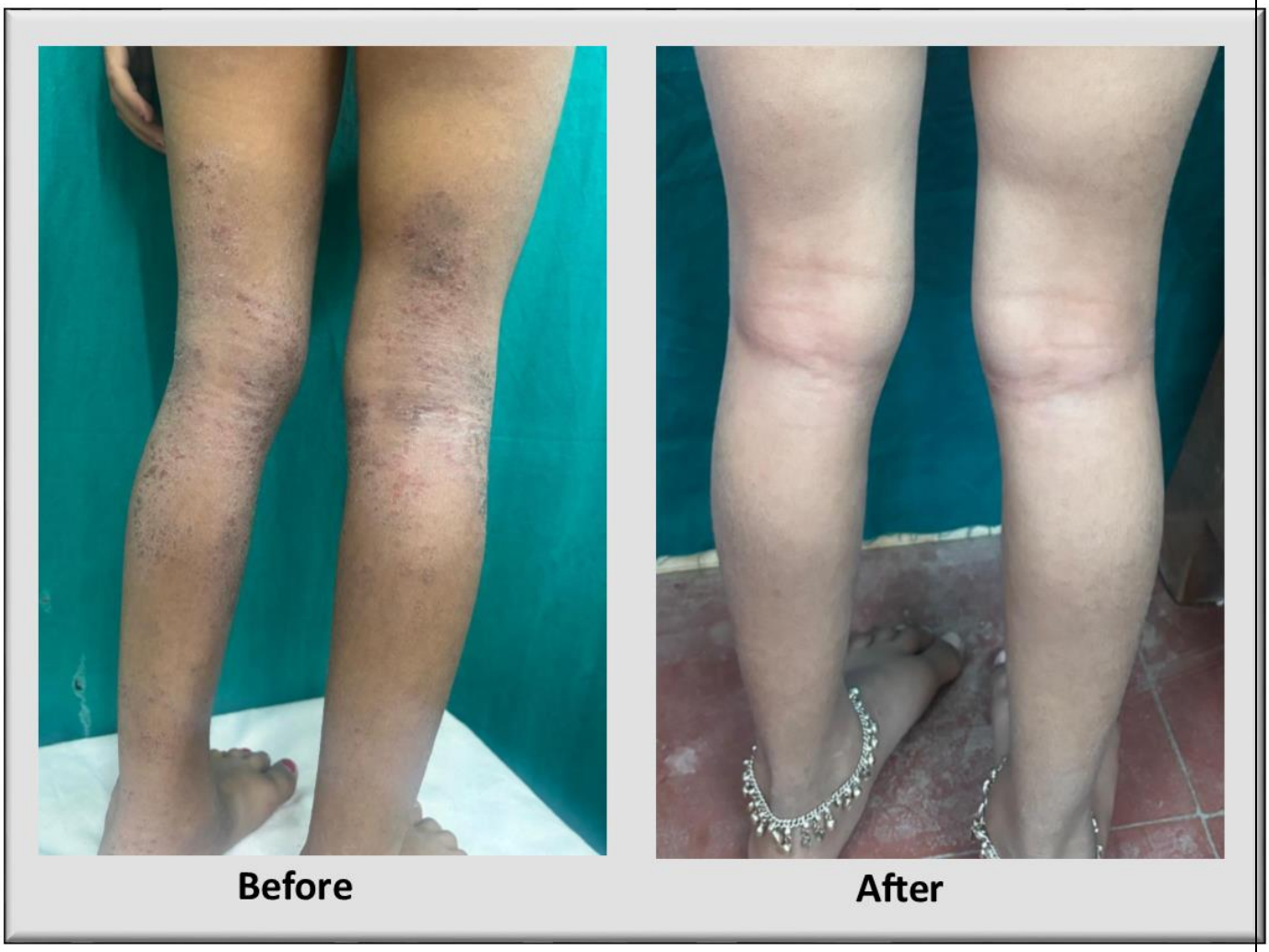


Fig 4 (a)

