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# The Esthetic Difference of Chinese Beauty Evaluated by Two Different Human Races Based on Three-Dimensional Average Face Analysis

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**Purpose:** The aim of this study was to establish a new method of facial soft tissue analysis based on 3dMDFace system and to find the different esthetic preferences of Chinese beauties from the Chinese and Indian evaluators perspective.

**Methods:** Three-dimensional facial images of 242 females and 168 males were evaluated and ranked by 8 Chinese and nine Indians using a 10-point visual analog scale (VAS). Total 120 subjects in 2 panels (from Chinese perspective and Indian perspective) including 30 male and 30 female faces with top 30 scores were analyzed with the “average face” method respectively. Then 17 linear measurements, 13 curve measurements and 14 ratios of 4 average faces were calculated and compared with the divine proportion.

**Results:** Distinct differences were founded based on the average face analysis. Similar total facial types were preferred by both Chinese and Indian evaluators, while Indian evaluators preferred a wider male face with a protrusive lower lip. Delicate noses with lower nose ridge but protrusive lower lips in females were more acceptable by Indian evaluators. The differences of linear measurements were limited in 2.0mm except the facial width, lower facial width, upper facial height and forehead height while curve measurements differ distinctly as the table shows. No ratios equal to the divine proportion were founded.

**Conclusion:** The 3D Average face based on stereophotogrammetry is a feasible method to analyze the facial characters and discrepancy of esthetic preferences. Chinese and Indian evaluators have some certain differences when judging beauties. Attractive faces have some certain ratios but not the divine proportion.

**Key Words:** Attractiveness, average face, Chinese, Indian

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As we all know, facial attractiveness plays a vital role in daily social interactions. A good personal image will strengthen our belief in ourselves, which is of great benefit to achieving self confidence in a competitive society. Moreover, as the living standards improve, an increasing number of people explore every accessible avenue to improve their facial aesthetics, such as cosmetic injections, micro-plastic surgeries, orthodontic treatment, and orthognathic surgeries. In addition to a good dental occlusion, patients are now seeking to obtain a more harmonious facial morphology. An interesting research on the chief complains of orthodontic patients showed that a desire to improve the overall appearance has become the second most important motivation following the desire to straighten the teeth from the orthodontic patients.<sup>1</sup> Another research stated that patients’ perception of unpleasant appearance has played an increasingly important role in the main motivating factors.<sup>2</sup> This requires our practitioners (orthodontics, who concentrate on modifying the lower face) to endeavor to improve the facial attractiveness of our patients.

In spite of the core situation of facial beauty in our orthodontic specialty, the definition of facial attractiveness is still a matter of debate.<sup>3–5</sup> Esthetical standards are subjective opinions which vary with every individual, influenced by occupational experiences, regional disparities, ethnicities and genders.<sup>3,6–9</sup> The deviation between orthodontists and patients about aesthetics has become a relevant point on the satisfaction of the orthodontic treatment. Thus, clarifying the discrepancy of facial esthetics is a compulsory task.

Enormous methods have been referred to evaluate the facial soft tissue esthetics since the beginning of our specialty.<sup>10,11</sup> Subjective evaluation scales such as visual analogue scales (VAS), numerical rating analysis (NRS), likert scale and Q-sort are combined with objective anthropometric measures to find the characteristics of attractive individuals.<sup>12–15</sup> However, whether direct anthropometric measures or two-dimensional photogrammetry and cephalometry, facial characters in 3 dimensions cannot be depicted accurately by just angles or lines.<sup>6</sup> Many researchers concluded with descriptive words to illustrate the features of facial esthetics, but not visual objects in a stereoscopic view, which is not convenient for clinicians to compare the evaluating discrepancies between clinicians and patients, practitioners from different countries, especially in today’s era of globalization.

