ORIGINAL RESEARCH

Facial Skin Aging Characteristics of the Old-Perceived Age in a 20–40 Years Old Chinese Female Population

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Purpose: In the quest for a youthful appearance, women use a variety of anti- aging cosmetics. Defining skin problems is especially important for the selection of anti-aging solutions. However, the skin problems faced by Chinese women at different ages are different. This study aimed at Chinese women aged 20–40 years old and analyzed facial skin aging characteristics of those with old-perceived age.

Patients and Methods: The total of 400 standard facial photographs from Chinese female volunteers aged 20–40 was assessed by another 126 Chinese women. The facial areas and skin aging characteristics that influenced age estimation were collected at the same time. Skin aging characteristics, including wrinkles, skin tone, pigmentation and pores, were analyzed based on facial photographs. Groupings were made based on deviation of perceived age from chronological age, and skin aging characteristics among groups were compared.

Results: The perceived age of Chinese women aged 20–40 has a moderate correlation with chronological age. Women aged 20–30 generally had an old-perceived age. Deep skin tone was a prominent problem in this age group, with those who had the older-perceived age observed the darker and redder skin tone. Women aged 31–40 were perceived partly old but appeared with wrinkle aggravation, as well as deepening of redness, enlarged pores, and increased pigmentation at the mid-face. The perceived older women also had more visible frown lines and darker skin tone at the upper face.

Conclusion: The perceived age of Chinese women aged 20–40 tends to deviate from their chronological age. Women aged 20–30 with old-perceived age are associated with deep skin tone, even found darker and redder in older-perceived women group, while women aged 31–40 are associated with wrinkles and deterioration at mid-face area and upper-face problems drive more attention in older-perceived women group.

Keywords: perceived age, Chinese female, wrinkles, skin tone, skin aging

Introduction

Skin aging is a compulex biological behavior involving a wide range of skin cells and tissues, including intrinsic and extrinsic factors.[1] External factors such as lifestyle and environment (such as UV rays, air pollution and microorganisms) can accelerate skin aging.[2,3] As a result of multiple exposures, the skin ages to varying degrees, making some people look older than their peers.[4,5.]

Skin aging has many different manifestations, such as wrinkles and uneven skin tone. Skin care can improve the skin condition,[6] so there are a lot of anti-aging efficacious cosmetic products that target different manifestations. However, a youthful appearance linked with beauty and health is the ultimate goal the consumers are looking for.[7] Perceived age, age estimated visually, is a relevant measure of the overall face, which would be influenced by facial profile and skin condtion.[8]

In recent years, research has begun to focus on the impact of skin aging characteristics on perceived age. Wrinkles have been found to correlate strongly with perceived age, whereas pigmentation and skin tone were reported weakly correlated.[9] The eye is a key area of facial perception, and dark circles and bags under eye have also been found to be significantly related to perceived age.[10] The influence of skin aging characteristics on perceived age is complex and varies in degree across ethnicities.[11] Among Chinese women, not only wrinkles but also pigmentation are important

contributors to older-perceived age, whereas skin tone and hydration are less influential.[12] As research has progressed, wrinkles on the upper face have been found to be the key to aging in Chinese women.[13]

Skin aging in Chinese females is periodic, with differences in the rate of skin aging characteristics between different age groups.[14] Women between the ages of 20–40 years are at the latent onset of skin aging.[14] For them, it is important to understand how facial skin aging characteristics influence perceived age to guide their anti-aging strategies. However, at present, there is limited research on the apparent age of Chinese women, with the majority of studies focusing on wide age groups.[13]

Hence, we estimated the age of 400 20–40 years old Chinese women based on their facial photographs by recruiting Chinese women as evaluators and analyzed relevant facial skin aging characteristics. By comparing the differences in aging characteristics among those who look young, those who look old, and those who match their actual ages, we searched for skin aging characteristics in women with old-perceived age.

