

**Estimation of Stature from Nasal Height in Living Subjects in Gujarati population**Sapana B. Shah<sup>1</sup>, Hemal Dholakia<sup>2</sup>, Divya V. Parmar<sup>3</sup><sup>1</sup>Associate Professor, Department of Anatomy, Dr. N.D. Desai Faculty of Medical Science and Research, Dharmsinh Desai University, Nadiad, Gujarat, India.<sup>2</sup>Assistant Professor, Department of Pharmacology, Dr. N.D. Desai Faculty of Medical Science and Research, Dharmsinh Desai University, Nadiad, Gujarat, India.<sup>3</sup>Assistant Professor, Department of Anatomy, Dr. N.D. Desai Faculty of Medical Science and Research, Dharmsinh Desai University, Nadiad, Gujarat, India.

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**Abstract****Introduction:** Stature is a very important parameter for identification of an individual, either living or dead. This is based on a principle that bones and remains of body parts are positively correlated with stature. The aim of this study is to find correlation of nasal height with stature in Gujarati population and also do linear regression analysis for accurate measurement of stature from nasal height.**Material and methods:** This study was conducted on 510 individuals (243 males and 267 females) aged between 18 to 30 years in Gujarat region. Nasal height and total body height of the subject were measured by sliding caliper and standard height measuring instrument respectively. The data was analysed statistically for mean, standard deviation, significance, Pearson's correlation (r) and for regression equations to measure stature from nasal height.**Result:** Calculation for Mean and Standard deviation of nasal height and body height was done. We found  $r = 0.36$ ,  $p = 0.0000$  for all subjects;  $r = 0.15$ ,  $p = 0.0179$  for males and  $r = 0.21$ ,  $p = 0.0004$  for females. We also derived regression equations to estimate stature from nasal height.**Conclusion:** Nasal height is showing positive correlation with body height. Regression equations are also derived from obtained data. Region wise there is some difference in measurements, so state and population wise different regression formula can be used to estimate accurate stature from nasal height.**Keywords:** Nasal height, stature, correlation.**DOI:** 10.25258/ijcpr.18.3.204This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.**Introduction**

Stature is a very important parameter for identification of any person. Estimation of stature is necessary in forensic anthropology and archaeology. Height estimation is important for calculating lung volume, metabolic rate and glomerular filtration rate. [1] Stature exhibits racial variation and are affected due to environmental factors, genetic, age, sex and nutrition.[2]

Anthropometry is a systematized measuring technique that expresses quantitatively the dimensions of the human body and skeleton. [3]

In archaeological procedures or in forensic examination after mass disasters like earthquakes, landslides, explosions, floods, aeroplane crash, animal attacks, mining accidents where only few body fragments are available, body height measurement would be difficult. In such cases,

collected data can be used for measuring height of a person with the use of regression equation. Many studies have been carried out for measurement of stature from long bones by many authors.[4,5] Many authors also reported studies using different body parameters such as head circumference,[6] arm span measurements, [7] external ear,[8] as well as hand and foot measurements[9,10] and found them correlated with stature. Studies have also done on different craniofacial measurements for estimation of stature which also showed significant correlation.[11,12]

**Material and Methods**

The present study was conducted with a total of 510 (243 males & 267 females) living subjects in Gujarat region. The candidates selected for study were medical students, students of other faculties,

staffs and other persons belonging to different regions of Gujarat.

**Inclusion Criteria:** Male and female Gujarati people in the age group of 18-30 years were selected.

**Exclusion Criteria:**

1. Individuals having any obvious craniofacial abnormalities affecting facial and nasal dimensions like congenital, developmental or acquired through any form of trauma.
2. Individuals having history of plastic or reconstructive surgery.
3. Pregnant woman and malnourished person.

**Ethical Consideration:** The prior permission was taken from the concerned authorities and also informed consent from every person was taken for the measurements pertaining to the study. Strict confidentiality of all the subjects was maintained.

Equipments used in study:

Sliding caliper

Standard height measuring instrument

**Methodology**

All the subjects were informed in advance about the whole procedure of taking the measurements. Nasal height was taken with the person sitting in a chair, in relaxed condition and head in anatomical position. Nasal height was taken by measuring the distance between nasion (Point at the intersection of frontal and two nasal bones) and subnasale (Midpoint of the angle at the columella base where the lower border of the nasal septum and the surface of the upper lip meet) with the help of sliding caliper (Figure-1). [13,14] Height of the individual was measured in standing erect anatomical position with bare foot from vertex to heel with standard height measuring instrument (Figure-2). [15] All above mentioned measurements were measured in centimeters and during fix time of the day to avoid diurnal variation. They were taken by the same person to avoid subjective error in methodology.

