

## Morphometric variation among the Central Indian populations

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### **ABSTRACT**

*Data on 8 anthropometric characters of 6663 adult males belonging to 22 caste groups, distributed in 38 districts of Central India were taken for present investigation, to study the morphometric variation. Cephalic index, nasal Index, Generalized Mahalanobis distances and its size and shape components were computed and dendrograms were drawn. Comparison of coefficient of variations shows that there exists variation in nasal breadth, nasal length, weight and hence in nasal index. But no marked variation was seen in respect of other anthropometric variables. Comparison of Mahalanobis distances leads to some close clusters among the caste groups, but many of the caste groups remained separated from other caste groups keeping their identities.*

**KEY WORDS:** Genetic distance, Anthropometry, Central India, Caste and divergence, Mahalanobis Generalized, Size and shape distances

### INTRODUCTION

Population variation in body size represents one of the most important parameters in the study of ongoing evolution of man. There is considerable evidence indicating that human variation in body size is the result of the interaction of environmental and genetic factors at both the developmental and adult stages (Frisancho et.al., 1973). The rate of evolution of a population becoming adapted to an environment is positively correlated with the initial amount of genetic variability in the population (Ayala, 1968). A population endowed with greater genetic variability may thus be considered to be capable of adapting itself to a new environment with greater ability and in less time.

The data on 8 anthropometric traits of these populations collected from 38 different districts of central India are used for present investigation with the objective of finding out the level of nutrition and analyzing the way of adaptation and process of evolutionary distance.

## **MATERIAL AND METHODS**

### **The study area**

The erstwhile Madhya Pradesh or undivided Madhya Pradesh state as its name implies—Madhya means “central” and Pradesh means “region” or “state”, is the area of present study and called as Central India (Figure 1). One new state Chhattisgarh is formed after division of this state in November 2000. The study area is situated between  $18^{\circ}$  to  $36^{\circ}$  of latitude at the north of equator and  $74^{\circ}$  to  $84^{\circ}$  of longitude at east of prime meridian, the geographical area according to Surveyor General of India is 443446 sq. kms., there were 66135862 persons as per 1991 census in the region. This region is demographically lagging behind in the country. Its physiography is characterized by low hills, extensive plateaus, and river valleys. The elevation of the region ranges from 300 to 3,900 feet above mean sea level (100 to 1,200 metres). In the northern part of the region the land rises generally from south to north, while in the southern part it increases in elevation toward the west.

More than 23 percent of the people in this region are officially classified as members of Scheduled Tribes. Among these tribes are the Bhil, Baiga, Gond, Korku, Kol, Kamar, and Maria. More than three-fourths of the population is rural, but the distribution of this population is highly uneven. Densely populated regions are confined to the Mahanadi valley, the upper Wainganga valley, the lower Chamba valley, and the Narmada valley, as well as those on the Malwa Plateau in western Madhya Pradesh. The principal urban centers are found in the Jabalpur, Chhindwara, and Hoshangabad districts, located in the western and central parts of the region.

Hindi, the official state language in the region, is also the language most widely spoken. Eastern Hindi, represented by the Awadhi, Bagheli, and Chhattisgarhi dialects, is spoken in Baghelkhand, Satpura, and Chhattisgarh and in the upper Narmada valley. Bundeli, a Western Hindi dialect, is spoken in the central and northwestern districts of Madhya Pradesh; Malvi, recognized by some as a Western Hindi dialect, is the speech of western Madhya Pradesh. The Bhil speaks in Bhili, and the Gond speaks in Gondi. The second most important language, in terms of numbers of speakers, is Marathi. Urdu, Oriya, Gujarati, and Punjabi are spoken by



Fig.1 Map of Madhya Pradesh

sizable numbers. Telugu, Bengali, Tamil, and Malayalam are also spoken by some in this region. Most of the people are Hindus. There are, however, sizable minorities of Muslims, Jains, Christians, and Buddhists. There is also a small Sikh population. Agriculture is the basis of economy in this region.

### **The people**

As presented in Tables 1 and 2, the present study is confined on 22 caste groups of 38 districts of the erstwhile Madhya Pradesh state of India. These caste groups belong to 13 traditional occupational groups (Table 2). The information regarding traditional occupation of most of the caste groups are based on an official document of the Government of Madhya Pradesh (Central India) i.e. Part-I of Gazette, notification No. F. 85-XXV-4-84 dated 26<sup>th</sup> December, 1984 (amended from time to time). A brief account of the occupational group and castes are being presented below for further elaboration.

**1. Agriculture:** A total of 9 out of 22 castes are traditionally engaged in Agriculture. These are Jat, Khati, Koli, Kulmi, Kurmi, Kurumbanshi, Lodha, Lodhi and Lora. A majority of population of these castes is based on agriculture for their subsistence. The sample of Jat is taken from Gwalior district; possibly they are immigrated from Haryana and Punjab state of India. As evident from Table 1, the rest of the sample is taken from different districts. The largest sample (349) is of Kurmi, followed by Lodhi (300) and so on. In this way a total of 1007 sample belongs to this group. Though these castes are traditionally agriculturist but they are not large landholders. In general, majority of them are medium landholders.

**2. Animal Husbandry:** Agriculture and animal husbandry are linked together in the course of human evolution. In the present study there are 2 caste groups, which are known as traditionally pastoralists. These are Ahir and Gujar. Their primary as well as traditional occupation is domestication of cow and buffalo. Very few of them also domesticate goat and sheep. Beside domestication of animal they are also engaged in production and marketing of milk and milk-products. They also own small patches of land for cultivation.

**3. Blacksmith:** The caste groups Loхар, Lohgadia and Agaria of Central India are traditionally engaged in the extraction of iron and manufacturing and repairing of iron implements. For present investigation the sample are taken from Loхар only. Still in 21<sup>st</sup> century, the importance and contribution of Loхар as blacksmith cannot be ignored in rural India. They are the supportive

hands of agriculturists, vegetable cultivators, potters, oil merchants and others. Generally, they are land less, as they hardly have cultivable land. They earn their livelihood, either through blacksmith or as daily wage labourer.

**4. Fishing:** In Central India, certain groups are based on fishing for their livelihood. This profession is also traditionally inherited. For present investigation the sample is drawn from Majhi of district Surguja, who are scheduled tribes. Such groups do fishing, not only for their own food, but they sell it to other neighbouring population, or many times practice barter system, and exchange it with other required items like grains, oils, iron-implements and so on. They also own small patch of cultivable land.

**5. Labour:** The caste group Panka is identified as labourer by the Government. By and large the members of this caste earn their livelihood as daily wage labourer in the fields of agriculturist or landlords or at any construction site. Besides, they are engaged as labour or informant or guide by the forest, revenue and police department. In many villages, one of the members of this caste is deputed as village guard. Recently few of them have started practicing, priesthood among followers of *Kabirpanth* (a sect of Hinduism). Simultaneously, those who are deputed as village guard are allotted small patch of barren land.

**6. Oil Merchant:** The members of the caste known as Teli are traditionally oil merchant. They are widely distributed in Central India. Up to pre-industrial era, they were earning livelihood through extraction and trading of oil. But with the advent and introduction of technology, gradually their traditional occupation is forgotten by themselves as well as by the society too. Now they are shifted to other business enterprises like general store, grain merchant, middleman, agriculture etc. For the present investigation, a total of 1156 samples of Teli caste are taken from 23 different district of Central India.

**7. Potter:** Pottery is possibly first mark of revolution of human culture and civilization. In the history of human evolution, possibly potters would had been regarded as technocrats. Still they are artisan, their skill and occupation is socially patented for them only. Except Kumbhar, no other caste practice pottery. Kumbha means water pot. Beside water pot, Kumbhars manufacture other kinds of utensils of daily uses as well as toys for children; they slightly turned their traditional occupation with the wave of change and modernity. Now, many of their artistically designed objects can be seen in the modern drawing rooms.