The technological advances of three-dimensional (3D) stereophotogrammetry opens up a new territory on facial soft tissue

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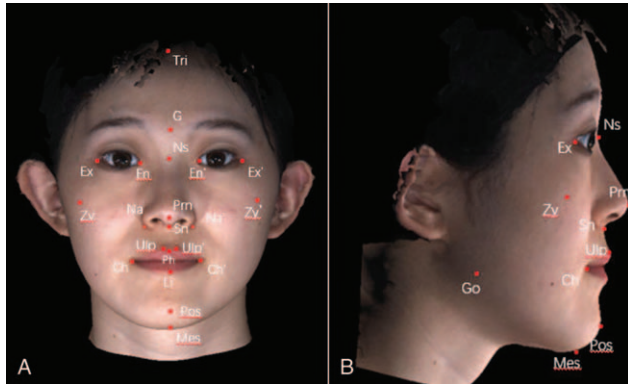
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**FIGURE 1.** A face captured by the 3dMDvultus system was showed in three dimensions.

analysis.<sup>16</sup> The noninvasive, time-saving and easily-cooperated peculiarities of 3D photogrammetry are attracting widespread interest in clinicians. Three-dimensional stereophotogrammetry have been proved to be an accurate and reliable imaging method for use in orthodontics.<sup>17,18</sup> However, major current studies on facial soft tissue attractiveness based on the 3D stereophotogrammetry are still restricted to the line and angle measurements in 2 dimensions. Parts of the face but few as a whole were fully assessed.<sup>15,19</sup> In addition, soft tissue characteristics of attractive Chinese Han population and the discrepancy between genders and interethnic valuations have not been fully studied.

In the last half century, the concept of “average” has been utilized wildly in orthodontics, and enormous average data are considered to be superior to demonstrate facial skeletal characters;<sup>20</sup> however, the characters of facial soft tissue, playing a vital role in the diagnoses and evaluations of treatment outcome, were rarely expressed with the average face due to the limit acquisition and information processing of faces in three dimensions.

Thus, the aim of the present study is to

1. find out a visible way relying on the average face to describe the soft tissue characters of attractive Chinese Han population in three dimensions;
2. Assess whether there is a discrepancy between genders;
3. whether different inclination exist between the Chinese and the Indian evaluators when judging facial attractive.

## MATERIALS AND METHODS

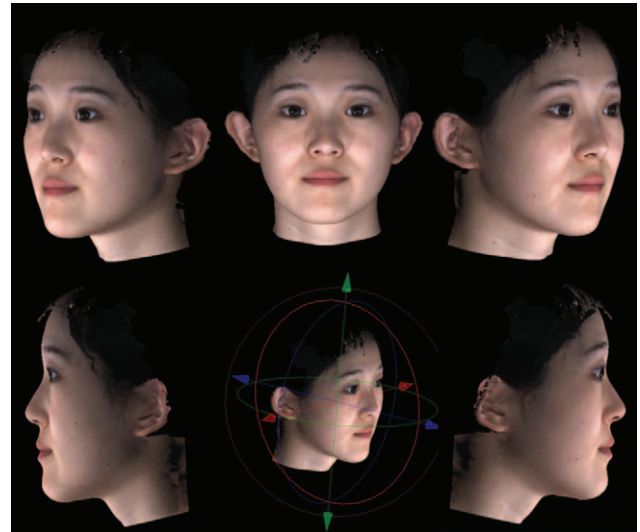
The whole study process can be described in following 5 steps:

### The Sample Population

Ethical approval was obtained from the Ethics Committee of the stomatology hospital of the Nanjing Medical University. Informed consent of all samples has been achieved. Four hundred ten individuals, including 242 females (mean age 23.0 years) and 168 males (mean age 22.1 years) were recruited in this study. The inclusion criteria as follows: Chinese Han people in a good general health; aged between the age of 18 and 32 years; with no obvious facial acne, craniofacial trauma or severe skeletal deformity; with body mass index scores between 18 and 25.

### Three-Dimensional Stereo-Photogrammetry Acquisition of the Samples

The 3dMDface system (3dMD, Atlanta, GA), a structured light system based on the stereophotogrammetry and the structured light technique, was utilized in this study to take the initial images of



**FIGURE 2.** ALL samples were adjusted by panning and rotating to process an average face in a three-dimensional coordinate.

samples (Fig. 2). The accuracy and reliability of the 3dMDface system have been proved with a relative accuracy less than 0.5 mm and it can be a widespread facility for diagnosis and research in clinic.<sup>21</sup> With 3 cameras at both the left and right side of the subjects, an ear-to-ear facial image surface can be captured in .OBJ file format in less than 0.5 second. While being taken, the subjects were sitting still on a chair in a natural head position, with their mandible in a relax postural position and their eyes focusing on a distinct point. Several images would be taken until a clear facial surface with no holes or fissures was achieved. In addition, all subjects were not allowed to make up the day they were captured.

