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Original Article

Skin–mind connection in atopic dermatitis: Associations of disease severity with skin barrier function, stress, anxiety, and quality of life

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Abstract

Although skin barrier dysfunction and psychosocial impairment are well-recognized features of atopic dermatitis, the association remains incompletely understood. Evidence integrating objective measures of skin barrier function with stress, anxiety, quality of life, and disease severity is limited. Therefore, the aim of this study was to investigate the associations of disease severity with skin barrier function, psychological status, and quality of life in patients with atopic dermatitis. A hospital-based cross-sectional study was conducted at the Dermatology, Venereology, and Aesthetic Outpatient Clinic of Dr. Zainoel Abidin Hospital, Banda Aceh, Indonesia, in 2025. Adults aged ≥20 years with atopic dermatitis diagnosed according to the Hanifin–Rajka criteria were recruited consecutively. Disease severity was assessed using the Scoring Atopic Dermatitis (SCORAD) index. Skin barrier function was evaluated by measuring transepidermal water loss (TEWL) and stratum corneum hydration using a Tewameter and Corneometer, respectively. Anxiety, perceived stress, and quality of life were assessed using the Zung Self-Rating Anxiety Scale (SAS), Perceived Stress Scale (PSS), and Dermatology Life Quality Index (DLQI). Most patients were female (62.5%), and 68.8% had mild disease. Disease severity was not significantly associated with TEWL (p=0.923), skin hydration (p=0.208), SAS (p=0.560), PSS (p=0.841), or DLQI (p=0.621). Spearman's correlation analysis likewise demonstrated no significant correlation between disease severity and TEWL (r=-0.052, p=0.770), skin hydration (r=-0.136, p=0.450), SAS (r=−0.015, p=0.930), PSS scores (r=−0.155, p=0.390), or DLQI (r=0.062, p=0.730). In conclusion, although greater skin barrier dysfunction and psychosocial burden tended to be observed in patients with moderate and severe atopic dermatitis, no significant associations were observed between disease severity and skin barrier function, anxiety, perceived stress, or quality of life. The relatively small sample size and cross-sectional design may have limited the ability to detect significant associations.

Keywords: Atopic dermatitis, skin barrier, transepidermal water loss, quality of life, psychological stress

Introduction

Atopic dermatitis is a chronic relapsing inflammatory skin disorder characterized by intense pruritus, eczematous lesions, and impaired epidermal barrier function [1]. Affecting an estimated

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223 million individuals worldwide, including approximately 43 million children aged 1–4 years, atopic dermatitis represents one of the most prevalent chronic dermatologic diseases and contributes substantially to global morbidity, healthcare utilization, and reduced quality of life [2,3]. Despite advances in therapeutic strategies, disease burden remains considerable because of its chronic course, recurrent exacerbations, and multifaceted impact on physical and psychological well-being.

A hallmark of atopic dermatitis is disruption of the epidermal barrier, which predisposes the skin to excessive transepidermal water loss (TEWL), reduced hydration, and increased penetration of environmental irritants, allergens, and microbial antigens [4]. Defects in structural proteins such as filaggrin, along with alterations in epidermal lipid composition and mutations involving genes such as *SPINK5*, compromise barrier integrity and contribute to sustained cutaneous inflammation [4,5]. These abnormalities promote a self-perpetuating cycle in which barrier dysfunction enhances immune activation, further aggravating skin inflammation and disease severity [4,5]. Consequently, objective measures of skin barrier function, including TEWL and skin hydration, have emerged as important indicators of disease activity and epidermal health in patients with atopic dermatitis [6-9].

Beyond cutaneous manifestations, atopic dermatitis is increasingly recognized as a systemic condition with significant psychological consequences [10]. Persistent pruritus, recurrent sleep disturbance, visible skin lesions, and social stigmatization contribute to elevated levels of stress and anxiety, as well as substantial impairment in quality of life [6-9,11-13]. Emerging evidence suggests that chronic itch and inflammation may induce neurobiological adaptations involving central neural circuits responsible for reward processing, emotional regulation, and stress responses [8-10,13]. In turn, psychological distress can exacerbate scratching behavior, disrupt skin barrier recovery, and intensify inflammatory pathways, creating a bidirectional interaction between the skin and the nervous system [6,10]. A better understanding of the interaction between skin barrier dysfunction and psychosocial burden may facilitate a more holistic approach to atopic dermatitis management. Integrating objective skin barrier measurements with patient-reported outcomes into routine clinical practice may help identify patients who require both optimized skin barrier management and psychosocial support.