TABLE 1. Caste and district wise distribution of sample

S.No.	Districts	Caste Group																				Total		
		Ahir	Brahmin	Chamar (Jat)	Gujar	Jat	Kachi	Kaller	Khatri	Koli	Kori	Kulmi	Kumbhar	Kurmi	Kurumbanshi	Lodha	Lodhi	Lohar	Lora	Majhi	Panka		Rajput	Teli
1	Balaghat	0	0	0	0	0	0	50	0	0	0	0	0	0	0	50	0	0	0	0	0	50	0	150
2	Betul	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	50	50	150
3	Bilaspur	50	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	150
4	Chhatarpur	0	51	52	0	0	50	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	203
5	Chhindwara	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	50	150
6	Damoh	0	50	50	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	50	200
7	Dewas	0	0	0	0	0	0	0	50	0	0	0	50	0	0	0	0	0	0	0	0	48	0	148
8	Dhar	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	50	49	149
9	Durg	50	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	150
10	Guna	0	54	52	0	0	0	0	0	0	0	0	0	0	51	0	0	0	0	0	0	0	54	211
11	Gwalior	0	50	50	50	50	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	250
12	Hoshangabad	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49	50	149
13	Indore	50	50	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	150
14	Jabalpur	0	52	51	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	50	203
15	Jhabua	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	50	150
16	Khandwa	0	50	50	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	150
17	Khargone	50	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49	0	149
18	Mandla	50	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52	152
19	Mandsaur	0	0	50	0	0	0	0	0	0	50	50	0	0	0	0	0	0	0	0	0	50	0	200
20	Narsinghpur	0	50	50	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	50	200
21	Panna	0	51	52	0	0	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	204
22	Raigarh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57	0	52	109
23	Raipur	50	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	150
24	Raisen	0	0	0	0	0	50	0	0	50	0	0	0	0	0	0	0	0	0	0	0	50	50	200
25	Rajgarh	0	53	50	0	0	0	0	0	0	0	54	0	0	0	0	0	56	0	0	0	0	0	213
26	Ratlam	0	0	0	0	0	0	0	0	0	0	50	50	0	0	0	0	0	0	0	0	50	0	150
27	Rewa	0	49	50	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	50	199
28	Sahdol	49	50	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	199
29	Satna	0	53	50	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	50	203
30	Saugar	0	50	50	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	100	250
31	Seoni	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	50	150
32	Shajapur	0	0	0	0	0	0	0	0	0	0	52	49	0	0	0	0	0	0	0	0	50	0	151
33	Shibpuri	49	50	51	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	200
34	Sidhi	0	51	50	0	0	0	0	0	0	0	0	0	51	0	0	0	0	0	0	0	0	0	152
35	Surguja	50	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	150
36	Tikamgarh	52	50	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49	0	202
37	Ujjain	0	0	0	0	0	0	0	0	0	0	50	50	0	0	0	0	0	0	0	0	50	0	150
38	Vidisha	0	0	53	0	0	52	0	0	0	0	57	0	0	0	0	0	0	0	0	0	55	0	217
Total		600	1114	1062	100	50	253	50	50	50	50	413	349	51	51	300	50	56	50	57	701	1156	6663	

TABLE 2. Caste and Traditional Occupation wise distribution of the sample

S.No.	Caste Groups	Traditional Occupation													Total
		Agriculture	Animal Husbandry	Blacksmith	Fishing	Labour	Oil Merchant	Potter	Priest	Shoe Maker	Vegetable Cultivator	Warrior	Weaver	Wine Merchant	
1	Ahir	0	600	0	0	0	0	0	0	0	0	0	0	0	600
2	Brahmin	0	0	0	0	0	0	0	1114	0	0	0	0	0	1114
3	Chamar (Jat)	0	0	0	0	0	0	0	0	1062	0	0	0	0	1062
4	Gujar	0	100	0	0	0	0	0	0	0	0	0	0	0	100
5	Jat	50	0	0	0	0	0	0	0	0	0	0	0	0	50
6	Kachi	0	0	0	0	0	0	0	0	0	253	0	0	0	253
7	Kaller	0	0	0	0	0	0	0	0	0	0	0	0	50	50
8	Khati	50	0	0	0	0	0	0	0	0	0	0	0	0	50
9	Koli	50	0	0	0	0	0	0	0	0	0	0	0	0	50
10	Kori	0	0	0	0	0	0	0	0	0	0	0	50	0	50
11	Kulmi	50	0	0	0	0	0	0	0	0	0	0	0	0	50
12	Kumbhar	0	0	0	0	0	0	413	0	0	0	0	0	0	413
13	Kurmi	349	0	0	0	0	0	0	0	0	0	0	0	0	349
14	Kurumbanshi	51	0	0	0	0	0	0	0	0	0	0	0	0	51
15	Lodha	51	0	0	0	0	0	0	0	0	0	0	0	0	51
16	Lodhi	300	0	0	0	0	0	0	0	0	0	0	0	0	300
17	Lohar	0	0	50	0	0	0	0	0	0	0	0	0	0	50
18	Lora	56	0	0	0	0	0	0	0	0	0	0	0	0	56
19	Majhi	0	0	0	50	0	0	0	0	0	0	0	0	0	50
20	Panka	0	0	0	0	57	0	0	0	0	0	0	0	0	57
21	Rajput	0	0	0	0	0	0	0	0	0	0	701	0	0	701
22	Teli	0	0	0	0	0	1156	0	0	0	0	0	0	0	1156
	Total	1007	700	50	50	57	1156	413	1114	1062	253	701	50	50	6663

**8. Priest:** Brahmin is the only caste, who has patented this job, in Hinduism. They are at the top of caste hierarchy of Hinduism and occupied most of the political, administrative, academic and other advantageous positions, since long back and are continuing the tradition. Brahmin are also large landholders, but do not practice agriculture, who usually hire labour for the job of agriculture. A total of 1114 samples of Brahmin were drawn from 22 districts (Table 1) for present investigation.

**9. Shoe Maker:** The practitioner of this profession is traditionally regarded as untouchables. If the priests are at the top of Hindu caste hierarchy, the shoemakers are at the bottom. Though, after independence, the practice of untouchability is abolished by law in the country, but it is still being practiced in rural India. Beside shoemaking and repairing they also do scavenging. They

are called Chamar. In Central India, they are also known as Ahirwar, Jatav and by other names. To provide constitutional protection they are classified as scheduled caste. By and large, they are land less. Therefore, beside their traditional occupation of leatherwork, they also earn livelihood as agricultural labour. A total of 1062 samples of Chamar are included for present investigation. This sample is drawn from 21 districts of Central India (Tables 1 and 2).

**10. Vegetable Cultivator:** There are some caste groups who are exclusively dependent on vegetable cultivation. One of them is Kachi, who are traditionally vegetable cultivator. Their villages are generally at the bank of rivers and rivulets, where land and water is appropriate for cultivation of vegetable. Beside cultivation they also do marketing of the production. Generally they own small patches of lands on the bank of river or other water body.

**11. Warrior:** The Rajputs are traditionally warrior. They are landlords. They were sovereign part of feudal kingdoms of historical India. The Hindu society is constituted by four varna viz. Brahman, Kshatriya, Vaisya and Sudra. There are vertical hierarchies in varna, where the Brahman are at the top, Sudras are at the bottom, Kshatriya and Vaisya are in between. The Rajput are Kshatriya. Though, traditionally, they were prepared as guard of Hindu society, especially of Brahmins, but latter on they became rulers and established kingdoms. Still they have hold on Indian polity, they are in second position. They are large landholders; most of the advantageous positions and occupations are occupied by them. Still, there are regions, which are governed in traditional manner where law and order is at hand of the descendants of Kings and landlords. In modern India too, they are affluent and dominant. Now they are playing role as politician, administrator, industrialist and so on. A sample of 701 Rajputs is considered for present investigation. These samples were collected from 14 districts of Central India.

**12. Weaver:** In the course of human evolution, possibly, first technocrats were potters and second would have been weavers. Weavers now a day are in better position than potters, as textile making is getting more attention than pottery. But it is not clear at which stage of evolution they became untouchable. Now they have been provided constitutional protection as scheduled castes. For present investigation, only Kori caste is considered, who are weavers traditionally. Though, now they have forgotten their traditional occupation of weaving, but still they are untouchables. Now they are engaged in different occupations especially in the agriculture. Central India Koris are abundantly found in Northern India too.



**13. Wine Merchant:** The Kallers are known as traditionally wine merchant. The caste Kaller is also pronounced as Kallar. Still many of them are engaged in this business, though it has now lost its traditional form. Since wine shops are at present business of good profit making, it has crossed the boundary of caste, and is in the hand of dominant castes or individuals. The members of caste Kaller are also engaged in different other businesses.

## Methods

The study sample is based on the basic anthropometric data collected on adult males aged 18-70 years by the Anthropological Survey of India (Basu et al. 1994). For present investigation altogether 22 caste groups of 38 districts of Central India (Figure 1) comprising the States namely Madhya Pradesh and Chhattisgarh, were taken into consideration. These caste groups are practicing 13 different traditional occupations. The information related to traditional occupation of castes is obtained from an official document namely Part-I of Gazette vide notification No. F. 85-XXV-4-84 dated 26th December 1984 (amended from time to time). The study sample consists of a total of 6663 adult males. Data were collected by the trained physical anthropologists of Anthropological Survey of India, following standard techniques (Martin and Saller 1956). Therefore, it can be well assumed that accuracy of the data is properly taken care of. For convenience, measurements were taken only on adult males who looked apparently normal. Efforts were also made to exclude closely related individuals like brothers and fathers and sons and those with any kind of physical deformities. Therefore the samples were free from any selection bias.

