



ORIGINAL ARTICLE

Three-Dimensional Photogrammetric Study on Age-Related Facial Characteristics in Korean Females

Soon-Hyo Kwon, Jong Woo Choi¹, Hee Jin Kim², Woo Shun Lee³, Minsu Kim⁴, Jung-Won Shin⁴, Jung-Im Na⁴, Kyoung-Chan Park⁴, Chang-Hun Huh⁴

Department of Dermatology, Kyung Hee University Hospital at Gangdong, Kyung Hee University School of Medicine, ¹Department of Plastic and Reconstructive Surgery, Asan Medical Center, University of Ulsan College of Medicine, ²Department of Dental Anatomy, College of Dentistry, Yonsei University, ³Medytox Inc., Seoul, ⁴Department of Dermatology, Seoul National University Bundang Hospital, Seoul National University College of Medicine, Seongnam, Korea

Background: Understanding the age-related morphological changes of facial soft tissue is fundamental in achieving improved outcomes of rejuvenating procedures. Three-dimensional (3D) photogrammetry is a reliable and convenient anthropometric tool to assess facial soft tissue. **Objective:** The aim of this study was to establish age-related facial soft tissue morphology in Korean adult females using non-invasive 3D photogrammetry. **Methods:** One hundred and ninety-two female participants were divided into three groups based on age: the younger group (aged 20 ~ 39 years), middle group (40 ~ 59 years), and older group (60 ~ 79 years). Thirty-six landmarks were identified via 3D photogrammetric scanning (Morpheus 3D, Morpheus Co., Ltd., Seongnam, Korea). Forty-one facial dimensions were analyzed using the imaging software to find significance between the age groups. **Results:** Smaller upper-facial volume ($p=0.019$) and shorter upper-facial height ($p=0.034$) were observed in the older group than in the younger group. In the mid-face, narrowed palpebral fissure ($p<0.001$) with elongated upper eyelid height ($p<0.001$) and widened nose ($p<0.001$) were observed in

the older group compared with the younger group. Longer lower-facial height ($p<0.001$) with longer and wider philtrum ($p<0.001$, $p=0.004$, respectively), shorter lower vermilion height ($p<0.001$), wider mouth width ($p<0.001$), and smaller lower vermilion angle ($p<0.001$) were seen in the older group when compared with the younger group. Moreover, greater angles of nasofrontal, nasomental, and labio-mental angle ($p=0.015$, $p=0.015$, $p=0.080$, respectively), and smaller nasofacial angle ($p=0.034$) were observed in the older group than in the younger group. **Conclusion:** Our results provide clues of aging-related facial morphological characteristics in Korean female population. (*Ann Dermatol* 33(1) 52 ~ 60, 2021)

-Keywords-

Aging face, Anthropometry, Photogrammetry, Three-dimensional

INTRODUCTION

Face is an outward representation of an individual's unique identity, allowing it to be used to discriminate one person from another. Face undergoes morphological alterations with aging. These changes include volumetric change, redistribution of subcutaneous fat, progressive bone resorption, and decreased tissue elasticity¹. Facial aging and its consequence on facial morphology are important in the aesthetic medical field.

Anthropometry refers to the systematic measurement of the physical properties of the human body, primarily the dimensional descriptions, including length and angle. Anthropometry, especially facial anthropometry, is essential in

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Corresponding author: Chang Hun Huh, Department of Dermatology, Seoul National University Bundang Hospital, Seoul National University College of Medicine, 82 Gumi-ro 173beon-gil, Bundang-gu, Seongnam 13620, Korea. Tel: 82-31-787-7313, Fax: 82-31-787-4058, E-mail: chhuh@snu.ac.kr
ORCID: <https://orcid.org/0000-0003-3944-7777>

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the fields of aesthetic and reconstructive medicine. We have recently reported facial anthropometric differences between beauty pageant contestants and ordinary young female of Korean ethnicity, identifying factors that are commonly associated with beauty². Facial anthropometry also provides the average of standard values in planning reconstructive surgery in treating congenital or post-traumatic facial deformities. It is also utilized in the field of forensic science to analyze human physical variation and to provide biological profile for identifying a decedent.

