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Identification of new morphological differences between Chinese and Caucasian faces and influence of BMI on these characteristics

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Background: Concepts of beauty are more and more globalised leading to the homogenisation of the physical appearance. It is therefore important to identify morphological characteristics of ethnic groups. We compare faces from Chinese and Caucasian women, identify morphological differences that were not documented yet and study the influence of BMI on these differences.

Methods: The study was carried on groups of 60 women: a Chinese and a Caucasian group. Both included two equal subgroups: normal BMI and higher BMI. Face widths were measured from individual pictures and from reconstructed average faces obtained using a new reconstruction algorithm. Cheek/chin and neck/chin angles were determined from individual pictures. Topography of the cheekbone and temple face was determined by fringe projection technique. Ultrasound analysis allows measurements of hypodermis thickness.

Results: Our innovative average face reconstruction algorithm produced images of a yet unequalled quality with width characteristics similar to those of individual pictures. Analysis shows that faces of Chinese women are larger and rounder. They present other differences that were so far unidentified. Finally, overweight impacts differently Chinese and Caucasian women faces and has greater influence on Chinese women faces.

Key words: Caucasian – Chinese – face morphology – BMI – average face – ultrasound analysis – fringe projection

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The canons of beauty developed by artists during the Renaissance are well documented and imposed themselves for centuries (1) despite the lack of anthropometric data. Several studies focused on gathering these anthropometric data (2–4) and compared them among various ethnic groups (5–7). Some aspects of attractiveness are universal and cross-cultural (8, 9). Nevertheless, they can vary according to the environment (10) or the genetic origin (11). They also evolve with the period of time considered (12–14).

Today, with internationalisation of media, the concepts of beauty are becoming more and more globalised leading to the homogenisation of the physical appearance. Indeed, global marketing has homogenised images presented in advertisement around the world (15) and Western canons of beauty tend to impose in many countries. This is especially true in China where women's magazines present a high proportion of cosmetics and facial beauty products advertisements (16). As a result perception of aesthetic models has evolved. If Chinese men rank equally Chinese and Caucasian female models, they display a preference for the Caucasian male model (17). On their side, Chinese women display a marked preference for the Caucasian models over the Chinese models for both, male and female. This is also true for facial attractiveness. In addition, if lighter coloured skin is a long-standing and documented trait of attractiveness for part of the Chinese population (18), advertisement has accentuated this preference (19).

It is therefore important to identify morphological data of ethnic groups, not only for aesthetic purposes but also for reconstructive and orthodontic surgery. Indeed, increasing migration fluxes has created problems for practitioners in identifying natural facial characteristics from those resulting from illness or trauma. Previous study (20) shows that, compared to white women, Chinese women's faces present a wider intercanthal distance, a different profile of the lower part of the face and differences in the eyelids. Major differences were also identified in the nose region that, in the Chinese women population, is less prominent, has a wider nasal base, flared *alae*, a less defined nasal tip, more horizontally oriented nostrils and a different alar-columellar relationship. Similar differences are also observed between Chinese and Caucasian in another study (6) that also identified further differences: a smaller mouth width and a lower face smaller than the forehead height in the Chinese population.

Nevertheless, morphology is affected by several factors, among which age and weight are the two most obvious. Some inter-ethnic studies on morphological differences evaluated the influence of age. To our knowledge, none take into account the influence of weight while it is a factor with major impact on soft tissue thickness as shown by studies related to facial reconstruction in forensic science (21–23).

The goal of this study is to identify the morphological differences between the faces of Chinese and Caucasian women and to determine how overweight influences morphological characteristics within each group. Focusing on characteristics different than the nose and the eyes, that are already documented, we studied various parameters using different techniques: (1) high definition average face reconstruction, (2) analysis of standardised individual profile pictures to measure morphological differences and (3) fringe projection technique to measure topography of the face and (4) ultrasound analysis to measure thickness of the hypodermis.

