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Objective assessment of facial skin aging and the associated environmental factors in Japanese monozygotic twins

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Summary

Twin studies, especially those involving monozygotic (MZ) twins, facilitate the analysis of factors affecting skin aging while controlling for age, gender, and genetic susceptibility. The purpose of this study was to objectively assess various features of facial skin and analyze the effects of environmental factors on these features in MZ twins. At the Osaka Twin Research Center, 67 pairs of MZ twins underwent medical interviews and photographic assessments, using the VISIA® Complexion Analysis System. First, the average scores of the right and left cheek skin spots, wrinkles, pores, texture, and erythema were calculated; the differences between the scores were then compared in each pair of twins. Next, using the results of medical interviews and VISIA data, we investigated the effects of environmental factors on skin aging. The data were analyzed using Pearson's correlation coefficient test and the Wilcoxon signed-rank test. The intrapair differences in facial texture scores significantly increased as the age of the twins increased ($P = 0.03$). Among the twin pairs who provided answers to the questions regarding history differences in medical interviews, the twins who smoked or did not use skin protection showed significantly higher facial texture or wrinkle scores compared with the twins not exposed to cigarettes or protectants ($P = 0.04$ and 0.03, respectively). The study demonstrated that skin aging among Japanese MZ twins, especially in terms of facial texture, was significantly influenced by environmental factors. In addition, smoking and skin protectant use were important environmental factors influencing skin aging.

Keywords: twin study, skin aging, environmental factors

Introduction

Many studies investigating the relationships between skin aging and environmental factors have been reported.[1–4] These studies have indicated that environmental factors, including ultraviolet irradiation and cigarette smoking, markedly influence skin aging. Other environmental factors, such as body mass index (BMI), alcohol consumption, and marital status have also been

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suggested to be associated with skin aging.[2,5,6] Twin studies, especially those involving monozygotic (MZ) twins, provide unique opportunities to control for age, gender, and genetic effects in the analysis of the effects of environmental factors on skin aging.[5,7]

In the present study, we conducted medical interviews and facial photographic assessments of 67 pairs of adult, Japanese, MZ twins between 2010 and 2013. This study, conducted at the Osaka Twin Research Center, evaluated the influence of environmental factors on skin aging. Using a complexion analysis system, facial features were objectively evaluated. This was the first trial of its kind on a Japanese population.

Patients and methods

The subjects included 67 pairs of adult, MZ twins visiting the Osaka Twin Research Center. The Research Center was set up in 2010 at Osaka University, to provide comprehensive medical examinations to Japanese MZ and dizygotic adult twins. Volunteers for the twin study were recruited from the general community through various media advertisements. The study was approved by the Osaka University ethics committee, and all of the participants provided written, informed consent.

The MZ twins included 27 pairs of men and 40 pairs of women, aged 40–87 years. The subjects participated in medical interviews and photographic assessments designed to analyze the important visible features of facial skin aging. The medical interviews were conducted using a structured questionnaire to collect information regarding: age, alcohol consumption, smoking history, marital status, hormone replacement therapy, medical history, sun exposure history, BMI, and sunscreen or foundation use.

Photographic assessments were performed using the VISIA® Complexion Analysis System (Canfield Scientific., Fairfield, NJ, USA; Fig. 1).[8–10] The VISIA System, with a configurable head support, ensured consistent positioning of each subject's head. The subjects cleaned their skin with a gentle facial makeup remover before the image was obtained. The photographic images were captured with standard, cross-polarized, parallel polarized, and ultraviolet light. Images were taken in two different close-up views (right lateral 37°, left lateral 37°) for each subject to quantify the scores and percentiles of the cheek skin, including spots, wrinkles, pores, texture, and erythema. The percentiles enabled the evaluation of the subject's complexion analysis results through a comparison between the individual's scores and those of people of the same sex, generation, and skin type in the database. The scores provided a comprehensive measurement of the impact that each feature had on the client's complexion. The scores factored in the total size and area, as well as the intensity