Classical facial anthropometry has been used to identify the differences in facial dimensions between sex or ethnicity³⁻⁵. Contrastingly, to the best of our knowledge, age-related facial anthropometric data has not been investigated to any significant degree, and existing data is limited to certain age ranges. Moreover, three-dimensional (3D), quantitative data on normal subjects in their third-fourth decades of life and beyond are still incomplete⁶. Although Zhuang et al.⁷ attempted to determine sex-, ethnicity-, and age-specific facial dimensions, they included subjects with various ethnicities—mainly Caucasians (47%)—into the age groups in analyzing anthropometric data. Yang et al.⁸ identified facial anthropometric differences between adolescents and adults of Chinese Han ethnicity, however, age-related morphological change in adults was not demonstrated in the study. The studies of Raschke et al.⁹ and Sforza et al.⁶ described age-related anthropometric changes in Caucasians and Italians, respectively, however, their results were limited to the perioral area. Considering that facial morphology undergoes age-related changes, not only ethnicity- or sex-specific data, but also age-specific data on facial anthropometry is necessary for the aesthetic field. Nowadays, an increasing number of people undergo cosmetic procedures, including volume augmentation for facial rejuvenation¹⁰. However, the lack of age-related facial morphological change often results in ‘artificial’ or ‘operated’ appearance after the rejuvenating procedure¹⁰. Comprehensive understanding on age-related facial anthropometry could facilitate rejuvenating procedure to result in a natural young appearance.

The aim of this study was to investigate age-related characteristics in facial soft tissue morphology in the cohort of Korean female adults. We carried out 3D photogrammetry in 192 Korean females aged between 20 and 79 years. They were divided into three age groups—younger group, middle group, and older group—to identify any significance in their facial dimensions. There have been a few studies demonstrating the facial anthropometric characteristics of the Korean ethnicity, however, age-related characteristics of facial morphology specific to Korean females have not been fully investigated. Results of the study by

Kim et al.¹¹ revealed age-related morphological changes in Korean female, but were confined to the perioral area. Although Kim and Shin¹² and Baik et al.¹³ carried out 3D anthropometry study in Korean adults, they were limited to an analysis of sex-specific differences with respect to facial dimensions. Our study provides a comprehensive understanding of the age-related facial morphological changes in the Korean female population.

MATERIALS AND METHODS

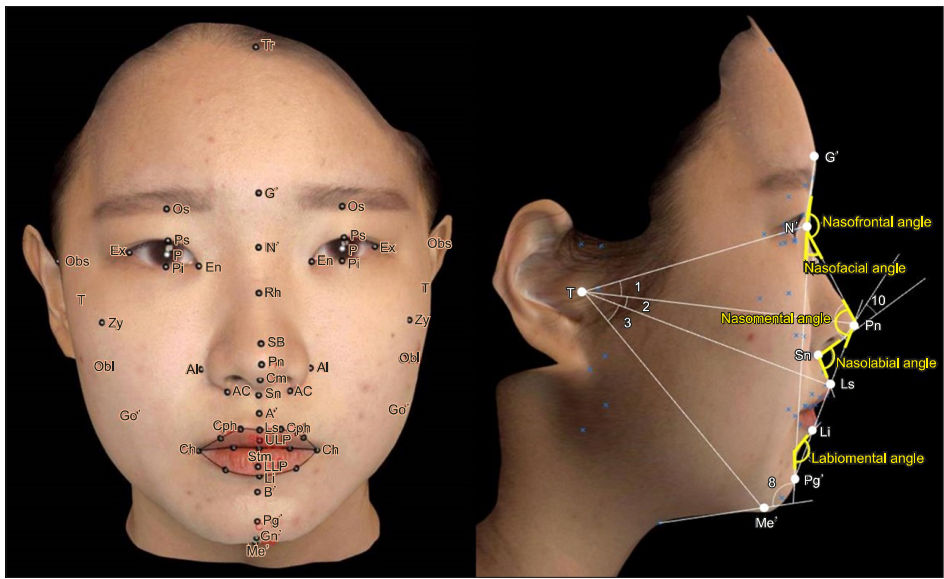
The 3D photogrammetric analysis was performed in 192 Korean female participants enrolled in the present study. Participants with a body mass index of between 18.5 and 24.9 kg/m² were included to eliminate the effect of overweight or underweight on facial soft tissue measurements¹⁴. Participants with histories of facial deformity, craniofacial syndromes, severe facial asymmetry, or histories of previous plastic surgery were excluded. They were divided into three groups based on age: the younger group (20~39 years), middle group (40~59 years), and older group (60~79 years).

