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A Comparative Study of Anthropometric Variations of Cephalo-Facial Dimensions

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Abstract:

Since the very beginning of anthropology, anthropometry has played a vital role in acknowledging human evolution and variations. It is a technique used to measure somato-metric dimensions of a body whether living, dead or a cadaver. Anthropometry had its importance in population variation and racial classification, but its newer applied magnitudes have gained heights in various other fields ergonomically. The present study focuses on the cephalo- facial aspects of two group of females- the Brahmin and the Rajput of Lucknow district which are endogamous in nature, having common gene pool. Thus, are Mendelian populations. 600 individuals were randomly selected as sample for the study (300 for each group). These types of studies are significant in India because India exhibits varied forms of castes, creeds, religions, culture, customs. It is seen that the two group of females under study have more differences for their cephalo- facial measurements. The similarities or say insignificant differences in two endogamous groups can be attributed to parallelism and their adaptive environments..

Keywords: *Anthropometry, Mendelian population, Cephalometry, Females, Brahmin and Rajput.*

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Introduction

Populations are organized with a definite form and are not merely clusters of individuals, and this change is dynamic as it has continuity. Thus, each population itself is structured having a definite form, manifested in a series of biological and cultural characteristics. This uniqueness of a population may be ascribed to the uniqueness of its individuals. Each population has specific structure, some resemble each other due to biological and cultural exchange on account of physical and cultural contacts. However, according to **Harrison and Boyce (1972)** it must be recognized that a complex interplay between biological and cultural factors can and probably does occur in the organization of human populations and that biological and social structure should not be seen as independent but as having broad interphase **(Agnihotri, 1996).** Populations are recognized on the basis of some particular components depending on the interest example- demographic, genetic, social, ecological, odontometeric, morphological etc.

Among all the attributes within human body, head and face have always been considered the most important. Besides their significance in the study of population classification and variation, these are equally important in individual identification. Head and face measurements provide important imprints which make an individual distinct from others and hence they are the best markers and indicators of phenotypic variability in humans.

The cranial vault, the base and the face are the major regions of growth. The dento-facial forms depend mainly upon the growth of skull from the early fetal life up to adolescence. The way teeth will develop depends largely upon the cephalo-facial structure and vice-versa. The reduction in the teeth size and the number of cusps will directly affect the cephalic structures. Similarly, greater reduction in the size of alveolar process with less of prognathism and increasing tendency for crowding of teeth in the jaws, reduction in the Supra orbital form and general robustness of the facial structure – especially mastication and development of chin, will also affect the jaw and cephalic structures.

Today it is a known fact the somatic measurements and observations are plastic in nature, hence flexible and are affected by environmental conditions and cultural heritage, and as such exhibit differential trends in their external phenotypic morphology.

Some of the anthropometric studies conducted on populations include that of **Agnihotri (1996), Farkas *et al.* (2005), Pandey (2006), Ngeow *et al.* (2009), Khan *et al.* (2018), Chandna *et al.* (2010), Staka *et al.* (2013), Akhter *et al.* (2013), Chakravarty (2015), Kataria *et al.* (2015), Shinde *et al.* (2016), Gupta *et al.* (2019), Wibneh *et al.* (2020).**

Aim & Objective

At present our interest lies in the morphological variability of the two female groups, based on anthropometric measurements, more precisely the cephalo- facial aspects. It is true, as per **Spielman and Smouse (1976)** that biological relationship and distances between human individuals and groups can be assessed by the use of anthropometric data, at least as successfully as this can be done by the use of serological traits, with the mode of inheritance **(Agnihotri, 1996)**. Moreover, the perception of human variation is first felt through morphological traits, hence it is necessary to study whether these variations of the population does exist in the two groups under study or not.

Methodology

The present study lays emphasis on two female groups of District Lucknow, namely the Brahmins and Rajput. A total of 600 samples (300 for each caste) were collected randomly from various areas and institutions, for the age group between 6 – 25 years. 10 cephalometric measurements have been considered. The measurements were taken by appropriate instruments on the left side of the subject, and were sought after the techniques suggested by **Martin and Saller (1957), Wilder (1924), Singh and Bhasin (1969).** For taking the measurements, the instruments used were sliding and spreading caliper. Statistical constants like range of variation mean, standard deviation standard errors have also been worked out. For a more meaningful comparative evaluation the student's t test have been used.

