Original Article

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Comparative Evaluation of Nasal Index and its Role in Sexual Dimorphism in Central Indian Population: A Cross-sectional Study

Others Section

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ABSTRACT

Introduction: Nasal Index (NI) is a sensitive anthropometric index. It exhibits sexual difference and has become useful tool in forensic medicine and reconstructive surgery. It is an important anthropometric parameter for classification of gender of a person whose identity is not known.

Aim: To determine the values of the nasal parameters such as Nasal Height (NH), Nasal Breadth (NB) and NI, clinically and radiographically for male and female and also to compare the NI and its role in sexual dimorphism.

Materials and Methods: This cross-sectional study was conducted in the Department of Anatomy of a premium Medical College in Bhopal, Madhya Pradesh, India, between July 2017 and July 2019, study included total 392 subjects (196 males and 196 females), aged between 18 to 60 years. Posteroanterior (PA) and Cephalogram (Ceph) was taken for all the study subjects. NH and NB were measured both clinically and radiographically. NI was then calculated as NB/NH×100. The data was analysed statistically using unpaired Student's t-test.

Results: Among the study population males and females were equally divided and the major subjects belonged to the age group of 41-50 years (31.63%), followed by 51-60 years (27.04%). Radiographic findings of NH were found to be statistically higher in males (47.46±2.26 mm) while clinical findings of NH were found to be statistically higher in females (55.66±3.21 mm). Radiographic findings and clinical findings of NB were found to be statistically higher in males (33.95±2.41 mm, 37.19±2.44 mm) as compared to females (30.55±1.50 mm, 32.41±1.58 mm). Radiographic findings and clinical findings of the NI were found to be statistically higher in males (71.70±6.21, 69.94±5.87) as compared to females (67.02±5.21, 58.44±4.70).

Conclusion: Nasal parameters showed significant differences between males and females in Central Indian population, suggesting sexual dimorphism and also serve as important clinical and radiographical tools useful in nasal surgeries, anthropometry and forensic medicine.

Keywords: Anthropometric index, Forensic science, Nasal breadth, Nasal height

INTRODUCTION

Fragmented, scattered, incomplete or burned remains [1] limit the success in sex identification, but broken parts are even sufficient, if appropriate areas (pelvis, femoral heads, sternum and skull) are represented [2]. The sexual dimorphism of that skeleton part should be studied, which are resistant to damage and most protected, as oftenly for forensic identification, only skeletal remains are left. Bony structures of the nose are preserved even in the case of serious bodily damage or following death [3]. In anthropology and forensic medicine, the knowledge of NI is relevant in distinguishing the race, ethnicity and sex of individuals whose identity is not known [4,5]. The importance of the nose is so great that one might label it as Nasal science [6]. The nose can be categorised on the basis of nasal parameters such as, NH, NB and NI; these three categories are commonly accepted [7]. The NI is expressed as the percentage of the width in relation to the height of the nose [8]. In clinical practice, NI is useful in rhinoplastic surgery (plastic surgery of the nose) as nasal analysis is the first step a rhinoplastic surgeon takes to change the size or shape of the nose for a desired aesthetic effect. Also, nasal analysis of various ethnic groups can help the rhinoplastic surgeon to change the shape of nose and forensic experts to determine the ethnicity [8].

Nasal analysis is also useful for surgeons in the diagnosis of some dysmorphic syndromes like cleft lip and cleft palate and associated nasal disorders [9]. Since the soft tissue landmarks for measuring width and height of nose are lost in disciplines of forensic medicine so the bony landmarks will be more reliable in live subjects, the radiographic techniques will help in identifying the bony landmarks better in such conditions.

