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Age-Related Facial Wrinkle Dynamics in the Chinese Population: Advanced Insights into Facial Wrinkles Changes and the Anti-Wrinkle Efficacy of a Targeted Serum

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Introduction: Facial wrinkles are a key sign of skin aging. Consumer insights show a growing demand for targeted, zone-specific anti-wrinkle solutions. This study explored the age-related dynamics of facial wrinkles. In conjunction with wrinkle-related physiological changes, focusing on ECM promotion, a serum containing key ingredients (retinol, HPR, peptides and silybin) was developed and validated to alleviate facial wrinkles in different age groups.

Methods: 1319 Chinese subjects (18-70 years) were divided into 5 age groups: 18-29, 30-39, 40-49, 50-59, and 60-70. Wrinkles in 6 areas including the outer canthus, lower eyelid, nasolabial fold, glabella, forehead, and cheek were graded by experts according to Skin Aging Atlas. The effect of key ingredients on TGF-β signaling (TGF-β1/2, p-smad2/3) and ECM-related proteins was assessed using ex vivo skin. Additionally, a 56-day serum clinical trial was conducted on 65 participants. Instrumental measurements were used to evaluate the anti-wrinkle efficacy of the serum in 6 areas across different age groups.

Results: Wrinkle grade increased with age. Facial wrinkles in 6 areas were significantly correlated with age ($p<0.01$), with crow's feet showing the strongest correlation ($r = 0.562$). Grade 1 wrinkles appeared earliest at 32.06±9.35 years (crow's feet) and latest at 40.70±10.09 years (glabellar lines), with the largest age gap between grade 1 and grade 2 in crow's feet. The key ingredients effectively activated the TGF-β-Smad signaling pathway and increased collagen and elastin content in the skin. After 56 days of serum application, significant improvements in all types of wrinkles across all age groups were observed, along with a notable increase in R2 value and dermal thickness.

Conclusion: Facial aging begins around the eyes, with crow's feet most indicative of early signs. Grade 1 wrinkles typically appear after 30s, with slower progression from grade 1 to 2 in crow's feet. These discoveries offer valuable perspectives for targeted anti-aging and personalized skincare approaches. Through rigorous in vitro and in vivo efficacy clinical evaluations, this serum has proven its ability to stimulate the synthesis of ECM-related proteins, increase skin elasticity and significantly improve both dermal thickness and various types of wrinkles, demonstrating its remarkable anti-wrinkle efficacy.

Keywords: age, facial wrinkles, correlation, in vivo clinical trial, in vitro study

1. Introduction

Facial wrinkles are among the most visible and intuitive manifestations of skin aging and are widely recognized as key clinical indicators for assessing the degree of cutaneous aging. These structural changes primarily occur at multiple levels of the skin, including the epidermis, dermis, and the dermal-epidermal junction [1]. Their formation is closely associated with the degradation of dermal extracellular matrix components, particularly collagen and elastin fibers, as well as with intrinsic physiological changes such as decreased hormonal levels and reduced cellular turnover. In addition, extrinsic factors—including chronic ultraviolet (UV) exposure, environmental pollution, and oxidative stress—further accelerate the development and deepening of wrinkles [2].

There are studies showing that there are differences in facial expression characteristics among different races and ages. While facial wrinkling has been extensively characterized in Caucasian populations, evidence suggests notable ethnic variations in both the severity and pattern of wrinkle formation [3]. Compared to Caucasians, Asians—particularly East Asians—tend to exhibit deeper and more localized wrinkles, often accompanied by prominent pigmentary changes rather than widespread fine wrinkling [4-5]. However, systematic studies focusing specifically on age-related wrinkle development within the Chinese population remain limited. Understanding the chronological patterns of wrinkles in Chinese individuals is essential for both clinical dermatology and targeted cosmetic interventions. In addition, With enhanced skincare awareness and the proliferation of technology-driven anti-aging concepts, Chinese consumers are transitioning from holistic facial rejuvenation paradigms to precision-targeted zonal wrinkle management strategies.

