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Establishment of Sexual Dimorphism in Cranio-Facial Parameters of a Population of Bhind M.P and Its Usage in Facial Reconstruction

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Abstract

The identification of humans is important in forensic investigation, especially in the case of mass disasters the procedure followed in death known as postmortem identification it is a challenging task for forensic anthropologists. Craniofacial measurements are related to the measurements of bone of the skull and face. Humans have 14 facial bones and 8 cranial bones that comprise our skull. Craniofacial measurements are very important landmarks, and they are very useful in facial reconstruction, identification, sexual dimorphisms, ethnicity, and physical variation of individuals. This study aims to set the population and sex-specific standard for the formulation of facial soft tissue.to serve this purpose there were 22 craniofacial measurements were taken from the 174 subjects out of which 80 were males and 92 were females. Our study shows significantly higher values in bi-gonial breadth measurement followed by ectocanthion to pronasale. The least significant sex difference is found for the height of integumental lips, and all facial dimensions are larger in males in comparison with females so, males are larger.

Keywords: Sexual dimorphisms; Facial reconstruction; Measurements; Sex determination

Introduction

Anthropology is one of the most important branches of forensic science that includes the study of the identification of human skeletons. The important task of Forensic anthropologists is to determine the identity of a deceased person like age, sex, race, and ethnic background of a person by the presence of bones at a crime scene. The identification of a human skeleton plays a very important role in a mass disaster, road accident, terrorist attack, or natural disaster. anthropologists can also determine the approximate age of a person by the presence of incremental lines on teeth and determine the ethnic background of the person, sex, and occupation. [1] worked on anthropometric predictors for sexual dimorphisms of the skull. This study was based on a total of 44 skulls. Bizygomatic diameter and mastoid length left side was found best predictor of sex determination with an accuracy of 79.5%. Skull is the most reliable bone for the determination of sexual dimorphisms because it is hard and resistant to most environmental conditions [1].

The study aims to set the population and sex-specific standard for the formulation of facial soft tissue in facial reconstruction by taking various direct and indirect measurements of crania to serve this purpose. In addition to those equations will be formulated for determining soft tissue thickness regarding its shape and size by taking its direct measurements on the skull when it is encountered in any of the crime scenes, or any the mass disaster cases.

Objective

a) To access the sexual differences in different craniofacial measurements.

b) To determine the most reliable measurement for sex determination in the concerned population.

c) To compute the multiplication factors for determining soft tissue thickness from the cranial measurements.

Material & Method

The present study sample comprises 172 subjects (80 Male and 92 Female) ranging from 20-45 age belonging to Brahmin of Bhind (MP).

Following 22 measurements were taken for the study

a) Morphological facial height: Measurement between Trichion to Gnathion.

b) Physiognomic facial height: Measurement between Trichion to gnathion.

c) Physiognomic upper facial height: Measurement between nasion to Stomion.

d) Morphological upper facial height: Measurement between nasion to prosthion.

e) Nasal height: Measurement between nasion to Subnasale.

f) Nasal depth: Measurements between Pronasale to Subnasale.

g) Nasal length: Measurement between nasion to Pronasale.

h) Height of integumental lips: Measurements between Labrale superior to Labrale inferior

i) Lip length: It is the straight distance between Chelion.

j) Height of lower face: It is the measurement between Stomion to gnathion.

k) Physiognomic ear length: It is the measurement between Superauracle to Subauracle.

l) Physiognomic ear breath: It is the measurement between the two most lateral points on the posterior margin of a helix.

m) Bi-orbital: It measures the arc from Ectocanthium to Ectocanthium.

n) External Biocular breath: It is the distance between external canthi.

o) Internal-ocular breath: It is the measurement between the internal canthus of the eye.

p) Nasal breath: It is the measurement between two Alare.

q) Minimum frontal breath: It is the measurement between the two frontotemporal.

r) The breadth of the bizygomatic arch: It is the distance between two zygia.

s) Bi- Gonial breadth: It is the straight distance between to gonia.

t) Intercanine breadth: It measures the distance between canine to canine.

u) Ectocanthium pronasale: It is the distance between Ectocanthion to Pronasale.

v) Gonion-Gnathion: It is the straight distance between Gonion to Gnathion.

Statistical Analysis

To fulfill the objective of the study, the data have been statistically analyzed for descriptive statistics, t-tests, mean, standard deviation, standard error of the mean, and the range for all facial dimensions of males and females.