Obtained data were statistically analyzed for mean, standard deviation, Pearson's correlation coefficient and linear regression analysis.



Figure 1: Photograph Showing Measurement of Nasal Height



Figure 2: Photograph Showing Measurement of Stature (Height) From Vertex to Heel with Bare Foot in Standing Position Using Standard Height Measuring Instrument

**Result**

All the readings were compiled and calculated in MS Excel Windows 10. As shown in Table-1, body height in all subjects varied from 142 cm to 186.8 cm with the mean of 164.689 cm + 9.4425 SD, while nasal height in all subjects varied from 3.46 cm to 5.7 cm with the mean of 4.4977 cm + 0.3662 SD. Body height in males varied from 143.7 cm to

186.8 cm with the mean of 172.2 cm + 6.7927 SD, while nasal height in males varied from 3.76 cm to 5.7 cm with the mean of 4.6241 cm + 0.3518 SD.

Body height in females varied from 142 cm to 172.8 cm with the mean of 157.878 cm + 5.5319 SD, while nasal height in females varied from 3.46 cm to 5.11 cm with the mean of 4.3799 cm + 0.3419 SD.

**Table 1: Statistical analysis of height and nasal height (NH) in all subjects.**

	All (Male and Female)		Male		Female	
	Height (cm)	Nasal height (cm)	Height (cm)	Nasal height (cm)	Height (cm)	Nasal height (cm)
Minimum (cm)	142	3.46	143.7	3.76	142	3.46
Maximum (cm)	186.8	5.7	186.8	5.7	172.8	5.11
Mean (cm)	164.689	4.4977	172.2	4.6241	157.878	4.3799
SD (SD)	9.4425	0.3662	6.7927	0.3518	5.5319	0.3419

Pearson’s correlation co-efficient was used to find the relationship between the height and nasal height. Table-2 shows nasal height is correlated with height. It also shows p value which is statistically highly significant for nasal height in all subjects, males and females.

**Table 2: Statistical analysis of Pearson’s correlation co-efficient and linear regression between nasal height and stature.**

		Correlation (r)	Regression Co-efficient (b)	Constant of Regression equation (a)
		Nasal height	Total	r = 0.36, p = 0.0000
	Males	r = 0.15, p = 0.0179	2.9296	158.6497
	Females	r = 0.21, p = 0.0004	3.4532	142.7526

Linear regression analysis was done from obtained data which provided regression equations for estimation of stature from nasal height.

Regression equations are: Stature (y) = value of constant [a] + regression co-efficient [b] X nasal height [x]. Table – 3 shows regression equations

for measuring stature for mean value of nasal height (total, male and female). It also shows comparison of estimated stature calculated from regression equation with actual stature.

It shows no significant difference between estimated stature and actual stature.

**Table 3: Estimation of stature from linear regression equation for nasal height and comparison of measured height from height.**

		Regression equation (for mean value)	Estimated stature (for mean value) (cm)	Actual stature (for mean value) (cm)
		Nasal height	Total	y = 122.3989+9.4026x = 164.6890 122.3989+9.4026X 4.49771
	Males	y = 158.6497+2.9296x = 172.1965 158.6497+2.9296X 4.6241	172.1965	172.1963
	Females	y = 142.7526+3.4532x = 157.8773 142.7526+3.4532X 4.3799	157.8773	157.8775

Figure 3, 4 and 5 shows scatter diagram and regression lines in all subjects, males and females respectively. The graphs represent linear relation between body height and nasal height.