Materials and Methods

Subjects and Photographs Capture

Four hundred facial photographs of Chinese women aged 20–40 were included from the Yunnan Baiyao image database, including 198 women aged 20–30 and 202 women aged 31–40. Photos were collected using Mobile Intelligent Skincare, a facial high-definition image collection instrument developed independently by Yunnan Baiyao company, which is equipped with a high-definition camera (Canon 90D, Japan) and a stable light source. Facial photographs were collected from the front and at 45° to the left and right of the volunteers. In the facial photographs, the volunteers maintained a natural expression, and the eyes were closed. The image inclusion criteria included that the volunteers took off make-up, had no visible skin disorders, no facial tattoos or extensive scarring on their faces. All volunteers signed agreements to approve the use of images at the time of photo collection. To protect the privacy of the volunteers, only age information was used in this study. This study was conducted following the tenets of the Declaration of Helsinki.

Perceived Age Assessment

A total of 126 Chinese women aged 20–50 were recruited as evaluators. Frontal and left lateral facial photographs of the volunteers were placed in the A4 sheet of paper as an atlas by random ordering. Under the same ambient lighting, evaluators were asked to estimate the age of subjects according to the atlas and recorded it. After that, evaluators finished an electronic questionnaire collecting the factors related with age estimation focuses, including facial areas (eyes, nose, mouth, periorbital, cheeks and forehead) and skin aging characteristics (wrinkle, sagging, spot, skin tone, pore). All evaluators were fully informed and signed an informed consent form. The median age of the estimation was used as the perceived age of the subjects.

Measurement of Facial Aging Characteristics

The measurement of facial aging characteristics includes wrinkles, skin tone, pigmentation and pores. The measurement of wrinkles (forehead wrinkles, crow's feet wrinkles, glabellar frown lines, nasolabial folds and wrinkles in the corner of the lips) referenced the evaluation criteria for human skin aging released by the China Anti-aging Promoting Association in 2022. The rating scores ranged from 0 to 8, with a total of nine grades. Skin tone, pores and pigmentation were analyzed on the basis of the images using Image Pro-Plus software 7.0. Measurements were made for L*a*b* and ITA° for the forehead, cheeks and lips; pore diameters for the forehead, cheeks and nose; and stain density for the forehead and cheeks. Facial aging characteristics were measured by two researchers with clinical experience in dermatology.

Statistical Analysis

All statistical analyses were performed with SPSS 23.0. Perceived age and chronological age were analyzed using Spearman correlation analysis. According to the difference between perceived age and chronological age, subjects were divided into three groups, with perceived age greater than 2 years of chronological age as the older group, perceived age less than 2 years as the younger group, and the rest as the real age group. Facial skin aging characteristics were compared

among the three groups using the Kruskal–Wallis *H*-test. For further analysis, subjects with older-perceived age were divided into the older more than five years group and the older less than five years group, and compared using the Mann–Whitney *U*-test. The 5% threshold of significance was used.

Results

Deviation Between Perceived Age and Chronological Age Among Chinese Women

The mean chronologicaly age of the 400 subjects was 30.21 ± 5.56 years, and the mean perceived age was 31.04 ± 4.57 years. There was only a moderate correlation between perceived age and chronological age ($r = 0.648$, $P < 0.001$), as shown in Figure 1. Only 102 (25.5%) of the women's perceived ages corresponded to their chronological ages, as shown in Table 1.

For further study, subjects were divided into a 20- to 30-year-old group and a 31- to 40- year-old group. There was a different trend of deviation in perceived age for different age groups.

In the 20–30 age group, the mean perceived age (28.40 ± 3.22 years) was higher than the mean chronological age (25.37 ± 2.94 years). More than half of the women were in the older group, with a maximum age deviation of 13.5 years (26 vs 39.5). A number of 59 women perceived age to be greater than their chronological age by five years, and 10 women were greater than ten years. There were a few women who perceived younger, with an age deviation of up to 4 years (28 vs 24, 29 vs 25).

