

Study of Moisture Content on Various Skin Sites in Different Seasons in Indian Population

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Abstract

Background and Aim: Skin moisture reflects the health and good functionality of the skin, so analysis of variation in skin moisture in baseline individuals may be useful. Results and interpretations of this kind of studies may be useful for the management of common cutaneous disorders associated with decreased skin surface moisture and in the field of cosmetology. Therefore, in the present study, we aimed to measure the variations in skin moisture level with regard to different seasons and skin sites in both genders of healthy Indian volunteers. **Methods:** Study was conducted on 600 (100 in each season) healthy Indian volunteers of age between 5 and 75 years. Skin moisture level was measured on the forehead, right ocular region, right cheek, right arm, and right palm by digital moisture monitor instrument from skin care company. The measurements were performed for one particular day of different seasons. All readings were measured in percentage. On the day of study, all individuals were placed in controlled environment. **Results:** Moisture level was found to be decreased in aging skin. Results varied with sites showing higher moisture in the right palm and lowest in the ocular region. Males were hydrated better than females, and temporal variation without uniform pattern was seen. Most differences were small and insignificant. **Conclusion:** Variation in moisture content will be helpful in quantitative evaluation of absorption, and action of various topical drugs and vehicles in normal individuals. It is also helpful in the field of cosmetology and developing new skin care product which may normalize skin physiology in diseased state.

Keywords: Gender, season, site, skin moisture

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INTRODUCTION

The skin is the largest organ of the body. Stratum corneum and the insoluble lipid envelope formed by corneocytes act as a natural moisturizer and physical barrier against mechanical and chemical stress as well as microbial invasion mainly by its water retention property.^[1] Changes in this physiological cutaneous barrier have been associated with various cutaneous pathologies such as psoriasis and other dermatitis. Skin moisture level has a pivot role in thermoregulation which in turn is regulated by cutaneous blood flow.^[2] Cutaneous hydration content depends on water-binding glycosaminoglycans such as hyaluronic acid and evaporation rates which reflect the skin moisture content.

Skin moisture level is varied by multiple factors such as age, gender, body sites, ethnicity, geographical distribution, seasons, diurnal variation, temperature, and humidity. Thus, noninvasive *in vivo* measurement of skin moisture level helps in determining health and good functionality of the skin.

The aim of the study is to assess the moisture level in normal Indian skin with standardized experimental conditions in different seasons.

MATERIALS AND METHODS

After receiving approval from Institutional Review Board, this study was conducted in outpatient clinic at Department of Dermatology in six subsequent seasons in 2016. A total of 600 healthy individuals of both sexes of age group between 5 and 75 years were randomly enrolled in the study. We excluded participants with systemic diseases and generalized skin involvement disorders such as psoriasis, leprosy,

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atopic dermatitis and localized disorders affecting sites of measurement, and individuals who had applied moisturizer on the sites of measurement and pregnant females. The skin surface moisture was evaluated on five predecided sites such as forehead (S1), right side of ocular region (S2), cheek (S3), arm (S4), and palm (S5) in six consecutive seasons – spring, prewinter, winter, summer, monsoon, and autumn using digital moisture meter (Skin Care Company, Australia). This instrument uses bioelectric impedance as the principle to calculate cutaneous moisture levels.

The measurements were performed on one particular day of 1st week of six seasons as unlike other countries Indian subcontinent has 6 seasons. All readings and values were measured in percentage.

On the day of the study after obtaining written and informed consent, all individuals were placed in controlled environment for 30 min, and the room temperature was measured. After the individuals are stabilized, measurements were taken from the above-mentioned body sites.

Statistical analysis of data

All statistical calculations were done using GRAPHPAD INSTAT 3.0 software (California USA). Nonparametric tests were applied as the collected data were in nonGaussian distribution. Kruskal–Wallis test with posttest was used for multiple comparisons between values from different sites. $P < 0.05$ was considered statistically significant.

RESULTS

We evaluated skin moisture level in 600 healthy controls including 358 males and 242 females on the forehead, right ocular region, right cheek, right arm, and right palm in six consecutive seasons. We have divided the age group into four classes – childhood and adolescent age Group 1 (5–20 years), adult Group 2 (21–40 years), middle age Group 3 (41–60 years), and older age Group 4 (61–75 years).

Table 1 represents baseline demographic data of different study groups including 600 volunteers in different seasons in Indian continent.

Moisture level in different age groups on five body sites in both genders in all six seasons is described in Tables 2 and 3.

Age-wise distribution of skin moisture revealed better hydration in age Groups 1, 2, and 3 compared to older age group. Trends of maximum skin moisture were variable with sites and seasons for all age groups except elderly. This pattern was same in both the genders.

