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ORIGINAL RESEARCH

The Characteristics and Inheriting Pattern of Skin Aging in Chinese Women: An Intergenerational Study of Mothers and Daughters

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Introduction: The aging of the skin, which is affected by both external and internal causes, can reflect the external age and the internal health status. While the aging characteristics differ across ethnic groups, the specific changes in skin aging within the Chinese population have been underexplored. Moreover, investigating the similarity of aging skin characteristics between parent-offspring pairs remains uncharted territory. This study aims to fill these gaps by examining the skin aging features of Chinese women and assessing the similarity in aging skin characteristics between mother-daughter pairs.

Methods: A total of 40 mother-daughter pairs were recruited and analyzed. The perceived ages of the participants were evaluated, and their aging skin traits were systematically graded. Statistical methods were employed to discern the trends of the aging skin characteristics. By introducing a novel similarity parameter, we compared whether various skin aging characteristics have similar patterns between mothers and daughters.

Results: Our findings indicate that age 50 represents a pivotal point in skin aging. Beyond this age, the increase in rhytides and laxity scores accelerated noticeably, whereas the escalation in dyschromia scores became less marked. By introducing similar parameters between mother-daughter pairs and the radar map, we discovered that the skin aging characteristics are remarkably consistent between mother-daughter pairs.

Conclusion: Understanding the main aging skin characteristics of different age groups can allow caregivers to devise treatments for preventing skin aging in women of various ages. The mother's skin aging trend is also significant for the daughter's skin aging prevention.

Plain Language Summary: Skin aging, a complex process influenced by both internal and external factors, exhibits distinct patterns across ethnic groups. Despite this, the specific aging characteristics within the Chinese population and the hereditary similarities between parents and offspring have not been thoroughly investigated. To address this gap, our study focused on the skin aging features of Chinese women and explored the resemblance in these features between mother-daughter pairs. Eighty-seven women from the same community, including 40 mother-daughter pairs, participated in our study. We assessed how old each participant appeared to be and methodically evaluated their skin aging signs by a modified scale. With the introduction of a new similarity parameter, we further examined the extent to which skin aging traits showed parallel trends between mothers and their daughters.

Our findings pinpoint age 50 as a pivotal moment in the skin aging trajectory, where the increase in wrinkles and skin laxity becomes more pronounced, contrasting with a deceleration in skin discoloration. Remarkably, a consistent pattern of aging characteristics was observed between mother-daughter pairs, suggesting a potential genetic influence. This study not only sheds light on the specific skin aging patterns among Chinese women but also underscores the significance of genetic factors in shaping these patterns. The insights gained pave the way for developing targeted interventions for skin aging prevention and treatment, emphasizing the importance of considering familial aging trends.

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Introduction

Aging is a complicated process characterized by functional decline in multiple organs. Given that the skin is the largest organ and provides an interface between external and internal environments, the signs of aging are predominantly visible in the skin.[1] The cutaneous structure and function are significantly affected in the aging process.[2] In contemporary society, there is a growing awareness regarding skin aesthetics, leading individuals to pursue various cosmetic procedures to enhance their skin's appearance and mitigate aging-related alterations, including wrinkles, skin laxity, and pigmentation changes. The primary focus of these interventions is to alter the apparent age of the individual. Perceived age not only reflects biological age and has socio-psychological importance but also reflects internal health.[3] Facial skin aging characteristics vary across nationalities and ages. Targeted research on aging skin changes among Chinese women remains limited.

Skin aging is a result of both internal and external influences.[4] Intrinsic aging, commonly referred to as chronological aging, is an unavoidable process influenced by factors such as genetics, race, age, and gender. Wrinkles often appear at the periorbital and perioral areas, and laxity of the skin is usually found in the lower jaw, submental area, and nasolabial folds.[5] Histologically, intrinsically aged skin is frequently characterized by a loss of skin thickness,[6] reductions in dermal blood vessels and sweat glands, and decline in density and function of melanocytes and Langerhans cells.[7] Collagen production also decreases, and elastic fibers degenerate.[8] Furthermore, aging is associated with loss of soft tissue volume in some regions and hypertrophy of fat in others,[9] as well as alterations in the bone structure.[10] Moreover, estrogens have an essential effect on the physiology of women's skin.[11] Post-menopausal skin often appears drier and less elastic with more wrinkles.[12]

