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PAPER

ANTHROPOLOGY

Wing Nam Joyce Chan,[1] *M.A.; Ginesse A. Listi,*[2] *Ph.D.; and Mary H. Manhein,*[2] *M.A.*

In Vivo Facial Tissue Depth Study of Chinese-American Adults in New York City*

ABSTRACT: This study examines facial tissue depth in adult Chinese-Americans. Using ultrasound, measurements were taken at 19 landmarks across the faces of 101 individuals aged from 18 to 87 years. Summary statistics are reported for a sample of 67 individuals of normal weight (as determined by a body mass index [BMI] of 19–25). Statistical analyses were used to assess relationships between tissue thickness, age, and BMI. Results indicate that no significant relationship exists between tissue thickness and age for males, and for only 3/19 points in females. Also, only four points showed significant relationships between tissue thickness and sex. However, significant relationships exist between BMI and tissue thickness at multiple points for both males and females. Compared to other American and Asian populations in the literature, Chinese-Americans generally had thinner facial tissue; though, this difference was not assessed statistically. Finally, data generated in this study will add to the body of knowledge concerning facial tissue depth variation in modern humans.

KEYWORDS: forensic science, forensic anthropology, facial reconstruction, Chinese-Americans, facial tissue thickness, forensic imaging

Facial reconstruction is a tool used by law enforcement agencies to assist in solving cases involving unidentified skeletal remains. These reconstructions in the form of three-dimensional clay images, two-dimensional drawings, or computer-generated likenesses can suggest an identity for a set of remains and then dental X-rays, other antemortem records, or DNA can confirm the identification.

Multiple methods can be used to create viable reconstructions. In the U.S., forensic artists often use the tissue depth marker method to sculpt a three-dimensional image from clay. In this method, a forensic artist places tissue depth markers on certain skull landmarks to indicate the soft tissue thickness and recreates a facial image using the markers as guides (1–3).

Standards published from the late 19th century to the present have reported that facial tissue depth is variable by sex, age, and ancestry (4–15), although other research suggests some of these differences may be negligible (16–19). Currently, tissue depth standards are available for several population groups, including, among others, European and African Americans, Native Americans, Europeans, Koreans, Japanese, and Chinese (5–16). Among American populations, the Chinese remain underrepresented in forensic research, despite the fact that they represent the largest Asian-American group in the U.S. (20). This limitation in forensic data potentially hinders forensic identification for this population in America.

The purpose of the present study is to investigate facial tissue thicknesses in adult Chinese-Americans. The goals are (i) to report summary statistics for facial tissue thickness; (ii) to evaluate the influence of age, sex, and body mass index (BMI) on facial tissue thickness in Chinese-Americans; and (iii) to discuss variation between Chinese-Americans and other Asian and American populations published in the literature.

[1]Department of Anthropology, The Ohio State University, 4034 Smith Laboratory, 174 West 18th Avenue, Columbus, OH 43210.

[2]Department of Geography and Anthropology, Louisiana State University, 227 Howe-Russell Geoscience Complex, Baton Rouge, LA 70803.

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Materials and Methods

The sample is comprised of 101 self-identified Chinese-American volunteers residing in New York City, aged from 18 to 87 years. Many of the participants immigrated from the southeastern region of China. Prior to scanning, the volunteers completed a biographical data sheet and consent form, and those who permitted were photographed in the frontal and lateral views.

Following protocol outlined in Manhein et al. (8), tissue depth measurements were collected at 19 landmarks across the face using an Aloka SSD-500 OB/GYN ultrasound system (Aloka Co., Ltd, Wallingford, CT) in B-mode (Table 1, Fig. 1). At each landmark, a flat transducer liberally coated with coupling gel was placed gently on the volunteer's face for 3–5 sec. Care was taken to control the amount of pressure applied to the face, thus minimizing any soft tissue deformation at the landmark. The resulting ultrasound image was recorded by the machine, and the system's internal calipers were used to measure the distance between the bone and the skin surface. Each image (Fig. 2), which contained the measurements for two landmarks, then was printed using a Sony Videographic thermal printer (Sony Corporation, Tokyo, Japan) and stored for future reference. While measurements were taken, the subjects were seated in an upright position, and data were collected from the right side of the face only to minimize the subject's discomfort.

A subsample of 67 individuals who fell into the "normal" BMI range was selected for reporting summary statistics and for assessing relationships between tissue thickness, age, and sex. "Normal" consisted of a BMI of 19–25, which was based on standards from

TABLE 1—*Facial landmark numbers and descriptions.**

Point Number	Description
1: Glabella	Approximately 10 mm above and directly between the subject's eyebrows
2: Nasion	Directly between eyes
3: End of nasals	Palpating to determine where bone ends and cartilage begins
4: Lateral nostril	Approximately 5 mm to the right of the nostril
5: Mid-philtrum	Centered between nose and mouth
6: Chin–lip fold	Centered in fold of chin, below lips
7: Mental eminence	Centered on forward-most projecting point of chin
8: Beneath chin	Centered on inferior surface of mandible
9: Superior eye orbit	Centered on eye, at level of eyebrow
10: Inferior eye orbit	Centered on eye, where inferiorly bony margins lie
11: Supra canine	Upper lip, lined up superiorly/inferiorly with lateral edge of nostril
12: Sub-canine	Lower lip, lined up superiorly/inferiorly with lateral edge of nostril
13: Supra M2	Cheek region, lateral: lined up with bottom of nose; vertical: center of transducer lined up beneath lateral border of eye, measurement taken 5 mm to the left of center mark
14: Lower cheek	Cheek region, lateral: lined up with mouth; vertical: same as 13
15: Mid-mandible	Inferior border of mandible, vertically lined up same as 13
16: Lateral eye orbit	Lined up laterally with corner of the eye, on the bone
17: Zygomatic	Lined up with the lateral border of the eye, on the zygomatic process
18: Gonion	Found by palpating
19: Root of zygoma	Anterior to and 5 mm superior to tragus

*After Manhein et al. (8).

the United States Center for Disease Control (CDC) and calculated using the formula weight (kg)/(height [m])^2 (21). For the summary statistics, males and females were analyzed separately, and data were categorized into four age groups (18–34, 35–45, 46–55, and greater than or equal to 56 years of age). These groups correspond to Manhein et al.'s (8) age categories for adult European and African American populations and allowed for easy comparisons with those data sets in subsequent analyses. Also for the "Normal BMI" sample, Pearson's correlations (using the actual ages) and analysis of variance (ANOVA; using the age categories described above) were used to test the relationship between facial tissue thickness and age. Last, for the "Normal BMI" sample, a Student's t-test was used to examine differences in facial tissue depth between the sexes. To assess the relationship between facial tissue thickness and BMI, both Pearson's correlations and ANOVA were calculated using the entire sample of 101 individuals. For the former analysis, individual BMIs were used. For the latter, the sample was divided into four categories that correspond to standards set by the CDC ("Underweight" [BMI < 19], "Normal" [BMI 19–25], "Overweight" [BMI 26–29], and "Obese" [BMI > 29]) (21). For all statistical analyses, the level of significance was $p < 0.05$. Finally, for the purpose of discussing variation in facial tissue thickness among different ethnic groups, data from Chinese-Americans in this study were compared to populations from the literature, including Chinese, Koreans, Japanese, and European and African Americans.

