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Research Article

FACIAL ANTHROPOMETRY IN SOUTH INDIAN POPULATION: AUTOPSY-BASED CORELATIONS OF SEXUAL DIMORPHISM AND STATURE

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ABSTRACT

Background: In Forensic anthropology, the estimation of stature from the bones plays an important role in the identification of missing persons. In order to determine stature separate regression formulae should be developed for each population group. the present study is thus conducted to derive regression equations for estimation of stature from facial dimensions in the state of Kerala. **Aims and objectives: the present study aims to** study the correlation between Stature and different facial measurements and to derive a regression formula for estimation of Stature from Cephalo-facial measurements. **Materials and methods:** Data from total of 354 subjects were collected. The height of the deceased was measured by placing the body on autopsy table. Bigonial Breadth, Bizygomatic Breadth, Morphological Facial Length, Physiognomic Facial Length, Nasal Height and Nasal Breadth were measured using Calipers. All the measurements were documented in cm. Data was analyzed using SPSS 1.1 software. Simple linear regression was carried to predict Stature using facial measurements. $p<0.01$ was considered the threshold for statistical significance. **Result:** The mean values of facial measurements were also higher in males than females. There was significant correlation between Stature and different facial measurements (p-value< 0.01) in case of both males and females. Physiognomic Facial Length showed high correlation with stature when both sexes combined together and separately. Nasal Breadth showed low correlation with stature when both sexes combined together and very low correlation in case of females. Regression analysis was carried out to derive Linear regression equation to estimate Stature from different Cephalo-facial measurement(s) in each population group. The Standard Error of Estimate of the Linear regression equations using a single measurement in the present study ranged between ±0.23 and ±1.63 in men and between ±0.31 and ±1.67 in women. All facial measurements are significant for estimating Stature except Nasal breadth. **Conclusion:** In

this study Physiognomic Facial Length showed next high correlation with stature when both sexes combined together and showed moderate correlation with stature when the gender considered separately. Nasal Breadth and Head Circumference showed low correlation with stature when both sexes combined together, Head Circumference showed very low correlation with stature in case of males and Nasal Breadth showed very low correlation in case of females.

Key Words: correlation, facial measurements, linear regression equation,

INTRODUCTION

The stature/height of a person is an inherent character, it is considered to be one of the important parameters of personal identification.

In identification of human remains, Forensic anthropologists help to interpret evidence pertaining to manner or cause of death. Marks on bones provide very important information as to how death occurred. Scientific support to establish identity of a living person is required when the subject is unconscious or has some mental sub-normality in cases of death due to criminal acts. Mostly half of the problem is solved if the identity of the deceased is established as it provides the investigating officer a definite tool for further proceedings [1].

Stature has a definite and proportional biological relationship with each and every part of the body i.e; head, face, trunk and extremities which helps a Forensic expert to calculate stature from dismembered and mutilated body parts in forensic examinations[2].

Many studies have been conducted on Stature Estimation from various body parts like upper and lower limbs, hands, individual long and short bones, trunk, intact vertebral column, foot and footprints etc .[3-6] Since all these parts of the body and bones are not always available for Forensic examination, it becomes necessary to make use of other parts of the body like head and face region. But only a few studies have been conducted on facial region with respect to estimation of stature. There are plenty of studies which focus on other aspects of the facial identification. Determination of sex and race from cephalic region, various methods of reconstructing the face appearance in an individual from the bones of the skull, new facial soft tissue depth data, ultrasound, computerized tomography-scans, 3D reconstruction computer programs are in full development throughout the world[7-9] .With the advent of modern sophisticated techniques like DNA fingerprinting and digital superimposition one may get inclined to consider ideas like stature estimation, race identification etc. as obsolete, but these modern techniques and scientific tools even though better in terms of high precision, are not better in terms of cost, feasibility and availability in various parts of the world. Besides these require antemortem data for comparison and are more complex in nature and require high degree of expertise to interpret the findings. In order to determine stature separate regression formulae should be developed for each population group. So the present study is conducted to derive regression equations for estimation of stature from cephalic dimensions in the state of Kerala. Our aim was to estimate stature from Facial dimensions.

