

Comparison of age-related changes in wrinkling and sagging of the skin in Caucasian females and in Japanese females

KAZUE TSUKAHARA, TSUTOMU FUJIMURA, YASUKO YOSHIDA, TAKASHI KITAHARA, MITSUYUKI HOTTA, SHIGERU MORIWAKI, PAMELA S. WITT, F. ANTHONY SIMION, and YOSHINORI TAKEMA, *Biological Science Laboratories, Kao Corporation, Tochigi, Japan (K.T., T.F., Y.Y., T.K., M.H., S.M., Y.T.)*, and *The Andrew Jergens Company, Cincinnati, Ohio (P.S.W., F.A.S.)*.

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Synopsis

We compared age-related changes in wrinkles in eight areas of facial skin (forehead, glabella, upper eyelid, corner of the eye, lower eyelid, nasolabial groove, cheek, and corner of the mouth) and sagging in the subzygomatic area of Caucasian females and of Japanese females.

The subjects studied included 85 healthy Caucasian females (ages 20–69 years) living in Cincinnati in the U.S. and 70 Japanese females (ages 20–69 years) living in Tokyo. Photos of the face in frontal and in oblique 45° views were analyzed. Wrinkles in the face and sagging in the subzygomatic area were graded on Japanese photoscales, respectively, by the same experienced observer.

The wrinkle score increased with age in all eight areas of the face examined in Caucasian females as well as in Japanese females. In the group aged 20–29 years, the wrinkle score in each area was significantly higher in Caucasian females than in Japanese females. The wrinkle scores in the forehead, glabella, upper eyelid, and corner of the eye were similar at advanced ages between the two groups, while the wrinkle scores in lower areas of the face (lower eyelid, nasolabial groove, cheek, and corner of the mouth) were markedly higher in Caucasian females than in Japanese females in each age group, and reached an upper limit at advanced ages in Caucasian females. The sagging score also increased with age in Caucasian females as well as in Japanese females. The sagging score was significantly higher in Caucasian females than in Japanese females in the groups aged 40 years or more.

These results suggest more marked wrinkle formation in all areas of the face in younger age groups of Caucasian females living in North America than in Japanese females living in Tokyo. In particular, Caucasian females showed marked age-related wrinkle formation in the lower areas of the face, probably due to sagging in the subzygomatic area, which suggests a higher susceptibility to sagging in the subzygomatic area of Caucasian females.

Address all correspondence to Kazue Tsukahara.

INTRODUCTION

The major methods to quantitatively assess wrinkles and fine wrinkles include macroscopic assessment and measurement of replicas using an instrument (1–3). In general, the macroscopic assessment method lacks objectivity due to differences in the criteria among observers. To solve this problem, the use of a photoscale with a confirmed statistical validity has been reported (4,5). In recent years, we obtained facial photos from Japanese females ranging in age from 10 to 80, and we developed a photoscale to assess wrinkles in eight areas of their faces (6). In that study we found that the wrinkle score in all areas of the face increased with age. We also developed a photoscale to measure sagging in the subzygomatic area, and we reported an age-related increase in the sagging score (7). On the other hand, Griffiths *et al.* (4) and Larnier *et al.* (5) developed a scoring system for photodamage using close-up facial photos as standard images, but they suggested that those standards cannot be used in Asians because of more marked influences of photoaging on pigmentation than on wrinkle formation compared with Caucasians (4,5). There have been no detailed studies comparing wrinkles in eight areas of the face (forehead, glabella, upper eyelid, corner of the eye, lower eyelid, nasolabial groove, cheek, and corner of the mouth) between Caucasians and Japanese using the same wrinkle score criteria. In addition, there have been no studies comparing sagging in the subzygomatic area according to the same criteria. Therefore, we have now compared wrinkles in those eight areas of the face, and we have measured morphological differences in the subzygomatic area in Caucasian females living in Cincinnati, Ohio, in the U.S. and in Japanese females living in Tokyo, using our previously developed photoscale, which was originally established by using photos of various grades of wrinkling and sagging in eight facial areas of Japanese female subjects (6,7).

METHODS

SUBJECTS AND PHOTOGRAPHIC METHODS

Eighty-five healthy Caucasian females (ages 20–69) living in Cincinnati, Ohio, in the U.S. volunteered for this test, and adequate consideration was given to their human rights and safety. After washing their faces, they entered a room at a temperature of 22°C. After 20 minutes of acclimatization, they sat on chairs with their eyes open, and two photos of each subject (a frontal view and an oblique 45° view) were taken with a Fuji Film S1 digital camera. After a standard color sample was attached to each subject, all photographs were taken at a shutter speed of 1/125 sec, with an aperture stop of 22, and printing was adjusted to provide consistent color.

Seventy Japanese females (ages 20–69) living in Tokyo and its environs also participated in this test, and adequate consideration was given to their human rights and safety. After washing their faces, they entered a room at a temperature of 20°C with 50% RH. After 15 minutes, they sat on chairs with their eyes open, and two photos (a frontal view and an oblique 45° view) were taken with a Nikon D1 digital camera. After a standard color sample was attached to each subject, all photographs were taken at a shutter speed of 1/250 sec, with an aperture stop of 29, and prints were similarly standardized. Table I shows the age distribution of the Caucasian and Japanese females in this study.

