

# An Anthropometric Study of the Morphologic Facial Index of Tibetan Youth in Tibet

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**Abstract:** The purpose of this study was to understand sex differences and variations in facial indices among Tibetans and to create and evaluate anthropometric data on facial morphology. The study population consisted of 476 native Tibetans (241 males and 235 females) aged 18 to 24 years. The means and SD facial width was  $133.53 \pm 7.31$  mm for males and  $133.95 \pm 8.10$  mm for females; the difference between the sexes was not statistically significant. The means and SD facial height was  $107.68 \pm 5.76$  mm for males and  $111.95 \pm 14.28$  mm for females; the difference between the sexes was statistically significant ( $u = -8.394$ ,  $P = 0.000$ ). The morphologic facial index was  $80.86 \pm 5.82$  (means  $\pm$  SD) for males and  $83.91 \pm 11.90$  (means  $\pm$  SD) for females; the difference between the sexes was statistically significant ( $u = -6.581$ ,  $P = 0.000$ ). The proportion of the Tibetan male facial shape was hypereuryprosopic (45.6%) > euryprosopic (31.1%) > mesoprosopic (18.7%) > leptoprosopic (3.3%) > hyperleptoprosopic (1.2%). The proportion of the Tibetan female facial shape was hypereuryprosopic (25.5%) > mesoprosopic (22.6%) > euryprosopic (21.7%) > leptoprosopic (17.4%) > hyperleptoprosopic (12.8%). Facial width was positively correlated with height (male  $r = 0.306$ ,  $P = 0.000$ ; female  $r = 0.144$ ,  $P = 0.027$ ), weight

( $r = 0.470$ ,  $P = 0.000$  for males;  $r = 0.337$ ,  $P = 0.000$  for females), and BMI ( $r = 0.378$ ,  $P = 0.000$  for males;  $r = 0.291$ ,  $P = 0.000$  for females). Facial height was positively correlated with height ( $r = 0.329$ ,  $P = 0.000$  for males;  $r = 0.137$ ,  $P = 0.035$  for females) and weight ( $r = 0.391$ ,  $P = 0.000$  for males;  $r = 0.170$ ,  $P = 0.009$  for females). Facial height was positively correlated with BMI in Tibetan males ( $r = 0.293$ ,  $P = 0.000$ ), but no significant correlation was found in Tibetan females. The morphologic facial index of Tibetans was positively correlated with age ( $r = 0.183$ ,  $P = 0.004$  for males;  $r = 0.171$ ,  $P = 0.009$  for females). The results indicated that Tibetan youth in Tibet have a predominantly hypereuryprosopic facial shape and that facial features are related to age, height, and weight. Some common facial morphology features exist among the Tibetans, north-eastern Indians, and Nepalese in the 3 different regions of the Sino-Tibetan language family. The data from this study provide basic information for the study of Tibetans in the fields of physical anthropology, forensic medicine, maxillofacial surgery, and plastic surgery.

**Key Words:** Anthropometry, facial height, facial width, morphologic facial index, Tibetan population

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The morphologic facial index is an index of the head and face in physical anthropology. It primarily reflects the facial features of humans, thereby revealing the similarities or differences of facial features among different races or ethnic groups. The morphologic characteristics of the face are related to age,<sup>1</sup> sex,<sup>2</sup> race,<sup>3</sup> geography,<sup>4</sup> climate,<sup>5</sup> and genetics.<sup>6</sup> Human cephalofacial features are the result of a long history of adaptation to the environment in which humans live,<sup>7</sup> with genetic factors playing an intrinsically dominant role.<sup>8</sup> In the field of physical anthropology, differences in cephalofacial features are reflected not only between different human races<sup>9</sup> but also between humans of the same race in different regions<sup>10,11</sup> and between different ethnic groups of the same race in the same region.<sup>12</sup>

East Asians make up the largest proportion of the Asian population. East Asians are predominantly of Mongolian ethnicity, and Han Chinese, Yamato Japanese, Korean, and Mongolian are the primary ethnic groups in China, Japan, Korea, and Mongolia, respectively. A large amount of adult facial anthropometric data is available for the Han Chinese,<sup>13,14</sup> the Japanese,<sup>15,16</sup> and Koreans<sup>17,18</sup> in East Asia. However, these data cannot be generalized to other ethnic groups in China; thus, it is important to establish facial anthropometric data for the Tibetan population in China. This population is primarily distributed in the Tibet Autonomous Region and Qinghai, Gansu, Sichuan, and Yunnan Provinces. The total population of Tibetans in China exceeds 7 million, of which about 44.44% are concentrated in Tibet.<sup>19</sup> In addition,

Tibetans are also found in South Asia, North America, Europe, and Australia.