Extrinsic aging refers to any skin aging caused by environmental factors, the most common of which is sunlight exposure, also known as photoaging. Clinical manifestations of photoaging include dryness, coarse wrinkles, uneven pigmentation, loss of elasticity, telangiectasia, and local purpura.[13] Histologically, photoaged skin is characterized by an accumulation of elastin material below the dermo-epidermal junction, known as solar elastosis. In addition, epidermal atrophy, collagen, and elastic fiber breakage are also related to photoaging.[14,15] Skin DNA may be damaged by prolonged exposure to UV radiation.[16–18] External aging is not only caused by photoaging but also air pollution that is frequently linked to skin changes that might result in wrinkles and pigmentation.[19] Furthermore, smoking results in noticeable skin changes, including significant wrinkle formation, oral mucosal melanosis, facial pigmentation, and diminished skin sheen. Poor nutrition and certain vitamin deficiencies may also cause skin aging, leading to dermatitis and pigmentation.[18]

Perceived age is influenced by both intrinsic and extrinsic factors, leading to intriguing questions: Do parents and their children share similar aging features? How are these features transmitted to offspring? And to what extent can these features predict the perceived age of the children? These aspects remain largely unexplored. This study aimed to investigate the skin aging features of Chinese women and explore the similarity of aging skin characteristics in mother-daughter pairs.

Materials and Methods

Study Design and Population

Upon execution of written informed consent and consent of publication, a total of 47 mother-daughter pairs were included as participants in this study, among which 7 pairs of information and images were missing. None of our participants has a history of plastic surgery or other anti-aging treatments, such as lasers and injectables. Excluding 7 mother-daughter groups with incomplete information, finally, 80 participants, including 40 mother-daughter pairs, were analyzed.

Collection of Socio-Environmental Factors and Photographs

Data for all participants' sociodemographic characteristics (age, height, weight, and educational background) and environmental factors (sunshine exposure time, cooking time, and drinking condition) were collected by a questionnaire.

After the participants had thoroughly cleansed their faces, they were photographed using a VISIA skin detection apparatus (Canfield USA) under uniform lighting, photo angles, settings, and conditions. Images were captured of the frontal and both lateral views of the face.

Assessment of Perceived Age

Two experienced dermatologists assessed all participants' perceived age (AGE_p, the estimated age according to the evaluator's observation) based on their photos. All the assessments took place in the same setting (including light and screen displaying the images). Eighty photographs of participants were presented at random in the evaluation, and each picture was evaluated for no longer than 10 seconds. The evaluator estimated the AGE_p of each participant independently.

Evaluation with Modified Skin Aging Assessment Scale

Facial aging (not including neck) is primarily evaluated using a modified skin aging assessment form with more detailed content to rate aging characteristics. Two original SCINEXA (Score for Intrinsic and Extrinsic Skin Ageing) items were deleted from our skin aging scale since "cutis rhomboidal nuchae" described neck skin aging, and "change of skin phototype" was unavailable in our assessment. Three new items, including "nasolabial folds", "lax appearance", and "eye bags", were added since they were important skin aging attributes. Finally, 23 items in total are divided into eight categories of skin aging: rhytides, laxity, elastosis, dyschromia, erythema telangiectasia, texture, benign skin tumors, and aging-related skin diseases. Table 1 lists the specific items. In this study, the skin aging apparent in the photos of participants was scored using the modified skin aging scale by 2 well-trained and experienced dermatologists, who received a thorough explanation of the precise clinical manifestations of each aging item before evaluation. The

Table 1 The Skin Aging Assessment Scale Optimized on the Basis of SCINEXA is More Suitable for Chinese People

