Nasal Index and Nasal Morphology among Adults of Nagaur District, Rajasthan, India: A Forensic Anthropometric Study

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Abstract: Nasal morphology is an important craniofacial characteristic widely used in forensic anthropology for personal identification, ancestry estimation, facial reconstruction, and population-based studies. The nasal index, which is calculated from nasal height and nasal width, varies considerably among different populations owing to genetic, environmental, and climatic influences. Despite the anthropometric diversity of India, region-specific data on the nasal index remain limited, particularly for the population of Nagaur district in Rajasthan. A cross-sectional anthropometric study was conducted among 100 healthy adults (50 males and 50 females) aged 17–50 years from Nagaur district, Rajasthan, India. Nasal height and nasal width were measured via a manual sliding Vernier calliper following standard anthropometric landmarks. The nasal index was calculated via the following formula: Nasal Index = (Nasal width / nasal height) × 100. Descriptive statistics, including the means and standard deviations, were calculated via Microsoft Excel. Nasal morphology was classified into leptorrhine, mesorrhine, and platyrrhine categories according to standard anthropometric criteria. The study demonstrated variation in nasal dimensions between male and female participants. Males presented greater mean nasal height and nasal width than females did. Mesorrhine was the predominant nasal type observed in the mean nasal index in both sexes, followed by leptorrhine and platyrrhine. The findings provide baseline anthropometric data for the Nagaur population and demonstrate sexual variation in nasal morphology.

***Index Terms* - Forensic anthropology, Nasal Index, Rajasthan population, Human identification, Anthropometry**

I. Introduction

Forensic anthropology is a crucial discipline in the identification of unknown human remains, utilizing anthropometric, anatomical, and osteological methods to estimate biological characteristics such as sex, age, stature, and ancestry (Austin and King, 2016). Craniofacial anthropometry can be useful in cases with decomposed, skeletonized, burned or fragmented remains where traditional means of identification are unavailable or compromised, to help narrow the identity of unknown individuals (Adserias-Garriga et al. 2024). Molecular techniques such as DNA profiling are highly accurate, but are often limited by issues such as sample degradation, availability of reference samples, cost and laboratory infrastructure (Alonso et al. 2005). Anthropometric measurements are still a key part of forensic human identification, especially in resource-limited settings (Omolara et al. 2025).

The nasal index is one of the most informative anthropometric parameters among craniofacial measurements, and reflects variations in nasal morphology among different populations (Shrestha et al. 2019). The nasal index is calculated as the ratio of the maximum nasal width to the nasal height multiplied by 100 and is commonly used to classify noses into leptorrhine (NI <69.9, narrow), mesorrhine (NI 70–84.9, medium) and platyrrhine (NI ≥85, broad) categories (Şafak et al. 2023). These morphological variations are influenced by complex interactions of genetic inheritance, environmental adaptation, climatic conditions, and evolutionary pressures, making the nasal index a useful indicator in forensic anthropology, biological anthropology, and population studies (Premraj et al. 2025).

The human nose is morphologically quite variable across geographical regions (Hubbe et al. 2009). Populations living in colder and drier climates tend to have narrower nasal apertures which help warm and humidify inspired air, whereas those living in hotter and humid climates tend to have broader nasal structures (Zaidi et al. 2017). Therefore, nasal morphology varies widely among different ethnic groups and populations, suggesting the need for population specific anthropometric standards rather than universal reference values (Khademi Mansour et al. 2026).

Studies on different populations have consistently shown considerable differences in nasal dimensions according to ethnicity, sex and geographic origin (Khademi Mansour, 2026; Raghavan et al. 2013). Studies from Gujarat, Uttar Pradesh, Madhya Pradesh, Kerala, Jammu and Kashmir, and Central India have also reported sexual dimorphism in nasal dimensions and variation in the frequency of leptorrhine, mesorrhine, and platyrrhine nasal types (Rohith et al. 2020; Khademi Mansour et al. 2026; Ray et al. 2016; Jabeen et al.

