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## **Association between lifestyle and skin moisturizing function in community-dwelling older adults**

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## **Abstract**

The skin moisturizing function decline with age, leading to skin dryness in approximately 40% of the elderly. Various lifestyle habits may affect the skin moisturizing function, however it is not clear which ones are particularly relevant. A cross-sectional study was conducted between September and December 2023, involving individuals aged 65 years and older. Self-administered questionnaire were employed to collect information on lifestyle habits. Stratum corneum hydration (SC hydration), as an indicator of skin hydration, was measured and analyzed using multiple regression. A total of 124 individuals participated in the study, with a mean age of 83.6 years. Daily use of moisturizer ( $p=0.024$ ) and activity level ( $p=0.002$ ) demonstrated significant associations with increased SC hydration. Although not statistically significant, smoking exhibited a trend towards decreased SC hydration ( $p=0.173$ ). The findings of this study suggest that, among various lifestyle habits, exercise and daily moisturizing contribute to enhanced SC hydration. These results suggest that lifestyle modifications may improve the skin moisturizing function of elderly.

## **Introduction**

A key function of the skin is its moisturizing function, through which it regulates the release of water from inside the body to the atmosphere, and a barrier function, by which it acts as a barrier to prevent the entry of chemicals and microorganisms into the body.<sup>1</sup> Skin moisturizing and barrier functions are related, and the skin's barrier function is reduced with reduced skin moisturizing function.<sup>2</sup> The skin's moisturizing function declines with age,<sup>3,4</sup> and mechanisms of functional decline include reduced hydration of the stratum corneum (SC) due to its thickening associated with prolonged turnover with age and a decrease in factors controlling the skin's moisturizing function.<sup>3</sup>

A decreased moisturizing function leads to skin dryness.<sup>5</sup> Approximately 40% of older adults have dry skin,<sup>6</sup> making it a universal problem. Skin dryness is a high-risk factor for dermatitis, eczema, and psoriasis, increasing the risk of their development by two to five times.<sup>6</sup> It also causes structural

abnormalities in the SC, which can lead to itching and skin infections by allowing the entry of bacteria and other organisms, thus reducing the quality of life.<sup>5,6</sup> It has also been shown that people with skin diseases such as psoriasis and acne have a higher risk of depression;<sup>7</sup> therefore, maintaining and improving the skin's moisturizing function is important for the physical and mental health and quality of life of older adults. Therefore, interventions to maintain and improve the skin's moisturizing function are highly warranted.

Both internal and external factors are associated with the skin's moisturizing function.<sup>8</sup> Internal factors include ageing,<sup>4</sup> race,<sup>9</sup> and changes in hormonal balance,<sup>10</sup> whereas external factors include the surrounding environment<sup>4</sup> and lifestyle.<sup>8</sup> Of these, lifestyle habits can be controlled by oneself; therefore, it is expected that the maintenance of the skin's moisturizing function can be improved by adjusting one's lifestyle. Various lifestyle habits have been examined in relation to the skin's moisturizing function, and specific lifestyle habits associated with the skin's moisturizing function have been identified as exercise, daily moisturizing care habits, smoking, diet, and stress.<sup>11,12,13,14</sup> Other lifestyle habits associated with skin moisturizing function in older adults include bathing habits,<sup>15</sup> which indicates that the skin of older adults is strongly influenced by lifestyle habits. Therefore, lifestyle habit interventions can be expected to improve the maintenance of the skin's moisturizing function in older adults.

Our prior study have scrutinized the influence of exercise on skin moisturization in adults and the alterations in skin moisturizing function post an exercise intervention. Findings indicate a probable favorable effect of exercise on skin moisturizing function.<sup>16,17</sup> Nonetheless, these inquiries focused on adults, leaving uncertainties regarding whether analogous outcomes would manifest in older individuals with more delicate skin. Hence, exploring lifestyle habits strongly linked to elderly skin is imperative.