Aging Type	Skin Aging Symptoms	Evaluation	Score for Each Type	Total Score
1. Rhytides	Fine wrinkles/Lines (Wrinkles at rest, superficial)	0/1/2/3	6	69
	Coarse wrinkles/Lines (Wrinkles at rest, deep)	0/1/2/3		
2. Laxity	Nasolabial Fold	0/1/2/3	12	
	Lax appearance (Sagging)	0/1/2/3		
	Reduced fat tissue	0/1/2/3		
	Eye bags	0/1/2/3		
3. Elastosis	Yellowness	0/1/2/3	6	
	Coarse pores	0/1/2/3		
4. Dyschromia	Uneven pigmentation	0/1/2/3	12	
	Lentigines	0/1/2/3		
	Freckles	0/1/2/3		
	Pigment change	0/1/2/3		
5. Erythema telangiectasia	Telangiectasia	0/1/2/3	6	
	Permanent erythema	0/1/2/3		
6. Benign skin tumors	SK/Skin Tags/Cherry angiomas/Milia/Sebaceous Hyperplasia	0/1/2/3	6	
	Pseudo scars	0/1/2/3		
7. Texture	Dryness	0/1/2/3	9	
	Comedones	0/1/2/3		
	Favre racouchot	0/3		
8. Aging related skin diseases	Actinic keratosis	0/3	12	
	Basal cell carcinoma	0/3		
	Squamous cell carcinoma	0/3		
	Melanoma	0/3		

Notes: 0 indicates no such aging characteristic, 1 indicates mild, 2 indicates moderate, and 3 indicates severe. For aging features with only 0 and 3 options, 0 means none and 3 means yes.

dermatologists who assessed for perceived age were not consistent with those who evaluated using the modified Skin Aging Assessment scale, avoiding possible subjective influences in the scoring process.

Statistical and Analytical Methods

Each mother-daughter pair was controlled in a relatively consistent environment when the participants were enrolled. The proportion of mother-daughter groups that were both older (or younger) in appearance was observed to see if mother-daughter aging trends are similar. A radar map of each mother and daughter was used to show how similar their aging characteristics were. In order to intuitively reflect the similarity of mother-daughter radar maps, a parameter S was introduced. S was calculated by the standard deviation of the mother's aging trait score ratio to the daughter's aging trait score for each aging characteristic. For the impact of environmental factors, we used multiple linear regression analysis; the *t*-test was used to compare the similarity between the non-mother-daughter groups and the mother-daughter groups. The radar map was made by Microsoft Excel, and the other analysis software was SPSS and Prism GraphPad.

Results

Participants' Perceived Age and Biological Age Show a Linear Correlation

The consistency in the ratings between the two evaluators was notably high (shown in Supplementary Figure 1). The participants were categorized into three groups based on the difference between perceived age (AGE_p) and biological age (AGE_b): appear older (AO) group (AGE_p - AGE_b ≥ 3 years), appear younger (AY) group (AGE_p – AGE_b ≤ −3 years), and group with no significant difference between AGE_p and AGE_b (−3 years < AGE_p – AGE_b < 3 years, NSD) (shown in Figure 1). The sociodemographic characteristics, environmental factors, and past medical history of the participants in the three groups were summarized in Table 2. When participants were enrolled, the consistency of environmental factors was controlled as much as possible. All participants lived in cities and had relatively consistent living habits. Consequently, environmental factors other than sun exposure were determined to have an insignificant impact on the skin aging observed among our participants (shown in Supplementary Table 1). All participants' perceived ages are linearly correlated to their biological ages (P<0.0001) (shown in Figure 2a).

