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Original Research Article

Estimation of Stature from Nasal Dimension: A Correlation Meta-Analysis

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Abstract:

Aim of the study: The study based on the positive linear relationship existing between nasal dimension and stature is used to estimate stature in living as well as dead people in forensic anthropology. The dimension of the nose used as a plausible alternative to estimate stature when long bones are missing, fragmented or damaged.

Material and Methods: This meta-analysis aims to quantify evidence on the correlation between the nasal dimension and stature. 100 male cases and 100 female cases were randomly selected from patients attending the SDM trust's Ayurvedic medical college, Danigod post-graduate center & Padma Ayurvedic hospital & research center, Terdal, Karnataka. Age groups selected for the study are between 21 to 50 years.

Results: In Males, individually Nasal Height (r=0.284) show strong correlation between with stature while Nasal Breadth is showing the correlations (r=0.207) with stature in males individually. In Females Nasal Height (r=0.199) and Nasal breadth (r=0.122) showing correlation with stature. In total cases correlation of nasal height is strongest (r=673) with stature while with nasal breadth correlation (r=532) with stature also stronger.

Discussion: Estimation of stature from nasal height, nasal breadth and nasal index in our study shows significant result in our population. Our results and other author's results show little difference in formula to calculate stature due to selection of different population group.

Conclusion: Nasal dimensions are showing positive linear correlation as well as Significant gender difference (p value <0.001)) with stature. So, nasal dimensions are useful for determination of stature. Region wise there is minor to moderate difference in all the measurements, so state and population wise different regression formula and multiplication factor are required to estimate accurate stature.

Keywords: Nasal Height, Nasal Breadth, Nasal Index, Stature, Regression Formula.

Introduction

"Everyone has the right to recognition everywhere as a person before the Law." - Article 6 of the Universal Declaration of Human Rights [1]. As stated above, Identification is matter of utmost importance for every human being. Even in medico-legal cases, identification plays a vital role as it is prime component of Corpus Delicti i.e. Essence of crime [2]. Different anthropological parameters of the body are used for estimation of stature. Complete identification means absolute fixation of the individuality of a person, which is possible only when all facts about the individual are available. Whereas partial identification implies ascertainment of only some facts about the identity like race, age, sex, stature etc. while others remain unknown [3]. According to Krogman (1986), for establishment of identity from human remains, it is customary to start with Sex, Age, Stature and Race at the time of death known as the "Big Four". Sex and Stature are two key components of partial identification. They provide one important aspect of an individual's physiognomy. Stature has relation with dimensions of various body parts [4]. Methods based on the positive linear relationship existing between stature and the length of various parts of the body are the most commonly employed alternatives [5] for establishment of identity, various studies have been done throughout the world by means of stature from various body parts like hand, feet, fingers, ear etc. Nose is the important physiognomic features in humans. Nasal dimensions are among the most important cephalometric parameters used in the descriptions of human morphology, identification of individuals

and classification of sex and races. However, different population exhibits variation in their body proportions as they are affected by race, diet, genetic variation of a person, geographical location and climatic conditions [6]. Due to which, results of a study conducted on one population cannot be applied on other population. In disastrous conditions such as earthquake, landslides, aircraft road-railway accidents, explosions, stampede; building collapse, fire, mining accidents etc., and isolated body parts are found. Also during legal investigations when such isolated body parts are recovered by investigating agencies, the medical professional is often required to give an opinion regarding personal identification of deceased by collecting data for partial identification like race, age, sex, stature etc. which, in the course, help for absolute identification and thus to serve the justice. Therefore, the present study was carried out to evaluate the anthropometric relationship of nasal dimensions with the stature.

Materials and Methods:

This study was conducted in the Department of in Agadatantra Avum Vidhivaidyaka, SDM Trust's Ayurvedic Medical College, Danigond Post-Graduate Center & Padma Ayurvedic Hospital & Research Center, Terdal, during the period of January 2018 to December 2018. The candidates for the present study were randomly selected from the area nearby Terdal and patient comes to Padma Ayurvedic Hospital & Research Center, Terdal. Randomly collected 100 male candidates and 100 female candidates were selected from the area. Consent was taken after explaining the procedure and motive of examination. Age group from 21 years to 50 years were selected for the study. The information about the age of the candidates were obtained by asking them and verified by necessary documents in case where age was not known.