In response to this emerging trend, the present study conducted a comprehensive investigation of facial wrinkle patterns across different age groups in a Chinese female population, involving over one thousand participants. Based on the findings and informed by key physiological mechanisms underlying skin aging, we developed a multi-functional anti-wrinkle serum. The formulation incorporates retinol, hydroxypinacolone retinoate (HPR), peptide complexes, and silymarin, targeting the stimulation of essential collagen synthesis. The product was specifically designed to address region-specific wrinkles, and its efficacy in improving wrinkles across distinct facial zones was systematically evaluated.

2. Materials and Methods

Study Design Overview

This study was conducted in two parts to evaluate facial wrinkle characteristics across different age groups and to assess the age-stratified anti-aging efficacy of a targeted serum.

Part I: Retrospective Wrinkle Characterization Study

A retrospective analysis based on standardized facial images collected at SGS from 2022 to 2024. A total of 1319 Chinese participants aged 18 to 70 years were included. All images were acquired using the VISIA® Complexion Analysis System (Canfield Scientific Inc.), under consistent lighting and positioning protocols. Two dermatologists independently performed visual grading of six major facial wrinkle types—glabellar lines, crow’s feet, nasolabial folds, cheek wrinkles, forehead wrinkles, and Under-eye wrinkles—according to the standard Asian facial aging atlas. Subjects were grouped into five age brackets: 18–29, 30–39, 40–49, 50–59, and 60–70 years. The wrinkle severity trends and distribution characteristics were analyzed across age groups to delineate aging patterns in the Chinese population. Table 1 summarizes the distribution of subjects according to age-classes.

Table 1. Distribution of Participants by Age Group

Age group	Number	Average age
18-29	90	24.26±3.34
30-39	213	35.77±2.47
40-49	487	44.82±2.74
50-59	460	54.08±2.85
60-70	69	61.28±2.01
total	1319	46.05±9.61

Part II: Clinical Study on Anti-Aging Efficacy

Participants

A total of 65 healthy Chinese women were enrolled and stratified into five age groups: 18–29, 30–39, 40–49, 50–59, and 60–70 years, with no fewer than 10 subjects per group. All participants provided written informed consent before enrollment. The study protocol was reviewed and approved by the ethics committee of a third-party testing institution. For participants aged ≥30 years, inclusion criteria required visible signs of facial aging based on visual grading using the Asian Standard Wrinkle Atlas [6]. Specifically, participants were eligible if they exhibited: crow's feet, and glabellar lines scores ≥2. All subjects were free of active dermatologic conditions and had not undergone any recent aesthetic treatments.

Product Application

Participants were instructed to apply the test serum twice daily (morning and evening) after cleansing the face. The treatment period lasted 56 consecutive days. During the study, no other anti-aging or active skincare products were permitted. Product usage compliance and skin tolerability were monitored at each visit.

Clinical Evaluation

Clinical assessments were performed at three time points: Day 0 (baseline), Day 28, and Day 56 to evaluate changes in facial wrinkles and skin elasticity.

Wrinkles evaluation methods: Wrinkle levels at representative facial regions—including glabellar lines and crow's feet wrinkles were assessed using a 3D skin surface roughness analyzer, Primos CR (LMI Technologies, USA). During the measurement, subjects closed their eyes in a relaxed state. Wrinkle volume was quantitatively calculated to evaluate changes in wrinkle severity. The smaller the parameter values, the fewer wrinkles.

Skin elasticity evaluation methods: Cutometer® MPA580 (Courage+Khazaka Electronic GMBH, Germany) was applied to measure the skin elasticity and firmness, with the gross elasticity parameter R2 representing the elastic characteristics, and F4 representing the firmness of the skin. The closer the R2 parameter is to 1 (100%), the more elastic the skin. The lower the F4 value, the firmer the skin.

Statistical Analysis

Statistical analysis was performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). The Shapiro–Wilk test was applied to assess the normality of data distribution. For normally distributed data, paired Student's t-tests were used to determine statistical significance. For non-normally distributed data, the Wilcoxon signed-rank test was applied. Differences in wrinkle metrics among different age groups were assessed using one-way analysis of variance (ANOVA). Spearman correlation coefficients (r) were calculated to explore the relationships between facial wrinkle parameters and age. A p-value of < 0.05 was considered statistically significant.

