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Original Article

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Profile of Transepidermal Water Loss in Non-Atopic Dermatitis and Atopic Dermatitis in Indonesian Adults

Damayanti[1,2,3], Sylvia Anggraeni[1,2,3], Menul Ayu Umborowati[1,2], Asmahan Farah Adiba[4], Cita Rosita Sigit Prakoeswa[1,2]

[1]*Department of Dermatology Venereology and Aesthetic, Dr. Soetomo General Academic Hospital, Surabaya – Indonesia*

[2]*Department of Dermatology Venereology and Aesthetic, Faculty of Medicine Universitas Airlangga, Surabaya – Indonesia*

[3]*Universitas Airlangga Academic Hospital, Surabaya – Indonesia*

[4]*Faculty of Medicine Universitas Airlangga, Surabaya – Indonesia*

ABSTRACT

Background: Atopic dermatitis (AD) is a recurrent and chronic inflammatory skin disease affecting the quality of life and productivity of individuals. Several studies have reported the profile of transepidermal water loss (TEWL) in AD patients, however, there is either no data or very limited data on TEWL values in normal skin or in non-atopic individuals. **Purpose:** This study aims to update of the available evidence about TEWL values in healthy (non-AD) adults and AD patients, especially in Indonesia. **Methods:** This analytic study involved 37 non-AD subjects and 37 subjects with AD. TEWL measurements were assessed on the volar side of the left forearm. **Result:** The mean values in the non-AD group were 5.61 ± 3.85, while the mean values in the AD group were 18.07 ± 4.88. There is a significant difference in TEWL values between the groups with non-atopic dermatitis and atopic dermatitis ($p<0.001$). **Conclusion:** TEWL value is significantly higher in AD patients compared to non-AD individuals, indicating a compromised skin barrier function in AD. The consistent results across populations and geographic regions support the utility of TEWS as a reliable measure of AD severity, which can help clinicians customize treatment plans to meet the needs of each patient.

Keywords*:* Atopic dermatitis, non-atopic dermatitis, sensitive skin, TEWL, human and health.

Correspondence*:* Prof. Cita Rosita Sigit Prakoeswa, MD, PhD, Department of Dermatology Venereology and Aesthetic, Faculty of Medicine Universitas Airlangga/Dr. Soetomo General Academic Hospital, Surabaya, Indonesia Prof Dr. Moestopo Number 47, Surabaya, 60286, East Java, Indonesia. Phone: +62-811328199, Email: cita-rosita@fk.unair.ac.id.

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BACKGROUND

Atopic dermatitis (AD) is a recurrent and chronic inflammatory skin diseases that affects the quality of life and productivity of individuals[1,2]. AD which is known as a childhood disease because of its frequent incidence, is also an important health concern among the adult population. The prevalence of AD varies greatly across countries. The prevalence of AD among adults in the United States was 4.9%, while in Japan it was reported at 2.1%[3].

Atopic dermatitis is characterized by a disruption in the skin barrier, which may lead to an increase in *Staphylococcus aureus* colonization. This can exacerbate the severity of eczema and intensify pruritus and dry skin, hich is one of the minor criteria for diagnosing atopic dermatitis based on the Hanifin Rajka criteria[4,5].

Barrier disruption is the important element of AD pathophysiology. To evaluate skin barrier disruption, several methods can be used, such as measuring electrical impedance of the skin, dermoscopy, stratum corneum hydration (SCH), and transepidermal water loss (TEWL)[6,7]. Transepidermal water loss is defined as a quantitative assessment of the skin barrier function by quantifying the amount of water lost through the stratum corneum. TEWL results may vary depending on several factors, such as age, anatomical location, and disruption of the skin barrier, which has been

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associated with inflammatory skin diseases such as atopic dermatitis. Disruption of the skin barrier function increases susceptibility to environmental insults and increases TEWL[8,9]. Increased TEWL values associated with skin barrier impairments, whereas decreased TEWL values indicate optimal skin health[10].

Several studies have reported profiles of TEWL in AD patients, however there is either no data or very limited data on TEWL values in normal skin or in non-atopic dermatitis individuals. In the previous study, it was oberved that the lowest TEWL value in the healthy population was 2.3 (95% CI 1.9-2.7) g/m2/h measured on the breast skin, while highest TEWL value was 44.0 (39.8-48.2) g/m2/h measured on axillary skin[11]. In Indonesia, there has been no report on TEWL values in either healthy population or non-atopic individuals. We conducted this study to compare the baseline TEWL values of non-atopic dermatitis patients with those of atopic dermatitis patients.