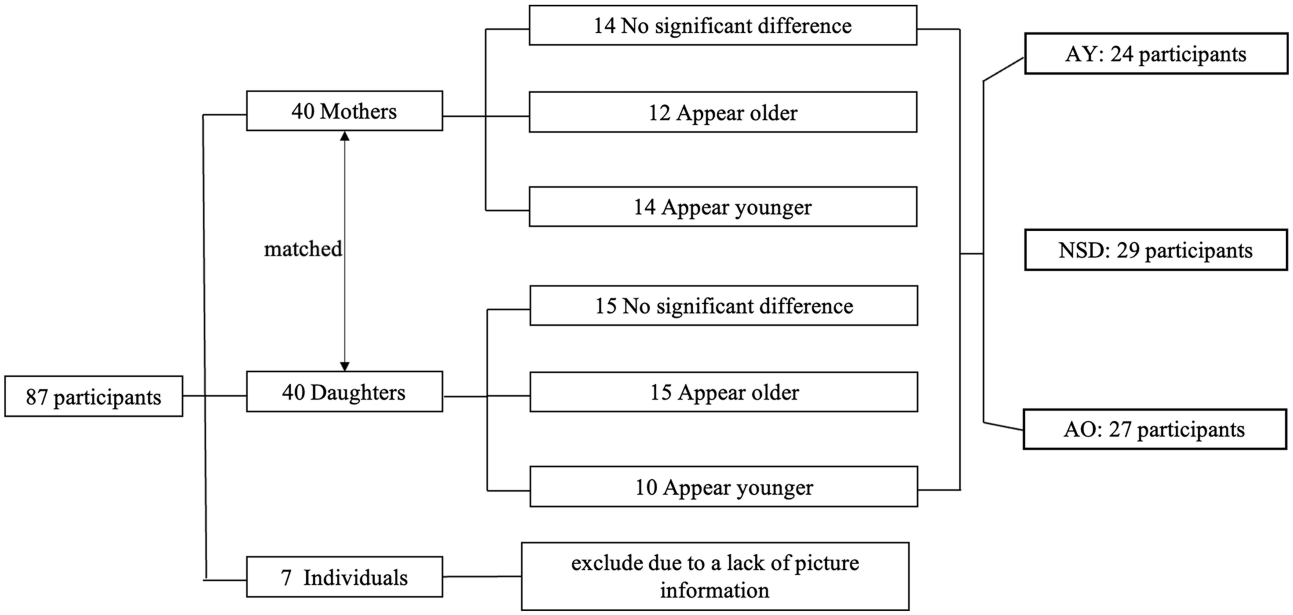

Figure 1 Grouping of participants. All participants (including 40 mother-daughter pairs) were grouped according to the relationship between perceived age and biological age. Seven mother-and-daughter pairs were excluded from the study due to a lack of picture information.

Table 2 Baseline Characteristics of All Participants (n = 80 Pts)

	Variable	Aging Condition			All 80 (100%)
		AY 24 (30.0%)	NSD 29 (36.3%)	AO 27 (33.7%)	
Characteristics	Mean age, yrs±SD	56.7±13.1	52.2±15.4	47.4±14.1	51.9±14.6
	Mean weight, kg±SD	59.5±7.1	58.1±8.7	56.5±6.5	58.0±7.5
	Mean height, cm±SD	160.6±6.5	160.2±5.2	160.3±5.4	160.4±5.6
	BMI, kg/m2±SD	23.1±2.7	22.7±3.3	22.0±2.2	22.6±2.8
Average daily sun exposure	<30min, n(%)	14(58.3%)	13(44.8%)	6(22.2%)	33(41.3%)
	30min-2h, n(%)	8(33.3%)	13(44.8%)	17(63.0%)	38(47.5%)
	2–4h, n(%)	1(4.2%)	2(6.9%)	2(7.4%)	5(6.3%)
	>4h, n(%)	1(4.2%)	1(3.5%)	2(7.4%)	4(5%)
Educational level	Completion of Specialized or General Sec. Ed. and Under, n(%)	7(29.2%)	7(24.1%)	6(22.2%)	20(25.0%)
	Junior college, n(%)	7(29.2%)	6(20.7%)	5(18.6%)	18(22.5%)
	Undergraduate, n(%)	6(25.0%)	9(31.1%)	9(33.3%)	24(30.0%)
	Bachelor or above degree, n(%)	4(16.7%)	7((24.1%)	7(25.9%)	18(22.5%)
Smoking	No, n(%)	24(100.0%)	29(100.0%)	27(100.0%)	80(100.0%)
	Yes, n(%)	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)
Drinking	No, n(%)	15(62.5%)	15(51.7%)	13(48.1%)	43(53.7%)
	Occasionally, n(%)	8(33.3%)	14(48.3%)	13(48.1%)	35(43.8)%
	Frequently, n(%)	1(4.2%)	0(0.0%)	1(3.8%)	2(2.5%)
	Always, n(%)	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)
Cooking	No, n(%)	7(29.2%)	4(13.7%)	2(7.4%)	13(16.3%)
	Occasionally, n(%)	5(20.8%)	14(48.3%)	11(40.7%)	30(37.5%)
	Frequently, n(%)	2(8.3%)	1(3.5%)	5(18.6%)	8(10.0%)
	Always, n(%)	10(41.7%)	10(34.5%)	9(33.3%)	29(36.2%)

Abbreviations: AY, appear younger group; NSD, group with no significant difference between perceived age and biological age; AO, appear older group.