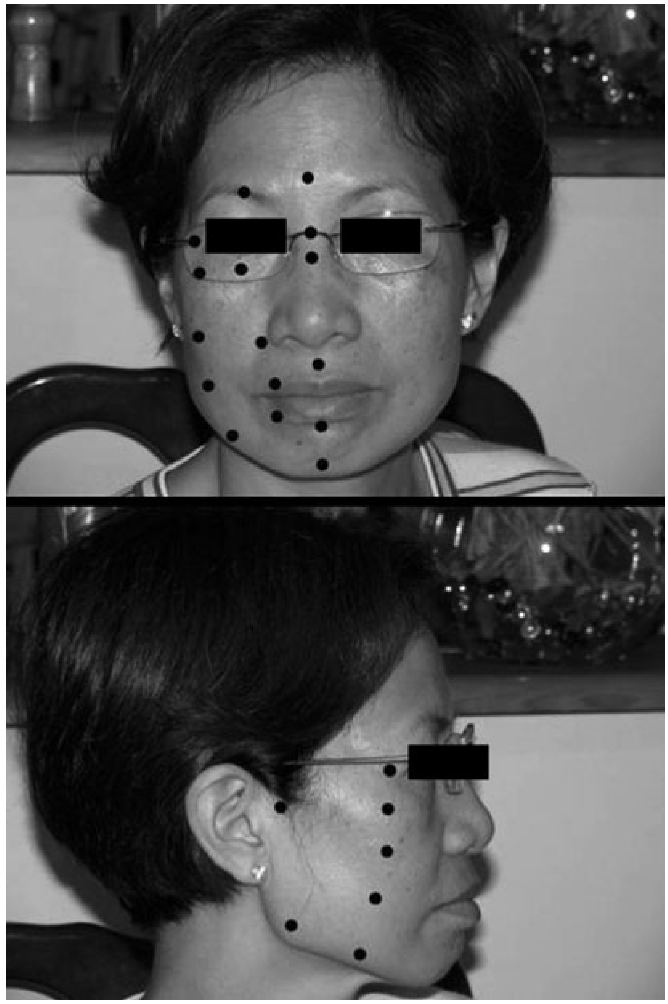

FIG. 1—*Frontal and lateral views of female volunteer showing measurement sites.*

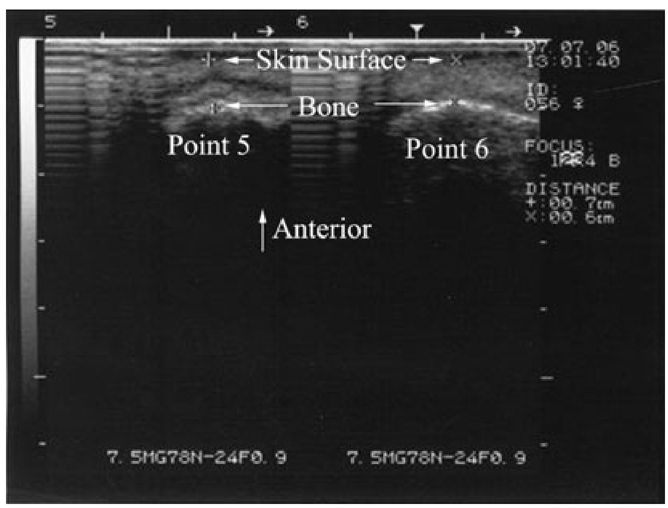

FIG. 2—*Thermal printout of ultrasound data displaying measurement points 1 and 2.*

Results

Tables 2 and 3 report the summary statistics (including means, standard deviations, and ranges) for the different age categories of Chinese-American males and females, respectively. For Chinese-Americans, regardless of age or sex, facial tissue generally was thickest and had the greatest variation in the cheek region (points 4, 10, 13, 14, and 15) and at gonion (point 18).

TABLE 2—*Facial tissue depth means (mm) for Chinese-American males.*

	18–34 (n = 8)			35–45 (n = 10)			46–55 (n = 5)			≥56 (n = 6)		
Point Numbers/Name	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
1: Glabella	4.5	1.1	3.0–6.0	4.2	0.6	3.0–5.0	4.4	0.6	4.0–5.0	4.3	0.5	4.0–5.0
2: Nasion	3.4	0.7	2.0–4.0	3.9	1.2	2.0–5.0	3.4	1.1	2.0–5.0	3.5	1.1	2.0–5.0
3: End of nasals	1.8	0.7	1.0–3.0	1.9	0.7	1.0–3.0	1.8	0.5	1.0–2.0	1.7	0.5	1.0–2.0
4: Lateral nostril	8.9	1.6	7.0–11.0	9.2	3.2	5.0–14.0	8.8	1.9	6.0–11.0	8.5	2.2	6.0–11.0
5: Mid-philtrum	7.9	2.0	4.0–10.0	8.1	1.6	6.0–10.0	6.6	1.1	5.0–8.0	7.2	1.2	6.0–9.0
6: Chin–lip fold	9.6	1.4	8.0–12.0	9.5	1.7	7.0–12.0	8.4	0.9	7.0–9.0	9.3	2.3	7.0–13.0
7: Mental eminence	7.5	1.2	6.0–10.0	7.4*	1.9	5.0–11.0	7.8	1.3	6.0–9.0	7.0	1.3	6.0–9.0
8: Beneath chin	4.9	1.2	4.0–7.0	5.0*	1.4	3.0–7.0	5.6	2.6	3.0–9.0	5.2	2.5	3.0–10.0
9: Superior eye orbit	4.5	1.2	3.0–6.0	4.6	0.8	4.0–6.0	4.8	1.3	4.0–7.0	4.7	1.0	4.0–6.0
10: Inferior eye orbit	6.1	1.1	5.0–8.0	6.1	2.9	3.0–11.0	5.4	2.3	3.0–8.0	8.0	3.0	3.0–11.0
11: Supra canine	9.3	2.4	6.0–14.0	8.0	1.9	5.0–12.0	7.8	2.2	5.0–10.0	7.8	1.6	5.0–9.0
12: Sub-canine	8.1	2.2	5.0–12.0	8.9	1.7	6.0–12.0	9.6	4.3	7.0–17.0	8.2	1.7	5.0–10.0
13: Supra M2	24.8	3.2	20.0–30.0	27.3	5.3	20.0–38.0	25.4	5.4	20.0–32.0	23.2	2.0	20.0–26.0
14: Lower cheek	19.9	3.5	13.0–25.0	19.5	3.1	16.0–26.0	20.0	5.0	14.0–26.0	19.0	2.3	15.0–21.0
15: Mid-mandible	8.1	2.7	4.0–13.0	9.4	4.3	5.0–20.0	8.0	1.9	6.0–11.0	9.7	2.4	7.0–14.0
16: Lateral eye orbit	4.6	0.9	4.0–6.0	4.7	0.7	4.0–6.0	4.0	1.0	3.0–5.0	4.2	0.8	3.0–5.0
17: Zygomatic	6.9	0.6	6.0–8.0	6.6	2.7	4.0–13.0	5.4	1.3	4.0–7.0	7.0	1.4	5.0–9.0
18: Gonion	10.8	3.7	6.0–16.0	10.9	2.9	7.0–15.0	9.6	2.3	6.0–12.0	12.3	3.2	7.0–16.0
19: Root of zygoma	6.4	1.5	4.0–9.0	6.9	2.3	3.0–10.0	6.6	1.8	4.0–9.0	6.7	3.3	2.0–11.0

SD, standard deviation.
*n = 9 (number excludes individual with facial hair).