The modern Tibetan population is closest in terms of physical characteristics to the East Asian type of the Mongolian population.<sup>20</sup> There is a large body of literature on the anthropology of Tibetan body characteristics<sup>21,22</sup> and composition<sup>23,24</sup> but a smaller body of literature on Tibetan facial types. The aim of this study is to assess the morphologic facial indices of the Tibetan population and to identify the different facial shapes and sex differences by measuring their facial indices, thereby providing basic data for research in the fields of physical anthropology, forensic medicine, maxillofacial surgery, and plastic surgery for this population.

## MATERIALS AND METHODS

### Ethics Statement

This study was performed in accordance with the ethical rules of the Helsinki Declaration. All the procedures used in this research were approved by the Ethics Committee, General Hospital of Tibet Military Region (NO.2022XZZYYKY-005).

### Study Participants

In this study, Tibetan university students who voluntarily gave informed consent were the study participants. Data were collected at the General Hospital of Tibet Military Region. All participants were native to Tibet for many generations and were examined by clinicians to exclude those with head and facial deformities, trauma, or physical or developmental abnormalities. A total of 476 individuals (241 males and 235 females) aged 18 to 25 years were investigated.

### Methods and Definitions

A Martin anthropometer was used to measure height, an electronic scale was used to measure weight, and the body mass index (BMI) was calculated as weight (kg)/height (m)<sup>2</sup>.

A curved caliper was used to measure facial width (zy-zy, M6), which was defined as the straight distance between the most laterally placed zygia (zy) when the head is oriented in the eye-ear plane.

A straight caliper was used to measure the facial height (n-gn, M18), which was defined as the straight distance between nasion (n) to gnathion (gn) when the head is oriented in the eye-ear plane.

The morphologic facial index is calculated as morphologic facial height (n-gn)/facial breadth (zy-zy)×100. Banister's classification of facial types<sup>25</sup> was applied based on the morphologic facial index (Supplementary Digital Content, Table 1, Supplemental Digital Content 1, <http://links.lww.com/SCS/F543>).

### Statistical Analysis

IBM SPSS Statistics 26.0 software was used for data processing (IBM SPSS Statistics 26, IBM, Armonk, NY, USA). All data were tested for normality and homoscedasticity. The Mann-Whitney *U* rank-sum test was used to compare data between the 2 groups. Spearman's rank correlation was used for correlation analysis. All statistical tests were 2-sided. Differences with *P* < 0.05 were considered statistically significant.

## RESULTS

The mean age of the 476 Tibetan university students was 20.38 ± 1.70 y. The 241 Tibetan males had a median height, weight, and BMI of 1.71 m, 58.64 kg, and 20.06, respectively. The 235 Tibetan females had a median height, weight, and BMI of 1.65 m, 51.02 kg,

and 20.06, respectively. The differences in 2 measures between the sexes were statistically significant (height: *u* = -16.703, *P* = 0.000; weight: *u* = -10.834, *P* = 0.000; Supplementary Digital Content, Table 2, Supplemental Digital Content 2, <http://links.lww.com/SCS/F544>).

### Facial Width

Mean facial width was 133.53 ± 7.31 mm for males and 133.95 ± 8.10 mm for females; the difference was not statistically significant (Supplementary Digital Content, Table 2, Supplemental Digital Content 2, <http://links.lww.com/SCS/F544>).

### Facial Height

Mean facial height was 107.68 ± 5.76 mm for males and 111.95 ± 14.28 mm for females; the difference was statistically significant (*u* = -8.394, *P* = 0.000; Supplementary Digital Content, Table 2, Supplemental Digital Content 2, <http://links.lww.com/SCS/F544>).

### Morphologic Facial Index

The mean morphologic facial index was 80.86 ± 5.82 for males and 83.91 ± 11.90 for females; the difference was statistically significant (*u* = -6.581, *P* = 0.000; Supplementary Digital Content, Table 2, Supplemental Digital Content 2, <http://links.lww.com/SCS/F544>).