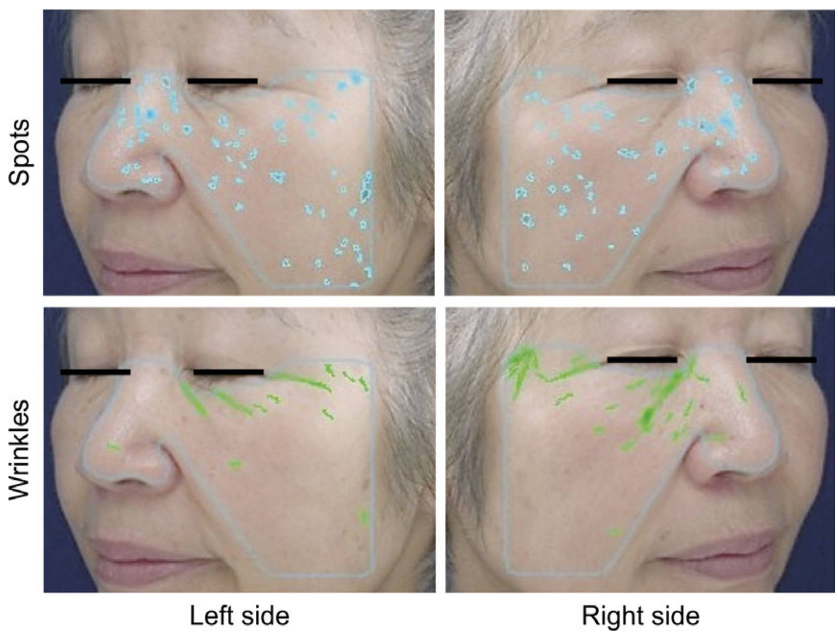

Figure 1 Photographic images acquired by the VISIA® Complexion Analysis System. Two close-up views show spots and wrinkles over the subject's cheek.

of the feature being analyzed. Skin with a lower score for each factor was considered to be more youthful in appearance (values ranged from 0 to 100). In the present study, we used the scores to more objectively assess skin condition. Skin texture represents the degree of uniformity of the surface of cheek skin. A subject with shallow sulcus cutis and closely shaped crista cutis was considered to have tidy skin. Skin wrinkle indicated to folds resulting from dermal connective tissues including elastic and collagen fibers.

The average scores for the right and left cheeks were calculated, and the differences between individuals in each pair of twins were recorded and chronologically compared. In addition, the results of the pairs of twins who provided answers to the medical interviews were compared with the VISIA data to explore the effects of environmental factors on their facial features. The twin pairs who differed by more than 4 BMI points from each other were also compared.

All calculations were performed with the JMP statistical software package (SAS, Cary, NC, USA). The data were analyzed using Pearson's correlation coefficient test and the Wilcoxon signed-rank test; a *P*-value of <0.05 was considered statistically significant.

Results

Of the 67 pairs of MZ twins, two male pairs were excluded from the analysis due to the interference of their mustaches, with the photographic assessments. Therefore, 25 pairs of men and 40 pairs of women were evaluated in this study. The patients had a range of Fitzpatrick skin types, from II to IV.

Subject's baseline characteristics

The characteristics of the evaluated subjects, based on their medical interviews, are presented in Table 1. The subjects ranged in age from 40 to 87 years and represented all the regions in Japan. Alcohol consumption, smoking histories, and outdoor work were more frequent among men than women, although sunscreen or foundation use was more frequent in women. In 11 twin pairs, the individuals differed from each other by more than 4 BMI points.

VISIA® complexion analysis system assessments

By using the VISIA® system, differences in facial feature scores (facial spots, wrinkles, pores, texture, and erythema) in each pair of twins were calculated and chronologically compared, by comparing the results for twins of various ages. The results of the intrapair comparisons are shown in Fig. 2. As the ages of the twins increased, the intrapair differences in facial texture scores also increased ($P = 0.03$). However, significant correlations between increasing ages and intrapair differences in facial spots, wrinkles, pores, and erythema were not observed ($P = 0.27$, 0.08, 0.63, and 0.23, respectively).

