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ORIGINAL ARTICLE

Age-dependent changes in skin features and perceived facial appearance in women of five ethnic groups

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Abstract

Objective: Research documents effects of skin features on assessments of age, health and attractiveness of female faces. Ethnic variation also has been reported for the impact of age-related changes in skin features on face assessments. Here, we investigate women's self-ratings across age cohorts and ethnic groups and discrepancies with (non-expert) assessor ratings of facial appearance together with age-dependent changes in skin features.

Methods: Faces of women 20–65 years from five ethnic groups (each $n=36$) were imaged. Participants provided self-ratings of age, health and attractiveness, and were judged on these attributes by members of the same ethnic group (each $n=120$). Digital image analysis was used to quantify skin gloss, tone evenness, wrinkling and sagging. Age-dependent changes in ratings and skin features within and between ethnic groups were assessed by comparing information from 10-year cohorts. We also tested whether menopausal status could be predicted by self-ratings, assessor ratings and image-based skin features.

Results: Women of all ethnic groups judged themselves younger and higher in attractiveness and health compared to third-party assessors, with the largest discrepancies for age in French women and for attractiveness and health in South African women. In Indian and South African women, specular gloss and skin tone evenness were lower compared to other participants, and sagging was higher in Indian, Japanese and South African women compared to Chinese and French women. Women's menopausal status could be predicted from assessor ratings and image-based skin features but not from self-ratings.

Conclusion: There are differences between women's self-ratings and assessor ratings of facial appearance. These discrepancies vary with female age and ethnicity. Age and ethnicity effects also are evident in age-dependent changes in skin features within and across ethnic groups, which together with assessor (but not self-) ratings of facial appearance predict menopausal status.

KEYWORDS

age, attractiveness, ethnicity, facial skin features, health, menopause

Résumé

Objectif: l'étude documente les effets des caractéristiques de la peau sur les évaluations de l'âge, de la santé et de l'attractivité des visages féminins. Des variations ethniques ont également été rapportées en ce qui concerne l'impact des changements liés à l'âge dans les caractéristiques de la peau sur les évaluations du visage. Ici, nous étudions les auto-évaluations des femmes à travers les cohortes d'âge et les groupes ethniques et les divergences avec les évaluations (non expertes) de l'apparence du visage ainsi que les changements des caractéristiques de la peau dépendant de l'âge.

Méthodes: les visages des femmes âgées de 20 à 65 ans issues de cinq groupes ethniques (chacun $n=36$) ont été examinés par imagerie. Les participantes ont fourni des auto-évaluations de leur âge, de leur santé et de leur attractivité, et ont été jugées sur ces attributs par les membres du même groupe ethnique (chacun $n=120$). L'analyse d'images numériques a été utilisée pour quantifier la luminosité de la peau, l'uniformité du teint, les rides et le relâchement cutané. Les changements dépendants de l'âge dans les évaluations et les caractéristiques de la peau au sein et entre les groupes ethniques ont été évalués en comparant les informations provenant de cohortes sur 10 ans. Nous avons également évalué si le statut ménopausique pouvait être prédit par les auto-évaluations, les évaluations de l'évaluateur et les caractéristiques de la peau basées sur l'imagerie.

Résultats: les femmes de tous les groupes ethniques se sont jugées plus jeunes et plus performantes en termes d'attractivité et de santé par rapport aux évaluateurs tiers, les plus grandes discordances concernant l'âge chez les femmes françaises et l'attractivité et la santé chez les femmes sud-africaines. Chez les femmes indiennes et sud-africaines, la luminosité spéculaire et l'uniformité du teint de la peau étaient inférieures à celles des autres participantes, et le relâchement cutané était plus élevé chez les femmes indiennes, japonaises et sud-africaines que chez les femmes chinoises et françaises. Le statut ménopausique des femmes pouvait être prédit à partir des évaluations de l'évaluateur et des caractéristiques cutanées basées sur l'imagerie, mais pas à partir des auto-évaluations.

Conclusion: il existe des différences entre les auto-évaluations des femmes et les évaluations de l'apparence faciale par l'évaluateur. Ces divergences varient en fonction de l'âge et de l'origine ethnique des femmes. Les effets sur l'âge et l'origine ethnique sont également évidents dans les changements dépendants de l'âge des caractéristiques de la peau au sein et entre les groupes ethniques, qui, avec les évaluations de l'évaluateur (mais pas de l'auto-évaluation) de l'apparence du visage, prédisent le statut ménopausique.

INTRODUCTION

Research on age-dependent facial skin changes in lightly pigmented women documents effects of skin surface topography [1, 2] and skin tone evenness [3, 4] on perceptions of appearance. Greater facial wrinkles, sagging and discolouration lead assessors to judge a woman's face as older, less attractive and less healthy [5]. Some of these relationships transcend populations even in the absence of familiarity with age-related changes in the features. For example, members of two traditional societies, the Maasai (Tanzania) and the Tsimane' (Bolivia), judged images of even-toned British women's facial skin younger and healthier than images with heterogeneous skin colouration (from older women) [6].

Evidence on cross-cultural consistency in assessments of facial appearance is mixed [7–12]. According to evolutionary scientists, some of the mental algorithms deployed in social perception evolved to facilitate decisions relevant to reproduction [13]. Thus, they should be shared across populations [8, 14]. However, this does not preclude variation in, for example, beauty standards, as the constituents of attractiveness in a population are likely influenced by both evolved adaptations and sociocultural factors in response to local settings [15, 16].

As we age, skin deteriorates due to intrinsic and extrinsic factors [5, 17, 18]. Intrinsic factors include (naturally occurring) genetic and hormonal processes that have degenerative effects on the skin that are more difficult to address from a cosmetic dermatology perspective than extrinsic factors [19]. Extrinsic factors on cutaneous ageing include environmental causes such as photoaging due to sun exposure [20–22] (but see Ref. [23] for photoaging as a distinct physiological process), pollution [24, 25], lifestyle (e.g. smoking [26] and diet [27]) and cosmetic habits [28]. The first signs of intrinsic and extrinsic effects on age-related skin changes begin to manifest at the cellular level around the age of 25–30 years [29, 30]. Later, skin elasticity progressively deteriorates and becomes visible as wrinkling and sagging [18, 31]. In addition, pigmentary changes due to cumulative photodamage lead to an increase in skin tone unevenness and diminishing skin radiance [32], making the skin appear duller and less healthy. Skin ageing processes in women are accelerated by decreases in oestrogen and progesterone synthesis after menopause [19, 33], that is, the permanent cessation of menstruation (at least 12 months of amenorrhoea from failed ovarian function [34]). Age at menopause varies between individuals and across populations [35]. Mean age of final menstruation around 50–52 years has been reported for Western societies [36]. However, these mean ages range from 40 to 60 years and the variation is attributable to several factors, including socioeconomic status, menarche age, oral contraceptive use and ethnicity [35]. A meta-analysis of 36 studies across six continents reported an overall mean age of menopause of 48.8 years (ranging from 46 to 52 years) [37].

Changes in female physiology at menopause affect intrinsic skin ageing. Estimates suggest that ~30% of skin collagen is lost in the first 5 years of menopause [38]. Skin becomes thinner due to structural changes in the dermis and, together with loss of elasticity and hydration, this leads to wrinkling [39]. In addition, skin melanocyte level decreases by 10%–20% per decade in post-menopausal women, leading to a decrease in skin tone evenness [39]. Ethnic differences in skin ageing at menopause have been reported [40, 41]. Menopausal darkly pigmented women, for example, have lower wrinkling scores than menopausal lightly pigmented women, possibly attributable to ethnic differences in susceptibility to photoaging [41–44]. Many women report skin disorders during menopause, including pruritus, hyperhidrosis androgenic alopecia and impaired wound healing [45]. These symptoms are distressing for most women and, together with the experience of bodily changes and loss of fertility, can affect self-image [46] and contribute to a decline in quality of life [47, 48]. It is not surprising, therefore, that many women pursue coping strategies, ranging from psychological intervention to hormone therapy [49].