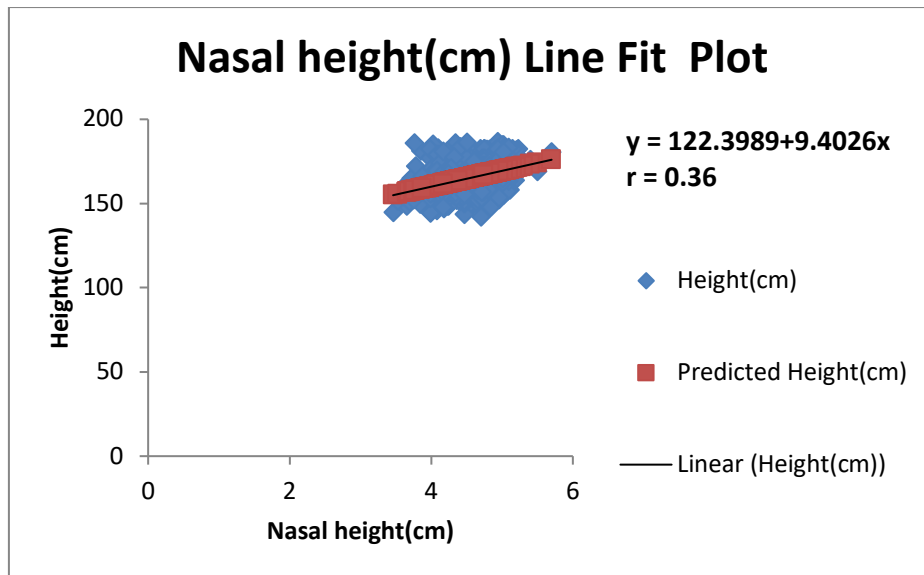


Figure 3: Scatter diagram showing correlation between body height and nasal height in all subjects

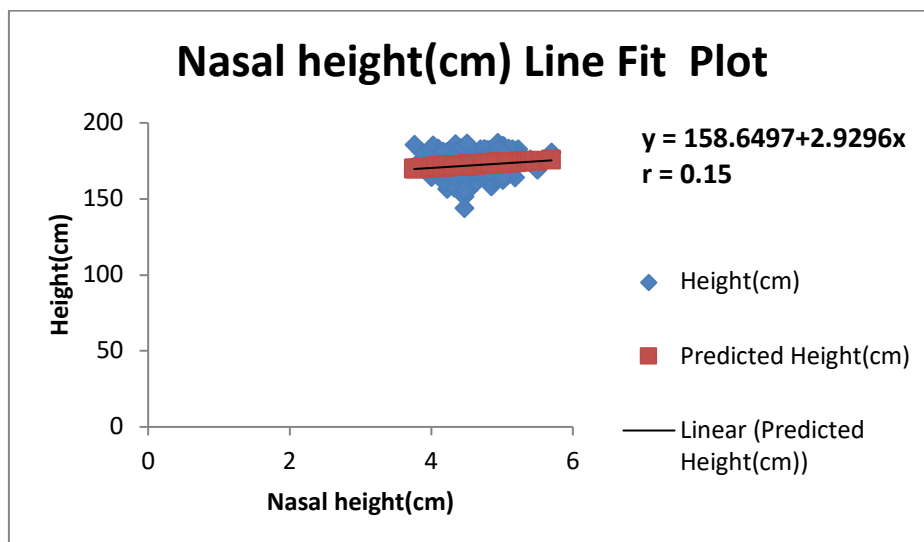


Figure 4: Scatter diagram showing correlation between body height and nasal height in males

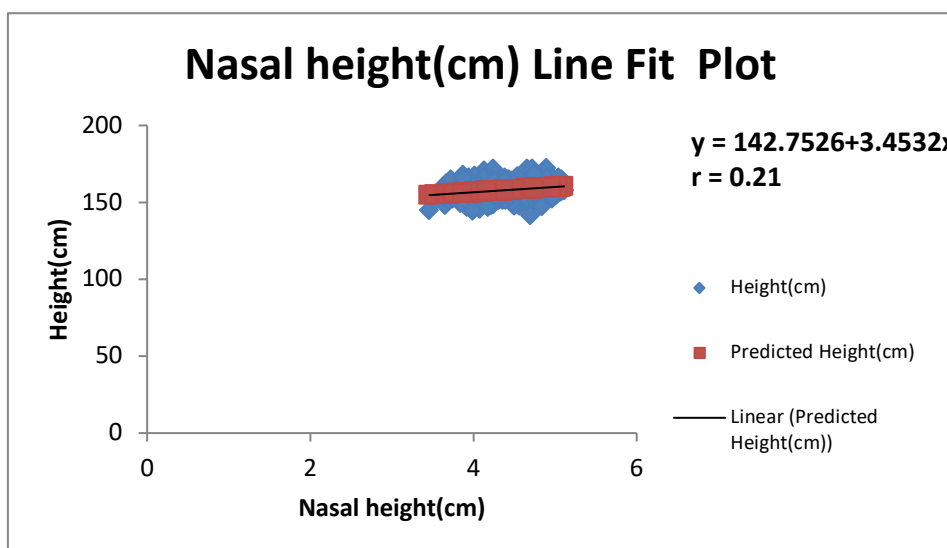


Figure 5: Scatter diagram showing correlation between body height and nasal height in females