The following candidates were not included in the study.

- The person with any injury to face that might have affected facial and nasal dimensions.
- The person with history of any congenital anomaly that might have affected facial/nasal dimensions and stature.
- Pregnant woman and malnourished person.
- Severely sick person.

To estimate the stature, the candidate was advised to stand in erect position with eyes looking straight and back of head touch the wall. Head was fixed in such way that Frankfort plane remains at right angle to the wall. Stature (Total Body Height) was measured between the vertex of the head and the heel using a measuring tape up to nearest of 0.1 cm. Nasal height was measured as straight distance between nasion and subnasale (In the midline, the point where nasal septum merges with the upper lip). Measurement was done by spreading caliper with scale as follows: one tip of the caliper was placed at subject's nasion and the movable part was moved and placed on subnasale. Nasal breadth was measured as straight distance at right angle to the Nasal Height from ala to ala (lateral surface of external nose) by spreading caliper. Nasal index was calculate by (nasal breadth × 100)/ nasal height up to accuracy of two decimal.

Statistical Analysis: The data was analyzed statistically using software like Epi info 7, SPSS and Microsoft Excel. To evaluate the anthropometric relationship of nasal dimensions with the stature (height), data was analyzed for male and female cases separately as well as for total cases i.e. both sexes together. Result of data analyzed for total cases can be applied to determine stature (height) nasal dimensions, when stature (height) and sex is unknown. The mean and standard deviation were derived for stature, Nasal Height, Nasal Breadth and Nasal Index in both the sexes. Pearson's correlation coefficient (r) was calculated to assess the correlation between stature and nasal dimensions. P-value of less than 0.05 was considered significant. Coefficient of determination (R^2) was calculated to assess amount of variation in the stature accounted by nasal dimensions. P-value less than 0.05 were considered significant and less than 0.001 was considered highly significant. Simple and multiple regression equations and multiplication factors were derived to estimate stature from nasal dimensions. Standard error of estimate (SEE) was calculated for simple and multiple regression equations to assess their accuracy to predict stature from nasal dimensions.

Results

The demographic and clinical data of the Table 1 is showing descriptive statistics of all the cases. It is evident from the above table 1, that highest number of total cases (19%) was found in age group 46-50 years and lowest numbers of total cases (14.5%) were found in age group 31-35 years and 41-45 years. Highest numbers of male and female cases (18% and 20% respectively) were found in age group of 26-30 years and 46-50 years respectively and lowest numbers of male and female cases (15% and 14% respectively) were found in age group of and 31-35 years and 41-45 years.

However, as shown in table 2, those highest numbers of total cases (36.5%) were found in stature range of 161-170 cm and lowest numbers (1%) were found in stature range of 181-190 cm. highest numbers of male cases (68%) were found in stature range of 161-170 cm and lowest numbers (1%) were found in stature range of 181-190 cm. No any male cases were found in stature range of 131-140,141-150 cm. highest numbers of female cases (52%) were found in stature range of 151-160

cm and lowest numbers (5%) were found in stature range of 161-170 cm. No any female cases were found in stature range of 13-140 cm, 171-180 cm and 181-190 cm.

It is evident from the table 3, showing descriptive statistics of male and female cases and of total cases respectively. Mean Stature of total, male and female cases are 159.81 ± 9.25 cm, 167.91±4.39 cm and 151.7 ± 4.39 cm respectively.

Mean Nasal height is more than Mean Nasal breadth in all cases. Mean of Stature, Nasal Height and Nasal Breadth are more in male cases than in female cases.