TABLE 3—*Facial tissue depth means (mm) for Chinese-American females.*

	18–34 (n = 12)			35–45 (n = 7)			46–55 (n = 8)			≥56 (n = 11)		
Point Numbers/Name	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
1: Glabella	4.3	0.9	3.0–6.0	4.0	0.8	3.0–5.0	4.0	0.8	3.0–5.0	4.4	1.1	2.0–6.0
2: Nasion	3.9	1.4	2.0–6.0	3.1	0.9	2.0–5.0	3.1	1.6	2.0–7.0	3.3	0.9	2.0–5.0
3: End of nasals	1.9	0.5	1.0–3.0	1.6	0.5	1.0–2.0	1.3	0.5	1.0–2.0	1.9	0.5	1.0–3.0
4: Lateral nostril	9.6	2.2	6.0–13.0	8.4	0.8	8.0–10.0	11.4	2.8	6.0–15.0	8.9	2.7	5.0–14.0
5: Mid-philtrum	7.4	1.7	5.0–10.0	6.4	0.8	6.0–8.0	5.6	0.9	4.0–7.0	5.9	0.5	5.0–7.0
6: Chin–lip fold	9.6	1.9	8.0–15.0	9.1	0.9	8.0–10.0	8.4	1.6	7.0–11.0	10.3	0.9	9.0–12.0
7: Mental eminence	8.3	2.3	4.0–13.0	7.3	1.6	5.0–10.0	8.4	1.9	5.0–11.0	8.6	1.0	7.0–10.0
8: Beneath chin	5.3	2.0	4.0–7.0	5.0	2.2	3.0–8.0	5.0	1.1	4.0–7.0	5.2	1.9	3.0–8.0
9: Superior eye orbit	5.3	1.6	3.0–8.0	5.6	1.9	3.0–8.0	5.0	1.3	3.0–7.0	5.1	1.2	4.0–7.0
10: Inferior eye orbit	7.4	2.4	5.0–14.0	6.7	2.4	4.0–11.0	7.9	2.5	4.0–11.0	7.5	2.0	5.0–12.0
11: Supra canine	8.1	2.0	5.0–11.0	7.0	1.2	6.0–9.0	6.3	1.2	5.0–8.0	7.3	1.7	5.0–10.0
12: Sub-canine	9.2	1.7	6.0–12.0	8.1	2.0	5.0–10.0	7.1	1.1	5.0–9.0	8.8	1.9	6.0–12.0
13: Supra M2	25.4	3.0	21.0–31.0	26.3	3.7	24.0–34.0	25.1	6.2	18.0–39.0	26.3	3.6	22.0–33.0
14: Lower cheek	19.6	2.8	14.0–23.0	22.6	4.8	17.0–31.0	22.5	5.6	16.0–35.0	22.2	3.4	18.0–30.0
15: Mid-mandible	10.5	2.9	7.0–17.0	9.4	3.7	4.0–14.0	9.3	3.0	5.0–14.0	10.4	2.5	7.0–16.0
16: Lateral eye orbit	4.3	1.2	3.0–7.0	4.1	0.7	3.0–5.0	4.6	1.2	3.0–7.0	5.1	1.3	3.0–7.0
17: Zygomatic	7.8	1.3	6.0–10.0	7.9	1.8	6.0–10.0	8.0	2.6	4.0–12.0	8.2	1.9	6.0–11.0
18: Gonion	12.4	3.0	9.0–19.0	12.4	4.2	9.0–20.0	10.6	2.2	8.0–15.0	11.5	3.1	6.0–18.0
19: Root of zygoma	5.1	1.9	3.0–9.0	5.1	2.2	3.0–9.0	6.9	2.8	4.0–12.0	5.6	1.6	3.0–8.0

SD, standard deviation.

Results of the Pearson's correlation and ANOVA to assess the relationship between facial tissue thickness and age are reported in Tables 4 and 5, respectively. In Chinese-American males, no significant relationship exists between tissue thickness and age at any landmark regardless of whether individual ages or age categories are used. In Chinese-American females, when individual ages are used (i.e., Pearson's), two points, mid-philtrum (point 5) and lower cheek region (point 14), are significant. When age categories are assessed (i.e., ANOVA), the same two points and one additional point (point 11, supra canine) show a significant relationship with age.

Results of the Pearson's correlation and ANOVA to assess the relationship between facial tissue thickness and BMI are reported in Tables 6 and 7, respectively. When individual BMIs are used (i.e., Pearson's), 12 of 19 points in males and 11 of 19 points in females are significant. Ten of these points are the same for both sexes (points 1, 6, 8, 9, 10, 13, 14, 15, 17, and 18), six of which are located in the cheek region. When BMI categories are used (i.e., ANOVA), 10 of 19 points in males and 6 of 19 points in females are significant. Five of these points are the same for both sexes (points 1, 6, 7, 9, and 18), three of which are located in the cheek region.

Table 8 presents the results of the Student's t-test assessing the relationship between tissue thickness and sex. Four points, mid-philtrum, supra canine, lower cheek, and zygomatic (points 5, 11, 14, and 17), show significant variation between the sexes.