However, previous studies only investigated the relationship between certain lifestyle aspects, such as diet, bathing habits, daily moisturizing care, and skin moisturization. The aim of this

study was to comprehensively examine multiple lifestyle habits and obtain suggestions for lifestyle habits to maintain the skin moisturizing function in community-dwelling older adults.

## **Methods**

### ***Study design***

A cross-sectional study was conducted to investigate lifestyle habits and measure corneal water content using the International Physical Activity Questionnaire (IPAQ) short version (partially modified) and a self-administered questionnaire for study participants.

### ***Data collection period.***

We collected data from 1 September 2023 to 31 December 2023.

### ***Research participants***

#### ***Sample size***

The sample size was approximately 100 older adults aged  $\geq 65$  years, and was calculated using Gpower 3.1 with multiple regression analysis with  $\alpha = 0.05$ ,  $\beta = 0.80$ , effect size  $f = 0.25$ , and seven explanatory variables.

Study participants were recruited from open spaces for older people living in the community and those currently enrolled in local facilities (day services and daycare) and sports clubs, irrespective of the level of care required.

However, those with a history of skin diseases such as atopic dermatitis or psoriasis and those who had difficulty answering the questionnaire because of cognitive decline were excluded. The following three instructions were provided to the study participants and adhered to.<sup>12</sup>

(1) Avoid applying body cream or other products to the measurement site 12 hours before participation in the study.

- (2) Do not smoke for 3 hours before study participation.
- (3) Avoid strenuous exercise 1 hour before study participation.

### *Recruitment methods*

The recruitment of research participants was carried out according to the following procedure:

- (1) The purpose and methods of the study were explained to the managers of the collaborating institutions, and their approval was obtained.
- (2) Leaflets were posted at the facilities, and researchers distributed leaflets on research cooperation at the collaborating facilities and asked facility users to cooperate.
- (3) The researcher provided a written explanation of the research to those interested in the research.
- (4) Those willing to participate in the research were asked to sign a consent form.
- (5) Arrangements were made for the dates of research cooperation.

### *Survey methods*

#### *Survey environment and setting*

- (1) The room in which the survey was conducted was part of the facility in which the study participants were recruited.
- (2) The temperature and relative humidity of the air in the application room were stabilised.<sup>12</sup>
- (3) The two investigators were trained in the measurements to avoid errors due to their technique and measurement errors between investigators.

#### *Survey items*

- (1) Basic attributes included sex, age, daily moisturizing care, how to wash the body when bathing (bathing habits), and smoking history.

(2) Lifestyle habits included:

a. Dietary habits

Participants were asked about whether their diet was well-balanced based on the Dietary Balance Guide.<sup>18</sup> This indicates that the higher the score, the more ideal the eating habits.

b. IPAQ Short version

This questionnaire was developed by a WHO working group to assess physical activity in accordance with globally standardised criteria. The IPAQ assesses the number of days and duration of high- and moderate-intensity physical activity per week.<sup>19</sup> The long version provides questions about life situations, such as at work, on the move, at home, and during leisure time, while the short version comprises questions only according to activity intensity. The results were classified as “low physical activity,” “medium physical activity,” and “high physical activity.” The correlation between the long and short versions is high,<sup>19</sup> and the short version with fewer questions was adopted because it was considered less burdensome for the study participants.

c. Stratum corneum hydration

SC hydration refers to the amount of water contained at approximately 15 µm from the skin surface. The tip of the probe was shaped like comb electrodes facing each other, and electrolysis was performed on the skin via a glass plate to measure the electrostatic capacitance, which was displayed numerically as a relative value between 0 and 120. Measurements were taken at the centre point of the medial forearm (8 cm palmar to the centre point of the elbow socket). Measurements were taken three times, and the average of the three measurements was used as the data,<sup>12</sup> measured using a Mobile Moisture HP10-N (Courage+Khazaka).

*Specific research procedures*

(1) Study participants were allowed to rest in the study room for 20 min without any sweating activity or cleaning of the measurement site to acclimatise them to the measurement environment.<sup>12</sup> During



this resting period, participants were asked to explain the research procedure and answer the questionnaire.

(2) The questionnaire was collected on the spot, and SC hydration was measured on the right forearm.