2019; Devika & Sequeira, 2024; Sharma et al. 2023). The findings demonstrate the impossibility of extrapolating anthropometric reference standards created for a certain population to another population because of the biological variability among regions.

India is one of the most genetically and ethnically diverse countries in the world. There is a considerable variation in craniofacial traits across different geographical regions of India (Raghav et al. 2013). Rajasthan is located in the northwestern part of India and has an arid climate, high temperatures, low humidity and a diverse range of ethnic groups (Singh and Kumar 2015). It is anticipated that environmental and genetic factors influence nasal morphology through long-term climatic adaptation.

The development of population-specific nasal index data for Rajasthan will enhance regional anthropometric databases and improve the accuracy of forensic identification, estimation of ancestry and craniofacial reconstruction. The data may also be useful for comparative anthropological studies by recording the morphological variation of the Indian population. Therefore, the present study was undertaken to determine the nasal index among adult individuals from Nagaur District Rajasthan and classify nasal morphology according to standard anthropometric criteria. The results are expected to provide baseline reference values that might be useful in forensic investigations, medico-legal practices and future anthropological research related to the Rajasthan population.

II. Methods

A cross-sectional anthropometric study was conducted on 100 adult individuals (50 males and 50 females) belonging to Distt. Nagaur Rajasthan of India, aged between 17 and 50 years, were permanent residents of Rajasthan and were divided into 7 age groups ranging from 15-20--45-50 years. Only individuals with no history of surgery or and facial trauma or deformities were included, and individuals with nasal deformity were excluded.
A standard manual sliding Vernier calliper was used for anthropometric measurements with individuals seated comfortably. All measurements were recorded by the same researcher to minimize interobserver variation.
Two parameters were measured:
Nasal height was measured from the nasion (n) to the subnasale (sn).
Nasal width was measured from the right alare and left alare (al).
The nasal Index was calculated by using standard anthropometric formula: nasal width/ nasal height * 100
The statistical data were analysed via Microsoft Office Excel. Descriptive statistics, including the means and standard deviations and percentage distributions were calculated.

III. Results

A larger number of participants were in the 21-25 years age group and fewer were in the 41-45 years age group presented in Figure 3.1.

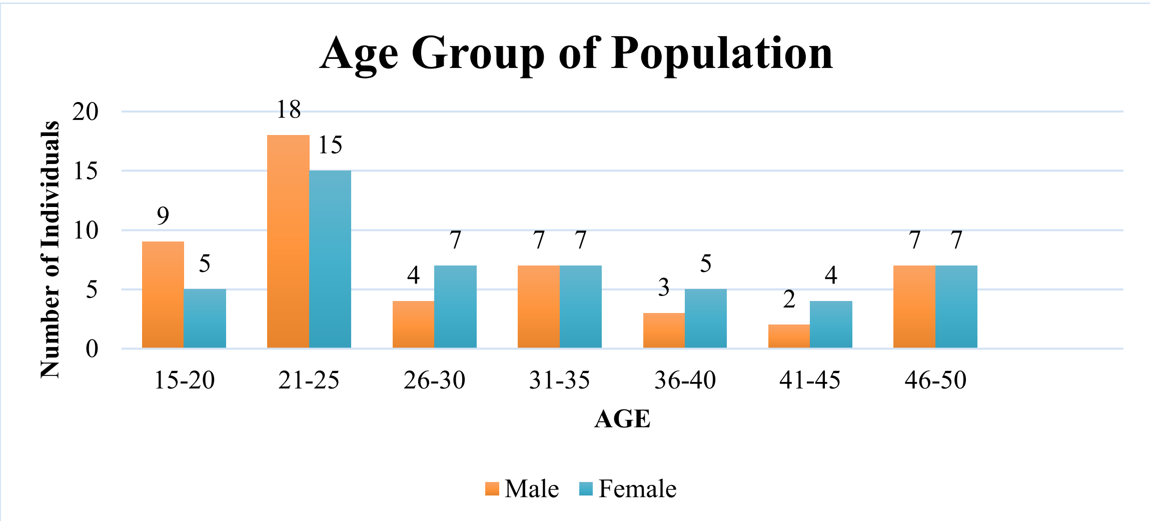

Fig 3.1: Age distribution of male and female individuals included in study.

