

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

Ryosuke Oizumi, Risa Shibata

Faculty of Nursing, Shijonawate Gakuen University, Osaka, Japan

## Abstract

The skin's moisturizing function declines with age, resulting in skin dryness in around 40% of older people. Various lifestyle habits

Correspondence: Ryosuke Oizumi, Shijonawate Gakuen University Faculty of Nursing, Gakuen-cyo, Daito-shi, 6-45, Osaka, 574-0001, Japan.

Tel.: +81.728132601.

E-mail: r-oizumi@un.shijonawate-gakuen.ac.jp

Key words: skin moisturization; lifestyle; older adults.

Acknowledgments: we greatly appreciate the cooperation of the survey participants and the staff at "Share House Hana," "Kaigo no Jun," "RehaPrideHD Neyagawa," and "WakuWaku saron".

Contributions: RO, conceived and designed the study; RO, RS; contributed to obtaining and analyzing the data; RO, RS, drafted and revised the manuscript. All the authors critically reviewed and approved the submitted version of the manuscript.

Conflict of interest: the authors declare no potential conflict of interest.

Funding: this work was supported by JSPS KAKENHI (grant number 23K16529).

Ethical approval and consent to participate: this study was conducted under the research permission of the Research Ethics Committee of the Faculty of Nursing, Shijonawate-Gakuen University (approval no. 2023001).

Availability of data and materials: raw data were generated at Shijonawate Gakuen University. Derived data supporting the findings of this study are available from the corresponding author on request.

Consent for publication: not applicable.

Received: 6 February 2024.

Accepted: 10 March 2024

This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License (CC BY-NC 4.0).

©Copyright: the Author(s), 2024

Licensee PAGEPress, Italy

Dermatology Reports 2024; 16:9964

doi:10.4081/dr.2024.9964

*Publisher's note: all claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article or claim that may be made by its manufacturer is not guaranteed or endorsed by the publisher.*

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 over. Self-administered questionnaires 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 exercise 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 indicate that lifestyle modifications may improve the skin moisturizing function of the elderly.

## Introduction

The skin serves a crucial role in moisture regulation, controlling the release of water from the body to the environment, and functions as a barrier to inhibit the ingress of chemicals and microorganisms into the body.<sup>1</sup> 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 reduces with age,<sup>3,4</sup> and mechanisms of functional decline include decreased 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 hydration function is important for the physical and mental health and quality of life of older adults. Consequently, 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 age,<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> Among 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 behaviors 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> Bathing behaviors are also connected with skin moisturizing function in older adults,<sup>15</sup> indicating

that lifestyle habits have a significant impact on older adults' skin. As a result, lifestyle habit treatments are likely to increase the skin's ability to retain moisture in older persons.

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 purpose of this study was to comprehensively examine multiple lifestyle habits and provide suggestions to preserve the skin moisturizing function in community-dwelling older adults.

## Materials and 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 persons 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 study participants received and followed the three instructions listed below:<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 stabilized.<sup>12</sup>
- (3) The two investigators were trained in the measurements to avoid errors caused by 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 healthier 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  $\mu\text{m}$  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 acclimatize 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 their replies to the IPAQ at the beginning of the study, the participants 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 to 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 before the submission.

## Results

The study included a total of 124 individuals. 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.

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. According to the findings of this study, two lifestyle factors, exercise level and daily moisturizing practices, have a substantial impact on SC hydration. Although not statistically significant, smoking was connected with SC hydration.

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.

**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 $\beta$	p-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.

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 persons 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 daycare 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.

