JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

# DETERMINATION OF STATURE FROM FACIAL WIDTH AND FACIAL HEIGHT AMONG MAHADEV KOLI POPULATION OF M.S. (INDIA)

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*Abstract*—**Estimation of stature is of great help to solve the cases where identification of victim/s is difficult due to complete degradation of corpses. Stature is a matter of physical development of an individual of a particular community since physical development is dependent on culinary habits, economic activities and preferred lifestyle. Hence, Mahadev Koli population of India was studied for stature estimation from facial parameters. The study involved 500 individuals (250 females and 250 males) within the age range of 18-40 years from Mahadev koli population. Facial parameters such as facial width and facial height were measured using sliding calipers and stature was measured using measuring tape. The data was subjected to statistical analysis using Microsoft Excel 2010 and R software. The correlation obtained for facial width and facial height with respect to stature was positive and significant. Regression equations were obtained. The stature of the Mahadev koli population cannot be deduced from facial parameters.**

*Index Terms*—**Forensic anthropology, Facial width, Facial height, stature, R Software**

## I. INTRODUCTION

Anthropometry is made up two words ' anthropos' meaning 'human' and 'metry' meaning process of 'measurement ' this was first introduced by Alphonse Bertillon, in 1879, while working as chief of criminal identification, for the police of Paris, he came up with physical measurement and photographs-based technique which is popularly known as the 'portrait'. He included various measurements such as head length, standing height, sitting height, left arm length, foot length, right ear, etc. This information was recorded on a card known as the Bertillon card. He also tried to prove that measurements do not alter throughout life and hence can identify a human being through disguising himself with external materials.Such anthropometric measurements are driven by geographical locations, climate conditions, culinary habits, behavioral activities, economics activities, etc. Hence measurements may vary from population to population.The present study takes into consideration this variation and therefore tries to focus on 'Mahadev Koli' population of India. The community practices fishing as the primary economic activity hence they have robust physical build. The consumption of fish and rice provide them with a great amount of calcium, proteins and omega-3 that strengthens their physical development. They have a marked bone morphology and hence can be used in forensic applications.Human skull withstands all the environmental insults and remains in its original state for centuries. The cheek bone that is the zygomatic bone below the eye socket is durable and the distance between left and right zygomatic bone can aid stature estimation. Nasion to gnathion distance also plays a role in stature estimation.Stature estimation through regression analysis is better suited as it is difficult to obtain a complete skeleton most of the time. This method serves as a quick identification tool.

## II. MATERIALS AND METHODS

A cross-sectional study was conducted at Institute of Forensic Science, Mumbai. The said study was received acquiesce by the Institute Ethical Committee. The study was based on 500 Mahadev Koli subjects (250 males and 250 females) from Maharashtra within the age range of 18-40 years. A written informed consent was obtained from the participants.The method utilized by Madadi *et al.* (2018)[1], Mane *et al.* (2021)[2], Gupta *et al.*[3], Prasanna *et al.* (2013)[4], etc. was employed in the present study.
Measurements:

- Stature: the subjects were made to stand in Frankfurt horizontal plane with feet flat on ground and vertex of head and back touching a plane surface (preferably wall).

- Facial width: the maximum horizontal distance from zygion on the left zygomatic arch to zygion on the right zygomatic arch.
- Facial height: the vertical distance from nasion to gnathion, through closed mouth.

Anthropometric landmarks:

1. Nasion: It is the point between the two eyebrows where frontonasal and internasal sutures meet.
2. Gnathion: It is the lowest median point on the lower border of the mandible.
3. Zygion: It is the lateral most point on the zygomatic arch.
4. Vertex: The highest point of the head in the mid-sagittal plane, when the head is held erectly or in Frankfurt plane.

Statistical analysis:

The data was subjected to statistical analysis to determine mean, maxima. minima, standard deviation, Pearson 'r' value and significance of correlation. Microsoft Excel 2010 was used for structuring data and 'R' software 4.1.2 was used for analysis. The free version of the software was used.

## III. RESULTS

The present study reveals that facial width and facial height are higher in Mahadev Koli males than females. Also, the mean stature in males is 66.04 inch (Table II) and that of females is 61.02 inch (Table III). Mean facial width of males is 4.5 inch (Table II) and that of females is 4.3 inch (Table III). Mean facial height of males is 4.8 inch (Table II) and that of females is 4.4 inch (Table III). The correlation between stature and facial width is positive and statistically significant for both males (r=0.28) and females (r=0.18). Same is true in males (r=0.34) and females (r=0.40) in correlation with stature and facial height. (Table VII)

The linear regression equations in the form

$Y= a + bx$

were deducted for the Mahadev Koli population, where 'Y' denotes stature and 'x' shall be facial width and facial height (as required).