Three-dimensional photogrammetry

Morpheus 3D[®] light-emitting diode-based light scanner (Morpheus Co., Ltd., Seongnam, Korea) was used to acquire the 3D facial images of participants. The participants sat upright in neutral head position without makeup. Scanning was performed three times per participant at the frontal and 45° oblique (right and left) views at 60 cm from the face under the same brightness. After reconstructing the 3D facial image by merging three scanned images, the entire scanned image was automatically reoriented. The horizontal plane contains the right and left pupils (P) and nasion (N'). The sagittal plane is perpendicular to the horizontal plane, which contains the nasion (N') and subnasale (Sn). The coronal plane is perpendicular to the other two planes. Various facial landmarks were defined on the reconstructed 3D facial image (Fig. 1). Based on the landmarks, measurements of volumes, ratios, lengths, and angles were analyzed using Morpheus 3D Plastic Solution (Morpheus Co., Ltd.). We received the patient's consent form about publishing all photographic materials.

Ethics statement

This study was conducted in accordance with the Declaration of Helsinki and International Conference on Harmonization and Good Clinical Practice Guidelines, which was reviewed by the Institutional Review Board (no. B-1810/497-103). Written informed consent was obtained from all subjects before study enrollment.



Abbreviation	Landmarks	Definition
Tr	Trichion	Midpoint of the hairline
G'	Glabella	Midpoint between the center of eyebrows
N'	Nasion	Midpoint of the transverse line of the highest points of the Ps
Pn	Pronasale	Tip of the nose
Sn	Subnasale	Central junction of the nasal septum and the upper lip
A'	A-point	Posterior midpoint of philtrum
Ls	Labiale superius	Midpoint of the upper vermillion line
Stm	Stomion	Midpoint of the oral fissure
Li	Labiale inferius	Midpoint of the lower vermillion line
B'	B-point	The most posterior midpoint of labiomental soft tissue contour
Pg'	Pogonion	The most anterior midpoint of the chin
Me'	Menton	Inferior midpoint of the chin
C	Cervical point	Junction of the inferoposterior extension of the chin and the neck
Os	Orbitale superius	Highest point on the lower border of the eyebrow
Ps	Palpebrale superius	Highest point on the free margin of each upper eyelid
P	Pupil center	Central point of the iris
Pi	Palpebrale inferius	Lowest point on the free margin of each lower eyelid
Ex	Exocanthion	Lateral point of each palpebral fissure
En	Endocanthion	Medial point of each palpebral fissure
T	Tragion	Highest point of each tragus
Al	Alare	Lateral point of each nasal alare
Cph	Crista philtri	Point at each crossing of the vermillion line and the elevated margin of the philtrum.
Ch	Cheilion	Point of each labial commissure
C'	C-point	Point where the straight line from Tr and T meets the horizontal plane passing through G'
D'	D-point	Point where the straight line from T and C meets the horizontal plane passing through Sn
E'	E-point	Point where the straight line from T and C meets the horizontal plane passing through Me'

Fig. 1. Landmarks and their definitions in the three-dimensional photogrammetry. Rh: rhinion, SB: supra-tip breakpoint, Cm: columella, ULP: upper lip point, LLP: lower lip point, Gn': gnathion, Obs: otobasion superius, Zy: zygomatic point, Obl: otobasion inferius, Go': gonion.

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics 20.0 (IBM Corp., Armonk, NY, USA). *p*-values were obtained using the one-way ANOVA with post hoc test with the Bonferroni correction to determine the significance for the volumes, lengths, and angles among the three groups. *p*-values < 0.05 were accepted as statistically significant. The statistical outcomes are presented as the mean ± standard deviation.

RESULTS

A total of 192 female participants enrolled in the study were grouped according to age. The younger group included 48 subjects (mean age of 26.4 ± 5.0 years), the middle group included 56 subjects (51.3 ± 5.3 years), and the older group included 88 subjects (69.0 ± 6.2 years). A total of 41 facial measurements, including 4 volumes, 23 lengths, 12 angles, and 2 ratios in Korean females, are summarized in the Table 1.

Volume measures

Total facial volume showed no significant difference among

Table 1. The facial dimensions measured in the three-dimensional photogrammetric analysis