The calculation of the nasal index for male individuals was shown in Table 3.1. The mean nasal height in males was 3.58 ± 0.49 cm, whereas the mean nasal width was 4.88 ± 0.47 cm. The calculated mean nasal index was 73.45 ± 7.88 shown in Table 3.2. According to standard anthropological classification, this mean value falls within the Mesorrhine category (70–84.9). The highest proportion of males was also in the Mesorrhine category.

Table 3.1 Calculation of nasal index and classification of nasal morphology of male individuals of Rajasthan

Sr. No.	Nose width (cm)	Nose height (cm)	Nasal index	Type of nose
1	5	3.4	68	Leptorrhine
2	4.9	3.2	65.30612245	Leptorrhine
3	4.7	3.5	74.46808511	Mesorrhine
4	4.7	4	85.10638298	Platyrrhine
5	5.1	4	78.43137255	Mesorrhine
6	5.3	2.9	54.71698113	Leptorrhine
7	4.9	3.5	71.42857143	Mesorrhine
8	4.7	3.6	76.59574468	Mesorrhine
9	5.2	4.3	82.69230769	Mesorrhine
10	4.9	4.1	83.67346939	Mesorrhine
11	5.5	4.7	85.45454545	Platyrrhine
12	5.4	4.6	85.18518519	Platyrrhine
13	5.4	4.3	79.62962963	Mesorrhine
14	5.9	4.5	76.27118644	Mesorrhine
15	5.7	4.3	75.43859649	Mesorrhine
16	5.6	3.9	69.64285714	Leptorrhine
17	4.5	3.6	80	Mesorrhine
18	4.9	2.7	55.10204082	Leptorrhine
19	4.7	3.2	68.08510638	Leptorrhine
20	5.1	4.3	84.31372549	Mesorrhine
21	5.4	3.8	70.37037037	Mesorrhine
22	4.4	3.4	77.27272727	Mesorrhine
23	4.3	3	69.76744186	Leptorrhine
24	4.1	3.4	82.92682927	Mesorrhine
25	4.8	3.3	68.75	Leptorrhine
26	4.3	3.7	86.04651163	Platyrrhine
27	5	4.3	86	Platyrrhine
28	4.8	3.3	68.75	Leptorrhine
29	4.1	3	73.17073171	Mesorrhine
30	4.5	3.1	68.88888889	Leptorrhine
31	6	3.9	65	Leptorrhine
32	5.4	4	74.07407407	Mesorrhine
33	5.1	3.7	72.54901961	Mesorrhine
34	5.1	3.6	70.58823529	Mesorrhine
35	5.5	3.6	65.45454545	Leptorrhine
36	4.3	3.6	83.72093023	Mesorrhine
37	4.7	3.6	76.59574468	Mesorrhine
38	4.9	3.4	69.3877551	Leptorrhine
39	4.2	3.1	73.80952381	Mesorrhine
40	4.8	3.7	77.08333333	Mesorrhine
41	4.4	3.6	81.81818182	Mesorrhine
42	4.6	3.5	76.08695652	Mesorrhine
43	4.2	3.1	73.80952381	Mesorrhine

44	5.1	3.2	62.74509804	Leptorrhine
45	4.5	3	66.66666667	Leptorrhine
46	4.9	3.3	67.34693878	Leptorrhine
47	4.1	2.8	68.29268293	Leptorrhine
48	5	3	60	Leptorrhine
49	4.8	3.1	64.58333333	Leptorrhine
50	4.6	3.3	71.73913043	Mesorrhine

Table 3.2 Calculation of mean and standard deviation of nasal morphology of male individuals

Calculation	Nasal Height	Nasal Width	Nasal Index
Mean	3.58	4.88	73.45674171
± SD	0.491561444	0.471644972	7.886983239

The percentage distribution of nasal types among males revealed the following:
Leptorrhine = 19 individuals (38%) Mesorrhine = 26 individuals (52%) Platyrrhine = 5 individuals (10%) are presented in Figure 3.2.