MATERIALS AND METHODS

Study Design: Descriptive study

Study Setting: Department of Forensic Medicine, Govt. Medical College, Kottayam

Study Population: All dead bodies of 20-60 years age group brought to the Department of Forensic Medicine, Govt. Medical College, Kottayam for medico-legal autopsy fulfilling inclusion and exclusion criteria during the study period (354cases).

Inclusion Criteria

All dead bodies in the age group of 20 – 60 years.

Exclusion Criteria

1. Those with physical deformities and /or/with fracture skull, spine, pelvis, extremities.
2. Decapitation due to which the actual stature could not be ascertained.
3. Grossly oedematous bodies such as in sepsis and burn injuries and advanced decomposed bodies.

Methodology.

The following measurements will be considered for the study. Instruments used for the various measurements included Graduated steel tape, Caliper and measuring tape.

The following external linear dimensions of the skulls are recorded (Williams*et al.*)[10].

1.Height of the deceased: was measured by placing the body on autopsy table and measuring the highest point from the vertex to tip of the heel. This was achieved by placing the body in supine position on the flat, hard surfaced autopsy table with the knee and hip joints extended and the neck and feet in neutral position and placing two rectangular wooden blocks at the head end and heel. The length is documented in centimeters.

2. Bigonial breadth: It is the maximum breadth of the lower jaw between two gonion (It is the most posterior, inferior and laterally situated point on the external angles of the mandible) points on the angles of mandibles. This was measured using Caliper.

3. Bizygomatic breadth: It is measured between the two most lateral points on the zygomatic arches i.e. zygion to zygion by using Caliper.

4. Nasal height: It is measured from the nasal root (nasion) to the nasal base (subnasale) by using Caliper.

5. Nasal breadth: It is the distance between two most prominent points on the lateral aspect of the alanasi and measured by using Caliper.

6. Morphological facial length: It is measured from the nasion to the gnathion (the lowest point on the lower border of mandible in the mid sagittal plane) by using Caliper.

7. Physiognomic facial length: It is the straight distance, measured from trichion (the midpoint of anterior line) to the gnathion by using Caliper.

ANALYSIS

The various measurements taken were recorded in a separate proforma maintained for the study purpose. The data obtained is analysed using SPSS (Statistical Package For Social Sciences) to calculate mean, standard deviation, correlation coefficient, regression analysis and comparison of various parameters are done using student's t test.

RESULT

Table 1: Descriptive statistics regarding Height in total subjects and based on sex

Height	Mean	SD	Median	Minimum	Maximum
Total subjects	166.2	9.2	167.0	142.0	191.0
Male	171.5	6.7	172.0	146.0	191.0
Female	158.1	6.1	159.0	142.0	175.0

Table 2: Descriptive statistics regarding different facial measurements in total population

Cephalofacial measurements	Mean	SD	Median	Minimum	Maximum
Bigonal breadth	10.6	0.6	10.6	8.9	12.5
Bizygomatic Breadth	13.0	0.6	13.0	10.8	14.5
Nasal height	4.0	0.3	4.0	3.0	4.9
Nasal breadth	4.0	0.4	4.0	2.0	4.9

Morphological facial length	10.3	0.8	10.2	8.0	12.5
Physiognomic facial length	20.0	1.5	20.0	14.2	24.0

Table 3: Descriptive statistics regarding different facial measurements based on Sex

Sex	facial measurements	Mean	SD	Median	Minimum	Maximum
Male	Bigonal breadth	10.8	0.6	10.9	9.2	12.5
	Bizygomatic Breadth	13.3	0.5	13.2	11.5	14.5
	Nasal height	4.1	0.3	4.1	3.4	4.9
	Nasal breadth	4.1	0.3	4.0	2.0	4.9
	Morphological facial length	10.6	0.7	10.5	8.4	12.5
	Physiognomic facial length	20.7	1.3	20.9	14.2	24.0
Female	Bigonal breadth	10.2	0.6	10.2	8.9	11.9
	Bizygomatic Breadth	12.7	0.5	12.8	10.8	13.9
	Nasal height	3.9	0.3	3.9	3.0	4.8
	Nasal breadth	3.8	0.3	3.9	2.8	4.7
	Morphological facial length	9.8	0.7	9.8	8.0	11.9
	Physiognomic facial length	19.0	1.2	18.9	16.0	21.8

Table 4: Correlation between Stature and different facial Measurements in combined subjects