3. Results

Age-related Analysis of Facial Wrinkles

The severity of all six facial wrinkle types increased progressively with age (Table 2). Statistical analysis revealed significant differences in wrinkle severity among the five age groups (p<0.001 for all wrinkle types). These findings indicate a strong age dependency of facial wrinkle development. Spearman correlation analysis further confirmed these observations (Table 3). Among the six wrinkle types, Crow's feet showed the strongest positive correlation with age (r = 0.562, p<0.01), followed by cheek wrinkles (r = 0.514, p<0.01) and under-eye wrinkles (r = 0.512, p<0.01). These findings indicate that both the number and severity of facial wrinkles increase significantly with age, particularly in the periorbital and midface regions.

Table 2. Descriptive Statistics of Wrinkle Severity Across Age Groups (Mean ± SD)

Wrinkles	18-29	30-39	40-49	50-59	60-70	*p value*
Forehead lines	1.18±0.76	1.87±1.02	2.18±1.09	2.59±1.21	3.35±1.30	0.000
Glabellar lines	0.73±0.50	1.33±0.88	1.74±1.03	2.38±1.20	3.15±1.44	0.000
Crow’s feet	0.96±0.55	2.05±0.85	2.78±1.02	3.40±1.14	3.89±1.09	0.000
Under-eye wrinkles	1.57±0.70	2.17±0.91	2.82±1.04	3.40±1.14	4.08±1.29	0.000
Cheek wrinkles	0.75±0.38	1.52±0.83	1.96±0.90	2.51±1.02	2.99±0.86	0.000
Nasolabial folds	1.16±0.74	1.63±0.80	2.17±1.02	2.73±1.11	3.21±1.05	0.000

Table 3. Correlation Between Wrinkle Scores and Age in Different Age Groups

Wrinkles	18-29	30-39	40-49	50-59	60-70	18-70
Forehead lines	0.158	0.197^{**}	0.124^{**}	0.199^{**}	0.167	0.370^{**}
Glabellar lines	0.238^{*}	0.190^{**}	0.139^{**}	0.271^{**}	0.293^{*}	0.491^{**}
Crow’s feet	0.275^{**}	0.292^{**}	0.210^{**}	0.208^{**}	0.095	0.562^{**}
Under-eye wrinkles	0.421^{**}	0.255^{**}	0.154^{**}	0.211^{**}	0.274^{*}	0.512^{**}
Cheek wrinkles	0.279^{**}	0.263^{**}	0.164^{**}	0.217^{**}	0.121	0.514^{**}
Nasolabial folds	0.176	0.183^{**}	0.175^{**}	0.147^{**}	0.142	0.476^{**}

Age Distribution of Different Wrinkle Types

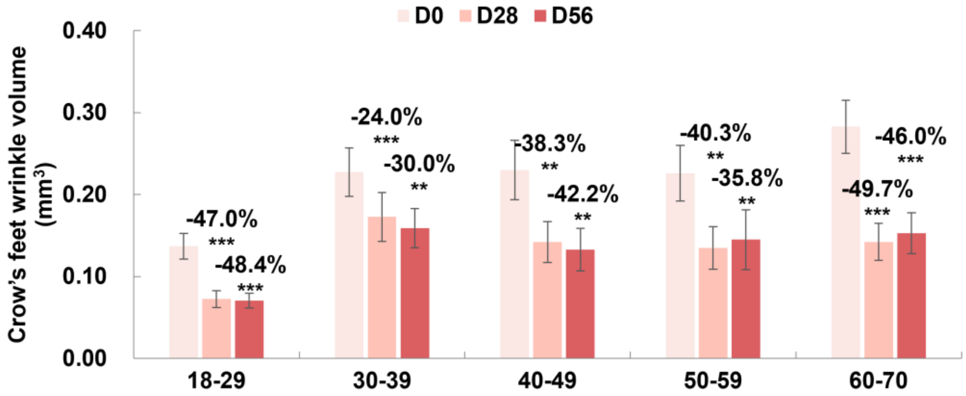
As shown in Table 4, Among all wrinkle types, crow’s feet appeared earliest, with level 1 observed at a mean age of 32.06 years, followed by under-eye wrinkles (37.79 years), cheek wrinkles (38.17 years), nasolabial folds (39.30 years), forehead lines (40.14 years), and glabellar lines as the latest (40.70 years). The widest age gap between level 1 and level 2 was also found in crow’s feet, spanning 11.72 years, indicating that although crow’s feet emerge early, their progression is relatively slow.