Regarding the comparisons between Chinese-Americans and other American populations, results demonstrate notable differences. Tables 9 and 10 compare the data from Chinese-Americans males to those from Manhein et al.'s (8) European and African American

TABLE 4—*Pearson's correlation (*r*) between facial tissue depth and age for Chinese-Americans (normal body mass index).*

	Males (n = 29)		Females (n = 38)	
Point Numbers/Descriptions	r-Value	p-Value	r-Value	p-Value
1: Glabella	−0.090	0.644	−0.023	0.890
2: Nasion	−0.059	0.761	−0.143	0.393
3: End of nasals	−0.056	0.772	−0.044	0.791
4: Lateral nostril	−0.055	0.775	0.053	0.753
5: Mid-philtrum	−0.277	0.146	−0.536†	0.001
6: Chin–lip fold	−0.144	0.455	0.155	0.352
7: Mental eminence	−0.015*	0.941	0.104	0.534
8: Beneath chin	0.106*	0.592	−0.079	0.636
9: Superior eye orbit	0.118	0.543	−0.084	0.616
10: Inferior eye orbit	0.249	0.193	−0.014	0.935
11: Supra canine	−0.116	0.550	−0.103	0.540
12: Sub-canine	0.093	0.631	−0.099	0.552
13: Supra M2	−0.118	0.541	0.184	0.268
14: Lower cheek	−0.136	0.482	0.382‡	0.018
15: Mid-mandible	0.104	0.590	−0.029	0.865
16: Lateral eye orbit	−0.262	0.170	0.185	0.266
17: Zygomatic	−0.037	0.848	0.122	0.467
18: Gonion	0.134	0.490	−0.165	0.321
19: Root of zygoma	0.041	0.833	0.182	0.274

*n = 28 (number excludes individual with facial hair).
†$p < 0.01$.
‡$p < 0.05$.

TABLE 5—*Analysis of variance (*F*) between facial tissue depth and age for Chinese-Americans (normal body mass index).*

	Males (n = 29)		Females (n = 38)	
Point Numbers/Descriptions	F-statistic	p-Value	F-statistic	p-Value
1: Glabella	0.247	0.863	0.317	0.577
2: Nasion	0.473	0.704	2.929	0.096
3: End of nasals	0.178	0.910	2.424	0.128
4: Lateral nostril	0.107	0.955	0.003	0.959
5: Mid-philtrum	1.244	0.315	13.642†	0.001
6: Chin–lip fold	0.660	0.584	0.007	0.931
7: Mental eminence	0.267*	0.849	0.024	0.879
8: Beneath chin	0.223*	0.880	0.230	0.634
9: Superior eye orbit	0.086	0.967	0.013	0.911
10: Inferior eye orbit	1.222	0.322	0.002	0.968
11: Supra canine	0.845	0.482	4.444‡	0.042
12: Sub-canine	0.480	0.699	2.908	0.097
13: Supra M2	1.253	0.312	0.129	0.722
14: Lower cheek	0.103	0.958	4.179‡	0.048
15: Mid-mandible	0.478	0.700	0.510	0.480
16: Lateral eye orbit	1.172	0.340	0.790	0.380
17: Zygomatic	0.838	0.486	0.203	0.655
18: Gonion	0.730	0.544	0.776	0.384
19: Root of zygoma	0.079	0.971	1.087	0.304

*n = 28 (number excludes individual with facial hair).
†$p < 0.01$.
‡$p < 0.05$.

TABLE 6—*Pearson's correlation (*r*) between facial tissue depth and body mass index for Chinese-Americans (full sample).*

	Males (n = 48)		Females (n = 53)	
Point Numbers/Descriptions	r-Value	p-Value	r-Value	p-Value
1: Glabella	0.639*	0.000	0.372†	0.006
2: Nasion	−0.174	0.237	0.165	0.237
3: End of nasals	−0.008	0.958	0.005	0.971
4: Lateral nostril	0.136	0.357	−0.019	0.893
5: Mid-philtrum	0.208	0.156	0.043	0.761
6: Chin–lip fold	0.359‡	0.012	0.302‡	0.028
7: Mental eminence	0.500*§	0.000	0.236	0.089
8: Beneath chin	0.582*§	0.000	0.364†	0.007
9: Superior eye orbit	0.579*	0.000	0.472*	0.000
10: Inferior eye orbit	0.331‡	0.022	0.511*	0.000
11: Supra canine	0.224	0.126	0.057	0.686
12: Sub-canine	0.405†	0.004	0.173	0.214
13: Supra M2	0.347‡	0.016	0.379†	0.005
14: Lower cheek	0.528*	0.000	0.339‡	0.013
15: Mid-mandible	0.651*	0.000	0.371†	0.006
16: Lateral eye orbit	0.224	0.126	0.311‡	0.023
17: Zygomatic	0.590*	0.000	0.485*	0.000
18: Gonion	0.641*	0.000	0.445†	0.001
19: Root of zygoma	−0.238	0.104	0.266	0.054

*$p < 0.001$.
†$p < 0.01$.
‡$p < 0.05$.
§n = 47 (number excludes individual with facial hair).

TABLE 7—*Analysis of variance (*F*) between facial tissue depth and body mass index for Chinese-Americans (full sample).*

	Males (n = 48)		Females (n = 53)	
Point Numbers/Descriptions	F-statistic	p-Value	F-statistic	p-Value
1: Glabella	11.824*	0.000	3.505†	0.022
2: Nasion	0.877	0.460	1.296	0.286
3: End of nasals	0.251	0.861	0.968	0.415
4: Lateral nostril	0.820	0.490	0.732	0.538
5: Mid-philtrum	0.750	0.528	0.567	0.639
6: Chin–lip fold	3.734†	0.018	4.488‡	0.007
7: Mental eminence	7.015‡§	0.001	3.069†	0.036
8: Beneath chin	5.811‡§	0.002	2.567	0.065
9: Superior eye orbit	10.418*	0.000	3.495†	0.022
10: Inferior eye orbit	1.869	0.149	3.781†	0.016
11: Supra canine	1.339	0.274	0.562	0.643
12: Sub-canine	4.304†	0.010	1.075	0.368
13: Supra M2	1.169	0.332	2.154	0.105
14: Lower cheek	5.222‡	0.004	1.440	0.243
15: Mid-mandible	9.623*	0.000	2.379	0.081
16: Lateral eye orbit	1.042	0.383	0.637	0.595
17: Zygomatic	7.745*	0.000	2.704	0.055
18: Gonion	10.858*	0.000	5.997‡	0.001
19: Root of zygoma	0.641	0.593	1.385	0.258

*$p < 0.001$.
†$p < 0.05$.
‡$p < 0.01$.
§n = 47 (number excludes individual with facial hair).

males, respectively. Facial tissue depths generally were thinner in Chinese-American males. Also, the number of landmarks with differences in tissue thickness of 2 mm or more was higher for the younger age groups (in both European and African American males), while fewer such differences were noted in the older groups. Regardless of ancestry, the landmarks with the greatest differences clustered in the cheek and lower facial regions.

Tables 11 and 12 compare the data from Chinese-Americans females to those from Manhein et al.'s (8) European and African American females, respectively. As with the males, facial tissue depths generally were thinner in Chinese-American females. However, fewer landmarks exhibited differences of 2 mm or more overall, and the number of such landmarks was higher in the older age groups (in both European and African American females) than in the younger groups. Nevertheless, similar to the males, the landmarks with the greatest differences in females clustered in the lower cheek and facial regions regardless of ancestry.

Tables 13 and 14 compare the data from Chinese-Americans to other Asian populations. Among the comparative populations, the designations "historic" and "modern" are based on the dates in which the data were published. For both males and females, Chinese-Americans generally have thinner facial tissue than other Chinese (5,15), Korean (7), and "modern" Japanese (9) populations. Chinese-Americans generally have thicker facial tissue than Suzuki's (14) and Ogawa's (10) more "historic" Japanese populations.