Radiographical modalities such as sinus radiography are currently used for identification of skeletal remains and gender determination in forensics. There are various imaging modalities like conventional techniques such as water's view (PNS) and Lateral Ceph (Lat Ceph) to advanced technologies including Computed Tomography (CT) and Cone Beam CT (CBCT) [10]. Lateral and PA Ceph play an important role in providing morphological and anatomical details of the skull, thereby disclosing supplementary characteristics and multiple points for comparison. Various researchers have claimed this conventional radiograph as economical, accessible, and reliable [10-13]. Most of the previous studies used dry human skulls and live subjects to determine NI for sexual dimorphism [14-17]. The studies conducted on dry human skulls to determine NI for sexual dimorphism is not 100% accurate and there is paucity of data for calculating NI radiographically on live subjects for sexual dimorphism. Therefore, present study was conducted to evaluate and compare the NI and its role in sexual dimorphism. The objectives of the study were to determine NI clinically and radiographically and to compare and evaluate NI in males and females radiographically and clinically.

MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Anatomy of a premium Medical College in Bhopal, Madhya Pradesh India, between July 2017 and July 2019. The study was conducted after taking approval from the Institutional Ethical Committee (IEC) (IEC no.-PCMS/OD/2016/3159). Written informed consent was obtained from the subjects and objectives of the study were explained before taking their consent.

Inclusion criteria: Subject aged between 18-60 years, irrespective of gender and who were willing to participate in the study, were included in the study.

Exclusion criteria: Subjects with history of any rhinoplastic surgery, orthognathic surgery, facial or any cosmetic surgery, history of any congenital disorder, trauma and having any habit like mouth breathing were excluded from the study.

Sample size calculation: The sample size of 392, which was equally divided into 196 males and 196 females, was calculated with the precision error of 5% and type I error of 5% using the formula for cross- sectional studies, as stated below:

$$\frac{Z_{1-\alpha/2}^{2}\,SD^{2}}{d^{2}}$$

Where, $Z_{1-\alpha/2}$=standard normal variate (at 5% type I error) ($p<0.05$) is 1%

SD=Standard Deviation of variable

d=absolute error/precision

Subjects were selected randomly from the Outpatient Department of the Medical College, Bhopal, Madhya Pradesh, India during the data collection period of two years.

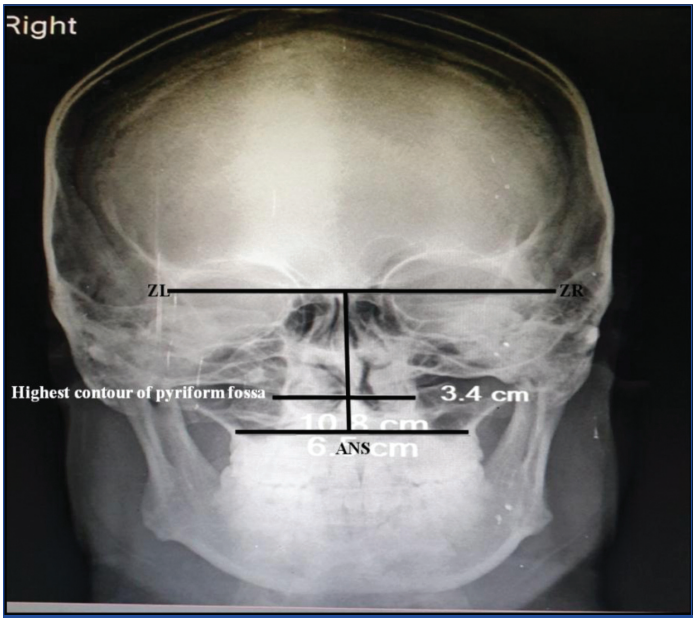
Data Collection

A prestructured proforma was prepared including the demographic details of the subjects like age, gender etc. PA cephalometric view of the subject was taken with a panoramic X-ray machine and digital X-rays were analysed using the software (Allengers DR2000C, Allengers Corp, version 4.25.6.9). The following landmarks were noted on PA-Ceph [Table/Fig-1] as shown below:

ZL/ZR- The most internal point of the frontozygomatic suture, ANS- Anterior Nasal Spine [18]:

Radiographic measurement of NI [18]:

- The height of nose was measured on PA-Ceph by joining ZL and ZR points and a perpendicular line drawn from it to ANS [Table/Fig-1].
- The breadth of the nose (maximum breadth of the nose) was measured on PA-Ceph by measuring the distance at highest contour of pyriform fossa [Table/Fig-1].



