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Anthropometric Study of the Human Craniofacial Morphology among different castes of Punjab Pakistan

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Abstract

Background: It appears from the literature that there is a research vacuum in craniofacial anthropometric studies in Pakistani population. Therefore, this study was carried out to characterize the craniofacial parameters among different castes of the Punjab Pakistan.

Methods: This cross-sectional study was conducted on population of the Punjab, Pakistan, with age 18-45 years in a normal healthy state and data was collected using a questionnaire. Anthropometric instruments such as standard spreading caliper, round ended caliper, vernier caliper and scale were used for the measurement of craniofacial parameters. Data was analyzed by using SPSS version 20.0 and MS Excel 16. Morphological anthropometry of face, head, nose and ears was observed and noted.

Results: Hyperleptoprosopic face was most common one in the studied population. The dominant nose type was Leptorrhine while the most dominant head shape was Dolichocephalic. The average ear index was 50.42 and 51.19 of right and left ears, respectively.

Conclusion: This data is a base for the anthropometric data bank of the Punjab province of Pakistan. This data is helpful in medico legal cases, forensic investigations, and in facial surgeries. This study is also important for anthropological and forensic research.

Introduction

Anthropometry is a simple and reliable technique for quantifying body size by measuring the length, width and indices [1]. Craniofacial anthropometry is the measurement of the head and face. Among humans, the shape of head and face is one of the most distinctive features, and in the areas such as social interaction, psychology, forensics, and clinical genetics, there are substantial implications of craniofacial morphology [2-5]. Craniofacial complex measurements are of great importance in the studies of medico legal cases, human growth, population variation, clinical treatment, reconstruction and plastic surgeries [6,7]. In measurable characters of body, two persons cannot be alike [8,9] which is likely a reason of anthropologist's interests in studying the variation of inter- and intra-population among different morphological parameters [10-12]. For evaluating these variations, a particular population should be established [13]. Humans have the ability to recognize faces [14].

Although due to recent ongoing developments, the role of DNA technology in human identification is becoming an important forensic tool [15], but to distinguish individual humans from one another, face shape is also one of the best features in human body [5]. The face is used for recognition because it contains a large number of features. Face is the part of a person that we look at while communicating with someone and, this is one of the reasons for opting face as recognition character [16,17]. Thus, there are no top-secrets in using face in forensic sciences for identification [2,18-21].

By craniofacial measurements, types of faces are determined and divided into five international anatomical categories which are Hypereuryprosopic, Euryprosopic, Mesoprosopic, Leptoprosopic and Hyperleptoprosopic [22]. Many factors influence head and face shape, which are gender, race, ethnicity, climate, socio-economic, nutritional, and genetic factors. In medical field, determination of craniofacial parameters is of great importance for evaluating facial trauma, congenital and traumatic deformities [23-25]. Craniofacial anthropometry is a key area for forensic anthropometric studies in human body [26-28]. Accurate facial and head analysis such as facial/head height, facial/head width and facial/head index is essential for diagnosis of genetic and acquired anomalies for the study of normal and abnormal growth and for morphometric investigations. By comparing the changes in craniofacial indices between parents and their offspring and also between siblings, it can give clue to the genetic transmission of human inherited characters [29]. Standard charts should be followed to evaluate the change in the head index and facial index.

Facial (Prosopic) index is relation of maximum facial width between two zygomatic points to the facial height from the point of "nasion" to "gnathion". The Prosopic Index (PI) categorizes individual's face into five (5) groups; Hypereutrophic (very wide faces), Euryprosopic (wide faces), Mesophotic (round), Leptoprosopic (long faces) and Hyperleptous (very long faces). These groups are formed on the basis of face index which is described as ratio of facial length (FL) to facial width (FW). Variations in facial types are found in every population. Studies reveal ethnic differences in face type among individuals [30]. The head index is a measure related to the shape of the skull. Head index is also very useful for detecting individual's racial and gender differences. Cephalic index is the term for Retzius's measures used for classification of cranial morphology of living individuals. Cephalic index when applied to living individuals and for the measurements of dry skull, it is known as Cranial Index [31]. By calculating the ratio between the maximum width of head to the maximum length of head, craniofacial index can be determined. Like prosopic index, cephalic index is also categorized in six (6) groups; Hyperdolichocephalic (very long skull), Dolichocephalic (long skull), Mesocephalic (broad skull), Brachycephalic (short skull), Hyperbrachycephalic (very short skull) and Ultabrachycephalic (very short skull) [32]. Nasal anthropometry, now-a-days, is very important in medico legal cases for investigation purposes and in fashion industry like rhinoplasty and nose reconstruction [25,33-35]. According to Martin and Saller classification of nasal index (NI), the human nose shape is categorized into five (5) groups; Hyperleptorrhine (long narrow nose), Leptorrhine (moderately narrow nose), Mesorrhine (moderate or medium size nose), Platyrrhine (moderately wide nose), and Hyperleptorrhine (very wide nose) [22].