Environmental factors

Alcohol consumption, smoking history, hormone replacement therapy, sun exposure history, sunscreen or foundation use, marital status, medical history, and BMI were also investigated for their effects on facial skin aging. Comparing the VISIA scores of each factor in the twins of each pair, the twins who smoked showed significantly higher facial texture scores compared with the twins who were nonsmokers ($P = 0.04$). The twins who did not use sunscreen or foundation also showed significantly higher facial wrinkle scores compared with the twins who used these products ($P = 0.03$) (Table 2). There were no significant intrapair differences in the other environmental factors, namely alcohol consumption, hormone replacement therapy, sun exposure history, marital status, medical history, or BMI.

Discussion

Skin aging is influenced by the interaction of both intrinsic and extrinsic factors.[11,12] Intrinsic aging is an inevitable process that is regulated by a genetically programmed pattern, characterized by cellular senescence, decreased proliferative capacity, decreased cellular DNA repair capacity, oxidative stress, and gene mutations. Extrinsic aging is regulated by various external factors such as ultraviolet irradiation, cigarette smoking, alcohol consumption, marital status, and medical history.[2,5,6,13] Skin aging is manifested as spots, wrinkles, pores, coarseness, and telangiectasia, which are significantly correlated with the appearance of elderly individuals.[14,15] Therefore, accurate assessment of facial features is of great importance for esthetic surgeries and may also provide important information about several skin disorders.

There have been many reports regarding the relationship between skin aging and environmental factors.[1–4,16] Up to 40% of the changes that contribute to an aged appearance are reported to be due to nongenetic factors.[2,15] The first proposed correlation between smoking and skin aging was made by Solly in 1856.[17]

Table 1 Baseline characteristics of subjects

	Men (n = 25) No. of twin pairs (%)	Women (n = 40) No. of twin pairs (%)
Age		
40–49	0 (0.0)	7 (17.5)
50–59	3 (12.0)	6 (15.0)
60–69	4 (16.0)	18 (45.0)
70–79	8 (32.0)	7 (17.5)
80–89	10 (40.0)	2 (5.0)
Alcohol consumption: Twin1/Twin2		
(+)/(+)	16 (64.0)	13 (32.5)
(+)/(−)	4 (16.0)	8 (20.0)
(−)/(−)	5 (20.0)	19 (47.5)
History of smoking		
(+)/(+)	18 (72.0)	4 (10.0)
(+)/(−)	2 (8.0)	6 (15.0)
(−)/(−)	5 (20.0)	30 (75.0)
Marital status		
(+)/(+)	23 (92.0)	32 (80.0)
(+)/(−)	1 (4.0)	5 (12.5)
(−)/(−)	0 (0.0)	2 (5.0)
Missing	1 (4.0)	1 (2.5)
Sun exposure		
Outdoor work		
(+)/(+)	10 (40.0)	4 (10.0)
(+)/(−)	7 (28.0)	7 (17.5)
(−)/(−)	8 (32.0)	29 (72.5)
Outdoor sports		
(+)/(+)	7 (28.0)	12 (30.0)
(+)/(−)	8 (32.0)	11 (27.5)
(−)/(−)	10 (40.0)	17 (42.5)
Sunscreen or foundation use		
(+)/(+)	0 (0.0)	30 (75.0)
(+)/(−)	3 (12.0)	6 (15.0)
(−)/(−)	22 (88.0)	4 (10.0)
Medical history		
Diabetes		
(+)/(+)	1 (4.0)	4 (10.0)
(+)/(−)	4 (16.0)	2 (5.0)
(−)/(−)	20 (80.0)	34 (85.0)
Cardiovascular disease		
(+)/(+)	0 (0.0)	1 (2.5)
(+)/(−)	2 (8.0)	1 (2.5)
(−)/(−)	23 (92.0)	38 (95.0)
Asthma		
(+)/(+)	0 (0.0)	1 (2.5)
(+)/(−)	0 (0.0)	0 (0.0)
(−)/(−)	25 (100.0)	39 (97.5)
Depression		
(+)/(+)	0 (0.0)	0 (0.0)
(+)/(−)	0 (0.0)	2 (5.0)
(−)/(−)	25 (100.0)	38 (95.0)
History of hormone replacement therapy		
(+)/(+)	0 (0.0)	2 (5.0)
(+)/(−)	2 (8.0)	9 (22.5)
(−)/(−)	23 (92.0)	29 (72.5)
	Mean (range)	Mean (range)
Body mass index	22.9 (14.9–30.8)	21.6 (17.1–27.8)

