Original Article

Estimation of Stature from Nasal Dimensions in Newborns from the Himalayan Region of Himachal Pradesh

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ABSTRACT

Introduction: Anthropometric measurements play an important role in forensic identification and neonatal assessment. Nasal dimensions are known to vary according to ethnicity and geography, but limited data exist regarding their relationship with stature in newborns from hilly regions of India.

Aim: To assess nasal height and nasal width in full-term newborns of Himachal Pradesh and to evaluate their role in the estimation of stature.

Materials and Methods: This cross-sectional study included 409 full-term newborns (216 males and 193 females) from outer and inner Himalayan regions of Himachal Pradesh. Nasal height (NH) and nasal width (NW) were measured using a digital vernier caliper, and stature was recorded as crown–heel length (CHL) using an infantometer. Independent sample t-test, Pearson correlation, and linear regression analyses were performed. A p-value < 0.05 was considered statistically significant.

Results: Male newborns demonstrated significantly higher nasal width (p = 0.036) and stature (p = 0.001) compared to females. Nasal height showed significant regional variation, with higher values in inner Himalayan newborns (p = 0.013). Pearson correlation analysis revealed a positive association between nasal dimensions and stature. Regression analysis indicated that nasal height was a stronger predictor of stature compared to nasal width.

Conclusion: Nasal dimensions can be reliably used to estimate stature in full-term newborns. Regression analysis based on nasal measurements provides valuable information for stature estimation in forensic identification and neonatal anthropometric assessment.

Keywords: Anthropometry; Newborn; Nasal dimensions; Stature estimation; Himalayas; Forensic anthropology.

INTRODUCTION

The nose, centrally located on the face, is a prominent feature that significantly contributes to a person's appearance. Its shape can reflect ethnicity, race, age, and sex[1]. Advanced anthropometric methods and surgical techniques have been developed to successfully treat congenital or post-traumatic facial disfigurements in individuals from diverse racial and ethnic backgrounds.[2]

Human features are unique and crucial for personal identification. Anthropometry, the field dedicated to measuring the human body, helps us to understand these variations. Each population has specific facial anthropometry, influenced by genetic and environmental factors.[3]

Nasal anthropometry involves the precise measurement of the nose's size, proportions, and shape. A key metric in this field is the nasal index, which is the ratio of nasal breadth to height expressed as a percentage. This index is essential in forensic sciences for identifying and differentiating individuals based on sex and race. By examining nasal dimensions, forensic

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experts can infer a person's demographic background, which is valuable in criminal investigations, archaeological studies, and other fields requiring accurate human identification[4].

Anthropometric methods and surgical practices have now merged to effectively treat congenital or post-traumatic facial disfigurements in various racial and ethnic groups. Nasal surgery requires precise facial data from accurate anthropometric measurements to achieve optimal correction for any condition. Although cosmetic nasal surgery for men is technically similar to that for women, it requires additional considerations due to differing expectations. Anthropometric analysis is vital in addressing these factors and forms the foundation for planning corrective surgery[5].

Humans have an insatiable and ongoing drive to understand themselves and their surroundings better. They continuously seek to explore new areas of significance, pushing the boundaries of their knowledge and wisdom. Geographical location, racial background, and environmental factors greatly influence human growth and body composition.

The geographical and environmental conditions of Himachal Pradesh distinguish it from the rest of India. With this in mind, we conducted an anthropometric study of newborns in the hilly regions of Himachal Pradesh. This region is celebrated for its unique socio-political and cultural traditions. Its distinct geography, location, and cultural heritage make it a truly unique wonderland[6].

In ancient times, anthropometry was used in criminology to identify criminals based on body measurements. By the early 20th century, it was also used to study racial differences. The nasal index, a key parameter, reflects regional and climatic variations. For example, colder and drier climates often produce longer, narrower noses, while warmer and more humid regions tend to have broader nasal shapes.[7]

AIM AND OBJECTIVES
1. To measure nasal height and nasal width in full-term newborns of Himachal Pradesh.
2. To study sexual and regional variations in nasal dimensions.
3. To evaluate the relationship between nasal dimensions and stature.
4. To derive regression models for estimation of stature from nasal dimensions in newborns.

MATERIALS AND METHODS
This cross-sectional study was conducted on 409 full-term newborns (216 males, 193 females) from various districts of Himachal Pradesh, categorized into outer and inner Himalayan regions. Measurements were recorded within 12–24 hours of birth using standardized anthropometric techniques (Table-1and Figure-1).