The regression equation for stature estimation from facial width and facial height of total 500 samples is given by

Stature=46.796+ 3.77 X Facial width

and

Stature=34.731+ 6.18 X Facial length

respectively (Table IV.).

The regression equations for the female population can be given by

Stature=54.649 + 1.47 X Facial Width

and

Stature=46.127+ 3.33 X Facial Height

to determine stature from facial width and facial height, respectively (Table V).

Similarly, regression equations were also obtained for male population, they are

Stature=56.783+ 2.04 X Facial Width for facial width

and

Stature=51.21+ 3.06(Facial Height) for facial height (Table VI).

***Tables***

**Table 1:** Descriptive statistics of 500 samples (in inches)

| Parameter | Mean | Min. | Median | Max. | Standard error | $R^2$ |
|---|---|---|---|---|---|---|
| Facial Width | 4.4 | 3.5 | 4.4 | 5.7 | 0.015483 | 0.1358 |
| Facial Height | 4.6 | 3.8 | 4.6 | 5.5 | 0.015616 | 0.3701 |
| Stature | 63.53 | 56.29 | 62.99 | 72.04 | 0.158765 | - |

**Table 2:** Descriptive statistics of 250 females (in inches)

| Parameter | Mean | Min. | Median | Max. | Standard error | $R^2$ |
|---|---|---|---|---|---|---|
| Facial Width | 4.3 | 3.5 | 4.3 | 5.5 | 0.018623 | 0.03353 |
| Facial Height | 4.4 | 3.8 | 4.5 | 5.2 | 0.018167 | 0.1638 |
| Stature | 61.02 | 56.29 | 61.02 | 71.65 | 0.149708 | - |

**Table 3:** Descriptive statistics of 250 males (in inches)

| Parameter | Mean | Min. | Median | Max. | Standard error | $R^2$ |
|---|---|---|---|---|---|---|
| Facial Width | 4.5 | 3.5 | 4.5 | 5.7 | 0.02308 | 0.03353 |
| Facial Height | 4.8 | 3.8 | 4.9 | 5.5 | 0.018793 | 0.1638 |
| Stature | 66.04 | 59.44 | 66.33 | 72.04 | 0.166931 | - |

**Table 4**: Simple linear regression equation for stature estimation of total population (N=500) (in inches)

| Parameter | Linear regression equation | ± SEE | $R^2$ | P-value |
|---|---|---|---|---|
| Facial Width | Stature=46.796+3.77(Facial width) | ±3.303 | 0.1358 | < 2.2e-16 |
| Facial Length | Stature=34.731+6.18(Facial length) | ± 2.82 | 0.3701 | < 2.2e-16 |

**Table 5:** Simple linear regression equation for stature estimation of 250 females (in inches)

| Parameter | Linear regression equation | ±SEE | $R^2$ | P-value |
|---|---|---|---|---|
| Facial Width | Stature=54.649+1.47(Facial Width) | ±2.332 | 0.03353 | 0.00367 |
| Facial Height | Stature=46.127+3.33(Facial Height) | ±2.169 | 0.1638 | 2.85e-11 |

**Table 6:** Simple linear regression equation for stature estimation of 250 males (in inches)

| Parameter | Linear regression equation | ±SEE | $R^2$ | P-value |
|---|---|---|---|---|
| Facial Width | Stature=56.783+2.04(Facial Width) | ±2.537 | 0.0079 | 5.57e-06 |
| Facial Height | Stature=51.21+3.06(Facial Height) | ±2.483 | 0.1186 | 2.26e-08 |

**Table 7:** Pearson correlation coefficient (r) for facial width and facial height with stature (female, N=250; male, N=250; total, N=500)

| Parameter | Coefficient of Correlation (r) | | |
|---|---|---|---|
| | Female | Male | Both |
| Facial width vs Stature | 0.18 | 0.28 | 0.36 |
| Facial height vs Stature | 0.40 | 0.34 | 0.64 |