Facial dimension	Definition	Younger group	Middle group	Older group	p-value
Volume measure (ml)					
Total facial volume	Volume of Tr-T (Rt)-C-Me'	1112.89 ± 145.31	1099.23 ± 100.39	1124.59 ± 115.84	0.464
Upper-facial volume	Volume of Tr-C'-G'	153.76 ± 35.50	137.18 ± 33.17	138.01 ± 33.56	0.019*
Mid-facial volume	Volume of G'-C'-T(Rt)-D'-Sn	569.94 ± 66.98	558.66 ± 49.86	572.04 ± 59.08	0.393
Lower-facial volume	Volume of Sn-D'-E'-Me'	389.19 ± 67.67	403.39 ± 47.64	414.54 ± 58.86	0.464
Frontal view					
Total facial height (mm)	Distance of Tr-Me'	187.05 ± 8.20	187.65 ± 7.39	188.60 ± 8.02	0.634
Vertical ratio	Upper-facial height: Mid-facial height: Lower-facial height	0.76:1:0.89	0.73:1:0.92	0.72:1:0.92	
Upper-face					
Upper-facial height (mm)	Distance of Tr'-G'	53.64 ± 4.92	51.48 ± 5.28	51.19 ± 5.68	0.034*
Mid-face					
Mid-facial height (mm)	Distance of G'-Sn	70.81 ± 3.55	70.68 ± 3.67	71.43 ± 4.12	0.458
Palpebral fissure width (mm)	Mean distance of Ex (Rt)-En (Rt) and Ex (Lt)-En (Lt)	26.26 ± 1.58	25.56 ± 1.48	23.46 ± 1.67	0.000*
Palpebral fissure height (mm)	Mean distance of Ps (Rt)-Pi (Rt) and Ps (Lt)-Pi (Lt)	9.16 ± 1.18	8.00 ± 1.31	6.61 ± 1.24	0.000*
Intercanthal width (mm)	Distance of En (Rt)-En (Lt)	36.29 ± 3.17	34.03 ± 2.68	35.71 ± 3.41	0.001*
Interpupillary width (mm)	Distance of P (Rt)-P (Lt)	61.28 ± 2.99	60.70 ± 2.68	60.94 ± 2.67	0.557
Binocular width (mm)	Distance of Ex (Rt)-Ex (Lt)	88.81 ± 4.11	85.15 ± 4.14	82.29 ± 5.81	0.000*
Upper eyelid height (mm)	Mean Distance of Os (Rt)-Ps (Rt) and Os (Lt)-Ps (Lt)	13.42 ± 2.33	14.07 ± 2.54	15.42 ± 2.82	0.000*
Nasal width (mm)	Distance of Al (Rt)-Al (Lt)	39.59 ± 2.30	40.52 ± 2.57	43.83 ± 2.78	0.000*
Nasal height (mm)	Distance of N'-Sn	51.88 ± 2.74	51.26 ± 2.94	52.02 ± 3.27	0.326
Horizontal ratio	Palpebral fissure width (Rt): Intercanthal width: Palpebral fissure width (Lt)	0.73:1:0.73	0.76:1:0.75	0.66:1:0.66	
Palpebral fissure slant (°)	Mean angle of [Ex (Rt)-En (Rt)-Pi (Rt) and [Ex (Lt)-En (Lt)-Pi (Lt)]	8.03 ± 2.56	7.42 ± 2.54	6.59 ± 6.32	0.213
Lower-face					
Lower-facial height (mm)	Distance of Sn-Me'	62.60 ± 4.27	65.39 ± 3.58	65.72 ± 4.05	0.000*
Philtrum height (mm)	Distance of Sn-Ls	12.94 ± 2.09	15.15 ± 1.61	15.47 ± 2.04	0.000*
Philtrum width (mm)	Distance of Chp (Rt)-Chp (Lt)	12.73 ± 1.42	12.63 ± 1.21	13.36 ± 1.54	0.004*
Upper lip height (mm)	Distance of Sn-Stm	19.85 ± 2.11	22.09 ± 1.64	22.49 ± 2.17	0.000*
Upper vermilion height (mm)	Distance of Ls-Stm	6.91 ± 1.26	6.94 ± 1.19	7.03 ± 1.26	0.853
Lower vermilion height (mm)	Distance of Stm-Li	9.58 ± 1.41	9.11 ± 1.55	8.32 ± 1.68	0.000*
Lower lip height (mm)	Distance of Stm-B'	17.34 ± 1.75	17.08 ± 1.60	16.78 ± 1.99	0.221
Mouth width (mm)	Distance of Ch (Rt)-Ch (Lt)	44.45 ± 2.87	45.87 ± 3.20	47.77 ± 3.51	0.000*
Upper vermilion angle (°)	Mean angle of [Ls-Ch (Rt)-Stm] and [Ls-Ch (Lt)-Stm]	37.58 ± 4.96	33.03 ± 5.61	32.43 ± 5.62	0.814
Lower vermilion angle (°)	Mean angle of [Li-Ch (Rt)-Stm] and [Li-Ch (Lt)-Stm]	37.00 ± 4.67	34.91 ± 6.45	30.82 ± 5.59	0.000*
Cupid's bow angle (°)	Mean angle of [Ch (Rt)-Chp (Rt)-Ls] and [Ch (Lt)-Chp (Lt)-Ls]	157.99 ± 8.34	157.39 ± 6.56	159.16 ± 7.10	0.340
Lateral view					
Length from T to N' (mm)	Distance of T (Rt)-N'	89.76 ± 4.84	90.95 ± 4.43	90.89 ± 4.65	0.329
Length from T to Pn (mm)	Distance of T (Rt)-Pn	104.88 ± 4.79	104.86 ± 4.26	104.62 ± 4.52	0.931
Length from T to Ls (mm)	Distance of T (Rt)-Ls	101.79 ± 5.42	102.49 ± 4.66	102.89 ± 4.92	0.471
Length from T to Me' (mm)	Distance of T (Rt)-Me'	111.85 ± 7.29	112.76 ± 5.36	113.21 ± 4.52	0.393
N'-T-Pn angle (°)	Angle of [N'-T (Rt)-Pn]	24.18 ± 1.80	24.06 ± 1.77	24.26 ± 1.96	0.830
Pn-T-Ls angle (°)	Angle of [Pn-T (Rt)-Ls]	15.26 ± 1.14	16.09 ± 1.44	16.48 ± 1.62	0.000*
Ls-T-Me' angle (°)	Angle of [Ls-T (Rt)-Me']	29.49 ± 2.48	29.38 ± 2.18	29.46 ± 2.30	0.966
Nasofrontal angle (°)	Angle of (G'-N'-Pn)	145.61 ± 5.02	146.55 ± 4.78	148.07 ± 4.88	0.015*
Nasofacial angle (°)	Angle of [(G'-Pg')-(N'-Pn)]	29.12 ± 2.95	28.42 ± 2.96	27.77 ± 2.87	0.034*
Nasomental angle (°)	Angle of (N'-Pn-Pg')	135.04 ± 4.54	136.65 ± 4.87	137.47 ± 4.50	0.015*