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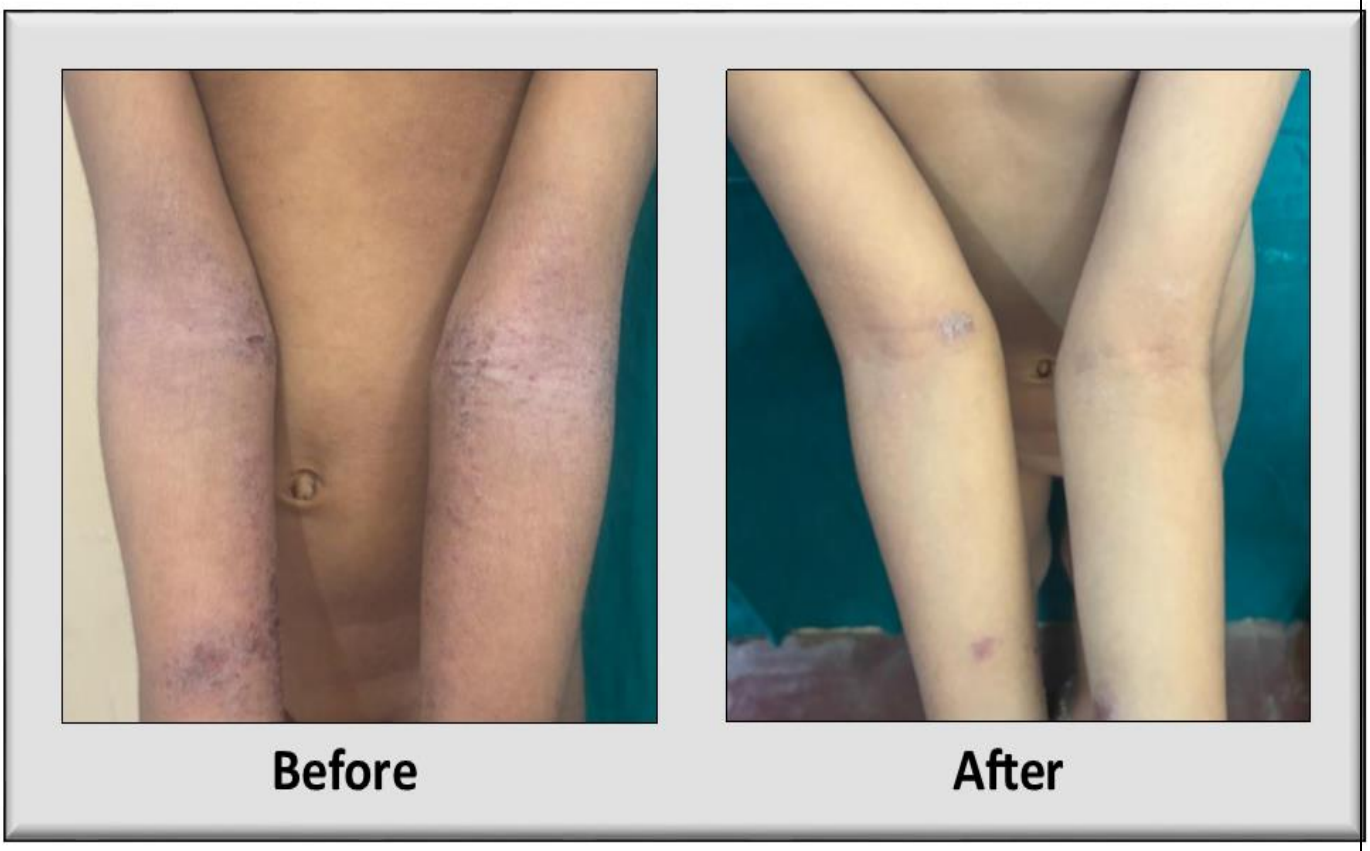


Fig 4 (b) Pre and post images of 3-year-old female with decreased lichenification and exudation over flexural region after 12 months of YPV intervention.

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Fig 5 Images of a 9-year-old female with resolved skin lesions after 12 months of YPV intervention.

4. Discussion:

Atopic dermatitis (AD) is a complex, multifactorial, and chronic, relapsing inflammatory skin disorder characterized by intense pruritus, xerosis, and eczematous lesions with a fluctuating course. [1,2] It commonly begins in early childhood but may persist or even present de novo in adulthood. The disease imposes a substantial physical, psychological, and socioeconomic burden on patients and their families. [4]

Pathophysiology

The pathogenesis of AD is multifactorial and involves complex interactions among genetic predisposition, epidermal barrier dysfunction, immune dysregulation, and environmental triggers. [13]

1. *Skin Barrier Dysfunction:*
   Mutations in the filaggrin gene and other structural proteins compromise the epidermal barrier, leading to increased transepidermal water loss and enhanced allergen penetration.