Although skin barrier dysfunction and psychological burden are both recognized components of atopic dermatitis, the interrelationship between these domains remains incompletely understood. Most studies have evaluated either epidermal barrier abnormalities or psychosocial outcomes separately [6-9,12], whereas evidence integrating objective measures of skin barrier function with stress, anxiety, quality of life, and disease severity remains limited. Therefore, the aim of this study was to investigate the associations of disease severity with skin barrier function, psychological stress, anxiety, and quality of life in patients with atopic dermatitis.

Methods

Study design and setting

A hospital-based cross-sectional study was conducted at the Dermatology, Venereology, and Aesthetic Outpatient Clinic of Dr. Zainoel Abidin Hospital, Banda Aceh, Indonesia, in 2025. Adults with atopic dermatitis were included, and disease severity, skin barrier function, and stratum corneum hydration were assessed. Psychological status (anxiety and stress) and quality of life were also assessed.

Sample size, sampling method, and eligibility criteria

The minimum sample size was calculated for correlation analysis using a significance level of 0.05, statistical power of 80%, and an anticipated moderate correlation coefficient, yielding a required sample size of 29 patients. Eligible patients were adults aged ≥20 years with atopic dermatitis diagnosed according to the Hanifin–Rajka diagnostic criteria by a board-certified dermatologist. Exclusion criteria included concurrent dermatological diseases or systemic conditions that could affect skin barrier function and hydration, including hyperthyroidism,

diabetes mellitus, chronic kidney disease requiring hemodialysis, chronic liver disease, hepatitis, and active secondary skin infection.

Assessment of atopic dermatitis severity

Disease severity was evaluated using the Scoring Atopic Dermatitis (SCORAD) index, a validated instrument incorporating the extent of skin involvement, intensity of clinical signs, and subjective symptoms [14]. The extent of disease (A) was assessed as the percentage of body surface area affected. Clinical intensity (B) was evaluated through six objective signs, including erythema, edema or papulation, oozing or crusting, excoriation, lichenification, and dryness. Subjective symptoms (C), consisting of pruritus and sleep disturbance during the preceding three days, were assessed using a 10-point visual analogue scale. The SCORAD score was calculated according to the formula A/5 + 7B/2 + C, yielding a maximum score of 103. Disease severity was categorized as mild (<25), moderate (25–50), or severe (>50).

Assessment of skin barrier function

Skin barrier function was evaluated objectively through measurements of TEWL and stratum corneum hydration [15]. TEWL was measured using a Tewameter and expressed in g/m²/h. Skin barrier parameters were measured using the Multi Display Device (MDD 4; Courage - Khazaka Electronic GmbH, Cologne, Germany) equipped with a Tewameter and Corneometer probes. Elevated TEWL values indicate increased epidermal permeability and impaired skin barrier integrity, whereas values below 10 g/m²/h are generally considered within the normal range for healthy skin. Stratum corneum hydration was assessed using a Corneometer and expressed in arbitrary units (AU). Hydration values greater than 40 AU were considered normal, values between 30 and 40 AU indicated reduced hydration, and values below 30 AU were considered indicative of very dry skin. Before the measurements, participants were allowed to acclimatize in an air-conditioned room. Measurements were performed on skin areas free from topical emollients or other topical products at the time of assessment to minimize the influence of recent topical application on skin barrier measurements.

Assessment of anxiety, stress, and quality of life

Anxiety symptoms were assessed using the Zung Self-Rating Anxiety Scale (SAS), a self-administered questionnaire comprising 20 items rated on a four-point Likert scale [16]. The instrument evaluates cognitive, affective, somatic, and autonomic manifestations of anxiety. Total scores were classified as normal (20–44), mild anxiety (45–59), moderate anxiety (60–74), and severe anxiety (75–80). Perceived stress was evaluated using the Perceived Stress Scale (PSS), which measures the degree to which individuals perceive situations in life as stressful during the preceding month [17]. Total scores range from 0 to 40 and were categorized as low (0–13), moderate (14–26), or high stress (27–40). Quality of life was assessed using the Dermatology Life Quality Index (DLQI), a validated dermatology-specific questionnaire consisting of 10 items with a total score ranging from 0 to 30. Higher scores indicate greater impairment in quality of life attributable to skin disease and are categorized as no effect, mild, moderate, severe, and very severe.