Table I
Distribution of the Subject Population

Age group	Number in Group	
	Caucasian	Japanese
20-29	16	14
31-39	21	14
41-49	17	14
51-59	15	14
61-69	16	14
Total	85	70

WRINKLE SCORE ASSESSMENT

The wrinkle score in eight areas of facial skin (forehead, glabella, upper eyelids, corner of the eye, lower eyelids, nasolabial groove, cheeks, and corner of the mouth) and sagging in the lower cheek area were measured according to photo standards as previously reported (6,7). These standards were originally established from photos of various grades of wrinkling and sagging in eight facial areas of Japanese female subjects and statistically proved useful by kappa coefficient analysis (8,9), respectively. Wrinkles were graded on a scale of 5: 1 = no wrinkles; 2 = mild wrinkles; 3 = mild/moderate wrinkles; 4 = moderate wrinkles; 5 = severe wrinkles. Sagging was graded on a scale of 6: 0 = no sagging (no irregularities on the cheek); 1 = slight sagging (the relief of the nasolabial groove was distinct due to the descent of the upper cheek area); 2 = mild sagging (the relief of the nasolabial groove was distinct due to the descent of the upper cheek area, and a shallow relief formed from the anterior area of the ear toward the jaw); 3 = moderate sagging (the relief of the nasolabial groove to the corner of the mouth was clear); 4 = severe sagging (the relief of the nasolabial groove was connected to the corner of the mouth and from the anterior area of the ear toward the jaw); 5 = very severe sagging (the cheek dropped beyond the outline of the jaw, and a silk crepe-pattern relief appeared in the cheek). Score assessment was performed by an experienced observer.

STATISTICAL ANALYSIS

A linear function was used to calculate the correlation coefficients between the wrinkling or sagging scores and the ages of the subjects, as shown in the tables. Differences were analyzed by Mann-Whitney's U test.

RESULTS

COMPARISON OF WRINKLE SCORE IN CAUCASIAN FEMALES AND IN JAPANESE FEMALES

Table II shows the wrinkle scores in eight areas of the face in the 85 Caucasian females using the photoscale established for Japanese females. In the group aged 20-29 years, the score was 2 (mild wrinkles) or more in all areas, except for the upper eyelid. The wrinkle scores in all areas increased with age. The group aged 60-69 years showed high mean

Table II
Mean Wrinkle Grade Variation With Age (mean \pm SD) at Different Skin Sites (Caucasian)

Age group	Forehead	Glabella	Upper eyelid	Corner of the eye	Lower eyelid	Nasolabial groove	Cheek	Corner of the mouth
20–29	2.50 \pm 0.89	2.06 \pm 1.06	1.86 \pm 0.66	2.06 \pm 0.68	3.25 \pm 0.58	2.56 \pm 0.73	2.25 \pm 0.68	2.25 \pm 0.45
30–39	3.00 \pm 1.00	3.05 \pm 0.97	2.89 \pm 0.90	3.14 \pm 0.65	3.81 \pm 0.68	3.19 \pm 0.68	3.14 \pm 0.73	3.00 \pm 0.71
40–49	3.88 \pm 0.70	3.88 \pm 0.70	3.50 \pm 1.00	3.88 \pm 0.60	4.65 \pm 0.49	3.71 \pm 0.99	3.65 \pm 0.49	3.76 \pm 0.75
50–59	4.13 \pm 0.83	3.87 \pm 0.74	3.91 \pm 0.83	4.00 \pm 0.76	4.47 \pm 0.64	4.33 \pm 0.72	3.87 \pm 0.74	4.27 \pm 0.80
60–69	3.81 \pm 0.98	4.19 \pm 0.66	4.36 \pm 0.63	4.44 \pm 0.51	4.88 \pm 0.34	4.69 \pm 0.60	4.56 \pm 0.63	4.69 \pm 0.48
Average	3.44 \pm 1.06	3.39 \pm 1.12	3.25 \pm 1.18	3.48 \pm 1.03	4.19 \pm 0.81	3.66 \pm 1.05	3.47 \pm 1.00	3.55 \pm 1.07
Correlation coefficient	r = 0.516 <i>p</i> < 0.001	r = 0.655 <i>p</i> < 0.001	r = 0.762 <i>p</i> < 0.001	r = 0.769 <i>p</i> < 0.001	r = 0.681 <i>p</i> < 0.001	r = 0.711 <i>p</i> < 0.001	r = 0.755 <i>p</i> < 0.001	r = 0.808 <i>p</i> < 0.001

Table III
Mean Wrinkle Grade Variation With Age (mean \pm SD) at Different Skin Sites (Japanese)