Material and Methods

Subjects

The study was carried out on 120 women from two different ethnic groups with an age ranging from 25 to 40 years old. Each ethnic group encompasses two sub-groups: one with normal BMI and another one with a BMI reflecting overweight. The Chinese subjects (n = 60) were women from the Han ethnic group of the region of Shanghai. The normal BMI sub-group, according to WHO's standards (24), included 30 women with a BMI ranging between 18 and 22.5 kg/m^2 (mean BMI = 20.6 ± 1.2; mean age = 32.5 ± 4.8 years). The overweight Chinese sub-group, high BMI Chinese sub-group, encompassed 30 women with a BMI ranging from 23 to 25 kg/m^2 (mean BMI = 24.1 ± 0.7; mean age = 32.6 ± 4.6 years). The second group was from the region of Paris (France) and comprised 60 Caucasian women. The normal BMI Caucasian sub-group (n = 30) has a BMI between 18.5 and 25 kg/m^2 (mean BMI = 20.8 ± 1.7; mean age = 32.5 ± 4.9 years) and the overweight Caucasian sub-group, high BMI Caucasian sub-group, was characterised by a BMI ranging from 25.5 and 30 kg/m^2 (mean BMI = 27.4 ± 2.0; mean age = 33.2 ± 4.2 years).

For all groups, the following inclusion criteria were retained: (1) absence of aesthetic surgery or therapy on the face or the neck, (2) absence of any care product claiming an anti-aging and/or firming effect and/or lifting and/or slimming effect for at least 2 weeks, (3) absence of any care product on the face or the neck for at least 5 days, (4) absence of any make-up for at least 2 days.

Analysis of standardised pictures

Individual high-resolution (3744x5616px) jpeg pictures of front face and right profile of subjects were taken under normal diffused light using a digital camera (Canon 5D Mark II with a 50 mm lens, F/22, 1/160s, ISO-100, WB: 5200K). To avoid positioning variations, subjects were placed in a bench holding their head in a fixed position. Front face pictures were used to determine the width of the face at the corner of the mouth. They were also used to determine the neck–chin bending angle. Right half-face pictures were used to measure the cheek/chin angle.

Reconstruction of average faces

Standardised front pictures were also used to reconstruct a high definition average face for each of the four sub-groups using an innovative superposition algorithm developed by Newtone Technologies® (Newtone, Lyon, France). This method uses automatic detection of characteristic morphological points (25, 26) on every individual image. This detection is then optimised by a Machine Learning algorithm that significantly improves the results thanks to the volume of data available. Using these characteristic morphological points detected on every individual image, and based on a diffeomorphic deformation algorithm (27), all pictures are spatially registered in a common reference space (28, 29). For every pixel, a statistical analysis then ensures the best spatial and colorimetric consistency in order to generate high-resolution average images.

These reconstructed average front faces were used to measure width of the faces at different levels: below eyes, at the level of the cheek, at the corner of the mouth and below mouth. Width of the mouth was also determined.

Analysis of the lower area of the face

Topography of the cheekbone and of the maxillary zones was calculated by the fringe projection technique [(30), Peritesco, France]. For this, the zones to be analysed, are first defined according to their texture rather than by their topography. Illumination by polarized light stripes and software analysis allows isolation of the corresponding topographic zones and definition of an average plan going through the contours. The volume of the selected zone above the reference plan is then computed.

Analysis of the skin structure by ultrasound

Ultrasound analysis (Dermcup Ultrasound Scan, Atys Medical, Soucieu-en-Jarrest, France) was performed at 16 MHz on three different zones of the left half-face: a zone on the bottom of the

Fig. 1. Reconstructed average front faces. (a) Reconstructed average front face picture from the Chinese sub-group with normal BMI. (b) Reconstructed average front face picture from the Caucasian sub-group with normal BMI. (c) Reconstructed average front face picture from the Chinese sub-group with high BMI. (d) Reconstructed average front face picture from the Caucasian sub-group with high BMI. White bar = 10 mm.

cheek, another on the bottom of the cheekbone and a last one on the temple. Results were used to measure the thickness of the hypodermis.