Table 1: Age and Sex Wise Distribution of Cases

Age Group (In Years)	Number of Cases		
	Male (%) (Out of 100)	Female (%) (Out of 100)	Total (%) (Out of 200)
21-25	17 (17%)	16 (16%)	33 (16.5%)
26-30	18 (18%)	18 (18%)	36 (18%)
31-35	15 (15%)	14 (14%)	29 (14.5%)
36-40	17 (17%)	18 (18%)	35 (17.5%)
41-45	15 (15%)	14 (14%)	29 (14.5%)
46-50	18 (18%)	20 (20%)	38 (19%)

Table 2: Stature and Sex Wise Distribution of Cases

Stature Range (In Cm)	Number of Cases		
	Male (%) (Out of 100)	Female (%) (Out of 100)	Total (%) (Out of 200)
131-140	0 (0%)	0 (0%)	0 (0%)
141-150	0 (0%)	43 (43%)	43 (21.5%)
151-160	7 (7%)	52 (52%)	59 (29.5%)
161-170	68 (68%)	5 (5%)	73 (36.5%)
171-180	24 (24%)	0 (0%)	24 (12%)
181-190	1 (1%)	0 (0%)	1 (0.5%)

Table 3: Descriptive Statistics of Male and Female Cases

Parameter*	Male Cases			Female Cases			Total		
	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.	Mean ± SD
Stature	156	182	167.93±4.45	142	163	151.7±4.39	142	182	159.81±9.25
Nasal Height	3.7	5	4.28±0.24	3.2	4.5	3.84±0.26	3.2	5	4.05±0.34
Nasal Breadth	3.1	4.5	3.66±0.24	2.8	4	3.36±0.24	2.8	4.5	3.50±0.28

***All Measurements Are In Centimeters**

Table 4: Stature Wise Mean of Nasal Dimensions in Male Cases

Stature Range*	No. of Cases	Stature* (Mean ± SD)	Nasal Height (Mean ± SD)	Nasal Breadth (Mean ± SD)
151-160	7	158.86±4.33	4.14±0.24	3.59±0.24
161-170	68	166.88±4.37	4.28±0.24	3.65±0.24
171-180	24	173.24±4.56	4.33±0.25	3.69±0.25
181-190	1	182±0	4.6±0.0	3.9±0.0

***All Measurements Are In Centimeters**

Table 5: Stature Wise Mean of Nasal Dimensions in Female Cases

Stature Range*	No. of Cases	Stature* (Mean ± SD)	Nasal Height (Mean ± SD)	Nasal Breadth (Mean ± SD)
141-150	43	147.81±2.04	3.83±0.30	3.36±0.26
151-160	52	153.92±2.41	3.81±0.22	3.35±0.22
161-170	5	162±1	4.14±0.15	3.5±0.14

***All Measurements Are In Centimeters**

Table 6: Stature Wise Mean of Nasal Dimensions in Total Cases

Stature Range*	No. of Cases	Stature* (Mean ± SD)	Nasal Height (Mean ± SD)	Nasal Breadth (Mean ± SD)
141-150	42	147.81±8.82	3.82±0.33	3.36±0.27
151-160	60	154.51±8.22	3.85±0.33	3.37±0.26

161-170	74	166.55±7.92	4.27±0.26	3.64±0.19
171-180	23	172.96±7.80	4.32±0.24	3.68±0.30
181-190	1	182±0	4.6±0.0	3.9±0.0

***All Measurements Are In Centimeters**

Table-7: Correlation of Stature with Facial and Nasal Dimensions

Parameter	Male Cases		Female Cases		Total Cases	
	r*	R^2	r*	R^2	r*	R^2
Nasal Height	0.284	0.080	0.199	0.039	0.673	0.452
Nasal Breadth	0.207	0.043	0.122	0.015	0.532	0.283
Nasal Height & Nasal Breadth	0.304	0.093	0.207	0.043	0.676	0.457

r=Pearson Correlation Coefficient and R^2=Coefficient of Determination, *p Value Is 0.000 For All Parameters. p Value<0.001 Is Highly Significant.

