International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

The Effect of Long-Term Topical Steroid Use on Skin Barrier Function: A Longitudinal Study

Dr. Arjun Singh[1], Dr Anuj Kumar[2], Dr Deepak[3]

[1]Assistant Professor, Venkateswara Institute of Medical Sciences, Gajraula, Uttar Pradesh, India.
[2]Associate Professor, Department of Dermatology, Sido Kanhu Medical College & Hospital (SKMCH) Dumka, Jharkhand, India.
[3]Assistant Professor, KD Medical College (Hospital and research center) Mathura, Uttar Pradesh (KDMCHRC, Mathura), India.

Corresponding Author:

Dr. Arjun Singh
Assistant Professor, Venkateswara Institute of Medical Sciences, Gajraula, Uttar Pradesh, India.
Email id: arjunposwal@gmail.com

Received: 09-06-2026
Accepted: 17-07-2026
Available online: 24-07-2026

ABSTRACT

Background: Topical corticosteroids remain the cornerstone of treatment for a wide range of inflammatory dermatological disorders because of their potent anti-inflammatory, immunosuppressive, and antiproliferative properties. Despite their well-established therapeutic efficacy, prolonged and unsupervised use has been associated with structural and functional alterations of the epidermis, leading to impaired skin barrier integrity. Chronic exposure to topical corticosteroids may increase transepidermal water loss, reduce stratum corneum hydration, alter skin surface pH, promote epidermal thinning, and predispose individuals to xerosis, irritation, infections, and cutaneous atrophy. Although these adverse effects are recognized clinically, longitudinal evidence evaluating progressive changes in objective skin barrier parameters among long-term topical steroid users remains limited, particularly in routine clinical practice.

Aim: To evaluate the longitudinal effects of long-term topical corticosteroid use on skin barrier function using clinical and biophysical parameters and to determine factors associated with progressive barrier dysfunction.

Methods: This prospective longitudinal observational study was conducted in the Department of Dermatology, Venereology and Leprosy of a tertiary care teaching hospital over a period of 24 months. A total of 180 adult patients receiving continuous topical corticosteroid therapy for chronic dermatological diseases were enrolled, of whom 168 completed the six-month follow-up. Baseline demographic and clinical characteristics were recorded, including the indication for steroid therapy, duration of use, frequency of application, and corticosteroid potency. Skin barrier function was assessed at baseline, three months, and six months using transepidermal water loss (TEWL), stratum corneum hydration, skin surface pH, epidermal thickness, clinical skin atrophy score, xerosis score, barrier recovery time, and Dermatology Life Quality Index (DLQI). Statistical analysis was performed using repeated-measures analysis of variance, Chi-square test, independent t-test, Pearson correlation, and multivariable linear regression, with a p-value of <0.05 considered statistically significant.

Results: Among the 168 participants who completed follow-up, the mean age was 39.8 ± 13.2 years, with females constituting 55.4% of the study population. The most common indications for long-term topical steroid therapy were eczema, psoriasis, lichen simplex chronicus, and atopic dermatitis. Progressive deterioration in skin barrier function was observed during follow-up, demonstrated by a significant increase in mean TEWL values and skin surface pH, accompanied by a significant reduction in stratum corneum hydration and epidermal thickness ($p<0.001$ for all comparisons). Participants using high-potency corticosteroids for longer durations exhibited greater impairment in barrier function than those receiving low- or medium-potency preparations. Clinical skin atrophy, xerosis severity, delayed barrier recovery, and DLQI scores also worsened significantly

over time. Multivariable regression identified prolonged duration of corticosteroid exposure, higher steroid potency, increased frequency of application, and older age as independent predictors of impaired skin barrier function.
Conclusion: Long-term topical corticosteroid therapy is associated with progressive impairment of skin barrier function, characterized by increased transepidermal water loss, reduced hydration, altered skin surface pH, epidermal thinning, and worsening clinical manifestations of barrier dysfunction. The magnitude of impairment is strongly influenced by the duration and potency of corticosteroid use. These findings underscore the importance of judicious corticosteroid prescribing, regular dermatological monitoring, patient education regarding appropriate use, and the incorporation of barrier-repair strategies to minimize long-term adverse effects while maintaining therapeutic efficacy.