In the 31–40 age group, the mean perceived age (33.62 ± 4.20 years) was slightly lower than the mean chronological age (34.94 ± 2.72 years). Half of the women were in the younger group, with 44 women whose perceived age was five years younger, and the maximum age deviation was 11 years (40 vs 29.37 vs 26). There were still quarter of women received older-perceived age, with a maximum age deviation of 9 years (31 vs 40), and there were 20 people whose perceived age was five years older.

Among Chinese women aged 20–40, there is a deviation between perceived age and chronological age. Moreover, over 40% of these women experience a bias towards an older perceived age.

Wrinkles and Skin Tone, Important Skin Aging Characteristics Affecting Age Estimation

In order to understand what factors contribute to the perception of older age in Chinese women, we conducted a questionnaire that focused on facial areas and skin aging characteristics. The majority of evaluators (76.2%) associated
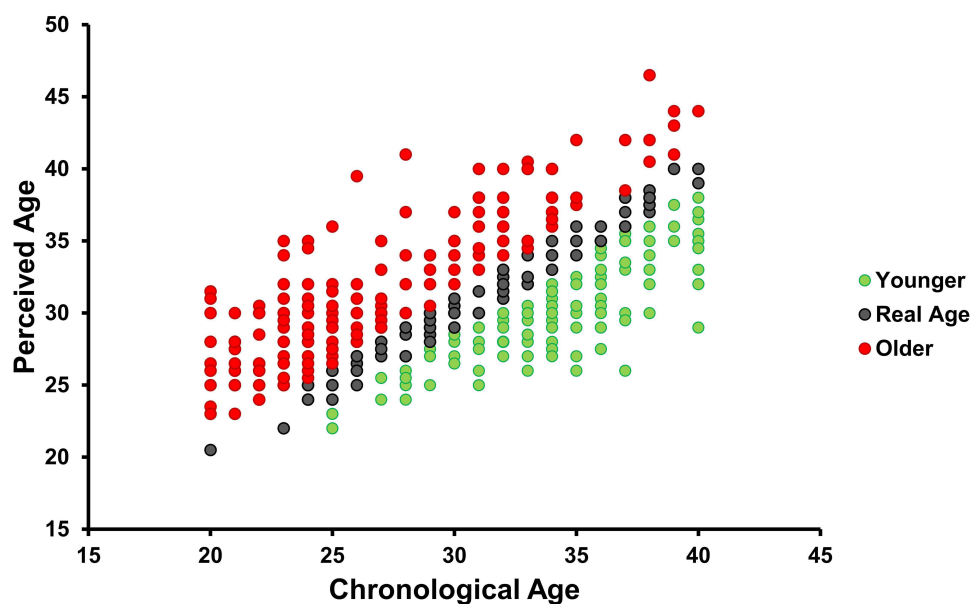

Figure 1 Correlation between perceived ages and chronological ages of all subjects. According to the difference between perceived age and chronological age, volunteers were divided into three groups, with perceived age greater than 2 years of chronological age as the older group, red spot, perceived age less than 2 years as the younger group, green spot, and the rest as the real age group, black spot.

Table 1 Number of Volunteers Among Three Perceived Age Groups

	Younger Group	Real Age Group	Older Group	Total
20–30 years old	20	53	125	198
31–40 years old	107	49	46	202
	127	102	171	400

the cheeks and eyes with perceived age, followed by the forehead area (see Figure 2A). Wrinkles and sagging were identified as the most significant aging features, with over 80% of evaluators recognizing their impact on perceived age. Additionally, skin tone and pigmentation were also found to affect age perception (see Figure 2B).

Evaluators deemed wrinkles and skin tones as crucial factors contributing to an older perceived age, with the mid-face and forehead as significant areas for assessment.

Facial Skin Aging Characteristics in Old-Perceived Women: deep Skin Tone for Women Aged 20-30, Wrinkles and Rough Mid-Face for Women Aged 31-40

From the subjects themselves, we analyzed the skin aging characteristics by comparing differences among the older, younger and real age groups. Due to differences in perceived age bias and skin aging phase, we divided women into a 20–30 group and a 31–40 group.