### The Evaluators and the Scaling

The facial surfaces of 410 samples were divided into 14 groups randomly, from 28 to 32 in each. The data were imported into the 3dMDpatient software (3dMD, Atlanta, GA) and evaluators can have an all-round view of every facial surface. Seventeen students from Nanjing medical university, with no orthodontic background, including 8 Chinese (mean age 22.5 years) and 9 Indians (mean age 21.4 years) were invited as 2 panels to assess the attractiveness of each sample based on their own first impression. The assessing procedure was reliant on the VAS from 1 (the least attractive) to 10 (the most attractive). Each view process was limited to two minutes, a suitable time length for an overall view and beneficial to the avoidance of aesthetic fatigue. And then evaluators typed in their marks in a pre-created sheet. Moreover, after all samples have been marked, the evaluators had to remark 28 samples selected beforehand, each group having 2 samples, to ensure the numerical stability of every evaluator.

### The Average Face Construction

In total, 6970 scores of 410 samples were obtained. The VAS outcome of 3 evaluators (1 Chinese and 2 Indians) were recruited for their poor consistency. As a result, total scores of every subject was integrated (see Supplemental Digital Content, Table 1, <http://links.lww.com/SCS/A617>) and the former 30 male subjects and the former 30 female subjects in 2 evaluation groups (the Chinese evaluation group-CG; the Indian evaluation group-IG) were picked out respectively—the former female subjects in CG (FCG); the former male subjects in CG (MCG); the former female in IG (FIG);

the former male in IG (MIG). These 120 facial surfaces were imported into the 3dMDface software and 4 average face shells were constructed to represent the most attractive facial morphology from the view of the above 2 evaluation groups, encompassing the average face of FCG (AFCG), the average face of MCG (AMCG), the average face of FIG (AFIG) and the average face of MIG (AMIG). Several steps are compulsory as follows to construct an average face:<sup>22</sup>

1. importing all based facial surfaces (in .OBJ file format) needed;
2. cutting redundant facial surfaces along the smooth line of facial margin;
3. taking the three-dimensional coordinate axials as reference, panning and rotating each facial surface to meet following requirements: in a natural head position; no obvious inclination; the positions of every subject along x, y, z coordinate axials are consistent (Fig. 3);
4. four landmarks (the Nasion, the Pogonion, the right Exocanthion and the left Exocanthion in this experiment) are demanded to improve the stability and accuracy of the averaging process;
5. Processing the average procedure (Command -3dMD Analysis-Average Face).

### Color Map Analysis

In order to illustrate the deviations among these 4 subgroups, their average faces were imported into the Geomagic Control software (Geomagic Control 2014, 3D Systems Inc, Cary, NC) to instruct color maps. Four panels of groups were analyzed: AMCG versus AMIG, AMCG versus AFCG, AFCG versus AFIG, AMIG versus AFIG. As a result, color histograms and fold line diagrams, describing the distributions and the quantities in millimeter of differences between two shells, were generated (Fig. 4).

### Ratio Analysis

In this study, for purpose of finding the proportion rules in these 4 average facial shells, in virtue of 20 soft tissue landmarks in a three-dimensional ordinate system (Fig. 1), 17 linear measurements and 13 curve measurements were carried out by the 3dMDface system (3dMD, Atlanta, GA). 14 ratios were calculated in Supplemental Digital Content, Tables 4 and 5, <http://links.lww.com/SCS/A620> and <http://links.lww.com/SCS/A621>.

## RESULTS

### The Visualized Average Faces

Four average faces were constructed as shown in Figures 4 and 5. Both male and female faces show infant-like shapes.