2. *Immune Dysregulation:*
   AD is primarily driven by type 2 helper T-cell (Th2)–mediated inflammation, particularly in the acute phase. Cytokines such as IL-4, IL-13, and IL-31 play a central role in inflammation and pruritus. Chronic lesions may also involve Th1 and Th17 pathways.
3. *Microbial Factors:*
   Colonization with *Staphylococcus aureus* is common and may exacerbate inflammation.
4. *Neuroimmune Interactions:*
   Psychological stress can aggravate disease activity via neuroendocrine pathways, contributing to flare cycles. [14]

Psychosocial and Holistic Considerations

In a systemic review and meta-analysis study, conducted by Almutawa et al. suggested that AD significantly impacts the psychological well-being of patients. Stress, depression, anxiety, and suicidal ideation are among the mental health issues commonly associated with AD. [15] Therefore, clinicians should consider mental health evaluations for patients with AD.

Given the strong link between stress and disease exacerbation, holistic approaches including psychological support, stress management techniques, and behavioural interventions may offer additional benefit alongside pharmacological therapy. Integrative approaches are increasingly being explored to improve overall disease control and quality of life.

The present case–control study evaluated the role of the **YPV system as an adjuvant therapy** in patients with moderate to severe **Atopic Dermatitis**, assessing clinical severity (EASI), quality of life (DLQI/CDLQI), and frequency of disease flares over a one-year follow-up period.

Baseline Characteristics

Both groups were comparable at baseline with respect to age distribution, gender, disease duration, severity grading, and systemic treatment profile. All patients had disease duration of more than one year, indicating a chronic and established disease cohort. The majority of participants in both groups had severe disease at baseline (62.5% in cases and 57.1% in controls), with comparable mean EASI scores (21.0 ± 6.2 vs 20.3 ± 6.4; $p = 0.83$). Similarly, baseline DLQI/CDLQI scores were not significantly different ($p = 0.88$), suggesting that both groups were clinically and functionally matched before intervention.

The similarity in systemic therapy use, including cyclosporine, tofacitinib, azathioprine, and tapering oral steroids, further supports the comparability of groups and reduces treatment-related confounding.

Clinical Severity Outcomes (EASI Scores)

No statistically significant differences were observed between cases and controls at baseline, 3 months, or 6 months. However, by 9 months, a trend toward significance emerged ($p = 0.092$),

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while at 1 year, the difference became statistically significant (p = 0.024), with cases demonstrating lower mean EASI scores (5.38 ± 4.8 vs 10.3 ± 1.8).

This delayed but sustained divergence suggests that the adjunctive YPV intervention may exert gradual cumulative benefits rather than immediate short-term effects. The findings indicate that while conventional systemic therapy improves disease activity in both groups initially, the addition of YPV may enhance long-term disease control.

The progressive reduction in EASI scores among cases also suggests improved inflammatory control and possibly better adherence or stress modulation over time.

Quality of Life Outcomes (DLQI/CDLQI)

Quality of life impairment at baseline was substantial in both groups, with nearly half of patients experiencing a "very large effect" on daily life. No early differences were observed up to 6 months. However, significant improvement in the cases group became evident at 9 months (p = 0.037) and persisted at 1 year (p = 0.027).

The earlier statistical significance in DLQI (at 9 months) compared to EASI (at 12 months) may suggest that psychosocial and subjective symptom improvements precede measurable clinical severity changes. Given that atopic dermatitis is strongly influenced by stress, sleep disturbance, and psychological burden, YPV may contribute through stress reduction and emotional regulation mechanisms, thereby improving perceived quality of life before substantial objective lesion reduction occurs.

Flare Frequency

One of the most notable findings of this study is the significant reduction in flare frequency in the cases group. The mean number of flares over one year was markedly lower in cases (0.75 ± 0.66) compared to controls (2.29 ± 0.90; p = 0.005).

Furthermore:

- 37.5% of cases experienced no flares (vs 0% of controls).
- 85.7% of controls experienced more than two flares, compared to only 12.5% of cases (p = 0.02).

Flare prevention is clinically significant in chronic atopic dermatitis, as repeated exacerbations contribute to cumulative morbidity, increased systemic therapy exposure, and impaired quality of life. The substantial difference in flare frequency suggests that YPV may enhance disease stability and resilience against triggers.

Possible Mechanisms

Although the exact mechanism of YPV is beyond the scope of this study, several plausible explanations may be considered:

1. *Stress reduction:* Psychological stress is a well-established trigger for atopic dermatitis exacerbations. YPV may modulate neuro-immune interactions, thereby reducing flare susceptibility.
2. *Improved treatment adherence:* Engagement in structured healing practices may enhance patient motivation and compliance.
3. *Autonomic balance:* Mind–body interventions have been shown to influence inflammatory pathways via neuroendocrine modulation.

Future mechanistic studies are required to validate these hypotheses.

