

12-31-2022

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Recommended Citation

Prihadi, Ihsany Arafiasetyanto; Ellistasari, Endra Yustin; and Kusumawardani, Arie (2022) "The Difference In Transepidermal Water Loss (TEWL) Values Between Sun-exposed and Non-sun-exposed Skin Among Male Medical Students," *Journal of General - Procedural Dermatology & Venereology Indonesia*: Vol. 6: Iss. 2, Article 4.

DOI: 10.7454/jdvi.v6i2.1003

Available at: <https://scholarhub.ui.ac.id/jdvi/vol6/iss2/4>

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The difference in transepidermal water loss (TEWL) values between sun-exposed and non-sun-exposed skin among male medical students

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Abstract

Background: Transepidermal Water Loss (TEWL) is the amount of water released from the human body into the atmosphere through a diffusion process per unit of time. Changes in TEWL indicate impaired skin barrier function. Exposure to ultraviolet light for an extended period can cause photoaging, characterized by rough and dry skin (xerosis cutis). TEWL will increase significantly in the skin exposed to ultraviolet radiation. This study aims to determine the difference in the TEWL values among male medical students in the sun-exposed and non-sun-exposed skin areas.

Methods: An analytical observational cross-sectional study was conducted at the Dermatology and Venereology Department of RSUD Dr. Moewardi Surakarta in January-March 2021. Sampling was carried out through consecutive sampling and 25 samples were obtained. TEWL examination was performed on the dorsal area of the forearm and the medial area of the upper arm using the Tewameter[®] TM300. The mean value of TEWL was analyzed using the non-parametric Wilcoxon signed rank test and Spearman's correlation test.

Results: Based on the Wilcoxon signed rank test, there was a significant difference in the value of TEWL ($p = 0.000$). Spearman correlation analysis shows the coefficient value of $r = 0.599$, with $p = 0.002$.

Conclusion: There is a significant difference in TEWL values in the sun-exposed skin area compared to the non-sun-exposed skin area, with a moderate positive correlation.

Keywords: *Barrier system, Non sun-exposed skin, Skin, Sun-exposed skin, Transepidermal water loss*

Background

Photoaging is a condition caused by prolonged exposure to ultraviolet light, which is characterized by hyperpigmentation, deep wrinkles, and rough dry skin (xerosis).^{1,2} Xerosis cutis is a disorder of impaired natural barrier function and/or lack of moisture in the skin, leading to decreased skin hydration.³ Xerosis cutis is a skin disorder in which the skin looks rougher, scaly, wrinkled, and less elastic than normal skin. The prevalence of this dermatosis disorder reaches 50–80% of xerosis cutis in Indonesia. While in several other countries, such as Australia, Brazil, and Turkey, it reached 35-70%.⁴

Transepidermal water loss (TEWL) is the amount of water released from the human body into the atmosphere through the skin processes of diffusion

and evaporation per unit of time. The skin barrier has an important role in limiting the evaporation of water from the human body. When the skin barrier is disturbed, the water retention function will be disrupted, and the amount of evaporated water will also increase. Hence, TEWL can also be used to determine the skin barrier function. In skin with impaired barrier function is impaired, there is an increase in TEWL.⁵ TEWL in humans ranges from 300–400 ml/day; the accuracy of TEWL measurements can be affected by environmental factors (humidity, temperature, ventilation) and intrinsic factors (age, race, anatomical position of skin, skin temperature, sweating, circadian rhythm, and skin health).^{6,7} Sunlight is one of the environmental factors. The rays that reach the earth are ultraviolet A and ultraviolet B (UVA and UVB) rays and are the leading causes of skin damage due to sunlight. In a study by Mizuno, the

value of TEWL increased at one-time exposure to UV light in a minimal erythema dose.⁸ Continued exposure to the sun's UV rays results in a relative impotence of the stratum corneum (SC), disrupting its role as a skin barrier, which relies on intercellular lipids and a hydrolipidic layer on the skin's surface. On the surface of the skin, especially SC, UV rays will result in intercellular lipids changes and abnormal keratinization, leading to water metabolism disorders in the skin.⁹ Water level in human skin (TEWL) decreased significantly in skin exposed to UVB radiation with minimal erythema dose and decreased SC hydration, followed by an increase in melanin index.¹⁰