Statistical analysis

For each set of data, several statistical indicators were calculated: mean, standard deviation, minimum, maximum and box-plots were used to get an idea of data distribution. Student's *t*-test was performed to compare data sets between sub-groups, normality being addressed by a Shapiro–Wilk normality test with a 1% threshold. When at least one data set was not following normal distribution, data sets were compared using a Wilcoxon– Mann–Whitney test.

For global ANOVA analysis, an analysis of variance was first performed for each parameter with two fixed factors (country and BMI group) and the interaction between those two factors. If residual's normality distribution was rejected by the Kolmogorov–Smirnov test ($n > 50$, 1% threshold), this analysis was carried on transformed data or non-parametric tests are used. Moreover, if variance homogeneity of residuals is rejected by the Bartlett test, the heterogeneity is taken into account in the model (with the option 'group').

All analyses were performed under SAS 9.2 and conclusions were interpreted with a significant threshold at 5% (except for normality at 1% as mentioned above).

Results

Width of Chinese and Caucasian faces

Comparison of widths from reconstructed average front faces of the normal BMI sub-groups indicate that Chinese faces are larger than Caucasian faces at all points measured (Fig. 1a–b, Table 1): below eyes (+13.0%), at the level of the cheek (+12.0%), at the level of the corner of the mouth (+10.9%) and below mouth (+7.4%). Only the width of the mouth itself is smaller in Chinese faces (−1.2%) as previously noted (6). It should also be noted that face widths determined from reconstructed average front faces are in the corresponding widths determined from individual pictures (Table 1).

In the Chinese group, BMI influences widths of the face (Fig. 1a–c, Table 1) by a + 0.7% increase below eyes, by a larger increase in width at the level of the cheek and of the corner of the mouth, +2.5% and +2.7% respectively. The largest increase is +4.3%, below mouth. In

TABLE 1. Width of the face (mm) and percentage of differences determined from the reconstructed average faces and from the analysis of individual front face pictures (mean ± standard deviation) for the normal- and high-BMI sub-groups of the Chinese and Caucasian groups

	Width in mm		
	Normal BMI	High BMI	Differences (%)
Width of the Chinese faces determined from average front face pictures			
Below eyes	141.9	142.9	+0.7
Cheek	136.4	139.7	+2.5
Corner of the mouth	117.6	120.8	+2.7
Mouth	46.4	46.9	+0.3
Below mouth	91.4	95.3	+4.3
Width of the Caucasian faces determined from average front face pictures			
Below eyes	125.5	142.9	+0.9
Cheek	121.7	139.7	+1.6
Corner of the mouth	106.0	120.8	+1.1
Mouth	47.0	46.9	−1.5
Below mouth	85.1	95.3	+2.8
Difference (%) in width between Chinese and Caucasian faces determined from average front face pictures			
Below eyes	+ 13.0	+12.8	
Cheek	+ 12.0	+13.0	
Corner of the mouth	+ 10.9	+12.7	
Mouth	−1.2	+0.6	
Below mouth	+7.4	+9.0	
Width of the Chinese faces determined from individual pictures			
Corner of the mouth	118.6 ± 6.7	122.2 ± 7.3	+3.02
Width of the Caucasian faces determined from individual pictures			
Corner of the mouth	104.8 ± 4.6	106.0 ± 5.2	+1.15
Difference (%) in width between Chinese and Caucasian faces determined from individual pictures			
Corner of the mouth	+13.19	+15.28	

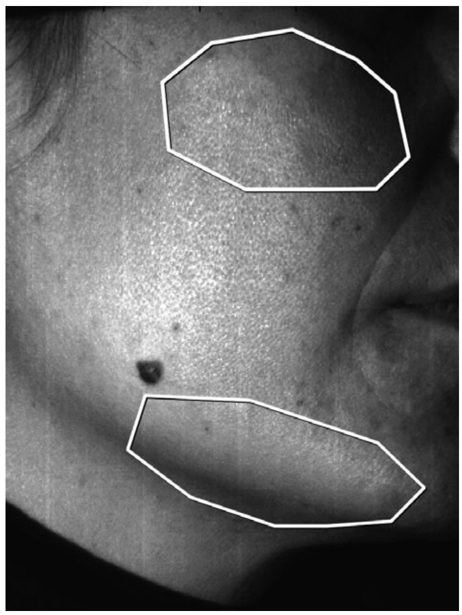

Fig. 2. Illustration of the measurement zones for determining the volume of the cheekbone and the volume at the level of the maxillary.