Strengths

- Prospective follow-up over 1 year.
- Comparable baseline characteristics between groups.
- Use of validated outcome measures (EASI and DLQI/CDLQI).
- Assessment of flare frequency, which reflects real-world disease burden.

Limitations

- Small sample size (n = 15), limiting statistical power.
- Non-randomized design, with potential selection bias (consent-based allocation).
- Lack of blinding.

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Conflict of interest:
None

Ethical approval:
Not required

Reference:

Itch characteristics in atopic dermatitis: results of a web-based questionnaire. Dawn A, Papoiu AD, Chan YH, Rapp SR, Rassette N, Yosipovitch G. Br J Dermatol. 2009;160:642–644. doi: 10.1111/j.1365-2133.2008.08941.x. [DOI] [PubMed] [Google Scholar]

Atopic dermatitis. Archer CB. Medicine. 2021;49:370–373. [Google Scholar]

Atypical and unusual clinical presentation of atopic dermatitis: a case report. Diogo AB, De-Carvalho IS, Campos ES, Stracci J, Tajra TD. Arq Asma Alerg Imunol. 2021;5:437–

441. [Google Scholar]

Atopic dermatitis and the atopic march. Spergel JM, Paller AS. J Allergy Clin Immunol. 2003;112:0–27. doi: 10.1016/j.jaci.2003.09.033. [DOI] [PubMed] [Google Scholar]

Association of perceived stress with atopic dermatitis in adults: a population-based study in Korea. Park H, Kim K. Int J Environ Res Public Health. 2016;13:760. doi: 10.3390/ijerph13080760. [DOI] [PMC free article] [PubMed] [Google Scholar]

Allergen immunotherapy in atopic dermatitis: light and shadow in children. Caminiti L, Panasiti I, Landi M, et al. Pediatr Allergy Immunol. 2020;31 Suppl 26:46–48. doi: 10.1111/pai.13390. [DOI] [PubMed] [Google Scholar]

Worldwide time trends in the prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and eczema in childhood: ISAAC Phases One and Three repeat multicountry cross-sectional surveys. Asher MI, Montefort S, Björkstén B, Lai CK, Strachan DP, Weiland SK, Williams H. Lancet. 2006;368:733–743. doi: 10.1016/S0140-6736(06)69283-0. [DOI] [PubMed] [Google Scholar]

Allergic manifestations of skin diseases--atopic dermatitis. Breuer K, Werfel T, Kapp A. Chem Immunol Allergy. 2006;91:76–86. doi: 10.1159/000090231. [DOI] [PubMed] [Google Scholar]

Nayak L, & Nanduri V.S. (2024). Atopic Dermatitis (Eczema): Successful Energy Healing Treatment Using Yoga Prana Vidya (Ypv) Protocols As Alternative Medicine. WORLD JOURNAL OF ADVANCE HEALTHCARE RESEARCH. 8(12), 159-162. ISSN: 2457-0400. https://www.wjahr.com/admin/assets/article_issue/67112024/1732874447.pdf

Nanduri, V. S., & Nayak L. (2023). A case of successful yoga prana vidya energy healing treatment of contact dermatitis caused by Holigarna ferruginea Marchand . International Journal of Research in Dermatology, 9(2), 81–84. https://doi.org/10.18203/issn.2455-4529.IntJResDermatol20230456

Dholakia M., & Ramnani K. (2026). Successful healing treatment of gangrene cases using Yoga Prana Vidya (YPV) System. International Journal of Medicine Research. 11(1), 9-14. ISSN: 2455-7404. https://www.medicinesjournal.com/archives/2026/vol11/issue1/11003.

Shah S., Atheesh M., Balaji S., Kotian S., & Nanduri V.S.(2023) Role of Yoga Prana Vidya healing techniques in successful and speedy recovery of skin ailments: A multiple case study. World Journal of Advanced Pharmaceutical and Medical Research. 05(01), 001–008. https://doi.org/10.53346/wjapmr.2023.5.1.0030

Boguniewicz M, Leung DYM. Atopic dermatitis: a disease of altered skin barrier and immune dysregulation. Immunol Rev. 2011;242(1):233–246.

Kim JE, et al. Stress and atopic dermatitis: psychosocial aspects and effects on disease severity. Psychiatry Investig. 2017;14(3):310–319.

Almutawa YM, AlGhareeb M, Bhattarai E, Aljalahma J. Investigation of the Impact of Atopic Dermatitis (AD) on Stress, Depression, Anxiety, and Suicidal Ideation: A Systematic Review and Meta-Analysis. Cureus. 2024 Jun 28;16(6):e63376. doi: 10.7759/cureus.63376. PMID: 39077283; PMCID: PMC11283933.