### The Color Maps

Two male face shells both emerged larger facial shapes than females. Analogous butterfly-like lineaments, reflecting the differences between genders were founded in Figure 6. Attractive men

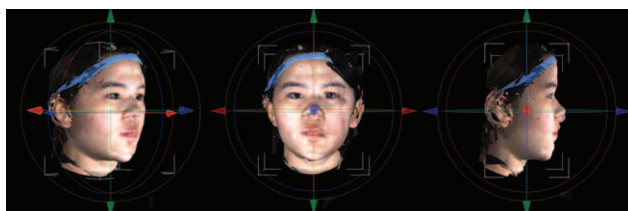


FIGURE 3. a–d show the average faces of AFCG, AFIG, AMCG, and AMIG.



FIGURE 4. a–d show the average faces of AFCG, AFIG, AMCG, and AMIG in grayscale images.

were apt to have a tall and straight bridge of the nose and a prognathous chin while attractive women tend to manifest an infant-like character, which includes plump cheeks, petite mouth and nose. Moreover, women had more protrusive eyelids than men. Specially, among the lip area, from the view of Chinese evaluators, attractive women showed thicker morphology than attractive men while in Indian evaluators' viewpoint, magnetic women shared similar lip fullness with men.

When it comes to the comparison of AMCG versus AMIG, in general, comparable types of faces were founded but a larger face was considered esthetically pleasing by the Indian evaluators. Except of this, obvious discrepancies were discovered among the mouth especially the lower lip, where the total average discrepancy were about 2.0 mm while other parts of the face shell deviated less than 1.0 mm.

The color map deviation of AFCG versus AFIG, which respectively represented the aesthetic tendency towards Chinese attractive females of the Chinese and the Indian evaluators, were showed in Figure 6b. Absolutely, 2 facial shells, sharing an identical face contour, deviated from each other less than 1.0 mm except for the region of nose and the center of upper and lower lips. With respect to the attractiveness of

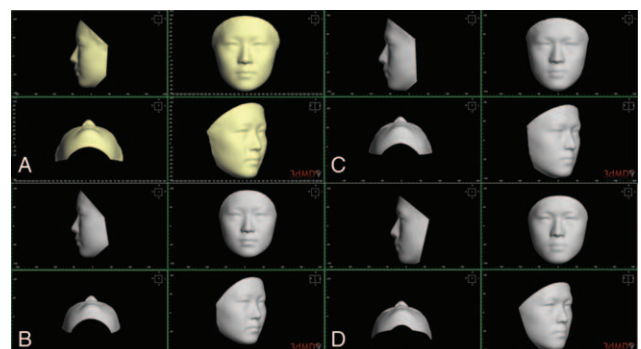


FIGURE 5. Four color maps illustrating the deviation of AMCG versus AMIG, AFCG versus AFIG, AMCG versus AFCG, and AMIG versus AFIG as the a–d show.



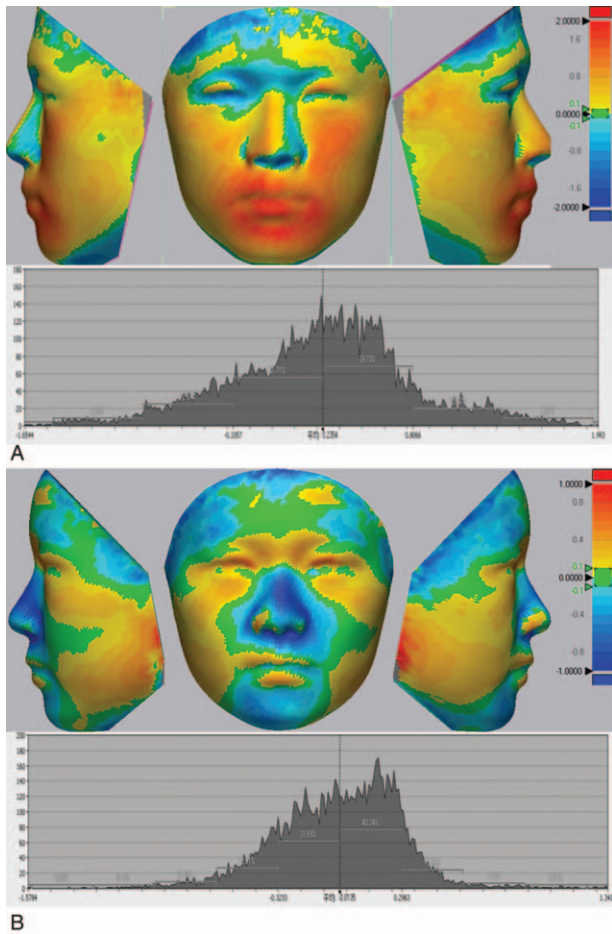


FIGURE 6. Sixteen soft tissue landmarks were marked.