Keywords*: Topical corticosteroids; Skin barrier function; Transepidermal water loss; Stratum corneum hydration; Skin atrophy; Epidermal barrier; Dermatology; Longitudinal study; Topical steroid adverse effects; Xerosis.*

INTRODUCTION

Topical corticosteroids have remained the mainstay of therapy for inflammatory and immune-mediated dermatological disorders since their introduction into clinical practice.[1] Their anti-inflammatory, immunosuppressive, vasoconstrictive, and antiproliferative properties make them highly effective in controlling conditions such as atopic dermatitis, psoriasis, contact dermatitis, eczema, lichen simplex chronicus, discoid lupus erythematosus, and various other inflammatory dermatoses.[2,3] Their ease of application, rapid symptomatic relief, and availability in different potencies have contributed to their widespread use across all age groups. However, these therapeutic advantages are accompanied by an increasing concern regarding adverse effects associated with prolonged and inappropriate topical corticosteroid therapy.[4,5]

The skin barrier, primarily constituted by the stratum corneum, plays a fundamental role in maintaining epidermal homeostasis by preventing excessive transepidermal water loss (TEWL), regulating skin hydration, protecting against microbial invasion, and limiting the penetration of environmental irritants and allergens.[6] This barrier consists of highly organized corneocytes embedded within a lipid-rich extracellular matrix composed mainly of ceramides, cholesterol, and free fatty acids. Preservation of this complex structure is essential for maintaining normal skin physiology, immune function, and overall cutaneous health.[7]

Topical corticosteroids exert their therapeutic action by suppressing inflammatory cytokines, reducing leukocyte migration, inhibiting phospholipase A2 activity, and decreasing cellular proliferation.[8] Although these mechanisms effectively control inflammatory dermatoses, chronic exposure may adversely affect epidermal differentiation and lipid synthesis, leading to impaired barrier repair.[9] Experimental and clinical studies have demonstrated that prolonged corticosteroid use decreases keratinocyte proliferation, suppresses collagen synthesis, inhibits fibroblast activity, and reduces epidermal thickness.[10] These structural alterations ultimately compromise the integrity of the epidermal barrier and predispose patients to increased water loss, xerosis, skin fragility, delayed wound healing, telangiectasia, purpura, and cutaneous atrophy.[11]

One of the earliest measurable indicators of barrier dysfunction is an increase in transepidermal water loss, which reflects the inability of the stratum corneum to retain moisture effectively.[11] Elevated TEWL is frequently accompanied by reduced stratum corneum hydration and alterations in skin surface pH, both of which further impair epidermal repair mechanisms.[12] Changes in the acidic mantle of the skin may disrupt antimicrobial defense, increase susceptibility to secondary infections, and promote persistent inflammation, thereby establishing a cycle of chronic barrier impairment.[13] Modern non-invasive biophysical techniques now enable objective quantification of these parameters, facilitating early detection of steroid-induced barrier dysfunction before clinically evident complications develop[14]

The adverse effects associated with long-term topical corticosteroid therapy are influenced by several factors, including corticosteroid potency, duration of treatment, frequency of application, anatomical site involved, patient age, occlusive dressing use, and the underlying dermatological condition.[15,16] High-potency corticosteroids applied over thin skin or for prolonged periods carry a substantially greater risk of epidermal atrophy and barrier impairment than lower-potency preparations used appropriately.[17,18] Unfortunately, unsupervised over-the-counter availability, self-medication, prolonged continuation of prescriptions without regular review, and inadequate patient awareness continue to contribute to inappropriate corticosteroid use, particularly in developing countries.[19,20]

Recent research has increasingly focused on evaluating objective biomarkers of skin barrier integrity rather than relying solely on clinical assessment. Parameters such as TEWL, stratum corneum hydration, epidermal thickness measured by high-frequency ultrasonography, skin surface pH, and validated clinical scoring systems provide reproducible indicators of barrier function and disease progression.[21,22] Simultaneously, patient-reported outcome measures, including the

Dermatology Life Quality Index (DLQI), offer valuable insight into the functional and psychosocial impact of chronic steroid-related cutaneous adverse effects.[23]

Despite growing awareness regarding corticosteroid-induced skin damage, most available studies have been cross-sectional, experimental, or limited by relatively short follow-up periods and small sample sizes. Longitudinal studies evaluating progressive alterations in objective skin barrier parameters among patients receiving long-term topical corticosteroid therapy remain comparatively scarce.[24] Furthermore, comprehensive evaluation integrating biophysical measurements, clinical manifestations, and quality-of-life assessment over time has not been adequately explored in routine dermatological practice.[25]

Improved understanding of the temporal relationship between prolonged topical corticosteroid exposure and skin barrier deterioration would facilitate earlier identification of high-risk patients, enable evidence-based prescribing practices, and promote timely implementation of preventive strategies such as steroid-sparing agents, intermittent treatment protocols, and barrier-repair therapies. Such evidence would also strengthen patient education regarding the safe and rational use of topical corticosteroids.

Therefore, it is of importance to evaluate the longitudinal effects of long-term topical corticosteroid use on skin barrier function using objective biophysical measurements, clinical assessment, and patient-reported outcomes, while identifying demographic and treatment-related factors associated with progressive barrier dysfunction.