Age group	Forehead	Glabella	Upper eyelid	Corner of the eye	Lower eyelid	Nasolabial groove	Cheek	Corner of the mouth
20–29	1.79 \pm 0.70	1.21 \pm 0.43	1.29 \pm 0.47	1.21 \pm 0.43	1.71 \pm 0.47	1.57 \pm 0.65	1.14 \pm 0.36	1.14 \pm 0.36
30–39	2.43 \pm 0.94	1.86 \pm 0.66	2.00 \pm 0.55	2.07 \pm 0.83	2.43 \pm 0.51	2.21 \pm 0.58	1.64 \pm 0.50	1.86 \pm 0.66
40–49	2.86 \pm 0.86	2.93 \pm 0.92	2.79 \pm 0.80	2.86 \pm 0.53	3.07 \pm 0.47	3.00 \pm 0.96	2.57 \pm 0.51	2.57 \pm 0.51
50–59	3.57 \pm 1.02	2.86 \pm 0.86	3.50 \pm 0.65	3.50 \pm 0.52	3.86 \pm 0.66	3.29 \pm 0.73	3.14 \pm 0.53	3.50 \pm 0.52
60–69	4.43 \pm 0.76	4.14 \pm 0.95	4.36 \pm 0.50	4.14 \pm 0.36	4.50 \pm 0.52	4.50 \pm 0.52	3.64 \pm 0.50	3.93 \pm 0.47
Average	3.01 \pm 1.25	2.60 \pm 1.27	2.79 \pm 1.24	2.76 \pm 1.17	3.11 \pm 1.12	2.91 \pm 1.21	2.43 \pm 1.04	2.60 \pm 1.15
Correlation coefficient	$r = 0.766$ $p < 0.001$	$r = 0.801$ $p < 0.001$	$r = 0.898$ $p < 0.001$	$r = 0.911$ $p < 0.001$	$r = 0.892$ $p < 0.001$	$r = 0.842$ $p < 0.001$	$r = 0.889$ $p < 0.001$	$r = 0.910$ $p < 0.001$

scores (4.5 or greater) in the lower eyelid, nasolabial groove, cheek, and the corner of the mouth.

Table III shows the wrinkle scores in eight areas of the face in 70 Japanese females using the same photoscale. In the group aged 20–29 years, the mean score was between 1 and 2 in all areas except the forehead, which was consistent with our previous study (6). As seen in Caucasian females, the wrinkle scores in all areas increased with age.

Figure 1(A–H) compares the results between the Caucasian and Japanese females in each area of the face in each age group.

Forehead. The wrinkle scores were significantly lower in Japanese females than in Caucasian females in the groups aged 20–29 and 40–49 years, slightly lower in Japanese females than in Caucasian females in the groups aged 30–39 years, but similar between Japanese and Caucasian females in the groups aged 50–59 and 60–69 years (Figure 1A).

Glabella. The wrinkle scores were significantly lower in Japanese females than in Caucasian females in the groups aged 20–29, 30–39, 40–49, and 50–59 years, but similar between Japanese and Caucasian females in the groups aged 60–69 years (Figure 1B).

Upper eyelid. The wrinkle scores were significantly lower in Japanese females than in Caucasian females in the groups aged 20–29 and 30–39 years, slightly lower in Japanese females than in Caucasian females in the groups aged 40–49 years, but similar between Japanese and Caucasian females in the groups aged 50–59 and 60–69 years (Figure 1C).

Corner of the eye. The wrinkle scores were significantly lower in Japanese females than in Caucasian females in the groups aged 20–29, 30–39, and 40–49 years, but similar between Japanese and Caucasian females in the groups aged 50 years or more (Figure 1D).

Lower eyelid. In all age groups (20–69 years), Japanese females showed significantly lower wrinkle scores than Caucasian females (Figure 1E).

Nasolabial groove. The wrinkle scores were significantly lower in Japanese females than in Caucasian females in the groups aged 20–29, 30–39, 40–49, and 50–59 years, but similar in the groups aged 60–69 years (Figure 1F).

Cheek. In all age groups (20–69 years), Japanese females showed significantly lower wrinkle scores than Caucasian females (Figure 1G).

Corner of the mouth. In all age groups (20–69 years), Japanese females showed significantly lower wrinkle scores than Caucasian females (Figure 1H).

COMPARISON OF LOWER CHEEK SAGGING BETWEEN CAUCASIAN AND JAPANESE FEMALES

Table IV compares the lower-cheek sagging scores between the Japanese and Caucasian females. In the Caucasian females as well as in the Japanese females, the sagging scores increased with age.

Figure 2 compares subzygomatic sagging between Caucasian and Japanese females in each age group. The sagging scores did not significantly differ between Caucasian and Japanese females in the groups aged 20–29 and 30–39 years, but were significantly higher in Caucasian females than in Japanese females in the groups aged 40 years or more.