Results

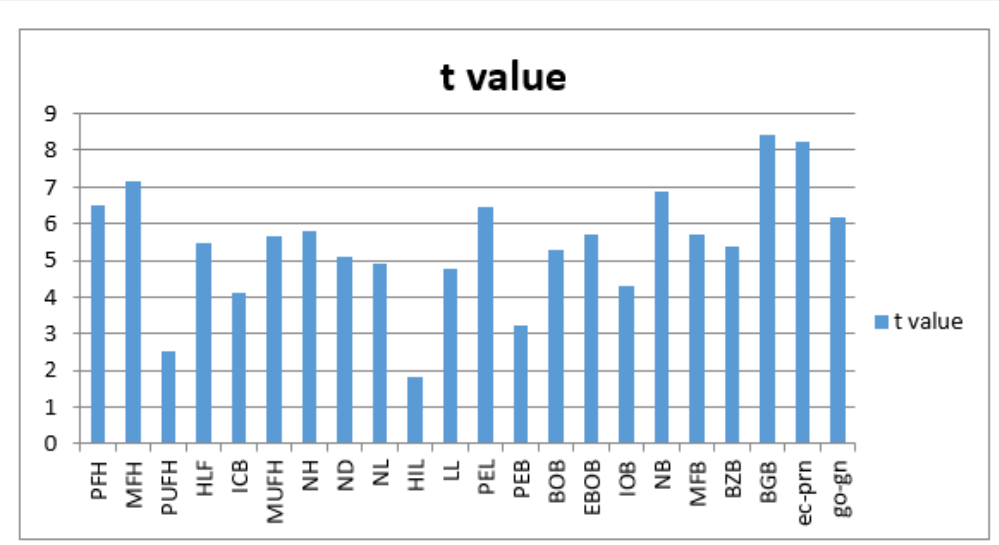

Figure 1: Representing the t-values for the soft tissue thickness from the measurements.

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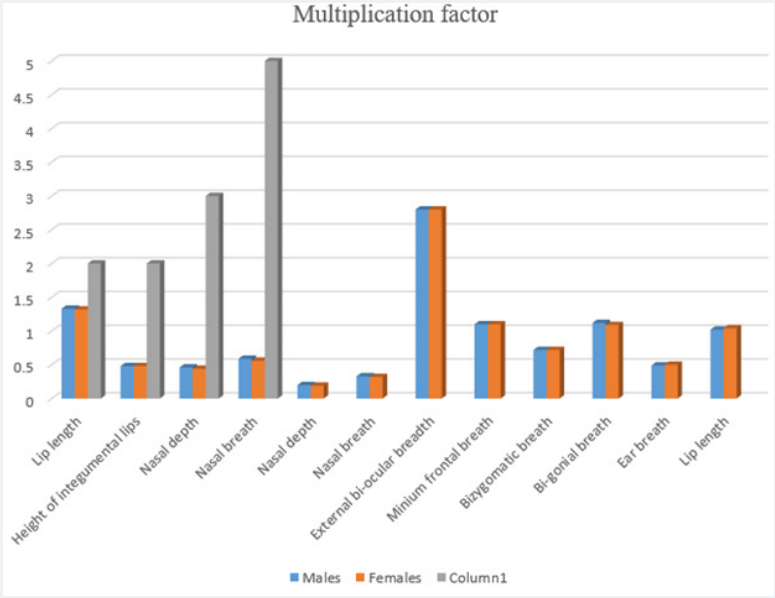

Figure 2: Depicts the Multiplication factor values of Males and Females for the soft tissue from the direct measurements.

Table 1: Descriptive statistics for all craniofacial measurements in females of Bhind M.P.

Measurement (cm)	Mean	Standard Deviation (±)	The Standard Error (±)	Range	Minimum	Maximum
Physiognomic facial height	16.53	0.77	0.08	3.9	15	18.9
Morphological facial height	10.13	0.55	0.05	3	8.5	11.5
Physiognomic upper facial height	5.99	0.49	0.05	3	4.6	7.6
Height of lower face	4.61	0.4	0.04	1.9	3.6	5.5
Inter canine breadth	3.63	0.29	0.03	1.8	2.9	4.7
Morphological upper facial height	5.55	0.42	0.04	1.9	4.8	6.7
Nasal height	4.39	0.42	0.04	2.3	3.1	5.4
Nasal depth	1.97	0.26	0.02	2	1.2	3.2
Nasal length	3.76	0.42	0.04	2	3	5
Height of integumental lips	1.75	0.27	0.02	1.7	0.8	2.5
Lip length	4.81	0.37	0.03	2	3.7	5.7
Physiognomic ear length	5.83	0.38	0.03	1.6	5.1	6.7
Physiognomic ear breadth	2.96	0.23	0.02	1.1	2.5	3.6
Bi-orbital breadth	9.88	0.43	0.04	2.3	9	11.3
External bi-ocular breadth	8.99	0.45	0.04	2.4	8	10.4
Inter ocular breadth	3.2	0.22	0.02	1.1	2.7	3.8
Nasal breadth	3.36	0.26	0.02	1.4	2.7	4.1
Minimum frontal breadth	9.89	0.45	0.046	2.9	8.8	11.7
Bizygomatic breadth	12.05	0.58	0.06	4.8	9.2	14
Bigonial breadth	11.13	0.72	0.07	4.3	9.8	14.1
Ectocanthion-pronasale	7.37	0.41	0.04	2.7	6.2	8.9
Gonion-gnathion	9.02	0.66	0.06	5	6.4	11.4

