Study for the age-dependent difference of trans-epidermal water loss (TEWL) response to dry environment in Korean

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Summary

Our skin responds to changes in various environmental conditions to maintain internal homeostasis. Especially, the skin can be affected in big by environmental humidity, low humidity or high humidity. This study was designed to investigate the difference of skin's responding properties to dry environment (low humidity) in young and old skin.

A total of 267 healthy Korea women and men aged between 20 and 57 years participated in the study (20s: 32, 30s: 58, 40s: 101, 50s: 76). The test conditions were adjusted to provide 20±2℃ of temperature and 20±5% of relative humidity(RH) for dry environment. The trans-epidermal water loss (TEWL) was measured on the ventral forearm before exposure and after exposure of 20 min to Low RH. The statistical significance was determined at $p<0.05$.

General TEWL (data of before exposure to low RH) increased by 20s to 50s, and there was significant difference between (20s and 30s) and (40s and 50s) ($p<0.05$). The difference between general TEWL and Low RH TEWL (∆TEWL) decreased by 20s to 50s, and there was significant difference between 30s and 50s ($p<0.05$).

As results, TEWL showed significant increase in their 40s and older and ∆TEWL showed significant decrease in their 50s. This means that young skin (20s and 30s) can show more dynamic response to dry environment (low RH) than 40s and older. And ∆TEWL may be a useful parameter to evaluate the skin's adaptability to dry environment.

Introduction

The skin always responds to changes in the external environment. In this process, the function of the skin is affected by the continuous external environment change. That is, psoriasis or atopic dermatitis may be exacerbated by changes in environmental humidity. A lot of research has been done on these environmental humidity changes and the functions of the skin. A low humidity environment can affect the skin barrier function, and skin exposed to low humidity is relatively more stressed physically compared to skin exposed to high humidity. In addition, when healthy skin is exposed to low humidity (RH<10%) for a long time, the moisture content of the skin decreases and the skin becomes dry. When exposed to a dry environment, TEWL increases and the elasticity of the skin decreases.

Therefore, this study was conducted to study the changes according to age when the skin was exposed to a dry environment, that is, relatively low humidity, in Korean skin.

Materials and methods

Test Subjects

A total of 267 healthy Korea women and men aged between 20 and 57 years participated in the study. Subjects who participated in this study had voluntarily consented to participate in the clinical test. The number of subjects by age who participated in the study was 32 in their 20s, 58 in their 30s, 101 in their 40s, and 76 in their 50s.

Before starting the study, all subjects waited for at least 20 minutes in temperature and humidity (22±2°C, 50±5%).

Experimental environment

Dry environment conditions (low relative humidity; LRH) were adjusted to provide 20±2℃ of temperature and below 20±5% of relative humidity(RH) for dry environment (low relative humidity; LRH) through self-made device.

Instrument measurements and Evaluating Method

The transepidermal water loss (TEWL) was measured with Tewameter (TM 300, Courage & Khazaka Electronic GmbH, Germany). The measurement site is the inner part of the forearm. Measurements were carried out before exposure to a low relative humidity (Low RH) and after exposure to a Low RH for 20 minutes. The evaluation was analyzed by age using the TEWL measurement value in the general relative humidity (General RH), the TEWL measurement value after exposure to the Low RH, and the amount of change in TEWL (ΔTEWL = TEWL in Low RH – TEWL in General RH).

In addition, using the overall average TEWL value in the General RH, the above-average and below-average levels were classified for each age group, and the comparative analysis performed above was performed again.

Statistical analyses

All statistical analyses including mean values and standard deviations were performed with IBM SPSS™ Statistics 26 (IBM, Armonk, NY, USA). Conformity with normal distribution was determined by *Kolmogorov–Smirnov test*. After normality verification was performed, parametric *paired sample t-test*, and nonparametric *Mann–Whitney U-Test* were carried out. A *p-value<0.05* was considered as statistically significant.

Results

Results of Trans-epidermal water loss (TEWL) measurement

Table 1 and Figure 1 show the TEWL measurements according to age. General RH TEWL values showed a tendency to increase with age. In particular, compared to those in their 20s and 30s, the TEWL values in their 40s and 50s are increasing statistically significantly. However, Low RH TEWL does not show changes with age. ΔTEWL shows a tendency to decrease with increasing age. In particular, those in their 30s and 50s showed statistically significant changes. Although the 20's and 50's were not statistically significant (p=0.058), it can be judged that the meaning is a change worth considering.