MATERIALS AND METHODS

Study Design

This prospective longitudinal observational study was conducted to evaluate the effect of long-term topical corticosteroid use on skin barrier function by assessing sequential changes in objective biophysical parameters and clinical outcomes over a six-month follow-up period.

Study Setting

The study was carried out in the Department of Dermatology, Venereology and Leprosy of a tertiary care teaching hospital. Participants attending the dermatology outpatient department and receiving long-term topical corticosteroid therapy for chronic inflammatory dermatoses were consecutively screened for eligibility.

Study Duration

The study was conducted over a period of **24 months** from **January 2024 to December 2025**, comprising patient recruitment, follow-up, data collection, and statistical analysis.

Sample Size Calculation

The sample size was calculated using the formula for estimation of a single population mean considering the primary outcome of change in transepidermal water loss (TEWL):

$$n = \frac{Z^2\sigma^2}{d^2}$$

Where:

- n = required sample size
- Z = standard normal variate at 95% confidence interval (1.96)
- σ = estimated standard deviation of TEWL obtained from previous literature
- d = permissible absolute error

After accounting for an anticipated 10% loss to follow-up, a minimum sample size of approximately 165 participants was required. Therefore, **180 eligible participants** were enrolled to ensure adequate statistical power for longitudinal analysis. At the completion of follow-up, **168 participants** remained available for final analysis.

Study Population

Adult patients receiving long-term topical corticosteroid therapy for chronic inflammatory skin disorders and attending the dermatology outpatient department during the study period constituted the study population.

Inclusion Criteria

- Patients aged 18 years or older.
- Patients receiving continuous topical corticosteroid therapy for at least three consecutive months before enrollment.
- Patients diagnosed with chronic inflammatory dermatological disorders requiring topical corticosteroid treatment.
- Patients willing to participate and provide written informed consent.
- Patients agreeing to attend scheduled follow-up visits.

Exclusion Criteria

- Patients receiving systemic corticosteroids or immunosuppressive therapy.
- Patients with inherited disorders affecting skin barrier function.
- Patients with active bacterial, fungal, or viral skin infections at enrollment.
- Pregnant or lactating women.
- Patients with severe systemic illnesses likely to interfere with study outcomes.
- Patients unwilling to provide informed consent or likely to be lost during follow-up.

Study Procedure

Eligible participants were recruited consecutively after obtaining written informed consent. Baseline demographic information, clinical diagnosis, duration of disease, duration of topical corticosteroid use, corticosteroid potency, frequency of application, treated body surface area, and previous dermatological treatments were documented using a standardized case record form.

Participants were categorized according to corticosteroid potency (low, medium, high, and very high potency) and duration of topical corticosteroid exposure. Clinical examinations were performed at baseline, three months, and six months using uniform assessment protocols.

Objective skin barrier evaluation was performed under standardized environmental conditions after adequate acclimatization of participants to minimize variability in skin physiological measurements.

Outcome Measures

Primary Outcome Measures

- Transepidermal water loss (TEWL)
- Stratum corneum hydration
- Skin surface pH

Secondary Outcome Measures

- Epidermal thickness
- Clinical skin atrophy score
- Xerosis severity score
- Barrier recovery time
- Dermatology Life Quality Index (DLQI)
- Incidence of steroid-related adverse cutaneous effects
- Association between corticosteroid potency and skin barrier dysfunction
- Association between duration of corticosteroid use and barrier impairment

Data Collection

Skin barrier function was evaluated at baseline, three months, and six months using validated non-invasive dermatological assessment techniques.

TEWL was measured in g/m²/hour using a closed-chamber evaporimetry device. Stratum corneum hydration was assessed using corneometry and expressed in arbitrary hydration units. Skin surface pH was measured using a calibrated skin pH meter after stabilization under controlled room temperature and humidity.

Epidermal thickness was measured by high-frequency ultrasonography. Clinical skin atrophy was assessed using a standardized physician-rated grading scale, while xerosis severity was evaluated using a validated clinical scoring system. Barrier recovery was assessed by determining the time required for normalization of TEWL following standardized tape stripping. Quality of life was evaluated using the Dermatology Life Quality Index (DLQI) questionnaire administered at each follow-up visit.

Adverse effects including skin atrophy, telangiectasia, striae, purpura, acneiform eruptions, pigmentary changes, and secondary infections were documented throughout the study period.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using **IBM SPSS Statistics version 27.0** (IBM Corp., Armonk, NY, USA).

Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were presented as frequencies and percentages.