Pakistan is the sixth most populous country in the world. Based on population, among the all provinces of Pakistan, Punjab is the largest province of Pakistan [36,37]. It appears from the literature that there is a research vacuum in craniofacial anthropometric studies in Pakistani population. Therefore, this study was carried out to characterize the craniofacial parameters among the population of the Punjab, Pakistan. This data is a base for the anthropometric data bank of the Punjab province of Pakistan. This data is helpful in medico legal cases, forensic investigations and in facial surgeries. This study is also important for anthropological and forensic research.

Methods

This study was conducted on 500 persons (both male and female) of the Punjab, Pakistan, with age 18-45 years in a normal healthy state. The Institutional Ethical Review Committee (IERC) approved the study. Anthropometric instruments such as standard Spreading Caliper, Sliding Calipers, Vernier Calipers and Scale were used for the measurement of craniofacial parameters. Repeated measurements were employed to ensure accuracy.

The data was recorded on a questionnaire specially designed for this purpose. All subjects were informed briefly about this study, its benefits, and confidentiality of the information or data collected from them. From each of the subject, included in this study, verbal consent was taken. All the subjects were asked to sit relaxed in a well illuminated place, to look forward with their head in an anatomical state. To avoid any error in the measurements, subjects were asked to make their facial muscles in a relaxed state and not in stretched state. Measured parameters were height and breadth of face, length and width of head, length and width of external ears and indices for all of these parameters.

The morphological facial height was measured with round ended Caliper and Scale from nasion (n) to gnathion (gn). Face width was measured as the straight distance between the right and left zygion (zy).

Facial or Prosopic index was determined by using formula:

FI = Facial height /Facial width x 100

The above index was calculated on the basis of international anatomical descriptions. Based on this index, the types of face shapes were classified according to Banister's classification as shown in table 1.

Face shape	Prosopic (Facial) index
Hypereuryprosopic (very broad face)	<79.9
Euryprosopic (broad face)	80–84.9
Mesoprosopic (round face)	85–89.9
Leptoprosopic (long face)	90–94.
Hyperleptoprosopic (very long face)	>95

Table 1: Type of face shape and their prosopic index.

As for the nasal indices, nasal length was measured as the distance between nasion (n) and subnasale (sn), while nasal width was the interalar distance (al-al). All these measurements were recorded in millimeter (mm). The average for all measurements was calculated.

Nasal index was calculated by using the following formula:

NI =Nasal width/Nasal length x 100

Based on the index, the types of nose shapes are categorized as given in table 2.

Head width and length were measured using Spreading Calipers. Cephalic index was computed by the following formula:

CI = Max cranial breadth/Max cranial length x 100

The head shapes were classified according to cephalic indices as shown in table 3.

Standard Vernier Caliper was used for the measurement of ear length and ear width, lobule width and lobule length. Distance from the caudal most projection of the ear lobule to the cephalic most projection of the ear helix was measured as length for both ears. Ear width was measured by taking the distance between the most anterior and posterior points of the external ear. All the variables were measured in mm.

Ear index either REI or LEI was determined by the following formula:

EI = Ear width / Ear length x 100

Nose Shape	Nasal Index
Hyperleptorrhine (long narrow)	40 – 54.9
Leptorrhine (narrow)	<70
Mesorrhine (moderate)	70 – 84.9
Platyrrhine (moderately wide)	85 –99.9
Hyperleptorrhine (very wide)	100 or more

Table 2: Type of nose shape and their nasal index.