the Caucasian group, increase in BMI also leads to larger widths (Fig. 1b–d, Table 1): +0.9% below eyes, 1.6% at the level of the cheek, 1.1% at the level of the corner of the mouth and +2.8% below mouth. Therefore, overweight-related increase in width of Chinese faces is more pronounced than in Caucasian faces and is especially localised below mouth. In Caucasian faces the overweight-related increase in face width is mostly localised at the level of the cheek and below mouth.

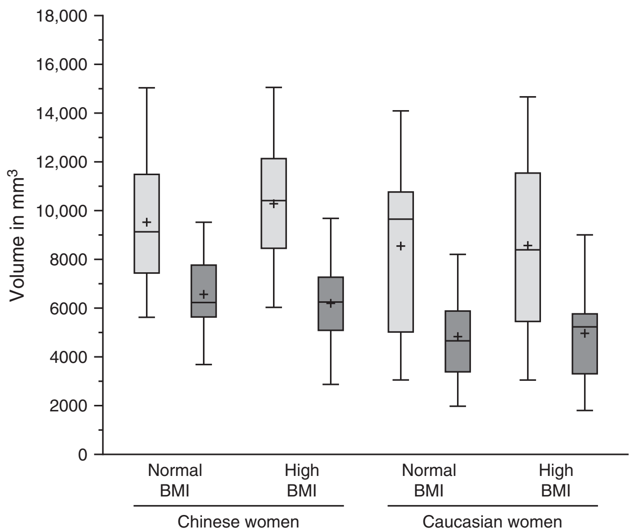

Fig. 3. Box-plot representation of the volume at the level of the cheekbone (light grey) and at the level of the maxillary (medium grey) for the normal- and high-BMI sub-groups of the Chinese and Caucasian groups.

Cheekbone and maxillary volumes

To better characterise differences in face morphology, we used fringe projection technic to determine the volume of the cheekbone and at the level of the maxillary (Fig. 2). In the normal BMI sub-groups, only the volume at the level of the maxillary is significantly higher in Chinese faces compared to Caucasian faces (Fig 3 and Table 2, +35.9%, $P = 0.0003$).

Higher BMI has no significant influence on the volume of the cheekbone or on the volume of the maxillary zone (Fig. 3 and Table 2). This result is true for both, the Chinese and the Caucasian group.

Cheek/chin and neck/chin bending angles

We also compared the cheek/chin and the neck/chin angles to better describe the morphology of the bottom of the face (Fig. 4, 5 and Table 3). At normal BMI, there are no signifi-

TABLE 2. Volumes, data distribution and percentage of differences in the cheekbone and the maxillary zone for the normal- and high-BMI sub-groups of the Chinese and Caucasian groups

	Volume in mm^3		Statistical analysis of the difference between normal and high BMI sub-groups		
	Normal BMI	High BMI	Difference (%)	*t*-test *P*-value	Conclusion
Cheekbone of Chinese women faces					
Average	9523.1	10280.6			
Standard deviation	2688.7	2586.4	+ 8.0	0.22	Not significant
Normality test *P*-value	0.368	0.378			
Cheekbone of Caucasian women faces					
Average	8546.2	8384.4			
Standard deviation	3283.9	3345.8	−1.9	0.22	Not significant
Normality test *P*-value	0.054	0.179			
Statistical analysis of the difference between Chinese and Caucasian faces of normal BMI					
Difference (%)	+ 11.4				
t-test *P*-value	0.22				
Conclusion	Not significant				
Maxillary zone of Chinese women faces					
Average	6564.3	6195.3			
Standard deviation	1582.7	1767.4	−5.6	0.41	Not significant
Normality test *P*-value	0.667	0.734			
Maxillary zone of Caucasian women faces					
Average	4829.70	4964.95			
Standard deviation	1830.25	1776.95	+ 2.8	0.77	Not significant
Normality test *P*-value	0.239	0.621			
Statistical analysis of the difference between Chinese and Caucasian faces of normal BMI					
Difference (%)	+ 35.9				
t-test *P*-value	0.0003				
Conclusion	Significant				