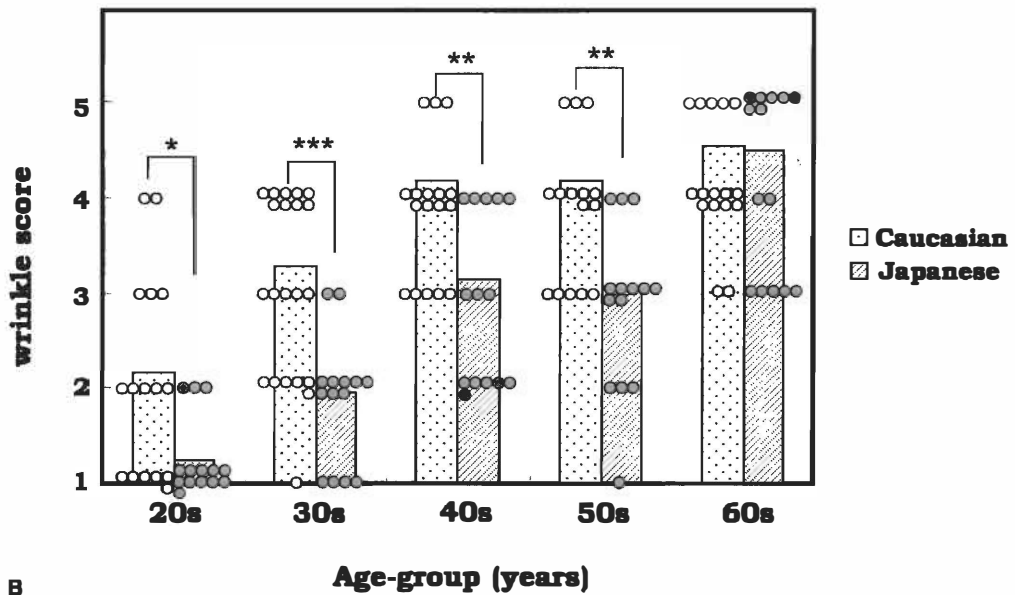
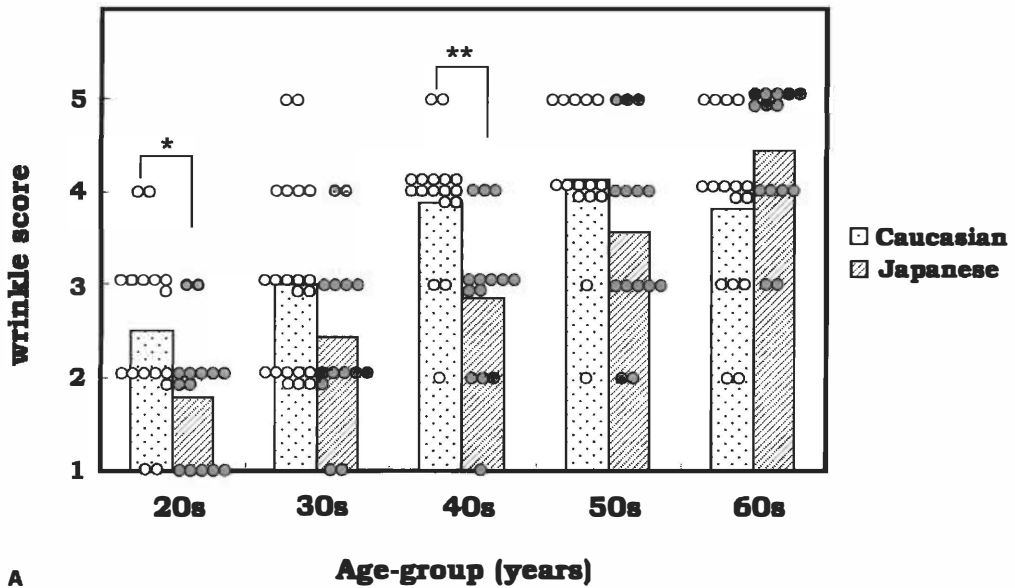


Figure 1. Comparison of wrinkle scores between Caucasian and Japanese females. (A): Forehead. (B): Glabella. (C): Upper eyelid. (D): Corner of the eye. (E): Lower eyelid. (F): Nasolabial groove. (G): Cheek. (H): Corner of the mouth. ***, **, *: $p < 0.001, 0.01, 0.05$, respectively. (Continued on pp. 380–382)

In this study, photos were taken with the subjects' eyes open. Wrinkle score assessment in the upper eyelid was possible in all Japanese females but was impossible in the 16 Caucasian females with markedly depressed upper eyelids (data not shown).