Among women aged 20–30, skin tone is an important aging characteristic. On the forehead and cheeks, L* in the older group was lower than that in the younger group ($P = 0.015$, $P = 0.02$) and the real age group ($P < 0.001$, $P < 0.001$), and ITA° in the older group was also lower than that in the real age group ($P = 0.003$, $P = 0.005$) and the younger group ($P < 0.001$, $P < 0.001$). The a* in the older group was higher than that in the younger group ($P = 0.018$, $P = 0.012$), while the b* in the younger group was lower ($P = 0.028$, $P = 0.03$). In addition, pigmentation, as a skin problem of uneven skin tone, also had a significant impact on perceived age. In the older group, the stain density of the forehead and cheeks was higher than that in the younger group ($P = 0.001$, $P < 0.001$), as shown in Table 2. However, except for lower L* of lips in younger group, other skin characteristics were not significantly different between the groups (see Supplementary Table 1).

Among women aged 31–40 years, the skin aging characteristics were complex. Wrinkles were significant aging characteristics. Women in the older group had higher scores of crow's feet ($P = 0.004$) and glabellar frown lines ($P = 0.017$) than women in the younger group. Other wrinkle scores, such as forehead lines, nasolabial folds and wrinkles in the corner of the lips, tended to be higher in the older group (see Figure 3). In addition, middle face also had a significant effect on perceived age. Compared to the younger group, the older group had a higher a* ($P = 0.04$), a greater stain density ($P = 0.036$), and larger pore diameters ($P = 0.004$), as shown in Table 3. The other skin characteristics were not significantly different between the groups (see Supplementary Table 2).
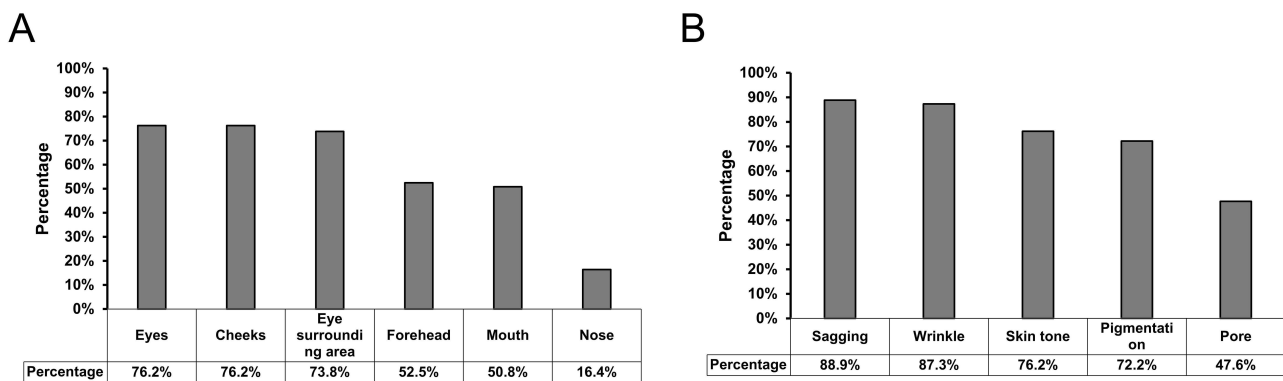
A

Percentage	Eyes	Cheeks	Eye surrounding area	Forehead	Mouth	Nose
Percentage	76.2%	76.2%	73.8%	52.5%	50.8%	16.4%

B

Percentage	Sagging	Wrinkle	Skin tone	Pigmentation	Pore
Percentage	88.9%	87.3%	76.2%	72.2%	47.6%

Figure 2 Percentage of evaluators' perceived factors affecting age estimation (**A**) facial areas (**B**) skin aging characteristics.