Table 1. TEWL measurements according to age

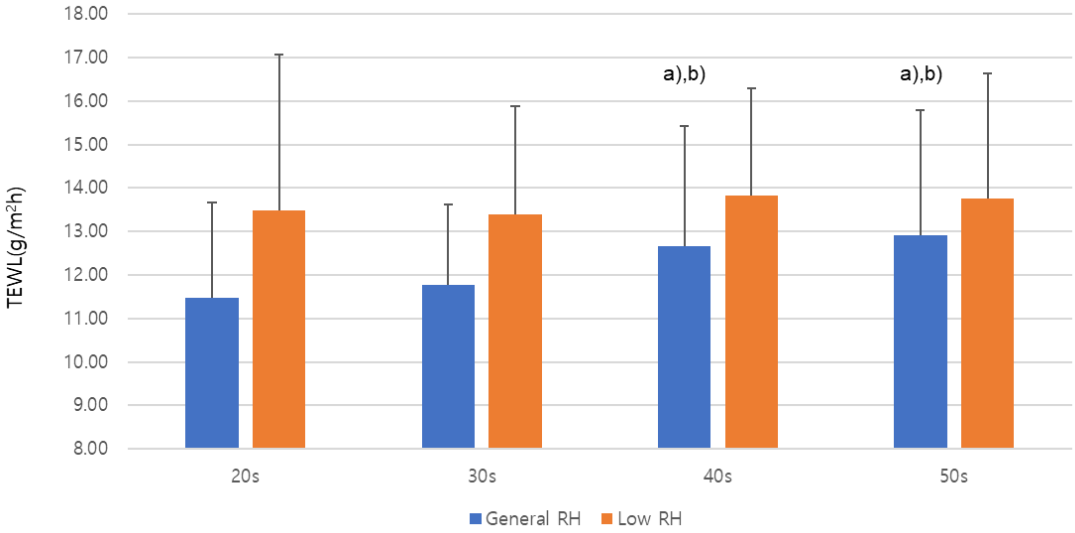
age	General RH (Avg ± std)	Low RH (Avg ± std)	ΔTEWL (Avg ± std)
20's (n=32)	11.48±2.197	13.49±3.592	2.013±2.3720
30's (n=58)	11.78±1.851	13.40±2.477	1.628±1.6513
40's (n=101)	12.66±2.768	13.83±2.472	1.176±2.3086
50's (n=76)	12.92±2.880	13.76±2.867	0.839±2.1677

Avg., Average; Std., Standard deviation

General RH	20's	30's	40's	Low RH	20's	30's	40's	ΔTEWL	20's	30's	40's
20's				20's				20's			
30's	0.468 (2)			30's	0.643 (2)			30's	0.883 (2)		
40's	0.015 (2)	0.035 (2)		40's	0.152 (2)	0.237 (2)		40's	0.133 (2)	0.114 (2)	
50's	0.006 (2)	0.010 (2)	0.581 (2)	50's	0.408 (2)	0.711 (2)	0.742 (2)	50's	0.058 (2)	0.023 (1)	0.425 (2)

(1) *Independent samples t-test* (2) *Mann-Whitney U test*

(a)



(b)