Table 1. Continued

Facial dimension	Definition	Younger group	Middle group	Older group	p-value
Nasolabial angle (°)	Angle of (Pn-Sn-Ls)	108.32±8.79	109.18±7.98	108.32±8.39	0.813
Labiomental angle (°)	Angle of (Li-B'-Pg')	143.58±10.48	144.65±9.84	147.18±8.74	0.080*

Values are presented as mean±standard deviation. See Fig. 1 for abbreviations. Rt: right, Lt: left. *Statistically significant in the one-way ANOVA ($p < 0.05$).

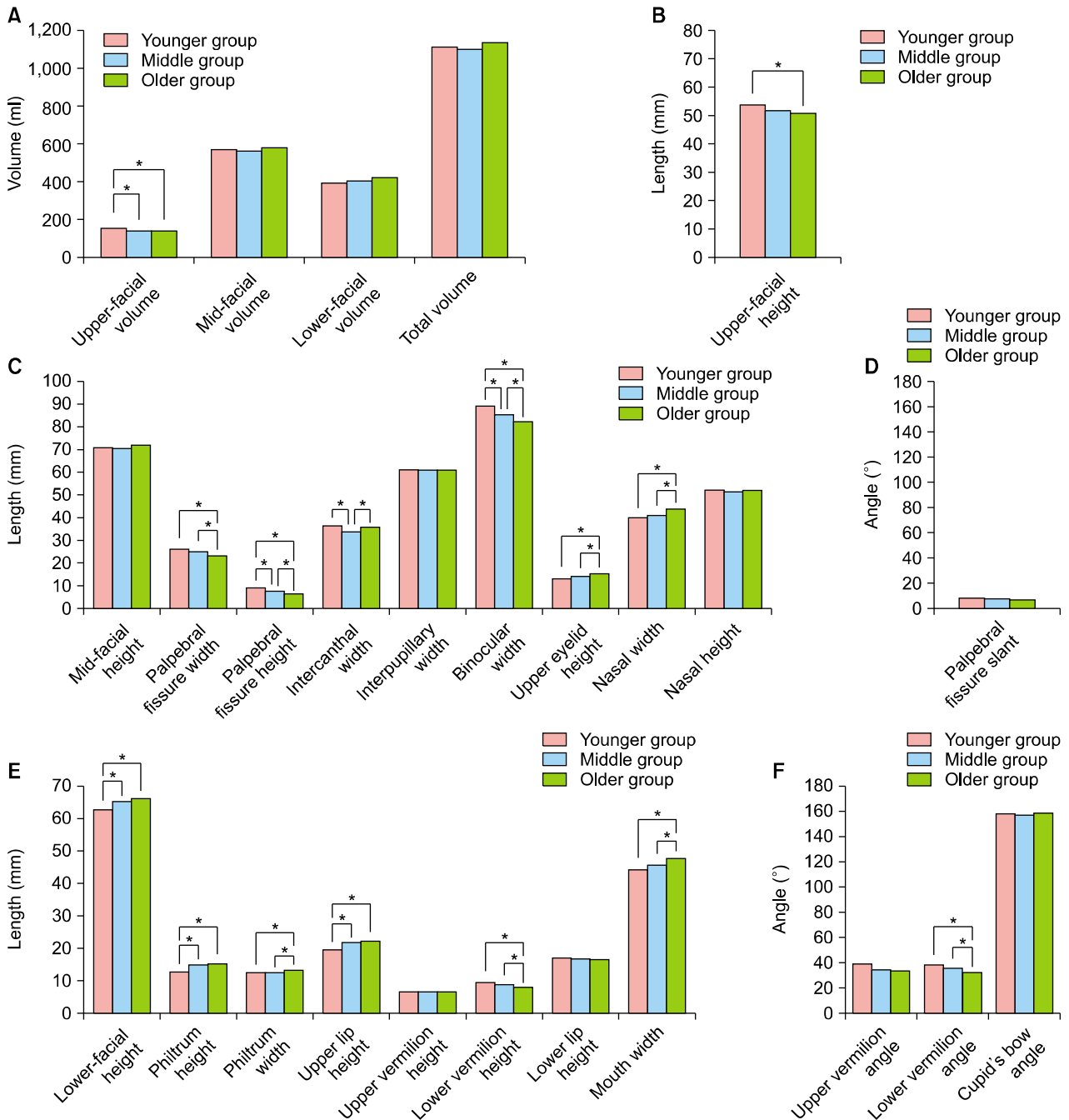


Fig. 2. Results of three-dimensional photogrammetric analysis for Korean female population. (A) volume measures, (B) upper-facial height, (C) length measures