***Figures***

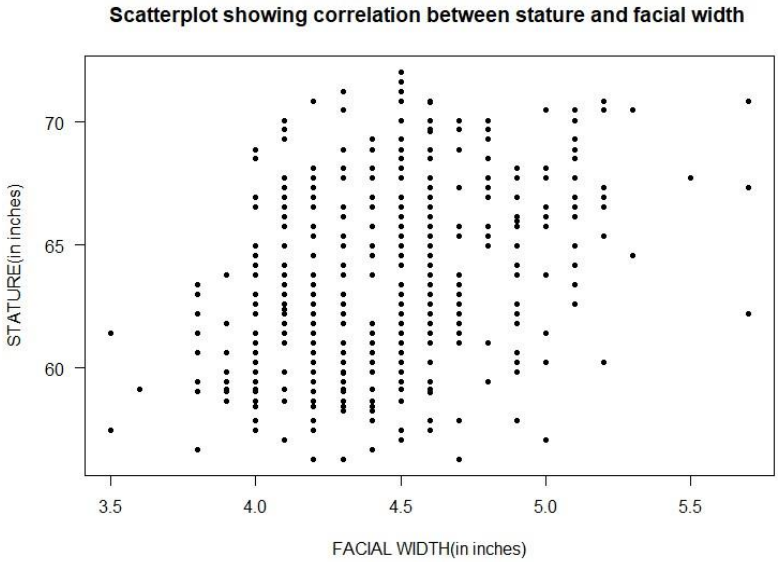


Figure 1: Scatterplot showing correlation between stature and facial width (N=500)

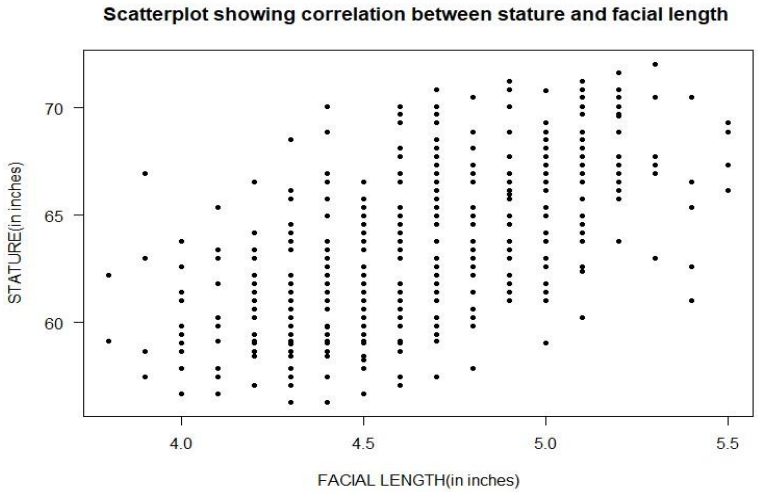


Figure 2: Scatterplot showing correlation between stature and facial width (N=500)

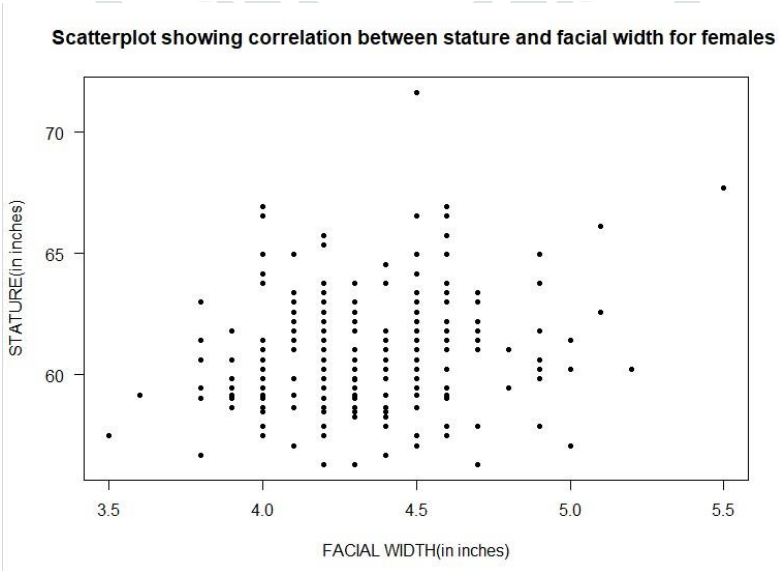


Figure 3: Scatterplot showing correlation between stature and facial height for females (N=250)