[Table/Fig-1]: Points to measure Nasal Height (NH) and Nasal Breadth (NB) on PA Cephalogram.
ANS: Anterior nasal spine; ZR: Zygomatic suture right; ZL: Zygomatic suture left

Clinical measurement [18]:

Digital vernier caliper was used for clinical measurements of NB and NH.

- The height was measured from nasion (intersection of the frontal bone and two nasal bones) to the subnasale (where the nasal septum touches the upper lip).
- Manifestation of nasion on the visible surface of the face is a distinctly depressed area directly between the eyes, just superior to the bridge of the nose [Table/Fig-2].

[Table/Fig-2]: Clinical measurement of Nasal Height (NH).
[Table/Fig-3]: Clinical measurement of Nasal Breadth (NB). (Images from left to right)

- NB was measured by measuring the maximum distance between the two alae of the nose [Table/Fig-3].

NI was then calculated as follows:

$$\text{Nasal Index (NI)}=\frac{\text{Nasal Breadth (NB)}}{\text{Nasal Height (NH)}}\times 100\ [7,8]$$

STATISTICAL ANALYSIS

The data were analysed using Statistical Package for the Social Sciences (SPSS) version 26.0. Frequency of data was presented in the form of tables and graphs. Univariate analysis was done to find out the sexual dimorphism in NI if any, using unpaired t-test. The p-value <0.05 was considered statistically significant.

RESULTS

The study subjects were categorised according to age. As males and females were equally divided, major subjects belonged to the age group of 41-50 years 124 (31.63%), followed by 51-60 years 106 (27.04%). From age group of 18-20 years there were only 14 (3.57%) study subjects [Table/Fig-4].

Age (years)	Male (n=196) (%)	Females (n=196) (%)	Total, N (%)
18-20	8 (4.08)	6 (3.06)	14 (3.57)
21-30	32 (16.33)	28 (14.29)	60 (15.31)
31-40	40 (20.41)	48 (24.49)	88 (22.45)
41-50	60 (30.61)	64 (32.65)	124 (31.63)
51-60	56 (28.57)	50 (25.51)	106 (27.04)

[Table/Fig-4]: Age and gender wise distribution of subjects (N=392).

Radiographic findings of the mean NB of males was 33.95±2.41 and for females was 30.55±1.50, clinical findings of the mean NB of males was 37.19±2.44 and of females was 32.41±1.58. This shows that males of this region have a significantly higher NB than females (p-value-0.001) [Table/Fig-5]. Radiographic findings of the mean NH of males was 47.46±2.26 and for females was 45.74±2.57, clinical findings of the mean NH of males was 53.30±2.68 and of females was 55.66±3.21. This shows that males of this region have a significantly higher NB radiographically than females but females have significantly higher NB clinically than males (p-value-0.001) [Table/Fig-5].

Radiographic findings of the mean NI of males was 71.70±6.21 and for females was 67.02±5.21, clinical findings of the mean NI of males was 69.94±5.87 and of females was 58.44±4.70. This shows that males of this region have a significantly higher NI than females p-value-0.001 [Table/Fig-5].