Discussion

The present study examined facial tissue depth in Chinese-Americans. In addition to providing new data for use in forensic facial reconstructions, our goals included evaluating the influence of age, sex, and BMI on facial tissue thickness in Chinese-Americans, and discussing variation in tissue thickness between Chinese-Americans and other Asian and American populations.

TABLE 8—*Student's* t-*test comparing facial tissue depth and sex for Chinese-Americans of normal body mass index* (n = *67*).

Point Numbers/Descriptions	*t*-Value	*p*-Value
1: Glabella	0.656	0.514
2: Nasion	0.581	0.563
3: End of nasals	0.586	0.572
4: Lateral nostril	−1.109	0.271
5: Mid-philtrum	3.287†	0.002
6: Chin–lip fold	0.643	0.522
7: Mental eminence	−1.848*	0.069
8: Beneath chin	−0.212*	0.832
9: Superior eye orbit	−1.863	0.067
10: Inferior eye orbit	−1.750	0.085
11: Supra canine	2.217‡	0.030
12: Sub-canine	0.405	0.687
13: Supra M2	−0.341	0.734
14: Lower cheek	−2.062‡	0.043
15: Mid-mandible	−1.535	0.130
16: Lateral eye orbit	−0.516	0.607
17: Zygomatic	−3.097†	0.003
18: Gonion	−1.097	0.277
19: Root of zygoma	1.997	0.050

*$n = 66$ (number excludes one individual with facial hair).
†$p < 0.01$.
‡$p < 0.05$.

Age

While previous research demonstrates that a correlation between age and facial tissue thickness exists (1,7,8,10,16,22), a clear pattern among adults is not evident. For example, whereas several studies showed that tissue thickness for some points decreases with age (8,10,22,23), the opposite was reported for other points (8,10,15,16,23). Ultimately, Wilkinson (23) and Tyrell et al. (24) similarly summarize that age-related changes are variable and growth trends difficult to determine.

This study employed two statistical methods to assess the relationship between tissue thickness and age. Whereas Pearson's was used to test whether a direct relationship existed between tissue depth and individuals' ages, ANOVA was used to assess whether or not variation was significant among different age groups. Among Chinese-American males, no significant relationships were found between tissue thickness and age regardless of which statistical method was used. That is, tissue thickness is neither correlated with age in males, nor do the averages vary significantly among different age groups. Among Chinese-American females, linear relationships existed between age and tissue thickness for the upper lip (negative) and the lower cheek (positive), which indicates that as age increased, tissue thickness decreased in the former, but increased in the latter. When the averages among different groups were assessed, these same two points, as well as supra canine, showed significant differences. The cause of the variation in the upper lip and lower cheek signified by the ANOVA is likely attributable to age (considering the results of the Pearson's). However, for supra canine, neither age nor BMI (see below) shows a direct linear relationship to tissue thickness, thus indicating that

TABLE 9—*Comparison of facial tissue thickness between Chinese-American and European American males.**

	18–34 Years Old			35–45 Years Old			46–55 Years Old			≥56 Years Old		
Point Number/ Description	Chinese (*n* = 8)	European American† (*n* = 28)	Difference	Chinese (*n* = 10)	European American (*n* = 10)	Difference	Chinese (*n* = 5)	European American (*n* = 5)	Difference	Chinese (*n* = 6)	European American (*n* = 5)	Difference
1: Glabella	4.5	5.0	−0.5	4.2	5.5	−1.3	4.4	6.0	−1.6	4.3	5.6	−1.3
2: Nasion	3.4	6.0	−2.6	3.9	6.4	−2.5	3.4	7.2	−3.8	3.5	6.6	−3.1
3: End of nasals	1.8	1.9	−0.1	1.9	2.4	−0.5	1.8	1.8	0.0	1.7	2.0‡	−0.3
4: Lateral nostril	8.9	7.5	1.4	9.2	9.8	−0.6	8.8	10.4	−1.6	8.5	10.8	−2.3
5: Mid-philtrum	7.9	11.9	−4.0	8.1	10.6	−2.5	6.6	8.0‡	−1.4	7.2	9.4	−2.2
6: Chin–lip fold	9.6	11.1§	−1.5	9.5	13.1	−3.6	8.4	11.6	−3.2	9.3	12.2	−2.9
7: Mental eminence	7.5	10.0	−2.5	7.4¶	12.0	−4.6	7.8	11.0	−3.2	7.0	11.8	−4.8
8: Beneath chin	4.8	7.2§	−2.4	5.0¶	8.0	−3.0	5.6	7.2	−1.6	5.2	5.6	−0.4
9: Superior eye orbit	4.5	5.3	−0.8	4.6	5.9	−1.3	4.8	7.7	−2.9	4.7	5.6	−0.9
10: Inferior eye orbit	6.1	5.8	0.3	6.1	6.2	−0.1	5.4	6.8	−1.4	8.0	5.0	3.0
11: Supra canine	9.3	11.9§	−2.6	8.0	10.1	−2.1	7.8	10.0‡	−2.2	7.8	9.2	−1.4
12: Sub-canine	8.1	11.5	−3.4	8.9	10.2	−1.3	9.6	10.0	−0.4	8.2	11.8	−3.6
13: Supra M2	24.8	28.5	−3.7	27.3	24.6	2.7	25.4	28.2	−2.8	23.2	23.6	−0.4
14: Lower cheek	19.9	25.1	−5.2	19.5	21.1	−1.6	20.0	21.4	−1.4	19.0	20.6	−1.6
15: Mid-mandible	8.1	14.8	−6.7	9.4	15.6	−6.2	8.0	15.4	−7.4	9.7	11.4	−1.7
16: Lateral eye orbit	4.6	4.2	0.4	4.7	4.3	0.4	4.0	5.4	−1.4	4.2	5.2	−1.0
17: Zygomatic	6.9	7.8	−0.9	6.6	8.2	−1.6	5.4	8.2	−2.8	7.0	6.4	0.6
18: Gonion	10.8	20.0	−9.2	10.9	19.6	−8.7	9.6	19.0	−9.4	12.3	14.0	−1.7
19: Root of zygoma	6.4	7.8	−1.4	6.9	6.6	0.3	6.6	5.4	1.2	6.7	5.2	1.5

*Based on Manhein et al. whose comparative population is referred to as "White" (8).
†Age range for comparative data is 19–34.
‡$n = 4$ (number excludes individual with facial hair).
§$n = 27$ (number excludes individual with facial hair).
¶$n = 9$ (number excludes individual with facial hair).