Table 4. Age Distribution Across Wrinkle Severity Grades

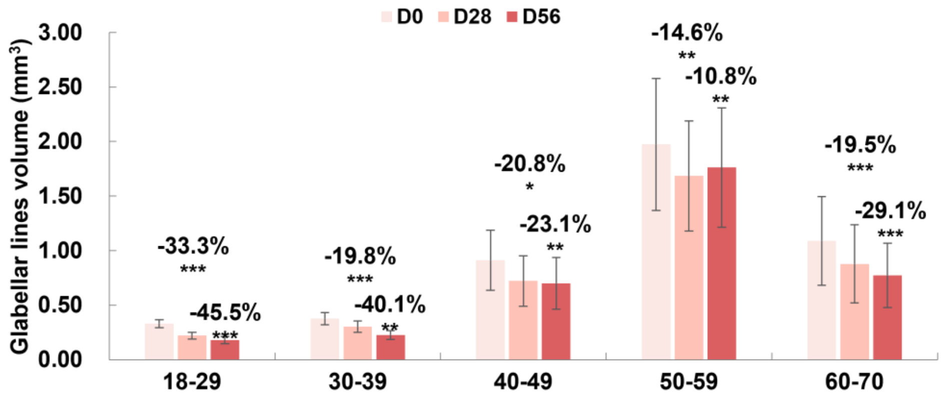
Average age	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
Forehead lines	40.14	45.41	47.64	50.57	51.89	57.44
Glabellar lines	40.70	46.75	49.55	51.54	55.17	57.82
Crow’s feet	32.06	43.78	46.41	50.58	53.18	57.44
Under-eye wrinkles	37.79	40.58	46.27	49.33	53.74	56.16
Cheek wrinkles	38.17	45.69	49.46	53.61	54.40	56.50
Nasolabial folds	39.30	44.58	47.78	52.54	54.53	53.50

Anti-Wrinkle Effect of Serum

As shown in Figure 1, the wrinkle volume of both crow's feet and glabellar lines significantly decreased from baseline at Day 28 and Day 56 across all age groups ($p < 0.05$). Specifically, the crow's feet wrinkle index improved by 48.4%, 30.0%, 42.2%, 35.8%, and 46.0% in the 18–29, 30–39, 40–49, 50–59, and 60–70 age groups after 56 days respectively. These findings indicate that the test product effectively reduces the severity of facial wrinkles following 28 and 56 days of application. The representative images of improvement in crow's feet and glabellar lines from the 60–70 age group are presented in Figure 2.

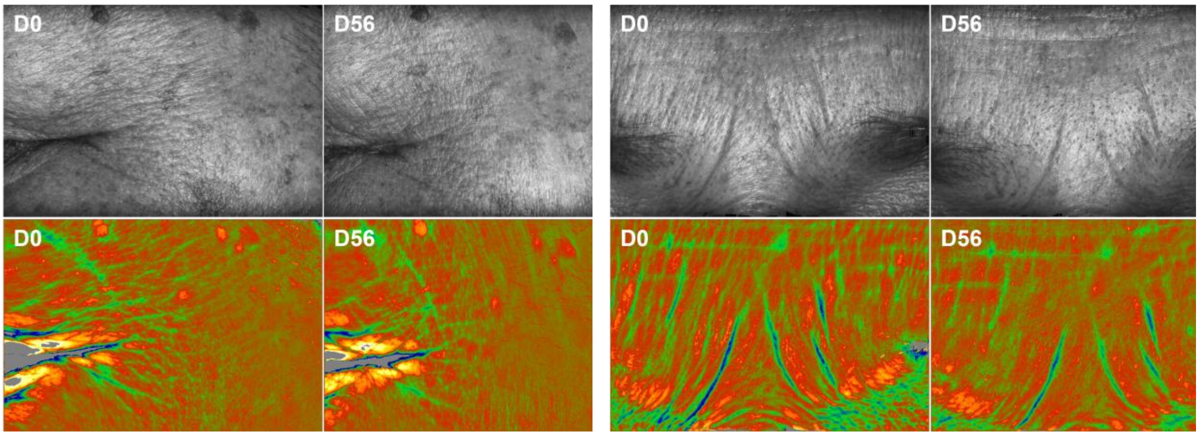


(a)



(b)

Figure 1. Age-stratified changes in wrinkle volume after 56 days of product application. (a) Crow's feet wrinkle volume. (b) Glabellar lines volume. Data represent mean ± SEM of wrinkle volume (mm³) at baseline (D0), D28), and D56 across different age groups. Improvement (%) from baseline are labeled above bars. Statistically significant differences from D0 were determined by paired t-test and marked as follows: *p<0.05, **p<0.01, ***p<0.001.