The Trends of Skin Aging Characteristics with Advancing Chronological Age

All aging skin features can be grouped into eight categories using our improved aging skin rating scale: rhytides, laxity, elastosis, dyschromia, erythema telangiectasia, texture, benign skin tumors, and aging-related skin diseases. Following the scoring of the aging skin characteristics of 80 participants, the variation trends of the eight skin aging traits across subjects of varying ages were depicted in Figure 2b.

In our findings, the age of 50 emerged as a critical juncture in the progression of skin aging. Before reaching 50, scores consistently increased for rhytides, laxity, elastosis, dyschromia, erythema telangiectasia, and benign skin tumors, correlating with advancing age. Post-50, however, the pattern altered significantly. While the escalation in dyschromia scores became less marked, the increase in rhytides and laxity scores accelerated noticeably. In contrast, the progression trends for elastosis and benign skin tumors showed no significant change. Erythema telangiectasia presented substantial variability among individuals, and the scores for skin texture remained relatively stable across the age spectrum.

Mother-Daughter Pairs Exhibit Higher Similarity in Skin Aging Patterns

The aging skin characteristics of each of the 40 mother-daughter pairs were individually compiled, and their aging features' similarity was examined. According to our findings, out of 40 mother-daughter pairs, 11 pairs appeared older than their actual age, 6 pairs appeared younger, and 9 pairs showed no discernible difference between perceived age and biological age (shown in Table 3). There was also one mother-daughter pair in which the mother appeared significantly older than her biological age, yet the daughter seemed considerably younger. In two mother-daughter pairs, the