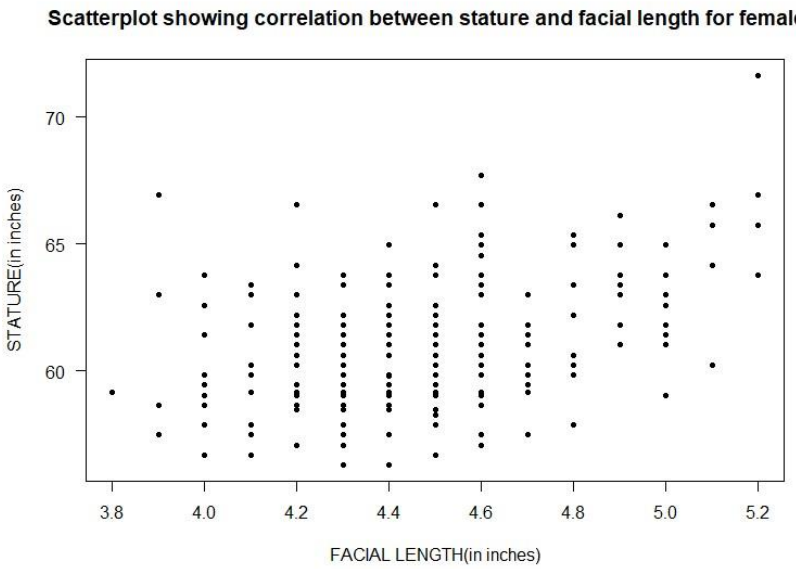


Figure 4: Scatterplot showing correlation between stature and facial height for females (N=250)

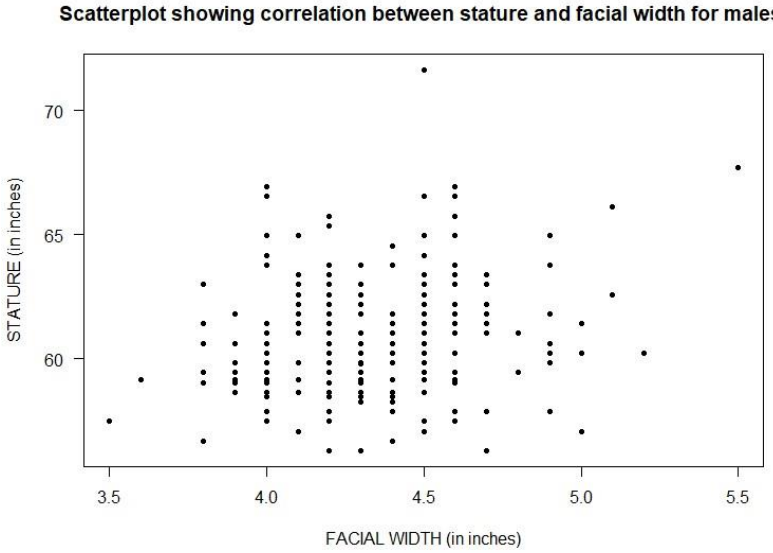


Figure 5: Scatterplot showing correlation between stature and facial width for males (N=250)

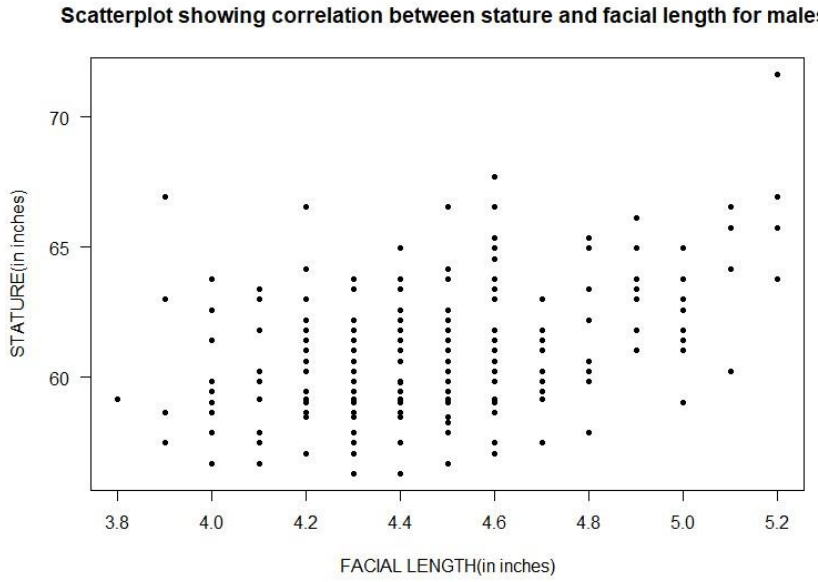


Figure 6: Scatterplot showing correlation between stature and facial height for males (N=250)