TABLE 10—*Comparison of facial tissue thickness between Chinese-American and African American males.**†

Point Number/Description	18–34 Years Old			35–45 Years Old		
	Chinese (n = 8)	African American‡ (n = 19)	Difference	Chinese (n = 10)	African American (n = 3)	Difference
1: Glabella	4.5	5.2	−0.7	4.2	5.3	−1.1
2: Nasion	3.4	6.6	−3.2	3.9	5.7	−1.8
3: End of nasals	1.8	2.2	−0.4	1.9	1.7	0.2
4: Lateral nostril	8.9	9.2	−0.3	9.2	10.3	−1.1
5: Mid-philtrum	7.9	13.0	−5.1	8.1	11.0	−2.9
6: Chin–lip fold	9.6	12.7	−3.1	9.5	12.7	−3.2
7: Mental eminence	7.5	12.1	−4.6	7.4§	12.3	−4.9
8: Beneath chin	4.8	8.8	−4.0	5.0§	7.0	−2.0
9: Superior eye orbit	4.5	6.4	−1.9	4.6	6.3	−1.7
10: Inferior eye orbit	6.1	5.8	0.3	6.1	7.0	−0.9
11: Supra canine	9.3	12.8	−3.5	8.0	10.3	−2.3
12: Sub-canine	8.1	14.4	−6.3	8.9	10.7	−1.8
13: Supra M2	24.8	28.2	−3.4	27.3	27.3	0.0
14: Lower cheek	19.9	24.5	−4.6	19.5	23.7	−4.2
15: Mid-mandible	8.1	14.1	−6.0	9.4	13.3	−3.9
16: Lateral eye orbit	4.6	4.8	−0.2	4.7	3.7	1.0
17: Zygomatic	6.9	8.4	−1.5	6.6	6.3	0.3
18: Gonion	10.8	21.1	−10.3	10.9	20.7	−9.8
19: Root of zygoma	6.4	7.4	−1.0	6.9	5.7	1.2

*Based on Manhein et al. whose comparative population is referred to as "Black" (8).
†Comparative data are not available for individuals over age 45.
‡Age range for comparative data is 19–34.
§n = 9 (number excludes individual with facial hair).

TABLE 11—*Comparison of facial tissue thickness between Chinese-American and European American females.**

Point Number/ Description	18–34 Years Old			35–45 Years Old			46–55 Years Old			≥56 Years Old		
	Chinese (n = 12)	European American† (n = 52)	Difference	Chinese (n = 7)	European American (n = 15)	Difference	Chinese (n = 8)	European American (n = 6)	Difference	Chinese (n = 11)	European American (n = 9)	Difference
1: Glabella	4.3	4.8	−0.5	4.0	4.7	−0.7	4.0	4.8	−0.8	4.4	5.2	−0.8
2: Nasion	3.9	5.5	−1.6	3.1	5.3	−2.2	3.1	6.2	−3.1	3.3	6.0	−2.7
3: End of nasals	1.9	1.8	0.1	1.6	1.6	0.0	1.3	1.8	−0.5	1.9	1.8	0.1
4: Lateral nostril	9.6	8.6	1.0	8.4	8.0	0.4	11.4	10.8	0.6	8.9	9.8	−0.9
5: Mid-philtrum	7.4	9.1	−1.7	6.4	7.4	−1.0	5.6	8.0	−2.4	5.9	8.0	−2.1
6: Chin–lip fold	9.6	10.3	−0.7	9.1	9.6	−0.5	8.9	9.8	−0.9	10.3	11.4	−1.1
7: Mental eminence	8.3	9.2	−0.9	7.3	9.2	−1.9	8.4	10.7	−2.3	8.6	12.3	−3.7
8: Beneath chin	5.3	6.0	−0.7	5.0	5.4	−0.4	5.0	6.7	−1.7	5.2	8.0	−2.8
9: Superior eye orbit	5.3	5.7	−0.4	5.6	5.5	0.1	5.0	6.5	−1.5	5.1	6.3	−1.2
10: Inferior eye orbit	7.4	6.1	1.3	6.7	5.7	1.0	7.9	7.3	0.6	7.5	7.0	0.5
11: Supra canine	8.1	9.3	−1.2	7.0	7.8	−0.8	6.3	7.7	−1.4	7.3	8.0	−0.7
12: Sub-canine	9.2	9.4	−0.2	8.1	8.7	−0.6	7.1	9.0	−1.9	8.8	9.7	−0.9
13: Supra M2	25.4	26.3	−0.9	26.3	25.1	1.2	25.1	27.2	−2.1	26.3	29.4	−3.1
14: Lower cheek	19.6	23.4	−3.8	22.6	20.1	2.5	22.5	21.7	0.8	22.2	27.2	−5.0
15: Mid-mandible	10.5	13.7	−3.2	9.4	12.6	−3.2	9.3	13.0	−3.7	10.4	17.4	−7.0
16: Lateral eye orbit	4.3	4.7	−0.4	4.1	4.3	−0.2	4.6	4.5	0.1	5.1	4.9	0.2
17: Zygomatic	7.8	9.3	−1.5	7.9	8.7	−0.8	8.0	10.2	−2.2	8.2	11.0	−2.8
18: Gonion	12.4	17.4	−5.0	12.4	15.3	−2.9	10.6	14.7	−4.1	11.5	16.9	−5.4
19: Root of zygoma	5.1	7.4	−2.3	5.1	4.9	0.2	6.9	6.0	0.9	5.6	7.4	−1.8

*Based on Manhein et al. whose comparative population is referred to as "White" (8).
†Age range for comparative data is 19–34.

some other factor (perhaps genetic) is influencing variation at this point.

Sex

Regarding differences between the sexes, previous research has shown that, with the exception of the cheeks, facial tissue generally is thicker in males for most points, particularly in the brow, mouth, and jaw regions (8,18,19,23). However, for Chinese-Americans, the data do not correspond to the traditional pattern noted above: with the exception of age group 35–45, females had thicker tissue than males for the majority of points (12 of 19 points in the youngest group, 11 of 19 points in the 45–55 age group, and 13 of 19 points in the 56 and older age group). Only five points, glabella, nasion, mid-philtrum, supra canine, and root of zygoma, consistently were thicker in males than in females. When differences were assessed statistically, four points (mid-philtrum, supra canine, lower cheek, and zygomatic) showed significant variation by sex. Two of these points (mid-philtrum and supra canine), along with glabella (also noted in this study as consistently thicker in males), do correspond

TABLE 12—*Comparison of facial tissue thickness between Chinese-American and African American females.*[*,†]