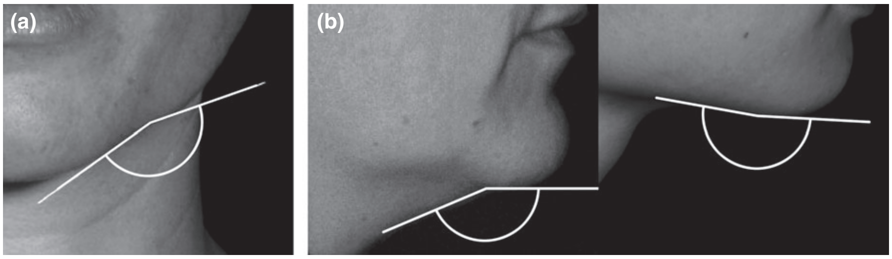

Fig. 4. Measurement points of the cheek/chin and neck/chin angles. (a) Determination of the cheek/chin angle. (b) Determination of the neck/chin angle with an example of a morphology leading an angle <180° (left) and >180° (right).

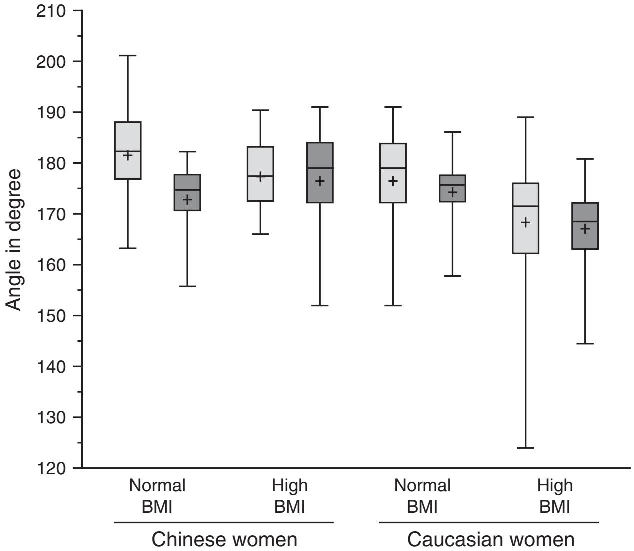

Fig. 5. Box-plot representation of the neck/chin (light grey) and the cheek/chin (medium grey) angles for the normal- and high-BMI subgroups of the Chinese and Caucasian groups.

cant difference in the cheek/chin angle between the Chinese and the Caucasian group. Only the neck/chin angle is significantly larger in the Chinese group (+2.8%, $P = 0.044$).

For the Chinese group, overweight has no significant influence on the cheek/chin angle ($P = 0.68$) and only limited influence on the neck/chin angle (−2.2%, $P = 0.0497$). On the contrary, overweight influences significantly the neck/chin angle (−4.6%, $P = 0.014$) and the cheek/chin angle (−4.1%, $P = 0.0005$) in the Caucasian group. Taken together, these results indicate that overweight-induced changes in the neck/chin and cheek/chin angles are more important in Caucasian faces that in Chinese faces.

Hypodermis thickness

To gain more insight in the morphological differences observed, we used ultrasound analysis to determine hypodermis thickness of three regions of faces: cheekbone, cheek and temple (Fig. 6). Data analysis (Table 4) shows that, at normal BMI, hypodermis is significantly thicker at the level of the cheekbone (+13.8%, $P = 0.012$) and at the level of temple (+21.5%, $P = 0.0003$) in the Chinese group compared to the Caucasian group. No significant difference is observed at the level of the cheek.