Cephalic measurements	Correlation coefficient (r)	p
Bigonal breadth	0.61	p<0.01
Bizygomatic Breadth	0.61	p<0.01
Nasal height	0.53	p<0.01
Nasal breadth	0.43	p<0.01
Morphological facial length	0.61	p<0.01
Physiognomic facial length	0.73	p<0.01

Table 5: Correlation between Stature and different facial measurements based on gender

facial measurements	Male		Female	
	Correlation coefficient(r)	p	Correlation coefficient(r)	p
Bigonal breadth	0.51	p<0.01	0.36	p<0.01
Bizygomatic Breadth	0.50	p<0.01	0.33	p<0.01
Nasal height	0.44	p<0.01	0.30	p<0.01
Nasal breadth	0.38	p<0.01	0.15	0.089

Morphological facial length	0.44	p<0.01	0.42	p<0.01
Physiognomic facial length	0.61	p<0.01	0.53	p<0.01

Table 6: Linear Regression formula for estimation of Stature from different facial measurements based on gender.

facial Measurements		Regression formulae
Physiognomic facial length	Male	Stature =107.70+3.09 x Physiognomic facial length
	Female	Stature =109.06+2.59 x Physiognomic facial length
Morphological facial length	Male	Stature =127.86+4.13 x Morphological facial length
	Female	Stature =123.54+3.54 x Morphological facial length
Bizygomatic Breadth	Male	Stature =85.24+6.50x Bizygomatic Breadth
	Female	Stature =103.20+4.32x Bizygomatic Breadth
Bigonal breadth	Male	Stature =105.29+6.12x Bigonal breadth
	Female	Stature =120.17+3.72x Bigonal breadth
Nasal Height	Male	Stature =123.41+11.74x Nasal Height
	Female	Stature =134.66+6.08x Nasal Height
Nasal breadth	Male	Stature =142.23+7.22x Nasal Breadth
	Female	Stature =147.16+2.87x Nasal Breadth

Table 7: Coefficient of Determination and Standard error of Estimate of different facial measurements.

facial measurements		Coefficient of Determination(R^2)	Standard error of Estimate(SEE)
Morphological facial length	Male	0.19	0.58
	Female	0.17	0.66
Maximum Head Breadth	Male	0.21	0.76
	Female	0.11	0.69
Bigonal breadth	Male	0.26	0.72
	Female	0.13	0.82
Bizygomatic Breadth	Male	0.25	0.77
	Female	0.11	1.07
Nasal Height	Male	0.19	1.63
	Female	0.09	1.65
Nasal breadth	Male	0.14	1.22
	Female	0.02	1.67

DISCUSSION

Different Cephalic and Facial Measurements along with Stature were considered for this study. Correlation was analyzed and Linear regression formulae were derived to estimate stature using these parameters in each population group.

Pearson correlation coefficient (r) calculated between Stature and different Cephalo-Facial measurements was significant (p - value 0.01)

In the present study the mean value of Physiognomic Facial Length (male=20.7cm; female=19cm), Morphological Facial Length (male=10.6cm; females=9.8cm), Bizygomatic Breadth (males=13.3cm; females=12.7cm), Bigonial Breadth (males=10.8cm; females=10.2cm), Nasal

Height(male=4.1cm; female=3.9cm) and Nasal Width (male=4.1cm; female=3.8cm) in males were higher than the females.

Physiognomic Facial Length explains 38% variability of stature in case of males and 28% variability of stature in case of females and showed low SEE (Male=0.27, Female=0.36)

Formulae for stature estimation from Physiognomic Facial Length

In males

Stature (cm) =107.70 +3.09 x Physiognomic Facial Length in cm

In females

Stature (cm) = 109.06 +2.59 x Physiognomic Facial Length in cm

Table 8: Studies Showing Comparison of Mean Stature and different Cephalo-Facial measurements of Present Study with Previous Studies