Point Number/ Description	18–34 Years Old Chinese (n = 12)	18–34 Years Old African American[‡] (n = 18)	18–34 Years Old Difference	35–45 Years Old Chinese (n = 7)	35–45 Years Old African American (n = 21)	35–45 Years Old Difference	46–55 Years Old Chinese (n = 8)	46–55 Years Old African American (n = 5)	46–55 Years Old Difference
1: Glabella	4.3	4.6	−0.3	4.0	4.5	−0.5	4.0	4.8	−0.8
2: Nasion	3.9	6.0	−2.1	3.1	5.2	−2.1	3.1	6.0	−2.9
3: End of nasals	1.9	1.7	0.2	1.6	1.5	0.1	1.3	2.0	−0.7
4: Lateral nostril	9.6	8.4	1.2	8.4	8.4	0.0	11.4	8.4	3.0
5: Mid-philtrum	7.4	9.2	−1.8	6.4	8.8	−2.4	5.6	8.2	−2.6
6: Chin–lip fold	9.6	11.8	−2.2	9.1	11.7	−2.6	8.9	10.0	−1.1
7: Mental eminence	8.3	10.8	−2.5	7.3	11.2	−3.9	8.4	10.8	−2.4
8: Beneath chin	5.3	6.7	−1.4	5.0	6.4	−1.4	5.0	7.2	−2.2
9: Superior eye orbit	5.3	6.1	−0.8	5.6	6.0	−0.4	5.0	5.8	−0.8
10: Inferior eye orbit	7.4	6.2	1.2	6.7	6.9	−0.2	7.9	5.8	2.1
11: Supra canine	8.1	10.0	−1.9	7.0	9.6	−2.6	6.3	9.0	−2.7
12: Sub-canine	9.2	10.9	−1.7	8.1	11.5	−3.4	7.1	12.4	−5.3
13: Supra M2	25.4	26.6	−1.2	26.3	26.8	−0.5	25.1	26.8	−1.7
14: Lower cheek	19.6	21.7	−2.1	22.6	22.5	0.1	22.5	21.2	1.3
15: Mid-mandible	10.5	12.6	−2.1	9.4	13.1	−3.7	9.3	13.4	−4.1
16: Lateral eye orbit	4.3	5.0	−0.7	4.1	4.9	−0.8	4.6	4.8	−0.2
17: Zygomatic	7.8	10.2	−2.4	7.9	9.8	−1.9	8.0	9.8	−1.8
18: Gonion	12.4	17.0	−4.6	12.4	16.2	−3.8	10.6	14.8	−4.2
19: Root of zygoma	5.1	6.4	−1.3	5.1	5.6	−0.5	6.9	6.0	0.9

* Based on Manhein et al. whose comparative population is referred to as "Black" (8).
†Comparative data are not available for individuals over the age of 55.
‡Age range for comparative data is 19–34.

TABLE 13—*Comparison of facial tissue thickness in males.*

Point Numbers/ Description	Current study Chinese (n = 29)*	Birkner (5) "Historic" Chinese (n = 9)		Chen et al. (15) "Modern" Chinese (n = 233)		Lebedinskaya et al. (7) "Modern" Koreans (n = 91)		Suzuki (14) "Historic" Japanese (n = 48)		Ogawa (10) "Historic" Japanese (n = 44)		Miyasaka et al. (9) "Modern" Japanese (n = 56)	
	Mean	Mean	Difference	Mean	Difference	Mean	Difference	Mean	Difference	Mean	Difference	Mean	Difference
1: Glabella	4.3	5.5	−1.2	5.4	−1.1	5.1	−0.8	3.8	0.5	3.6	0.7	5.9	−1.6
2: Nasion	3.6	6.6	−3.0	4.4	−0.8	4.5	−0.9	4.1	−0.5	3.9	−0.3	6.9	−3.3
3: End of nasals	1.8	2.4	−0.6	2.6	−0.8	2.8	−1.0	2.2	−0.4	2.0	−0.2	2.4	−0.6
4: Lateral nostril	8.9					2.9	6.0						
5: Mid-philtrum	7.6	11.7	−4.1	10.4	−2.8	11.1	−3.5			10.2	−2.6	13.5	−5.9
6: Chin–lip fold	9.3	11.0	−1.7	10.3	−1.0	11.3	−2.0	10.5	−1.2	8.7	0.6	13.1	−3.8
7: Mental eminence	7.4[†]	11.0	−3.6	9.4	−2.0	10.6	−3.2	6.2	1.2	10.8	−3.4	12.9	−5.5
8: Beneath chin	5.1[†]	6.2	−1.1	5.7	−0.6	6.3	−1.2	4.8	0.3	4.5	0.6	7.5	−2.4
9: Superior eye orbit	4.6	6.6	−2.0	5.9	−1.3			4.5	0.1	4.7	−0.1		
10: Inferior eye orbit	6.4	5.5	0.9	5.3	1.1			3.7	2.7	5.7	0.7		
11: Supra canine	8.3			11.5	−3.2								
12: Sub-canine	8.7			18.3	−9.6								
13: Supra M2	25.4			10.9	14.5			14.5	10.9	18.0	7.4		
14: Lower cheek	19.6			16.3	3.3			10.2	9.4	11.8	7.8		
15: Mid-mandible	8.9	7.1	1.8	11.1	−2.2	12.8	−3.9						
16: Lateral eye orbit	4.5			4.6	−0.1			5.4	−0.9	6.5	−2.0		
17: Zygomatic	6.6	10.0	−3.4	6.5	0.1			4.4	2.2	5.3	1.3	7.5	−0.9
18: Gonion	10.9	11.7	−0.8	14.9	−4.0	4.6	6.3	6.8	4.1	8.8	2.1	13.6	−2.7
19: Root of zygoma	6.7	8.6	−1.9										

*Normal body mass index sample.
†n = 28 (number excludes individual with facial hair).

with the conventional understanding that males tend to be thicker at the "brow and mouth" (8,18,19,23).

Regarding variation between the sexes in facial tissue thickness, Stephan and Simpson (19), in their comprehensive review and analysis of tissue depth data, point out that while facial tissue generally is thicker in males (except for the cheeks), differences are "extremely small" (they report a median difference between the sexes of 0.4 mm and a range of variation of 0.0–1.9 mm). Based on these seemingly minor differences (and taking into account other sources of error), they favor "collapsing the data across the sexes and using weighted means to yield one set of data for all adults" (19, p. 1264). Considering that variation in tissue thickness between Chinese-American males and females generally is not significant (with the exception of the four points mentioned previously), it may seem reasonable to collapse the data within each age group to increase sample size. On the other hand, considerable differences in tissue thickness between the sexes for some points would support the use of separate standards for each sex (e.g., differences >3 mm