METHODS

This analytic study involved 74 subjects, comprising 37 with non atopic dermatitis and 37 with atopic dermatitis. This study took place in the Dermatology, Venereology, and Aesthetic Outpatient Clinic of Dr. Soetomo General Academic Hospital Surabaya from October 2023 to October 2024. The inclusion criteria of this study were both female and male, aged 18 years and above, non-atopic dermatitis and atopic dermatitis individuals, and willing to participate this study by signing an informed consent. The inclusion criteria in the group with atopic dermatitis were patients diagnosed with AD according to the Hanifin-Rajka criteria and had AD lesions on the hands and/or feet, in a state of generally good health, while non-AD group consisted of individuals who had never been diagnosed with atopic dermatitis. We excluded pregnant and breastfeeding women from participation. This study was to assess physiological skin function through transepidermal water loss (TEWL). A TEWL value below 15 g/m^2/h is considered healthy skin[12]. The measurement of TEWL were assessed using GPSkin barrier® on the volar side of the forearm for both groups. In the AD group, measurement was conducted on the lesional skin, while in the control group, it was performed on the healthy skin. Measurement was conducted three times simultaneously on a 5x4 cm skin area on the volar side of the forearm to minimize the potential bias, such as ultraviolet exposure.

Before the starts of the study, a power analysis was conducted to identify the necessary sample size for identifying significant differences between the groups of participants with atopic dermatitis and non atopic dermatitis. Power analysis was conducted utilizing the G*Power program with the subsequent parameters. The significance level (alpha) is established at 0.05, the required power is 0.80, and the estimated effect size (Cohen's d) is 0.58, indicating a modest effect. Two groups were compared: atopic dermatitis and non-atopic dermatitis, each comprising 37 patients.

Power analysis results indicate that to identify mean differences between the two groups, a significance level of 0.05 and a power of 80% necessitate a sample size of 37 subjects per group. The computed noncentrality parameter was 2.51, accompanied by a critical t value of 1.67 at 72 degrees of freedom (df), and a Cohen's d effect size of 0.58, signifying a moderate disparity between the two groups. This study utilized a sample size determined by power analysis to reduce the possible type II error and to guarantee the detection of significant differences between the two groups with enough statistical power.

The data was collected, mean values were calculated, and presented as means ± SD. Statistical analysis was conducted using SPSS version 26.0 with independent t-test in order to determine significance with a p-value. Approval for the study was obtained from the ethical committee of Dr. Soetomo General Academic Hospital Surabaya (No. 296/EC/KEPK/FKUA/ 2023).

RESULT

The study participants were adults with non-atopic dermatitis and with atopic dermatitis; both groups have an equal total number of subjects. In terms of age distribution from Table 1, both groups are mostly aged 20-29 years, with the non-AD group having a higher percentage in the 20-29 age range (51.36%) compared to the AD group (40.54%). Regarding gender, both groups in this study show a predominance of female subjects, with the non-AD group having a higher percentage of females (81.08%) compared to the AD group (72.98%).

Table 1. Subject characteristic

Subject characteristic	Non-Atopic Dermatitis		Atopic Dermatitis	
	n	%	n	%
Age				
20-29	19	51.36	15	40.54
30-39	5	13.51	8	21.62
40-49	8	21.62	8	21.62
50-59	5	13.51	3	8.11
60-69	0	0	3	8.11
Gender				
Male	7	18.92	10	27.02
Female	30	81.08	27	72.98
Total	37	100	37	100

All participants underwent the TEWL assessments. Table 2 shows the mean values in Non-Atopic Dermatitis group were 5.61 ± 3.85, with the lowest level of TEWL in this group 1.00 g/m²/h and the highest level of TEWL being 14.50 g/m²/h. While the mean values in the atopic dermatitis group were 18.07 ± 4.88, with the lowest level of TEWL being 11.60 g/m²/h and the highest level of TEWL being 30.70 g/m²/h. Based on the analysis conducted, it is known that there is a significant difference in TEWL values between the groups with non-atopic dermatitis and atopic dermatitis ($p \leq 0.05$).

Table 2. Comparison of TEWL values between groups

	TEWL	p-value
Non-Atopic Dermatitis		
Mean ± SD	5.61 ± 3.85	
Median	5.00	
Minimum	1.00	
Maximum	14.50	<0.001*
Atopic Dermatitis		
Mean ± SD	18.07 ± 4.88	
Median	17.60	
Minimum	11.60	
Maximum	30.70	

*Significant difference ($p \leq 0.05$)

DISCUSSION

In atopic dermatitis, a disturbance in the skin barrier arises due to irritants that may potentially impact the water balance in the stratum corneum through alterations in lipid components and the amounts of natural moisturizing factors (NMF). This condition may lead to reduced hydration of the stratum corneum and result in dry skin[9]. Dry skin can be evaluated by measuring TEWL levels[13].

