Experimental Studies of Meteorological Influences on Skin Moisture in Warm Seasons

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Keywords: facial skin surface, skin surface moisture, statistical analysis

Purpose of Study

The skin condition is thought to be controlled by the external environments such as weather conditions and others it is researched from the various viewpoint. The clarification of relationship between the weather and skin conditions could be the fundamental data for remedy of some skin diseases, and most of researching reports about them are concerning skin moisture which has severe influences on appearance.

Lately, many weather companies pay attention to the relationship between skin and weather so that they make efforts to forecast Dry Skin Information. Dry Skin Information is computed from minimum and maximum temperature as dry index. It is obviously understood that when dry condition continues several days the skin moisture is more decreased and the skin condition becomes worse comparing with the case of only one day dryness. Then we think that not only concerned day but past weather conditions should be considered in order to assess the skin condition accurately. In this study, therefore, we purpose to make clear how the skin is effected by meteorological elements and life history under natural condition.

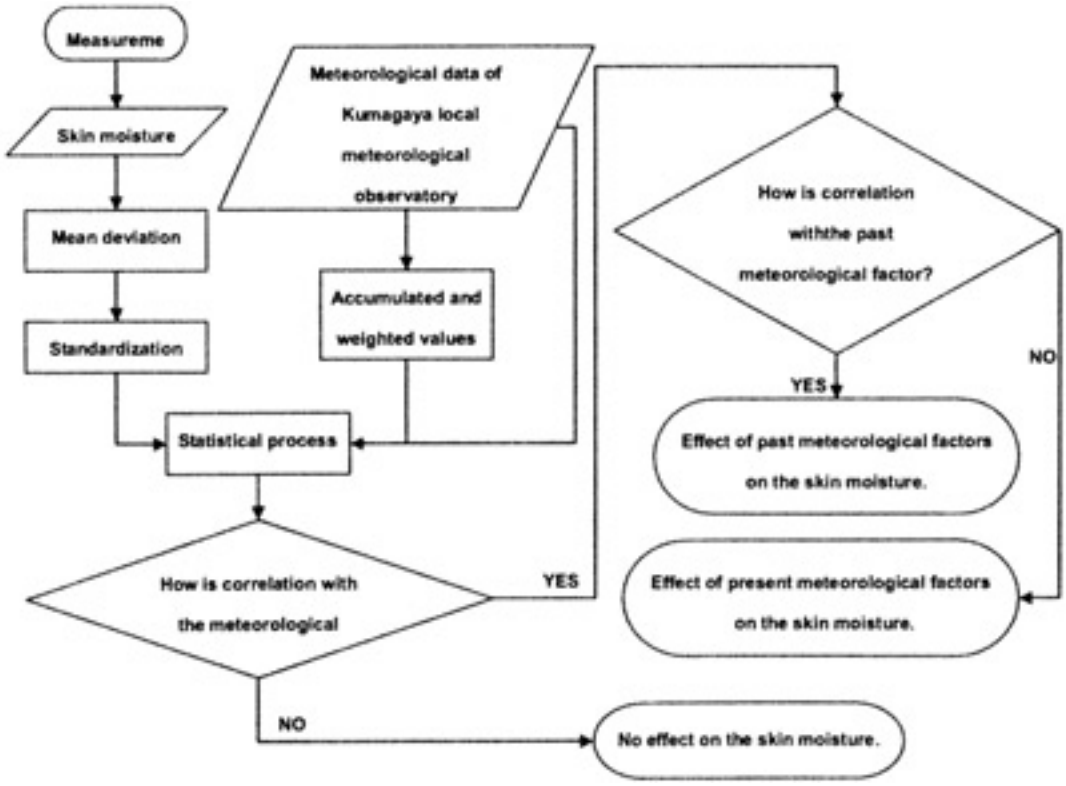

Fig.1 Flow Chart of Study

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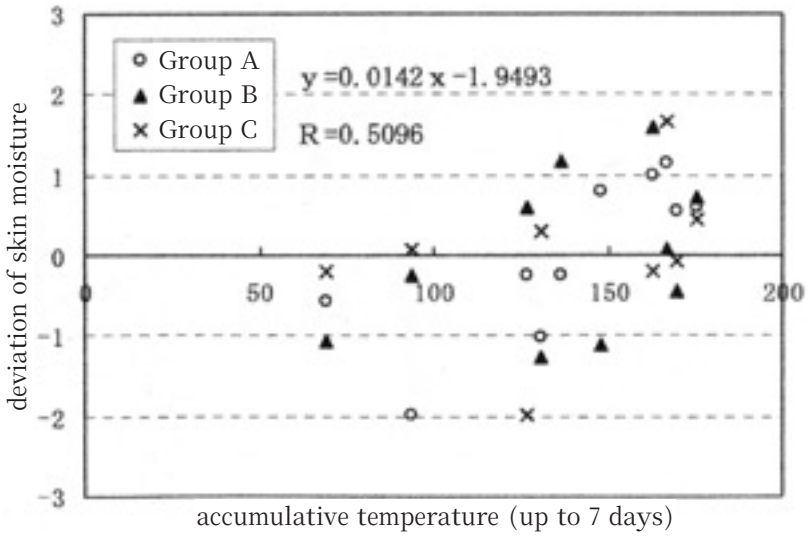

Fig.2 Relationship between accumulative temperature (up to 7 days) and deviation of skin moisture

Study Methods

The examinees in this study are twelve healthy female students of Rissho University who are between 20 and 22 years old. Measurements are carried on at air-conditioned laboratory of Rissho University in Kumagaya City, Saitama during April 6 to July 9, 2007.