Skin exposed to a certain dose of sunlight can be measured with the value of transepidermal water loss. Sun-exposed skin can be defined as skin that is exposed to direct sunlight. Based on the description above, this study hypothesizes that there is a difference in the value of transepidermal water loss (TEWL) between sun-exposed and non-sun-exposed skin among male medical students.

Methods

This is an analytic observational study with a cross-sectional approach, conducted at the Dermatology and Venereology Department of RSUD Dr. Moewardi Surakarta. This study was approved by the Health Research Ethics Commission (KEPK) RSUD Dr. Moewardi (9/II/HREC/2021) and the Faculty of Medicine, Sebelas Maret University through a research permit intended for RSUD Dr. Moewardi and the Dermatology and Venereology Department (27/UN27.06/PK.01.06/2021).

The subjects of this study are the medical students at RSUD Dr. Moewardi Surakarta who match the inclusion and exclusion criteria as follows.

1. Inclusion Criteria
 - a. Male
 - b. Medical students at RSUD Dr. Moewardi Surakarta
 - c. Willing to participate as respondents and sign an informed consent
2. Exclusion Criteria

Men with :

 - a. History of skin diseases such as atopic dermatitis, psoriasis vulgaris, pemphigus vulgaris
 - b. History of chronic kidney disease (CKD), diabetes mellitus (DM), or hormonal disorders such as hyperthyroidism/hypothyroidism
 - c. History of using cosmetic moisturizer in the examination area in the last 2 weeks

The sampling technique was consecutive sampling. We obtained 25 samples (based on the paired t-test sample size formula). We tested the hypothesis using the non-parametric Wilcoxon signed rank test. The correlation test was carried out using the Spearman's rank test if the data was not normally distributed.

Results

Characteristics of 25 respondents (Table 1) were obtained through a questionnaire. Forty-eight percent of the subjects were in the range of 20-22 years and 52% were 23-25 years. Two subjects (8%) had history of moisturizer use and one (4%) had a history of skin disease in the form of atopic dermatitis.

Table 1. Subjects' characteristics

Characteristic	N	%
Age (years)		
20-22	12	48%
23-25	13	52%
History of moisturizer use		
Yes	2	8%
No	23	92%
History of skin disease		
Atopic dermatitis	1	4%

N is number of participants included in this study

For each subject, TEWL was measured in two skin areas representing two categories of factors, namely the dorsal antebraial area (sun-exposed skin) and the medial brachial area (non-sun-exposed skin). The TEWL values of each area are expressed in Table 2.

Table 2. Correlation test, difference test, and transepidermal water loss (TEWL) values between sun-exposed and non-sun-exposed skin

Statistic	Sun-Exposed Skin	Non Sun-Exposed Skin
Mean	17,80	9,53
Median	13,40	8,85
Deviation Std.	15,29	7,83
Minimum	5,23	2,86
Maximum	63,87	43,62
Correlation and Different Test		
• Spearman's Rank Test		$r_s = 0,599$ $p = 0,002$
• Wilcoxon Signed Rank Test		$p = 0,000$

TEWL value is expressed in units g/m²/h ($n = 25$).
Deviation Std. : Deviation standard
 r_s : Spearman's rank correlation coefficient
 p : p-value

Table 2 shows that the TEWL values in the sun-exposed skin area are higher than the non-sun-exposed skin area. The increase in TEWL in the sun-exposed skin area can be attributed to a state of xerosis due to excessive sun exposure.⁹

Spearman's rank non-parametric correlation test was calculated to confirm the independence of the two samples and the Wilcoxon signed rank test was performed to test the significance of the difference in TEWL between the two areas.