(3) While answering the questionnaire, the researcher remained close to the participants and was ready to respond immediately to any questions.

### ***Methods of data analysis***

First, based on the study participants' responses to the IPAQ at the beginning of the study, they were classified into three groups according to their activity levels.

Multiple regression analysis using the forced entry method was conducted using respondents' attributes, dietary habit scores, and activity levels as explanatory variables and SC hydration as the objective variable. The multicollinearity of the predictors (including covariates) was explored using variance inflation factor (VIF) statistics. The VIF values were suitable for all variables and were less than the values of multicollinearity (VIF values >10).

Missing values were complemented using a multiple imputation method. Statistical software R ver. 4.0.3 was used for statistical analysis, with a significance level of 5%.

### ***Ethical considerations***

#### ***Conditions for research commencement***

This study was conducted under the research permission of the Research Ethics Committee of the Faculty of Nursing, Shijonawate-Gakuen University (approval no. 2023001).

#### ***Method of obtaining research consent***

Participants were informed that they had the right to decline participation and that they could withdraw from the study at any time. Participation was completely voluntary, and all participants

received both oral and written information about the study's purpose, content, and extent. They were then assured that all their responses were confidential. Participants' confidentiality was protected by providing a code number to each participant prior to data collection and analysis. The collected questionnaires were stored in a locked cabinet. As consent checkboxes were placed on each questionnaire form, participants' consent was indicated when they checked their respective boxes, which was done prior to submission.

## **Results**

A total of 124 participants participated in the study. The mean age was  $83.6 \pm 8.6$  years. There were 38 males (30.6 %) and 86 females (69.4 %). Table 1 shows the results of the participants' responses to the questionnaire (Table 1).

Multiple regression analysis using the forced entry method was conducted with the study participants' basic demographics, dietary habit scores, and activity levels as explanatory variables and SC hydration as the objective variable (Table 2). The results showed that daily moisturizer use and activity level variables were statistically significantly associated with SC hydration.

## **Discussion**

This study investigated the relationship between lifestyle factors and the skin's moisturizing function based on SC hydration and a self-administered questionnaire on lifestyle. Previous studies have demonstrated a relationship between several individual lifestyle factors and the skin's moisturizing function. However, it remains unclear how the skin's moisturizing function is affected by the overall lifestyle. This study found that the two lifestyle factors, namely activity level and moisturizing habits, significantly affected SC hydration. Although not statistically significant, smoking tended to be associated with SC hydration.

The lifestyle habits associated with increased SC hydration include activity levels and daily

moisturizing habits. First, regarding activity level, individuals with an exercise routine tend to exhibit higher corneal water content.<sup>11</sup> While the present study investigated weekly activity levels rather than specific exercise habits, the obtained results are considered valid because, even among institutionalised patients, those with low activity levels are at a heightened risk of skin dryness.<sup>20</sup> Exercise influences the skin of older adults by enhancing epidermal thickness and dermal collagen content.<sup>21</sup> This phenomenon is attributed to exercise-induced mitochondrial biosynthesis, which correlates with diminished mitochondria.<sup>21</sup> Endurance exercise promotes mitochondrial biosynthesis.<sup>21,23</sup> In this study, individuals with higher activity levels may have experienced augmented mitochondrial biosynthesis, consequently enhancing skin structure and increasing epidermal water content. Additionally, exercise increases blood flow to the skin and induces sweating.<sup>24</sup> The likelihood that those with higher activity levels perspire more frequently may also contribute to an enhanced skin moisturizing function.

Concerning daily moisturizing care habits, various studies have indicated that the use of moisturizers contributes to increased SC hydration.<sup>25</sup> The mechanism underlying a moisturizer's enhancement of SC hydration includes mitigating water evaporation through direct skin hydration or the formation of a protective film on the skin.<sup>26,27</sup> Despite the diverse formulations of moisturizers, including ointments, lotions, and gels, their efficacy in augmenting SC hydration has been demonstrated, irrespective of their specific type.<sup>25</sup> However, given the alterations in the skin's structure associated with ageing, it is plausible that distinct moisturizer formulations may exert varying effects on SC hydration in older individuals. Notably, this study did not investigate the specific types of moisturizers used. Future investigations should delve into the nuances of moisturizer formulations to explore the impact of daily moisturizing care on the skin of older individuals more comprehensively.