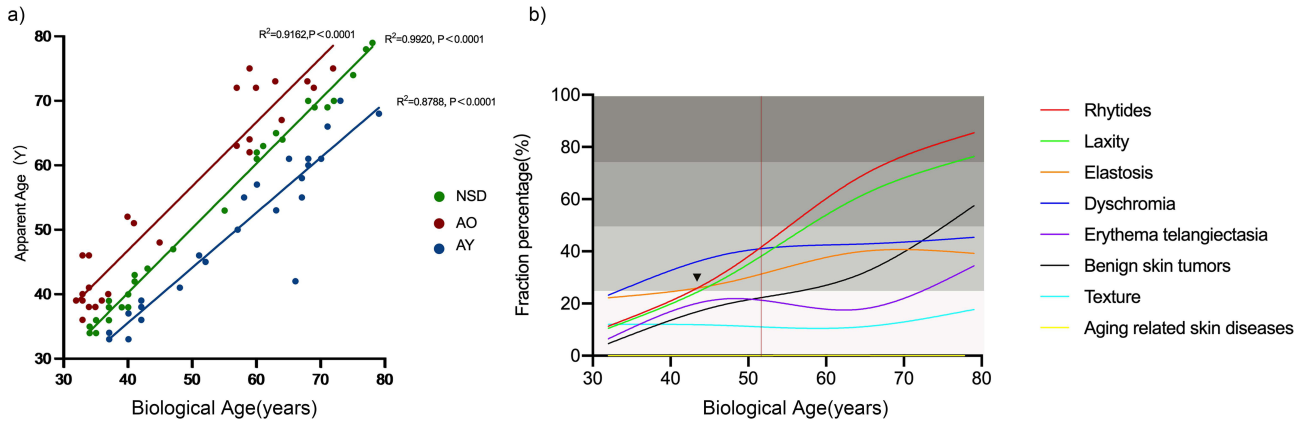

Figure 2 Characteristics of skin aging in Chinese women. (**a**) Scatter plot of biological and perceived age (both in years). Solid lines indicate a linear relationship between appearance and actual age. Green represents the group with no significant difference (NSD, R^2=0.9920, P < 0.0001), red represents the group that looks older (AO, R^2=0.9162, P < 0.0001), and blue represents the group that looks younger (AY, R^2=0.8788, P < 0.0001). (**b**) The trend of aging characteristics with the increase of biological age. The horizontal axis is biological age; The vertical axis is the ratio of the score of each aging feature to the total score of that feature, and the aggravation change of the background gray level represents the severity of the aging features (level 1: Absent feature, level 2–4: mild, moderate and severe features). The longitudinal red dotted line is the intersection of the leading skin aging characteristics; The black triangle marks the point at which the slope increases rapidly.

daughters' perceived age was much older than the biological age, while the mothers' perceived age was significantly younger. In the remaining 11 mother-daughter pairs, either the mother or the daughter had no discernible difference between apparent and biological age, but the latter appeared younger or older. In total, 26 of the 40 mother-daughter pairs (65%) displayed consistent aging disposition, while the remaining 14 displayed inconsistent aging tendency (35%).

A "mother-daughter skin aging similarity parameter", denoted as S value, was introduced to quantitatively assess the resemblance in skin aging characteristics between mothers and daughters (reflected through similarities in their respective radar maps). Assuming that under ideal circumstances, daughters and mothers have exactly the same trend of skin aging, then their scores of each aging feature should increase in equal proportion; that is, the standard deviation of the ratio of all aging features between mother and daughter is 0. However, in the actual situation, there are definitely differences in the ratio of aging characteristics between mother and daughter, and the smaller the difference, the more similar they are. So, similarities could be intuitively reflected by calculating the standard deviation of the mother's aging trait score ratio to the daughter's aging trait score for each aging characteristic. A lower S value indicates a higher similarity in skin aging traits between mother-daughter pairs (a more similar shape in the radar map). The average S values were calculated for the mother-daughter pairs and, for comparison, generated multiple random non-mother-daughter pairs, computing the mean S values for these as well. A *t*-test was employed to determine if there was a statistically significant difference between the two groups. As illustrated in Figure 3b, the average S values for the mother-daughter group were consistently lower than those for the non-mother-daughter group, although the difference was not statistically significant, possibly due to the limited sample size. Additionally, Figure 3a presents representative images of mother-daughter pairs with similar aging characteristics alongside their corresponding multidimensional radar maps, demonstrating the congruence in skin aging patterns within these pairs.

Table 3 Consistency of Skin Aging Between Mother and Daughter (40 Pairs)

		Mother Group		
		Older	**Younger**	**No Significant Difference**
Daughter Group	Older	11	2	1
	Younger	1	6	3
	No significant difference	1	6	9