Apart from the above, data of the present study was also compared with other populations, for a more meaningful evaluation and conclusion.

Name of the measurements and their landmarks

1. Maximum head length: - g to op
2. Maximum head breadth: - eu to eu
3. Minimum frontal breadth: - ft to ft
4. Bizygomatic breadth: - zy to zy
5. Bi-gonial breadth: - go to go
6. Morphological Upper facial height: - n to sto
7. Morphological facial height: - n to gn
8. Physiognomic facial height: - tri to gn
9. Nasal length: - n to sn
10. Nasal breadth: - al to al.

Result:

Table No. 1: Statistical Constants of Cephalic Measurements of Females

Measurements of Head and Face	Group R=Rajput B=Brahmin	Range in (cm.)	Mean (cm)	Standard Error (SE)	Standard Deviation (SD)	SE of SD	t- test & p value
Maximum head length	R	15.8-18.62	17.73	.42	2.38	.19	t- .0740
	B	15.28-19.15	17.69	.35	1.66	.20	p ≥ 50
Maximum head breadth	R	12.98-14.78	13.74	.55	2.25	.19	t- 2.9285
	B	11.21-14.46	13.33	.32	1.31	.17	p ≤ .005
Mini. Frontal Breadth	R	9.18-11.32	10.29	.52	1.63	.18	t- 2.1666
	B	9.37-11.42	10.55	.34	1.29	.16	p ≤ .02
Bizygomatic Breadth	R	10.56 - 12.62	11.68	.61	1.88	.20	t- 3.3846
	B	9.82-12.89	12.12	.36	1.35	.19	p ≤ .001
Bi-gonial Breadth	R	8.22 - 10.58	9.57	.32	1.54	.10	t- 1.900
	B	8.75 - 10.86	9.76	.26	1.20	.14	p ≤ .05
Upper facial height	R	5.54 - 7.00	6.36	.34	1.03	.11	t- 2.875
	B	4.91 - 7.00	6.13	.22	1.04	.64	p ≤.005
Physiognomic facial height	R	14.42 - 17.08	15.93	.61	2.52	.22	t-1.754
	B	14.72 -16.74	16.05	.40	1.40	.19	p ≤ .05
Morphological facial height	R	8.74 - 11.04	10.28	.46	1.67	.15	t- 2.583
	B	9.23- 11.28	9.35	.27	1.14	.14	p ≤ .01
Nasal length	R	3.9 - 5.3	4.72	.35	.76	.13	t- 2.3333
	B	3.7 - 5.7	4.86	.26	.82	.24	p ≤ .02
Nasal Breadth	R	2.6- 3.4	3.05	.27	.49	.09	t-.0606
	B	2.2 - 3.7	3.07	.20	.44	.07	p ≥ 50

Head Measurements

1. Maximum Head Length

It is noted from the table that maximum head length varies from 15.28-19.15cms, with the highest range exhibited by Brahmins (15.28-19.15cms) and lowest by Rajput (15.8-18.62cms). It is further noted that in case of mean value, it falls in a very close range. The highest value is noted among Rajput's (17.73±. 42cms) and for the Brahmin females (17.69±. 35cms). Thus, it is apparent that the two groups have more or less similar pattern of variation of the head length. The usual statistical constants like SD and SE are low, showing low variability. Student's t test values indicate non-significant differences with p ≥ 50, and confidence level of 50%, as they differ slightly with respect to head length.

2. Maximum Head Breadth

The maximum head breadth varies from 11.21-14.78cms, with the range exhibited by Brahmins (11.21-14.46cms) and Rajput (12.98-14.78cms). It is further noted that the mean values fall in a very close range. The highest value is noted in Rajput (13.74±. 55) and in Brahmin it is lowest (13.33±.32cms). Although the two groups show more or less similar pattern of variations for the head breadth, yet the differences are significant. The p value is .005, and confidence level is 99.5%.

3. Minimum Frontal Breadth

The minimum frontal breadth determining the anterior dimensions of head and face varies from 9.37-12.08cms in Brahmin to 9.56-11.32cms in Rajput females. Group wise range of variation further reveals that Brahmins show maximum variability for this trait. The mean value for the Brahmin s is 10.55±34cms and that of Rajput it is 10.29 ±.52cms. A significant difference for t-test was observed. The probability value in this case is p ≤ .02, and confidence level of more than 98%.