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Table 2: Descriptive statistics for all craniofacial measurements in males of Bhind M.P.

Measurement (cm)	Mean	Standard Deviation (±)	The Standard Error (±)	Range	Minimum	Maximum
Physiognomic facial height	17.38	0.93	0.1	4.4	15	19.4
Morphological facial height	10.77	0.6	0.06	3.2	9.5	12.7
Physiognomic upper facial height	6.17	0.45	0.05	2.6	5.1	7.7
Height of lower face	4.96	0.44	0.04	1.8	3.9	5.7
Inter canine breadth	3.82	0.3	0.03	1.8	2.7	4.5
Morphological upper facial height	5.9	0.39	0.04	2.4	4.6	7
Nasal height	4.76	0.42	0.047	2.9	3.1	6
Nasal depth	2.23	0.38	0.04	3.1	1.7	4.8
Nasal length	4.09	0.45	0.05	2.6	3.2	5.8
Height of integumental lips	1.83	0.29	0.032	1.5	1	2.5
Lip length	5.08	0.36	0.04	1.8	4.3	6.1
Physiognomic ear length	6.23	0.43	0.04	2.1	5.2	7.3
Physiognomic ear breadth	3.1	0.3	0.03	1.7	2.1	3.8
Bi-orbital breadth	10.25	0.47	0.05	2.2	9.2	11.4
External bi-ocular breadth	9.42	0.53	0.05	3.2	8.1	11.3
Inter ocular breadth	3.35	0.23	0.02	1.2	2.7	3.9
Nasal breadth	3.66	0.31	0.03	2.1	2.2	4.3
Minimum frontal breadth	10.36	0.61	0.06	4	9	13
Bizygomatic breadth	12.53	0.58	0.06	2.4	11.3	13.7
Bigonial breadth	12.13	0.82	0.09	4	10.2	14.2
Ectocanthion – pronasale	7.92	0.46	0.05	2.7	6.3	9
Gonion – gnathion	9.68	0.73	0.08	3.6	8.2	11.8

Table 3: Sexual difference of all facial dimensions of Brahmin of Bhind M.P.

S. No.	Measurement	t- values
1	Physiognomic facial height	6.48*
2	Morphological facial height	7.16*
3	Physiognomic upper facial height	2.51*
4	Height of lower face	5.45*
5	Inter canine breadth	4.12*
6	Morphological upper facial height	5.68*
7	Nasal height	5.79*
8	Depth	5.09*
9	Nasal length	4.92*
10	Height of integumental lips	1.84
11	Lip length	4.77*
12	Physiognomic ear length	6.45*
13	Physiognomic ear breadth	3.25*
14	Bi-orbital breadth	5.30*
15	External bi-ocular breadth	5.71*
16	Breadth	4.30*
17	Nasal breadth	6.88*

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18	Minimum frontal breadth	5.72*
19	Bizygomatic breadth	5.39*
20	Bigonial breadth	8.42*
21	Ectocanthion – pronasale	8.23*
22	Gonion – gnathion	6.19*

*Significant at p> 0.05 level.

Table 4: Multiplication factors (M.F) for all the direct measurements of males which can be taken on the skull.

Soft Tissues	Direct Measurements	M.F. Value
Lip length	Intercanine breadth	1.33
Height of integumental lips	Intercanine	0.48
Nasal depth	Nasal height	0.46
Nasal breadth	Physiognomic upper facial height	0.59
Nasal depth	Nasal height + Physiognomic upper facial height	0.2
Nasal breadth	Nasal height + physiognomic upper facial height	0.33
External bi-ocular breadth	Inter ocular breadth	2.8
Minimum frontal breadth	External bi-ocular breadth	1.1
Bizygomatic breadth	Physiognomic facial height	0.72
Bi-gonial breadth	Morphological facial height	1.12
Ear breadth	Ear length	0.49
Lip length	Height of lower face	1.02

Table 5: Multiplication factor (M.F) of all the direct measurements of females which can be taken on the skull.