### Face Type

The facial type of Tibetan males was primarily hyper-uryprosopic (45.6%), followed by euryprosopic (31.1%), meso-uryprosopic (18.7%), leptoprosopic (3.3%), and hyperleptoprosopic (1.2%; Table 3). The facial type of Tibetan females was primarily hypereuryprosopic (25.5%), followed by mesoprosopic (22.6%), euryprosopic (21.7%), leptoprosopic (17.4%), and hyperleptoprosopic (12.8%; Supplementary Digital Content, Table 3, Supplemental Digital Content 3, <http://links.lww.com/SCS/F545>).

### Spearman Correlation Analysis

Male facial width was positively correlated with height (*r* = 0.306, *P* = 0.000), weight (*r* = 0.470, *P* = 0.000), and BMI (*r* = 0.378, *P* = 0.000). Facial height was positively correlated with height (*r* = 0.329, *P* = 0.000), weight (*r* = 0.391, *P* = 0.000), and BMI (*r* = 0.293, *P* = 0.000). Morphologic facial index was positively correlated with age (*r* = 0.183, *P* = 0.004; Supplementary Digital Content, Table 4, Supplemental Digital Content 4, <http://links.lww.com/SCS/F546>).

Female facial width was positively correlated with height (*r* = 0.144, *P* = 0.027), weight (*r* = 0.337, *P* = 0.000), and BMI (*r* = 0.291, *P* = 0.000). Facial height was positively correlated with height (*r* = 0.137, *P* = 0.035) and weight (*r* = 0.170, *P* = 0.009). Morphologic facial index was positively correlated with age (*r* = 0.171, *P* = 0.009; Supplementary Digital Content, Table 4, Supplemental Digital Content 4, <http://links.lww.com/SCS/F546>).

## DISCUSSION

The present study found that the mean height of Tibetan males and females is slightly higher than reported by Xi et al.<sup>26</sup> This may be related to the adequate dietary intake of the Tibetan population in recent years, as studies have shown that there is a close relationship between nutritional status and physical development, whether living at high or low altitudes.<sup>27</sup> The mean height of Tibetans in the present study is comparable to the average height of Han Chinese.<sup>28</sup> With respect to BMI, the range of BMI was 16.16 to 29.76 in Tibetan males and 14.42 to

29.63 in Tibetan females, and the extremes suggest a double burden of both undernutrition and overnutrition. This is consistent with the findings of Peng et al<sup>29</sup> and indicates that the Tibetan university student population exhibits nutritional imbalance.

In general, for the majority of a population in the same ecological environment, males tend to be taller and heavier than females. The results of the present study also showed that the height and weight of Tibetan males are greater than those of Tibetan females. We showed that Tibetans' facial width and height are positively correlated with height and weight, and facial size or facial soft tissue thickness also increases with increasing BMI.<sup>30</sup> Li et al<sup>31</sup> concluded that due to genetics, increasing age, nutritional level, and physiological status, the composition and content of soft tissues in humans change significantly more than bony tissues in adulthood, and accumulation of body fat and slow structural changes in the bone tissue and bone joints gradually cause changes in the external morphology of the human body. The results of the present study also showed that the facial width and height of Tibetans increased with increasing height and weight.

In the present study, we showed that Tibetans have a predominantly hypereuryprosopic facial shape (35.6%), followed by euryprosopic (26.4%) and mesoprosopic (20.5), consistent with Bhasin et al's<sup>32</sup> description indicating that Mongolian races have broader faces. Cephalofacial morphology is a genetic trait formed by complex morphologic combinations, and different groups have significant differences in cephalofacial characteristics, which are closely related to human origins, migration, and evolution.<sup>33</sup> Currently, the different human races on Earth are, in fact, geographical human races formed by long-term and continuous adaptation within a certain range of natural environments. The Tibetan people in Tibet, the peoples of northern and northeastern India, and the Nepalese people are mostly concentrated on both sides of the Himalayas, from the Vindhya Range to the south to the Kailash Range to the north.