Facial Measurements

The assessment of the dimensions of the face of each individual was done on the basis of following

measurements taken on face, so as to understand the variations in the size and shape of the face. These measurements and indices indicate a trend of variability and provide a base for comparative evaluation of the two population's understudy.

1. Bizygomatic Breadth

Breadth of the face is indicated by the maximum horizontal distance between the two zygomatic arches. Highest range of variation is visible among the Brahmin (9.82-12.86cms). For the Rajput females the range is from 10.56-12.62cms. A mean value is also of the same ordered i.e., for Brahmins it is 12.12 ± .36cms. They show higher mean value than the Rajput females, who have the value of 11.68±. 61cms. The SD and SEs computed for the two groups further indicate a variability of the sample. Significant differences could be observed with regard to the t-test conducted at any stage of years. The value of t test equals to 3.3846. The p value is ≤ .001, and confidence level of 99.9%.

2. Bi-gonial Breadth

It is a measure of breadth of the lower jaw at the angles of the jaw. The observation made in this respect varies from 8.22cms in Rajput females to 10.85cms in Brahmin females. Group wise range of variation further reveals that the Brahmin females have higher range of variation (8.75-10.85cms) than the Rajput (8.22-10.58cms). However, the mean value varies from 9.76±. 26cms in case of Brahmin to 9.57±. 32cms in Rajput females. This indicates larger breadth of the mandible in Brahmins, but the difference in accord to students t-test is significant. The p value is ≤ .05, and confidence level of more than 95%.

3. **Upper Facial Height**

The upper facial height as recorded for the two groups exhibits more or less similar pattern. It ranges from 4.91-7.00cms in Brahmin and 5.54-7.00cms in Rajput females. Mean values being more or less similar, being lowest in Brahmins (6.13±. 22cms) and slightly higher in Rajput females (6.36±. 34cms). The standard deviation also shows low variability among the two i.e. for Brahmins it is 1.04 ±. 64. And for Rajput it is 1.03 ±. 11. Inter group variations based on t-test reveals that the Brahmins and Rajput show quiet similar pattern for this trait but significant differences occur in between the two at student's t-test. The p value is .005, and confidence level of 99.5%.

4. Morphological Facial Height

Morphological face is the actual anatomical face which excludes the forehead formed by the frontal bone, actually, belonging to the cranial parts. So the morphological facial height measures the straight distance between nasion and gnathion, the observations made in respect indicate that the Rajput females in general exhibit the highest range of variation (8.74-11.04cms), with the mean value of 10.28±.46cms, whereas the Brahmin females have lower range of variation (9.23-11.28cms) with the mean of 9.35 ±.27cms. The statistical constant show low variability the SD for Rajput's is 1.67±. 15 and that Brahmin females it is 1.14±.14. Significant difference occurs at the students t- test (2.583) level among the two castes groups understudy. The p value is, p ≤ .01 and confidence level of 99%.

5. Physiognomic Facial Height

Physiognomic face is the anatomical total face, which includes the forehead formed by the frontal bone, belonging to the cranial parts. So, the physiognomic facial height measures the straight distance between trichion and gnathion. The observations made in this context reveals that highest range variation is observed among the Rajput (14.58-17.12cms) and low amongst the Brahmins (14.83-16.92cms). The mean value of Rajput females lies at 15.93±.61cms, whereas for the Brahmins it is 16.05 ± .40cms. i.e., the Brahmin females have longer face than the Rajput counterparts. The standard deviations show considerable variations. (For the Rajput SD= 2.52 ± .22, Brahmin S.D. = 1.40±. 19). The student t-test (1.754) reveals significant difference for the two castes. The p value is, p ≤ .05 and confidence level of 95%.

Nasal Aperture

A current anthropological view is that the temperature of air habitually breathed affects the form of nose. Broad nosed races with wide nostrils usually live in hot climates and can snuff up great draughts of warm air without cooling the linings of the respiratory organs (Hooton, 1965).