Head shape	Cephalic index
Hyperdolichocephalic (very long skull)	65.5 – 69.9
Dolichocephalic (long skull)	70 -74.9
Mesocephalic (broad skull)	75–79.9
Brachycephalic (short skull)	80–84.9
Hyperbrachycephalic (very short skull)	85–89.9
Ultrabrachycephalic (very very short skull)	>90

Table 3: Type of head shape and their cephalic index.

Statistical Analysis

Statistical analysis was done by Descriptive statistics and Student's (independent) *t*-test. All the statistical analysis was done by using SPSS version 20.0 and MS Excel 16.

Results

Data of 500 subjects was taken randomly in this study. Consanguinity statistics of the subjects showed that 3.6% were Khalazad (the child of your aunt), 20% Chachazad (the child of your uncle), 12.7% were Second Cousins, 5.5% Distant Blood Relatives, 38.2% same Caste and 20% belonged to Different Caste (fig. 1). The facial or prosopic index (PI) was classified according to types of face shapes (Table 1). The mean facial (prosopic) index was 98 (table 7). In this study, the minimum facial index was 84.54 and the maximum facial index was 118.75. According to this study 65.5% subjects of Punjab population of Pakistan have Hyperleptoprosopic (very long) face shape, 23.6% have Leptoprosopic (long) face shape and 10.9% have Mesoprosopic (round) face shape (Table 4). Hyperleptoprosopic face was most common one in the studied population (Fig 2).

The nasal index (NI) was classified according to types of nose shapes (Table 2). In this study, the mean nasal index was 66.02. The minimum nasal index was 38.88 and the maximum nasal index was 175.86. According to

this study, the dominant nose type was Leptorrhine (Fig 3). 56.4% subjects of Punjab population of Pakistan have Leptorrhine (narrow) nose shape, 20% have Hyperleptorrhine (long narrow) nose shape, 16.4% have Mesorrhine (moderate) nose shape, 5.5% have Platyrrhine (moderately wide) nose shape and 1.8% have Hyperleptorrhine (very wide) nose shape as shown in table 5.

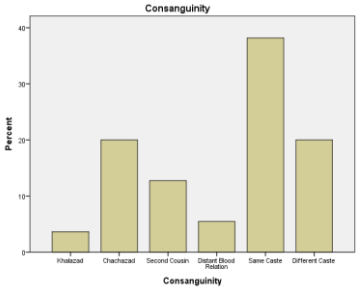

Figure 1: Consanguinity Status of the given population.

Face Shape	Percent (%)
Hyperleptoprosopic	65.5
Leptoprosopic	23.6
Mesoprosopic	10.9

Table 4: Face Shape of Pakistani (Punjab) population on the basis of Prosopic Index (PI).

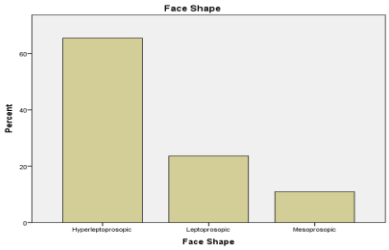

Figure 2: Face Shape Distribution Chart of the given population.

Nose Shape	Percent (%)
Hyperleptorrhine	20.0
Hyperplatyrrhie	1.8
Leptorrhine	56.4
Mesorrhine	16.4
Platyrrhine	5.5

Table 5: Nose Shape of Pakistani (Punjab) population on the basis of Nasal Index (NI).

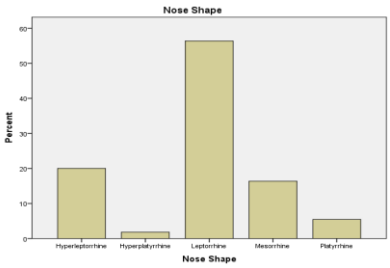

Figure 3: Nose Shape Distribution Chart of the given population

Head Shape	Percent (%)
Dolichocephalic	92.7
Mesocephalic	5.5
Ultrabrachycephalic	1.8

Table 6: Head Shape of Pakistani (Punjab) population on the basis of Cephalic Index (CI).