**Discussion:****Table 4: Comparison of studies done by various authors.**

Author		Mean Height (cm)	Mean nasal height (cm)	Correlation of NH with Height
Vaghela R D[16]	T	159.49	4.15	p<0.05
	M	167.59	4.34	r = 0.240, p<0.05
	F	151.39	3.93	r = 0.196, p<0.05
Dinakaran J et al[17]	M	168.76	4.78	r = 0.248, p=0.082
	F	155.10	4.80	r = 0.271, p=0.057
Elrewieny N M et al [18]	T	164.52	5.43	r = 0.254, p<0.001
	M	-	5.56	r = 0.119, p= 0.255
	F	-	5.32	r = 0.128, p= 0.190
Acharya S et al[19]	T	164.97	4.76	r = 0.283, p= 0.002
	M	170.3	4.85	r =0.222, p=0.103
	F	159.61	4.67	r =0.123, p=0.367
Yadav S et al[20]	M	172.72	5.13	r = 0.022
	F	157.50	5.13	r = 0.248
Wankhede K P et al[21]	M	170.97	4.69	r = 0.186, p= 0.003
	F	156.89	4.57	r = 0.196, p= 0.000
Sugavanam S et al[22]	T	-	-	r = 0.271
	M	171.05	5.44	r = 0.390
	F	154.64	5.29	r = 0.121
Malaviya S K et al[23]	T	159.81	4.05	r = 0.673, p= 0.000
	M	167.93	4.28	r = 0.284, p= 0.000
	F	151.7	3.84	r = 0.199, p= 0.000
Barwa J et al[24]	T	165.64	4.86	r = 0.437, p= 0.000
	M	172.34	5.03	r = 0.194, p= 0.043
	F	158.94	4.68	r = 0.090, p= 0.216
Shrestha R N et al[25]	M	160.4	4.6	r = 0.18, p= 0.01
	F	151.8	4.3	r = 0.19, p= 0.03
Present study	T	164.689	4.4977	r = 0.36, p = 0.0000
	M	172.2	4.6241	r = 0.15, p = 0.0179
	F	157.878	4.3799	r = 0.21, p = 0.0004

(NH- Nasal height, T- Total, M-Male, F- Female)

Table – 4 shows the comparison of studies done by different authors on different population. Previous studies showed significant correlation between nasal height and stature. Mean values for nasal height in other studies are varying with the results of present study, which can be due to racial differences.

The estimation of stature from measurements of bones and different body measurements like head circumference, hand length, foot length, ear length, waist circumference has been done by many researchers. So growth of a person is affected by many factors. But when only few remnants of body are available, then estimation of body height is done by known relationship between body parts and stature.[20,26] Many authors also derived regression equations for measuring stature using nasal height. Vaghela R D et al[16] derived regression equation as stature = 148.039 + 4.470 x NH in male and stature= 137.803 + 3.456 x NH in female in cadavers collected in medical college of Rajkot of Gujarat. Elrewieny N M et al [18]

calculated equation as stature=140.908+0.435 XNH in total subjects in Egyptian population. Acharya S et al [19] derived regression equation as Y=134.053+0.648× NH for total students, Y=146.487+0.496×NH for males, Y=151.328+0.177× NH for females in students of Udaipur of Rajasthan. Wankhede K P et al[21] derived equations for stature estimation as Stature (cm) = 156.86 + 3.01 × NH in male and Stature (cm) = 142.71 + 3.11 × NH in female of medical students of Maharashtra population.

Barwa J et al[24] derived equation as Y = 115.480 + 10.331 XNH in total subjects, Y = 151.170 + 1.662 XNH in females and Y = 155.251+ 3.395 XNH in males in Dehradun region of Uttarakhand. Shrestha R N et al[25] elicited equation in population of Nepal as stature=148.22+3.02XNH in male and stature=133.01+3.12XNH in female. Kamdar R S et al[27] derived regression equation as Y= 1.882 X NH + 152.455 in south-Indian population. These all equations may vary but they all got non- significant difference between

estimated stature and actual stature. Comparing with previous studies, it is seen that nasal height is a good parameter to be having significant correlation with height of an individual. Regression equations from our study, show good reliability and applicability but there might be always estimation error of few centimetres. Regression equations found in other studies for one population, may not be applied to other population. Present study also found that data derived here may vary with other studies due to racial changes.

#### Conclusion:

It was determined that nasal height shows strong correlation with stature for males, females and in all subjects by measuring Pearson's correlation coefficient. The findings also showed highly significant relation ( $p < 0.05$ ) of nasal height with stature. Hence, stature of an individual in Gujarati population can be easily estimated by means of regression equations using nasal height when only few facial remains are available.

This method is not only reliable, relatively easy and quick to apply without much techniques but also the anatomical landmarks measured are standard and easier to locate. These data can be greatly useful in forensic, anthropological and medico-legal scenarios. As these formulas are population and area specific, more studies among different regions and races would be required in future to make stature estimation more reliable.

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