Table 2 Forehead and Cheek Skin Tone Among Three Perceived Age Groups in Women Aged 20–30

		Younger Group	Real Age Group	Older Group	H	P
Forehead	L*	59.20 (56.79, 62.41)	56.01 (53.19, 59.72)	54.47 (51.09, 57.65)	23.015	0
	a*	9.76 (9.09, 11.15)	11.01 (9.89, 11.83)	11.37 (10.12, 12.52)	8.1	0.017
	b*	20.36 (18.87, 26.23)	25.44 (21.30, 29.22)	25.16 (20.56, 28.60)	6.773	0.034
	ITA°	24.58 (17.35, 29.24)	12.45 (6.72, 21.36)	10.32 (2.66, 17.85)	25.566	0
	Stain density	128.07 (123.98, 134.76)	135.12 (125.71, 144.77)	138.34 (130.10, 149.17)	13.205	0.001
Cheek	L*	60.79 (56.47, 61.39)	57.14 (54.11, 58.93)	55.54 (52.67, 58.44)	18.327	0
	a*	11.11 (9.63, 12.05)	11.50 (10.98, 13.15)	12.43 (11.02, 13.84)	8.814	0.012
	b*	20.66 (18.68, 25.31)	25.59 (20.86, 28.40)	24.63 (19.70, 28.27)	6.69	0.035
	ITA°	25.46 (18.75, 30.42)	14.58 (9.86, 20.45)	12.10 (6.31, 18.65)	21.112	0
	Stain density	118.97 (113.52, 124.83)	128.70 (122.69, 136.35)	132.63 (123.70, 139.58)	19.293	0

Notes: Skin tone analysis was conducted using Image Pro-Plus software 7.0, assessing L* (brightness), a* (redness), and b* (yellowness). ITA° (Individual Type Angle) was determined based on L*, a*, and b*, representing the depth of skin tone.

In women with an old-perceived age, the skin aging characteristics differ between age groups: skin tone for those aged 20–30 and wrinkles along with a rough mid-face for those aged 31–40.

Facial Skin Aging Characteristics in Women with Much Older- Perceived Age: Deeper Skin Tone for Women Aged 20-30, Frown Lines and Dark Forehead for Women Aged 31-40

Figure 1 shows that there were some people in the older group whose perceived age was much greater. To investigate the facial skin aging characteristics in older-perceived women, women with an old perceived age were divided into older than 5 years old and less than 5 years old groups.

In women aged 20–30, skin tone remained the key aging characteristic (see Table 4 and Supplementary Table 3). Among the women whose perceived age was greater than 5 years, a* on the forehead and cheeks ($P = 0.034$, $P = 0.042$) were greater, L* ($P = 0.038$) and ITA° ($P = 0.030$) were even smaller on the cheeks.
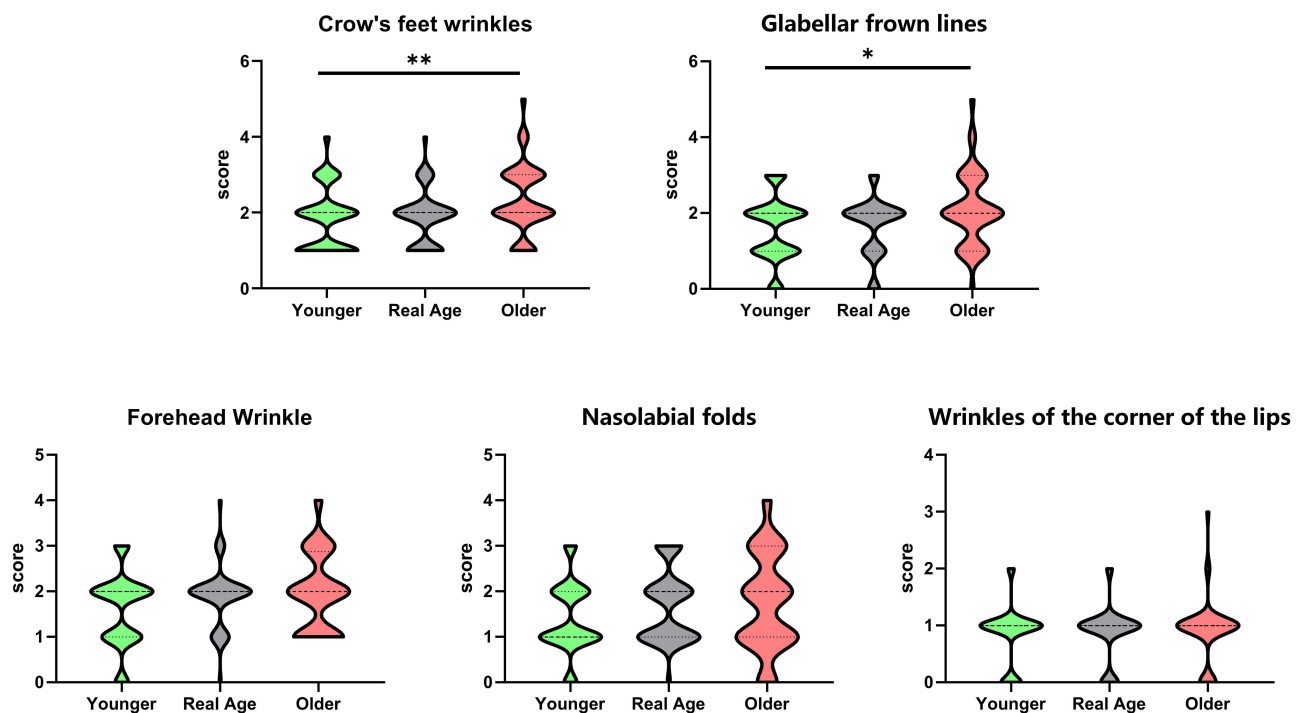