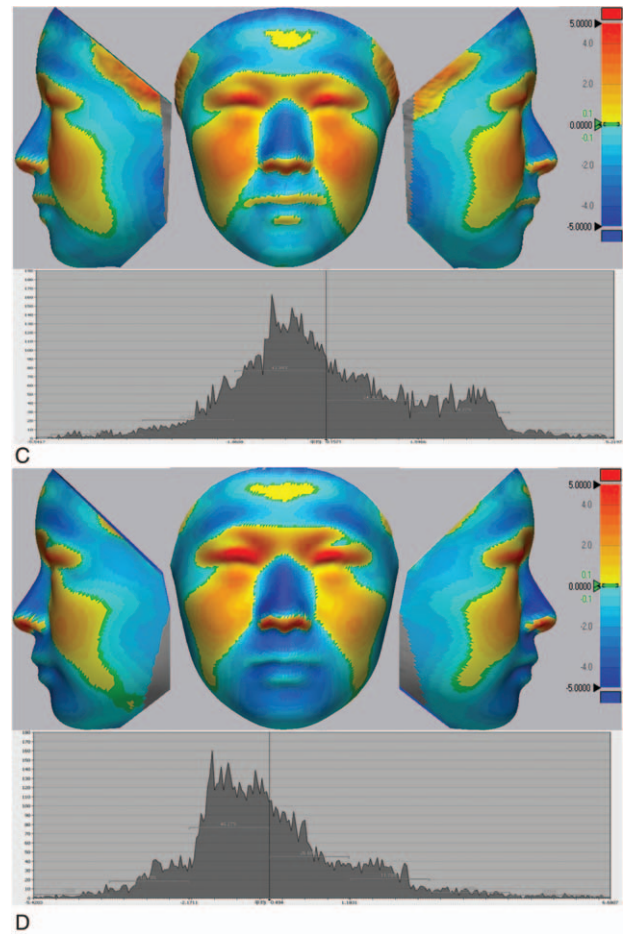


FIGURE 6. Continued.

females, the Indian evaluators inclined to prefer a delicate nose with lower nose ridge but a protrusive lower lip.

### Linear and Curve Measurements and Ratio Analysis

The outcome of linear and curve measurements were consistent with the color map manifested (see Supplemental Digital Content, Tables 2 and 3, <http://links.lww.com/SCS/A618> and <http://links.lww.com/SCS/A619>). The attractive males and females that the Indian evaluators preferred both had a prominent upper and lower lip but a higher nasal prominence, and these differences were limited in 0.5 mm on females while males' deviation was about 0.8 mm. When it comes to facial height analysis, in Indians' opinions, both beautiful males and females had a shorter total facial height but a longer lower facial height than Chinese evaluators preferred. From the view of the Chinese evaluators, on average, attractive females had a shorter lower lip-chin height and a mouth 0.36 mm smaller than the Indians desired but a little longer nasal height. On the contrast, males with a longer nose but shorter mouth and lower lip-chin height were selected as an alternative by the Indians. In the aspect of facial width analysis, the parameters of facial width showed that Indians valued males with wider faces and females having slender faces more highly. Nevertheless, both charming males and females had smaller lower facial width.

Several ratios were calculated in this study, as described in Supplemental Digital Content, Tables 4 and 5, <http://links.lww.com/SCS/>

A620 and <http://links.lww.com/SCS/A621>. It was interesting to find that no significant discrepancy was founded in these proportions and 4 average faces shared similar ratio relations.