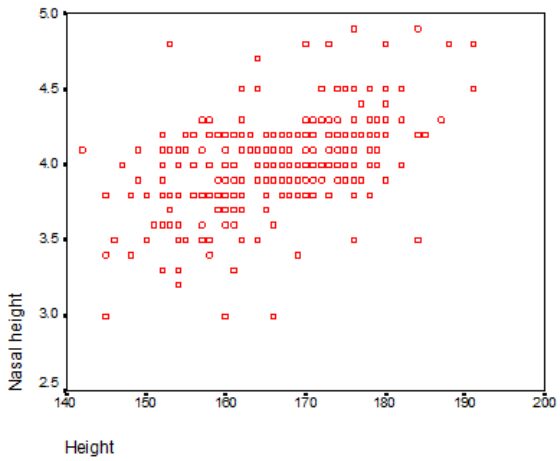
		Stature	MHL	MHB	HC	HV	PFL	MFL	BZD	BGD	NH	NB
Present study	Male	171.5	22.1	15.4	55	31	20.7	10.6	13.3	10.8	4.1	4.1
	Female	158	20	14.8	54.4	29.9	19	9.8	12.7	10.2	3.9	3.8
Krishan[3] (2007)	Male	152.64	16.28	13.019	52	33.9	16.3	10.24	9.945	8.34	4.77	3.19
Kewal Krishan[9] (2008)	Male	172.3	17.832	13.917	53.2	-	-	10.81	-	9.783	-	-
Agnihotri[12] (2011)	male	173.4	18.66	15.45	56.7	37.6	17.8	11.58	14.39	10.55	5.27	3.28
	female	157.36	18.13	14.48	54.7	36.1	16.4	11.0	14.01	9.90	5.20	2.95
Ekezie[13] (2015)	Male	173.66	32.07	21.69	56.6		20.0	14.71	-	-	-	-
	Female	163.17	32.07	24.25	56.5	-	19.4	14.08	-	-	-	-
Lukpata [14](2016)	Male	157.3	-	-	55.3	-	-	-	-	-	4.39	4.74
	Female	155.7	-	-	54.6	-	-	-	-	-	4.54	4.95
Thoudam Devi[15] (2017)	Male	164.07	19.41	15.41	-	-	-	11.99	-	12.26	-	-
Mohammed Ali[16] (2017)	Male	167.21	19.21	14.77	22.1	-	18.0	11.57	12.53	10.92	5.3	3.7
	Female	154.25	18.36	14.51	21.7	-	16.8	10.84	11.86	10.40	4.91	3.37
Munish Reddy[17] (2018)	Male	169.9	19.6	14.64	56.7	-	-	11.96	-	12.26	-	-
	Female	158.16	18.92	13.40	54.5	-	-	11.25	-	11.80	-	-

Table 9: Studies Showing Comparison of Correlation Coefficient of Present Study With Previous Studies

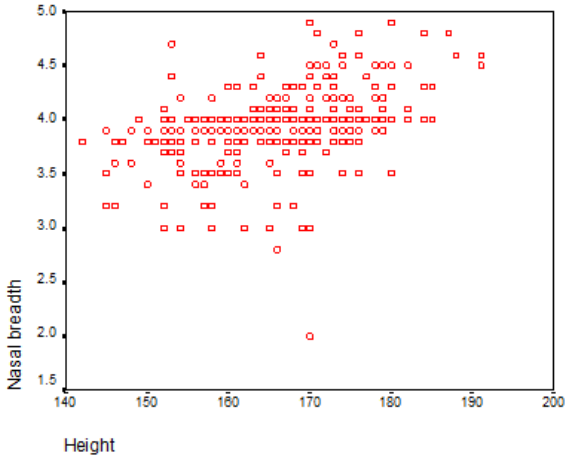
	Correlation Coefficient	MHL	MHB	HC	HV	PFL	MFL	BZD	BGD	NH	NB
Present study	Total	0.80	0.56	0.43	0.69	0.73	0.61	0.61	0.61	0.53	0.43
	Male	0.73	0.46	0.55	0.25	0.61	0.44	0.50	0.51	0.44	0.38
	Female	0.56	0.33	0.50	0.30	0.53	0.42	0.33	0.36	0.30	0.15