DISCUSSION

We compared wrinkle and sagging scores between Caucasian females living in North

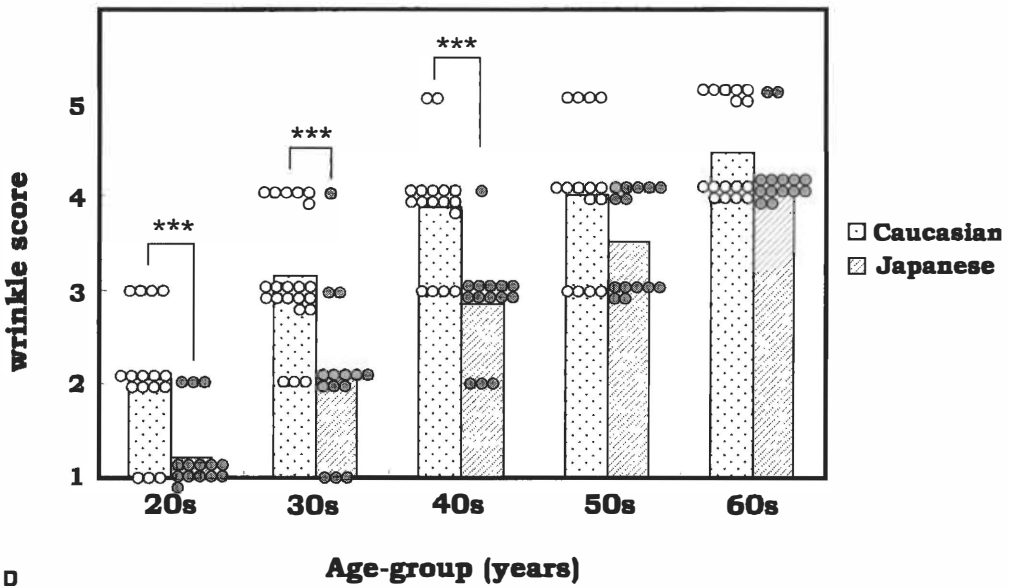
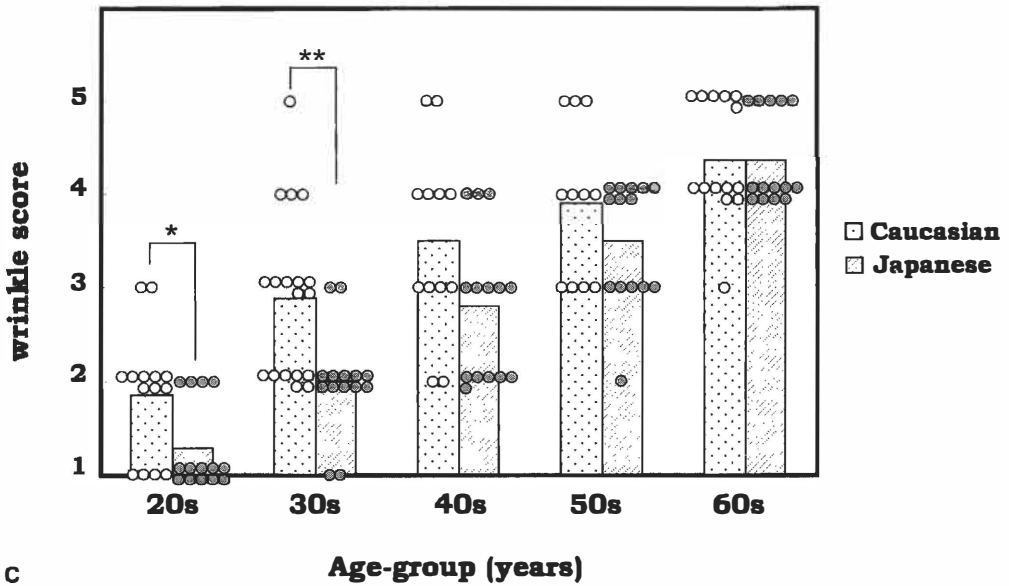
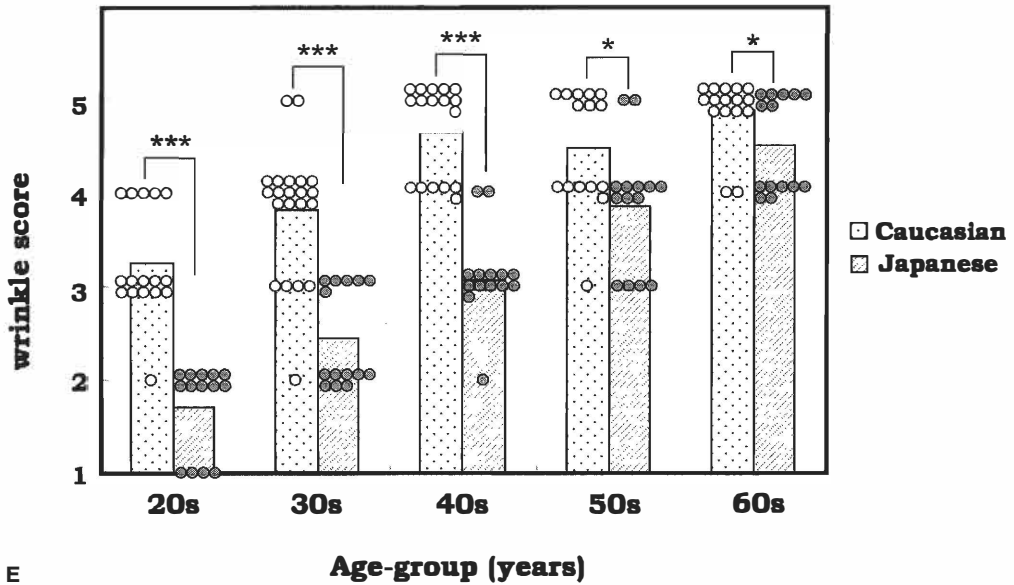
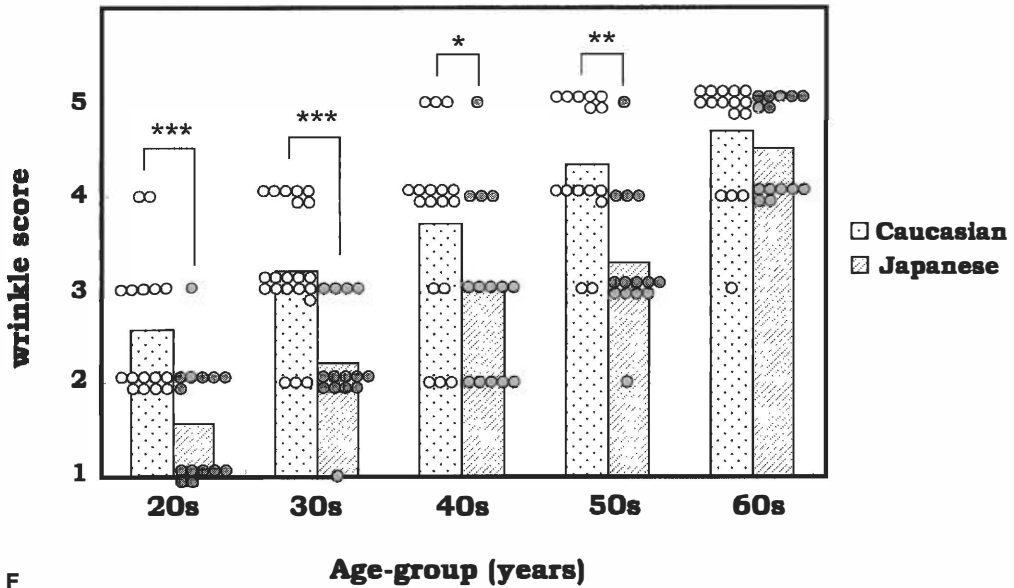