The data collected on 8 anthropometric traits of these caste groups are used for present investigation. Cephalic index, nasal index, cormic index ( $SH/H$ ) and body mass index ( $W/H^2$ ) were calculated for each individual. Calculation of central tendency (arithmetic mean), dispersion (standard deviation) and relative dispersion (coefficient of variation) for each caste and occupational group was done using MS-Excel and SPSS software packages. Subsequent calculations were also done using both the softwares. For screening the Chronic Energy Deficiency (CED) groups, the value of Body Mass Index below 18.5 is taken as a cut-off point following James et al. (1988), Ferro-Luzzi et al. (1992) and Khongsdier (2001 and 2002), Adak et.al. (2006).

Since there are 22 caste groups, it is interesting to find their evolutionary closeness or distances. Coefficient of Racial Likeness (CRL) proposed by Pearson (1926) is one such measure to analyze closeness. This measure can be broken into two components known as size and shape (Penrose 1947, 1954). The CRL is thus the sum of size and shape distances. This measure, however, does not take correlations between the characteristics into considerations. Mahalanobis' D-squared measure is a distance measure that corrects for intercorrelations. Though it is known that the two measures are very close (Penrose, 1954), it is better to use Mahalanobis'  $D^2$  measure because it takes due considerations of the inter-correlations between variables and is statistically more sound. The Mahalanobis'  $D^2$  ( $MD^2$ ) measure between groups  $i$  and  $j$  can be defined as

$$MD_{ij}^2 = (\bar{x}_i - \bar{x}_j)' \Sigma_{ij}^{-1} (\bar{x}_i - \bar{x}_j),$$

where  $\bar{x}_i$  is the mean vector of a group of  $k$  variables for the tribal community  $i$  and  $\bar{x}_j$  is mean vector of the same group of  $k$  variables for the tribal community  $j$  and  $\Sigma_{ij}$  is the common dispersion matrix of tribal communities  $i$  and  $j$  obtained as

$$\Sigma_{ij} = (\Sigma_i + \Sigma_j)/2,$$

$\Sigma_i$  and  $\Sigma_j$  being the sample estimates of the corresponding dispersion matrixes for tribal groups  $i$  and  $j$ .

It is possible to decompose the Mahalanobis'  $D^2$  measure into  $k$  distances corresponding to the principal component vectors of the dispersion matrix. The distance measure corresponding to the first principal component vector signifies the size distance. The shape distance is found from subtracting the size distance from the overall distance. Shape distance thus gives the combined effect of all other principal component vectors. The closeness of the tribal groups with respect to size and shape can be found from these measures.

## RESULTS AND DISCUSSION

The mean and standard deviation of anthropometric characters viz. stature, sitting height, head length, head breadth, nasal height, nasal breadth, head circumference and body weight are presented in Tables 3 and 4. Among 22 caste groups, the Jat with a mean of  $168.61 \pm 6.63$  cm are tallest while Panka with a mean value of  $157.39 \pm 6.50$  cm are the shortest. The range of mean indicates that all the populations are short to medium in stature. The Kachi, Kaller, Koli, Kori, Majhi and Panka are short in stature, while Gujar, Brahmin, Rajput, Kulmi, Kurmi, Lohar,

TABLE 3. Mean and standard deviation of 8 anthropometric measurements among 22 caste groups of central India

Stature (cm)	Sitting Height (cm)		Head Length		Head Breadth		Nasal Height		Nasal Breadth		Head Circumference		Weight (in Kg)		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
163.72	5.86	81.94	3.42	18.68	0.75	13.94	0.53	4.91	0.41	3.75	0.28	53.58	1.75	49.41	6.35
166.46	5.69	84.60	3.36	18.99	0.64	14.15	0.55	5.04	0.36	3.74	0.29	54.31	1.74	53.97	8.10
163.70	6.06	81.93	3.94	18.72	0.72	13.88	0.48	4.83	0.36	3.75	0.27	53.09	2.27	48.51	6.10
166.51	7.32	83.05	4.66	18.93	0.73	14.16	0.38	4.93	0.40	3.67	0.25	52.99	3.34	54.84	9.57
168.61	6.63	85.57	3.64	19.42	0.63	14.14	0.45	5.20	0.37	3.57	0.27	54.71	1.41	55.28	7.86
162.96	5.49	81.48	4.63	18.80	0.70	13.92	0.46	4.86	0.39	3.71	0.26	52.77	1.84	48.70	5.29
162.96	6.78	80.25	3.93	18.96	0.81	14.10	0.54	4.85	0.33	3.68	0.24	54.44	1.75	51.80	8.15
163.55	5.99	81.44	3.06	18.68	0.44	13.98	0.38	4.93	0.27	3.68	0.29	52.43	1.17	49.04	4.24
162.92	7.07	81.76	3.01	18.86	0.56	13.90	0.53	4.54	0.29	3.79	0.25	53.24	1.77	48.70	6.88
162.01	6.77	81.87	3.23	18.52	0.68	14.13	0.53	4.83	0.33	3.75	0.25	51.99	1.56	46.66	5.82
166.03	6.79	83.92	4.10	18.80	0.58	13.68	0.46	5.10	0.49	3.63	0.28	53.31	1.36	52.90	6.33
163.77	5.97	81.69	5.31	18.60	0.62	13.71	0.47	4.85	0.40	3.72	0.28	52.61	2.64	49.15	6.73
165.78	6.11	82.28	3.39	18.86	0.69	14.00	0.55	4.93	0.35	3.76	0.26	53.04	1.90	52.38	6.68
163.67	5.95	82.14	3.11	18.87	0.62	13.95	0.56	5.03	0.37	3.67	0.24	52.85	1.79	52.10	5.18
164.67	5.13	83.26	3.24	18.80	0.64	13.77	0.44	5.06	0.41	3.89	0.48	52.99	1.39	49.76	4.98
164.42	5.49	81.41	3.51	18.93	0.61	14.16	0.54	4.84	0.33	3.78	0.25	54.62	1.65	50.87	6.39
164.93	6.56	82.69	3.14	18.88	0.63	14.14	0.53	4.98	0.33	3.88	0.30	52.91	1.38	49.02	6.31
163.87	6.89	82.49	4.25	18.58	0.76	13.85	0.53	4.91	0.31	3.74	0.31	52.95	1.72	49.32	5.38
158.43	5.72	79.21	2.93	18.94	0.53	13.96	0.42	4.70	0.30	3.92	0.29	52.80	1.42	48.76	5.04
157.39	6.50	78.23	3.58	18.65	0.65	13.88	0.47	5.01	0.31	3.81	0.27	52.42	1.56	44.40	4.72
166.07	6.22	82.54	3.44	18.83	0.73	13.99	0.54	4.97	0.37	3.74	0.26	53.82	2.24	52.29	7.33
163.29	5.70	81.90	3.40	18.79	0.67	14.04	0.52	4.87	0.36	3.75	0.27	53.60	1.88	49.66	6.78
164.45	6.14	82.41	3.90	18.81	0.69	13.99	0.53	4.91	0.38	3.74	0.27	53.52	2.08	50.67	7.17
22.75*		32.12*		11.56*		18.42*		18.55*		5.33*		28.28*		31.47*	

\*Significant at 1% level.

TABLE 4. Mean, standard deviation and coefficient of variation of cephalic, and nasal index among 22 caste group of central India

Caste Group	Cephalic Index			Nasal Index		
	Mean	SD	CV	Mean	SD	CV
Ahir	74.67	3.48	4.67	77.04	8.91	11.56
Brahmin	74.57	3.66	4.91	74.58	7.46	10.00
Chamar (Jat)	74.19	3.25	4.38	78.06	8.07	10.34
Gujar	74.93	3.15	4.20	74.93	7.24	9.66
Jat	72.85	3.07	4.21	67.97	9.23	13.59
Kachi	74.10	3.33	4.50	76.88	8.29	10.78
Kaller	74.30	3.53	4.75	76.18	6.43	8.43
Khati	74.83	2.78	3.71	74.89	7.38	9.86
Koli	73.74	3.00	4.07	83.84	7.47	8.91
Kori	76.37	3.73	4.88	77.98	7.00	8.98
Kulmi	72.83	2.92	4.01	71.86	8.71	12.12
Kumbhar	73.80	3.21	4.34	77.16	7.79	10.09
Kurmi	74.30	3.54	4.77	76.52	7.01	9.15
Kurumbanshi	74.01	3.59	4.85	73.30	7.28	9.93
Lodha	73.41	3.56	4.85	76.20	8.63	11.32
Lodhi	74.85	3.52	4.70	78.35	6.84	8.73
Lohar	74.96	3.92	5.23	78.24	7.32	9.35
Lora	74.66	3.77	5.05	75.09	11.33	15.09
Majhi	73.73	2.29	3.11	83.57	6.95	8.32
Panka	74.47	3.09	4.15	76.38	7.17	9.38
Rajput	74.29	3.53	4.75	75.67	7.02	9.28
Teli	74.77	3.71	4.96	77.25	7.55	9.78
Total	74.42	3.50	4.70	76.61	7.90	10.31
F-Ratio	4.35*			16.20*		

\* Significant at 1% level

Lodha, Lodhi, Lora, Kumbhar, Ahir, Chamar (Jat), Kurumbanshi, Khati, Teli are lower medium and Jat are medium in stature. Occupations have great role in shaping and sizing of individuals and population as a whole. The mean value of stature is found to be shortest ( $157.39 \pm 6.50$  cm) for occupation group who are traditionally labourer, whereas the mean value of stature is found to be highest ( $166.46 \pm 5.69$  cm) for priest. Here it should be noted that as an individual caste the Jat, traditionally agriculturist, are on an average taller. Traditional occupation wise mean value of stature is further illustrated in Figure 2. The mean value of sitting height varies between  $78.23 \pm 3.58$  cm among Panka to  $85.57 \pm 3.64$  cm among Jat.