In the current study, we considered women's self-ratings and (non-expert) assessor ratings of age, attractiveness and health of facial images. We examined the relationships of these ratings to perceptions of digital facial portraits of women from different age groups, ranging from 20 to 65 years. We also secured objective, quantitative measurements of skin from participants' portraits. Participants comprised women from five ethnic groups (Chinese, Japanese, French, Indian and South African) and assessors for each group were the same ethnicity as the rated women. Previous reports of data from this multi-ethnic and multi-centre study indicated some variation in perceptions of female facial appearance across ethnicities, with the universal finding of an age-related decline in attractiveness and health assessments [50, 51]. More recently, we reported differences in the relative predictive utility of individual skin features (assessed by skin image analysis) in accounting for ratings of age, health and attractiveness. These differences were also observed between ethnic groups, although facial wrinkling and sagging remained the best predictors of face ratings across ethnicities [52].

The current study provides a more detailed assessment of age-dependent perceptions of female faces and related skin features (skin gloss, tone evenness, wrinkles and sagging). We were primarily interested in discrepancies between self-ratings and assessor ratings of women's faces, and whether such discrepancies differ between ethnic groups. This investigation was exploratory as information from systematic investigation is scarce, especially in cross-cultural contexts. Concerning age-dependent changes in skin features, we expected to detect differences between age cohorts of female participants, especially in peri- and post-menopausal women. Finally, we investigated whether self-ratings, assessor ratings and skin image variables predict women's responses to the question about their menopausal status.

METHODS

Study sample

Digital portraits of women and rating data were taken in five locations – Guangzhou (China), Tokyo (Japan), Lyon (France), New Delhi (India) and Cape Town (South Africa) – using identical experimental equipment and protocols that were part of a multi-ethnic and multi-site project on the perception of female facial appearance. Currently, there are five reports on study data [50–54], including two in this journal [52, 53]. Therefore, we keep the description of the methods brief but comprehensive enough so that consultation of previous articles is not required to understand the current report.

The faces of women from five ethnic groups ('participants'; $n=526$) were imaged: Chinese ($n=106$), Japanese ($n=100$), French ($n=105$), Indian ($n=100$) and South African ($n=115$). Participants aged 20–69 years were equally distributed for each group around the mean ages of 10-year cohorts. According to the Fitzpatrick scale [55], participants' facial skin tone corresponded to the following types (as assessed by skin experts at the study centres): Chinese II–IV, Japanese II–IV, French II–III, Indian IV–V and South African V–VI. Women were screened before recruitment (for details, see Refs. [50, 52, 53]) and provided written informed consent. The study was approved by the Reading Independent Ethics Committee (RIEC), Woodley (U.K.), and the ACEAS Independent Ethics Committee, Ahmedabad (India).

Self-ratings

Participants rated themselves for age, attractiveness and health on computer screens after providing the requested demographic information. Concerning age, participants were asked 'How old do you feel?' (in years) and responded on a scale ranging from 0 to 100. Self-rated attractiveness and health were provided on a scale ranging from 'not attractive/not healthy' (0) to 'attractive/healthy' (100).

Facial imaging

Female portraits were imaged in frontal view, with eyes open and with a neutral facial expression using the ColorFace® System (Newtone Technologies, Lyon, France) (see Figure 1). The flash intensity was reduced, and the light sensitivity of the camera sensor increased to minimize disturbance of the participant during imaging. Facial images were recorded under different polarization angles – a requirement for skin image analysis from portraits (for details, see Ref. [52]).

Face ratings

For the image ratings, a subset of 180 images (of the total sample with $n=526$ participants) was selected, following quality control by three independent raters and the randomly stratified selection for participant/assessor ethnicity, assessor gender and age cohort. Thus, each ethnic group included participants from the ages of 20–65 years and age-matched assessors. Participants were equally distributed around the mean ages of 10-year cohorts and assessors around the mean ages of 15-year cohorts (see Ref. [50]). This procedure identified 36 images per ethnicity for presentation on 27″ (68.6 cm) colour-calibrated LCD monitors (ColorEdge CG277, Eizo, Hakusan, Japan). In total, 600 assessors (299 women) rated the images on computer screens for perceived age (in years), attractiveness and health [on continuous scales ranging from 0 to 100; 0 = low on attribute to 100 = high on attribute] in the study centres

FIGURE 1 Sample images of female participants for presentation in the rating study. Chinese (a), Japanese (b) French (c), Indian (d) and South African (e).

where the facial images were recorded. There were 120 female and male assessors in each ethnic group.

Facial portraits were judged sequentially (with attributes in blocks), and each assessor rated 90 randomly selected facial images per attribute, balanced across cohorts (i.e. 270 images, in total). Thus, each image was assessed ~300 times in total, 10 times per subgroup (cohort, ethnicity and gender) (for additional details about the rating procedure, see Ref. [52]). In the analyses of the present study, we considered only the face ratings provided by raters of the same ethnicity as the women‘s (participant‘s faces) ethnicity.

Skin image measurements

The skin image measurements have been described in detail in a previous report [52]. In brief, several regions of interest (ROIs) in the digital portraits were defined. Gloss and skin tone evenness were measured in the full face, wrinkles at the glabella, the crow's feet region, the area underneath the eyes and the upper lips area. Sagging was measured from the nasolabial fold and the marionette lines (see fig. 2 in Ref. [52]). Additional measurements recorded by Voegeli et al. [52] were used in the present study. Here, we focussed on a minimum number of non-redundant, technical measurements that played a role in predicting face ratings across ethnic groups [52].

Specular gloss was defined as the mean luminance of bright pixels in the image. Higher specular gloss corresponds to higher gloss intensity. Skin tone evenness (contrast) was based on grey-level co-occurrence matrices, as described by Haralick et al. [56]. Contrast measures local variations present in an image. Contrast is high for skin that shows local distribution and concentration of melanin (e.g. hyperpigmentation or dyspigmentation) and haemoglobin (e.g. bruising, flushing) [57]. Wrinkles were identified using an algorithm that detects anisotropic elements and retains elements considered wrinkles based on thresholding. Wrinkle length was measured in pixels, such that a lower value corresponds to smaller wrinkles. The wrinkle segmentation algorithm was identical for a given ROI across ethnic groups, but the thresholding was adapted to the respective phototypes. The procedure for the measurement of sagging followed that of wrinkles (but in different ROIs).

Statistical analysis

We report descriptive statistics ($M \pm$ SEM) for participants' self-ratings, assessor ratings and skin image measurements by age group and ethnicity. A univariate ANOVA was used to test for differences in chronological age-by-age group and ethnic group. Chi-square tests were used to assess smoking habits across age groups and ethnicity and for participants' reports about whether menstrual bleeding had stopped completely. Multivariate analyses were performed to assess the significance of effects for self-ratings, assessor ratings and skin image measurements, followed by univariate ANOVAs. For some variables, the assumption of homogeneity of variances (i.e. homoscedasticity) was violated. Thus, we report White's test for heteroscedasticity for information about the variance of the model's error term. In addition, we report R^2 (i.e. coefficient of determination) for the proportion of variance in dependent measures that can be explained by independent variables (i.e. predictors), and partial η^2 as a measure of the effect size (i.e. the proportion of variance [of the total variance] explained by a variable after accounting for variance explained by other variables). Finally, we performed a binary logistic regression to explain participants' responses (yes/no) to a single item about menopause using self-ratings, assessor ratings and skin features. Nagelkerke R^2 was used as the coefficient of determination. For all significance tests, the alpha level was set to 0.05. All tests were performed using IBM SPSS 26 (IBM Corp., Armonk, NY) and JMP 16 (SAS Institute Inc., Cary, NC).