Figure 1. (continued)

American and Japanese females living in Tokyo using a photo scale originally established for Japanese female subjects (6,7). Table V compares the wrinkle scores between Caucasian and Japanese females in eight areas of the face and the sagging scores in the subzygomatic area. The wrinkle score in each area was significantly higher in the Caucasian females than in the Japanese females in the young groups aged 20–29 years. The Caucasian females showed especially high wrinkle scores in the lower eyelid, nasolabial groove, cheek, and the corner of the mouth at all ages, and a marked increase in the subzygomatic sagging score in the group aged 40–49 years. Since wrinkles in the



E



F

Figure 1. (continued)

nasolabial groove, cheek, and the corner of the mouth are considered to be due to subzygomatic sagging (7), Caucasian females may tend to develop wrinkles in their faces from a young age, and become more susceptible to sagging than Japanese females during the middle and later years. In Caucasian females, the wrinkle score in the lower eyelid was very high (3.25) in the group aged 20–29 years, but appeared to reach a plateau in the group aged 40–49 years. Therefore, in Caucasian females, the assessment of wrinkles in all areas of the face, excluding the lower eyelid, and subzygomatic sagging may be possible using photo standards established for Japanese under the age of 60–69 years. In

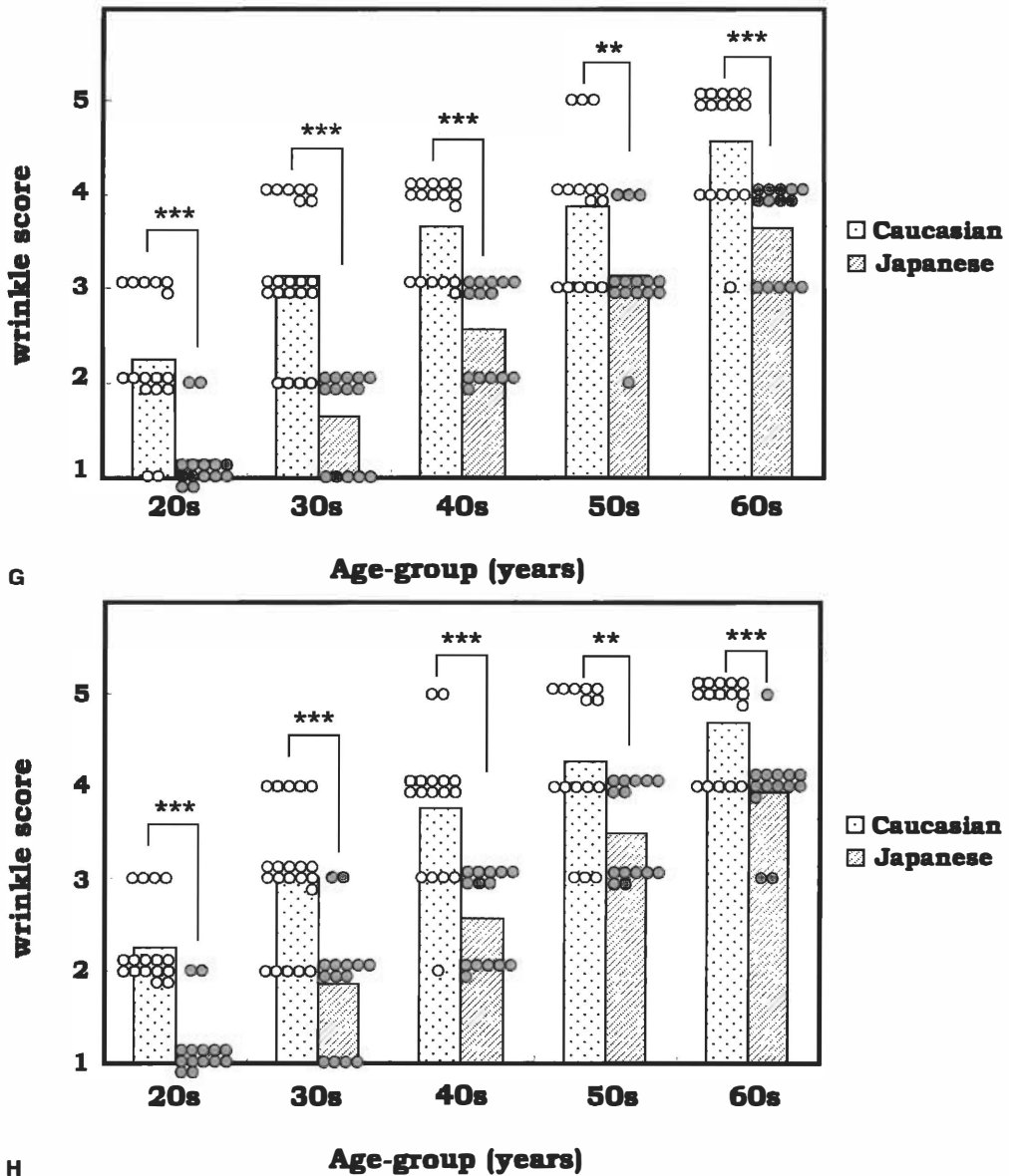


Figure 1. (continued)

the lower eyelids of Caucasian females, marked lateral wrinkle formation from the lower area of the inner eye canthus was observed at a young age, and the mean wrinkle score almost reached a peak value of 5 in the group aged 40–49 years. Therefore, to assess wrinkles in this area, new criteria should be established. On the other hand, since photos with the eyes open were used in this study, there were some Caucasian subjects with wrinkles in the upper eyelid that could not be assessed. Shirakabe (10) reported that methods of cosmetic surgery differ between Westerners and Japanese due to differences in facial morphology. To make aged eyes look younger, he depresses the upper eyelids