Krishan[3] (2007)	male	0.732	0.625	.773	0.514	0.493	0.345	0.461	0.449	0.294	0.265
Kewal Krishan[9] (2008)	male	0.775	0.682	0.781	-	-	0.455	-	0.462	-	-
Agnihotri[12] (2011)	male	0.331	0.015	0.494	0.178	0.192	0.328	0.177	0.022	0.190	0.038
	female	0.159	0.193	0.375	0.318	0.382	0.164	0.276	0.159	0.154	0.054
Ekezie [13](2015)	Male	0.114	0.285	0.209	-	0.209	0.219	-	.216	-	-
	Female	0.113	0.023	0.087	-	0.087	0.122	-	.231	-	-
Lukpata [14](2016)	Male	-	-	0.385	-	-	-	-	-	0.006	0.066
	Female	-	-	0.006	-	-	-	-	-	0.135	0.030
Thoudam Devi[15] (2017)	Male	0.343	0.168	-	-	-	0.381	0.294	-	0.301	0.320
Mohammed Ali[16] (2017)	Male	.392	0.270	0.365	-	0.124	0.142	0.121	0.090	0.180	0.039
	Female	0.318	0.170	0.229	-	0.311	0.252	0.200	0.296	0.208	0.265
Munish Reddy [17] (2018)	Male	0.715	0.612	0.729	-	-	0.498	-	0.462	-	-
	Female	0.701	0.606	0.718	-	-	0.474	-	0.442	-	-

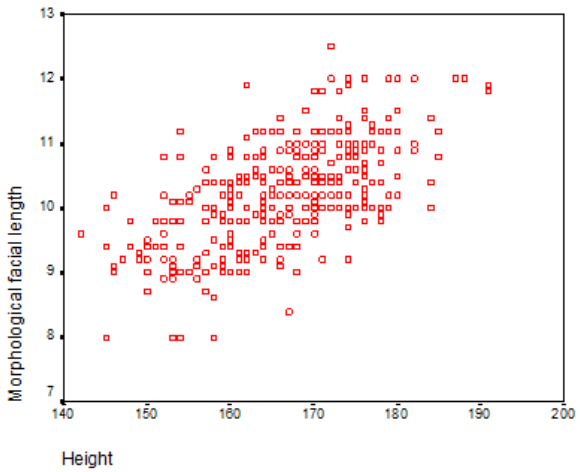
Scatter diagram showing correlation between Stature and different Facial measurements in total population