Parameters	Gender	Method of Measurement (mm)		p-value*
		Radiographic method (Mean±SD)	Clinical method (Mean±SD)	
Nasal Breadth (NB)	Male	33.95±2.41	37.19±2.44	0.001*
	Female	30.55±1.50	32.41±1.58	
Nasal Height (NH)	Male	47.46±2.26	53.30±2.68	0.001*
	Female	45.74±2.57	55.66±3.21	
Nasal index	Male	71.70±6.21	69.94±5.87	0.001*
	Female	67.02±5.21	58.44±4.70	

[Table/Fig-5]: Descriptive statistics of Nasal Height (NH), Nasal Breadth (NB) and Nasal Index of males and females.
*Unpaired Student t-test

DISCUSSION

Every human being is unique in terms of his/her physique and related measurements. The scientific technique called anthropometry is used to identify a person based on existing physical variability using body measurements. The physical anthropometry is useful in identification of dead and also in the study of living population. Measurement of face is now widely used in forensic identification. Nose is one of the protruding parts of the face and is variable in its size and shape [15].

NI is one of the important anthropometric parameters in forensic science [11]. Several authors have conducted various studies to measure nasal parameters and calculated the NI in different races, population using dry human skulls or on live subjects [14-17]. However, measuring parameters on dry skulls by classifying them as male and female skulls, by studying various traits and using them for sexual dimorphism is not 100% accurate. Measuring nasal parameters on live subjects may also vary due to different soft tissue thickness and may not give exact value of nasal parameters. Very few studies adopted different radiological techniques (Lat-Ceph and Multi Detector CT, respectively) to measure sinus and nasal parameters [10,15]. Since nasal parameters can be specifically measured with better precision using PA-Ceph and also considering the socioeconomic status of our study population at the time, the present study utilised the aforementioned radiographic technique to measure nasal parameters, calculate NI and also compare these parameters with clinical measurements.

The mean NI (±SD) for males with regards to clinical and radiographic findings was 69.94±5.87 and 71.70±6.21 respectively and for females, 58.44±4.70 and 67.02±5.21, respectively. This shows that males of this region have a significantly higher NI than females (p-value <0.05). This confirms the existence of sexual difference in nasal parameters between males and females of this region. The existence of sexual difference in nasal parameters between males and females is possible due to many aetiological factors such as genetic, hormonal, nutrition and other related factors. Present study results were consistent with the studies done by Ikechukwu E et al., Esomonu UG et al., Gangrade PR and Babel H, Kaushal S et al., Ikechukwu CFE et al., Staka G et al., Ogah SA and Segun SB, Sharma SK et al., Zolbin MM et al., Sudikshya KC et al., Bajracharya M and Sharma S, Anas IY and Saleh MS, Jimoh RO et al., Osunwoke EA et al., and Nasir N et al., [6,9,14,16,19-29]. But present study results differed from other studies done by Kotian R et al., Singh P and Pukrait R, Eboh DEO and John EA, Eboh DEO [15,30-32].

Various methodologies adopted by different authors and measured nasal parameters NH, NB, NI have been compared with present study in the [Table/Fig-6-8], respectively. From the above studies, it is shown that NI can be considered as a tool for sex determination which should be necessarily preceded by determination of race.