RESULTS

Due to the age-stratified recruitment of participants in each ethnic group, the mean (chronological) age differed between the age groups by ~10 years (adjusted $R^2 = 0.95$; White's test for heteroscedasticity, $\chi^2 = 48.08$, $p < 0.01$). There was a main effect for age group ($F = 836.81$, $p < 0.001$, partial $\eta^2 = 0.97$), no effect for ethnicity ($F = 0.04$, $p = 0.998$, partial $\eta^2 = 0.001$) and no interaction of Age Group × Ethnicity ($F = 0.15$, $p = 0.990$, partial $\eta^2 = 0.016$). The violation of homoscedasticity was caused by smaller ns in the age group 60–65 years, but this did not affect the confirmatory character of findings from this analysis (all pairwise comparisons for age group, $p < 0.001$; and for ethnicity, $p = 0.99$).

Smoking habits did not differ between age groups ($\chi^2 = 15.49$, df = 12, $p = 0.216$) with most participants reporting to have never smoked (Table 1). An ethnic difference was observed in smoking habits ($\chi^2 = 38.33$, df = 12, $p < 0.001$), driven by a lower frequency of French women who reported having never smoked and a higher frequency of current non-smokers compared with other ethnic groups.

No ethnic difference was observed for reports about whether menstrual bleeding has stopped completely ($\chi^2 = 1.31$, df = 4, $p = 0.860$). However, these reports differed between age groups ($\chi^2 = 122.62$, df = 4, $p < 0.001$),

Ethnicity	Never smoked	Current non-smoker	Smoke occasionally	Daily smoker
Chinese	35 (19.4%)	0 (0%)	0 (0%)	1 (0.6%)
Japanese	30 (16.7%)	4 (2.2%)	2 (1.1%)	0 (0%)
French	19 (10.6%)	11 (6.1%)	4 (2.2%)	2 (1.1%)
Indian	34 (18.9%)	1 (0.6%)	1 (0.6%)	0 (0%)
South African	30 (16.7%)	4 (2.2%)	2 (1.1%)	0 (0%)
Total	148 (82.2%)	17 (9.4%)	10 (5.6%)	5 (2.8%)

TABLE 1 Frequencies by ethnicity for participants' ($n=180$) reports of smoking habits.

TABLE 2 Frequencies by age group for participants' ($n=180$) reports of whether their menses have stopped completely.

Age group (years)	No	Yes
20–29	40 (22.2%)	0 (0%)
30–39	38 (21.1%)	2 (1.1%)
40–49	37 (20.6%)	3 (1.7%)
50–59	10 (5.6%)	30 (16.7%)
60–65	0 (0%)	20 (11.1%)
Total	125 (69.4%)	55 (30.6%)

with 75% of women in the 50–59 years group and 100% of women in the 60–65 years group reporting that menstrual bleeding has stopped completely (Table 2).

Self-ratings

Table 3 reports descriptive statistics for self-ratings and assessor ratings of participants by age group and ethnicity.

Multivariate tests indicated effects of age group (Pillai's trace $=0.83$, $F=14.69$, $p<0.001$; partial $\eta^2=0.28$) and ethnicity (Pillai's trace $=0.39$, $F=5.71$, $p<0.001$; partial $\eta^2=0.13$), but no interaction of Age Group × Ethnicity (Pillai's trace $=0.17$, $F=0.57$, $p=0.992$; partial $\eta^2=0.06$).

Age

A univariate ANOVA with self-reported age as the dependent variable and ethnicity and age group as factors (adjusted $R^2=0.77$; White's test for heteroscedasticity, $\chi^2=34.08$, $p=0.083$) revealed a main effect of age group ($F=148.02$, $p<0.001$, partial $\eta^2=0.79$), but no effect of ethnicity ($F=2.22$, $p=0.070$, partial $\eta^2=0.05$) and no interaction of Age Group × Ethnicity ($F=0.79$, $p=0.698$, partial $\eta^2=0.08$). Younger women reported feeling younger than their chronological age, independent of ethnic group membership. French women aged 60–65 years, in particular, reported feeling younger than their chronological age (Table 3) than did women of other ethnicities in that age group (with a difference of ~7–11 years) and the mean (across age groups) was lowest for French women (~1.5–3 years); these differences, however, did not reach statistical significance.

Attractiveness

There was an effect of ethnicity ($F=15.12$, $p<0.001$, partial $\eta^2=0.28$) on self-rated attractiveness, but no effect of age group ($F=0.86$, $p=0.491$, partial $\eta^2=0.02$) and no interaction of Age Group × Ethnicity ($F=0.49$, $p=0.947$, partial $\eta^2=0.05$; ANOVA; adjusted $R^2=0.26$, White's test for heteroscedasticity, $\chi^2=24.2$, $p=0.448$). South African women rated themselves highest for attractiveness, followed by Chinese, Indian, Caucasian and Japanese women (in this order). The mean differences in self-rated attractiveness between South African women and other women ranged from 15 to 30 points (on the 100-point rating scale; for pairwise comparison, all $p<0.001$).

Health

Self-rated health did not differ by age group ($F=0.53$, $p=0.711$, partial $\eta^2=0.01$) or ethnicity ($F=1.79$, $p=0.134$, partial $\eta^2=0.04$), and neither was there an interaction of Age Group × Ethnicity ($F=0.50$, $p=0.943$, partial $\eta^2=0.05$); ANOVA adjusted $R^2=-0.04$; White's test for heteroscedasticity ($\chi^2=26.96$, $p=0.306$). Across age groups, Indian women reported the lowest scores, and South African women reported the highest scores for health. However, as with self-rated attractiveness, variability in self-rated health was notable (see Table 1 for the SEMs); thus, no statistically significant effects emerged for self-rated health as a function of age group or ethnicity.

Assessor ratings

Table 4 reports descriptive statistics for assessor ratings of participants by age group and ethnicity. Multivariate

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TABLE 3 Descriptive statistics ($M \pm SEM$) for participants' self-ratings by age group and ethnicity.

Ethnicity	Age group, 20–29 years	Age group, 30–39 years	Age group, 40–49 years	Age group, 50–59 years	Age group, 60–65 years
Age					
Chinese	21.6 ± 1.5	29.4 ± 1.0	41.3 ± 1.6	51.0 ± 2.2	61.5 ± 1.0
Japanese	24.3 ± 1.3	33.8 ± 1.4	43.8 ± 3.1	49.4 ± 2.4	60.5 ± 4.5
French	21.3 ± 0.8	32.5 ± 1.7	38.5 ± 1.8	48.1 ± 1.9	51.3 ± 4.3
Indian	22.8 ± 0.9	30.9 ± 1.4	43.1 ± 1.6	51.4 ± 2.7	58.8 ± 1.5
South African	25.0 ± 2.5	34.6 ± 5.6	38.5 ± 3.5	52.1 ± 2.3	62.5 ± 3.1
Attractiveness					
Chinese	75.6 ± 4.6	60.0 ± 5.0	67.5 ± 3.1	61.3 ± 4.0	67.5 ± 4.8
Japanese	53.1 ± 3.8	54.4 ± 5.1	47.5 ± 4.1	48.1 ± 5.8	58.8 ± 13.9
French	53.8 ± 7.8	58.8 ± 6.7	47.5 ± 4.1	49.3 ± 1.4	62.5 ± 11.1
Indian	65.0 ± 4.9	64.4 ± 5.8	59.4 ± 5.1	59.9 ± 5.9	62.5 ± 7.5
South African	77.4 ± 7.9	80.0 ± 12.1	87.5 ± 7.2	79.4 ± 7.1	85.0 ± 11.9
Health					
Chinese	76.9 ± 6.8	71.3 ± 6.4	82.5 ± 2.5	73.8 ± 3.7	82 ± 6.4
Japanese	78.1 ± 5.2	78.8 ± 4.7	73.8 ± 6.8	75.6 ± 4.2	75.0 ± 3.6
French	80.0 ± 8.2	80.0 ± 5.6	72.5 ± 7.7	78.0 ± 6.4	87.5 ± 2.5
Indian	70.4 ± 7.2	61.9 ± 5.0	75.8 ± 4.3	78.5 ± 6.0	70.0 ± 7.1
South African	81.3 ± 7.4	77.5 ± 12.3	88.1 ± 5.0	79.4 ± 10.2	87.5 ± 9.5

Note: Age (in years), attractiveness and health were rated on scales ranging from 0 to 100.