We also performed a global ANOVA analysis to determine the influence of both, ethnic group and BMI effects, as well as the possible interaction of both factors on hypodermis thickness of the three regions of faces (Table 5). At the level of the cheek, ANOVA analysis rejected the effect of the ethnic group on hypodermis thickness with a probability at the limit of significance ($P = 0.053$). Nevertheless, hypodermis thickness at the level of the cheek is significantly influenced by BMI ($P = 0.006$) and higher BMI leads to larger hypodermis thickness. For hypodermis thickness at the level of the cheekbone, ANOVA analysis pointed a significant influence of both factors: ethnic group ($P < 0.0001$ with results of the Chinese women being higher than those of the Caucasian women) and BMI ($P = 0.043$ with results of women with a higher BMI being higher than those of women with a normal BMI). Finally, results of the Anova analysis on hypodermis thickness at the level of the temple pointed out a significant effect of the ethnic group ($P < 0.0001$ with a larger hypodermis thickness for Chinese women than for Caucasian women) but did not show a significant effect of BMI increase ($P = 0.143$).

Another result of the ANOVA analysis is the fact that the interaction between country and BMI is rejected for the three zones tested ($P = 0.73$ for the cheek, $P = 0.51$ for the cheekbone and $P = 0.66$ for the temple). This absence of interaction means that for each

TABLE 3. Angles, data distribution and statistical analysis for the neck/chin and the cheek/chin angles for the normal- and high-BMI sub-groups of the Chinese and Caucasian groups

	Angle in °		Statistical analysis of the difference between normal and high BMI sub-groups		
	Normal BMI	High BMI	Difference (%)	*t*-test *P*-value	Conclusion
Cheek/chin angle of Chinese women faces					
Average	172.82	172.11			
Standard deviation	6.92	6.22	−0.4	0.680	Not significant
Normality test *P*-value	0.022	0.757			
Cheek/chin angle of Caucasian women faces					
Average	174.25	167.08			
Standard deviation	6.65	8.17	−4.1	0.0005	Significant
Normality test *P*-value	0.018	0.163			
Statistical analysis of the difference between Chinese and Caucasian faces of normal BMI					
Difference (%)	−0.8				
t-test *P*-value	0.415				
Conclusion	Not significant				
Neck/chin angle of Chinese women faces					
Average	181.51	177.47			
Standard deviation	8.94	6.42	−2.2	0.045	Significant
Normality test *P*-value	0.490	0.766			
Neck/chin angle of Caucasian women faces					
Average	176.56	168.32			
Standard deviation	10.03	14.43	−4.6	0.014	Significant
Normality test *P*-value	0.043	0.007			
Statistical analysis of the difference between Chinese and Caucasian faces of normal BMI					
Difference (%)	+ 2.8				
t-test *P*-value	0.044				
Conclusion	Significant				

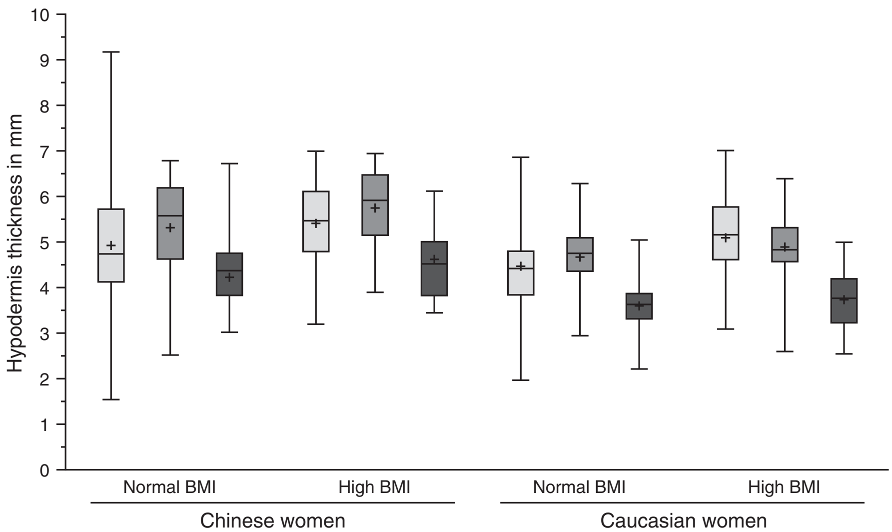

Fig. 6. Box-plot representation of the thickness of the hypodermis for the normal- and high-BMI sub-groups of the Chinese and Caucasian groups at the level of the cheek (light grey), of the cheekbone (medium grey) and of the temple (dark grey).

country, the BMI effect on hypodermis thickness is the same and that for each BMI sub-group, the country effect on hypodermis thickness is the same.

