Original Article

Classification of hard core and petty criminals using anthropometric measurements

Girdhar G. Agrawal[1], Akash Asthana[1,*], Amit Maurya[2]

[1] *Department of Statistics, University of Lucknow, Lucknow, India;*
[2] *Department of Geriatric Mental Health, King George's Medical University, Lucknow, India.*

Summary **The purpose of the present study was to compare the somatometric measurements among hard core criminals, petty criminals and community people. Using standard anthropometric procedures, somatometric dimensions were studied on 250 subjects each from the three groups: (*i*) experimental (hard core criminal) group, (*ii*) control-I (petty criminal) group, and (*iii*) control-II (community people) group. Univariate analysis of variance was used for making comparisons of somatometric measurements between these groups in the univariate case. Quadratic discriminant analysis (QDA) was used to develop a model based on measurements that classifies the cases into groups. The study revealed that the somatometric measurements such as morphological total facial height ($p < 0.01$), physiognomic total facial height ($p = 0.015$), nasal length ($p = 0.001$), height of lower face ($p = 0.001$), nasal depth ($p = 0.002$), sitting height vertex ($p = 0.011$), bigonial breadth ($p < 0.001$), maximum head breadth ($p = 0.001$), morphological upper facial height ($p < 0.001$), and physiognomic ear breadth ($p = 0.039$) were significantly different between the three groups. Morphological upper facial height, physiognomic total facial height, nasal length and height of lower face could be used as identifying factors for hard core criminals. Morphological total facial height, physiognomic upper facial height, physiognomic ear breadth, and sitting height were found different significantly in the experimental group as compared to the control-II group. The QDA provided an overall 72.4% correct classification of cases and 74.5%, 69.6%, and 72.9% correct classification for the experimental, control-I and control-II groups, respectively. The blurred distinction of the three groups could be explained by using the QDA model.**

Keywords: Somatometric measurements, hard core criminals, petty criminals, Kruskal-Wallis test

1. Introduction

The common belief that body-build is somehow related to function not only in general behavior, temperament, and disease as well as in socially unacceptable acts finds expression in folk-saying, verse, clinical observation, *etc*.

In a system of identifying criminals, the first use of anthropometrics was designed in the late 19th century by Alphonse Bertillon, a French criminologist. A study was done to find out a relationship between physique and intelligence of the criminals by Mohr and Gundlach (*1*). A small negative correlation between physique and intelligence of criminals was found by them. An anthropometric study of body-build among Illinois male prisoners was made by Gray (*2*). A major study of crime and morphology was done by Hooton on native white criminals of nine states in the United States (*3-5*). The anthropometric measurements on 4,000 males obtained by Snodgrasse revealed a very high correlation between physic and temperament of persons (*6*). A study to relate biological variables to criminal behavior was done by Ellis (*7*). Genovese (*8*) found a correlation between anthropometric measurements and IQ of criminals. Pavlich (*9*) analyzed two techniques, Alphonse Bertillon's techniques for measuring bodies

**Address correspondence to:*
Mr. Akash Asthana, Department of Statistics, University of Lucknow, Lucknow, Uttar Pradesh 226007, India.
e-mail: akash020184@rediff.com

and Francis Galton's composite portraits of criminal types, for identification of criminals.

The aim of the present study was to explore the extent to which the constitution, especially body build, and other morphological traits cause minor as well as major crime tendencies. For this purpose, we have selected three groups: (*i*) experimental (hard core criminal), (*ii*) control-I (petty criminal), and (*iii*) control-II (community people) in Uttar Pradesh, a northern state of India. Uttar Pradesh (area 240,928 sq. km.) is the largest state of India, consisting of about a 166.05 million population. In this study, 24 different somatometric dimensions were studied on 250 subjects from each of the three groups. Most of the studies in this area had used one way analysis of variance for comparison of somatometric dimensions of the study groups. In the present study discriminant analysis (DA) was used for the first time in order to make meaningful and substantive conclusions.