### DISCUSSION

It cannot be denied that facial appearance has a profound influence on our life and occupation opportunities. Same types of faces always reflect abundant information about similar characters; and even physiological health situation can be detected accurately from one's face.<sup>23</sup> All folks want to appear more charming which will do a great favor to their private and working life. But it has been proved that facial esthetics changed with time<sup>7</sup> and the preference of facial esthetics were influenced by many factors such as age, gender, demographic origin, media exposure to ideal faces, and different educating background.<sup>6,9</sup> As a result, before actions taken to improve the facial attractiveness of patients searching for orthodontic or orthognathic surgery treatment, explicit diagnosis and the inclination of facial esthetics from patients themselves need to be proposed.

With the trend of globalization, each orthodontist may have a chance to face patients from different races. So we should place more emphasis on esthetic difference between different ethnic groups.<sup>24</sup> Asian-Chinese individuals with bimaxillary retrusive profiles were considered more attractive than people with protrusive mandible and bimaxillary protrusive profiles among folks immigrate to north America and Australia community from a white

perspective<sup>25</sup>, and this is a possible evidence that living environment would influence the preference esthetics. What is more, numerous scholars have harbored the opinion that differences in perception of esthetic do exist among different judges.<sup>6</sup> So, 2 panels of laypersons constituted from 8 Chinese and 9 Indians respectively in Nanjing medical university were recruited as evaluators in this study to seek for the differences in esthetic inclination between different races.

Seden Akan et al found that attractive people do not always have a class I occlusion<sup>26</sup>, so a wide range of faces were inclusive as initial samples in this research, not divided by the Angle's classification. Not like former studies in which the evaluators usually make their decision just upon several photos, evaluators in our research can judge the faces through all of the directions; they can rotate the 3D faces from left to right, from up and down, which made the evaluation more precise than before. Although an army of studies concentrated on the characters of beautiful faces based on a linear or angle analysis, few visualize facial model was created. It still has not been clarified what a beautiful face looks like. By feat of the tridimensional analysis, 4 average faces constructed in this research manifested a visual understanding of facial attractiveness.

From the map analysis and linear measurements between genders in our study, attractive males tend to own a wider, longer face but a narrower zygomatic zone along with a mild thicker upper and lower lip and a more protrusive nose and chin than females, which is in accordance with the result of Ankur Gupta.<sup>27</sup> Accounting to Vijayalakshmi S, abundant subcutaneous fat in cheek region may explain why females had a thicker soft tissue depth in this region.<sup>28</sup> In their experiment about soft tissue thickness in Xinjiang's Han population, Jierui Wang also found that at each measurement point, male has thicker soft tissue than female except for the zygomatic area.<sup>29</sup> It was proved that anatomical differences, soft tissue thickness may account for the facial morphology differences between genders. Among those, vertical skeletal differences may account for a great proportion,<sup>30,31</sup> but to what extend the hard tissue and soft tissue influenced the facial morphology are still under debate.<sup>32</sup>

Not like our study, from the perspective of Jen Soh et al, a flatter male profile was considered to be more attractive by orthodontists and oral surgeons, and the numbers of years in orthodontic practice affect the perception of attractiveness.<sup>33</sup> This discrepancy may due to the different evaluators and different patterns of sample manifestation: in their study, some professional specialists were invited to rank a series of profile photos. But in our study, samples presented in a tridimensional manner were rated by laypersons, which is a pragmatic method to reappear the overall composition of faces expected to be evaluated and acquire the exact information about facial esthetics from general population.

In this study, 4 average faces' profiles all met the E line standard created by Ricketts. This result was inconsistency with some other researches, such as Qingjuan Shi, who reported that Chinese prefer the concave facial profile;<sup>34</sup> Macias, GA, who concluded that in young Spanish population, attractive females tended to present a convex profile than males and all attractive individuals had lips inside the Ricketts' E line;<sup>35</sup> Ioi, H et al, who found a slightly convex profile was more acceptable than a concave profile in Japan.<sup>36</sup>