Discussion

Until recently, plastic surgeons were relying on the standards of ideal proportions based upon neoclassical canons. These traditional canons reflect the European Caucasian facial morphology and are poorly adapted to other ethnic groups because of drastic differences in measurement and proportion. Over the years, several studies have gathered data, challenging the neoclassical canons and reflecting more accurately the differences in facial morphology specific to ethnic groups.

TABLE 4. Hypodermis thickness, data distribution and percentage of differences at the level of the cheekbone, of the cheek and of the temple for the normal-BMI sub-groups of the Chinese and Caucasian groups.

	Chinese women faces Normal BMI	Caucasian women faces Normal BMI	
Hypodermis thickness in mm (mean + standard deviation)			
Cheek	4.93 ± 1.35	4.47 ± 1.15	
Cheekbone	5.32 ± 1.14	4.67 ± 0.74	
Temple	4.37 ± 0.87	3.60 ± 0.69	
Normality test *P*-value of hypodermis thickness			
Cheek	0.104	0.216	
Cheekbone	0.037	0.700	
Temple	0.307	0.455	
Statistical analysis of hypodermis thickness [Difference Chinese/Caucasian in % (*t*-test *P*-value)]			
Cheek	+10.2	$P = 0.166$	Not significant
Cheekbone	+13.8	$P = 0.012$	Significant
Temple	+21.5	$P = 0.0003$	Significant

Most of these studies use direct anthropometric measurement or standardised picture analysis. If we used individual standardised picture analysis we also developed a new algorithm to produce high resolution reconstructed average front faces. These average front face pictures are very well defined but are especially remarkable by their quality and the morphological similarities between the images obtained. This achievement is possible because, contrary to other methods used so far, the reconstruction process we developed uses not only morphological criteria but also colorimetric criteria. A key point is the spatial deformation process that is highly efficient and allows an extremely precise positioning of pre-selected landmarks on localised zones. The second key point is that our method also uses a specific statistical analysis algorithm that treats colorimetric data. It is this latest analysis that greatly participates in the sharpness of both external and internal contours of the face. Nevertheless, it is the entire process and the innovative algorithms we developed that results in the high precision of the reconstruction, and therefore in the high quality of the resulting image, even on zones that varies greatly from one subject to another such as the eyes, the mouth, the nostrils and the eyebrows.

Aside from the quality of the images of the reconstructed faces, one point is supporting the quality of our reconstruction and the results we obtained from their analysis: the excellent agreement of the width of the face at the level of the corner of the mouth determined from the reconstructed images and from the analysis of individual front face pictures.

It is thanks to this quality that we reveal yet unidentified differences in the facial morphology of Chinese and Caucasian women. At normal BMI, the face of Chinese women is larger than the face of Caucasian women at all points measured. This width increase is more important for the region starting below eyes (+13.0%) and ending at the corner of the mouth (+10.9%), or below mouth (+7.4%). This repartition of width increases gives to faces of Chinese women a shape that is rounder than the face of their Caucasian counterparts. This rounder face shape is further reinforced by the fact that the cheekbone itself is not more prominent as shown by its volume determined by fringe projection. Another data from the fringe projection is that the volume of the maxillary zone is more important in Chinese women faces. Finally, if the cheek/chin angle is similar in both ethnic groups, the neck/chin angle is higher in Chinese face indicating a possible more important sagging of the skin at this region.