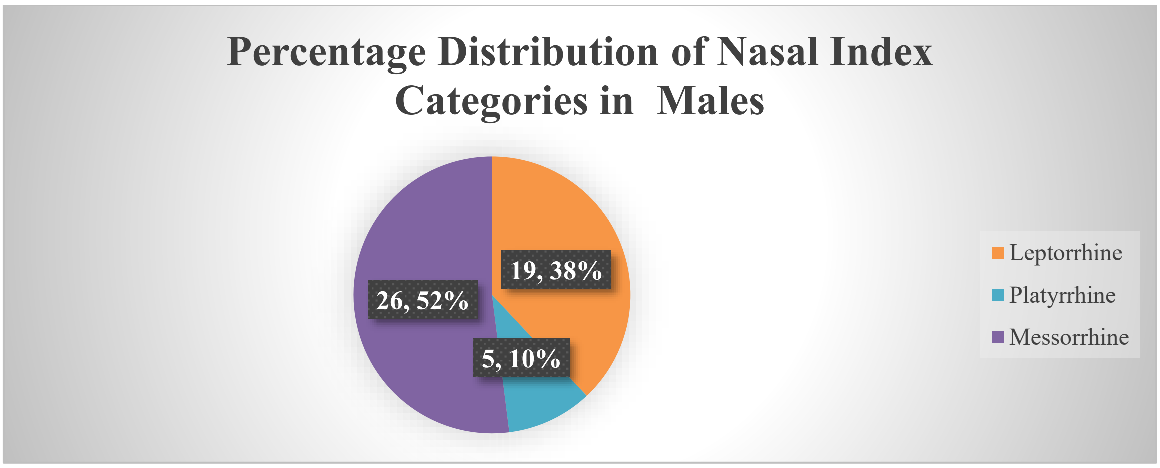

Fig 3.2 Pie Graph of the percentage distribution of Nasal Index categories of male individuals

The calculation of the nasal index of female individuals was shown in Table 3.3. Among females, the mean nasal height was 3.3 ± 0.37 cm and the mean nasal width was 4.57 ± 0.39 cm. The mean nasal index was calculated as 72.03 ± 9.52 and presented in Table 3.4 which was also within the Mesorrhine category, but the highest proportion of females were in the Leptorrhine category.

Table 3.3 Calculation of nasal index and classification of nasal morphology of female individuals of Rajasthan

Sr. No.	Nasal width (cm)	Nasal height (cm)	Nasal index	Type of nose
1	3	5.1	58.82352941	Leptorrhine
2	3.9	4.3	90.69767442	Platyrrhine
3	3.9	5.2	75	Mesorrhine
4	2.9	4.4	65.90909091	Leptorrhine
5	3.1	4.7	65.95744681	Leptorrhine
6	3.3	5.1	64.70588235	Leptorrhine
7	3.5	5.3	66.03773585	Leptorrhine
8	4	5.2	76.92307692	Mesorrhine
9	3	4.5	66.66666667	Leptorrhine