Variation in head length is apparent from mean values, as the Jat have longest ( $19.42 \pm 0.62$  cm) and Kori have shortest ( $18.52 \pm 0.67$  cm) head. In case of mean value of head breadth the

Gujars ( $14.16 \pm 3.78$  cm) have broadest and the Kulmis ( $13.68 \pm 4.56$  cm) have narrowest head.

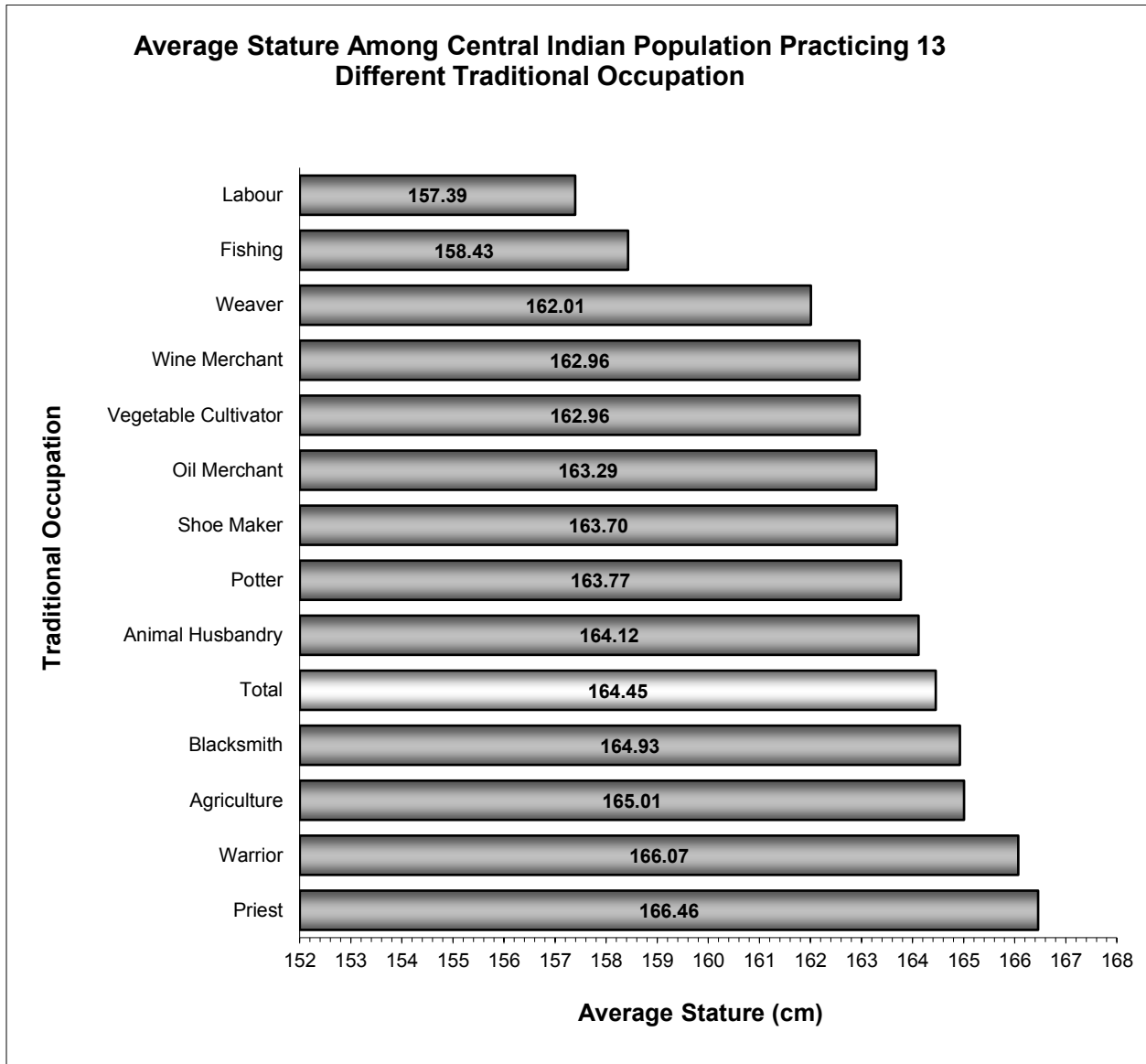


Figure 2: Traditional Occupation wise average stature of central Indian population of 22 caste groups

In this way the mean value of head circumference is found to be highest for Jat ( $54.71 \pm 1.40$  cm) and lowest for Kori ( $51.99 \pm 1.56$  cm). The cephalic index calculated for each individual shows that majority of population of central India is characterized by mesocephalic head, which is also apparent from mean value of cephalic index presented in Table 4.

The mean value of measurement of nose i.e. nasal height and nasal breadth shows that the Jat have longest ( $5.20 \pm 0.37$  cm) and narrowest ( $3.57 \pm 0.27$  cm) nose while the Majhi have shortest ( $4.70 \pm 0.30$ ) and broadest ( $3.92 \pm 0.29$  cm) nose. The nasal index is calculated for each individual. Caste wise mean value of nasal index is presented in Table 4. It is evident that majority of central Indian population is characterized by mesorhinae nose. The one-way analysis of variance (ANOVA) shows that the inter-population differences in respect of these anthropometric measurements are highly significant as the F-ratio is high for each of the anthropometric measurements (Table 3).

Table 5 shows the correlation matrix between anthropometric measurements using raw data of 6663 individuals as well as from mean values of 22 caste groups. Most of the correlation values are found to be significant, as the measurements of the same individuals are expected to be related. This should also be true for their mean values.

### **Divergence**

Tables 6-8 show Mahalanobis' generalized distance measures and the break-up of these measures into size and shape components. The comparison of these values reveals two broad level clusters among the tribal groups. All tribal groups except Majhi, Panka, Lohar, Lodha and Lodhi, are in one cluster and Majhi and Panka are in another cluster. Lohar, Lodha and Lodhi either keep separate entity or join one of these two groups depending on the closeness according to the size or shape distance measures.

From details of the clusters taking more close tribal groups in terms of distances, three sets of clusters emerged corresponding to Mahalanobis' total, size and shape distances respectively. On the basis of generalized distances and size and shape distances, three separate dendrograms are drawn (Figures 3-5).

Based on Figure 3 (i.e., Dendrogram on Mahalanobis  $D^2$  distance measures) altogether 9 clusters can be made:

Cluster-I: Ahir, Brahmin, Chamar (Jat), Gujar, Kachi and Jat

Cluster-II: Rajput and Teli

Cluster-III: Kurumbanshi, Lodha, Kulmi, Kumbhar, Kurmi and Lora

TABLE 5. Correlation matrix between anthropometric measurements using raw data of 6663 individuals as well as from mean of 22 castes (the above diagonal have the value of Pearson correlation, whereas the below diagonal have associated significance level (*p-value*))