TABLE 4 Descriptive statistics ($M \pm$ SD) for assessor ratings of participants by age group and ethnicity.

Ethnicity	Age group, 20–29 years	Age group, 30–39 years	Age group, 40–49 years	Age group, 50–59 years	Age group, 60–65 years
Age					
Chinese	32.0 ± 0.9	36.7 ± 1.5	44.8 ± 1.7	53.1 ± 1.0	61.5 ± 2.5
Japanese	27.7 ± 1.4	35.2 ± 2.2	43.2 ± 1.0	55.9 ± 2.3	67.0 ± 2.3
French	29.3 ± 1.2	33.7 ± 1.5	47.8 ± 2.4	59.3 ± 2.8	68.2 ± 3.1
Indian	32.2 ± 1.2	39.6 ± 1.2	47.0 ± 1.8	59.7 ± 2.3	61.9 ± 2.5
South African	32.7 ± 0.3	42.9 ± 1.4	49.0 ± 1.5	57.2 ± 1.9	69.0 ± 3.6
Attractiveness					
Chinese	51.7 ± 2.5	47.9 ± 1.9	41.1 ± 1.6	35.2 ± 1.4	32.4 ± 4.3
Japanese	47.7 ± 2.9	38.4 ± 2.4	37.6 ± 1.5	32.5 ± 0.8	31.3 ± 2.0
French	56.6 ± 2.4	49.8 ± 3.8	34.8 ± 3.4	31.7 ± 1.6	26.2 ± 5.0
Indian	48.1 ± 2.4	41.3 ± 1.4	36.4 ± 2.3	28.7 ± 1.8	26.6 ± 1.6
South African	49.5 ± 2.9	36.8 ± 2.6	38.2 ± 2.0	33.2 ± 1.4	26.8 ± 1.3
Health					
Chinese	68.0 ± 2.2	66.2 ± 1.6	59.3 ± 1.0	52.9 ± 1.7	52.5 ± 3.4
Japanese	72.1 ± 1.6	66.7 ± 2.3	63.5 ± 1.7	55.0 ± 1.5	52.7 ± 3.0
French	75.5 ± 1.8	70.9 ± 2.8	59.3 ± 3.1	56.7 ± 2.1	48.1 ± 4.7
Indian	60.7 ± 2.5	53.1 ± 1.7	46.3 ± 2.3	37.5 ± 2.7	34.8 ± 2.2
South African	64.0 ± 2.9	53.7 ± 3.0	51.9 ± 2.5	48.5 ± 2.4	38.7 ± 4.6

Note: Age (in years), attractiveness and health were rated on scales ranging from 0 to 100.

tests indicated effects of age group (Pillai's trace = 0.95, $F = 18.01$, $p < 0.001$; partial $\eta^2 = 0.32$) and ethnicity (Pillai's trace = 0.81, $F = 14.40$, $p < 0.001$; partial $\eta^2 = 0.27$), and an interaction of Age Group × Ethnicity (Pillai's trace = 0.41, $F = 1.54$, $p < 0.05$; partial $\eta^2 = 0.14$).

Age

A univariate ANOVA (adjusted $R^2 = 0.56$, White's test for heteroscedasticity, $\chi^2 = 37.73$, $p < 0.05$) with assessor-rated age as the dependent variable and age group and ethnicity as factors indicated an effect of age group ($F = 257.04$, $p < 0.001$, partial $\eta^2 = 0.87$) and ethnicity ($F = 4.82$, $p < 0.01$, partial $\eta^2 = 0.11$), and interaction of Age Group × Ethnicity ($F = 1.74$, $p < 0.05$, partial $\eta^2 = 0.15$). Women in younger age groups were rated younger than women in older age groups (all pairwise comparisons $p < 0.001$). South African faces were rated oldest, although the differences between French and Indian faces were not statistically significant. Chinese and Japanese faces received the lowest age ratings but differences (~4–4.5 years, respectively) were significant only in comparison to South African faces (both $ps < 0.01$). The interaction of Age Group × Ethnicity indicated some ethnic variation in the rank order of age groups. For example, the mean rated age for the group 20–29 years was lowest for Japanese women and highest for South African women, whereas the mean rated age for the group 30–39 years was lowest for French women and highest for South African women (Table 4). Because of the small effect size and F-ratio for the interaction, we did not further investigate this finding as it may not be robust.

Attractiveness

Concerning assessor-rated attractiveness, there were main effects of age group ($F = 61.07$, $p < 0.001$, partial $\eta^2 = 0.61$), ethnicity ($F = 4.13$, $p < 0.01$, partial $\eta^2 = 0.10$) and interaction of Age Group × Ethnicity ($F = 1.79$, $p < 0.05$, partial $\eta^2 = 0.16$); adjusted $R^2 = 60$; White's test for heteroscedasticity ($\chi^2 = 37.50$, $p < 0.05$). Attractiveness ratings were highest for women in the 20–29 years group, continuously declined and were lowest for women in the 60–65 years group. Pairwise comparisons were significant (all $p < 0.01$) except for the difference between 50–59 years and 60–65 years ($p = 0.438$). The mean difference in attractiveness ratings between the youngest (20–29 years) and the oldest (60–65 years) age groups was ~22 points (on the 100-point scale). Chinese women received the highest attractiveness ratings, followed by French, Japanese, South African and Indian women (in this order). However, these differences were within ~6 points (on average) on the rating scale, and pairwise comparisons indicated significance for Chinese women versus Japanese, Indian and South African (but not French) women. The effect size of ethnicity was smaller than for age group on attractiveness (~1/6). The interaction of Age Group × Ethnicity indicated variation in the progression of the decline in assessor-rated attractiveness across ethnic groups. However, due to the considerable variation in attractiveness assessments, such effects should be interpreted cautiously.

Health

There were main effects on assessor-rated health of age group ($F = 63.51$, $p < 0.001$, partial $\eta^2 = 0.62$) and ethnicity ($F = 40.02$, $p < 0.001$, partial $\eta^2 = 0.51$), but no interaction of Age Group × Ethnicity ($F = 1.12$, $p = 0.340$, partial $\eta^2 = 0.10$; adjusted $R^2 = 0.70$; White's test for heteroscedasticity, $\chi^2 = 25.20$, $p = 0.395$). Women in younger age groups were judged healthier than women in older age groups. Pairwise comparisons indicated significance for all but one difference (50–59 years vs. 60–65 years, $p = 0.058$). The mean difference in health rating between the youngest (20–29 years) and the oldest (60–65 years) was ~23 points on the 100-point scale. Chinese, French and Japanese women received the highest health ratings (no differences between these groups). South African women (all $p < 0.001$) and Indian women received the lowest health ratings (all comparisons, $p < 0.05$ or lower).

Discrepancy between self-ratings and assessor ratings

The difference between self-ratings and assessor ratings was calculated for each of the three attributes, respectively, and used as the dependent variable in an analysis with age group and ethnicity as factors. Multivariate tests indicated effects of age group (Pillai's trace = 0.29, $F = 4.21$, $p < 0.001$; partial $\eta^2 = 0.10$) and ethnicity (Pillai's trace = 0.40, $F = 6.00$. $p < 0.001$; partial $\eta^2 = 0.13$), but no interaction of Age Group × Ethnicity (Pillai's trace = 0.30, $F = 1.06$, $p = 0.377$; partial $\eta^2 = 0.10$).

Concerning age, there was an interaction between age group and ethnicity ($F = 2.14$, $p < 0.01$, partial $\eta^2 = 0.18$) in addition to an effect of ethnicity ($F = 3.69$, $p < 0.01$, partial $\eta^2 = 0.09$); adjusted $R^2 = 0.13$; White's test for heteroscedasticity, $\chi^2 = 30.79$, $p = 0.160$. Thus, the discrepancy between self-rated and assessor-rated age varied across age groups and ethnic groups (Figure 2).