10	3.5	4.9	71.42857143	Mesorrhine
11	3	4.4	68.18181818	Leptorrhine
12	3.2	4.1	78.04878049	Mesorrhine
13	3.5	4.3	81.39534884	Mesorrhine
14	3.4	4.3	79.06976744	Mesorrhine
15	3.2	4.6	69.56521739	Leptorrhine
16	2.9	4.8	60.41666667	Leptorrhine
17	4	5	80	Mesorrhine
18	2.9	5.6	51.78571429	Leptorrhine
19	2.7	4.2	64.28571429	Leptorrhine
20	2.9	4	72.5	Mesorrhine
21	3.1	3.3	93.93939394	Platyrrhine
22	2.6	3.8	68.42105263	Leptorrhine
23	3.1	4.1	75.6097561	Mesorrhine
24	3.2	4.4	72.72727273	Mesorrhine
25	3	4.2	71.42857143	Mesorrhine
26	3.5	4.5	77.77777778	Mesorrhine
27	3.3	4.9	67.34693878	Leptorrhine
28	2.8	4.4	63.63636364	Leptorrhine
29	3.4	5.1	66.66666667	Leptorrhine
30	3	4.6	65.2173913	Leptorrhine
31	3.1	4	77.5	Mesorrhine
32	3.5	5.2	67.30769231	Leptorrhine
33	3.2	4.3	74.41860465	Mesorrhine
34	3.5	4.9	71.42857143	Mesorrhine
35	2.9	5	58	Leptorrhine
36	3.6	5.2	69.23076923	Leptorrhine
37	2.8	3.1	90.32258065	Platyrrhine
38	3.4	4.6	73.91304348	Mesorrhine
39	3	3.9	76.92307692	Mesorrhine
40	2.7	4.7	57.44680851	Leptorrhine
41	3.4	4.8	70.83333333	Mesorrhine
42	4.2	5	84	Mesorrhine
43	2.8	4.8	58.33333333	Leptorrhine
44	3	3.7	81.08108108	Mesorrhine
45	3.2	4.8	66.66666667	Leptorrhine
46	2.9	4.4	65.90909091	Leptorrhine
47	4	5.2	76.92307692	Mesorrhine
48	3.3	3.8	86.84210526	Platyrrhine
49	4.6	5.4	85.18518519	Platyrrhine
50	3.5	4.4	79.54545455	Mesorrhine

Table 3.4 Calculation of mean and standard deviation of nasal morphology of female individuals

Calculation	Nasal Height	Nasal Width	Nasal Index
Mean	3.268	4.57	72.039607
± SD	0.37	0.39	9.52

The distribution of nasal types in female individuals was as follows:
Leptorrhine = 23 individuals (46%) Mesorrhine = 22 individuals (44%) Platyrrhine = 5 individuals (10%) are presented in Figure 3.3.