Author	Population	Methodology	Males		Females	
			Sample size	Mean±SD	Sample size	Mean±SD
Staka G et al., [20] (2012)	Kosovo Albanian	Live subjects using electronic digital caliper	101	55.26±3.57	103	52.01±3.01
Gangrade PR and Babel H [14] (2012)	Bheel-Meena	Live subjects using sliding vernier caliper	500	45.9	500	43.9
Kaushal S et al., [16] (2013)	Brahmins (Punjab)	Live subjects using caliper	100	47.59±4.24	100	44.09±3.79
	Majhabi-Sikhs (Punjab)	Live subjects using caliper	100	44.64±4.73	100	41.41±2.21
	Muslims (Punjab)	Live subjects using caliper	100	45.88±4.62	100	39.36±4.21
Esomonu UG et al., [9] (2013)	Bekwara (Nigeria)	Live subjects using caliper	50	38.4±2.9	50	39.1±2.9
Ikechukwu CFE et al., [19] (2013)	Ibibio (Nigeria)	Live subjects using sliding caliper	100	48.1±0.4	100	44.7±0.4
	Yakurr (Nigeria)	Live subjects using sliding caliper	100	51.6±0.4	100	37.7±0.5
Ogah SA and Segun SB [21] (2014)	Ilorin (Nigeria) (18 to 35 years)	Live subjects using caliper	428	41.21±3.53	465	40.07±2.92
Sharma SK et al., [22] (2014)	Hindus (Gwalior region)	Live subjects using digital vernier caliper	102	46.44±3.847	102	42.71±3.647
Kotian R et al.,[15] 2015	Radiographic study on South Indian population	Live subjects using Multidetector Computed Tomography 2-Dimensional scan	84	41.75±3.13	66	39.194 ±3.85
Zolbin MM et al., [23] (2015)	Qazvin (Iran)	Live subjects using caliper	160	60.6±0.29	140	56.8±0.28
Durga DG et al., [17] (2018)	Dry skulls of South Indian adults	Dry skulls using digital vernier caliper	51	16.3±1.9	51	17.4±2.3
Sudikshya KC et al., [24] (2019)	Nepalese and Indian students (17-25 years)	Live subjects using digital vernier caliper	81	49.1±0.35	75	45.8±0.28
Bajracharya M and Sharma S [25] (2019)	Nepalese people (17-25 years)	Live subjects using digital vernier caliper	80	43.9±0.33	80	48.3±0.33
Present study, 2023	18-60 years (Bhopal region)	-	196	53.30±2.68	196	55.66±3.21

[Table/Fig-6]: Statistical comparison of Nasal Height (NH) in mm estimated by different authors using different methods [9,14-17,19-25].

Author	Population	Male		Female	
		Sample size	Mean±SD	Sample size	Mean±SD
Singh P and Pukrait R [30] (2006)	Ahirwars (MP)	59	34	52	34
	Dangis (MP)	67	35	67	33

Gangrade PR and Babel H [14] (2012)	Bheel-Meena	500	38.1	500	35
Staka G et al., [20] (2012)	Kosovo Albanian	101	36.90±2.67	103	33.12±2.22
Kaushal S et al., [16] (2013)	Brahmins (Punjab)	100	37.47+4.29	100	34.24+2.73
	Majhabi-Sikhs (Punjab)	100	39.66+4.55	100	33.36+3.02
	Muslims (Punjab)	100	35.37+3.19	100	31.99+1.6
Esomonu UG et al., [9] (2013)	Bekwara (Nigeria)	50	40.1±2.4	50	39.8±2.1
Ikechukwu CFE et al., [19] (2013)	Ibibio (Nigeria)	100	41.4±4	100	36.3±0.4
	Yakurr (Nigeria)	100	40±0.4	100	38.2±0.4
Ogah SA and Segun SB [21] (2014)	Ilorin (Nigeria) (18 to 35 years)	428	46.25 ±3.18	465	45.10±3.50
Sharma SK et al., [22] (2014)	Hindus (Gwalior region)	102	39.17±2.49	102	34.86±2.892
Zolbin MM et al., [23] (2015)	Qazvin (Iran)	160	38±0.23	140	33.8±0.22
Kotian R et al., [15] (2015)	Radiographic study on South Indian population	84	27±2.43	66	26.07±3.13
Durga DG et al., [17] (2018)	Dry Skulls of South Indian Adults	51	11.3±1.6	51	12.05±1.7
Bajracharya M and Sharma S [25] (2019)	Nepalese people (17-25 years)	80	37.7±0.32	80	34.1±0.29
Sudikshya KC et al., [24] (2019)	Nepalese and Indian students (17-25 years)	81	37.2±0.23	75	34.5±0.28
Present study, 2023	18-60 years (Bhopal region)	196	37.19±2.44	196	32.41±1.58

[Table/Fig-7]: Statistical comparison of Nasal Breadth (NB) in mm estimated by different authors using different methods [9,14-17,19-25,30].