Table IV
Comparison of Lower Cheek Sagging Scores (mean \pm SD) Between Caucasian and Japanese Females

Age group	Sagging score	
	Caucasian	Japanese
20–29	1.06 \pm 0.44	0.71 \pm 0.61
30–39	1.86 \pm 0.65	1.42 \pm 0.51
40–49	2.82 \pm 0.64	2.00 \pm 0.68
50–59	3.47 \pm 0.74	2.50 \pm 0.52
60–69	4.19 \pm 0.66	3.43 \pm 0.51
Average	2.62 \pm 1.26	2.01 \pm 1.08
Correlation coefficient	$r = 0.886$ $p < 0.001$	$r = 0.875$ $p < 0.001$

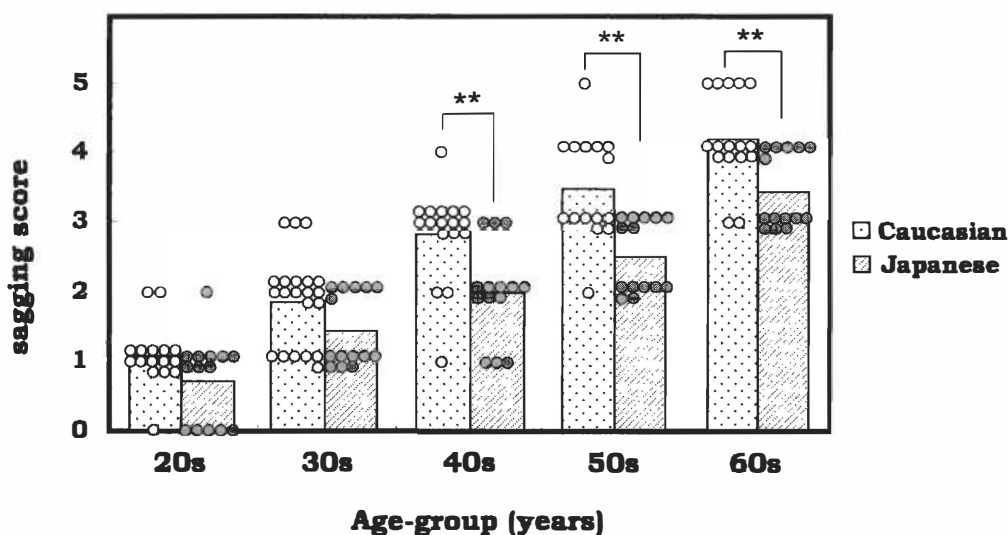


Figure 2. Comparison of the subzygomatic sagging scores between Caucasian and Japanese females. ***, **, *: $p < 0.001$, 0.01, 0.05, respectively.

in Westerners but, on the contrary, he reduces the depression of the eyes in Japanese. Therefore, different factors may be involved in age-related changes in the wrinkle morphology and sagging characteristics of each race.

Garstein and Shaya (11) evaluated age-related changes in the total length of facial lines by two-dimensional analysis of wrinkles using photos of Caucasian females. They compared two groups, one living in Seattle, Washington, who spent their time outdoors for five hours or less each day (low-UV-exposure group), and another group living in Tucson, Arizona, who spent their time outdoors for seven hours or more each day (high-UV-exposure group). In that study, the total length of facial lines was significantly greater in the high-UV-exposure group than in the low-UV-exposure group in almost all age groups from 20–29 years to 60–64 years. Hillebrand *et al.* (12) analyzed age-related changes in the number and length of wrinkles identified in images of the faces of females aged 5–65 years. They compared Japanese females living in Kagoshima, located in the southern part of Japan, with those living in Akita, located in the northern part. They

Table V
Comparison of Wrinkle Score and Sagging Score in Different Facial Skin Sites: Level of Caucasian Scores Compared With Japanese Scores

Age group	Wrinkling								
	Forehead	Glabella	Upper eyelid	Corner of the eye	Lower eyelid	Nasolabial groove	Cheek	Corner of the mouth	Sagging
20–29	↑	↑	↑	↑	↑	↑	↑	↑	↗
30–39	↗	↑	↑	↑	↑	↑	↑	↑	↗
40–49	↑	↑	↗	↑	↑	↑	↑	↑	↑
50–59	↗	↑	↗	↗	↑	↑	↑	↑	↑
60–69	↘	↔	↔	↗	↑	↗	↑	↑	↑



: Significantly higher scores than the Japanese females.



: Higher scores than the Japanese females (not significantly).



: Level equal to that of the Japanese females.



: Lower scores than the Japanese females (not significantly).

observed the same wrinkle levels in 40-year-old females in Kagoshima and 48-year-old females in Akita, suggesting the influence of UV exposure on wrinkle formation. Human skin is classified according to UV sensitivity into phototypes I–IV (13). One study, which evaluated the severity of wrinkles by scoring according to four skin types in 230 Japanese males and females aged 40 years or more, showed that subjects with skin types highly sensitive to UV tended to develop deep wrinkles due to photoaging (14). Therefore, the amount of UV exposure and skin type may be closely associated with wrinkle formation.