Skin moisture is measured by Derma Unit SSC3 (Cornemeter CM825, Courage+Khazaka Co,), Forehead and cheek are selected as measuring points. On those points, moisture is measured 2 times per 2 points to get average from 4 values. Those averages are compared with meteorological elements at Kumagaya Meteorological Observatory, where water vapor pressure (E_t) is not observed. We calculate Et from Tetens's formula as follows;

$$E_t = 6.11 \times 10^{f(t)} \quad \cdots\cdots (1)$$

where E_t means saturation water vapor pressure at temperature t(℃) and f(t) = 7.5t/(t+237).

In order to weight the past life-history, we computed the accumulative values of those meteorological elements, which are obtained for two days from previous day to 7 days from a week ago.

7 examinees of 12 are living in Kumagaya City, of which 3 examinees have no make-up. Therefore, all examinees are classified into three groups; make-up examinees in Kumagaya, no make-up ones in Kumagaya and examinees outside of Kumagaya when the relationship between weather and skin conditions are analyzed statistically. Examinees are divided into three groups; four examinees with make-up living in Kumagaya (Group A), three examinees without make-up living in Kumagaya (Group B) and five examinees with make-up living outside in Kumagaya (Group C).

Results of Study

Air tempereature

The correlation coefficients between the skin and air temperature are generally low and at most 0.15, which are not significant, especially in the case of the examinees outside of Kumagaya. But as the rough trend it is shown that the air temperature is higher the deviation of skin moisture becomes larger. On the other hand, in the case of the examinees inside of Kumagaya, the correlation coefficients indicated somewhat higher positive values, of which the indoor temperature showed the highest positive correlation coefficient 0.31. The mean air temperature and accumulative temperature (up to 7 days) are following and significant ($p<0.05$).

Especially, the skin moisture of no make-up group is highly correlated with the accumulative and mean air temperature, whose correlation coefficients are more than 0.50 and significant in $p<0.01$ (See Fig.2).

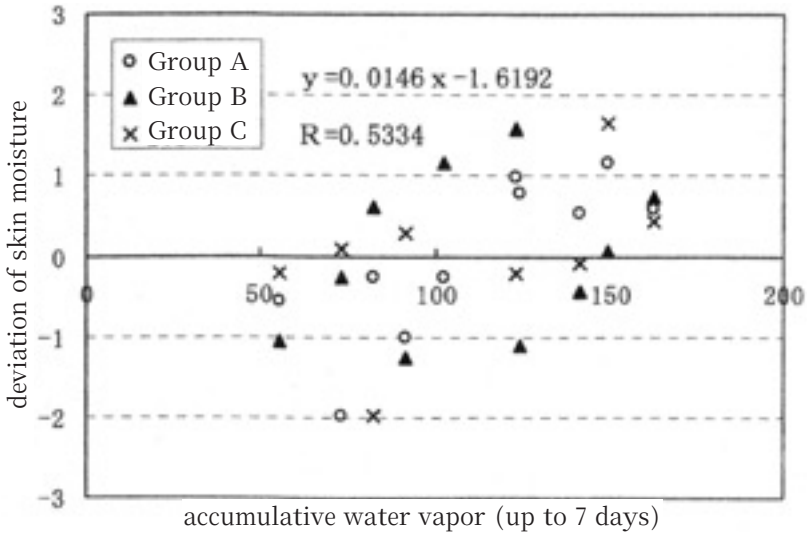

Fig.3 Relationship between accumulative water vapor (up to 7 days) and deviation of skin moisture

Humidity and Water Vapor Pressure

In the case of no make-up examinees the skin moisture has positive correlation coefficients more than 0.3 with minimum and accumulative humidity (6-7days), while in the case of the other groups the correlation coefficients are less than 0.1.

There could be found the positive correlation coefficients in the examinees outside of Kumagaya City, that is, the water vapor pressure is higher, the deviation of skin moisture is higher. As for the no make-up examinees in Kumagaya City, the correlation coefficient is highest and significant on all factors.

In conclusion, Kumagaya examinees indicate the highest correlation coefficient with increasing accumulative days. The case of seven days' accumulated water vapor pressure is expressed in Fig.3.