of mid-face, (D) angle measures of mid-face, (E) length measures of lower-face, (F) angle measures of lower-face, (G) length measures at lateral view, and (H) angle measures at lateral view. T: tragion, N': nasion, Pn: pronasale, Ls: labial superius, Me': menton. *Statistically significant in the post hoc test with the Bonferroni correction ($p < 0.05$).

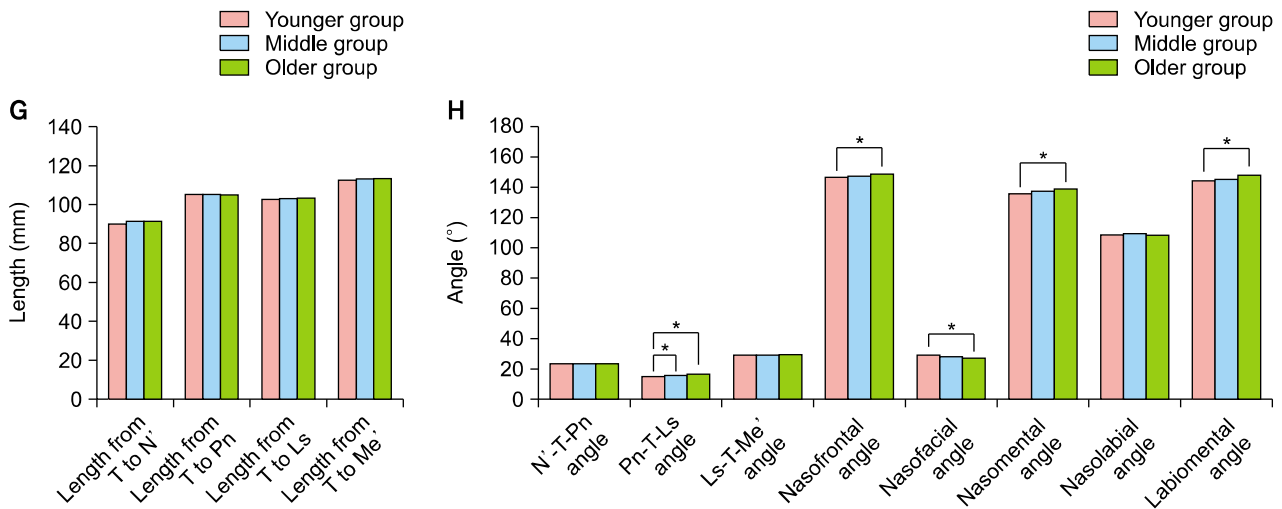


Fig. 2. Continued.

the groups (Fig. 2A). However, the younger group had a greater upper-facial volume than the middle or older group. No significant difference was found in the mid- and lower-facial volume among the groups.