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Using raw data of all 6663 Individuals												
(1) Stature (cm)	1	0.636	0.301	0.197	0.227	0.119	0.293	0.531	0.006	-0.189	-0.079	-0.087
(2) Sitting Height (cm)	0.000	1	0.279	0.176	0.196	0.099	0.338	0.462	0.151	0.627	-0.077	-0.077
(3) Head Length (cm)	0.000	0.000	1	0.177	0.203	0.176	0.551	0.339	0.216	0.051	-0.578	-0.023
(4) Head Breadth (cm)	0.000	0.000	0.000	1	0.113	0.140	0.370	0.341	0.282	0.023	0.668	0.013
(5) Nasal Height (cm)	0.000	0.000	0.000	0.000	1	0.047	0.167	0.225	0.126	0.022	-0.066	-0.704
(6) Nasal Breadth (cm)	0.000	0.000	0.000	0.000	0.000	1	0.225	0.184	0.145	0.008	-0.026	0.643
(7) Head Circumference (cm)	0.000	0.000	0.000	0.000	0.000	0.000	1	0.414	0.309	0.139	-0.136	0.032
(8) Weight (in Kg)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0.848	0.054	0.005	-0.039
(11) Cephalic Index	0.000	0.000	0.000	0.000	0.000	0.018	0.000	0.348	0.000	0.048	1	0.026
(12) Nasal Index	0.000	0.000	0.028	0.150	0.000	0.000	0.004	0.001	0.265	0.259	0.016	1
Using mean values of the 22 Caste Group												
(1) Stature	1	0.918	0.483	0.226	0.499	-0.533	0.515	0.827	0.406	0.335	-0.223	-0.610
(2) Sitting Height	0.000	1	0.446	0.136	0.549	-0.458	0.398	0.722	0.310	0.680	-0.265	-0.614
(3) Head Length	0.011	0.019	1	0.479	0.321	-0.277	0.713	0.709	0.695	0.152	-0.486	-0.348
(4) Head Breadth	0.156	0.273	0.012	1	0.023	-0.078	0.409	0.321	0.303	-0.085	0.532	-0.050
(5) Nasal Height	0.009	0.004	0.073	0.459	1	-0.404	0.223	0.455	0.268	0.368	-0.266	-0.896
(6) Nasal Breadth	0.005	0.016	0.106	0.366	0.031	1	-0.302	-0.561	-0.386	-0.112	0.194	0.752
(7) Head Circumference (cm)	0.007	0.033	0.000	0.029	0.159	0.086	1	0.638	0.549	-0.035	-0.296	-0.302
(8) Weight	0.000	0.000	0.000	0.073	0.017	0.003	0.001	1	0.848	0.176	-0.356	-0.579
(11) Cephalic Index	0.159	0.117	0.011	0.005	0.115	0.193	0.091	0.052	0.044	0.194	1	0.272
(12) Nasal Index	0.001	0.001	0.056	0.412	0.000	0.000	0.086	0.002	0.053	0.074	0.111	1

Cluster-IV: Khati, Koli and Kori

Cluster-V: Kaller

Cluster-VI: Lodhi

Cluster-VII: Majhi

Cluster-VIII: Panka

Cluster-IX: Lohar

The clusters on the basis of Mahalanobis size distances are:

Cluster-I: Ahir, Brahmin, Chamar (Jat), Gujar, Kaller, Kulmi, Khati, Kurumbanshi, Kachi, Koli, Kumbhar, Kurmi and Kori

Cluster-II: Rajput and Teli

Cluster-III: Lodhi and Lora

Cluster-IV: Lohar and Majhi

Cluster-V: Jat

Cluster-VI: Panka

Cluster-VII: Lodha

The clusters on the basis of Mahalanobis shape distances are:

Cluster-I: Ahir, Brahmin, Chamar (Jat), Gujar, Kachi and Jat

Cluster-II: Rajput, Teli, Kumbhar, Kurmi, Lodha, Kurumbanshi, Lora and Kulmi

Cluster-III: Khati, Koli and Kori

Cluster-IV: Kaller

Cluster-V: Lohar

Cluster-VI: Lodhi

Cluster-VII: Majhi

Cluster-VIII: Panka

It is clear that there are some tribal groups which remain in the same clusters regardless whether size, shape or total distances are taken. These groups are

1. Ahir, Brahmin, Chamar (Jat) and Gujar
2. Kumbhar and Kurmi
3. Rajput and Teli.

We may now discuss other tribal groups in terms of the closeness of these groups to the above three clusters. Closeness of Kachi and Jat, with respect to total measures, to the 1<sup>st</sup> cluster of groups is due to the closeness of shapes. Shape distance between Kurumbanshi and Lodha are small and these two groups seem to be very close to the cluster 2 which makes the overall distances also small with cluster 2. Other groups keep their identities either in terms of sizes or in terms of shapes.

A general feature of the size and shape distances is that size distances are found to be much smaller than the shape distances. Another remarkable aspect reflected in the dendrogram is that the castes groups, practicing same traditional occupation are not homogenous in size, they



TABLE 6. Generalized Mahalanobis distance matrix among Caste Groups of Central India

Caste groups	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
(1) Ahir	0.00	0.87	0.17	1.16	2.42	0.70	1.14	1.29	1.67	2.42	1.43	0.38	0.79	1.55	1.04	0.67	1.91	0.24	4.06	2.68	0.27	0.12
(2) Brahmin	0.87	0.00	1.26	0.91	1.17	1.47	2.02	2.31	3.40	3.04	1.19	1.47	1.25	1.38	1.55	1.65	2.48	1.14	6.87	4.83	0.66	0.90
(3) Chamar (Jat)	0.17	1.26	0.00	1.30	3.12	0.17	1.55	0.51	0.97	1.07	1.76	0.24	0.58	1.30	0.73	0.91	0.87	0.18	2.64	2.11	0.50	0.18
(4) Gujar	1.16	0.91	1.30	0.00	1.77	1.10	1.15	0.84	2.39	1.95	2.21	1.54	0.34	0.61	2.48	1.35	1.69	1.64	3.70	3.91	0.57	0.92
(5) Jat	2.42	1.17	3.12	1.77	0.00	2.65	4.83	3.96	5.80	6.08	1.92	3.43	2.83	2.59	2.91	4.24	5.13	3.51	10.2	6.44	2.11	2.77
(6) Kachi	0.70	1.47	0.17	1.10	2.65	0.00	2.87	0.24	1.27	1.03	1.94	0.41	0.53	0.82	0.95	2.24	0.86	0.58	2.16	1.98	0.73	0.43
(7) Kaller	1.14	2.02	1.55	1.15	4.83	2.87	0.00	5.03	2.98	6.69	3.43	1.95	1.88	4.31	4.12	0.60	6.65	2.36	5.35	5.37	0.90	1.00
(8) Khati	1.29	2.31	0.51	0.84	3.96	0.24	5.03	0.00	3.06	1.43	3.20	0.69	0.51	0.73	1.93	3.81	1.07	1.66	2.81	2.20	0.92	0.90
(9) Koli	1.67	3.40	0.97	2.39	5.80	1.27	2.98	3.06	0.00	3.51	3.84	1.45	1.91	3.36	2.81	2.17	3.42	2.09	2.56	5.00	1.93	1.37
(10) Kori	2.42	3.04	1.07	1.95	6.08	1.03	6.69	1.43	3.51	0.00	2.22	1.52	1.83	2.86	2.22	5.51	0.66	2.29	3.34	2.80	2.28	1.77
(11) Kulmi	1.43	1.19	1.76	2.21	1.92	1.94	3.43	3.20	3.84	2.22	0.00	1.16	1.69	1.71	1.54	3.17	4.86	1.48	7.91	5.69	1.06	1.85
(12) Kumbhar	0.38	1.47	0.24	1.54	3.43	0.41	1.95	0.69	1.45	1.52	1.16	0.00	0.54	1.00	0.62	1.53	1.42	0.17	3.16	2.75	0.56	0.61
(13) Kurmi	0.79	1.25	0.58	0.34	2.83	0.53	1.88	0.51	1.91	1.83	1.69	0.54	0.00	0.48	1.27	1.56	1.10	0.86	3.09	3.43	0.24	0.65
(14) Kurumbanshi	1.55	1.38	1.30	0.61	2.59	0.82	4.31	0.73	3.36	2.86	1.71	1.00	0.48	0.00	1.83	3.84	1.99	2.31	3.66	4.64	0.79	1.21
(15) Lodha	1.04	1.55	0.73	2.48	2.91	0.95	4.12	1.93	2.81	2.22	1.54	0.62	1.27	1.83	0.00	3.25	1.68	0.61	4.86	3.53	1.13	1.09
(16) Lodhi	0.67	1.65	0.91	1.35	4.24	2.24	0.60	3.81	2.17	5.51	3.17	1.53	1.56	3.84	3.25	0.00	4.72	1.69	5.92	4.77	0.60	0.63
(17) Lohar	1.91	2.48	0.87	1.69	5.13	0.86	6.65	1.07	3.42	0.66	4.86	1.42	1.10	1.99	1.68	4.72	0.00	2.28	2.64	2.39	1.53	1.50
(18) Lora	0.24	1.14	0.18	1.64	3.51	0.58	2.36	1.66	2.09	2.29	1.48	0.17	0.86	2.31	0.61	1.69	2.28	0.00	4.13	3.23	0.53	0.30
(19) Majhi	4.06	6.87	2.64	3.70	10.2	2.16	5.35	2.81	2.56	3.34	7.91	3.16	3.09	3.66	4.86	5.92	2.64	4.13	0.00	2.83	3.86	3.36
(20) Panka	2.68	4.83	2.11	3.91	6.44	1.98	5.37	2.20	5.00	2.80	5.69	2.75	3.43	4.64	3.53	4.77	2.39	3.23	2.83	0.00	3.37	2.28
(21) Rajput	0.27	0.66	0.50	0.57	2.11	0.73	0.90	0.92	1.93	2.28	1.06	0.56	0.24	0.79	1.13	0.60	1.53	0.53	3.86	3.37	0.00	0.38
(22) Teli	0.12	0.90	0.18	0.92	2.77	0.43	1.00	0.90	1.37	1.77	1.85	0.61	0.65	1.21	1.09	0.63	1.50	0.30	3.36	2.28	0.38	0.00