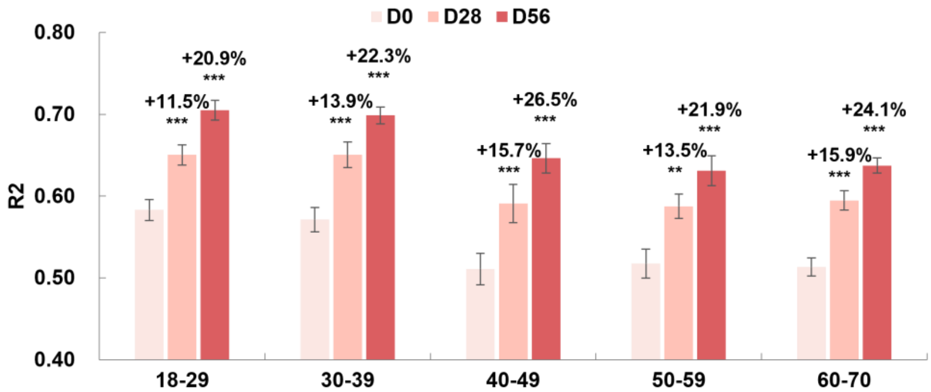


(a) (b)

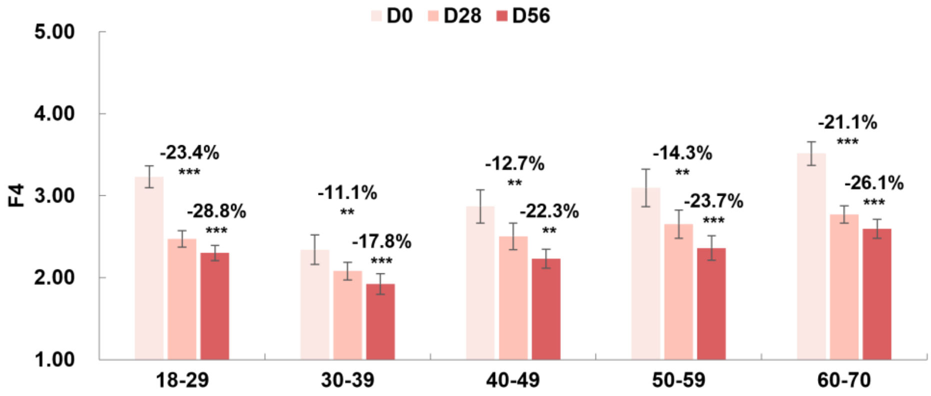
Figure 2. The representative images of the improvement in wrinkles captured in the 60-70 age group: (a) Crow's feet improvement image, subject 10, 65 years old, (b) Glabellar lines improvement image, subject 2, 63 years old.

Improvement in Skin Elasticity and Firmness

As shown in Figure 3, significant improvements were observed in both R2 and F4 parameters across all age groups following product application. The R2 value, indicative of gross skin elasticity, increased by 20.9%, 22.3%, 26.5%, 21.9%, and 24.1% in the 18–29, 30–39, 40–49, 50–59, and 60–70 age groups, respectively after 56 days of use (p<0.01). Concurrently, the F4 parameter, reflecting skin firmness, exhibited a statistically significant reduction in all age groups at both Day 28 and Day 56 (p<0.01). These findings demonstrate that the test product effectively enhances skin elasticity and firmness across a wide age range.



(a)



(b)

Figure 3. Changes in skin elasticity and firmness for 56 days: (a) R2 value Mean ± SEM), (b) F4 value (Mean ± SEM). Improvement (%) from D0 are shown. ***p*<0.01; ****p*<0.001.