Table 8: Comparison for Gender Difference in Means of Stature and Facial and Nasal Dimensions

Parameter	Mean (IN cm)		T Value	Df	p Value*
	Male	Female			
Stature	167.91±4.39	151.7±4.39	25.947	198	0.000
Nasal Height	4.28±0.24	3.84±0.26	12.645	198	0.000
Nasal Breadth	3.66±0.24	3.36±0.24	8.778	198	0.000

***p Value<0.05 Is Significant and p Value<0.001 Is Highly Significant**

Table 9: Demarking Point of Facial and Nasal Measurements and Their Accuracy to Differentiate Sex

Parameter	Demarking Point*	Correctly Assigned		Accuracy (%)
		Male (Out Of 100)	Female (Out Of 100)	
Nasal Height	**4.1**	76	91	83.5
Nasal Breadth	**3.5**	67	80	73.5
Nasal Index	**87.5**	35	42	38.5

***Value More Than Demarking Point Denotes Male and Less than Demarking Point Denotes Female**

Table 10: Simple Regression Formula

Parameter	Simple Regression Formula for Stature	SEE
For Male Cases		
Nasal Height	Stature= 145.247 + 5.296 x Nasal Height	7.73
Nasal Breadth	Stature= 153.758 + 3.875 x Nasal Breadth	6.76
For Female Cases		
Nasal Height	Stature= 138.849 + 3.350 x Nasal Height	6.42
Nasal Breadth	Stature= 144.099 + 2.261 x Nasal Breadth	6.27
For Total Cases		
Nasal Height	Stature= 84.441 +18.567 x Nasal Height	5.91
Nasal Breadth	Stature= 97.960 +17.625 x Nasal Breadth	7.01

Table 11: Multiple Regression Formula

Parameter	Multiple Regression Formula for Stature	SEE
For Male Cases		
Nasal Height & Nasal Breadth	Stature= 140.452 + 4.487 x Nasal Height + 2.258 x Nasal Breadth	8.74
For Female Cases		
Nasal Height & Nasal Breadth	Stature= 139.901 + 4.619 x Nasal Height – 1.761 x Nasal Breadth	6.693
For Total Cases		
Nasal Height & Nasal Breadth	Stature= 81.013 + 16.633 x Nasal Height + 3.214 x Nasal Breadth	6.485

Table 12: Multiplication Factor for Male and Female Cases

Parameter	Male Cases				Female Cases			
	Min.	Max.	Mean	SD	Min.	Max.	Mean	SD
Nasal Height	33.40	46.22	**39.32**	2.18	32.67	46.47	**39.71**	2.69
Nasal Breadth	38.89	55.81	**46.10**	3.02	36.50	54.48	**45.33**	3.29

Table 13: Multiplication Factor for Total Cases

Parameter	Min.	Max.	Mean	SD
Nasal Height	32.67	46.47	**39.51**	2.46
Nasal Breadth	36.50	55.81	**45.72**	3.18

Discussion:

Table 14: Comparison of Mean Stature, Mean Nasal Height and Nasal Breadth

Author	Study Population	Age Range (Years)	Mean Stature* (Mean ± SD)		Mean Nasal Height* (Mean ± SD)		Mean Nasal Breadth* (Mean ± SD)	
			Male	Female	Male	Female	Male	Female
Sagar S et al. [7]	**Jatvas of Delhi**	**17-40 years**	152.33±0.56	152.44±0.39	4.77±0.06	4.88±0.23	3.90±0.05	3.75±0.15
Agnihotri AK et al. [8]	**Muaritius**	**20-28 years**	173.40±7.70	157.36±6.17	5.27±0.33	5.20±0.35	3.28±0.49	2.95±0.37
Present Study	**Terdal,Karnataka**	**>20 years**	167.91±4.39	151.70±4.39	4.28±0.24	3.84±0.26	3.66±0.24	3.36±0.24

Table-14 is showing comparison of mean stature, mean nasal height and mean nasal breadth with similar studies done by other authors. It is evident from the table that all these studies have been carried out on adult population. Mean Nasal Height, Mean Nasal Breadth as well as Mean Stature of all studies are different from present study. This is due to the fact that all these studies have been conducted on different populations.