TABLE 7. Size Distances among Caste Groups of Central India

Caste groups	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
(1) Ahir	0.00	0.02	0.00	0.05	0.59	0.00	0.21	0.00	0.00	0.03	0.08	0.01	0.02	0.01	0.54	0.02	0.42	0.00	0.50	0.30	0.00	0.00
(2) Brahmin	0.02	0.00	0.05	0.01	0.38	0.02	0.09	0.01	0.04	0.11	0.02	0.05	0.08	0.00	0.79	0.00	0.63	0.04	0.74	0.49	0.01	0.01
(3) Chamar (Jat)	0.00	0.05	0.00	0.08	0.69	0.01	0.27	0.01	0.00	0.02	0.12	0.00	0.01	0.03	0.46	0.04	0.34	0.00	0.42	0.24	0.02	0.01
(4) Gujjar	0.05	0.01	0.08	0.00	0.30	0.04	0.05	0.03	0.08	0.17	0.00	0.09	0.12	0.01	0.92	0.01	0.75	0.08	0.87	0.60	0.03	0.03
(5) Jat	0.59	0.38	0.69	0.30	0.00	0.56	0.10	0.52	0.67	0.91	0.23	0.70	0.80	0.42	2.26	0.40	1.99	0.67	2.18	1.73	0.50	0.52
(6) Kachi	0.00	0.02	0.01	0.04	0.56	0.00	0.19	0.00	0.01	0.04	0.07	0.01	0.02	0.01	0.57	0.01	0.44	0.01	0.53	0.33	0.00	0.00
(7) Kaller	0.21	0.09	0.27	0.05	0.10	0.19	0.00	0.17	0.26	0.41	0.03	0.28	0.34	0.11	1.42	0.10	1.21	0.26	1.35	1.01	0.16	0.17
(8) Khati	0.00	0.01	0.01	0.03	0.52	0.00	0.17	0.00	0.01	0.06	0.06	0.01	0.03	0.01	0.62	0.01	0.48	0.01	0.57	0.36	0.00	0.00
(9) Koli	0.00	0.04	0.00	0.08	0.67	0.01	0.26	0.01	0.00	0.02	0.12	0.00	0.01	0.03	0.47	0.04	0.35	0.00	0.43	0.25	0.01	0.01
(10) Kori	0.03	0.11	0.02	0.17	0.91	0.04	0.41	0.06	0.02	0.00	0.22	0.01	0.00	0.09	0.31	0.10	0.21	0.02	0.27	0.13	0.06	0.05
(11) Kulmi	0.08	0.02	0.12	0.00	0.23	0.07	0.03	0.06	0.12	0.22	0.00	0.13	0.17	0.03	1.05	0.02	0.86	0.11	0.99	0.70	0.05	0.06
(12) Kumbhar	0.01	0.05	0.00	0.09	0.70	0.01	0.28	0.01	0.00	0.01	0.13	0.00	0.00	0.04	0.45	0.04	0.33	0.00	0.41	0.23	0.02	0.01
(13) Kurmi	0.02	0.08	0.01	0.12	0.80	0.02	0.34	0.03	0.01	0.00	0.17	0.00	0.00	0.06	0.37	0.07	0.27	0.01	0.33	0.18	0.04	0.03
(14) Kurumbanshi	0.01	0.00	0.03	0.01	0.42	0.01	0.11	0.01	0.03	0.09	0.03	0.04	0.06	0.00	0.73	0.00	0.58	0.03	0.68	0.45	0.00	0.01
(15) Lodha	0.54	0.79	0.46	0.92	2.26	0.57	1.42	0.62	0.47	0.31	1.05	0.45	0.37	0.73	0.00	0.77	0.01	0.47	0.00	0.04	0.64	0.61
(16) Lodhi	0.02	0.00	0.04	0.01	0.40	0.01	0.10	0.01	0.04	0.10	0.02	0.04	0.07	0.00	0.77	0.00	0.61	0.04	0.72	0.47	0.01	0.01
(17) Lohar	0.42	0.63	0.34	0.75	1.99	0.44	1.21	0.48	0.35	0.21	0.86	0.33	0.27	0.58	0.01	0.61	0.00	0.35	0.00	0.01	0.50	0.48
(18) Lora	0.00	0.04	0.00	0.08	0.67	0.01	0.26	0.01	0.00	0.02	0.11	0.00	0.01	0.03	0.47	0.04	0.35	0.00	0.43	0.25	0.01	0.01
(19) Majhi	0.50	0.74	0.42	0.87	2.18	0.53	1.35	0.57	0.43	0.27	0.99	0.41	0.33	0.68	0.00	0.72	0.00	0.43	0.00	0.03	0.59	0.57
(20) Panka	0.30	0.49	0.24	0.60	1.73	0.33	1.01	0.36	0.25	0.13	0.70	0.23	0.18	0.45	0.04	0.47	0.01	0.25	0.03	0.00	0.37	0.35
(21) Rajput	0.00	0.01	0.02	0.03	0.50	0.00	0.16	0.00	0.01	0.06	0.05	0.02	0.04	0.00	0.64	0.01	0.50	0.01	0.59	0.37	0.00	0.00
(22) Teli	0.00	0.01	0.01	0.03	0.52	0.00	0.17	0.00	0.01	0.05	0.06	0.01	0.03	0.01	0.61	0.01	0.48	0.01	0.57	0.35	0.00	0.00

constitute separate clusters. For example the biggest group is of agriculture practitioners are distributed in different clusters.

In the rigid caste system of Hinduism, the social, political and economic milieu of a population in Central India is determined by his caste, which, by and large decide the occupation. Again occupation provides the level of subsistence and livelihood. Trans-generational practice of definite kind of occupation and inheritance pattern of occupation creates a set of constant environment, in which particular gene pools have to exist and manifest. The privileges and stigma associated with caste and occupation nurture and amplify the set of condition associated with it. Furthermore, these all castes are endogamous, so there are hardly any chances of change in any of gene pools. In this way, it can be postulated from the present study that Central Indian population have different socio-economic environment due to caste and occupation generated privilege and stress.