Figure 3 Wrinkle score among three perceived age groups in women aged 31–40.
Notes: *$P < 0.05$, **$P < 0.01$.

Table 3 Skin Aging Characteristics of the Middle Face Among Three Perceived Age Groups in Women Aged 31–40

	Younger Group	Real Age Group	Older Group	H	P
a*	12.10 (11.09, 14.00)	12.37 (11.34, 13.13)	13.19 (11.92, 14.32)	7.091	0.029
Stain density	134.78 (126.20, 141.48)	139.05 (129.95, 144.71)	139.98 (132.27, 146.60)	6.464	0.039
Pore diameter	0.29 (0.29, 0.30)	0.30 (0.29, 0.31)	0.30 (0.29, 0.31)	10.956	0.004

Notes: Skin tone analysis was conducted using Image Pro-Plus software 7.0, assessing a* (redness).

Table 4 Frontal and Cheek Skin Tone Between Perceived Age Older Than 5 Years Old and Less Than 5 Years Old Groups in Women Aged 20–30

		Older than 5 Years Old	Older Less than 5 Years Old	Z	P
Forehead	L*	54.13 (49.51, 56.87)	55.13 (52.20, 58.58)	−1.926	0.054
	a*	11.81 (10.82, 12.94)	11.10 (9.92, 12.37)	−2.122	0.034
	b*	23.30 (20.79, 28.91)	25.40 (20.65, 28.40)	−0.032	0.974
	ITA°	9.21 (−1.24, 14.32)	11.70 (5.42, 18.12)	−1.83	0.067
Cheek	L*	54.57 (52.35, 57.41)	55.94 (53.53, 58.57)	−2.074	0.038
	a*	12.90 (11.44, 14.34)	12.02 (11.01, 13.62)	−2.034	0.042
	b*	23.07 (19.69, 28.14)	25.16 (20.28, 28.21)	−0.376	0.707
	ITA°	10.22 (5.79, 15.67)	14.23 (7.99, 20.38)	−2.164	0.030

Notes: Skin tone analysis was conducted using Image Pro-Plus software 7.0, assessing L* (brightness), a* (redness), and b* (yellowness). ITA° (Individual Type Angle) was determined based on L*, a*, and b*, representing the depth of skin tone.