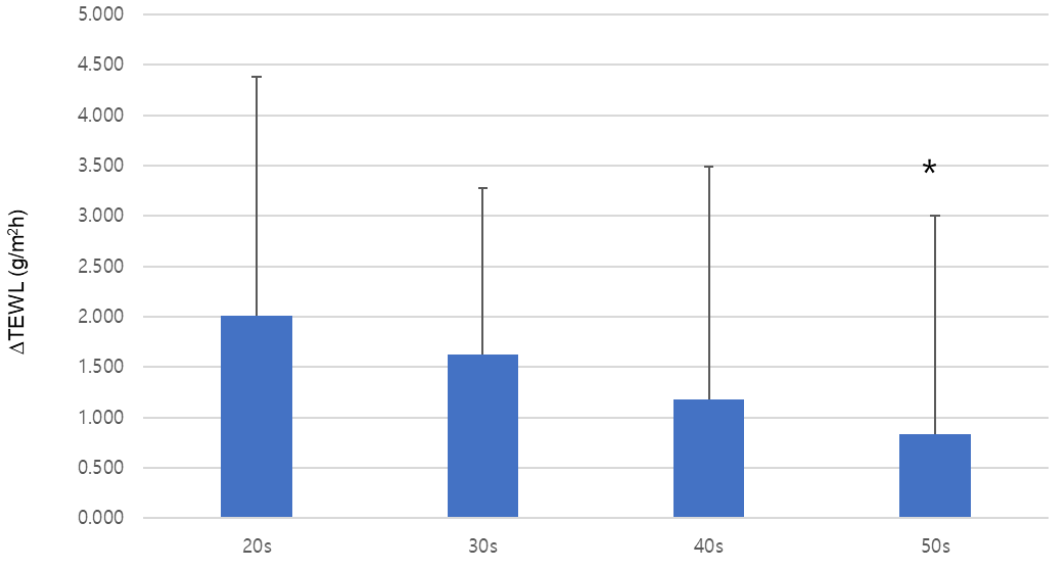


Figure 1. Graph of TEWL measurement results. (a) TEWL measurement according to age. (b) ΔTEWL according to age.

a),b): *Mann-Whitney U test, a) 20s vs 40s, 50s. b) 30s vs 40s, 50s, p<0.05*

*: *independent samples t-test*, *p<0.05*

The mean overall TEWL for 267 subjects at General RH was 12.40 ± 2.61. Based on the overall mean, above the overall average and below the overall average were classified in each age group. By age group, the proportion of subjects above the overall average was 25% in their 20s, 34.5% in their 30s, 53.5% in their 40s, and 51.3% in their 50s, showing a tendency to increase with age (Figure 2).

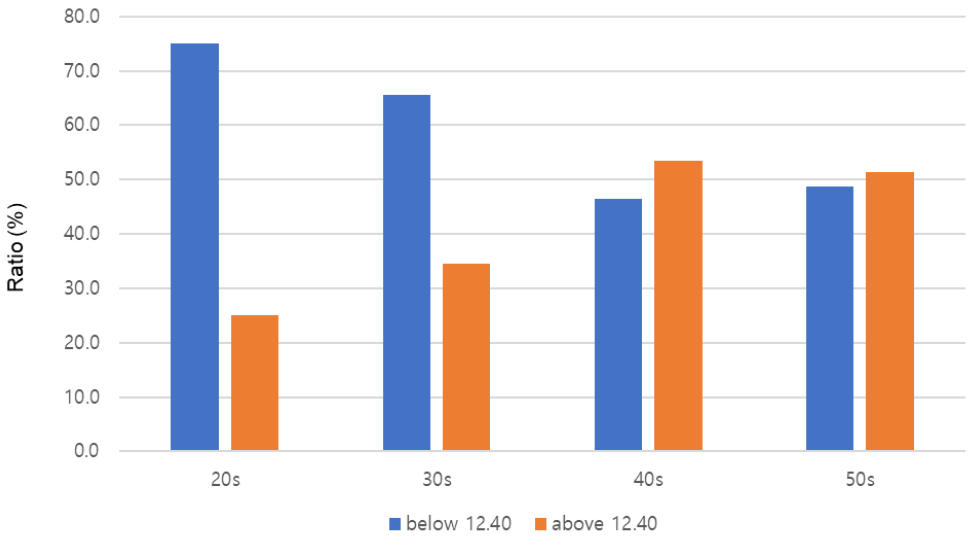


Figure 2. Percentage above and below the overall mean average according to age.

Table 2 and Figure 3 show the TEWL values in the groups classified as above and below the overall mean. Looking at the age-dependent change in the ΔTEWL value, there was significant decreases with age, especially in the group of above average. Both the 40s and 50s decreased to a statistically significant level compared to the 20s and 30s.

Table 2. TEWL measurements in the groups classified as above and below the overall mean.

age	General RH (Avg ± std)		Low RH (Avg ± std)		ΔTEWL (Avg ± std)	
	Below average	**Above average**	**Below average**	**Above average**	**Below average**	**Above average**
20's	10.569±1.3645	14.208±1.9780	12.400±2.9554	16.767±3.4799	1.8306±2.30146	2.5583±2.65693
30's	10.667±1.0026	13.887±1.0814	12.361±1.9869	15.387±2.0981	1.6947±1.60091	1.5000±1.77849
40's	10.430±1.3359	14.594±2.1648	12.437±2.3100	15.046±1.9153	2.0064±2.07820	0.4525±2.27206
50's	10.802±1.4692	14.933±2.4069	12.215±2.3320	15.223±2.5583	1.4135±2.15275	0.2932±2.06306