Fulwaria et al<sup>34</sup> studied the facial types of Tibetans in Rajasthan in northern India and found that they predominantly have the euryprosopic facial type (70%) followed by the mesoprosopic type (25%). This is similar to the results of the present study, but the difference is that there was no hypereuryprosopic facial type among Tibetans in Rajasthan. Moreover, in India, north Indians (Uttar Pradesh) have predominantly euryprosopic facial types (53.2%) followed by mesoprosopic (21.6%) facial types, nearly identical to the Tibetans of Rajasthan.<sup>35</sup> The facial characteristics of central Indians differ significantly from those of northern Indians, with central Indians (Madhya Pradesh) having a predominantly hyperleptoprosopic facial type (79.5%) and no euryprosopic or hypereuryprosopic facial types observed.<sup>36</sup> In contrast, the facial characteristics of the population located in northeastern India differ from those of all other parts of India, with northeastern Indians (Manipur) having predominantly mesoprosopic (30.1%) and leptoprosopic (30.1%) facial types, followed by hyperleptoprosopic (14.6%) and hypereuryprosopic facial types (7.7%).<sup>37</sup> India is the largest country in South Asia, spanning about 29 degrees of latitude and longitude (8°24'–37°36' N, 68°7'–97°25' E) from Tamil Nadu at the southeastern tip to Punjab in the northwest, and genetic and ecological adaptations may be responsible for the large differences in face shape among northern, central, and northeastern Indians.

In addition to Indians, Nepalese also have a predominantly mesoprosopic facial type (38.7%), followed by euryprosopic (29.3%), leptoprosopic (23.3%), and hyperleptoprosopic types (0.3%).<sup>38</sup> Northeast India and Nepal are close to Tibet, and not

only are their predominantly mesoprosopic and/or euryprosopic facial type characteristics similar to those of north Indians, but the presence of a certain proportion of leptoprosopic and hyperleptoprosopic types is also similar to that seen in Tibetan people in Tibet. This may be related to 2 factors. (1) The first is genetic similarity. Through genome-wide data analysis of ancient human samples obtained from high-altitude sites on the southern edge of the Tibetan Plateau in Nepal, Liu et al<sup>39</sup> found that these Nepalese were very closely related to modern-day Tibetans. Su et al<sup>40</sup> analyzed the genetic structure of 31 Sino-Tibetan language-speaking populations living in East, Southeast, and South Asia using 19 Y-chromosome biallelic markers and 3 Y-chromosome microsatellite markers. They found H8 (a haplotype derived from M122C) in the Himalayan region (including Tibet and northeastern India) in Sino-Tibetan language-speaking populations at an extremely high frequency, suggesting a strong bottleneck effect during the westward and then southward migration of Tibeto-Burman language-speaking founder groups. (2) The second factor is adaptation to the natural environment. Buretić-Tomljanović et al<sup>4</sup> suggested that the average sunshine duration is inversely proportional to the morphologic facial index; that is, the longer the average sunshine duration in a region is, the lower the morphologic facial index in that region. Tibet is the region in China with the most solar radiation energy, with an average annual sunshine duration of 1600 to 3400 hours;<sup>41</sup> this climatic adaptation may explain the euryprosopic facial type of Tibetans. An additional climatic factor may be that the lower temperature and atmospheric pressure in Tibet is related to Tibetans' relatively large nasal cavity.<sup>42</sup>

Academics often use anthropometry to study the physical types of modern populations.<sup>43</sup> The physical characteristics of modern Chinese people can be divided into northern and southern groups using the Yangtze River as the boundary<sup>44</sup> or into southern, northern, and Tibetan-Yi corridor types.<sup>45,46</sup> In the present study, the predominantly hypereuryprosopic and euryprosopic features of Tibetans are slightly similar to the results of the study of Tibetans (Tibet) by Lu et al<sup>47</sup> (28.8% euryprosopic in males and 33.3% euryprosopic in females). They also conducted a comparative study of the Han Chinese (Jiangsu), Li (Hainan), and Uyghur (Xinjiang) ethnic groups; the data showed that Han Chinese are predominantly hypereuryprosopic and that Tibetans have the narrowest faces compared with the other ethnic groups. In contrast, Yu et al<sup>48</sup> concluded that both male and female Han Chinese in northern China are predominantly hyperleptoprosopic (32.3% for males and 37.0% for females), whereas male Han Chinese in southern China are predominantly euryprosopic (26.0%), and females are predominantly leptoprosopic (25.9%). Through clustering analysis of cephalometric data, Du et al<sup>49</sup> showed that Tibetans are closer to northern ethnic groups such as Daur, Mongols, Oroqens, and Han Chinese in Gansu, Liaoning, and Shanxi.