2. Methods

2.1. *Subjects*

The sample for the present study consisted of 250 subjects each from experimental, control-I, and control-II groups. Experimental and control-I inmates were selected from prisons of the widely spread five districts (Lucknow, Barabanki, Kanpur, Unnao, and Sitapur) covering more than one-third of the population of Uttar Pradesh.

2.2. *Definitions*

2.2.1. *Experimental (hard core criminal) group*

Inmates charge-sheeted for major offences (murder, attempt to murder, kidnapping, rape, forgery, robbery, dacoit, and gangster) under specified criminal sections at least two times on different occasions with their cases being admitted by the courts of law for trial.

2.2.2. *Control-I (petty criminal) group*

Prisoners charge-sheeted for less serious offences (theft, house breaking, bribery, dishonestly receiving stolen property, hurt, rash driving, journey without ticket, gambling, and keeping arms unlawfully) under specified sections at least two times on different occasions with their cases being admitted by the courts of law for trial.

2.2.3. *Control-II (community people) group*

Neighbors of subjects of the experimental groups belonging to the same age-group and socio-demographic background, having no evidence of specified criminal behavior and willing to cooperate.

2.3. *Measuring instruments*

In somatometry, several instruments were used to take various measurements of different parts of the body. However, the most common instruments used for measurements were the spreading calliper, sliding calliper, anthropometer, rod compass, and measuring tape.

2.4. *Measurements*

Most of the measurements were taken from one landmark to another. Specific precautions were taken to know the definition of the landmark, to locate them accurately and then to take measurements correctly with the help of following a standard technique and instruments.

Measurements were taken on the 24 somatometric dimensions of the subjects. These dimensions are maximum head length (MAHL), maximum head breadth (MAHB), maximum head height (MAHH), minimum frontal breadth (MFRB), bizygomatic breadth (BIZB), bigonial breadth (BIGB), morphological upper facial height (MUFH), morphological total facial height (MTFH), physiognomic total facial height (PTFH), physiognomic upper facial height (PUFH), nasal length (NASL), nasal breadth (NASB), nasal depth (NASD), mouth breadth (MOUB), height of the lower face (HELO), physiognomic ear length (PEAL), physiognomic ear breadth (PEAB), height vertex or stature (HVER), height acromion(HACR), height iiliocristale (HILI), sitting height vertex (SHVE), biacronial breadth (BIAB), bicristal breadth (BICB), and transverse chest breadth (TCHB). All the measurements were taken in centimeters (cm).

2.5. *Statistical analysis*

For the comparison of somatometric measures between the three groups the univariate analysis of variance (ANOVA) technique was used. For making multiple comparisons Tukey's test was used. In paired comparison, two-tailed tests were implied. Discriminant analysis was used to develop a model based on measurements that classify the cases into different groups. This model can be used for the classification of the additional observations into correct groups. Several methods are defined for the discriminant analysis from which linear discriminant analysis (LDA) and quadratic discriminant analysis (QDA) are important methods. When the covariance matrices for each group were the same, linear discriminant analysis was used, otherwise quadratic discriminant analysis was used. Measurements found significant (or nearly significant, $p \leq 0.1$) in ANOVA were used for the discriminant analysis. The whole analysis was done using software R-2.7.0.

3. Results

The three groups were comparable across socio-demographic characteristics (Table 1). The majority of the persons in each group were male (above 95%). The majority of persons (nearly 80% in each group) were below 33 years of age. A little more than half of the persons in each group were inhabitants of an urban area (52%) and nearly one-third from each group were employed in a farming occupation. Nearly half of the subjects in each group were either illiterate or had education below high school. In the control-II groups, the number of subjects married in the experimental group (51.6%) was less compared to community people (64%).