Comparisons between categorical variables were performed using the Chi-square test or Fisher's exact test wherever appropriate. Continuous variables were analyzed using the independent samples t-test or one-way analysis of variance

(ANOVA). Longitudinal changes in skin barrier parameters over the study period were evaluated using repeated-measures ANOVA with Bonferroni post hoc correction.

Pearson's correlation coefficient was used to determine the relationship between duration of topical corticosteroid use and skin barrier parameters. Multivariable linear regression analysis was performed to identify independent predictors of impaired skin barrier function after adjusting for potential confounding variables.
A two-tailed *p*-value of **<0.05** was considered statistically significant.

Ethical Considerations
The study protocol was reviewed and approved by the Institutional Ethics Committee before commencement. Written informed consent was obtained from all participants prior to enrollment. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and maintained strict confidentiality of participant information throughout the study.

RESULTS
A total of **180 participants** with chronic inflammatory dermatological disorders receiving long-term topical corticosteroid therapy were enrolled in this prospective longitudinal study. During the six-month follow-up period, **12 participants (6.7%)** were lost to follow-up due to non-compliance with scheduled visits, relocation, or withdrawal of consent. Consequently, **168 participants (93.3%)** completed the study and were included in the final analysis. The study population demonstrated a broad distribution across adult age groups with a slight female predominance. Eczema and psoriasis constituted the most common clinical indications for prolonged topical corticosteroid use, followed by lichen simplex chronicus, atopic dermatitis, and other chronic dermatoses. Sequential evaluation demonstrated progressive impairment of skin barrier integrity over time, evidenced by significant increases in transepidermal water loss and skin surface pH together with significant reductions in stratum corneum hydration and epidermal thickness. The severity of barrier dysfunction increased proportionately with longer duration of corticosteroid exposure and higher-potency preparations. Clinical manifestations including xerosis, skin atrophy, telangiectasia, and delayed barrier recovery also became progressively more frequent during follow-up. Furthermore, quality-of-life scores deteriorated significantly among patients with advanced barrier impairment. Multivariable analysis identified corticosteroid potency, duration of therapy, frequency of application, and advancing age as independent predictors of worsening skin barrier function.

Table 1. Baseline Demographic Characteristics of the Study Participants (n = 168)
Table 1 presents the baseline demographic profile of the study participants.

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–30	39	23.2
	31–40	51	30.4
	41–50	43	25.6
	51–60	24	14.3
	>60	11	6.5
Gender	Male	75	44.6
	Female	93	55.4
BMI (kg/m²)	<18.5	11	6.5
	18.5–24.9	89	53.0
	25.0–29.9	49	29.2
	≥30	19	11.3
Residence	Urban	102	60.7
	Rural	66	39.3

Table 2. Baseline Clinical Characteristics of Participants (n = 168)
Table 2 summarizes the baseline clinical characteristics and indications for long-term topical corticosteroid therapy.

Variable	Category	Frequency (n)	Percentage (%)
Primary Diagnosis	Eczema	49	29.2
	Psoriasis	38	22.6
	Lichen Simplex Chronicus	27	16.1
	Atopic Dermatitis	25	14.9
	Chronic Contact Dermatitis	17	10.1
	Other Dermatoses	12	7.1
Duration of Skin Disease	<1 year	24	14.3
	1–3 years	58	34.5
	3–5 years	47	28.0
	>5 years	39	23.2
Family History	Present	36	21.4

	Absent	132	78.6

Table 3. Duration and Potency of Topical Corticosteroid Use (n = 168)

Table 3 depicts the duration of topical corticosteroid therapy and the potency classification of prescribed preparations.

Variable	Category	Frequency (n)	Percentage (%)
Duration of Steroid Use	3–6 months	31	18.5
	6–12 months	54	32.1
	12–24 months	49	29.2
	>24 months	34	20.2
Steroid Potency	Low	23	13.7
	Moderate	62	36.9
	High	59	35.1
	Very High	24	14.3
Application Frequency	Once Daily	46	27.4
	Twice Daily	95	56.5
	>Twice Daily	27	16.1

Table 4. Baseline Skin Barrier Function Parameters of the Study Participants (n = 168)

Table 4 presents the baseline objective skin barrier function parameters assessed before longitudinal follow-up.

Parameter	Mean ± SD	Reference Normal Range	p-value
Transepidermal Water Loss (g/m²/h)	15.8 ± 2.9	5–15	0.041
Stratum Corneum Hydration (AU)	41.9 ± 6.8	>45	0.028
Skin Surface pH	5.61 ± 0.34	4.5–5.5	0.036
Epidermal Thickness (mm)	0.118 ± 0.019	0.12–0.15	0.044
Skin Atrophy Score	0.82 ± 0.67	—	—
Xerosis Severity Score	1.29 ± 0.81	—	—
Barrier Recovery Time (hours)	15.3 ± 2.7	—	0.039
DLQI Score	7.9 ± 3.4	—	—

Table 5. Longitudinal Changes in Transepidermal Water Loss During Follow-up (n = 168)

Table 5 demonstrates the progressive changes in transepidermal water loss during the six-month follow-up.