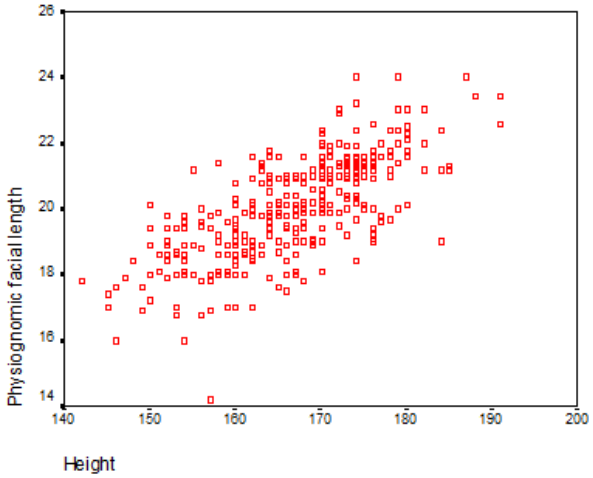
Nasal Height



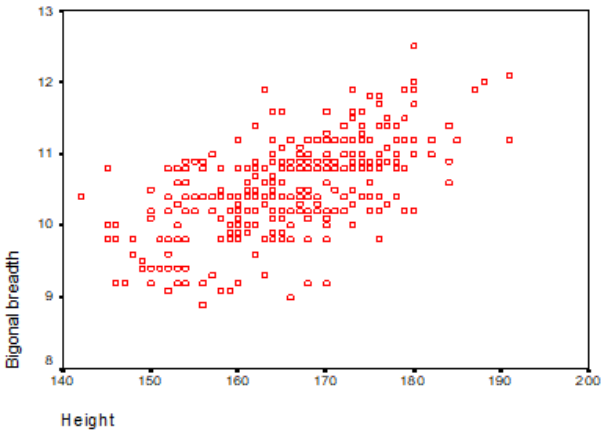
Nasal breadth



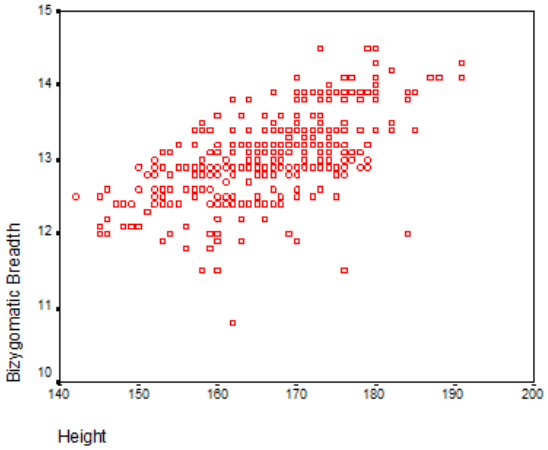
Morphological facial length



Physiognomic facial length

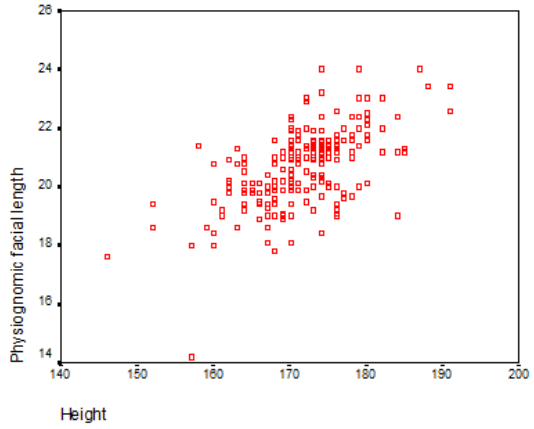


Bigonial Breadth

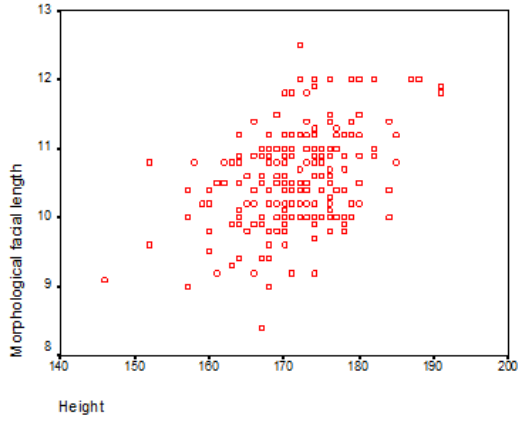


Bizygomatic breadth

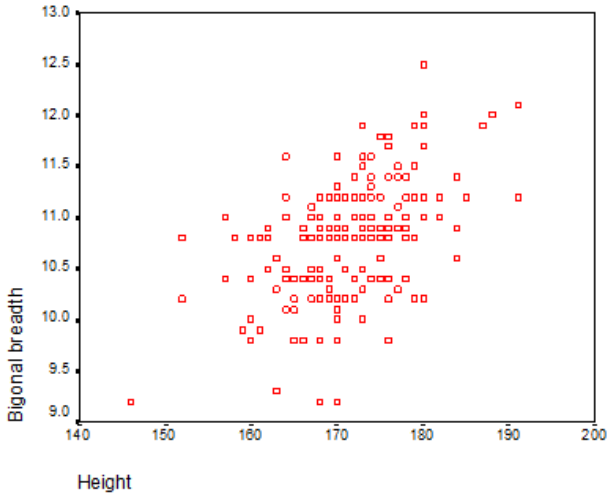
Scatter diagram showing correlation between Stature and different Facial measurements in males