The somatometric measurements between groups were compared by using univariate comparisons (ANOVA). The main assumption of ANOVA is that the measurements should be normally distributed. By using the Shapiro-Wilk's statistic, it was observed that measurements were not normally distributed. The Kruskal-Wallis test (non-parametric analog of ANOVA) was used for univariate comparisons because the assumption of normality failed. The results of univariate comparisons are shown in Table 2. The measurements MAHB, BIGB, MUFH, MTFH, PTFH, PUFH, NASD, NASL, PEAB, PEAL, HVER, HACR, SHVE, and HELO were significantly different between the groups.

Because the assumption of normality failed pair-wise comparisons were done, using the Mann-Whitney *U*-Test, for measurements found significant ($p < 0.05$) in univariate comparisons. The results of pair-wise comparisons are presented in Table 3. The measurements MUFH, MTFH, PUFH, NASL, HELO, HACR, and SHVE were significantly different between the experimental group and control-I group as well as control-II group. The measurements MAHB, PTFH, NASD, PEAL, and HVER were significantly different between the experimental group and control-I group, whereas BIGB and PEAB were different between the experimental group and control-II group. MAHB, BIGB, PUFH, NASD, and PEAL were significantly different between the control-I group and control-II group.

The homogeneity of covariance matrix of measurements was tested using Box's *M*-test because it is an important assumption for LDA. The covariance matrices for the three groups were found significantly different ($p < 0.001$). Because the data was not normally distributed, robust quadratic discriminant analysis was used for fitting the classification model. The classification obtained by robust LDA and robust QDA were compared using the original measurements. An overall correct classification of 72.4% was obtained by robust QDA (Table 4).

4. Discussion

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Table 1. Socio demographic profile of each group

Variables	Subject type		
	Experimental	Control-I	Control-II
Sex			
Male	239 (95.6%)	239 (95.6%)	238 (95.2%)
Female	11 (4.4%)	11 (4.4%)	12 (4.8%)
Age			
Less than 33 years	200 (80.0%)	205 (82.0%)	197 (78.8%)
Between 33-43 years	44 (17.6%)	36 (14.4%)	50 (20.0%)
More than 43 years	6 (2.4%)	9 (3.6%)	3 (1.2%)
Domecile			
Rural	120 (48.0%)	120 (48.0%)	120 (48.0%)
Urban	130 (52.0%)	130 (52%)	130 (52.0%)
None	26 (10.4%)	25 (10%)	32 (12.8%)
Occupation			
Currently unemployed	8 (3.2%)	8 (3.2%)	2 (0.8%)
Farming	91 (36.4%)	96 (38.4%)	99 (39.6%)
Service	21 (8.4%)	12 (4.8%)	16 (6.4%)
Business	37 (14.8%)	42 (16.8%)	47 (18.8%)
Self employed	57 (22.8%)	53 (21.2%)	42 (16.8%)
Other	10 (4.0%)	14 (5.6%)	12 (4.8%)
Marital Status			
Married	129 (51.6%)	147 (58.8%)	160 (64.0%)
Unmarried	114 (45.6%)	92 (36.8%)	89 (35.6%)
Others (Widow, Divorced, *etc.*)	7 (2.8%)	11 (4.4%)	1 (0.4%)
Education			
Illiterate	1 (0.4%)	0 (0.0%)	0 (0.0%)
Below high school	120 (48.0%)	121 (48.4%)	120 (48.0%)
High school	94 (37.6%)	96 (38.4%)	96 (38.4%)
Intermediate	22 (8.85%)	20 (8.0%)	21 (8.4%)
More than intermediate	13 (5.2%)	13 (5.2%)	13 (5.2%)

Table 2. Univariate comparison of somatometric measurements between three groups using Kruskal-Wallis test