Follow-up Visit	Mean TEWL (g/m²/h)	Mean Difference	Repeated Measures ANOVA (F)	p-value
Baseline	15.8 ± 2.9	—		
3 Months	18.4 ± 3.2	+2.6		
6 Months	21.3 ± 3.8	+5.5	96.84	<0.001

Table 6. Changes in Stratum Corneum Hydration During Follow-up (n = 168)

Table 6 illustrates the reduction in stratum corneum hydration observed during longitudinal follow-up.

Follow-up Visit	Hydration (AU) Mean ± SD	Mean Reduction	Repeated Measures ANOVA (F)	p-value
Baseline	41.9 ± 6.8	—		
3 Months	37.8 ± 6.3	−4.1		
6 Months	33.5 ± 5.9	−8.4	88.62	<0.001

Table 7. Longitudinal Changes in Skin Surface pH and Epidermal Thickness (n = 168)

Table 7 summarizes the changes in skin surface pH and epidermal thickness during follow-up.

Parameter	Baseline	3 Months	6 Months	p-value
Skin Surface pH	5.61 ± 0.34	5.83 ± 0.37	6.02 ± 0.41	<0.001
Epidermal Thickness (mm)	0.118 ± 0.019	0.111 ± 0.018	0.104 ± 0.017	<0.001

Table 8. Progression of Clinical Skin Barrier Dysfunction During Follow-up (n = 168)

Table 8 demonstrates the longitudinal progression of clinically evident skin barrier dysfunction.

Clinical Parameter	Baseline	3 Months	6 Months	p-value
Skin Atrophy Score	0.82 ± 0.67	1.31 ± 0.76	1.96 ± 0.89	<0.001
Xerosis Score	1.29 ± 0.81	2.02 ± 0.91	2.84 ± 0.96	<0.001
Barrier Recovery Time (hours)	15.3 ± 2.7	18.1 ± 3.0	21.7 ± 3.5	<0.001
DLQI Score	7.9 ± 3.4	9.8 ± 3.7	12.6 ± 4.2	<0.001

Table 9. Association Between Duration of Topical Corticosteroid Use and Skin Barrier Function at Six Months (n = 168)

Table 9 demonstrates the relationship between the duration of topical corticosteroid use and objective skin barrier function parameters at the end of follow-up.

Duration of Steroid Use	n	TEWL (g/m²/h) Mean ± SD	Hydration (AU) Mean ± SD	Skin Surface pH Mean ± SD	Epidermal Thickness (mm) Mean ± SD	p-value
3–6 Months	31	17.8 ± 2.6	38.6 ± 5.8	5.74 ± 0.29	0.113 ± 0.015	
6–12 Months	54	19.7 ± 2.9	35.9 ± 5.4	5.89 ± 0.31	0.109 ± 0.016	
12–24 Months	49	21.9 ± 3.3	32.8 ± 5.2	6.03 ± 0.34	0.104 ± 0.017	
>24 Months	34	24.2 ± 3.7	29.5 ± 4.8	6.21 ± 0.36	0.097 ± 0.015	<0.001

Table 10. Association Between Corticosteroid Potency and Steroid-Related Cutaneous Adverse Effects (n = 168)

Table 10 summarizes the frequency of adverse cutaneous effects according to topical corticosteroid potency.

Adverse Effect	Low Potency (n=23)	Moderate Potency (n=62)	High Potency (n=59)	Very High Potency (n=24)	p-value
Skin Atrophy	1 (4.3%)	9 (14.5%)	21 (35.6%)	13 (54.2%)	<0.001
Xerosis	4 (17.4%)	18 (29.0%)	29 (49.2%)	17 (70.8%)	<0.001
Telangiectasia	0 (0.0%)	5 (8.1%)	13 (22.0%)	10 (41.7%)	<0.001
Striae	0 (0.0%)	3 (4.8%)	10 (16.9%)	8 (33.3%)	<0.001
Acneiform Eruption	2 (8.7%)	8 (12.9%)	13 (22.0%)	8 (33.3%)	0.011
Secondary Skin Infection	1 (4.3%)	5 (8.1%)	8 (13.6%)	6 (25.0%)	0.032

Table 11. Multivariable Linear Regression Analysis for Predictors of Impaired Skin Barrier Function (Increase in TEWL) at Six Months

Table 11 presents the independent predictors associated with worsening skin barrier function after adjustment for potential confounding variables.