Sun exposure has also been associated with an older appearance and has been suggested to accelerate with age. Similarly, a history of outdoor activities and failure to use sunscreen has been correlated with an older appearance.[5,16] Guyuron *et al.*[6] reported that the use of hormone replacements helped to preserve a younger appearance. The use of antidepressants, various diseases (diabetes, asthma, and cardiovascular disease), marital status, alcohol consumption, and BMI have also been suggested to be associated with skin aging.[2,5,6] Despite the number of studies on skin aging, the effects of various environmental factors are still not conclusively understood.

The study of twins, especially MZ twins, provides a unique opportunity to control for age, gender, and genetic susceptibility to aging in order to analyze environmental influences on aging. Gunn *et al.* performed heritability analyses of skin aging features in the twin

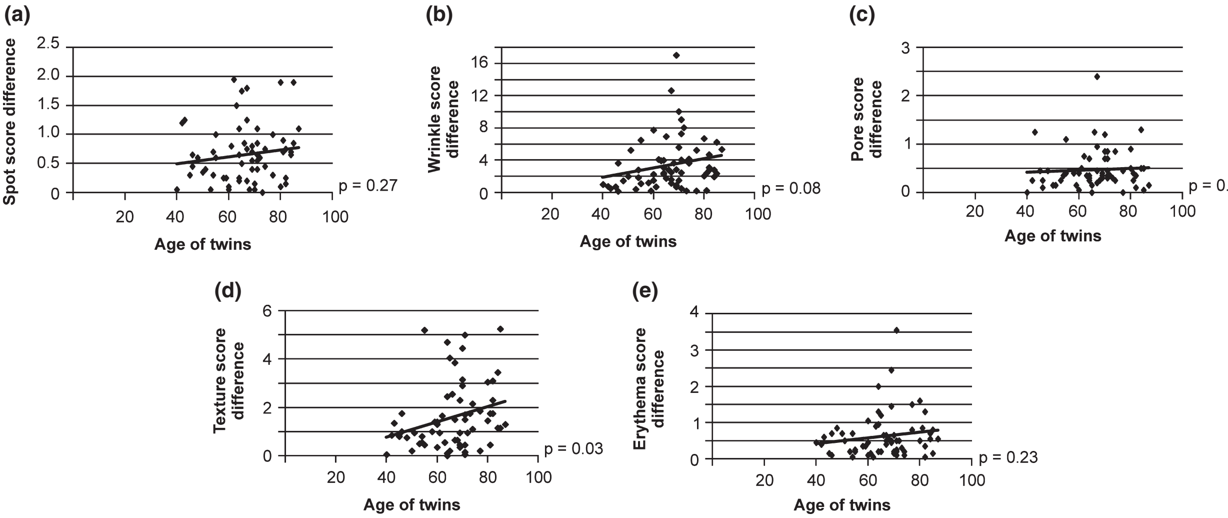

Figure 2 The differences in the VISIA scores for spots, wrinkles, pores, texture, and erythema in twin pairs. As the age of the twin increased, the intrapair differences in texture scores significantly increased as well ($P = 0.03$).

