Correlation between various skin biophysical properties and erythemal response to ultraviolet radiation

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Introduction:

Ultraviolet (UV) radiation induces acute and long term damages on human skin, such as sunburn, photocarcinogenesis and photoaging. As an indicator of individual skin response to UV radiation, minimal erythema dose (MED) is commonly used [1]. MED is defined as the lowest erythemal effective radiant dose that produces the first perceptible unambiguous erythema with defined borders appearing over more than 50% of exposure subsite, 16 h to 24 h after UV exposure. MED has been known to be affected by various factors including Fitzpatrick skin types, skin color, pigmentation, anatomical body sites, and so on. A number of studies found that individuals with the lower skin type and with the lighter skin color showed the lower MED, indicating the higher sensitivity to UV radiation [2]. However, studies on the relation between skin biophysical properties and erythemal response to UV radiation remain rare. Therefore, the aim of this study was to investigate various skin biophysical properties determining individual skin sensitivity to UV radiation.

Materials & Methods:

As an indicator of skin sensitivity to UV radiation, MED testing was conducted on 53 healthy Korean females (41.5 ± 5.2 years). Procedures of UV exposure and MED assessment were followed as described in the ISO 24444: 2019. MED of back, dorsal forearm, and ventral forearm skin of each subject were compared. Regarding the skin biophysical properties, skin hydration, trans epidermal water loss (TEWL), skin color, and pigmentation were measured on the same anatomical sites of MED assessment. Further variation of skin hydration and barrier disruption was conducted by additional application of moisturizer and slight removal of stratum corneum by tape stripping, respectively. SPSS Statistics 24.0 (SPSS Inc., Chicago, USA) was used for statistical analysis.

Results & Discussion:

We identified the statistically significant correlations between the quantitative skin properties with MED, as shown in Table 1. A significant negative correlation was found between TEWL, L* value, ITA˚ value and MED of back sites. Melanin content and b* value positively correlated with MED. Artificial alteration of skin conditions also showed the changed erythemal response to UV radiation as well. As represented in figure 1, MED showed an increasing trend in skin hydration condition. When skin barrier was slightly disrupted, MED significantly decreased. It is supposed that the altered penetration of UV radiation into the stratum corneum with respective skin conditions, caused different erythema reaction. Regarding the different body sites, forearm skin had significantly higher MED than back region. As shown in figure 2, average MED of back was 29.0 mJ/cm2, and that of dorsal forearm and ventral forearm was 40.0 and 31.3 mJ/cm2, respectively.

Table 1. Pearson's correlation coefficient between the skin biophysical properties and MED of back sites (* p<0.05; ** p<0.01)

Pearson's coefficient	TEWL	L*	a*	b*	ITA˚	Melanin index	Skin hydration
MED	-0.320*	-0.491**	0.251	0.404**	-0.511**	0.566**	0.137

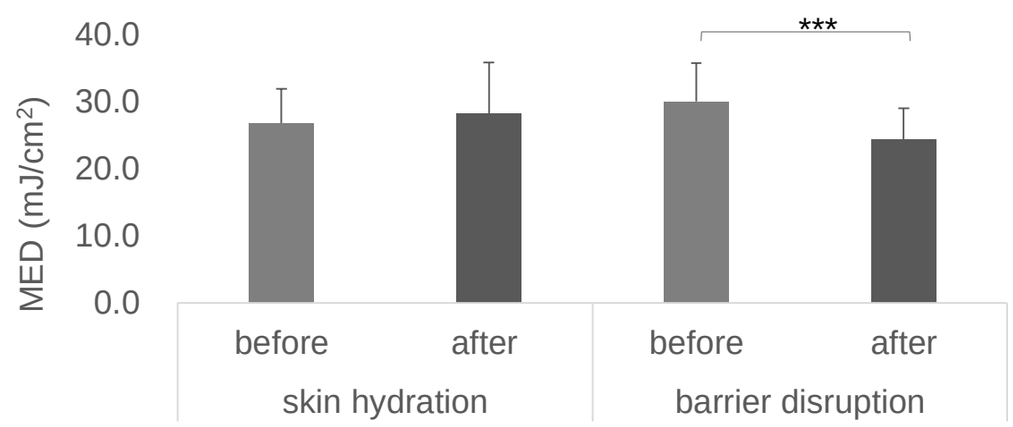

Figure 1. MED results in altered condition of skin hydration and barrier function (*** p<0.001)

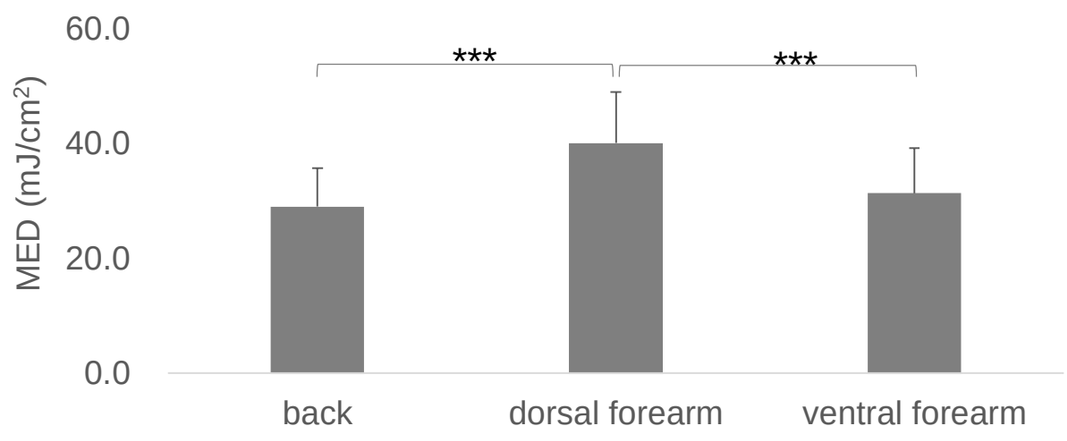

Figure 2. Comparison of MED among different body sites (*** p<0.001)

Conclusions:

Results of MED at different body sites demonstrated that the site variation is as important as the inter- individual variation. We also found out skin biophysical properties have significant effects on the skin sensitivity to UV radiation. It is meaningful as this could be a predictor of individual proneness to UV damages. Based on the results, skincare products that help the skin conditions associated with the skin UV sensitivity, as well as sunscreen are important for protection against the hazards of UV radiation. Furthermore, we suggest the personalized solution for UV protection is needed according to the individual skin properties.

References:

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2. TAN, Yimei, et al (2020) Identification of factors associated with minimal erythema dose variations in a large-scale population study of 22146 subjects. Journal of the European Academy of Dermatology and Venereology 34.7: 1595–1600