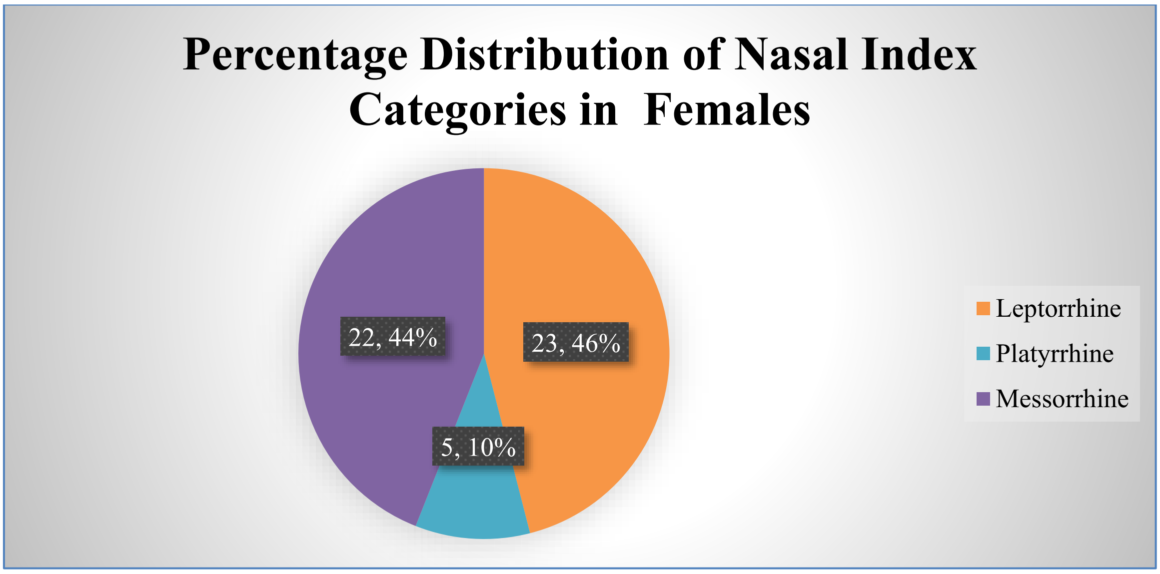

Fig 3.3 Pie graph of the percentage distribution of nasal index categories of females' individuals

A comparison of male and female nasal measurements revealed that males presented greater absolute nasal height and width than females did, present in Table 3.5. However, the mean nasal indices were relatively similar between the two sexes.

Table 3.5 Comparative study of nasal indices of male and female individuals

Parameter	Male (Mean ± SD)	Female (Mean ± SD)
Nasal Height	3.5 ± 0.49156	3.268 ± 0.37
Nasal Width	4.88 ± 0.47166	4.57 ± 0.39
Nasal Index	73.456 ± 7.8869	72.039 ± 9.52

IV. Discussion

The present study aimed to determine the nasal morphology among adults from the Rajasthan population via the nasal index. The overall study revealed that the mean nasal index values of males and females were within the mesorrhine category. These results are comparable with those of a study of the nasal indices of the Indian population, which ranged from 72--77 (Nasir et al. 2021). Similarly, another study on young adults from Gujrat revealed predominance of Mesorrhine nasal morphology (Kulkarni et al. 2019).
However, the most prevalent type of nose in males is mesorrhine and in females it is leptorrhine as demonstrated in the present study. This variation may be due to regional genetic differences, environmental adaptations, and climate influences (Noback et al. 2011). Although males presented greater nasal height and nasal width, the mean nasal index values were similar between individuals, which indicated that the nasal proportions remain relatively constant despite differences in size (Scendoni et al. 2023; Sharma et al. 2023).
In forensics, the nasal index serves as an important anthropometric parameter for population profiling, ancestry estimation, facial reconstruction, and personal identification. In situations involving decomposed, skeletonised, or unidentified remains, regional anthropometric databases such as those used in the present study can assist forensic experts in narrowing the identity of unknown individuals.

This study therefore contributes valuable baseline data on nasal morphology in the Rajasthan population and highlights the importance of craniofacial anthropometry in forensic anthropology and human identification.

V. Conclusion

This study determined the nasal height, nasal width and nasal index that establish the baseline for nasal anthropometric data for the Rajasthan population. The mesorrhine category was found predominantly in the mean nasal index in the male and female populations. Specifically, in females, the number of individuals who presented with leptorrhine-type of noses was greater than the number who presented with mesorrhine-type of noses. This finding indicates that about the population also contains the leptorrhine and platyrrhine types of noses. Although males presented greater nasal dimensions than female did, this highlights that only limited sexual dimorphism was observed in the nasal index values. These data may contribute to forensic anthropology by assisting in personal identification, ancestry estimation, facial reconstruction and the development of regional anthropometric databases. Further studies should involve larger sample sizes and diverse ethnic groups of the Rajasthan population which improve the applicability of these findings to forensics and anthropology.

VI. Declarations

Ethics approval and consent to participate

This study involved only non-invasive anthropometric measurements and did not involve any medical intervention or collection of biological samples. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from all participants prior to participation, and participation was voluntary. The institution where the study was conducted did not have an Institutional Ethics Committee; formal ethics committee approval was not available.

Consent for publication

Not applicable

Funding

Not applicable

VII. References

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