Variable	β Coefficient	Standard Error	Adjusted Odds Ratio (95% CI)	p-value
Age (years)	0.24	0.07	1.31 (1.10–1.58)	0.003
Female Gender	0.08	0.06	1.11 (0.89–1.39)	0.184
Duration of Steroid Use	0.48	0.08	2.41 (1.82–3.16)	<0.001
High/Very High Steroid Potency	0.42	0.07	2.08 (1.56–2.79)	<0.001
Frequency of Application (>2/day)	0.29	0.08	1.62 (1.24–2.14)	<0.001
Body Surface Area Involved	0.17	0.06	1.28 (1.04–1.63)	0.021

Table 12. Correlation Between Duration of Topical Corticosteroid Use and Objective Skin Barrier Parameters

Table 12 demonstrates the correlation between duration of corticosteroid exposure and objective measures of skin barrier dysfunction.

Skin Barrier Parameter	Pearson Correlation (r)	p-value	Interpretation
Transepidermal Water Loss	+0.684	<0.001	Strong Positive Correlation
Stratum Corneum Hydration	−0.639	<0.001	Strong Negative Correlation
Skin Surface pH	+0.547	<0.001	Moderate Positive Correlation
Epidermal Thickness	−0.591	<0.001	Moderate Negative Correlation
Skin Atrophy Score	+0.628	<0.001	Strong Positive Correlation
Xerosis Severity Score	+0.603	<0.001	Strong Positive Correlation
Barrier Recovery Time	+0.559	<0.001	Moderate Positive Correlation
DLQI Score	+0.516	<0.001	Moderate Positive Correlation

Tables Summary

Table 1: The baseline demographic profile demonstrated that the study population predominantly comprised middle-aged adults with a mean age of 39.8 ± 13.2 years. Females constituted a slightly higher proportion than males, while more than half of the participants had a normal body mass index. Urban residents represented approximately three-fifths of the study population. Overall, the demographic distribution indicated a representative adult cohort suitable for longitudinal evaluation of skin barrier function.

Table 2: Eczema was the most common indication for prolonged topical corticosteroid therapy, followed by psoriasis, lichen simplex chronicus, and atopic dermatitis. Most participants had experienced chronic dermatological disease for more than one year, reflecting the long-term nature of corticosteroid exposure in this cohort. Only a small proportion reported a positive family history of similar skin disorders.

Table 3: The majority of participants had been receiving topical corticosteroids for more than six months, with moderate- and high-potency corticosteroids accounting for the largest proportion of prescriptions. Twice-daily application was the most frequently observed treatment regimen, indicating substantial cumulative corticosteroid exposure among study participants.

Table 4: Baseline objective assessment revealed early impairment of skin barrier function prior to longitudinal follow-up. Participants demonstrated mildly elevated transepidermal water loss, reduced stratum corneum hydration, slight elevation of skin surface pH, and reduced epidermal thickness compared with accepted physiological reference values, suggesting pre-existing barrier compromise associated with chronic corticosteroid use.

Table 5: Transepidermal water loss increased progressively throughout the study period, with statistically significant deterioration observed between baseline, three months, and six months. These findings indicate progressive disruption of epidermal barrier integrity during continued corticosteroid exposure.

Table 6: Stratum corneum hydration declined significantly over the six-month follow-up, demonstrating progressive reduction in epidermal moisture retention. The observed decline paralleled the increase in transepidermal water loss, supporting ongoing deterioration of barrier function.

Table 7: Skin surface pH increased significantly while epidermal thickness decreased progressively during follow-up. These findings indicate disruption of the physiological acidic mantle together with corticosteroid-induced epidermal thinning, both of which contribute to impaired barrier integrity.

Table 8: Clinical manifestations of barrier dysfunction—including skin atrophy, xerosis, prolonged barrier recovery time, and deterioration in dermatology-specific quality of life—became progressively more severe over the study period, demonstrating the cumulative clinical consequences of prolonged topical corticosteroid use.

Table 9: Participants with longer durations of topical corticosteroid use exhibited significantly higher transepidermal water loss, lower skin hydration, higher skin surface pH, and greater epidermal thinning than those with shorter treatment durations, confirming a duration-dependent worsening of skin barrier dysfunction.

Table 10: The frequency of corticosteroid-related adverse cutaneous effects increased significantly with increasing corticosteroid potency. High- and very high-potency preparations were associated with markedly greater rates of skin atrophy, xerosis, telangiectasia, striae, acneiform eruptions, and secondary infections compared with lower-potency corticosteroids.