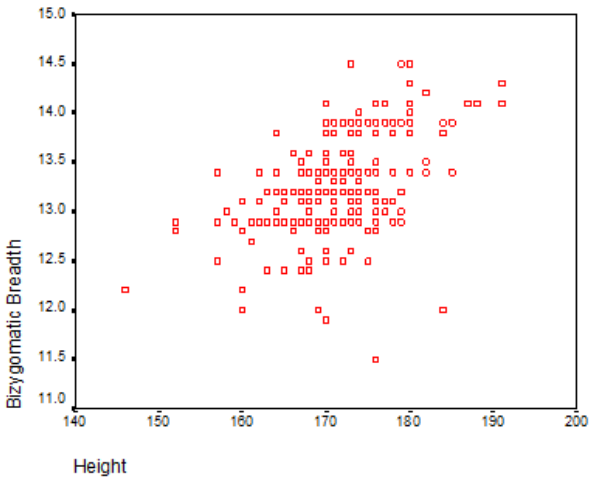
Physiognomic facial length



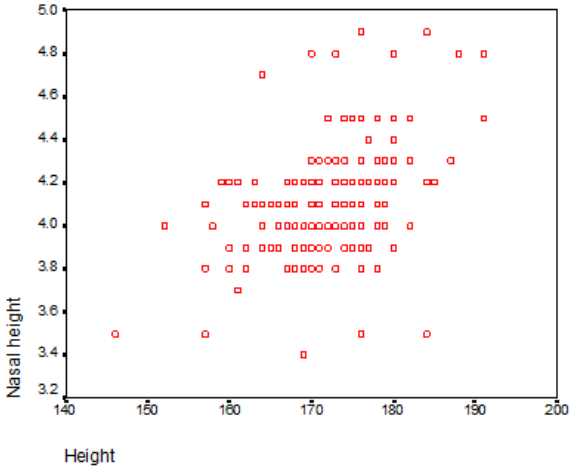
Morphological facial length



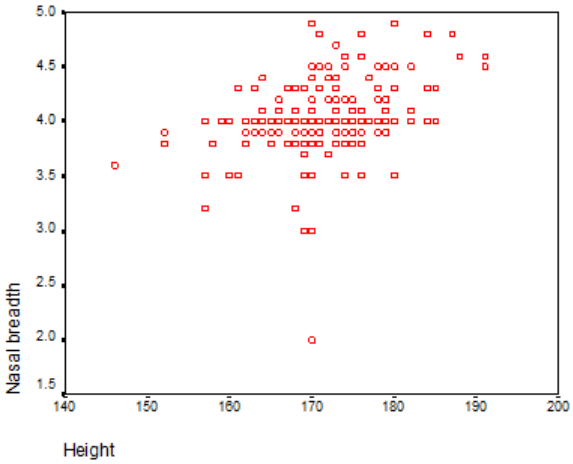
Bigonial breadth



Bizygomatic breadth

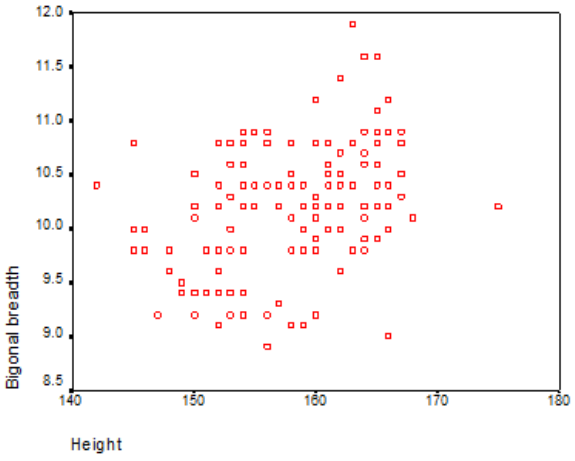


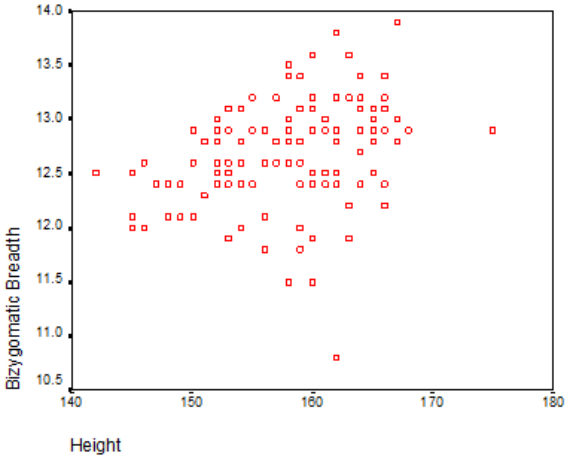
Nasal height



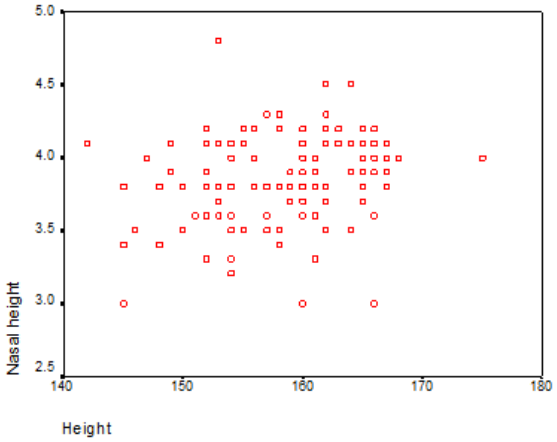
Nasal breadth

Scatter diagram showing correlation between different facial measurements in female