In males, average skin moisture of all six seasons was highest on palms in adults and middle age groups whereas it was highest on arms in young and older age groups. In females, average skin moisture was maximum on palm in all four age groups in all six seasons [Tables 2 and 3]. Table 4 shows the distribution of skin moisture in males compared to females across six seasons in five body sites. Overall, males had higher

Table 1: Baseline demographic data of different study groups in different seasons

	Number of individuals	Male	Female
March	100	53	47
May	100	52	48
July	100	50	50
September	100	48	52
November	100	57	43
January	100	49	51

skin moisture level than females which was significant in the forehead, right ocular region, and right cheek particularly in January, July, and September.

The month of May showed comparatively higher moisture content for all sites except in the right palm which showed maximum moisture in March. July season showed lower moisture content for all sites except in the right arm which showed minimum moisture in September. Thus, overall comparison of six seasons showed interseasonal difference in skin moisture content, but only a few of them were statistically significant [Table 4].

Considering the various body sites, in males, the right arm was the most hydrated in the extremes of age Groups (1 and 4) while palm was the most hydrated in adulthood and middle age group. Ocular and cheek regions demonstrated lower average hydration. Among females, maximum moisture was measured on palms followed by arms in all age groups. Whereas minimum moisture level was observed on cheeks in all regions in all age groups except in younger age group, where ocular region exhibited the least hydration [Tables 2 and 3].

DISCUSSION

Skin moisture reflects the hydration level in the upper dermis which is responsible for normal youthfulness of the skin. Healthy skin barrier retains the adequate moisture content by preventing excess transepidermal water loss. However, this barrier is disturbed in certain cutaneous abnormalities such as atopic dermatitis, leprosy, psoriasis, ichthyosis, and few systemic conditions such as postmenopause, psychological stress, malnutrition, and hemodialysis patient. Understanding the moisture level of skin in different age groups on different sites in various seasons helps facilitate proper approach to the management of skin diseases. However, it is known that environmental exposure, individual habits, and several extrinsic and intrinsic factors can modify the skin biophysical parameters including the hydration level.^[1-4]

In our study, moisture level in old age group was significantly lower compared to younger and middle age group suggesting that moisturizers are required in old age group. Marrakchi and Maibach reported that the oldest individuals had the least hydrated skin.^[5] This may be due to decrease in the amount of hyaluronic acid with age which impairs the barrier function

Table 2: Moisture level in different age groups on five body sites in males in all six seasons

Age group (year)	January (A)	March (B)	May (C)	July (D)	September (E)	November (F)
5-20						
S1	23.35 (4.66)	32.77 (19.5)	32.02 (19.5)	36.41 (22.9)	40 (28.2)	23.71 (5.4)
S2	24.8 (6.9)	23.4 (9.9)	30.6 (8.8)	42.2 (16.6)	40.7 (27.2)	25.4 (4.8)
S3	22.1 (2.4)	27.5 (9.1)	28.9 (7.2)	35.9 (16.4)	43 (24)	23.2 (5.4)
S4	24.9 (5.3)	25.1 (3.5)	43.1 (14.7)	60.2 (22.3)	43.6 (30.6)	24.2 (6.9)
S5	29.8 (14.7)	44.27 (28.1)	32.3 (20.7)	35.5 (19.4)	21.5 (2.1)	28.12 (14.3)
21-40						
S1	22.2 (4.1)	33.6 (12.8)	29.9 (6.5)	32.2 (17.5)	26.4 (7.9)	25.7 (10.6)
S2	28.7 (9.6)	24.1 (5.9)	32.8 (10)	32 (21.9)	26.2 (7.6)	24.9 (7.5)
S3	26.4 (6.5)	30.3 (7.8)	29.1 (6.3)	33.3 (2.3)	26.2 (9.6)	26.0 (8.2)
S4	25.7 (5.9)	28.3 (8.4)	43.8 (19.9)	34.3 (19)	27.8 (16.5)	26.8 (12.6)
S5	27.7 (12.9)	51.2 (27.2)	35.3 (17.1)	33.1 (22.8)	31.2 (14.3)	27.8 (12.7)
41-60						
S1	25 (7.6)	35.8 (19.3)	30.8 (6.4)	28.1 (16.8)	27.9 (14.3)	22.6 (3.9)
S2	26.3 (7.6)	23.4 (4)	36.7 (12.8)	35.3 (20.2)	30 (13.6)	24.7 (5.1)
S3	22.7 (3.8)	25.7 (5.3)	27.9 (4.7)	33.5 (17.1)	27.5 (13.5)	23.5 (5.3)
S4	26.4 (5.1)	30.3 (7.9)	45.3 (15.7)	44.5 (22.2)	28.9 (14.6)	23.5 (4.1)
S5	25.8 (8.6)	57 (27.8)	37.7 (20.3)	39.5 (23.5)	32 (14.5)	25.6 (8.3)
>60						
S1	22.2 (7.6)	31.4 (8.2)	29.7 (11.0)	22.8 (6.8)	32.4 (14.4)	23 (6.3)
S2	24.4 (7.2)	20.0 (1.5)	29.5 (7.7)	26.8 (12.6)	30.3 (14.4)	23.7 (4.0)
S3	18.8 (2.1)	29.0 (3.5)	30.0 (3.4)	29.2 (18.1)	29.2 (16)	24.1 (4.3)
S4	20.8 (2.5)	29.9 (5.4)	40.9 (17)	38.1 (20.9)	50.4 (42.1)	24.4 (4.3)
S5	20.4 (3.9)	34.4 (19.5)	30.9 (6.5)	28.5 (17.6)	29.1 (16.3)	22.0 (7.4)