Study variables

The primary independent variable was atopic dermatitis severity, assessed using the SCORAD index. The dependent variables were skin barrier function, psychological status (anxiety and stress), and quality of life. Skin barrier function was presented as TEWL (g/m²/h) and stratum corneum hydration (AU). Psychological status was assessed using the PSS and the Zung SAS, while quality of life was measured using the DLQI. Higher SCORAD, TEWL, PSS, SAS, and DLQI values indicate greater disease severity, skin barrier dysfunction, psychological burden, and quality-of-life impairment, whereas lower hydration values indicate reduced stratum corneum moisture and impaired skin barrier integrity.

Statistical analysis

Data were analyzed using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were presented as mean and standard deviation (SD) or median (min-max),

while categorical variables were reported as frequencies and percentages. Normality was assessed using the Shapiro–Wilk test. Differences in transepidermal water loss, skin hydration, SAS, PSS, and DLQI according to atopic dermatitis severity were analyzed using the Kruskal–Wallis test. Correlations between SCORAD score and TEWL, stratum corneum hydration, PSS, SAS, and DLQI scores were analyzed using Spearman's correlation test. Statistical significance was defined as a two-sided $p<0.05$.

Results

Patients' characteristics

A total of 32 patients were included and their characteristics are presented in **Table 1**. Females predominated (62.5%), and the most common age group was 17–25 years (31.3%), followed by 56–65 years (25.0%). Based on SCORAD classification, most patients had mild disease (68.8%), whereas 25.0% and 6.3% had moderate and severe disease, respectively. Assessment of skin barrier function showed that 59.4% of patients exhibited impaired TEWL (>10 g/m²/h), while 43.8% had very dry skin and an additional 43.8% had low skin hydration. Anxiety assessment demonstrated that 40.6% of patients had mild anxiety, whereas no patients had moderate or severe anxiety. Perceived stress was predominantly moderate, affecting 62.5% of patients, while the remaining 37.5% reported mild stress. No patients reported severe stress. Quality-of-life assessment revealed substantial disease burden, with severe and very severe impairment reported in 50.0% and 21.9% of patients, respectively.

Table 1. Characteristics of the included patients with atopic dermatitis (n=32)

Characteristic	Frequency (%)
Sex	
Female	20 (62.5)
Male	12 (37.5)
Age (years)	
17–25	10 (31.3)
26–35	5 (15.6)
36–45	4 (12.5)
46–55	4 (12.5)
56–65	8 (25.0)
>65	1 (3.1)
Atopic dermatitis severity	
Mild	22 (68.8)
Moderate	8 (25.0)
Severe	2 (6.3)
Transepidermal water loss (TEWL)	
Healthy (≤10 g/m²/h)	13 (40.6)
Impaired (>10 g/m²/h)	19 (59.4)
Skin hydration (arbitrary unit, AU)	
Very dry (<30 AU)	14 (43.8)
Low (30–40 AU)	14 (43.8)
Normal (>40 AU)	4 (12.5)
Zung Self-Rating Anxiety Scale (SAS)	
Normal	19 (59.4)
Mild anxiety	13 (40.6)
Moderate anxiety	0 (0.0)
Severe anxiety	0 (0.0)
Perceived Stress Scale (PSS)	
Low stress	12 (37.5)
Moderate stress	20 (62.5)
High stress	0 (0.0)
Dermatology Life Quality Index (DLQI)	
No effect	2 (6.3)
Mild effect	5 (15.6)
Moderate effect	2 (6.3)
Severe effect	16 (50.0)
Very severe effect	7 (21.9)

Association between atopic dermatitis severity, skin barrier, anxiety, stress and quality-of-life measures

TEWL, skin hydration, anxiety, perceived stress and quality of life did not differ significantly across atopic dermatitis severity groups (all $p>0.05$) (**Table 2**). Median TEWL ranged from 10.29 to 15.16 g/m²/h ($p=0.923$), whereas median skin hydration ranged from 14.82 to 33.35 AU ($p=0.208$). Similarly, median SAS ($p=0.560$), PSS ($p=0.841$) and DLQI ($p=0.621$) scores were comparable among severity groups. Although patients with moderate disease tended to have higher DLQI scores and those with mild and moderate disease showed higher TEWL and lower skin hydration, these differences were not statistically significant.