Numerous scholars dedicated to the findings of aesthetic tendencies among different racial evaluators, and this article aimed at ascertaining if any discrepancy exists between the Chinese and the Indian. As a result, little variance on the females' holistic average face types was found between these 2 races. With an average difference about 0.01 mm, 71.93% of the full facial soft tissue deviated lower than 0.3 mm while the area of nose and lips differs upon 0.5 mm. This implied that both Chinese and Indian had a similar preference of female facial types, but Indians were apt to a

lower nose bridge and fuller lips. When it comes to males, 71.44% of the whole facial soft tissues have a discrepancy between -0.34 mm to 0.81 mm with an average deviation of 0.24 mm. Indians tended to prefer a little wider face compared to Chinese, with the area of upper and lower lips thicker than Chinese desired, which deviated about 2 mm inferred from the color map. This phenomenon may be explained by 2 findings. According to Arnett soft tissue analysis by Shikha Singh<sup>37</sup>, Indians have thicker upper lip and a less nasolabial angle than Caucasians; both males and females have more convex profile than Caucasians, which was in agreement with the result of Ankur Gupta.<sup>27</sup> Combined with previous studies, Indians evaluators in our study seemed to be apt to the appearance resemble to themselves. However, few studies have probed into the regularity in the relationship between individuals' own facial characters and their preferred facial traits.

Some previous research put forward that proportion was a better way to illustrate the facial structure among different races<sup>38</sup> and attractive facial structures always satisfy a golden ratio (0.618 or 1.618) or some special proportional relations ( $\sqrt{2}$ ). We wondered if they also exist in the 4 average faces in this study. As a result, several ratios were calculated, as shown in Supplemental Digital Content, Tables 4 and 5 (<http://links.lww.com/SCS/A620> and <http://links.lww.com/SCS/A621>). However, no ratio about these 4 attractive faces met the above criteria and analogical outcome was founded by several investigators.<sup>26,39,40</sup> In contrast to this, most of the facial proportions of attractive females in the North-Indian population were close to the divine proportion in a previous research.<sup>41</sup> It may be suspected that specific ratios may have a high correlation with races. However, what is noticeable is that 4 average faces shared adjacent ratios on the above 7 ratio parameters except curve measurements in males. Scholars found that when the nasal height was 36% of the whole facial height and the distance between eyes is 46% of the facial width, the individual would be regarded as an attractive person.<sup>42</sup> Similar phenomenon but different norm was found in our study. If there exists a specific ratio norm other than the divine proportion need more studies to excavate.

There is a long story about the relationship between averageness and attractiveness. The theory based on information processing and cognitive averaging has been fully accepted. From the perspective of this theory, faces with a higher consistency with the prototype face assume to be more attractive.<sup>43</sup> As Neelam A Vashi stated, beautiful faces are more prototypical of, more representative of, and better examples of, a population of faces.<sup>44</sup> Although some investigations held that faces accompany with special features would be rated more magnetic than the average face, and some emphasized that the average face likely plays a role in face recognition rather than in judgments of facial attractiveness,<sup>45</sup> a growing number of researches have proved that resemble to a facial prototype is prerequisite to be attractive.<sup>46</sup> Furthermore, it has been reported that inclination of averageness is a cross-cultural neurobehavioral response. In our study, 4 average faces were created from 4 panels of attractive samples, and these 4 average faces would be excellent prototypes of Chinese from the view of Chinese and Indian laypersons. It is worthy to attempt to develop a facial prototype in 3 dimensions which can reflect an esthetic preference of different races and areas.

Some deficiency in this study are as follows: limited evaluators from Chinese and India individual in a circumscribed region instead of various population led an incomplete analysis; sometimes unclear borderline of the average face results in an inaccurate measurement; different averaged faces constructed from different face sets are highly perceptually similar imply that this averaging analysis may be suitable for a composite face but not a particular point or limited region; some specific features of attractive individuals may be covered up during the averaging process.

## CONCLUSION

- Average face based on stereophotogrammetry is a feasible method to analyze the facial characters;
- Discrepancy of esthetic preferences towards Chinese population exist between Chinese and Indians, specially centered on the area of upper and lower lips and nasal ridge; obvious difference were not found among the chin region.
- Attractive males tended to exhibit a wider, longer face but narrow zygomatic zone along with a mild thicker upper and lower lip and a protrusive nose and chin compared to females.

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