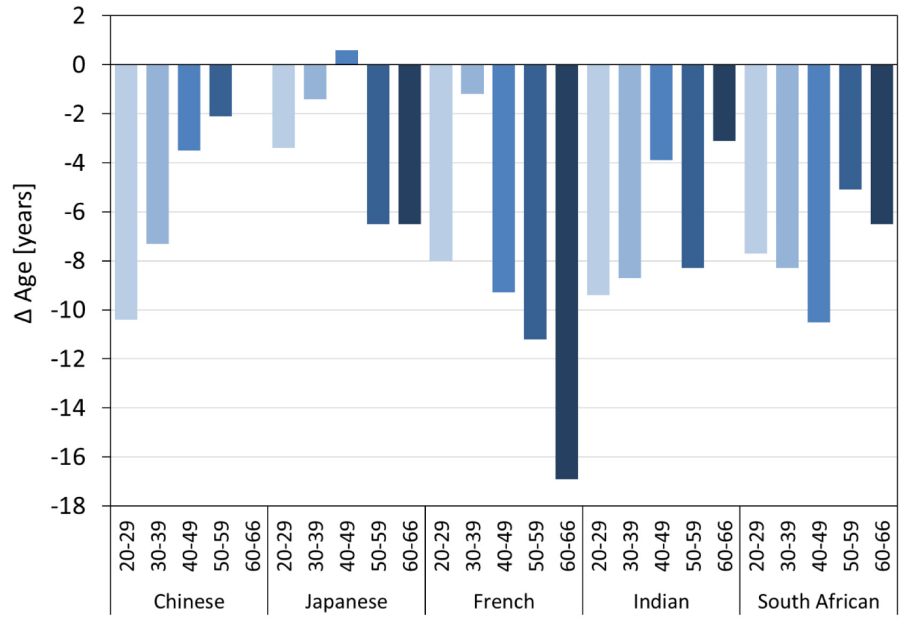

FIGURE 2 Difference between self-rated and assessor-rated age of female participants.

The largest changes in discrepancies included: (i) the decrease in the discrepancy between self-rated and assessor-rated age in Chinese women, from a mean of ~10 years difference in the age group 20–29 years to almost no mean difference in the age group 60–65 years, and (ii) the increase in the discrepancy between self-rated and assessor-rated age in French women, from ~8 years in the age group 20–29 years to ~17 years in the age group 60–65 years. The latter effect is reflected in the pairwise difference in the main effect (i.e. independent of age groups) of ethnicity (Japanese vs. French; difference = 5.88 years, $p < 0.01$).

There were effects of age group ($F = 7.07$, $p < 0.001$, partial $\eta^2 = 0.15$) and ethnicity ($F = 16.23$, $p < 0.001$, partial $\eta^2 = 0.30$) on the discrepancy between self-rated and assessor-rated attractiveness, but no interaction of these factors ($F = 0.65$, $p = 0.843$, partial $\eta^2 = 0.06$); adjusted $R^2 = 0.33$; White's test for heteroscedasticity, $\chi^2 = 30.42$, $p = 0.171$. The discrepancy between self-rated and assessor-rated attractiveness increased with age, that is, it was lowest in the age group 20–29 years (with a mean ~14 scale points) and highest in the age group 60–65 years (with a mean of ~39 scale points) (Figure 3). Women of all ethnic groups judged themselves higher in attractiveness compared to third-party assessors, with the largest discrepancy for South African women (with a mean of ~44 scale points).

Discrepancies in self-rated and assessor-rated health were also affected by age group ($F = 10.80$, $p < 0.001$, partial $\eta^2 = 0.22$) and ethnicity ($F = 4.96$, $p < 0.001$, partial $\eta^2 = 0.11$); no effect of the interaction of these factors was detected ($F = 0.72$, $p = 0.767$, partial $\eta^2 = 0.07$); adjusted $R^2 = 0.22$; White's test for heteroscedasticity, $\chi^2 = 26.05$, $p = 0.351$. As with attractiveness, the discrepancy between self-rated and assessor-rated attractiveness increased with age (mean difference of ~26 scale points between 20–29 years vs. 60–65 years) and was largest for South African women (with a mean difference of ~30 scale points across age groups) (Figure 4).

Skin image analysis

Table 5 presents descriptive statistics for skin image analysis variables by age group and ethnicity of participants.

Multivariate tests indicated effects of age group (Pillai's trace = 0.74, $F = 8.81$, $p < 0.001$; partial $\eta^2 = 0.19$) and ethnicity (Pillai's trace = 1.36, $F = 19.97$, $p < 0.001$; partial $\eta^2 = 0.34$), but no interaction of Age Group × Ethnicity. Further examination showed an effect of age group on specular gloss (partial $\eta^2 = 0.16$), wrinkle (partial $\eta^2 = 0.52$) and sagging (partial $\eta^2 = 0.63$) (all $p < 0.001$). Specular gloss decreased with age, especially in age groups 50–59 years and 60–65 years (compared to younger age groups). Wrinkles increased with age, with larger differences between younger age groups and age groups 50–59 years and 60–65 years (Figure 5). The pattern was more pronounced for sagging with significant differences for all pairwise age group comparisons (all $p < 0.001$; Figure 6).

Ethnicity affected specular gloss (partial $\eta^2 = 0.85$), tone evenness (contrast) (partial $\eta^2 = 0.79$) and sagging (partial $\eta^2 = 0.22$) (all $p < 0.001$). In Indian and South African women, specular gloss (Figure 7) and skin tone evenness (Figure 8) were lower compared to other participants.

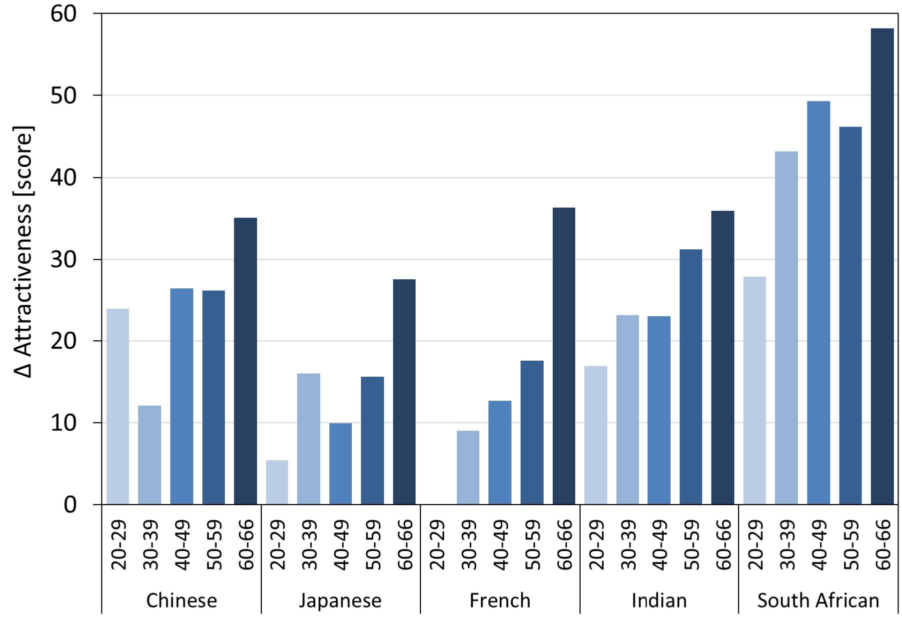

FIGURE 3 Difference between self-rated and assessor-rated attractiveness of female participants.