Table 3: Moisture level in different age groups on five body sites in females in all six seasons

Age group (year)	January (A)	March (B)	May (C)	July (D)	September (E)	November (F)
5-20						
S1	23.7 (4.6)	32.3 (7.9)	29.8 (5)	35.1 (19.3)	26.9 (5.5)	26.5 (9.8)
S2	24.2 (7.0)	20.4 (7.0)	29.3 (6.8)	25.3 (11.3)	24.4 (4.2)	26.1 (9.9)
S3	21.6 (3.6)	25.2 (4.5)	27.1 (4.7)	28.9 (14.9)	29.3 (11.5)	26.1 (8.5)
S4	24.7 (5.1)	35.5 (21.7)	51.6 (16.9)	36.9 (19.1)	26.9 (8.6)	25.8 (7.5)
S5	24.2 (8.1)	60 (32.4)	35.0 (20.8)	31 (17.1)	35.6 (16.0)	28.1 (7.2)
21-40						
S1	24.6 (5.9)	31.9 (10.6)	29.4 (4.8)	31.6 (20.1)	23.8 (7.1)	28.7 (11.6)
S2	24.2 (5.6)	22.9 (4.7)	31.2 (8.5)	23.5 (9.6)	23.6 (6.4)	30.0 (10.2)
S3	23.9 (5.6)	27.2 (6.5)	32.6 (11.3)	25.1 (13.6)	24.3 (7.3)	29.3 (10.9)
S4	25.3 (5.8)	28.0 (9.1)	47.2 (17.5)	31.1 (15.7)	27.1 (12.1)	29.2 (12.0)
S5	30.3 (18.9)	41.2 (30.9)	31.1 (12.3)	27.2 (13.6)	30.5 (15.2)	30.2 (12.1)
41-60						
S1	23.8 (4.0)	27.1 (6.7)	28.2 (4.0)	30.4 (22.2)	26.1 (10.9)	25.7 (10.2)
S2	22.9 (3.9)	24.0 (6.3)	31.5 (10.6)	30.0 (18.9)	24.9 (7.4)	24.4 (7.0)
S3	22.5 (2.3)	26.6 (6.1)	26.5 (6.2)	29.1 (15.7)	24.7 (7.4)	26.2 (6.2)
S4	27.9 (10.0)	34.4 (21.9)	30.7 (12.2)	35.9 (18.0)	30.4 (15.5)	23.4 (6.3)
S5	28.5 (11.0)	62.7 (22.1)	26.5 (10.8)	30.1 (17.9)	29.7 (13.8)	26.6 (11.3)
>60						
S1	20.4 (0.5)	29.7 (0.4)	29.4 (2.5)	34.7 (8.5)	18.7 (0.0)	24.5 (2.1)
S2	28.4 (11.3)	27.4 (6.9)	25.3 (6.1)	18.8 (0.2)	18 (0.0)	33.5 (13.4)
S3	20.8 (0.2)	29.8 (9.8)	26.7 (8.4)	18.2 (0.3)	19.8 (0.0)	31 (12.7)
S4	20.7 (0.7)	39.7 (8.9)	29.9 (7.6)	41.2 (27.7)	18.8 (0.0)	33.5 (12.0)
S5	34.1 (19.6)	60.8 (3.4)	30.2 (16.9)	20.8 (0.9)	18.8 (0.0)	32 (15.5)

ultimately leading to reduced capacity to retain moisture in older age skin.^[3] However, larger study on Chinese population

observed higher hydration in middle age group unlike our study.^[6]