Table 2. Transepidermal water loss, skin hydration, quality-of-life, anxiety, and stress scores according to atopic dermatitis severity

Variable Median (min-max)	Atopic dermatitis severity			Total (n=32)	*p*-value[a]
	Mild (n=22)	Moderate (n=8)	Severe (n=2)		
TEWL (g/m²/h)	11.11 (1.14–49.40)	10.29 (5.0–45.40)	15.16 (6.40–23.80)	10.58 (1.14–49.40)	0.923
Skin hydration	30.57 (11.20–49.60)	33.35 (14.00–53.00)	14.82 (4.00–25.65)	30.57 (4.00–53.00)	0.208
SAS score	38.50 (22.00–54.00)	39.50 (30.00–46.00)	32.50 (32.00–33.00)	38.50 (22.00–54.00)	0.560
PSS score	16.50 (7.00–25.00)	16.00 (8.00–24.00)	13.50 (7.00–20.00)	16.00 (7.00–25.00)	0.841
DLQI score	13.00 (1.00–29.00)	17.50 (5.00–28.00)	15.00 (14.00–16.00)	14.00 (7.80–29.00)	0.621

AU: arbitrary units; DLQI: Dermatology Life Quality Index; PSS: Perceived Stress Scale; SAS: Zung Self-Rating Anxiety Scale; TEWL: transepidermal water loss.
[a] Analyzed using Kruskal-Wallis test

Correlation between atopic dermatitis severity, skin barrier, quality-of-life, anxiety, and stress measures

Spearman correlation analysis showed that atopic dermatitis severity was not significantly correlated with any of the assessed skin barrier, psychological, or quality-of-life measures (**Table 3**). Disease severity showed very weak negative correlations with (TEWL; $r=-0.052$, $p=0.770$), skin hydration ($r=-0.136$, $p=0.450$), SAS score ($r=-0.015$, $p=0.930$), and PSS score ($r=-0.155$, $p=0.390$). A very weak positive correlation was observed between disease severity and DLQI score ($r=0.062$, $p=0.730$); however, this association was also not statistically significant (**Table 3**).

Table 3. Correlations of atopic dermatitis severity with skin barrier function, anxiety, perceived stress, and quality-of-life measures

Variable	Spearman's *r*	*p*-value[a]
Transepidermal water loss (TEWL) (g/m²/h)	−0.052	0.770
Skin hydration (arbitrary unit)	−0.136	0.450
Zung Self-Rating Anxiety Scale (SAS) score	−0.015	0.930
Perceived Stress Scale (PSS) score	−0.155	0.390
Dermatology Life Quality Index (DLQI) score	0.062	0.730

[a] Analyzed using Spearman correlation test

Discussion

The present study evaluated the association and correlation of atopic dermatitis severity with skin barrier function, psychological status, and quality of life in adult patients with atopic dermatitis. Although patients with moderate and severe disease had greater impairment in skin barrier parameters and psychosocial outcomes than those with mild disease, no statistically significant associations or correlations were observed between disease severity and TEWL, skin hydration, anxiety, perceived stress, or quality of life. These findings highlight the complex and multifactorial nature of atopic dermatitis, in which objective clinical severity does not necessarily correspond to the degree of barrier dysfunction or psychological burden experienced by patients.

Skin barrier dysfunction is a central feature of atopic dermatitis and is primarily driven by abnormalities in epidermal structural proteins and lipids, including filaggrin deficiency and impaired ceramide composition [5]. These alterations increase epidermal permeability, resulting in elevated transepidermal water loss and reduced stratum corneum hydration [18]. In the present study, the highest TEWL value was observed in the moderate disease group, whereas the lowest hydration level was found in the severe group. These findings suggest that barrier dysfunction may not progress linearly across clinical severity categories. The elevated TEWL observed in moderate disease may reflect ongoing active inflammation associated with maximal disruption of epidermal integrity [19-21]. In contrast, patients with severe disease may represent a more chronic phase characterized by lichenification, epidermal remodeling, and intensive use of emollients or anti-inflammatory therapies, resulting in relatively stable TEWL values despite persistently impaired hydration [19]. Furthermore, TEWL and skin hydration are influenced by multiple factors, including anatomical site, disease chronicity, environmental conditions, and treatment status, which may not be fully captured by clinical severity scores alone [19].