## IV. DISCUSSION

Regression analysis is better suited in scenarios where fragmented, mutilated or commingled remains are encountered. Regression equations are population specific as suggested by Agnihotri *et al.*, (2011)[5]; Pokhrel *et al.*, (2018)[6]; Prasanna *et al.*, (2013)[4]. Thus, the present study focused on the Mahadev Koli population of Maharashtra state. The mean stature of females (61.02 inch or 154.9 cm) was less than that of males (66.04 inch or 167.7 cm). Mean facial height of males (4.8 inch or 12.1 cm) was higher than that of females (4.4 inch or 11.7 cm). Mean facial width of males (4.5 inch or 11.4 cm) was higher than that of females (4.3 inch or 10.9 cm). The Pearson correlation of facial width and facial height with stature for females was 0.14 and 0.40, respectively and that for males was 0.28 and 0.34, respectively.

The present study has evaluated 500 individuals (250 males and 250 females) from Mahadev koli population of India. The correlation between stature and facial height was found to be r=0.40 in females and r=0.34 in males. Similar study was carried out by Wankhede *et al.* (2012) who studied 470 individuals (210 females and 260 males) among the central Indian population and the correlation obtained was r=0.14 in females and r=0.19 in males. Hence there is higher correlation of facial height and stature among Mahadev koli population in Maharashtra than the central Indian population. Studies resembling similar inference were carried out by Agnihotri et al. (2011)[5] studied stature estimation in 75 males and 75 females of Indo-Mauritian population wherein they inferred that there is no significant correlation in facial height and stature among males (r=0.32) and females (r=16). Similar studies were carried out by El-Kelany et al. (2015)[7] among Egyptian and Bengali population wherein Egyptian males (r=0.42) had better correlation than females (r=0.32) moreover Bengali males have better correlation of stature to facial height (r=0.58). Studies of Vaghela et al. (2017) among Egyptian population, Yadav et al. (2019)[9] among Gujarat population, Datta and Sawant (2017)[10] among Maharashtrian population, Pokhrel et al. (2018)[6] among Nepalese students, and Ekezie et al. among Igbos from Nigeria which have provided with similar results.

The correlation between stature and facial width in present study among 250 females and 250 males was found to be 0.18 and 0.28, respectively. Similarly, a study carried out by Yadav *et al.* (2019) among 361 individuals (210 females and 151 males) from Rajkot, Gujarat population showed the correlation of stature and facial width as r=0.25 in females and r=18 in males. Hence stature is better correlated with facial width among Mahadev koli female population of Maharashtra state than females in Gujarat state of India. Similarly, results obtained by Vaghela *et al.* (2017) among Egyptian population, Yadav *et al.* (2019)[9] among Gujarat population, Agnihotri *et al.* (2011)[5] among Indo-Mauritian population Datta and Sawant (2017)[10] among Maharashtrian population and Pokhrel *et al.* (2018)[6] among Nepalese students are in conformation with present study.

In contrast, the study done by Zaghloul *et al.* (2019)[12] showed higher significant correlation than present study among both males (r=0.98) and females (r=0.42) of Egyptian origin. They directed that facial width and facial height can be used as supplementary approaches to determine stature amid said population. Our study refutes the claim to determine stature from facial width among Mahadev koli population. Also, Kumar and Chandra (2006)[13] when studying males from Kabui Naga of Imphal, Manipur opined that stature cannot be established by facial height and facial width.

The present study opines that facial height is a better parameter than facial width to estimate stature. This is contradicted by Madadi et al. (2018)[1] among 200 Iranian students for correlation of stature with facial height (r=0.27) and facial width (0.54) which made them arrive at an opinion that stature is better correlated with facial width than facial height.

## V. CONCLUSION

This study was carried out amidst 250 females and 250 males in the age range of 18-40 years of Mahadev Koli population of Maharashtra. The study correlated stature with facial width and facial height furthermore developed regression equations to successfully carry out stature determination among said population. There is positive correlation among stature and facial width and facial height but stature cannot be estimated from facial width and facial height among Mahadev koli population.

## VI. ACKNOWLEDGMENT

Sincere thanks to the Institute of Forensic Science, Mumbai for providing the platform in order to carry out the research. Authors are grateful to the faculty and non-teaching staff of the Department of Forensic Biology, Institute of Forensic Science, Mumbai. We extend our gratefulness towards our family, friends and the subjects for espousing in our endeavors.

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