Transepidermal Water Loss (TEWL) is considered an important parameter that represents the quantity of water released from the stratum corneum of an area of skin and is typically used as an indicator of the skin's barrier integrity[8, 14, 15]. A compromised skin barrier is indicated by elevated TEWL levels, which can cause increased water loss, dryness, and susceptibility to irritation and infection[16, 17].

It is well known in dermatological research that the actual TEWL values measured in a study are influenced by many known factors such as age, gender, season, geographical region, and unknown factors[18-20]. TEWL is significantly impacted by variations in treatment techniques and the body area where they are applied. Emollients, barrier creams, and corticosteroids are just a few of the treatments demonstrated to lower TEWL by improving the skin's barrier function and decreasing inflammation[21-23]. Compared to regions like the medial brachial area, the skin on the dorsal antebrachial area tends to have a higher TEWL due to their increased exposure to the sun[24]. Anatomical variations in the density of sweat glands and stratum corneum thickness add to the variation in TEWL between various skin locations[6].

This study aims to provide an update on the available evidence about TEWL values in AD and healthy non-AD adults, especially in Indonesian adults. Overall, the updated estimates are similar to those in the previous studies. The results showed that the TEWL in non-AD populations was lower than in AD patients ($p<0.001$). According to a study by Toncic et al.[25], people with AD regularly showed TEWL values that were significantly higher than those of healthy controls ($p<0.0001$). Similar findings were made by Yoshida et al., who discovered that although the non-lesional skin of AD patients also showed higher TEWL than that of healthy individuals, this finding suggested a widespread barrier defect in AD. Ye et al. observed similar trends when they compared the TEWL values of infantile populations with AD. The study found that infants with AD had significantly higher TEWL values than infants without AD[26, 27].

In this study, the mean TEWL value in the nonAD group was 5.61 ± 3.85 g/m²/h. In a study in California, the mean TEWL value in healthy adults ranged from lowest on the thigh at 5.4 ± 2.2 and highest on facial skin at 17.6 ± 4.8 g/m²/h[28]. Meanwhile, a study in Florida looked at forearm TEWL values across gender groups and discovered that females and healthy adults had a mean TEWL of 7.9 ± 1.4 g/m²/h, which was marginally lower than that of male adults[29]. However, environmental conditions influence TEWL, potentially leading to differences in average TEWL values across different countries. [30,31]. Meanwhile, until now, no studies have reported TEWL values in healthy people in Indonesia, so it is hoped that this study can be the basis for future studies.

The mean TEWL value in this study's AD group was 18.07 ± 4.88 g/m²/h. The mean TEWL values varied significantly across the severity spectrum, according to a study conducted in Indonesia, which showed that in children with AD, the TEWL value in the non-lesion and lesion areas was 16.04 ± 5.23 and 22.5 ± 5.37 g/m²/h, respectively (p=0.00011)[32]. Furthermore, a study in Malaysia showed that greater AD severity correlates with higher TEWL (r=0.45, p<0.00) [33]. In Spain, a study by Montero-Vilchez et al. [34] also showed that the more severe the AD, the higher the TEWL values, but not statistically significant (p>0.05). These three studies showed unequivocally that TEWL values rise with the severity of atopic dermatitis, with notable variability attributable to individual skin type variations and environmental exposure. The clinical examination of AD often involves the measurement of TEWL as a parameter to assess skin integrity by reflecting the rate of water evaporation from the skin surface, as higher TEWL levels can lead to dry skin conditions and exacerbate AD symptoms[35]. The consistent results across these heterogeneous populations support the usefulness of TEWL as a trustworthy measure of AD severity, which can help clinicians customize intervention plans to meet the needs of each patient and evaluate the effectiveness of the treatment[32-34].

This study provides valuable insights into the baseline Transepidermal Water Loss (TEWL) values in Indonesian adults with and without Atopic Dermatitis (AD). TEWL is significantly higher in AD patients compared to healthy individuals, indicating a compromised skin barrier function in AD. These results underscore the importance of TEWL as a reliable indicator of skin barrier function and AD severity. The consistency of these findings across populations and geographic regions reinforces the utility of TEWL measurement in clinical practice to assess AD severity and develop treatment strategies. This study contributes to the growing body of evidence supporting the use of TEWL as an objective measure in dermatological research and practice, particularly in the context of AD management. Further research should continue to explore the correlation between TEWL, AD severity, and treatment efficacy, potentially leading to more personalized and effective therapeutic approaches for AD patients. Further research should continue to explore the relationship between TEWL, AD severity, and treatment efficacy, potentially leading to more personalized and effective therapeutic approaches for AD patients.

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