Table 15: Comparison of Multiplication Factor to Estimate Stature from Nasal Dimensions

Author	Sex	Mean Multiplication Factor	
		For Nasal Height	For Nasal Breadth
Sagar S et al. [7]	**Male**	34.14	41.59
	Female	33.17	43.06
Present Study	**Male**	33.40	46.10
	Female	39.71	45.33
	Total	39.51	45.72

Table 16: Comparison of Multiple Regression Formula to Estimate Stature from Nasal Dimensions

Author	Sex	Multiple Regression Formula
Agnihotri AK et al. [8]	**Male**	S=32.277+5.474×F.H.+5.474×N.B.+1.637×H.H.C
	Female	S=42.036+2.577×F.H.+1.849×F.B.+0.858×H.H.C
Present Study	**Male**	S= 140.452 + 4.487 x N.H. + 2.258 x N.B.
	Female	S= 139.901 + 4.619 x N.H. – 1.761 x N.B.
	Total	S= 81.013 + 16.633 x N.H. + 3.214 x N.B

Table-15 and 16 are showing comparison of multiplication factor and multiple regression formula to estimate stature from Nasal dimensions with similar studies done by other authors.

It is evident from the table that each formula as well as multiplication factor derived for different population is different from each other. Reason for the difference in regression formula and multiplication factor is the difference in study population, which substantiate views expressed by other authors that state and population wise different regression formula and multiplication factor are required to estimate stature.

Table 17: Comparison for Gender Variation in Mean Nasal Height

Author	Study Population	Mean Nasal Height		P Value
		Male	Female	
Sharma SK et al. [9]	**Madhya Pradesh**	4.90	4.53	<0.0001
Esomonu UG et al. [10]	**South Nigeria**	4.24	4.28	<0.05
Oladipo GS et al. [11]	**River State, Nigeria**	4.66	4.36	<0.05
Staka G et al. [12]	**Kosovo Albanian**	5.53	5.20	<0.0001
Jovanovic J et al. [13]	**Serbia**	5.43	5.26	<0.001
Kaushal S et al. [14]	**Brahmins**	5.37	4.91	<0.05

		Sikh	5.13	4.83	<0.05
		Muslim	5.32	4.68	<0.05
Wai MM et al. [15]	**Malay**		5.10	4.57	0.000
	Chinese		5.10	4.65	0.006
	Indians		5.13	4.77	0.002
Present Study	**Terdal, Karnataka**		4.28	3.84	0.000

***p Value<0.05 is Significant and p Value<0.001 is Highly Significant**

Table-17 is showing comparison for gender variation in mean of Nasal Height with similar studies done by other authors. T-test was used for comparison by all studies. It is evident from table that all studies have found significant gender difference in Nasal Height, Nasal Breadth and Nasal index ($p<0.05$) which is similar to the present study. Findings related to Discriminant Function Equation suggest that it is a useful method to derive stature from nasal dimensions.

Conclusion:

Nasal dimensions are showing positive linear correlation as well as Significant gender difference (p value <0.001)) with stature. So, Nasal dimensions are useful for determination of stature.

Significant gender difference exists in Nasal Height and Nasal Breadth. Demarking point for Nasal Height and Nasal Breadth are 4.1 and 3.5 respectively. Value of parameter more than demarking point denotes male and less than demarking point denotes female. According to r-value (Pearson Correlation Coefficient) derived from Nasal dimensions, nasal height and nasal breadth combined showing highest relationship with stature followed by nasal height and nasal breadth in total cases, male cases and female cases. Nasal Height is showing highest accuracy (83.5%) to determine sex from demarking point, followed by Nasal Breadth (73.5%). Nasal Index is showing lowest accuracy (38.5%) among three.

Discriminant function equation determines sex more accurately than demarking point. Rest parameters for nasal height and nasal breadth discriminant function equation show same accuracy as demarking point. Hence, it is the preferred method to classify sex compare to demarking points.

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