Measurement	Chi-square	Asymptotic significance
MAHL	5.015	0.081
MAHB	15.263	< 0.001
MAHH	0.301	0.86
MFRB	1.451	0.484
BIZB	4.006	0.135
BIGB	23.859	< 0.001
MUFH	21.298	< 0.001
MTFH	11.471	0.003
PTFH	7.678	0.022
PUFH	28.17	< 0.001
NASL	16.228	< 0.001
NASB	1.014	0.602
NASD	11.801	0.003
MOUB	3.302	0.192
HELO	20.324	< 0.001
PEAL	6.852	0.033
PEAB	7.516	0.023
HVER	13.662	0.001
HACR	11.442	0.003
HILI	5.909	0.052
SHVE	17.146	< 0.001
BIAB	0.635	0.728
BICB	0.657	0.720
TCHB	2.848	0.241

Table 3. Pair-wise comparison of somatometric measurements between groups using Mann-Whiteny *U* test

Measurements	Pair of groups		
	Experimental and control-I	Experimental and control-II	Control-I and control-II
MAHB	0.0002	0.3655	0.0032
BIGB	0.0834	< 0.001	0.0017
MUFH	0.0024	< 0.001	0.1027
MTFH	0.0409	< 0.001	0.1937
PTFH	0.0066	0.0631	0.3501
PUFH	< 0.001	< 0.001	0.0336
NASL	< 0.001	< 0.001	0.8971
NASD	0.0216	0.3376	< 0.001
HELO	< 0.001	0.0001	0.71
PEAL	0.019	0.8111	0.0278
PEAB	0.0624	0.0079	0.4017
HVER	< 0.001	0.0524	0.0743
HACR	< 0.001	0.0209	0.2836
SHVE	0.0214	< 0.001	0.0874

Table 4. Correct classification (in %) obtained by robust LDA and robust QDA

Group	Model	
	LDA	QDA
Experimental	64.3	74.5
Control-I	66.0	69.6
Control-II	63.8	72.9
Overall	64.6	72.4

behavior has received very little attention either from anthropologists or from behavior scientists. Such studies involving criminals are too scanty indeed, presumably because crime, as such, not only is a multi-dimensional phenomenon but also carries socio-cultural bias in terms of the assigned cognizance of its severity. Hooton (*3*) reported a number of somatometric indices of criminals but mostly restricted the scope of somatometric measures to somatoscopic observations, while this study was mainly concerned with somatometric measurements of hard core as well as petty criminals and community people. Hooton (*3*) also reported excessive thinner body hair, thin beard, and broad ears in his sample of criminals as was found in the present study.

Among the somatometric dimensions included in the present study, significant differences between hard core criminals and community people were observed in respect to physiognomic ear breath. In addition to this characteristic among the studied samples of criminals, as compared to community people, other significant somatometric dimensions of hard core criminals, as found in the present study, were bigonial breadth, morphological upper facial height, morphological total facial height, physiognomic upper facial height, nasal length, height acromion, and sitting height vertex.

As compared to the petty criminals, significant somatometric dimensions of the hard core criminals, as found in the study were maximum head breadth, morphological upper facial height, morphological total facial height, physiognomic total facial height, physiognomic upper facial height, nasal length, nasal depth, physiognomic ear length, height vertex, height acromion, and sitting height vertex.

Also in the petty criminal group when compared to community people only maximum head breadth, bigonial breadth, physiognomic upper facial height, physiognomic ear length, and nasal depth were found significant.

The QDA model using the variables significant in the ANOVA provides the highest (74.5%) correct classification for the hard core criminal (experimental) group. For the petty criminal (control-I) group and community people (control-II) group the correct classification using the QDA model were 69.6% and 72.9%, respectively. Whereas when using the linear discriminant analysis model the correct classification obtained for the experimental, control-I, and control-II groups were 64.3%, 66.0%, and 63.8%, respectively. This blurred distinctiveness of these groups was recovered by using the discriminant analysis.

In conclusion, some of the somatometric measurements obtained were significantly different between the three groups and the blurred distinctiveness of these groups was captured through the quadratic discriminant analysis. These measurements along with psychological traits (such as behavior, environment, mental health of person, *etc*.) could be used to distinguish the criminals from the community people.

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