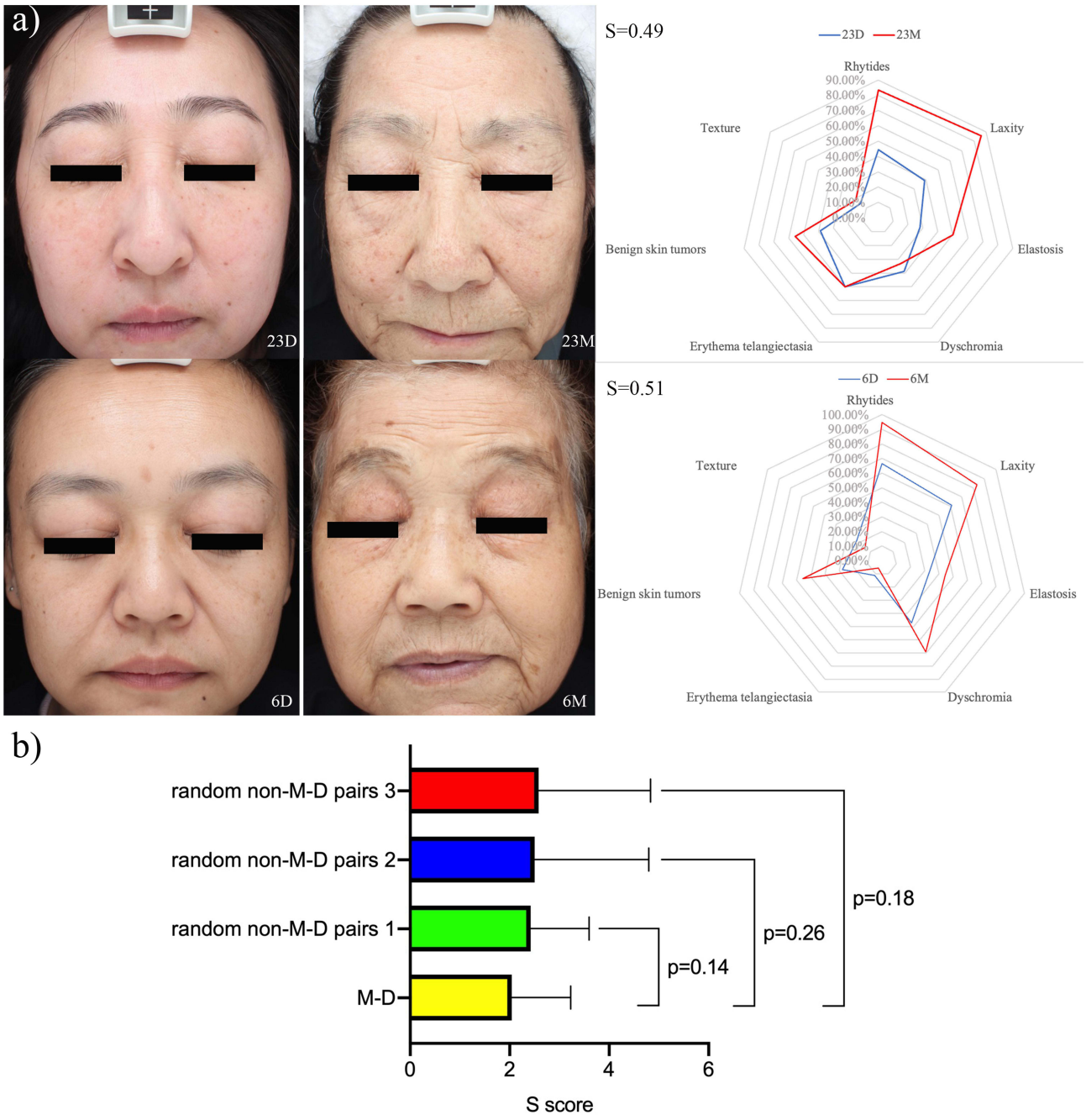

Figure 3 The similarity of skin aging between mother-daughter pairs. (**a**) Clinical picture and radar map of skin aging between mother and daughter (S values are 0.49 and 0.51). (**b**) S-value distribution of mother-daughter group and non-mother-daughter group. The mean similarity value of the mother-daughter group is S =2.04, ranging from 0.49 to 3.70, except for one mother-daughter pair (S =7.33). The mean similarity value of the non-mother-daughter group is 2.43, 2.51, and 2.58, respectively.

Discussion

Skin aging research has predominantly centered on Caucasian populations, with limited studies addressing Asian demographics, particularly those of Chinese descent. Our research focused on the changes in the aging skin attributes of Chinese women over time. Unlike previous research, our current investigation uniquely explores the correlation of aging characteristics between mothers and daughters, employing a more detailed and varied scale for assessing skin aging traits. This approach allows for a nuanced understanding of skin aging within this specific population, highlighting the need for further research in diverse ethnic groups.