1. Nasal Length

Nasal length is taken from nasion to subnasale. Observations indicate that the Brahmin females have a little longer nose as compared to the Rajput females, the difference being significant, in accordance to t-test. The Rajput shows high range of variation (3.9-5.3cms) and the Brahmin a little low (4.2-5.6cms). The mean value for the Rajput females lies at 4.72±.35cms and that of Brahmins -4.86± .26cms. the t- test signifies a value of 2.333 and p ≤ .02, with confidence level of 98%.

2. Nasal Breadth

Nasal Breadth as recorded for both the groups exhibit more or less similar pattern. This trait reveals that the two group do not hold any differences in the mean values i.e., the mean value for the Rajput females is 3.05 ± .27cms, and for the Brahmin females it is 3.07 ± .20cms. Even the SD shows no variability to great extent. S.D. for Rajput females = .49±. 09 and that of Brahmin it is .44 ±. 07. The range of variation for this trait among the Rajput females varies from 2.6-3.5cms, which is low as compared to Brahmin females. The student t- test conducted for this trait does not reveals any significant differences among the two castes studied. The $p \geq 50$ and confidence level of less than 50%.

Discussion

The study of the behaviour and structure of the populations can carry us a long way in reconstructing human evolution and variation (Ashley et al. 1961). Thus, in the view of its importance, the present study emphasizes on morphological traits of anthropometric methods for understanding of human variation and population interrelationship of the two endogamous groups of Lucknow namely the Brahmins and Rajput females. Furthermore, they have been compared with populations studied by Farkas et al. (2005), Pandey (2006), Ngeow et al. (2006), Gloria et al. (2013), Akhter et al. (2013), Shinde et al. (2016), & Gupta et al. (2019) from India and abroad, the trend of variability is noted.

Table no.2 represents a comparative chart of measurements on head conducted on different populations. It is seen that all the populations exhibit considerable differences among themselves in their head length. Rajput females (present study) have mean value of 17.73cm while Brahmin females mean is 17.69cm.Onge females (Pandey) have mean value of 16.49cm, Malaysian Indian female (Ngeow et al.) have mean of 17.27cm, Kosovo Albanian females (Gloria et al.) have mean value of 17.68cm, NWFA females (Farkas et al.) have mean value of 18.49cm, Indian females (Shinde et al.) have mean value of 17.69cm. Haryana females (Gupta et al.) have mean value of 17.68cm.

The head breadth also shows considerable variability-mean for Rajputs is 13.74cm, for Brahmins it is 13.33cm, Onge females have 14.34cm, for NWFA females it is 14.44cm, Malaysian Indians have 14.28cm, Kosovo Albanian females show a value of 14.98cm, and Indian females exhibit a value of 15.19cm.

Minimum frontal breadth of Rajput females is 10.29cm, Brahmin females it is 10.55cm and in Onge females it is 11.03cm.

Table no. 2: Comparative Chart of Measurements of Head

Studies	Sample size	Max. head length (cm)	Max. head breadth(cm)	Mini. Frontal Breadth (cm)
Present study (Rajputs)	300	17.73±.42	13.74 ± .55	10.29± .52
Present study (Brahmins)	300	17.69±.35	13.33 ± .32	10.55± .34
Pandey (2006)	26	16.49 ± 0.08	14.34 ± 0.12	11.03 ± 0.07
Farkas et al. (2005)	720	18.49	14.44	--
Ngeow et al. (2009)	50	17.27	14.28	--
Shinde et al. (2016)	75	17.69	15.19	--
Gloria et al. (2013)	103	17.68	14.98	--
Gupta et al (2020)	150	17.68	--	--

Table No. 3: Comparative Chart of Measurements of Face in cms

Studies	Sample size of female	Bizygomatic Breadth	Bi-gonial Breadth	Morphological facial height	Physiognomic facial height	Nasal length	Nasal breadth	Morphological upper facial height
Present study (R)	300	11.68± .61	9.57±.32	10.28±.46	15.93± .61	4.72±.35	3.05 ± .27	6.36±.34
Present study (B)	300	12.12± .36	9.76±.26	9.35±.27	16.05± .40	4.86±.26	3.07 ± .20	6.13±.22
Pandey (2006)	26	12.36±0.07	9.28±0.08	9.31 ± 0.11	15.06± .18	3.90±.05	3.50 ±.04	--
Gupta *et al.* (2020)	150	13.49	--	11.56	16.32	5.53	--	--
Akhter *et al.* (2013)	100	--	--	---	16.88	4.53	--	--
Farkas *et al.* (2005)	720	13.11	--	11.20	--	4.92	3.19	6.89
Ngeow *et al.* (2009)	50	12.67	--	10.81	--	5.04	3.53	6.96
Shinde *et al.* (2016)	75	12.67	--	11.18	--	5.48	3.49	7.14
Staka *et al.* (2013)	103	12.39	--	11.55	--	--	--	--