Table 4: Comparison of skin moisture content in six different seasons in India

Site and seasons	January (A)	March (B)	May (C)	July (D)	September (E)	November (F)	Significant (P)
Forehead							
Male	21 (4.4)	29 (19.8)	30 (7.1)	20.5 (20.9)	25 (9.9)	24 (5)	A~B, A~C, B~F, C~D, C~F
Female	22.2 (5.2)	29.9 (13.5)	30 (7.2)	22 (20.7)	22.5 (6.4)	25 (5)	
P	0.0352	0.4666 (NS)	0.436 (NS)	0.893 (NS)	0.568 (NS)	0.0975 (NS)	
Right ocular region							
Male	24 (10.3)	30 (5)	30 (15)	22.5 (21.3)	25 (10.1)	24 (6)	B~C, C~D, C~F
Female	21.4 (5)	22 (5)	29 (15)	20 (21)	22 (7.2)	25 (8)	
P	0.0238	0.901 (NS)	0.317 (NS)	0.0032	0.0022	0.2511 (NS)	
Right cheek							
Male	22 (3.2)	26 (8.5)	30 (10.5)	23.7 (16.5)	24.5 (10.4)	23 (5)	A~B, A~C, C~F, C~E
Female	22.3 (3.8)	25.7 (7.5)	29.4 (11)	20.1 (16.5)	22.1 (7.5)	25 (5.6)	
P	0.754 (NS)	0.288 (NS)	0.797 (NS)	0.0204	0.0411*	0.317 (NS)	
Right arm							
Male	24 (8.2)	26.5 (7.6)	42 (34)	39.5 (36.3)	21.8 (9.9)	23 (4)	A~B, A~C, A~D, C~F, C~E, D~E
Female	23.3 (9)	26.7 (10.6)	41.1 (34)	26.5 (36)	22.4 (9)	25 (6.8)	
P	0.557 (NS)	0.448 (NS)	0.630 (NS)	0.687 (NS)	0.0204	0.368 (NS)	
Right palm							
Male	23 (13.5)	50 (52.7)	30 (12.6)	21.7 (26.1)	24.4 (22.2)	24 (9.5)	A~B, B~E, B~F, C~D, C~F
Female	22 (14.6)	63.3 (57.7)	25.3 (12.4)	20.4 (26)	24.2 (18.5)	25 (8.2)	
P	0.5,*45 (NS)	0.564 (NS)	0.215 (NS)	0.335	0.223	0.325 (NS)	

NS: Not significant, * $P < 0.05$

We observed that the skin moisture level of males was relatively higher compared to females in all seasons unlike the study carried by de Farias *et al.*^[1] Males tend to perspire more than females due to higher basal metabolic rate which justifies our finding.^[7] However, Ehlers *et al.* reported that skin of females and males was hydrated equally which is different from our findings.^[8] In a study about the effect of menopause on physiological characteristics of the skin, late menopausal women had higher skin hydration than perimenopausal and premenopausal women.^[9]

In our study, maximum moisture level was seen in summer while minimum skin moisture level was observed in monsoon season. According to meteorological data, July month observes maximum sunlight duration which corresponds to lower moisture level in this season. Meyer *et al.* have stated that moisture level decreases in summer in patients having acne as well as controls which is different from our inferences.^[10] Agner and Serup observed decreased skin hydration in winter in their study about skin resistance to irritants.^[11]

Moisture content followed a definite pattern in various body sites as per the seasons. Extremities had greater moisture level than the face in both gender in all seasons. This is because extremities especially palms are more exposed to mechanical friction while the face is mostly photoexposed throughout the day. Furthermore, among males, the working adult and middle-aged groups showed maximum moisture on palmar region compared to inactive younger and older age Groups (1 and 4) which showed highest moisture on arms. One Korean study demonstrated higher moisture content in the cheek compared to forearm in females unlike our findings.^[12]

Limitations of the study

This present study was confined to a single geographical area, so the effect of environment changes reflects that particular area. Seasonal variation in particular individuals could not be studied as different people were assessed in different seasons.

CONCLUSION

The result of this study will provide an important step toward better understanding of skin moisture levels at various sites in all age groups across different seasons and its practical application in various clinical conditions. The data would assist in the production of topical pharmaceuticals in different age groups based on sites and seasons.

It is difficult to compare our study with other published studies because of ethnic and individual variation, variation in selected sites, age group, sample size, and difference in the types of instruments as well as principles used to measure skin moisture. This study may direct similar future studies in Indian population.

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Conflicts of interest

There are no conflicts of interest.

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