4. Discussion

Skin plays a vital role in protecting against external insults and maintaining internal homeostasis. However, with advancing age, metabolic activity in skin tissues slows down, and the cumulative effects of chronic UV exposure lead to increased skin roughness and deepening of wrinkles. Clinically, skin aging is primarily characterized by the development of wrinkles and tissue sagging. Histologically, aged skin typically exhibits epidermal thinning, impaired barrier function, and extensive degradation of the dermal extracellular matrix (ECM) [7]. Transforming growth factor-β (TGF-β) is a key regulator of ECM homeostasis. Together with its receptors and downstream Smad proteins, it constitutes the TGF-β/Smad signaling pathway. Through this pathway, TGF-β promotes the synthesis of structural ECM components such as collagen and elastin, suppresses the activity of matrix metalloproteinases (MMPs), and enhances ECM integrity [8].

In the first phase of this study, facial images from 1319 participants aged 18 to 70 years were assessed to evaluate the severity of six distinct wrinkle types: lateral canthal lines (crow's feet), nasolabial folds, forehead lines, cheek wrinkles, infraorbital lines, and glabellar lines. All six wrinkle types demonstrated highly significant positive correlations with chronological age ($p<0.01$), indicating a progressive and consistent increase in wrinkle severity with aging. Notably, the strongest correlation was observed in the lateral canthal region ($r = 0.562$), suggesting this site is particularly sensitive to age-related dermal changes. Among the six types, crow's feet were the earliest to manifest, while glabellar lines appeared at later stages. The transition from grade 1 to grade 2 was most temporally dispersed for crow's feet, indicating marked inter-individual variability.

Based on findings from a large-scale facial wrinkle assessment involving over one thousand individuals, we developed a novel serum formulation incorporating key active ingredients—retinol, HPR, peptides, and silymarin. The formulation was specifically designed to target facial wrinkles across different age groups. Clinical trial results demonstrated that the serum effectively improved wrinkle severity, as well as facial skin elasticity and firmness, in participants of all age categories.

The observed clinical efficacy is likely attributable to the synergistic activity of key active ingredients within the formulation. TGF-β-Smad signaling pathway is considered to be a major regulatory pathway for maintaining ECM homeostasis. A variety of ECM genes, such as collagen and fibronectin, can be directly up-regulated through the TGF-β-Smad signaling pathway [9].

Retinol and HPR, both retinoid derivatives, are known to stimulate fibroblast activity and up-regulate type I and III collagen synthesis, thereby improving dermal density and reducing wrinkle depth [10]. The inclusion of peptide complexes may further augment extracellular matrix remodeling by promoting elastin synthesis, while silymarin contributes antioxidative protection against UV-induced damage [11]. The key ingredients effectively activated the TGF-β-Smad signaling pathway and increased collagen and elastin content in the skin. Collectively, these components address multiple pathophysiological aspects of skin aging, from collagen degradation to reduced cellular turnover.

Despite the overall robustness of this two-part study, several limitations should be acknowledged. The wrinkle assessment relied solely on visual grading, lacking multidimensional analyses to capture other potential age-related influences on facial wrinkle development. Although instrumental evaluations were included in the clinical trial, no histological or molecular biomarkers were assessed to elucidate the underlying mechanisms of wrinkle reduction and elasticity improvement. Future studies should incorporate non-invasive imaging techniques, biomarker quantification, and extended follow-up periods to validate the durability and mechanistic basis of the observed treatment effects.

5. Conclusion

This two-part study provides robust clinical and instrumental evidence for age-related wrinkle progression and the therapeutic potential of a targeted anti-wrinkle serum in Chinese women. Retrospective analysis of 1,319 individuals revealed distinct age-related wrinkle patterns， and facial aging typically initiates around the eyes, with crow’s feet emerging as the earliest and most indicative sign. Grade 1 wrinkles generally appear after the age of 30, and the progression from grade 1 to grade 2 in crow’s feet tends to be relatively slow. In this study, a serum formulation containing retinol, HPR, peptides, and silymarin demonstrated notable anti-wrinkle efficacy across different facial regions and age groups. These findings highlight the importance of developing targeted anti-aging interventions and personalized skincare strategies based on specific wrinkle types and progression patterns.

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