Table 2 Comparison of the VISIA scores of each factor in the twins of each pair who provided answers to the medical interviews

	Average VISIA score				
	Spots	Wrinkles	Pores	Texture	Erythema
Alcohol consumption (+) (*n* = 12)	3.63	8.94	2.25	4.33	3.73
Alcohol consumption (–) (*n* = 12)	3.56	8.76	2.06	3.86	3.4
Smoking (+) (*n* = 8)	3.85	13.39	2.88	6.11*	4.49
Smoking (–) (*n* = 8)	3.83	9.64	2.57	4.46*	3.89
Hormone replacement (+) (*n* = 11)	3.2	8.02	2.21	4.35	3.36
Hormone replacement (–) (*n* = 11)	3.21	8.06	2.19	4.15	3.48
Sun exposure (+) (*n* = 19)	3.48	8.91	2.02	3.48	3.62
Sun exposure (–) (*n* = 19)	3.88	8.8	2.11	4.11	3.74
Marital status (+)† (*n* = 6)	3.69	8.03	2.38	3.88	3.95
Marital status (–)† (*n* = 6)	3.46	8.43	2.53	4.89	3.74
Diabetes (+) (*n* = 6)	4.47	12.38	2.93	6.09	4.44
Diabetes (–) (*n* = 6)	4.16	10.74	3.02	5.87	4.29
Cardiovascular disease (+) (*n* = 3)	4.12	9.4	3.02	6.02	4.18
Cardiovascular disease (–) (*n* = 3)	4.27	12.7	2.75	5.88	4.35
Depression (+) (*n* = 2)	4.83	10.23	2.23	4.33	3.83
Depression (–) (*n* = 2)	4.02	11.63	1.83	3.88	3.98
Foundation or sunscreen use (+) (*n* = 9)	3.82	7.91*	2.27	4.26	3.56
Foundation or sunscreen use (–) (*n* = 9)	3.88	11.71*	2.35	4.62	3.73
Body mass index (large)‡ (*n* = 11)	3.76	11.47	3.05	6.35	4.13
Body mass index (small)‡ (*n* = 11)	4.08	13.6	2.82	5.95	4.26

The numbers are the average scores of each twin.
*<0.05
†Marital status (+) twin showed the twins who were married. Marital status (–) twin showed the twins who were not married.
‡The BMI (large) was >4 BMI points of the BMI (small).

population and demonstrated that 41–60% of the variations in sun damage, skin wrinkling, wrinkle depth, and pigmented age spot measurements were explained by genetic factors.[12] Shekar *et al.*[18] concatenated the variations in epidermal reticular patterning into genetic and environmental influences and estimated the concomitant effects of sun exposure and skin color in MZ twins.

The objective evaluation of the characteristic features of the facial skin, however, has rarely been reported. The VISIA® Complexion Analysis System enables the procurement of high-quality digital facial photographs with standardized lighting and configurable head positioning. The images obtained allow the quantitation of the physical properties of the cheek skin, such as spots, wrinkles, pores, texture, and erythema. Differences in these properties between individual MZ twins were objectively analyzed, in this study, by the VISIA system.

The results indicated that as the age of the twins increased, the intrapair differences in facial texture scores also increased significantly ($P = 0.03$), suggesting that facial texture tends to be influenced by environmental factors. Environmental factors, including smoking and failure to use sunscreen or foundation, resulted in significantly higher facial texture and wrinkle scores ($P = 0.04$ and 0.03, respectively). These observations suggest that cigarette smoking and skin protection might markedly affect skin aging. Alcohol consumption, hormone replacement use, sun exposure history, marital status, medical history, and BMI did not demonstrate a significant correlation with facial skin aging. These results did not completely support previous reports, possibly due to the more objective assessments achieved using the VISIA system. However, ethnic differences may also affect skin aging.

The main limitation of this study was the sample size. If the sample sizes for most factors were sufficiently large, the intrapair differences of most environmental factors would be expected to be more significant. Moreover, our study had a bias toward a disproportionate number of female subjects. If more male subjects were included, the impact of additional environmental factors might be more apparent. Further investigations may help clarify the relationship between other environmental factors and skin aging in MZ twins.

As the age of the twins increased, facial texture scores were less similar between individual twins, within a pair. This suggests that facial texture is influenced by environmental factors rather than solely by genetic factors. Moreover, smoking and the failure to use skin protection resulted in significantly higher facial texture and wrinkle scores. These environmental factors were identified as important environmental factors contributing to skin aging.

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