Smoking has emerged as a lifestyle habit associated with the tendency to decrease SC hydration. Smoking is recognised for its various detrimental effects on the skin. Studies have

demonstrated that each additional pack-year of past smoking history correlates with the development of skin wrinkles, thinning, and increased SC fragility in long-term smokers.<sup>28,29</sup> Additionally, cornified water content has been observed to be lower in female smokers,<sup>12</sup> with vasoconstriction and diminished skin blood flow due to nicotine exposure,<sup>30</sup> and increased transepidermal water loss (TEWL) potentially causing reduced skin water content<sup>31</sup> being identified as causative mechanisms. These findings strongly suggest that smoking is a lifestyle habit detrimental to the skin moisturizing function. However, the persistence of the effects of past smoking on the skin remains uncertain, necessitating future research on changes in skin moisturizing function following smoking cessation.

Previous studies have primarily focused on elucidating the effects of specific lifestyle habits on the skin's moisturizing function. However, this study posits that among a diverse array of lifestyle habits, activities such as exercise, daily moisturizing, and smoking are associated with the skin's moisturizing function in community-dwelling older adults. Modifying these lifestyle habits may improve the skin moisturizing function in older adults with dry skin. This study had some limitations. First, its cross-sectional design did not prove causality. Second, this study only investigated the weekly quantity of activity, leaving uncertainties regarding the specific types of exercise that might be beneficial or the optimal amount of exercise required. Third, given that the research was conducted in day healthcare centres and senior day care centres, the generalizability of the findings to older adults who do not avail themselves of such facilities may be limited. Despite these constraints, the findings are significant in highlighting the distinct association between exercise habits and the skin's moisturizing function among community-dwelling older adults. In future investigations, it is imperative to delve deeper into this relationship by systematically tracking alterations in skin moisturizing function upon the commencement of exercise.

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**Table 1. Basic demographics of study participants and summary of questionnaire responses.**

Variables	Mean (SD)	n (%) <sup>a</sup>
Age	83.6 (8.6)	
Sex		
Male		38 (30.6%)
Female		86 (69.4%)
Moisturizer		
Used		32 (25.8%)
Not used		92 (74.2%)
Smoking		
Current or past		9 (7.2%)
Never		115 (92.7%)
Bathing habit		
Wash by scrubbing hard with a towel		20 (16.1%)
Wash by gently rubbing with a towel		84 (67.7%)
Wash gently by hand		19 (15.3%)
Dietary habits (7–35) <sup>b</sup>	24.5 (5.8)	
Activity Level		
Low		57 (46%)
Medium		66 (53.2%)
High		1 (0.0%)
SC hydration	28.7 (8.0)	

SD, standard deviation; SC hydration, stratum corneum hydration; <sup>a</sup>All values are expressed as n (%), where the sum of percentages may be over 100%, owing to rounding off at the second decimal place; <sup>b</sup>Higher scores for dietary habits indicate better eating habits.

**Table 2. Factors related to stratum corneum hydration.**

Variables	$\beta$ [95% CI]	Std $\beta$	<i>p</i> -value
Age	0.1[-0.1, 0.2]	0.06	0.499
Sex	-1.4[-4.6, 1.9]	-0.08	0.402
Moisturizer	3.8[0.5, 7.1]	0.21	0.024
Smoking	-3.9[-9.6, 1.8]	-0.13	0.173
Bathing habits	0.7[-3.0, 1.7]	-0.05	0.572
Dietary habits	-0.1-0.4, 0.1[]	-0.08	0.379
Activity Level	4.4[1.7, 7.1]	0.28	0.002
Adjusted R <sup>2</sup>	0.11		

CI, Confidence Interval; SC hydration, stratum corneum hydration; Std, Standardized.