Most clinical investigations on skin aging still rely on non-invasive assessment methods. Skin aging assessment scales are crucial tools in this context, and more than 100 such scales are extant.[20] However, only a few measurement criteria are standardized, and most such scales consider only a few criteria, such as the face, neck, and chest, or a few races.[21] Only five published multidimensional assessment scales were identified as having high methodological quality for all skin types from 1978 to 2016:[20] the Merz Aesthetics Scale (MAS),[22] SCore of INtrinsic and EXtrinsic skin Aging (SCINEXA),[19] Skin Aging Score (SAS) scale,[23] and two unnamed scales.[24,25] However, these scales are more applicable to Caucasians and lack precise terms and definitions for certain manifestations of skin aging. The SCINEXA scale offers a more comprehensive and detailed assessment of skin aging manifestations compared to existing scales. Additionally, it uniquely evaluates and differentiates between intrinsic and extrinsic factors contributing to skin aging. This scale has been used numerous times and has been proven to have widespread applicability.[26] In the past decade, some researchers have attempted to study the main aging characteristics and aging process of Chinese women[27] and looked for genes that might be associated with skin aging in Han women.[28] Other studies have also explored environmental influence[29] and the effects of different aging characteristics on perceived age.[30,31] However, previous studies' evaluation methods for aging characteristics mainly focused on pigmentation and wrinkles, lacking a more detailed and multidimensional evaluation. In this study, we employed a modified version of the SCINEXA scale to conduct a multi-dimensional assessment, taking into account factors rhytides, laxity, elastosis, dyschromia, erythema telangiectasia, skin texture, benign skin tumors, and aging-related skin diseases. Skin aging was scored as comprehensively as possible. Compared with previous studies, our methods show improvements in terms of completeness and detail.

Compared with Caucasians, East Asians (including Chinese) have different bone structure,[32] lipid distribution[33] and different tolerance to exogenous stimuli[34] that results in different trends of aging characteristics. In Caucasian women, laxity and wrinkling appear at a younger age than in Chinese women, who tend to develop pigmentation earlier;[35] by analyzing the data of our participants, we also confirmed this conclusion. In our study, the most common features of aging skin in Chinese women include rhytides, laxity, and dyschromia. For participants under 50, the predominant change is dyschromia, and for participants over 50, the increase in rhytides and laxity plays a more significant role. As reported previously, wrinkles tend to be more age-related than pigmentation changes in Chinese women.[36,37]

A 2009 study of 102 pairs of Danish twin sisters explored the effects of environmental and genetic factors on skin aging.[38] Our study explored possible aging skin similarities between Chinese mothers and daughters by comparing 40 mother-daughter pairs and found there were similarities between them. To explore the changes in skin aging characteristics between mother-daughter pairs, after minimizing the impact of environmental factors on our participants, S scores were calculated. But it's important to note that although we have controlled for consistent environmental factors as much as possible, there were still some differences. For example, we could not ensure that their sun exposure times were consistently the same, which would affect the aging of the skin. This explains why some of our mother-daughter pairs have differences in skin aging. The final results showed that the S-value of the mother-daughter matching group was always smaller than that of the non-mother-daughter matching group, indicating that the mother-daughter matching group had better similarity than the non-mother-daughter matching group, that is, the mother-daughter matching radar map was more similar. But again, we still need to consider the influence of other factors, such as the father's situation, which may also affect the similarity between mother and daughter, and this requires further research.

Understanding the main aging skin characteristics of different age groups can allow caregivers to devise treatments for preventing skin aging in women of different ages. Treatment should aim at ameliorating/removing pigmentation for younger women, whereas, for middle-aged and elderly women, interventions should target wrinkles and skin-tightening to achieve skin rejuvenation. Additionally, if the mother of the patient has wrinkles, treatment should focus on wrinkle prevention.

A limitation of our study is the relatively small sample size which may impact the quality of the statistical results. Future studies comprising large sample sizes are warranted. The twin cohort is actually more suitable for genetic background studies, but the collection of participants is difficult, so in our study, we explored the apparent similarity of mother-daughter aging skin characteristics. In addition, the genetic link between mother and daughter is also being further studied.

Conclusion

Our study provides valuable insights into Chinese women's skin-aging characteristics and the similarities between mothers and daughters. These findings can aid in developing more precise treatment and prevention strategies for skin aging in the future.

Data Sharing Statement

All relevant data are available from within the manuscript and the Supplemental Information file.

Statement of Ethics

This study was performed in accordance with the Declaration of Helsinki Principles, including Institutional Review Board approval at Beijing Tsinghua Changgung Hospital Ethics Committee (Approval Number 23356-0-02). For studies using human participants, state whether written informed consent was obtained from participants to participate in the study.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors have no conflicts of interest to declare for this work.

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