In addition to the skin, the skeleton and facial muscles have been reported to be closely involved in the aging of the face (15). We previously obtained wrinkle replicas in eight areas of the face from 136 Japanese females living in Tokyo in ten-year age groups ranging from 18 to 83 years of age, and we evaluated age-related changes in the depth and coarseness of wrinkles by 3D analysis. Although the entire face had been exposed to UV, the degree of wrinkle development differed among areas. We speculated that factors other than UV, namely, mechanical factors such as facial movements and sensitivity to transient wrinkle formation, are the primary causes of wrinkle formation (16). Loth (17) reported differences in anatomical morphology and incidence of facial muscles among races. Therefore, in addition to the amount of UV exposure and skin type, differences in the facial muscles and skeleton may have caused higher wrinkling and sagging scores in the Caucasian females than in the Japanese females. Resolution of this speculation will require further study.

This study compared age-related changes in wrinkling and subzygomatic sagging between Caucasian females living in North America and Japanese females living in Tokyo.

The Caucasian females showed significantly higher wrinkle scores than the Japanese females in the eight evaluated areas of the face in the groups aged 20–29 years; marked increases in wrinkles in the lower eyelid, and especially marked increases in wrinkles in the nasolabial groove, cheek, and corner of the mouth, which are considered to be due to subzygomatic sagging, in the groups aged 40–49 years or more; and a significantly higher sagging score in the groups aged 40–49 years or more.

REFERENCES

- (1) P. G. Agachi, J. Mignot, and S. Makki, "Microtopography of the Skin and Aging," in *Cutaneous Aging*, (University of Tokyo Press, Tokyo, 1988), pp. 475–499.
- (2) G. L. Grove and M. J. Grove, "Objective Methods for Assessing Skin Surface Topography Noninvasively," in *Cutaneous Investigation in Health and Disease*, J. L. Leveque, Ed. (Marcel Dekker, New York and Basel, 1989), pp. 1–32.
- (3) J. L. Leveque and P. Corcuff, "The Surface of the Skin," in *Noninvasive Methods for the Quantification of Skin Functions*, P. J. Frosch and A. M. Kligman, Eds. (Springer-Verlag, Berlin, 1993), pp. 223–240.
- (4) C. E. M. Griffiths, T. S. Wang, T. A. Hamilton, J. J. Voorhees, and C. N. Ellis, A photometric scale for the assessment of cutaneous photodamage, *Arch. Dermatol.*, **128**, 347–351 (1992).
- (5) C. Larnier, J. P. Ortonne, A. Venot, B. Faivre, J. C. Beani, P. Thomas, T. C. Brown, and E. Sendagorta, Evaluation of cutaneous photodamage using a photographic scale, *Br. J. Dermatol.*, **130**, 167–173 (1994).
- (6) K. Tsukahara, Y. Takema, H. Kazama, Y. Yorimoto, T. Fujimura, S. Moriwaki, T. Kitahara, and M. Kawai, A photographic scale for the assessment of human facial wrinkles, *J. Cosmet. Sci.*, **51**, 127–139 (2000).
- (7) K. Tsukahara, Y. Takema, T. Fujimura, S. Moriwaki, T. Kitahara, and G. Imokawa, Determination of age-related changes in the morphological structure (sagging) of the human cheek using a photometric scale and 3-dimensional surface parameters, *Int. J. Cosmet. Sci.*, **22**, 247–258 (2000).
- (8) J. Cohen, A coefficient of agreement for nominal scales, *Educ. Psychol. Meas.*, **20**, 37–46 (1960).
- (9) J. D. Fleiss and J. Cohen, Large sample standard errors of kappa and weighted kappa, *Psychol. Bull.*, **72**, 323–327 (1969).
- (10) Y. Shirakabe, Aging and rejuvenation of Japanese face from the aspect of cosmetic surgery, *J. Jpn. Cosmet. Sci. Soc.*, **25**, 100–103 (2001).
- (11) V. Gartstein and S. A. Shaya, Image analysis of facial skin features, *Proc. Int. Soc. Optic. Eng.*, **626**, 284–288 (1986).
- (12) G. G. Hillebrand, K. Miyamoto, B. Schnell, M. Ichihashi, R. Shinkura, and S. Akiba, Quantitative evaluation of skin condition in an epidemiological survey of females living in northern versus southern Japan, *J. Dermatol. Sci.*, **27**, S42–S52 (2001).
- (13) T. B. Fitzpatrick, The validity and practicality of sun-reactive skin types I through VI, *Arch. Dermatol.*, **124**, 869–871 (1988).
- (14) H. Nagashima, K. Hanada, and I. Hashimoto, Correlation of skin phototype with facial wrinkle formation, *Photodermatol. Photoimmunol. Photomed.*, **15**, 2–6 (1999).
- (15) M. S. Zimble, M. S. Kokoska, and J. R. Thomas, Anatomy and pathophysiology of facial aging, *Facial Plast. Surg. Clin. N. Am.*, **9**, 179–187 (2001).
- (16) Y. Takema, K. Tsukahara, T. Fujimura, and M. Hattori, Age-related changes of 3-dimensional morphological changes in the human facial skin, *Skin Res. Tech.*, **5**, 145–149 (1996).
- (17) E. Loth, "L'Anthropologie Spéciale des Parties Molles," in *Anthropologie des Parties Molles* (Masson Cie, Paris, 1931), pp. 14–70.