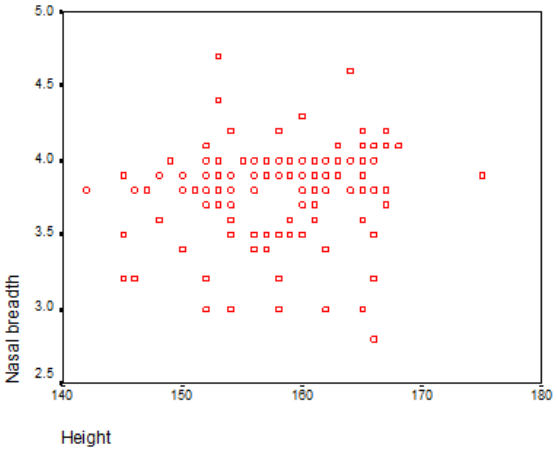




Bigonal breadth

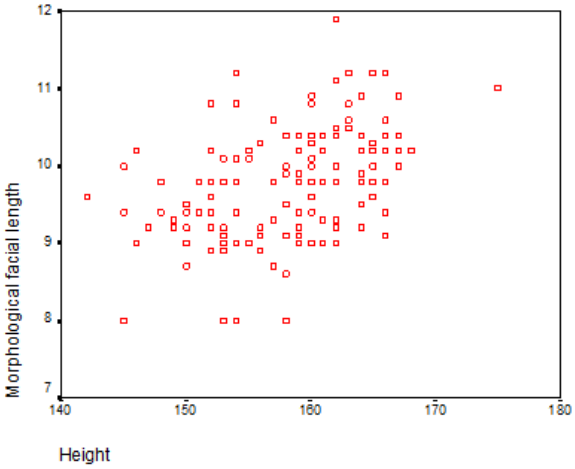


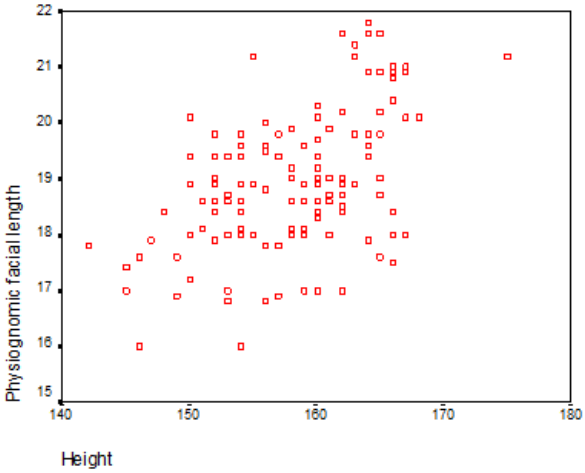
Bizygomatic Breadth



Nasal height

Nasal breadth





Morphological facial length

Physiognomic facial length

CONCLUSION

The present study agrees with earlier researches that males tend to have higher values of Cephalo-facial parameters than females. The cephalic measurements give better reliability for stature estimation than the facial measurements. From the present study, it has been concluded that, like other parts of the human body, the Cephalo-facial dimensions can also be used for estimation of stature when Cephalo-facial remains are brought for forensic examination. When the values of Karl Pearson's correlation coefficients and the standard error of estimate of each Cephalo-facial measurement are compared with one another, Maximum Head Length is found to be the best parameter for estimation of stature. It is further concluded that the calculated regression formulae show good reliability and applicability for Stature estimation in the sample which was originally used (genetically homogeneous population). While applying these formulae, one should keep in mind that these are population specific (specific to Kerala) and cannot be used for populations of other States. The result of this study will be of immense use in Forensic medicine and anthropology and will

also serve as a future framework for estimating the facial dimensions of other population groups. It is concluded that the study is quite useful for Forensic medicine personnel and Forensic scientists when unknown remains pertaining to Cephalo-facial region are brought for forensic examination.

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