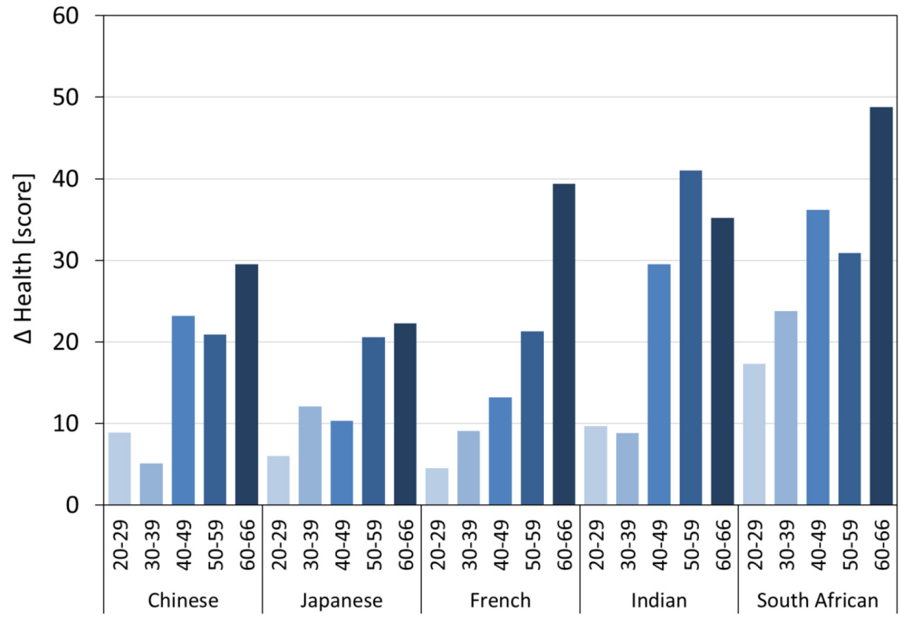

FIGURE 4 Difference between self-rated and assessor-rated health of female participants.

Sagging was higher in Indian, Japanese and South African women compared to Chinese and French women.

Menopause

To explore associations between women's reports of whether their menstruation has stopped completely with perceived facial appearance (i.e. age, attractiveness and health), three binary logistic regressions were performed with the response to the 'menopause' questions (yes/no) as the dependent variable, and self-rating, assessor rating and the discrepancy between self-rating and assessor rating as independent variables.

Concerning age, a significant model was obtained (Nagelkerke $R^2=0.80$; 92.8% correct classifications), with self-rated age ($B=0.06$, SE $B=0.04$, df$=1$, $p=0.138$) and assessor-rated age as significant predictors ($B=0.28$, SE $B=0.06$, df$=1$, $p<0.001$), and likewise, the significant regression model for attractiveness (Nagelkerke $R^2=0.47$; 79.4% correct classifications) included self-rated attractiveness ($B=0.002$, SE $B=0.01$, df$=1$, $p=0.810$) and

TABLE 5 Descriptive statistics ($M \pm$SEM) for skin features from female portraits by age group and ethnicity.

Ethnicity	Age group, 20–29 years	Age group, 30–39 years	Age group, 40–49 years	Age group, 50–59 years	Age group, 60–65 years
Specular gloss					
Chinese	32.0 ± 0.9	36.7 ± 1.5	44.8 ± 1.7	53.1 ± 1.0	61.5 ± 2.5
Japanese	27.7 ± 1.4	35.2 ± 2.2	43.2 ± 1.0	55.9 ± 2.3	67.0 ± 2.3
French	29.3 ± 1.2	33.7 ± 1.5	47.8 ± 2.4	59.3 ± 2.8	68.2 ± 3.1
Indian	32.2 ± 1.2	39.6 ± 1.2	47.0 ± 1.8	59.7 ± 2.3	61.9 ± 2.5
South African	32.7 ± 0.3	42.9 ± 1.4	49.0 ± 1.5	57.2 ± 1.9	69.0 ± 3.6
Tone evenness (contrast)					
Chinese	293 ± 23.1	321.5 ± 24.6	330.3 ± 15.6	310.6 ± 21.3	317.0 ± 9.9
Japanese	284.5 ± 12.4	273.5 ± 15.1	296.2 ± 15.3	337.2 ± 18.5	255.1 ± 21.2
French	263.2 ± 25.5	297.1 ± 12.7	277.5 ± 10.6	274.1 ± 20.8	273.7 ± 15.6
Indian	619.0 ± 33.6	699.1 ± 59.1	577.2 ± 58.6	587.9 ± 25.1	580.7 ± 20.0
South African	657.1 ± 19.2	728.4 ± 51.2	635.9 ± 50.9	673.7 ± 71.1	675.8 ± 24.7
Wrinkle (length)					
Chinese	40.4 ± 8.9	167.0 ± 116.8	411.7 ± 146.4	1114.6 ± 375.2	1451.6 ± 336.6
Japanese	29.1 ± 7.6	228.3 ± 103.2	365.5 ± 143.1	971 ± 145.5	1378.0 ± 393.2
French	192.2 ± 90.3	256.1 ± 69.4	445.5 ± 133.0	892.4 ± 188.2	1560.8 ± 450.0
Indian	96.5 ± 34.2	225.4 ± 52.8	633.4 ± 109.4	1312.7 ± 234.5	1196.2 ± 356.6
South African	176.3 ± 34.0	216.4 ± 58.5	562.5 ± 160.8	773.3 ± 169.0	1605.2 ± 445.0
Sagging (length)					
Chinese	63.8 ± 33.3	79.9 ± 47.4	392.9 ± 119.8	741.4 ± 120.3	1285.5 ± 161.1
Japanese	108.3 ± 44.5	264.4 ± 61.3	769.8 ± 167.2	1511.0 ± 148.7	2169.5 ± 192.5
French	49.0 ± 21.7	123.1 ± 42.7	648.4 ± 213.6	1007.9 ± 271.6	1167.6 ± 473.0
Indian	224.3 ± 76.1	445.3 ± 106.2	983.6 ± 103.7	1632.9 ± 248.1	2213.9 ± 575.4
South African	317.8 ± 117.7	457.7 ± 97.8	520.9 ± 138.9	1359.9 ± 196.0	1612.4 ± 216.2

Note: See Methods for a description of the skin features.

assessor-rated attractiveness as significant predictors ($B = -0.22$, SE $B = 0.04$, df = 1, $p < 0.001$). Finally, the significant regression model for health (Nagelkerke $R^2 = 0.40$; 77.8% correct classifications) indicated significant effects for assessor-rated health ($B = -0.14$, SE $B = 0.02$, df = 1, $p < 0.001$) but not for self-rated health ($B = 0.02$, SE $B = 0.01$, df = 1, $p = 0.101$).

The same logistic regression was performed with the skin features as independent variables and the final equation included all four skin features (Nagelkerke $R^2 = 0.67$; 86.1% correct classifications) as significant predictors (specular gloss: $B = -0.12$, SE $B = 0.05$, df = 1, $p < 0.05$; tone evenness: $B = -0.005$, SE $B = 0.002$, df = 1, $p < 0.05$; wrinkle: $B = 0.003$, SE $B = 0.001$, df = 1, $p < 0.001$; sagging: $B = 0.001$, SE $B = 0.0004$, df = 1, $p < 0.01$).

Collectively, these findings suggest that women's response to a single item about their menopausal status (yes/no) could be predicted from assessor ratings and image-based skin features but not from self-ratings. The explained variance of this prediction was greatest for age ratings and only slightly lower for the combined predictive capacity of the skin features.

DISCUSSION

The present multi-ethnic and multi-centre study (see also Refs. [50–54]) identifies effects of female participants' age and ethnicity on self-ratings and assessor ratings of facial age, attractiveness and health. Although younger women reported feeling younger than older women, participant age did not affect self-rated attractiveness and health. Ethnic differences were observed for self-rated attractiveness but not for age or health. Assessor ratings indicated effects of participant age and ethnicity on perceived facial age, attractiveness and health. In contrast to self-ratings, there were interactions between participant age and ethnicity for assessments of age and attractiveness (but not health), suggesting ethnic differences in the impact of participant age on assessor-rated age and attractiveness. Effects of participant age and ethnicity also were evident in