Table 5 Frontal Skin Tone Between Older More Than 5 Years Old and Less Than 5 Years Old Groups in Women Aged 31–40

	Older than 5 Years Old	Older Less than 5 Years Old	Z	P
L*	50.33 (48.71, 53.37)	53.60 (50.47, 57.48)	−2.244	0.025
a*	11.31 (10.53, 12.96)	11.32 (10.47, 12.43)	−0.041	0.967
b*	24.84 (22.53, 26.27)	25.53 (21.11, 28.99)	−0.715	0.475
ITA°	0.88 (−2.96, 7.31)	7.83 (1.11, 16.00)	−2.334	0.020

Notes: Skin tone analysis was conducted using Image Pro-Plus software 7.0, assessing L* (brightness), a* (redness), and b* (yellowness). ITA° (Individual Type Angle) was determined based on L*, a*, and b*, representing the depth of skin tone.

In women aged 30–40, skin aging characteristics on the upper face were more prominent (see Table 5 and Supplementary Table 4). Scores of glabellar frown lines were higher for those with a perceived age greater than 5 years ($P = 0.008$), while there was no significant difference for forehead wrinkles (see Figure 4). In terms of skin tone, L* ($P = 0.025$) and ITA° ($P = 0.020$) were lower for the forehead in those with a perceived age greater than 5 years.
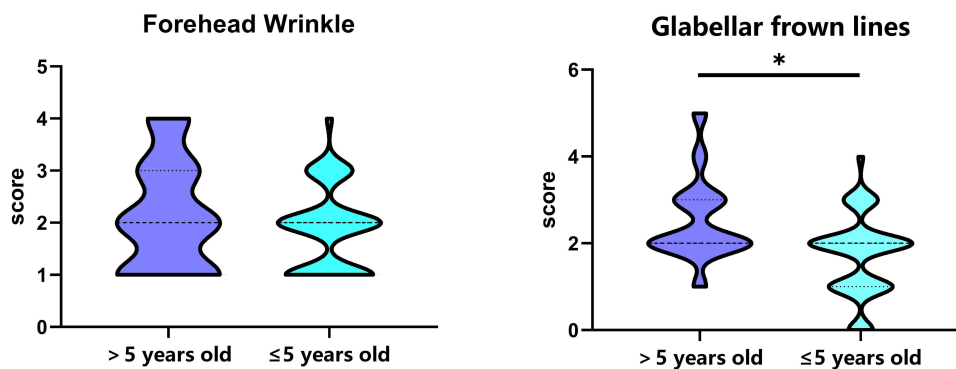

Figure 4 Upper face wrinkle score between older than 5 years old and less than 5 years old groups in women aged 31–40.
Note: *$P < 0.05$.

In women with a much older-perceived age, women aged 20–30 have deeper skin tone, while women aged 31–40 have frown lines and dark forehead.

Discussion

We evaluated the perceived age of the volunteers through photographs and found that among women aged 20–40, perceived age did not correlate strongly with chronological age. Further analysis revealed that women aged 20–30 years were generally perceived old and deep skin tone was an important aging characteristic, with a greater perceived age associated with deeper skin tone. Women aged 31–40 years were partly old, with more pronounced wrinkles and rougher skin in the middle face, and more visible glabellar frown lines and darker skin tone on the upper face for the older-perceived age group.

From the face, we can estimate approximate chronological age, and perceived age and chronological age have shown fair correlation in previous studies.[13,15] However, when the age range was narrowed in this study, the correlation was not particularly good among Chinese women aged 20–40. This result was also shown in Flank's study,[13] but they were not analyzed and elaborated due to different research objectives. The perceived age of women between 20 and 30 years old is older, while women between 31 and 40 years old are younger overall. This hints at a greater need for anti-aging in women in their 20s compared to women in their 30s.

The causes of skin aging are numerous and complex, encompassing environmental and lifestyle factors.[2] However, under the influence of various intricate factors, facial skin aging characteristics ultimately contribute to an increase in perceived age. Improving these skin aging characteristics is the most direct and straightforward approach to facial rejuvenation. So, this study focuses on what are the skin aging characteristics in women with old-perceived age.