TABLE 8. Shape Distances among Caste Groups of Central India

Caste groups	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
(1) Ahir	0.00	0.85	0.17	1.11	1.83	0.70	0.93	1.29	1.67	2.39	1.35	0.38	0.77	1.53	0.50	0.65	1.50	0.24	3.56	2.38	0.27	0.12
(2) Brahmin	0.85	0.00	1.21	0.91	0.80	1.45	1.93	2.30	3.36	2.92	1.17	1.42	1.17	1.38	0.76	1.65	1.85	1.10	6.14	4.34	0.65	0.89
(3) Chamar (Jat)	0.17	1.21	0.00	1.22	2.44	0.17	1.29	0.50	0.97	1.05	1.64	0.24	0.57	1.27	0.27	0.87	0.53	0.19	2.22	1.87	0.49	0.17
(4) Gujar	1.11	0.91	1.22	0.00	1.48	1.06	1.10	0.81	2.31	1.79	2.21	1.46	0.22	0.60	1.56	1.34	0.94	1.57	2.83	3.31	0.54	0.89
(5) Jat	1.83	0.80	2.44	1.48	0.00	2.09	4.74	3.45	5.13	5.17	1.69	2.73	2.03	2.17	0.65	3.85	3.14	2.85	7.98	4.70	1.61	2.25
(6) Kachi	0.70	1.45	0.17	1.06	2.09	0.00	2.68	0.24	1.27	0.99	1.87	0.41	0.51	0.81	0.37	2.23	0.42	0.58	1.63	1.65	0.73	0.43
(7) Kaller	0.93	1.93	1.29	1.10	4.74	2.68	0.00	4.87	2.72	6.28	3.40	1.68	1.54	4.20	2.70	0.50	5.44	2.10	4.00	4.36	0.74	0.83
(8) Khati	1.29	2.30	0.50	0.81	3.45	0.24	4.87	0.00	3.05	1.37	3.14	0.67	0.48	0.73	1.31	3.80	0.59	1.65	2.24	1.84	0.92	0.90
(9) Koli	1.67	3.36	0.97	2.31	5.13	1.27	2.72	3.05	0.00	3.49	3.73	1.45	1.91	3.33	2.34	2.13	3.07	2.09	2.13	4.76	1.92	1.36
(10) Kori	2.39	2.92	1.05	1.79	5.17	0.99	6.28	1.37	3.49	0.00	2.00	1.51	1.83	2.77	1.92	5.41	0.45	2.27	3.07	2.67	2.22	1.72
(11) Kulmi	1.35	1.17	1.64	2.21	1.69	1.87	3.40	3.14	3.73	2.00	0.00	1.03	1.51	1.69	0.50	3.15	4.00	1.37	6.92	5.00	1.01	1.80
(12) Kumbhar	0.38	1.42	0.24	1.46	2.73	0.41	1.68	0.67	1.45	1.51	1.03	0.00	0.53	0.96	0.18	1.49	1.09	0.17	2.76	2.52	0.54	0.60
(13) Kurmi	0.77	1.17	0.57	0.22	2.03	0.51	1.54	0.48	1.91	1.83	1.51	0.53	0.00	0.42	0.90	1.49	0.84	0.85	2.76	3.25	0.20	0.62
(14) Kurumbanshi	1.53	1.38	1.27	0.60	2.17	0.81	4.20	0.73	3.33	2.77	1.69	0.96	0.42	0.00	1.11	3.85	1.41	2.28	2.98	4.20	0.79	1.21
(15) Lodha	0.50	0.76	0.27	1.56	0.65	0.37	2.70	1.31	2.34	1.92	0.50	0.18	0.90	1.11	0.00	2.49	1.68	0.14	4.86	3.50	0.50	0.48
(16) Lodhi	0.65	1.65	0.87	1.34	3.85	2.23	0.50	3.80	2.13	5.41	3.15	1.49	1.49	3.85	2.49	0.00	4.11	1.66	5.21	4.30	0.60	0.62
(17) Lohar	1.50	1.85	0.53	0.94	3.14	0.42	5.44	0.59	3.07	0.45	4.00	1.09	0.84	1.41	1.68	4.11	0.00	1.93	2.64	2.38	1.04	1.02
(18) Lora	0.24	1.10	0.19	1.57	2.85	0.58	2.10	1.65	2.09	2.27	1.37	0.17	0.85	2.28	0.14	1.66	1.93	0.00	3.70	2.98	0.52	0.29
(19) Majhi	3.56	6.14	2.22	2.83	7.98	1.63	4.00	2.24	2.13	3.07	6.92	2.76	2.76	2.98	4.86	5.21	2.64	3.70	0.00	2.81	3.27	2.79
(20) Panka	2.38	4.34	1.87	3.31	4.70	1.65	4.36	1.84	4.76	2.67	5.00	2.52	3.25	4.20	3.50	4.30	2.38	2.98	2.81	0.00	3.00	1.93
(21) Rajput	0.27	0.65	0.49	0.54	1.61	0.73	0.74	0.92	1.92	2.22	1.01	0.54	0.20	0.79	0.50	0.60	1.04	0.52	3.27	3.00	0.00	0.38
(22) Teli	0.12	0.89	0.17	0.89	2.25	0.43	0.83	0.90	1.36	1.72	1.80	0.60	0.62	1.21	0.48	0.62	1.02	0.29	2.79	1.93	0.38	0.00

Possibly at one point of time all these caste members were similar in body structure. But due to practice of different occupation by different castes, and same occupation by same caste, since many generations, the disparity in socio-economic condition is widened. The caste groups practicing leisurely occupation like priesthood become affluent, whereas their counterparts who remain in laborious and less yielding jobs become poorer. The constant poor means of subsistence worked as a force to change body structure. Since birth they had to survive in poor means of livelihood resulting into growth retardation. As an adult too, they have to survive in limited means of subsistence. In this way, since many generations, members of some of the caste groups remained in malnourished condition, which ultimately resulted in permanent reduction of their body size so they can survive in such adverse circumstances. This permanent change in their body size as well as shape is inherited from one generation to another. In this way, the

castes are evolved and differentiated from their counterparts. And this is corroborated with dendrograms drawn, which provides an excellent way to find out the closeness and differences between different caste groups.