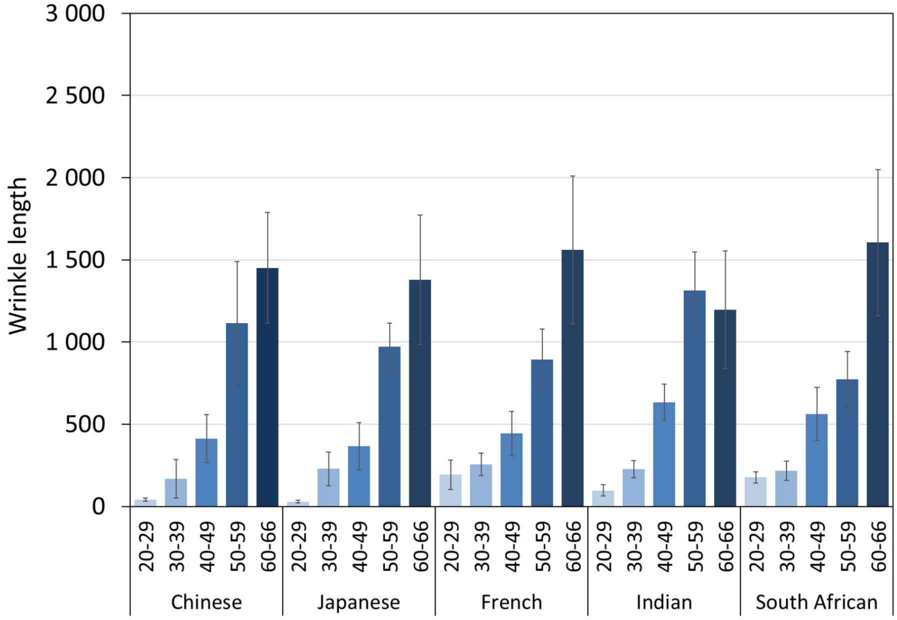

FIGURE 5 Wrinkles (length) of female participants by age group and ethnicity.

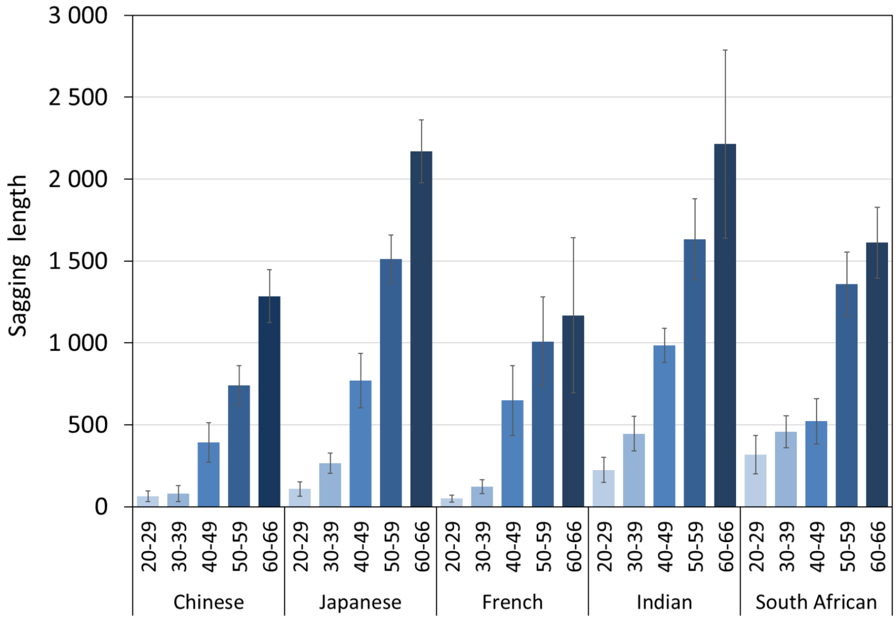

FIGURE 6 Sagging (length) of female participants by age group and ethnicity.

discrepancy scores (i.e. the difference between self-ratings and assessor ratings), with an interaction of age group and ethnicity indicating that the impact of participant age on differences between self-rated and assessor-rated age varies across ethnic groups. The discrepancy between self-rated and assessor-rated attractiveness increased with age. Women of all ethnic groups rated themselves higher in attractiveness and health than did assessors of the same ethnic group.

Digital skin image analysis identified an age-dependent decrease in specular gloss and an increase in wrinkles. Ethnic differences were detected for specular gloss, tone evenness, wrinkling and sagging. Assessor-rated age, attractiveness and health of participants and skin features extracted from image analysis predicted women's menopausal status. Collectively, these findings demonstrate effects of (participant) age- and ethnicity-dependent changes in skin features on assessments of female age, attractiveness and health, with assessor ratings better predicting menopausal status than self-ratings.

Previous reports from the multi-ethnic and multicentre study document cross-cultural variation within and

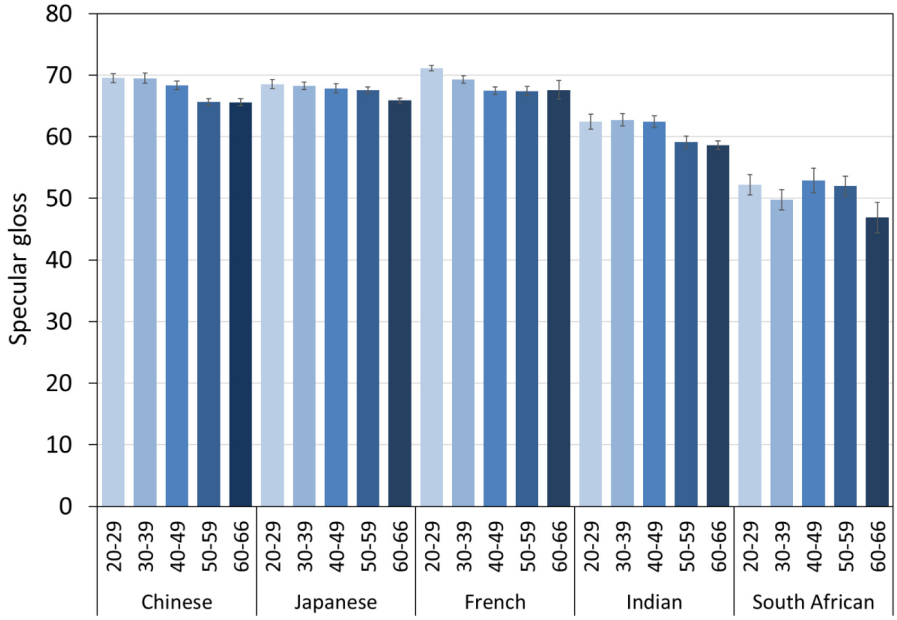

FIGURE 7 Specular gloss of female participants by age group and ethnicity.

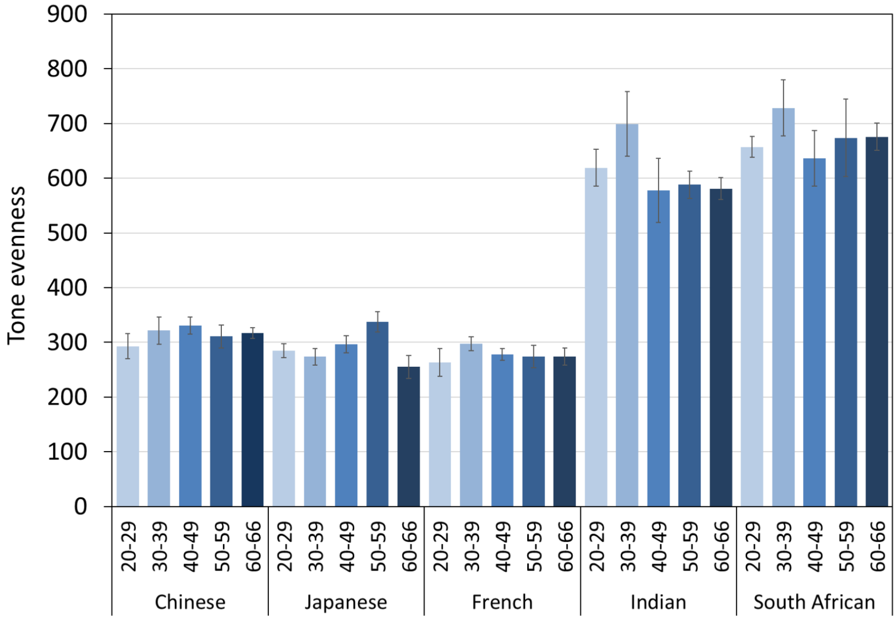

FIGURE 8 Tone evenness of female participants by age group and ethnicity.

between ethnic groups in assessor ratings of female facial appearance [50, 53]. The current study adds information about women's self-ratings and identifies discrepancies between self- and assessor ratings for age, attractiveness and health, such that women across ethnic groups reported feeling younger, more attractive and healthier compared to reports of non-experts. Regarding attractiveness and health, the discrepancies in ratings increased with participant age and were largest for South Africans. A different pattern was found for discrepancies in age ratings. Younger Chinese women (20–29 years) and older French women (60–65 years) showed the largest discrepancies between self- and assessor-rated age. In Japanese women, the discrepancies were larger for older women (50–59 and 60–65 years) than for younger women. The age discrepancy scores were more evenly distributed for Indian and South African women.