## References

1. Proksch E, Brandner JM, Jensen JM. The skin: an indispensable barrier. *Exp Dermatol* 2008;17:1063–72.
2. Madison KC. Barrier function of the skin: “la raison d’être” of the epidermis. *J Invest Dermatol* 2003;121:231–41.
3. Tanei R. Treatment and care of xeroderma, pruritus, and lipid deficient eczema in the elderly. *Japan Med J* 2012;4578:67–72. [In Japanese]
4. Berardesca E, Loden M, Serup J, et al. The revised EEMCO guidance for the in vivo measurement of water in the skin. *Skin Res Technol* 2018;24:351–8.
5. Verdier-Sévrain S, Bonté F. Skin hydration: a review on its molecular mechanisms. *J Cosmet Dermatol* 2007;6:75–82.
6. Augustin M, Kirsten N, Körber A, et al. Prevalence, predictors, and comorbidity of dry skin in the general population. *J Eur Acad Dermatol Venereol* 2019;33:147–150.
7. Dalgard FJ, Gieler U, Tomas-Aragones L, et al. The psychological burden of skin diseases: a cross-sectional multicenter study among dermatological out-patients in 13 European countries. *J Invest Dermatol* 2015;135:984–91.
8. Farage MA, Miller KW, Elsner P, Maibach HI. Intrinsic and extrinsic factors in skin ageing: a review. *Int J Cosmet Sci* 2008;30:87–95.
9. Robinson MK. Population differences in skin structure and physiology and the susceptibility to irritant and allergic contact dermatitis: implications for skin safety testing and risk assessment. *Contact Dermatitis* 1999;41:65–79.
10. Brincat MP, Baron YM, Galea R. Estrogens and the skin. *Climacteric* 2005;8:110–23.
11. Oizumi R, Sugimoto Y, Aibara H. Factors related to skin moisturizing functions in adults: a cross-sectional study. *Aesthetic Medicine* 2020;3:42–8.
12. du Plessis J, Stefaniak A, Eloff F, et al. International guidelines for the in vivo assessment of skin properties in non-clinical settings: Part 2. transepidermal water loss and skin hydration. *Skin Res Technol* 2013;19:265–78.
13. Yoshizaki T, Kimira Y, Mano H, et al. Association between skin condition and sleep efficiency in Japanese young adults. *J Nutr Sci Vitaminol (Tokyo)* 2017;63:15–20.
14. Cao C, Xiao Z, Wu Y, Ge C. Diet and skin aging-from the perspective of food nutrition. *Nutrients* 2020;12:870.
15. Iizaka S. Skin hydration and lifestyle-related factors in community-dwelling older people. *Arch Gerontol Geriatrics* 2017;72:121–6.
16. Oizumi R, Sugimoto Y, Aibara H. Effects of regular exercise on skin moisturizing function in adults. *Dermatol Reports* 2023;15:9711.
17. Ryosuke O, Yoshie S, Hiromi A. The association between activity levels and skin moisturising function in adults. *Dermatol Reports* 2021;13:8811.
18. Ministry of Health, Labour and Welfare, Ministry of Agriculture, Forestry and Fisheries, (2005). the Dietary Balance Guide. Available form: <https://www.mhlw.go.jp/bunya/kenkou/pdf/gaido-kihon.pdf>.
19. Murase N, Katsumura T, Ueda C, et al. Validity and reliability of Japanese version of international physical activity questionnaire. *J Health Welfare Statistics* 2002;49:1–9. [In Japanese]
20. Jiang Q, Wang Y, Liu Y, et al. Prevalence and associated factors of dry skin among older inpatients in hospitals and nursing homes: a multicenter cross-sectional study. *Int J Nurs Stud* 2022;135:104358.
21. Crane JD, MacNeil LG, Lally JS, et al. Exercise-stimulated interleukin-15 is controlled by AMPK and regulates skin metabolism and aging. *Aging Cell* 2015;14:625–34.
22. Lu CY, Lee HC, Fahn HJ, Wei YH. Oxidative damage elicited by imbalance of free radical scavenging enzymes is associated with large-scale mtDNA deletions in aging human skin. *Mutat Res* 1999;423:11–21.
23. Safdar A, Bourgeois JM, Ogborn DI, et al. Endurance exercise rescues progeroid aging and induces systemic mitochondrial rejuvenation in mtDNA mutator mice. *Proc Natl Acad Sci U S A*

- A 2011;108:4135–40.
24. Rossi M, Santoro G, Maurizio S, Carpi A. Spectral analysis of skin blood flow motion before and after exercise in healthy trained and in sedentary subjects. *Int J Sports Med* 2006;27:540–5.
  25. Hebert AA, Rippke F, Weber TM, Nicol NH. Efficacy of non-prescription moisturizers for atopic dermatitis: an updated review of clinical evidence. *Am J Clin Dermatol* 2020;21:641–55.
  26. Sethi A, Kaur T, Malhotra SK, Gambhir ML. Moisturizers: the slippery road. *Indian J Dermatol* 2016;61:279–87.
  27. Rajkumar J, Chandan N, Lio P, Shi V. The skin barrier and moisturization: function, disruption, and mechanisms of repair. *Skin Pharmacol Physiol* 2023;36:174–85.
  28. Yin L, Morita A, Tsuji T. Skin aging induced by ultraviolet exposure and tobacco smoking: evidence from epidemiological and molecular studies. *Photodermatol Photoimmunol Photomed* 2001;17:178–83.
  29. Sandby-Møller J, Poulsen T, Wulf HC. Epidermal thickness at different body sites: relationship to age, gender, pigmentation, blood content, skin type and smoking habits. *Acta Derm Venereol* 2003;83:410–3.
  30. Sørensen LT, Jørgensen S, Petersen LJ, et al. Acute effects of nicotine and smoking on blood flow, tissue oxygen, and aerobic metabolism of the skin and subcutis. *J Surg Res* 2009;152:224–30.
  31. Yazdanparast T, Hassanzadeh H, Nasrollahi SA, et al. Cigarettes smoking and skin: a comparison study of the biophysical properties of skin in smokers and non-smokers. *Tanaffos* 2019;18:163–8.