The difference test with the Wilcoxon signed rank test resulted in a p-value of 0.000. Due to the p-value <0.05, it can be concluded that there is a significant difference in the TEWL value between sun-exposed skin and non-sun-exposed skin.

Discussion

This study is a comparative observational study to empirically prove the difference in TEWL between sun-exposed and non-sun-exposed skin. This test is conducted to determine whether exposure to ultraviolet (UV) light is a risk factor for increasing TEWL. TEWL is one of the parameters of the skin barrier function in limiting the evaporation of water from the human body. An increase in the TEWL value is an indicator of disturbances in these functions.⁵

This study showed that there is a difference in TEWL values between sun-exposed skin and non-sun-exposed skin. The value of TEWL in sun-exposed skin is significantly higher due to frequent UV exposure. Please be cautious not to imply causation in this study as this is a cross-sectional study and not in any way able to prove causation. This finding supports the results of previous studies, including those conducted by Mizuno et al and Hu et al who reported that the mechanism of the effect of UV exposure on increasing TEWL is due to xerosis cutis caused by photoaging.^{8,11} Xerosis cutis is associated with impaired natural barrier function and/or lack of moisture in the skin, leading to decreased skin hydration.³

One of the causes of increased in TEWL is the existence of a xerosis condition due to photoaging, which causes the stratum corneum to undergo structural changes, leading to water metabolism disorders in the skin.⁹

Other influencing factors include many environmental and individual factors, including age, sex, race, anatomical region, skin temperature, and environmental conditions, season, smoking status, measurement technique, and many others.⁶

Rahrovan *et al* reported that among participants younger than 50 years, TEWL was significantly lower in male than in female, regardless of location.¹² This study includes specifically male population amongst medical students.

Regarding epidermal barrier function, it is known that atopic dermatitis patients develop higher TEWL in both damaged and undamaged skin due to skin barrier impairment.¹³ Due to this reason, we excluded atopic dermatitis patients. The screening was conducted using the Hanifin-Rajka criteria and skin prick tests. During follow-up visit, we randomly performed skin prick test on subjects with higher TEWL. We found one (4%) subject with a positive result on the skin prick test. Therefore, we suggest that this finding could be a biological marker for atopic dermatitis in asymptomatic patient, though further studies are needed, as reported by Gupta et al.¹⁴

The Spearman's rank test correlation test conducted in this study showed a moderate positive correlation coefficient ($r_s = 0.599$) This confirmed that the two groups were not independent or in pairs.

It is recommended for everyone, especially Indonesian people who live in areas with high ultraviolet exposure, to prevent their skin from being exposed to excessive ultraviolet. Further studies are needed to create sustainable and comprehensive findings.

The observations show that the variation in the TEWL values is quite high although it is measured from the same area. This variation can be attributed to the characteristics of respondents who vary from residence locations, history of the skin diseases, history of cosmeceutical moisturizer use, and frequency of activities. These factors could result in a significant difference in the TEWL values. As this study's limitation, these factors affecting TEWL values were not included in the study questionnaire.

Conclusion

In this study, there were significant differences in TEWL values in sun-exposed skin and non-sun-exposed skin on male medical students.

Acknowledgements

Acknowledgments are conveyed to the examiner, Suci Widhiati, who has tested, guided, and provided suggestions towards this study and all parties who have assisted in the completion of this study.

Author Contributions

I.P. performed the measurements, E.Y. and A.K. were involved in planning and supervised the work, I.P and A.K processed the experimental data, performed the analysis, E.Y drafted the manuscript and designed the figures. I.P., E.Y., and A.K. participated in the conception, data acquisition, data interpretation, and writing of the study. All authors discussed the results and commented on the manuscript.

Conflict of Interests

No conflict of interests.

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