The present findings also highlight the substantial psychosocial burden associated with atopic dermatitis. Patients with moderate disease had the highest DLQI and anxiety (SAS scores), whereas perceived stress (PSS score) was comparable between the mild and moderate groups and lower in patients with severe disease. This observation suggests that subjective disease burden may not parallel objective clinical severity. Chronic pruritus, sleep disturbance, visible skin lesions, and social stigmatization are well-established contributors to psychological distress in patients with atopic dermatitis [6,7,12,22]. However, psychological responses are influenced not only by disease severity but also by individual coping strategies, illness perception, social support, and treatment experience [22]. Patients with severe disease may have developed adaptive coping mechanisms over years of living with a chronic condition or may receive more intensive medical attention, counseling, and support. In contrast, patients with moderate disease often continue to experience significant symptoms that interfere with daily activities while not necessarily receiving the same level of clinical intervention, potentially contributing to greater perceived burden and emotional distress [20]. Although ongoing treatment and adaptive coping strategies may have influenced the observed findings, these factors were not examined in the present study. Therefore, this interpretation should be regarded as a possible explanation rather than a confirmed mechanism.

Despite these observed trends, no significant associations or correlations were identified between disease severity and skin barrier function, anxiety, stress, or quality of life. Several explanations may account for these findings. First, adult atopic dermatitis is frequently characterized by a chronic relapsing course, during which patients gradually adapt to symptoms and develop psychological resilience. As a result, stress and anxiety levels may not increase proportionally with clinical severity. Second, long-term use of emollients and anti-inflammatory therapies may partially normalize skin barrier measurements, reducing differences in TEWL and hydration across severity categories. Third, psychosocial outcomes are inherently multidimensional and are influenced by factors beyond dermatologic disease, including occupational stress, family responsibilities, socioeconomic status, and underlying personality traits. Consequently, psychological burden may not be determined solely by disease severity.

Methodological considerations should also be acknowledged when interpreting these results. The relatively small sample size may have limited statistical power to detect modest associations. Only two participants had severe atopic dermatitis, limiting meaningful comparisons across disease severity categories and reducing the statistical power to detect differences involving the severe group. In addition, TEWL and hydration measurements represent localized assessments of skin barrier function and may not fully reflect overall disease burden. Variations in lesion location, environmental exposure, and treatment use at the time of assessment may have further contributed to measurement variability. Furthermore, the cross-sectional design precludes evaluation of temporal relationships and does not capture fluctuations in disease activity, barrier function, or psychological status over time. Longitudinal studies incorporating repeated assessments of skin barrier integrity and psychosocial outcomes may provide a more comprehensive understanding of the dynamic interactions among these factors.

Conclusion

Although patients with moderate and severe atopic dermatitis tended to exhibit greater skin barrier dysfunction and psychosocial burden, no statistically significant associations between disease severity and skin barrier function, anxiety, perceived stress or quality of life were identified within this study population. These findings suggest that disease severity alone may not fully reflect the multidimensional impact of atopic dermatitis. Further longitudinal studies with larger and more balanced samples are warranted to clarify the causal relationship between skin barrier dysfunction and psychosocial burden.

Ethics approval

Ethical approval was obtained from the Health Research Ethics Committee, Dr. Zainoel Abidin Hospital, Banda Aceh, Indonesia (Approval number: 221/ETIK_RSUDZA/2025).

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Competing interests

All the authors declare that there are no conflicts of interest.

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Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

Declaration of artificial intelligence use

Artificial intelligence (AI) tool, ChatGPT, was employed in the language refinement (improving grammar, sentence structure, and readability of the manuscript). Authors confirm that all AI-assisted processes were critically reviewed by the authors to ensure the integrity and reliability of the results. The final decisions and interpretations presented in this article were solely made by the authors.

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