TABLE 5. Results of the global Anova statistical analysis for hypodermis thickness at the level of the cheek, of the cheekbone and of the temple

	Hypodermis thickness in mm (mean ± SD)				Results of the global ANOVA analysis						
	Chinese group		Caucasian group		Country effect (Chinese–Caucasian)			BMI effect (High BMI–Normal BMI)			
	Normal BMI	High BMI	Normal BMI	High BMI	mm difference	Probability	Conclusion	mm difference	Probability	Conclusion	Interaction effect
Cheek	4.93 ± 1.35	5.41 ± 0.96	4.47 ± 1.15	5.09 ± 0.88	+0.387	$P = 0.053$	Limit significance	+0.555	$P = 0.006$	Significant	Not significant
Cheekbone	5.32 ± 1.14	5.75 ± 0.83	4.67 ± 0.74	4.89 ± 0.78	+0.750	$P < 0.0001$	Significant	+0.326	$P = 0.043$	Significant	Not significant
Temple	4.37 ± 0.87	4.62 ± 0.62	3.60 ± 0.69	3.73 ± 0.73	+0.830	$P < 0.0001$	Significant	+0.194	$P = 0.143$	Not significant	Not significant

Another important aspect we were interested in is the influence of BMI on these morphological characteristics. Indeed, obesity has an increasing incidence in many countries and, as it has major impact on soft tissue thickness, it directly impacts face morphology. One interesting finding is that overweight affects differently the morphology of Chinese and Caucasian women.

For faces of Chinese women, overweight is characterised by an increased width of the face at the level of the cheek and at the corner of the mouth but this increase is especially pronounced at the bottom of the face. Overweight does not lead to a more prominent cheekbone or to a relative increase in the volume of the maxillary zone. There is no variation in the cheek/chin angle but a slight increase, at the limit of significance, of the neck/chin angle. In Caucasian women faces, overweight-related width increase at the level of the cheek and at the corner of the mouth is moderate. The increase in width below mouth is more pronounced, but still weaker than in Chinese women faces. Similar to Chinese women, overweight has no influence on the volume of the cheekbone or on the volume of the maxillary zone but it leads to a decrease in both angles, cheek/chin and neck/chin. This increase in the neck/chin angle reveals a trend to an increased ptosis of the skin at the level of the neck in overweight Chinese population that is, therefore, more prone to the appearance of a double chin.

Taken all together, the larger face width of Chinese women compared to Caucasian women is a morphological characteristic that is essentially influenced by the ethnic group. If BMI influence face width, its impact is limited and affects predominantly the bottom of the face, especially for Chinese women. Nevertheless, increased BMI leads to increased sagging of the skin at the neck/chin junction as shown by the increase in the neck/chin angle in both ethnic groups. Only Caucasian faces present also an overweight-related increase in the cheek/chin angle.

Part of the differences we observe is due to differences in the underlying craniofacial morphology as shown by orthodontic studies (31, 32). Indeed significant differences in hard and soft tissue characteristics were found between Chinese and Caucasian. Analysis of hypodermis thickness determined by ultrasound analysis shows that the region of the face analysed present different characteristics. Thickness of the hypodermis at the level of the cheek is essentially influenced by the BMI, the effect of the ethnic group being at the limit of significance. For the cheekbone, hypodermis thickness is influenced by the ethnic group and by the BMI. Finally, at the level of the temple, the ethnic group influences hypodermis thickness and there is no significant effect of the BMI. Nevertheless, the few tenths of millimeter differences we observed in hypodermis thickness clearly do not explain by themselves the differences in face width between Chinese and Caucasian women.

Conclusion

Comparative analysis of various parameters of Chinese and Caucasian women faces identify several differences. Widths of Chinese women faces are larger at all points measured, making them look rounder. The volume of the maxillary zone is also larger and sagging of the skin at the neck-chin junction is more pronounced. Hypodermis thickness could account for part of these differences as it is thicker at the level of the temple and the cheekbone. Increase in BMI also differently impacts Chinese and Caucasian. The effect is more pronounced on Chinese women faces, especially at the bottom of the face. In addition, overweight could slightly influence the neck/chin angle in Chinese women faces but influences clearly the neck/chin and the cheek/chin angles in faces of Caucasian women. Finally, overweight significantly increases hypodermis thickness at the level of the cheek and the cheekbone for both Chinese and Caucasian women. These differences will help to find appropriate responses to reconstructive surgery and aesthetic concerns.

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Competing Interests

MJ is working full time for Newtone Technologies, a company developing image acquisition and analysis solutions.

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