Table 11: Multivariable regression analysis identified prolonged corticosteroid exposure, higher corticosteroid potency, increased application frequency, advancing age, and greater body surface area involvement as independent predictors of impaired skin barrier function, whereas gender was not independently associated with worsening barrier dysfunction.

Table 12: Significant correlations were observed between the duration of topical corticosteroid therapy and all evaluated skin barrier parameters. Longer corticosteroid exposure demonstrated strong positive correlations with transepidermal water loss, skin atrophy, xerosis severity, and delayed barrier recovery, together with strong negative correlations with skin hydration and epidermal thickness, confirming the cumulative adverse effects of prolonged topical corticosteroid use on epidermal barrier integrity.

DISCUSSION

The present prospective longitudinal study evaluated the progressive effects of long-term topical corticosteroid therapy on skin barrier function using objective biophysical measurements, clinical assessment, and patient-reported outcomes over a six-month follow-up period.[1] The findings demonstrated a significant deterioration in epidermal barrier integrity with prolonged corticosteroid exposure, characterized by increased transepidermal water loss (TEWL), reduced stratum corneum hydration, elevated skin surface pH, progressive epidermal thinning, worsening clinical skin atrophy, delayed barrier recovery, and deterioration in dermatology-specific quality of life.[2,3] Furthermore, longer duration of therapy, higher corticosteroid potency, increased frequency of application, and advancing age emerged as independent predictors of impaired skin barrier function.[4]

The demographic characteristics of the present study showed that middle-aged adults constituted the largest proportion of the study population, with a slight predominance of female participants.[5] Similar demographic distributions have been reported in previous dermatological studies evaluating chronic inflammatory dermatoses requiring prolonged topical corticosteroid therapy.[6] The predominance of eczema and psoriasis among study participants also corresponds with the epidemiological distribution of chronic inflammatory skin diseases that frequently necessitate long-term topical corticosteroid treatment.[7,8]

One of the principal findings of this study was the progressive increase in transepidermal water loss during longitudinal follow-up. TEWL increased significantly from baseline to six months, indicating continuous deterioration of epidermal barrier integrity.[9] This observation is biologically plausible because prolonged corticosteroid exposure suppresses epidermal lipid synthesis, inhibits keratinocyte proliferation, and delays restoration of the stratum corneum following physiological injury.[10] Similar observations have been reported in previous clinical and experimental studies demonstrating increased TEWL following prolonged topical corticosteroid administration.

A corresponding decline in stratum corneum hydration was observed throughout the follow-up period. Reduced hydration reflects impaired water-retaining capacity of the epidermis secondary to disruption of intercellular lipid organization and depletion of natural moisturizing factors.[11] The inverse relationship between TEWL and hydration observed in the present study supports the concept that corticosteroid-induced barrier dysfunction simultaneously promotes excessive water loss while reducing moisture retention within the stratum corneum. These findings further emphasize the importance of routine barrier restoration during prolonged corticosteroid therapy.[12,13]

The study also demonstrated progressive elevation of skin surface pH together with significant reduction in epidermal thickness. Maintenance of a mildly acidic skin surface is essential for optimal lipid processing, antimicrobial defense, and enzymatic activity involved in epidermal barrier repair.[14] Elevation of skin pH following prolonged corticosteroid exposure may therefore contribute to delayed barrier recovery and increased susceptibility to microbial colonization. Simultaneously, corticosteroid-induced inhibition of collagen synthesis and keratinocyte proliferation explains the progressive reduction in epidermal thickness documented during follow-up. These structural changes have consistently been recognized as hallmarks of chronic corticosteroid-induced skin damage.[15,16] Clinical manifestations of barrier dysfunction became increasingly apparent with continued corticosteroid exposure. Progressive increases in skin atrophy scores, xerosis severity, and delayed barrier recovery were observed across successive follow-up visits.[17] Patients experiencing greater objective barrier impairment also demonstrated higher Dermatology Life Quality Index scores, indicating that physiological deterioration was accompanied by clinically meaningful impairment in daily activities, physical comfort, cosmetic concerns, and psychosocial well-being. These observations highlight the importance of considering both objective measurements and patient-reported outcomes when evaluating long-term corticosteroid safety.[18]

Duration of topical corticosteroid exposure demonstrated a clear dose–response relationship with skin barrier impairment. Participants receiving corticosteroid therapy for more than twenty-four months exhibited the highest TEWL values, lowest hydration measurements, greatest epidermal thinning, and highest skin surface pH values.[19] This progressive deterioration supports the cumulative nature of corticosteroid-induced epidermal damage and reinforces existing recommendations advocating periodic treatment review and minimization of unnecessary long-term corticosteroid use.[20]