Frontal view measures

Total facial height showed no significant difference between the age-groups. The vertical ratio was 0.76:1:0.89 in the younger group, 0.73:1:0.92 in the middle group, and 0.72:1:0.92 in the older group.

Frontal view measures of the upper-face

The older group had shorter upper-facial height compared with the younger group (Fig. 2B).

Frontal view measures of the mid-face

Mid-facial height showed no significant difference among the groups (Fig. 2C). Palpebral fissure width and height were smaller in the older group than in the younger or middle group. Inter-canthal width was smaller in the middle group than in the younger or older group. No significant difference was shown in the interpupillary width among the groups. Binocular width was shorter in the older group than in the younger or middle group. The older group had longer upper eyelid height compared with the younger or middle group. Nasal width was greater in the older group than in the other groups, while there was no significant difference in nasal height. The horizontal ratio was 0.73:1:0.73 in the younger group; 0.76:1:0.75 in the middle group, and 0.66:1:0.66 in the older group. For the angle measure, no significant difference was found in the slant of palpebral fissure among the groups (Fig. 2D).

Frontal view measures of the lower-face

Lower-facial height was greater in the middle and older group compared with the younger group (Fig. 2E). The height and width of philtrum were significantly increased in the older groups compared with the middle or younger group. Upper lip height was greater in the middle and older group than in the younger group, while upper vermilion height showed no significant difference among the groups. Lower lip height was not different among the groups, but the older group had a shorter lower vermilion height than the younger or middle group. The older group had greater mouth width and lower vermilion angle compared with the younger or middle group (Fig. 2F). No significant difference was observed in the angle of upper vermilion and Cupid's bow among the three groups.

Lateral view measures

In terms of the measurement from lateral view, statistical significance was not observed in the lengths from T to N', T to Pn, T to Ls, and T to Me' among the three groups (Fig. 2G). For the angle measures, the younger group had a smaller angle of Pn-T-Ls compared with the middle or older group (Fig. 2H). In contrast, the angle of N'-T-Pn and Ls-T-Me' was not significantly different between the age-groups. The older group had greater nasofrontal, nasomental, and labiomental angles, but smaller nasofacial angle than the younger group. No significant difference was found in the nasolabial angle among the three groups.

DISCUSSION

Highly accurate dimension measuring tools are required

in facial anthropometry¹⁵. Direct anthropometry is considered as the standard technique and widely used for the study of facial dimensions¹⁶. Although this technique is considered relatively reliable and inexpensive, it is time-consuming, impossible to archive, and requires patients to remain still during the procedure¹⁷. Cephalometry, which measures the facial dimensions by radiography, is essential in planning oral and maxillofacial surgeries. However, it does not reflect soft tissue structures accurately which determines postoperative patient's satisfaction^{18,19}. Two-dimensional photogrammetry based on digital cameras has been utilized as an alternative. It has the advantages of rapid acquisition, archival capabilities, and low cost¹⁶. However, this has the limitation of measurement errors with respect to the 2D representations of 3D surfaces²⁰.

3D photogrammetry is a non-invasive anthropometric tool to quantitatively measure linear distances, angles, and volumes of the facial soft tissue from reconstructed 3D facial images. Currently, 3D photogrammetry is widely accepted as a reliable and convenient method for facial anthropometry²¹. When compared with direct anthropometry using a digital caliper, it allows for a greater level of precision, with a mean difference of less than 1 mm^{17,22}. In a systematic review evaluating the various anthropometric methods for assessing facial dimensions in children, 3D photogrammetry was highly recommended due to the high correlation with direct anthropometry, millisecond quick capture of high-resolution image, archival capabilities for subsequent morphometric studies, and no exposure to ionizing radiation^{16,23}.

In the present study, we performed anthropometric assessments of the faces of Korean females in three age-groups to identify ethnicity-specific and age-related facial characteristics. The results indicated that older Korean females had less volume and shorter upper-face height compared with younger Korean females. Aging results in the loss of subcutaneous fullness of the forehead, eyebrow, and temple due to lipoatrophy, accentuating the underlying anatomic structures^{24,25}. Inferior migration of temporal fat compartments and inferior volume shift within the compartment could further lead to the loss of upper-facial volume²⁶. We also found lengthened lower-facial height in older subjects. It was consistent with the 10-year longitudinal study by Akgül and Toygar²⁷, which revealed increased lower-facial height in Turkish females in the third decade of life. They also found downward displacement of pogonion and menton with aging in female subjects²⁷. The slight continuous eruption of teeth that takes place even after the occlusion during post-adolescence has been suggested as the reason for lower-facial height lengthening²⁸.