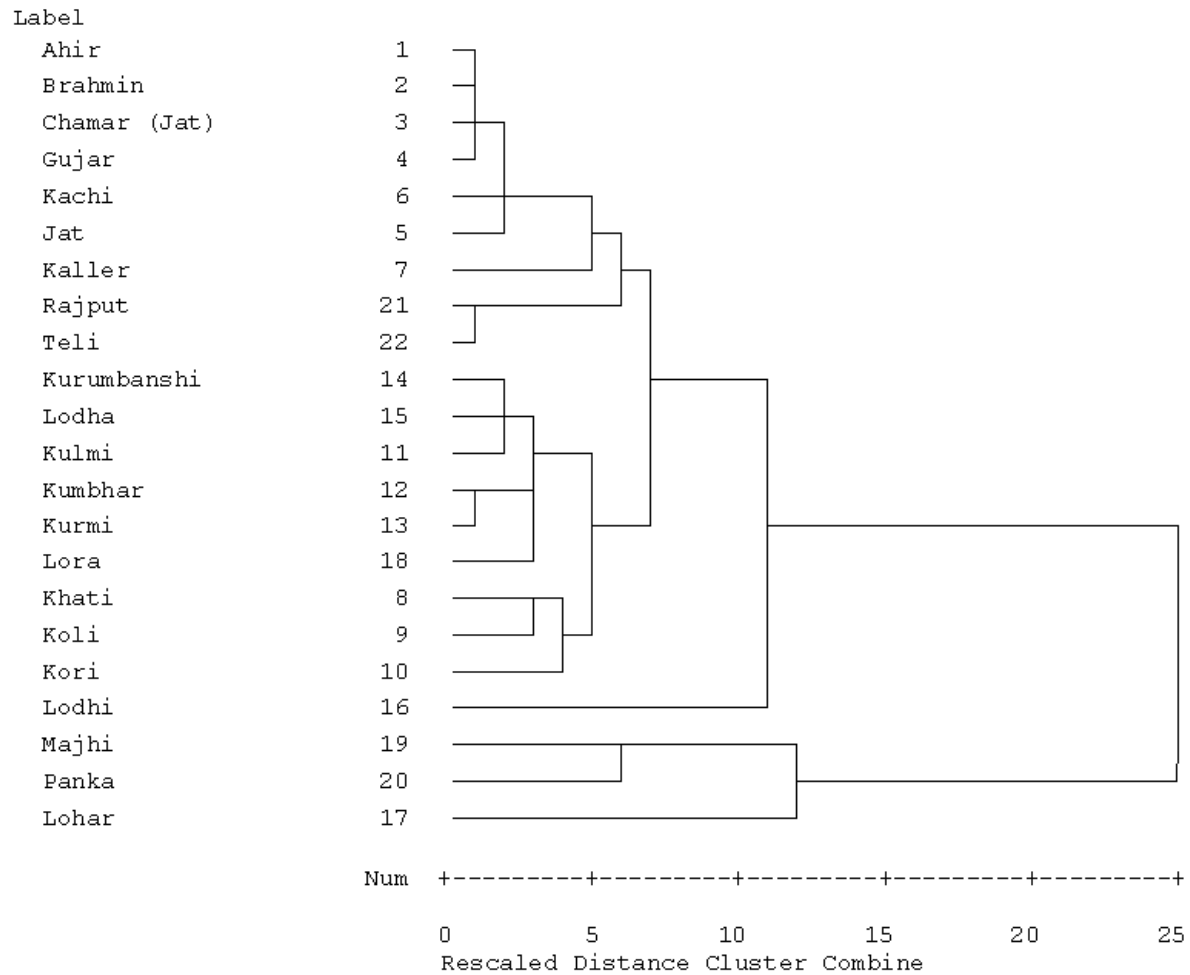
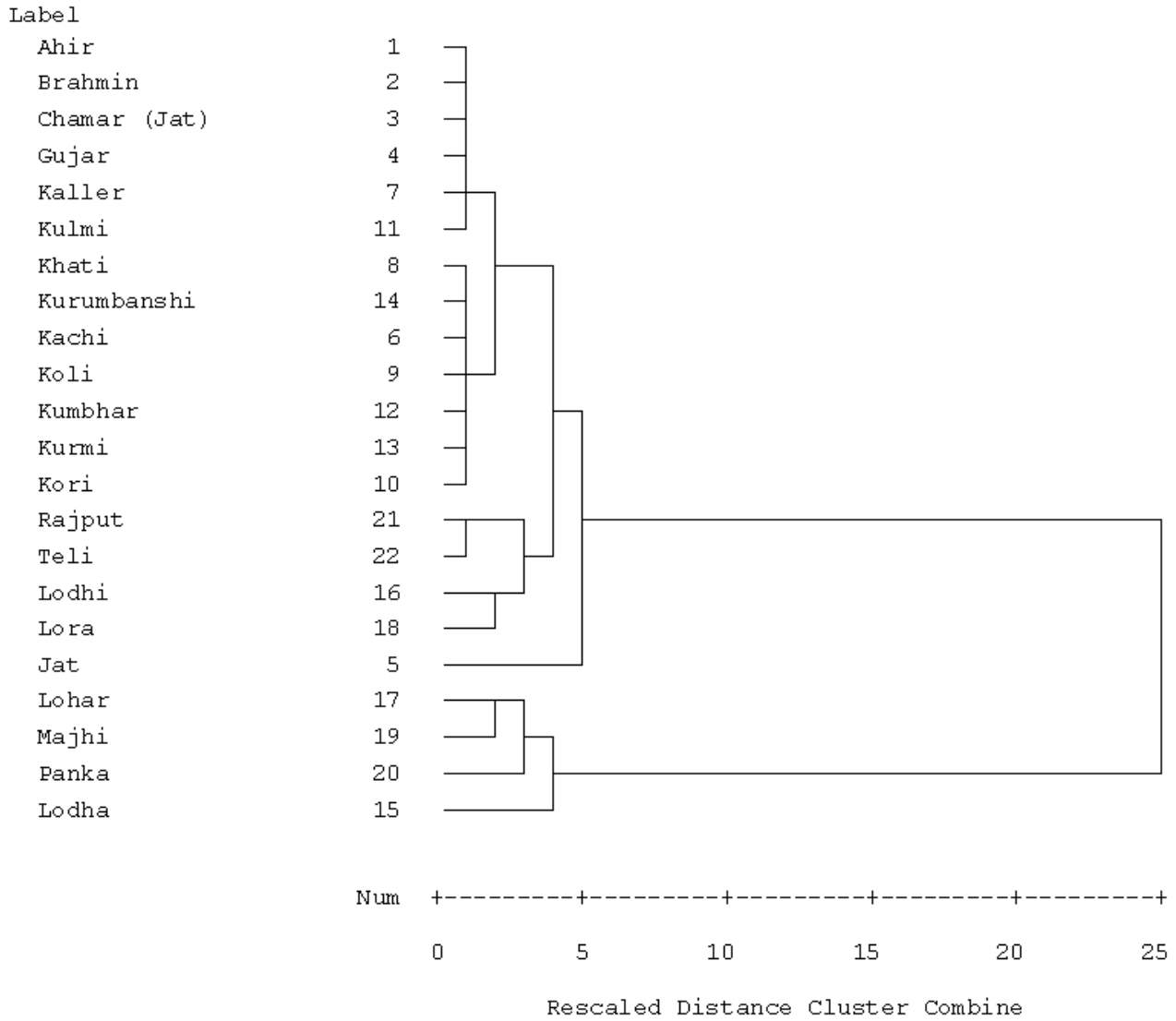
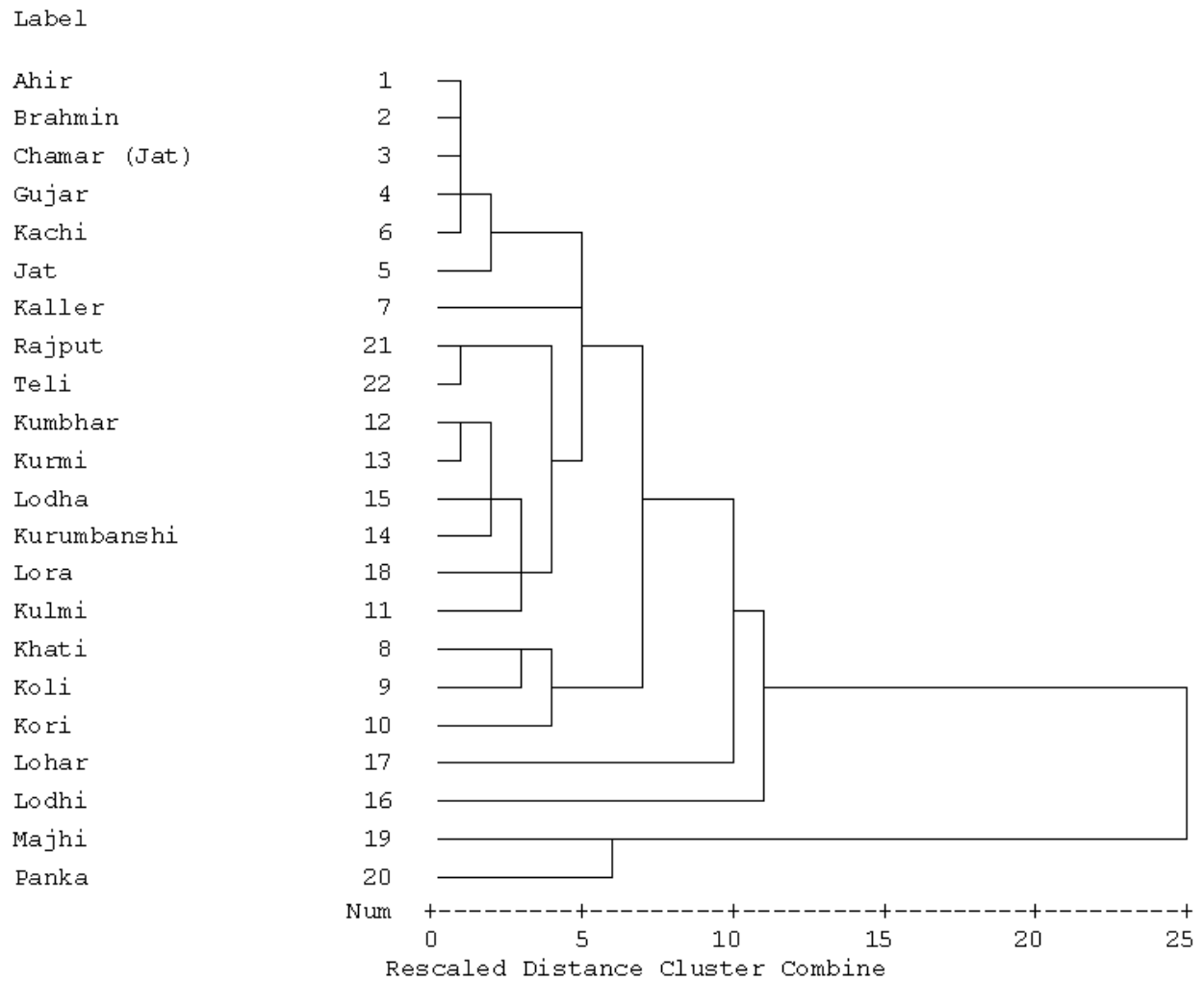


Figure 3: Dendrogram based on Mahalanobis D-Square Matrix of 22 caste groups of Central India



**Figure 4: Dendrogram based on Mahalanobis size distance of 22 caste groups of Central India**



**Figure 5: Dendrogram based on Mahalanobis shape distance of 22 caste groups of Central India**

## REFERENCES

Adak DK, Gautam RK, Bharati S, Gharami AK, Pal M, and Bharati P. 2006. Body Mass Index and Chronic Energy Deficiency of Adult Males of Central Indian Populations. *Hum. Biol.*, 78:201–218.

Ayala FJ. 1968. Genotype, environment and population numbers. *Science*, 162:1453-1459.

Basu A, Mukherjee DP, Dutta PC, Bose DK, Basu MP, Ghosh GD, Kumar GC and Huq F. 1994. *All India Anthropometric Survey: North Zone Basic Anthropometric Data, Vol.I: Madhya Pradesh*. Calcutta, Anthropological Survey of India.

Ferro-Luzzi A, Sette S, Franklin M and James WPT. 1992. A Simplified approach of assessing adult chronic energy deficiency. *Eur. J. Clin. Nutr.*, 46:173-186.

Frisancho AR, Sanchez J, Pallardel D and Yanez L. 1973. Adaptive significance of small body size under poor socio-economic conditions in Southern Peru. *Am. J. Phy. Anthrop.*, 39:255-61.

James WPT, Ferro-Luzzi A, and Waterlow JC. 1988. Definition of chronic energy deficiency in adults. *Eur. J. Clin. Nutr.*, 42:969-981.

Khongsdier R. 2001. Body mass index of adult males in 12 populations of Northeast India. *Ann. Hum. Biol.*, 28: 374-383.

Khongsdier, R. 2002. Body mass index and morbidity in adult males of the War Khasi in Northeast India. *Eur. J. Clin. Nutr.*, 56: 484-489.

Martin R, and Saller DK. 1956. *Lehrbuch der Anthropologie, Vol.3*, Stuttgart, G. Fisher.

Penrose LS. 1947. Some notes on discrimination. *Ann. Eugenics.*, 13:228-237.

Penrose LS. 1954. Distance, size and shape. *Ann. Eugenics.*, 18: 337-343.

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