Regardless of whether the Tibetan face type is closer to the northern or southern Chinese group, it exhibits Sino-Tibetan homology from a genetic perspective.<sup>50–52</sup> Tibetans, Han Chinese, and the northeastern Indians and Nepalese mentioned previously all belong to the Tibeto-Burman language group of the Sino-Tibetan language family in terms of linguistic affiliation. The Sino-Tibetan language family is the second largest language family in the world after the Indo-European language family, and there has been controversy regarding its phylogeny and the depth of its initial differentiation.<sup>53</sup> There are 2 major hypotheses: the "northern origin hypothesis" and the "southwestern origin hypothesis." The northern origin hypothesis suggests that the initial expansion of the Sino-Tibetan language

family occurred in the Yellow River basin in northern China about 4000 to 6000 years ago,<sup>54</sup> while the southwestern origin hypothesis suggests that the early expansion of the Sino-Tibetan language family occurred 9000 years ago in a region of Sichuan Province in southwestern China<sup>55</sup> or in present-day northeast India.<sup>56</sup> Although some common facial morphology features exist among the Tibetans, northeastern Indians, and Nepalese in the 3 different regions, an increasing amount of data in recent years supports the northern origin hypothesis of the Sino-Tibetan language family.<sup>57</sup>

In addition to the Chinese, Japanese, South Koreans, North Koreans, and Mongolians live in East Asia. Although the Japanese have a predominantly leptoprosopic facial type, they also have a higher proportion of the hyperuryprosopic facial type (23.6% of males and 23.2% of females),<sup>58</sup> while Koreans tend to have a predominantly leptoprosopic and hyperleptoprosopic facial type,<sup>59</sup> which may be related to their esthetic preferences.<sup>60</sup> Studies have shown that Asian women, as represented by Koreans, prefer a more pronounced taper from the maxilla to the mandible to reduce the prominence of the lower third and create a “V”-shaped face.<sup>61</sup> Currently, the number of nonsurgical cosmetic procedures performed on men is rapidly increasing,<sup>62</sup> and 3D simulations have confirmed that V-shaped lift/standard lift surgery in males leads to feminization of the male appearance.<sup>63</sup> A feminized male appearance in marketing appears to be more readily accepted or preferred by the public in some countries or regions,<sup>64</sup> while the public prefers masculine male faces or feminine female faces in terms of attractiveness of sex appearance.<sup>65</sup> As facial anthropometric data of adult Mongolians in Mongolia have not been identified, the data in the present study were compared with Chinese Mongolians (17 ethnic groups).<sup>66</sup> Tibetan males have narrower facial widths, Tibetan females have moderate facial widths, and morphologic facial heights are lower than in Mongolians for both sexes. A study on the facial characteristics of young Mongolian university students in Inner Mongolia<sup>67</sup> showed that the euryprosopic type was more common in 46.67% of Inner Mongolian males and that 56.67% of females had the hyperuryprosopic type, similar to the results of the present study.

The results of the present study are regional in nature, as Tibet accounts for about one-eighth of the total land area of China, spanning more than 2000 km from east to west and 1000 km from north to south, and differences in the facial features of Tibetan people living in different geographical environments may exist. Thus, further research is needed to reach final conclusions on the facial features and differences that apply to the entire Tibetan population in Tibet.

## CONCLUSION

The results of this study reflect the changing patterns of facial features of Tibetan youth in Tibetan areas as influenced by age, height, and weight. The results showed that the average morphologic facial index of the Tibetan youth population was  $80.86 \pm 5.82$  (means  $\pm$  SD) for males and  $83.91 \pm 11.90$  (means  $\pm$  SD) for females, and the facial type was primarily hyperuryprosopic. Facial width and height were correlated with height and weight, and morphologic facial index was correlated with age. The anthropometric measurements of 476 university students were a limitation of this study. Therefore, when conducting similar studies in the future, a wider age range of subjects should be considered in addition to increasing the sample size. This type of study is important not only in esthetic medicine applications but also for orthodontists, maxillofacial surgeons, plastic surgeons, anatomists, and anthropologists. The data

from this study will provide future reference for other researchers conducting facial morphometric analysis of Tibetans.

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