Avg., Average; Std., Standard deviation

ΔTEWL in below average	**20's**	**30's**	**40's**	**ΔTEWL in above average**	**20's**	**30's**	**40's**
20's				**20's**			
30's	0.598 (2)			**30's**	0.629 (2)		
40's	0.496 (2)	0.450 (1)		**40's**	0.014 (2)	0.032 (2)	
50's	0.550 (2)	0.522 (1)	0.205 (1)	**50's**	0.029 (2)	0.031 (2)	0.879 (2)

(1) *Independent samples t-test* (2) *Mann-Whitney U test*

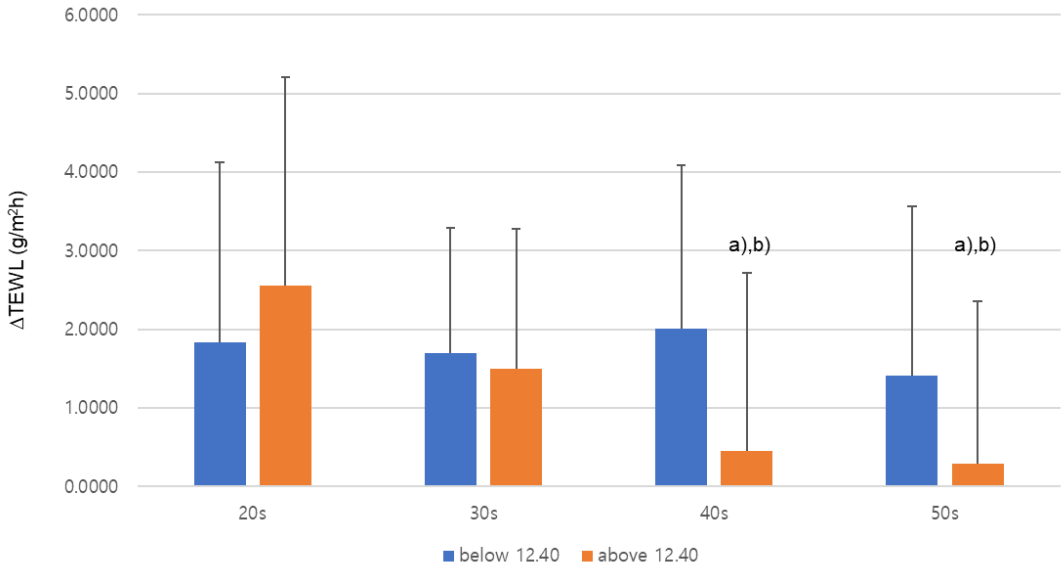


Figure 2. Graph of ΔTEWL according to age in the groups classified as above and below the overall mean.

a),b): *Mann-Whitney U test, a) 20s vs 40s, 50s. b) 30s vs 40s, 50s, p<0.05*

Discussion

As a result of this study, the TELW measured value in General RH showed a tendency to increase with age. In particular, compared with those in their 20s and 30s, they showed a statistically significant change from the 40s (Table 1). In other words, it means that the skin barrier function is declining from the 40s, and it is telling that people should pay attention to the skin barrier function for anti-aging care from the 40s.

In general, the skin evaluation measures the value of the skin characteristic most exposed on the surface, and the evaluation is performed using this value. However, the skin is not in a static state, but always changes in response to the external environment and is doing its best to maintain an optimal state. This study was attempted in consideration of the dynamic activity of the skin. This study was tried to find how the TEWL of the skin responds to changes in the environment according to age. As a result of comparative analysis using ΔTEWL values according to changes in General RH and Low RH, it was known that the ΔTEWL values in the 40s and 50s decreased compared to the 20s and 30s (Table 1). Using the general meaning that young skin has higher skin activity than aged skin, it can be considered that a large ΔTEWL value can mean that the skin's dynamic response against the external environment is that great.

As a result of comparing the number of subjects by age group by classifying above the overall average and below the overall average using the overall average TEWL value, it can be seen that the ratio increases from the 40s (Figure 2). This shows a trend consistent with the previous TEWL change and ΔTEWL value change. In particular, the ΔTEWL value shown in the group above the overall average decreased significantly in those in their 40s and 50s (Table 2, Figure 3). This suggests that the skin in their 40s and 50s does not dynamically respond to external environmental changes.

Also, through this study, ΔTEWL may be a useful parameter to evaluate the skin's adaptability to dry environment.

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