Author	Population	Male		Female	
		Sample size	Mean±SD	Sample size	Mean±SD
Singh P and Pukrait R [30] (2006)	Ahirwars (MP)	59	81	52	82.4
	Dangis (MP)	67	76.5	67	76.5
Anas IY and Saleh MS [26] (2010)	Hausa (Nigeria)	224	70.7±11.3	161	67.2±8.3
	Yoruba (Nigeria)	100	100.9±8.9	97	94.1±8
Eboh DEO [32] (2011)	Bini Adolescents (Nigeria)	100	99.13±9.26	100	99.27±11.67
Jimoh RO et al., [27] (2011)	Ilorin (Nigerian Africans)	58	90.7±6.26	47	88.2±6.32
Eboh DEO and John EA [31] (2011)	Ukwuani (Nigeria)	-	97.47±12.88	-	98.07 ±8.37
Gangrade PR and Babel H [14] (2012)	Bheel-Meena (Rajasthan)	500	83±7.33	500	79.73
Ikechukwu E et al., [6] (2012)	Ibo (Nigeria)	114	107.62±1.09	114	98.89±1.30
	Yoruba (Nigeria)	78	110.30±1.92	78	97.07±2.11
Staka G et al., [20] (2012)	Kosov Albanian	101	67.07±6.67	103	63.87±5.56
Osunwoke EA et al., [28] (2012)	Ikwerre (Nigeria)	250	93.8	250	95.8
	Ogu (Nigeria)	250	95.8	250	87.34
Kaushal S et al., [16] (2013)	Brahmins	100	70.02±9.13	100	69.89±6.04
	Majhabi-Sikhs	100	76.51±8.98	100	68.95±6.22
Kaushal S et al., [16] (2013)	Muslims	100	67.04±8.87	100	69.38±8.09
Esomonu UG et al., [9] (2013)	Bekwara (Nigeria)	50	94.65±6.42	50	90.33±6.45
Ikechukwu CFE et al., [19] (2013)	Ibibio (Nigeria)	100	86.58±1.20	100	81.75±1.14
	Yakurr (Nigeria)	100	77.76±0.82	100	102.27±1.31
Sharma SK et al., [22] (2014)	Hindus (Gwalior region)	102	80.59±9.122	102	77.29±8.472
Zolbin MM et al., [23] (2015)	Qazvin (Iran)	160	62.54±5.78	140	59.61±4.78
Kotian R et al., [15] (2015)	Radiographic study on South Indian population	84	66.02±6.80	66	66.963±8.85
Bajracharya M and Sharma S [25] (2019)	Nepalese people (17-25 years)	80	78.12±6.91	80	77.92±7.28
Sudikshya KC et al., [24] (2019)	Nepalese and Indian students (17-25 years)	81	76.25±7.75	75	75.70±8.05
Nasir N et al., [29] (2021)	Kashmir, Uttar Pradesh, Bihar and Kerala	398	73.09±0.46	410	72.85±0.36
Present study, 2023	18-60 years (Bhopal region)	196	69.94±5.87	196	58.44±4.70

[Table/Fig-8]: Statistical comparison of Nasal Index (NI) in mm estimated by different authors using different methods [6,9,14-16,19,20,22-32].

Limitation(s)

This study needs to be subjected to further investigations as the study was conducted on two- dimensional (2D) measurements.

CONCLUSION(S)

From the findings of present study, it can be concluded that there are significant differences in nasal parameters between males and females in Central Indian population. Determination, comparison and evaluation of nasal parameters both clinically and radiographically, not only suggests sexual dimorphism but also provides a baseline data for the Central Indian population that is valuable in nasal anthropometry for clinical practice, reconstructive surgeries, rhinoplasties and forensic sciences. Although not included in the present study, assessment and evaluation of nasal parameters in Central Indian population in regards to sexual dimorphism with the help of computed tomographic imaging has been prospected in the future for enhanced accuracy and precision.

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