Table no. 3 represents various measurements of different populations pertaining to face. It is observed that the Rajput & Brahmin females differ in almost all variables under study and with other populations too. For bizygomatic breadth Rajput females (present study) have mean value of 11.68cm while Brahmin females (present study) mean is 12.12cm. Onge females (Pandey) have mean value of 12.36cm, Malaysian Indian female **(Ngeow *et al.*, 2009)** have mean of 12.67cm, NWFA females **(Farkas *et al.*, 2005)** have mean value of 13.11cm, Indian females **(Shinde *et al.*, 2016)** have mean value of 17.6cm. Haryana females **(Gupta *et al.*, 2020)** have mean value of 17.68cm. The values for bi-gonial breadth are 9.57cm for Rajput females, 9.76cm for Brahmins, 9.28cm for Onge females **(Pandey, 2006)**. Morphological facial height shows the values of 11.55cm for Kosovo Albanian females **(Staka *et al.*)**, 11.28cm for Indian females **(Shinde *et al.*, 2016)**, 10.81cm for Malaysian Indian female **(Ngeow *et al.*, 2009)**, 11.20cm for NWFA females **(Farkas *et al.*, 2005),** Rajput females (present study) have value of 10.28cm, while for Brahmin females (present study) it is 9.35cm, 11.56cm for Haryana females **(Gupta *et al.*, 2020)** and 9.31cm for Onge females **(Pandey, 2006)**. The values for physiognomic facial height are 15.06cm for Onge females,16.05cm for Brahmins, 15.93cm for Rajputs, 16.32cm for Haryana females and 16.88cm for Garo females **(Akhter *et al.*, 2013).** Nasal length show values of 4.72cm in Rajput females, 4.86cm for Brahmin females, 3.90cm for Onge females, 4.53cm in Garo females, 5.53cm in Haryana females, 4.92cm in NWFA females, 5.04cm in Malaysian females and 5.48cm in Indian females. Nasal breadth is 3.19cm in NWFA females, 3.53cm in Malaysian Indian females, 3.49cm in Indian females, 3.50cm in Onge females, 3.07cm in Brahmin females and 3.05cm in Rajput females. Morphological upper facial height has values of 7.14cm in Indian females, 6.96cm in Malaysian Indian females, 6.89cm NWFA females, 6.13cm in Brahmins and 6.36cm in Rajputs.

Conlusion

Thus, in view of importance of morphological traits in understanding human variation, an attempt has been

made in this study to understand the extent of variability as expressed by the two populations understudy, each representing a Mendelian population. The analysis reflects the contrasts in the morphological make-up of the two caste groups so as to reflect their origins. The study indicates that in terms of morphological traits- anthropometrical approach, the two populations of females do show appreciable differences for most of the traits.

The majority of the Brahmins are characterized by broad and medium sized head (Dolichocephalic and Mesocephalic), face exhibits (Mesoproscopic and Leptoproscopic), Jugo mandibular index reveals broad and medium category, long nose (Leptorrhine), upper face includes Mesene and Leptene, mouth width is large, jugo-frontal index suggest very broad category, further more narrow bizygomatic breadth and narrow head breadth.

On the other hand, the Rajput females exhibits preponderance of Mesocephaly, with narrow head breadth, very narrow bizygomatic breadth, preponderance of Leptoproscopic face, jugo frontal index suggests very broad category. Jugo mandibular index reveals that broad faces are mostly encountered. Furthermore, they are long nosed (Leptorrhine), mouth width is large, upper face includes Euryen, Mesene and Leptene type.

Thus, it is clear from the above interpretation that differences are more pronounced. Furthermore the 10 measurements pertaining to head and face were examined on the basis of student's t-test, in order to understand the similarities and differences in their cephalometric characteristics.

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