Age estimation is a complex process, and to increase the interpretability of the estimation process, we collected facial areas and skin aging characteristics that influence the estimation.[16,17] Our results found a high number of evaluators focusing on the cheeks and forehead, illustrating the importance of skin condition as an influence on age among Chinese women. For skin aging characteristics, skin tone and pigmentation have a strong influence rather than a weak correlation as perceived age-related representations.

As women in their 20s are in the latent phase of aging, characteristics of aging such as wrinkles are not yet visible, and Chinese women are more likely to rely on tone and luminance cues to determine facial preference,[18] so skin tone becomes a pivotal factor in the perceived age of this age group. Facial brightness and redness have been found to correlate significantly with perceived age in previous studies.[18,19] Women in the older group of this study had a darkness and reddish skin tone. The problem was more severe in women with more advanced aging. In addition, dull yellow skin is also a concern for Asian women and is largely attributed to the yellow component of the skin tone.[20,21] In our study, younger women had significantly lower yellowness of their face. It is evident that darker skin tone increases the perceived age of women in this age group. Darker skin tone not only detracts from the perceived age but also adds to the sense of unhealthiness.[22] Therefore, for women in their 20s, improving their skin tone plays a very important role in their appearance.

Among the aging cycles of Chinese women's skin, the age of 30 is the beginning of rapid aging, with multiple skin aging characteristics, especially wrinkles.[14] As wrinkles had a clear significance on age estimation (Figure 2B), wrinkles had higher scores for older women aged 31–40. The eyes are the first part of the face to age, with signs of wrinkles appearing as early as 20 years old.[17] The periocular wrinkles (frown lines and crow's feet) were particularly pronounced in old-perceived age women in this study, and the frown lines particularly pronounced in the older. At this age range, the causes of older look are more numerous and complex. The cheeks, as the largest area of the face, are critical to age estimation (Figure 2A). Therefore, skin aging characteristics in cheeks, including redness, pigmentation and enlarged pores, were obvious in the old-perceived age women. The forehead area is the following prominent area (Figure 2A), and the skin tone in this area was dark in the older-perceived age women.

Young appearance is a widely sought goal by the public, and many studies are looking for facial skin signs that are related to perceived age, not only for women but also for men.[23,24] This study was conducted on Chinese women aged 20–40 years old to clarify variety of skin aging characteristics in old appearance among different age groups. For precision skincare, it is crucial to define the problems that affecting people's view to aging skin, and this study is

instructive in guiding the improvement of facial aging. The reasons for perceived older age seem to vary from the population of women over 40 years of age.

Some limitations in this study are still needed to be addressed. This study was conducted on a Chinese women population, and the results cannot yet be extrapolated to other races due to nonnegligible cultural differences.[25] In addition, the results were developed from the basis of photographs, therefore spatial information, such as wrinkle depth, was lost. In future studies, consideration should be given to collecting the more abundant skin aging characteristics from subjects to describe skin concerns with a more detailed way. There is still a considerable amount of research that needs to be done on perceived age.

Conclusion

This study found that perceived age did not correlate strongly with chronological age. Some of the women were older in perceived age, and there were different skin aging characteristics at different ages. Deep skin tone is the major problem in the old-perceived group of women aged 20–30, and women with older-perceived age are faced with darker and redder skin tone problem. Women aged 31–40 have more complex aging characteristics, with visible wrinkles and pigmentation, redness and enlarged pores in the mid-face, and women with older-perceived age are also bothered by dark skin tone and frown lines in the upper face.

Data Sharing Statement

The data used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Informed Consent

This study was examined and approved by Shanghai Ethics Committee for Clinical Research (Batch number: SECCR2023-149-01), and written informed consent was provided by all study subjects. The study was conducted in accordance with the Declaration of Helsinki.

Disclosure

This work was funded entirely by Yunnan Baiyao Group Shanghai Science & Technology Co., Ltd. There are no other conflicts of interest. All authors were employees of Yunnan Baiyao Group Shanghai Science & Technology Co., Ltd. at the time of writing.

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