The characteristic periorbital features of older Korean females are shorter palpebral fissure height, narrower palpebral fissure width, longer eyelid height, shorter binocular width, and smaller palpebral fissure slant. These are consistent with the result by Direk et al.²⁹, they reported shorter palpebral fissure height, narrower palpebral fissure width, and shorter binocular width in Turkish females aged over 60 years compared with younger (aged 20~44 years) or middle-aged (45~59 years) females. Age-dependent shortening of palpebral fissure width was also demonstrated in the Dutch population³⁰. Between the ages of 45 and 85 years, the palpebral fissure width is gradually shortened by approximately 2.5 mm³⁰. Morphological changes in the periorbital bony structures have been reported to cause changes in the overlying soft tissue envelope appearance¹⁰. Widening of the superomedial and inferolateral orbital rim leads to the rolling of soft tissues—especially the superior orbital fat pads—onto the orbital aperture, resulting in the ptosis of lateral upper eyelid and lateral orbital hooding^{31,32}. Another explanation for the shortening of palpebral fissure width and height is progressive laxity of the medial and lateral canthal structures³⁰.

Longer nasal width is demonstrated in older Korean females when compared with younger counterparts. Aging causes upper maxillary resorption and remodeling of the pyriform aperture^{28,29}. As a result, posterior displacement of pyriform aperture occurs^{33,34}. This bony change affects the overlying soft tissue, the alar base, and is thought to contribute to the wider nose in the elderly²⁴.

Aging of the perioral region is a common complaint of patients seeking facial rejuvenation³⁵. Our result indicated that lower-facial characteristics of older Korean females are attributable to the elongation of philtrum height, philtrum width, upper lip height, and mouth width, while shortening of lower vermilion height during the aging process. Upper vermilion height was not significantly different with age. These results are consistent with the previous study by Kim et al.¹¹, analyzing the age-related perioral morphological changes in Korean women. They reported that philtrum height and mouth width increased with age while lower vermilion height decreased. Upper vermilion height remained unchanged with age. Significant increase in the height of upper lip and philtrum with age was also found in Caucasians³⁶. Age-dependent elongation of mouth width and philtrum width, and shortening of lower vermilion height was also demonstrated in Italian female adults⁶. Iblher et al.³⁷ demonstrated that aging causes redistribution of the lip due to thinning of the orbicularis oris muscle, thinning of the cutis, and degeneration of the elastic and collagen fibers. Thinning of the lip without volume loss results in the elongation of the upper

lip³⁷. Loss of structural support induces ptosis of the lip and loss of its natural turned-up pout^{37,38}.

The present study revealed the changes in facial morphology according to aging in Koreans through non-invasive method. Compared to previous studies, this study presented a reliable method to measure comprehensive changes in facial morphology, while providing detailed information divided according to age and location.

In conclusion, this present study provided detailed information on the age-related facial dimensions in healthy Korean female adults via 3D photogrammetric analysis. The characteristic features of older Korean females are as follows: loss of upper-facial volume, shortened upper-facial height, narrowed palpebral fissure with elongated upper eyelid height, widened nose, elongated lower-facial height, elongated and widened philtrum, shortened lower vermilion height, widened mouth width, smaller lower vermilion angle, greater angles of nasofrontal, nasomental and labiomental angle, and smaller nasofacial angle.

CONFLICTS OF INTEREST

The authors have nothing to disclose.

FUNDING SOURCE

None.

DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Soon-Hyo Kwon, <https://orcid.org/0000-0002-7295-5725>
 Jong Woo Choi, <https://orcid.org/0000-0001-8047-9821>
 Hee Jin Kim, <https://orcid.org/0000-0002-7292-3491>
 Woo Shun Lee, <https://orcid.org/0000-0003-4584-0372>
 Minsu Kim, <https://orcid.org/0000-0003-0590-7894>
 Jung-Won Shin, <https://orcid.org/0000-0003-1166-0189>
 Jung-Im Na, <https://orcid.org/0000-0002-5717-2490>
 Kyoung-Chan Park, <https://orcid.org/0000-0002-1588-3307>
 Chang-Hun Huh, <https://orcid.org/0000-0003-3944-7777>

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