TABLE 14—*Comparison of facial tissue thickness in females.*

Point Numbers/ Description	Current Study Chinese (*n* = 38)*	Lebedinskaya et al. (7) "Modern" Koreans (*n* = 91)		Chen et al. (15) "Modern" Chinese (*n* = 192)		Suzuki (14) "Historic" Japanese (*n* = 7)		Miyasaka et al. (9) "Modern" Japanese (*n* = 12)	
	Mean	Mean	Difference	Mean	Difference	Mean	Difference	Mean	Difference
1: Glabella	4.2	5.4	−1.2	5.3	−1.1	3.2	1.0	5.1	−0.9
2: Nasion	3.4	4.4	−1.0	4.1	−0.7	3.4	0.0	5.6	−2.2
3: End of nasals	1.7	2.9	−1.2	2.4	−0.7	1.6	0.1	2.0	−0.3
4: Lateral nostril	9.6	2.9	6.7						
5: Mid-philtrum	6.4	9.6	−3.2	9.1	−2.7			11.9	−5.5
6: Chin–lip fold	9.6	11.1	−1.5	9.3	0.3	8.5	1.1	12.7	−3.1
7: Mental eminence	8.2	11.1	−2.9	9.1	−0.9	5.3	2.9	12.0	−3.8
8: Beneath chin	5.2	6.5	−1.3	5.4	−0.2	2.8	2.4	6.6	−1.4
9: Superior eye orbit	5.2			5.9	−0.7	3.6	1.6		
10: Inferior eye orbit	7.4			5.5	1.9	3.0	4.4		
11: Supra canine	7.3			10.3	−3.1				
12: Sub-canine	8.5			17.5	−9.0				
13: Supra M2	25.8			10.3	15.5	12.3	13.5		
14: Lower cheek	21.5			15.7	5.8	9.7	11.8		
15: Mid-mandible	10.0	14.6	−4.6	12.1	−2.1				
16: Lateral eye orbit	4.6			4.7	−0.1	4.7	−0.1	7.2	−2.6
17: Zygomatic	8.0			7.4	0.6	2.9	5.1	13.3	−5.3
18: Gonion	11.8	5.4	6.4	14.8	−3.0	4.0	7.8		
19: Root of zygoma	5.6								

*Normal body mass index sample.

are present in the oldest age group for points 13 and 14 and for point 13 in age group 35–45).

Ancestry

Regarding populational variation, comparisons of historically and more recently collected data from numerous population groups demonstrate that differences exist in facial tissue depth for different populations, particularly in the eye, upper cheek, chin, and jaw (specifically nasion, supraorbital, infraorbital, zygomatic arch, mid-masseter, mental eminence, and gonion; summarized from [23, p. 146]). Also, in their assessment of European and African Americans, Manhein et al. (8, p. 58) found significant variation in tissue thickness in all but four points. In the current study, Chinese-Americans generally were found to have thinner facial tissue depths than all of the populations to which they were compared, with the exception of historic Japanese (10,14). The largest differences, which were not assessed statistically, primarily were found in the cheek and lower mid-facial regions. The correspondence among different groups in areas that show the largest variation suggests that patterns of facial tissue thickness are influenced by population affinity. However, the extent of this influence, and whether or not it is based on genetic, environmental, or cultural differences, is unknown.

On the other hand, direct comparison between any new data set and data reported in the literature is limited by a number of factors, particularly when standardized methods for collecting data are not available (such as in research on facial tissue depths). Such "lack of methodological standardization" (as discussed expansively [19, pp. 1259–60]) introduces error from a variety of sources (including inter-observer variation in landmark placement, types of instruments used to collect data, subject positioning, etc.) and impedes statistically meaningful interpretation of populational differences in facial tissue depths. For example,

Stephan and Simpson's (19) analysis of tissue data indicated that, though "a broad degree of variation" existed among groups, the ranges and "central tendencies" for all groups were similar regardless of ancestry (see [19, p. 1264]). Furthermore, their results demonstrated that studies of the same populations by different researchers showed as much variation as did those of different populations. Based on levels of uncertainty due to both methodological and casework application errors, they concluded that "it seems justifiable to regard the effects of 'race' on soft tissue depths as minimal" (19, p. 1264). Ultimately, practitioners should exercise caution when using or interpreting populational differences in facial tissue data sets that originate from multiple researchers.

BMI

Nutritional status or "body build" is known to impact facial tissue thickness, particularly in areas of the face with higher fat content or well-developed musculature (6,11–14,16,23,25). Therefore, considering BMI's association to weight, significant relationships would be expected, for example, at the landmarks which correspond to the cheeks, jawline, or lips.

As with the analysis of age, the relationship between BMI and tissue thickness was assessed using two statistical methods. Pearson's was used to test whether a direct relationship existed between tissue depth and BMI; ANOVA was used to assess whether or not variation was significant among different BMI categories. For Chinese-American males, all of the points which showed significant variation among BMI categories (10/19 points) also showed significant linear relationships with BMI (12/19 points). Neither the correspondence in results, nor the regions of the face which showed significance (i.e., the more fleshy parts of the face including the cheeks and jawline), is surprising. Of more interest may be the landmarks that do *not* show a direct relationship to BMI. These points included the nasal bridge, root of zygoma, and the lips. The nasal bridge has limited tissue; therefore, its relationship to BMI would not be expected. However, the lack of relationship between BMI and the lips or root of zygoma suggests that other factors are influencing tissue thickness in those areas.

For females, the results are more complicated. Based on Pearson's, BMI is positively and significantly correlated with tissue thickness at 11 landmarks (which generally are consistent with those found in males). However, only five landmarks, including the inferior eye orbit, root of zygoma, and several that comprise the forehead and chin, show significant variation among BMI categories. Interestingly, in addition to those with limited tissue (i.e., the nasal bridge), areas that do not show significant variation among females of different BMI categories also include the fleshier parts of the face, such as the cheeks, lips, and jawline. For the lips, at least, results (as discussed above) indicate that age is likely influencing tissue thickness. However, for the other regions, factors other than weight (such as genetics) appear to have a greater impact on tissue thickness for Chinese-American females, even in areas of the face where tissue is thickest.

Conclusions

While specific data are not available for Chinese-Americans, a special report published by the U.S. Department of Justice indicates that, although they represent only 4% of the population, 2% of all homicide victims in 2006 were Asian (26). If the identity of these individuals is unknown, the data reported here for adult Chinese-Americans could be useful in creating facial reconstructions or images that more accurately reflect the appearance of the person during life. Although unidentified skeletal remains often cannot be attributed to a specific Asian population, these new data may be employed with a higher possibility of success in areas with large Chinese populations. Alternatively, if multiple Asian populations reside in an area, measurements from this study might be pooled with those from other groups to increase the data that are available (i.e., for landmarks that are not represented in previous research) and, thus, provide a more comprehensive data set for use in facial reconstructions.

In conclusion, this research set out to provide new data for a population that generally has been underrepresented in facial tissue depth studies and to explore the impacts of biological factors, such as age, sex, and BMI on tissue thickness, within this population. Results from this study suggest that tissue depth standards at *some* landmarks in adult Chinese-Americans could be collapsed for the sexes or for different age groups. However, other landmarks demonstrate either notable differences between the sexes (e.g., the cheek region) or statistically significant variation among sex or age categories, or both (i.e., the forehead, jawline, or lips). Forensic artists ultimately must decide on which standards to use based on their experience and the circumstances surrounding each case. The data presented here for Chinese-Americans not only will supplement those standards currently available for use in forensic facial reconstructions for Mongoloid populations, but will also add to the body of knowledge concerning facial tissue depth variation in modern humans.

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Additional information—reprints not available from author:
Wing Nam Joyce Chan, M.A.
Department of Anthropology
The Ohio State University
4034 Smith Laboratory
174 West 18th Avenue
Columbus, OH 43210
E-mail: chan.348@osu.edu