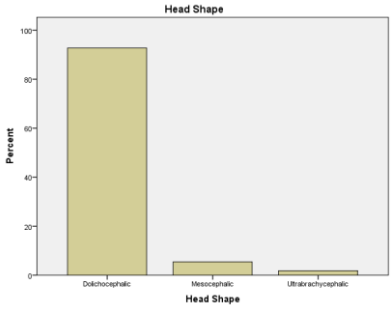

Figure 4: Head Shape Distribution Chart of the given population.

Statistics	Facial Index	Nasal Index	Cranial Index	Right Ear Index	Left ear Index
Mean	98	66.02	65.19	50.42	51.19
Median	99	62	66	48	50
Mode	87	60	48	41	50
Std. Deviation	6.99	18.49	7.87	9.61	9.78
Skewness	0.242	3.98	1.210	3.083	3.857
Std. Error of Skewness	0.322	0.322	0.322	0.322	0.322
Kurtosis	0.093	22.95	6.44	16.43	22.513
Std. Error of Kurtosis	0.634	0.634	0.634	0.634	0.634
Minimum	84.54	38.88	48.25	33.92	36.20
Maximum	118.75	175.86	100	103.44	109.09

Table 7: Descriptive Statistics of Craniofacial Morphology of the given Population.

The head or cephalic index (CI) was classified according to types of head shapes (Table 3). In this study, the mean cephalic (cranial) index was 65.19. The minimum cephalic index was 48.25 and the maximum cephalic index was100. According to this study, the most dominant head shape was Dolichocephalic (Fig 4). 92.7% subjects of the Punjab population of Pakistan have Dolichocephalic (long skull) head shape, 5.5% Mesocephalic (broad skull) head shape and 1.8% Ultrabrachycephalic (very short skull) head shape as shown in table 6.

In this study, the mean right ear index was 50.42 and that of left ear index was 51.19. The minimum right ear index (REI) was 33.92 and the maximum right ear index was 103.44 while the minimum left ear index (LEI) was 36.20 and the maximum left ear index was 109.09 (table 7). According to this study, the right and left ears of this population were slightly asymmetrical.

Discussion

Human head and face are fascinating subjects, which attract the attention of artists, poets, and scientists. Measurement of human head and face is used in the identification of person in forensics, plastic surgery, archaeology, orthodontics, hair style design and examination of the differences between races and ethnicities. In literature review, very limited materials are available on the anthropometric data in Pakistani population, and there is a research vacuum in craniofacial anthropometric studies of this population.

Therefore, this study was carried out to characterize the craniofacial parameters among the population of the Punjab, Pakistan. Present study was conducted using data of 500 subjects taken randomly. Consanguinity statistics of subjects was 3.6% Khalazad, 20% Chachazad, 12.7% Second Cousin, 5.5% Distant Blood Relation, 38.2% Same Caste and 20% belonged to Different Caste. The mean facial index was 98, with the minimum facial index 84.54 and the maximum facial index 118.75. According to this study 65.5% subjects of the Punjab population of Pakistan have Hyperleptoprosopic (very long) face shape, 23.6% have Leptoprosopic (long) face shape and 10.9% have Mesoprosopic (round) face shape. Similarly, in another examination led in Haryanvi grown-ups in India, out of 600 subjects, mean male facial index was 86.09 and mean female facial index was 84.84. All the participants had Mesoprosopic (round) face shape [38]. In another examination directed in Kosova by Rexhepi, among 754 subjects, mean male facial index was 90.38 and female facial index was 90.27, and among these 754 subjects 31.2% were with Leptoprosopic face shape and 31.6% were with Hyperleptoprosopic face shape [39]. The above studies show that the people in Asia are resemble to each other, this may be due to same environmental changes, or in other words, minute differences in the facial index is due to minimal difference in the environments of the regions of Asia. As the environment controls the hormone levels in the people and in Asia the hormones are regulated at same level with minor differences.