Discussion

1. Air Temperature

The fact that the correlation coefficient between air temperature and skin moisture is positive means that the perspiration increases with air temperature. The water absorption capacity of stratum corneum relating with morphological or functional abnormity, such as skin disease, does not change all the year round and is higher in summer and winter in the case of face surface. Therefore, the moisture variation occurs due to water supplement or dryness inside body or outside body. Since the water supplement inside body is not available, the skin moisture may be greatly affected by perspiration and dry atmosphere.

Perspiration is mainly affected by air temperature. It is reported that when ambient temperature is over 22℃ the invisible perspiration occurs and the stratum corneum moisture increases. Since the higher temperature brings about visible perspiration it is thought that perspiration increases and deviation of skin moisture results to be higher. As Fig.2 shows, the skin moisture is positively proportional to the accumulative temperature especially above 140 (℃・day). This degree 140 (℃・day) could be calculated into 20 per a day , which is roughly equal to the critical temperature when perspiration occurs. This result coincides with the studies by Tagami (2005) and Yoshikuni (1983).

2. Humidity and Water Vapor Pressure

Even if the humidity is same, the moisture including in the air differs under the different temperature. Therefore, the relative humidity can not express the moisture in the air, which makes the correlation coefficients smaller. In short, the water vapor pressure shuld be used for taking account of the reloationship between air moisture and stratum corneum moisture.

It is also concluded that two factors bring about positive correlation coefficient between skin moisture and water vapor pressure as same as air temperature.

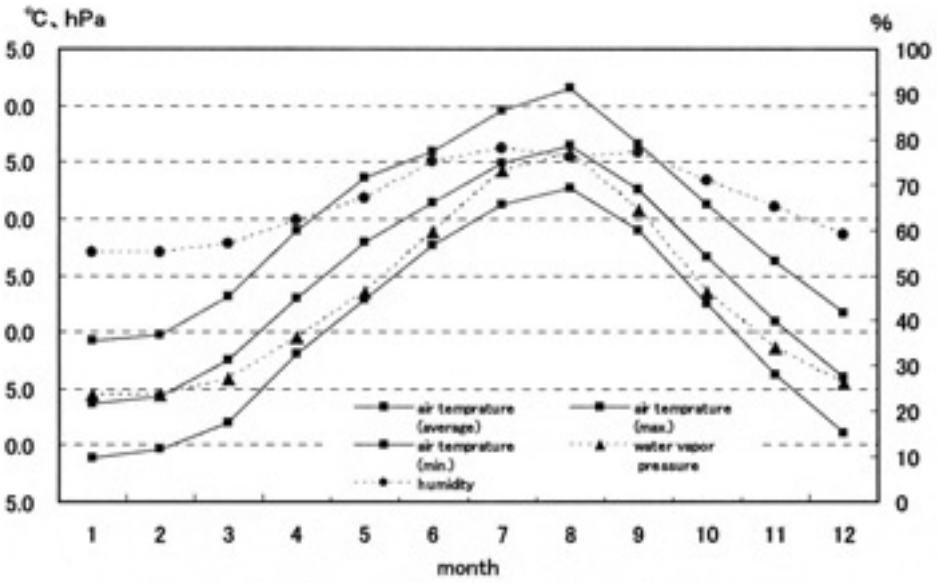

Fig.4 Seasonal change of water vapor pressure, humidity and air temperatures

One is the facts that Kumagaya has regular seasonal change weather, and that from spring to summer both of water vapor pressure and air temperature are increasing as shown in Fig.4. Second one is the effect of water vapor pressure. According to Sasaki (1982), evaporation by the perspiration is proportional to the difference of saturation water vapor pressure in skin temperature and water vapor pressure in ambient air. If the evaporation process on skin surface is almost same to that on earth, the evaporation may be calculated by the formula as follows.

$$E = {}_{\rho}C_E U (q_S - q) \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (2)$$

E: evaporation, $_{\rho}$;air density, C_E; latent heat transport coefficient, U; wind velocity,
q_S; saturation specific humidity, q: specific humidity

3. Effects of Regional Condition and Life-stile

We could conclude that relation of skin moisture and weather condition depends upon geographical conditions, that is, examinees are inside or outside of Kumagaya City. In this study, the past life-style means that the examinees could be influenced by the air condition in bus or electric car and that some of examinees powder her face while the other does not. It could be considered that powder makes her face little influences by weather conditions.

References

Denda,M. (2005): "Skin thinks", Iwanami Co. Japan.
Kagami,M. (1991): "Human-body guessed by weather", Kodansya Co.Tokyo, Japan.
Sasaki,T. (1982); "Health and weather", Asakura Co. Tokyo, Japan.
Tagami,H. (1999); "Medical science of skin", Tyuukoushinsyo, Japan.
Tamura,T. (2000); "Clothing hygienic", Bunkasyuppan, Japan.
Tanaka,M. (1996); "The relation of human and water", Rikoutosyo, Japan.
Yoshino,M. & Fukuoka,Y. (2002); "Med-weather forecast", Kodansya Co. Japan.

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