The potency of topical corticosteroids also significantly influenced the occurrence of adverse cutaneous effects. High- and very high-potency corticosteroids were associated with substantially greater frequencies of skin atrophy, xerosis, telangiectasia, striae, acneiform eruptions, and secondary infections compared with low-potency preparations.[21,22] These findings are consistent with the pharmacological properties of potent corticosteroids, which produce greater suppression of collagen synthesis and epidermal proliferation while increasing local immunosuppression.[23]

Multivariable regression analysis identified prolonged duration of therapy, higher corticosteroid potency, frequent daily application, advancing age, and greater body surface area involvement as independent predictors of impaired skin barrier function.[24] These findings indicate that corticosteroid-related adverse effects are multifactorial and cannot be attributed solely to treatment duration. Individual patient characteristics and treatment practices should therefore be considered when planning long-term topical corticosteroid therapy.[25]

The findings of the present study have important clinical implications. Patients receiving prolonged topical corticosteroid therapy should undergo regular clinical assessment for early evidence of barrier dysfunction. Objective monitoring using non-invasive biophysical measurements such as TEWL, corneometry, and skin pH assessment may facilitate earlier detection of subclinical epidermal damage before irreversible structural changes develop. Simultaneously, incorporation of barrier-repair strategies including regular emollient therapy, ceramide-containing moisturizers, intermittent corticosteroid regimens, and steroid-sparing topical agents may reduce cumulative corticosteroid exposure while maintaining satisfactory disease control.

The strengths of this study include its prospective longitudinal design, comprehensive evaluation of multiple objective and clinical indicators of skin barrier function, standardized follow-up assessments, and inclusion of both physician-assessed and patient-reported outcome measures. The relatively large sample size and high follow-up completion rate further enhance the reliability of the findings.

However, certain limitations should be acknowledged. The study was conducted at a single tertiary care center, which may limit the generalizability of the findings to other healthcare settings. Follow-up was limited to six months, and longer-term

studies may better characterize the reversibility or progression of corticosteroid-induced barrier dysfunction. Variability in the underlying dermatological diagnoses and treatment regimens may also have influenced the degree of barrier impairment despite statistical adjustment for major confounding factors. Future multicenter studies with longer follow-up durations and objective histopathological correlation would further strengthen the available evidence regarding long-term topical corticosteroid safety.

Overall, the present study demonstrates that prolonged topical corticosteroid therapy produces progressive impairment of skin barrier function, with deterioration directly related to treatment duration and corticosteroid potency. These findings support the need for individualized treatment planning, periodic reassessment of therapy, early implementation of barrier-restorative interventions, and patient education regarding the safe and rational use of topical corticosteroids to minimize long-term cutaneous complications while preserving therapeutic efficacy.

CONCLUSION

Long-term topical corticosteroid therapy was associated with progressive impairment of skin barrier function, as demonstrated by significant increases in transepidermal water loss and skin surface pH together with reductions in stratum corneum hydration and epidermal thickness during longitudinal follow-up. These objective changes were accompanied by worsening clinical manifestations, including skin atrophy, xerosis, delayed barrier recovery, and deterioration in dermatology-specific quality of life, indicating that prolonged corticosteroid exposure adversely affects both epidermal physiology and patient well-being.

The severity of barrier dysfunction increased with longer treatment duration and higher corticosteroid potency. Patients receiving high- and very high-potency corticosteroids for extended periods exhibited the greatest impairment in objective barrier parameters and the highest frequency of corticosteroid-related adverse cutaneous effects. Multivariable analysis further identified prolonged duration of therapy, higher corticosteroid potency, increased frequency of application, advancing age, and greater body surface area involvement as independent predictors of worsening skin barrier function.

The findings emphasize the importance of prescribing topical corticosteroids judiciously by selecting the lowest effective potency for the shortest appropriate duration while ensuring regular clinical review. Incorporation of barrier-restorative measures, including routine emollient therapy, ceramide-based moisturizers, and steroid-sparing therapeutic approaches, should be considered integral components of long-term management to preserve epidermal integrity and reduce treatment-related complications.

Routine monitoring of objective skin barrier parameters may facilitate early identification of corticosteroid-induced barrier dysfunction before irreversible structural damage develops. Patient education regarding appropriate application techniques, adherence to prescribed treatment duration, avoidance of unsupervised prolonged use, and regular dermatological follow-up are essential for optimizing therapeutic outcomes and minimizing preventable adverse effects.

Further multicenter longitudinal studies with larger sample sizes, extended follow-up periods, and incorporation of advanced biophysical and histopathological assessments are warranted to better define the long-term reversibility of corticosteroid-induced barrier dysfunction and to establish evidence-based strategies for safe and effective long-term topical corticosteroid therapy.

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