The mean nasal index was 66.02 in current study, the minimum nasal index was 38.88 and the maximum nasal index was 175.86. According to present study 56.4% subjects of Punjab population of Pakistan have Leptorrhine (narrow) nose shape, 20% have Hyperleptorrhine (long narrow) nose shape, 16.4% have Mesorrhine (moderate) nose shape, 5.5% have Platyrrhine (moderately wide) nose shape and 1.8% have Hyperplatyrrhine (very wide) nose shape. In contrast in another study, among all subjects in the three Nigerian ethnic groups, mean nasal index was >85.0. The most elevated nasal index (96.4) was found in the Ijaws, followed by Igbos (94.1) while the least worth was seen in Yorubas (89.2) [25]. Most Western Europeans have leptorrhine nose, having long and thin nose with a nasal index of 69.9 or less, the Bantus and Bushmen of Africa just as indigenous Australians have platyrrhine nose shape, having wide nose with nasal index 85.0 or more [23,40]. The sudroid race have a nasal index like indigenous Africans south of the Sahara and indigenous Australians with a nasal index of 85.0 or more, for example platyrrhine, while the German's nasal index is like that of the general Western European's normal of nasal index of 71.0 and underneath leptorrhine [23,41]. This shows that there is a great difference between the environments of Asia, Nigeria, Western Europe and Germany and hence there is a great variation in the hormones of populations in these areas and their genetic makeup is also different from each other on a great level leading the major differences in the nasal index of populations located in the areas.

In this study, the mean cephalic index was 65.19; the minimum cephalic index was 48.25 and the maximum cephalic index was 100. According to this study, 92.7% subjects of the Punjab population of Pakistan have Dolichocephalic (long skull) head shape, 5.5% Mesocephalic (broad skull) head shape and 1.8% Ultrabrachycephalic (very very short skull) head shape. In contrast, in another study, out of 110 students in North and South Brazil, the mean cephalic index was 80.93 in North Brazil and 79.06 in South Brazil, respectively. This displays that the mean cephalic index is alike in the population of north and south Brazil due to minute differences in the race, environment and genetic makeup, while it is different from the present study, showing that the environment, region, genes and race are responsible for the differences in the anthropological measurements and these differences are important for the identification of people related to their region. Mean Cephalic Index was 80.20 among 180 subjects of the Gujarat area of India [42,43], while in another study, out of 93 Indian subjects, the mean Cephalic Index was 77.98, with the mean male cephalic index equal to 76.97 in comparison to the mean female cephalic index 79.2 [44]. Similarly, mean Cephalic index was 78.54 out of 400 subjects in Sri Lanka [45]. These studies show that the cephalic index is almost resemble with each other in intra country and inter country of the same region with minor changes in environment, races and genes.

In this study, the mean right ear index was 50.42 and that of left ear was 51.19. The minimum right ear index (REI) was 33.92 and the maximum right ear index was 103.44 while the minimum left ear index (LEI) was 36.20 and the maximum left ear index was 109.09. According to this study, the right and left ears of this population were slightly asymmetrical. Complete 100% symmetry was noted with respect to the shape of ears in North West populace while one instance of uneven ears was noted among North East populace. Most normally oval state of ears was noted trailed by triangular, rectangular and round in the two populaces [46-49]. This is a major difference in present and previous studies and these studies were conducted in three totally different regions.

This study emphasizes the importance of anthropological indices and measurements related to identification of individuals in different castes of

Punjab Pakistan and summarized the indices of face, head, ear and nose of Pakistani population to identify the Pakistani people anthropometrically as the previous work is not documented yet.

This is the first data about the craniofacial anthropometric measurements of Pakistani (Punjab) population. The study concluded that the studied population, Punjabi population of Pakistan, has long face, long head and narrow nose with slightly asymmetric ears. This study will be helpful in criminal justice system by narrowing locality of an unknown person through its craniofacial morphology. This study will also be helpful for forensic experts to relate head and face of suicide bomb attackers and of dead bodies to specific region.

Like fingerprints databases, researchers are also working to compile craniofacial databases at population level. Due to variations of craniofacial measurements in population, these types of databases can assist in identification of individuals. In addition, this study will be helpful for researchers by providing the raw material to explore the genetic basis of normal human craniofacial variation among the population of Punjab, Pakistan.

This study has determined the variations among craniofacial parameters of Punjabi population of Pakistan and explored the dominant phenotype of face, head and nose morphology, which is important for anthropological, forensic and clinical practices.

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Competing Interest

The authors declare that there is no conflict of interest.

Author Contributions

MSZ: Research idea, study design and manuscript writing, TR: Data collection & Data entry, MZQ & MSA: Statistical analysis, MA: Study design, ON: Manuscript writing.

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