Soft Tissues	Direct Measurements	M.F. Value
Lip length	Intercanine breadth	1.32
Height of integumental lips	Intercanine	0.48
Nasal depth	Nasal height	0.44
Nasal breadth	Physiognomic upper facial height	0.56
Nasal depth	Nasal height + Physiognomic upper facial height	0.19
Nasal breadth	Nasal height + physiognomic upper facial height	0.32
External bi-ocular breadth	Inter ocular breadth	2.8
Minimum frontal breadth	External bi-ocular breadth	1.1
Bizygomatic breadth	Physiognomic facial height	0.72
Bi-gonial breadth	Morphological facial height	1.09
Ear breadth	Ear length	0.5
Lip length	Height of lower face	1.04

Table 1 & 2 Represent the mean, standard error, and standard deviation mean for all the craniofacial measurements of males and females of Brahmins of Bhind M.P and the mean values of males are greater than females which indicate that males have large facial dimension in comparison to females. Table 3 & Figure 1 Represents the test of significance (t-test) values to determine the sexual differences. It is observed from the table that sex differences are significant in all the measurements. The highest t-value is found for Bigonial breadth i.e., 8.4267 and the least is for the height of integumental lips i.e., 1.8434. Table 4 Represents the multiplication factor values for the craniofacial measurements. Table 5 & Figure 2 Represents the M.F values for the craniofacial measurement from the direct measurement which can be taken on the skull to determine the value for soft tissue formulation. After multiplying the M.F. values with the direct measurement soft tissue values can be determined.

For example: -

If soft tissue for lip length is to be determined then,

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LL= ICB × MF of LL

LL = ICB × 1.3229

Discussion

[2] worked on the correlation between upper facial height and lower facial height. In this study, [2] selected a total of 200 subjects and all the subjects were free from facial trauma, or surgery. The bisexual variation of upper facial and lower face height was observed. It is also evident from the study that the relationship between upper and lower face height is significant. [3] compared cephalo-facial measurements of Indian and Turkish for facial reconstruction application. In their study, he found the average for males is larger than the average for females. There are statistically significant differences between the face and head dimensions of both sexes of the young Turkish and Indian populations as in Turkish nasion – prosthion, infradental – gnathion, cranial breadth, bizygomatic breadth, nasion – subnasale and bigonial breadth are greater whereas nasal breadth and ala – tragus are greater in Indian individual. [1] worked on anthropometric predictors for sexual dimorphism of the skull.24 skulls of males and 20 skulls of females were included in the study. Nasal height, nasal width, and mastoid length were higher in males. Bizygomatic diameter and mastoid length left side was found best predictor of sex determination with an accuracy of 79.5%. However, the present study is based on a total of 22 craniofacial measurements. The highest significant sex difference was found for bi-gonial breadth measurement (t-value-8.4267) which was followed by ectocanthion to pronase (t-value- 8.23). And the Least significant sex difference is found for the height of integumental lips (t-value- 1.8434).

Conclusion

In this study, an attempt has been given to determine sexual dimorphism and facial soft tissue thickness for the facial reconstruction of Brahmins of district Bhind M.P. This study is useful in determining the facial soft tissue thickness to recreate the antemortem appearance of an individual to recognize and identify when the skull is found at the scene. It is also useful for determining the sex when a fragmented or decomposed body is found at the crime scene. With regards to sex prediction, bigonial breadth and ectocanthion to pronasale were most reliable. Many researchers have worked on sex determination from facial dimensions in different populations [4] and these studies showed significant dimorphisms in sex determination from facial measurements. This data was based on 172 subjects (80 male and 92 female) aged between 20-45 years. This study was based on 22 craniofacial measurements. Data were statistically analyzed for mean, standard deviation, standard error, range, t-test, and multiplication factor. The result of the present study reveals that all facial dimensions are larger in males than females which indicates that males are larger, and the Highest significant sex difference was found for bi-gonial breadth measurement (t-value-8.4267) which was followed by ectocanthion to pronasale (t-value- 8.23). And the Least significant sex difference is found for the height of integumental lips (t-value- 1.8434). In this research, I also formulate the Multiplication factors for soft tissue thickness from direct measurements which can be taken on the skull [5-11].

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