Research shows that self-assessments of appearance correlate with self-esteem [58, 59], and self-esteem, in turn, predicts quality-of-life assessments [60]. Brewer et al. [61] reported that attractive women are less realistic in rating their physical appearance. Women's tendency to overestimate their attractiveness may reflect self-deception [62], that is, the process of denying opposing evidence and logical arguments [63]. Self-deception has been described as a self-serving bias. Thus, we deceive ourselves to better deceive others [64]. In this view, it is not surprising that self-enhancement is among the most common forms of self-deception [65]. According to evolutionary scientists, the enhancement of physical appearance with cosmetic products exaggerates desirable features and may, therefore, confer individual benefits in mate selection [66]. In addition to individual differences and the influence of female age, ethnic differences in self-ratings and discrepancies between self- and assessor ratings could be due to population-specific variation in self-deception [67–69]. Results of the present study suggest ethnicity-specific effects of participant age, especially for the comparison of Chinese and French women. Younger Chinese women may (self-)deceive more than younger French women, whereas the opposite pattern is found for older women. It is beyond the scope of the current article to speculate further about the reasons for this ethnic difference. However, cultural differences in self-esteem have been documented [70–72] and we consider it plausible that these differences may affect self-ratings of physical appearance.

There also may be differences in lifestyle and habits that account for discrepancies in ratings across age groups and ethnicity. Most participants reported to have never smoked. However, relative to other groups, fewer French women reported having never smoked or were currently non-smokers. Previous research has identified cultural differences in smoking behaviour and attitudes towards smoking [73, 74], and although we do not think smoking had a significant impact on participant appearance (because of the high proportion reporting that they never smoked), French women may be particularly sensitive to the effects of smoking on age-related skin changes and consequently show greater self-deception regarding physical appearance. Moreover, there are ethnic differences in women's reports of skin problems (e.g. dry skin, sensitive skin, oily/shiny skin, visible pores and pigmented spots/uneven skin tone; [43, 75, 76]). We have previously reported variations across ethnicities in concerns about age-related skin changes, with South African and Indian women expressing fewer concerns than Chinese, Japanese and French women [51]. Also, skin care product use differs between ethnic groups, with, for example, Indian and South African women reporting rarely using night care products. Hence, there is ethnicity-specific concern and product use [77] that may contribute to ethnic differences in assessments of female appearance [51].

In the current study, digital image analysis provided an objective assessment of age-dependent changes in skin features (see also Ref. [52]). Sagging was greater in Indian, Japanese and South African women compared to Chinese and French women, but no ethnic differences were detected for wrinkling. Specular gloss and tone evenness were lower in Indian and South African women compared to Chinese and French women. Considering digital image analysis together with face ratings indicates that assessor ratings provide more accurate assessments of participant age, health and attractiveness than do self-ratings. Assessor-rated age and attractiveness were the only variables for which interaction of participant age and ethnicity was detected.

This means that there were ethnic differences in the assessments of women from different age groups in perceptions of age and attractiveness. Perceived age of younger women (20–29 years) was lower in Japanese and French women than in Chinese, Indian and South African women. A similar pattern was found for the assessments of women ages 30–39 years, and South African women in this cohort were judged oldest. With increasing age of female participants (>50 years), this pattern changed and Chinese women were perceived as younger than women of other ethnic groups (with no difference to Indian women ages 60–65 years). Thus, although assessors judged women of younger cohorts to be younger, and women of older cohorts to be older, the assessments reflect ethnic differences in the pace with which perceived age increases. Assessor-rated attractiveness also showed variation in age groups together with ethnic differences. Young French women (<40 years) were rated highest in attractiveness. This ethnic difference disappears with advancing age and, in the age group 60–65 years, French, Indian and South African women were judged lower in attractiveness than Chinese and Japanese women. Regarding self-ratings, we speculated about differences between Chinese and French women: the former showed a larger discrepancy with assessor ratings than the latter. Considering this finding together with those for assessor-rated age and attractiveness could indicate that young Chinese women and older French women are both self-deceive about their age and attractiveness, but they may do so for different reasons. We suggest that ethnic differences in age-dependent changes in skin features and the pace of their manifestation may account for the observed ethnic variation in self-deception [78, 79] about age and attractiveness.

Ethnic differences in female psychology due to population-specific attitudes and responses to age-related changes in female physical appearance may contribute to an account of the effects observed in the present study. Evolutionary psychologists have argued that age is a marker of fertility and reproductive value for women [13, 80]. Younger and healthier women are preferred as potential mating partners and are considered more attractive [81]. From a mating perspective, women who reach menopause cease to be viable reproductive partners, and there is little selective pressure to maintain facial attractiveness in post-menopausal women [82]. Consistent with this argument, research has shown that women 51–65 years (post-menopausal) experience a greater age-related reduction of facial attractiveness than women 35–50 years (peri-menopausal) and same-aged men [82]. The 'double standard of ageing' [83] posits that although both sexes diminish in attractiveness as they age, the decline for women is greater. Research has shown an additional effect of social class on 'ageing standards' such that ageing working-class women are less confident about their physical appearance than upper-class women [84], and the consequences for women's experience of social (in) equalities and sexuality are well-documented [85]. In the current study, we did not detect ethnic differences in women's reports of menopausal status, that is, across ethnic groups, most women who reported that their menstruation has stopped completely corresponded to age groups 50–59 years and 60–65 years (for cultural influences on menopause see Refs. [33, 86]). Thus, variation across ethnic groups in timing of the peri- and postmenopausal period seems unlikely as an explanation for ethnic differences in age-related (self-)perceptions of facial appearance and discrepancies with assessor-rated appearance.

Gupta and Gilchrest [46] stated that '[T]oday's consumer culture sends a strong message about the need to get older without the signs of ageing'. This places pressure on individuals to maintain a youthful appearance; in addition, 'looking good' offers many social benefits [87]. We consider it plausible that differences in socio-cultural traditions and perspectives about age-related changes in female physical appearance (e.g. [88]) may have contributed to some of the detected effects on self-perception. Self-ratings of participants in the current study did not predict menopausal status; however, assessor ratings of age, health and attractiveness, and skin features extracted from image analysis of participant's faces did predict menopausal status. Thus, assessor ratings seem to provide an accurate assessment of female age and reproductive status. Ethnic differences in the pace of perceived ageing may therefore originate from variations in structural differences of skin [43, 44, 89–91] and, in consequence, the susceptibility to intrinsic and extrinsic factors that impact age-related skin changes [18, 41]. This then leads to population-specific self-perceptions of an individual's physical appearance. An individual's ability to cope with and respond to population-specific perceptions of ageing might then affect cosmetic intervention [76, 92, 93] and subsequent well-being.

In conclusion, the present study corroborates age- and ethnicity-dependent variation in self-ratings of physical appearance. Ethnic differences in women's experiences of age-dependent skin changes may lead to variations in discrepancies between self- and assessor-rated age, health and attractiveness. Therefore, population-specific concerns about age-dependent skin changes are important to understand in cosmetic science to address objective, age-dependent, structural and functional changes in skin and their impact on female psychology, especially when age-dependent skin changes manifest.

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CONFLICT OF INTEREST STATEMENT

RV and RC are employees of DSM-Firmenich and BF is a consultant to DSM-Firmenich. TKS states no conflict of interest.

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