Table 1: Distribution of full-term newborns according to Himalayan region

Region	Male	Female	Total
Outer Himalayas	120	108	228
Inner Himalayas	96	85	181
Total	**216**	**193**	**409**

Anthropometric Measurements
- **Nasal Height (NH):** Nasion to nasopinale
- **Nasal Width (NW):** Alar to alar distance
- **Stature:** Crown–heel length measured using an infantometer

Statistical Analysis
- Mean ± standard deviation calculated
- Independent sample t-test used for comparison
- Pearson correlation coefficient (r) calculated
- Linear regression analysis performed
- $p < 0.05$ considered statistically significant

LIMITATIONS OF THE STUDY
- The study included only full-term neonates.

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Figure 1: All measurements were taken by the same observer to minimize inter-observer error
Right to left (above): Nasal breadth, nasal height
Right to left (Below): Crown–heel length

Exclusion criteria:
Neonates from high-risk or complicated pregnancies, including maternal hypertension, diabetes mellitus, infections, autoimmune disorders, and cardiac diseases, were excluded. Newborns with caput succedaneum, cephalhematoma, craniofacial deformities, or those delivered by caesarean section were also excluded.

Ethical Considerations
The study was approved by the Institutional Ethics Committee (GU/HREC/EC/2015/1033). Written informed consent was obtained from the parents or legal guardians of all newborns prior to enrollment. Permission to conduct the study was also obtained from the Director of Health Services, Government of Himachal Pradesh.

RESULTS
The present study included 409 full-term newborns, comprising 216 males (52.8%) and 193 females (47.2%), from outer and inner Himalayan regions of Himachal Pradesh (Table 1).

Nasal Dimensions and Stature in Full-term Newborns
The mean nasal height, nasal width, and stature (crown–heel length) of the study population are presented in (Table 2). Male newborns showed higher mean values of nasal height, nasal width, and stature compared to females. The difference in nasal width (p = 0.036) and stature (p = 0.001) between male and female newborns was statistically significant. Although nasal height was higher in males, the difference did not reach statistical significance (p = 0.063).

Table 2: Mean and standard deviation of nasal dimensions and stature in full-term newborns of Himachal Pradesh

S. No.	Parameter	Male (n = 216)	Female (n = 193)	Total (n = 409)	p value
1	Nasal Height (mm)	22.32 ± 2.70	21.84 ± 2.50	22.10 ± 2.62	0.063
2	Nasal Width (mm)	21.68 ± 4.50	20.96 ± 1.66	21.34 ± 3.48	0.036*
3	Stature (cm)	48.86 ± 4.55	48.55 ± 2.80	48.71 ± 3.68	0.001*

* Statistically significant (p < 0.05)

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Regional Variation in Nasal Dimensions and Stature

Comparison of nasal dimensions and stature between newborns from the outer and inner Himalayan regions revealed distinct regional differences. In the outer Himalayan region (Table 3), male newborns exhibited higher mean values of nasal height, nasal width, and stature compared to females. A statistically significant sex difference was observed for stature ($p = 0.014$), while differences in nasal height and nasal width were not statistically significant.

Table 3: Mean and standard deviation of nasal dimensions and stature in full-term newborns from Outer Himalayas

S. No.	Parameter	Male (n = 120)	Female (n = 108)	Total (n = 228)	*p* value
1	Nasal Height (mm)	21.48 ± 2.51	21.37 ± 2.47	21.42 ± 2.51	0.741
2	Nasal Width (mm)	21.78 ± 5.83	20.69 ± 1.68	21.03 ± 3.66	0.061
3	Stature (cm)	49.28 ± 3.34	48.94 ± 1.91	49.12 ± 2.76	0.014*

In the inner Himalayan region (Table 4), male newborns demonstrated significantly greater nasal height compared to females ($p = 0.013$). No statistically significant sex differences were observed for nasal width ($p = 0.327$) or stature ($p = 0.051$) in this region. When regional means were compared, nasal height was found to be higher in newborns from the inner Himalayan region than those from the outer Himalayan region.

Table 4: Mean and standard deviation of nasal dimensions and stature in full-term newborns from Inner Himalayas

S. No.	Parameter	Male (n = 96)	Female (n = 85)	Total (n = 181)	*p* value
1	Nasal Height (mm)	23.38 ± 2.57	22.44 ± 2.42	22.94 ± 2.54	0.013*
2	Nasal Width (mm)	21.54 ± 1.81	21.29 ± 1.59	21.42 ± 1.71	0.327
3	Stature (cm)	48.32 ± 5.68	48.06 ± 3.57	48.19 ± 4.71	0.051

Scatter plot demonstrating the linear relationship between nasal height (mm) and stature (cm) among male newborns from the Himalayan region of Himachal Pradesh (Figure-2). A positive correlation was observed. The regression line represents the best-fit linear model. The regression equation and coefficient of determination (R^2) are displayed within the figure.
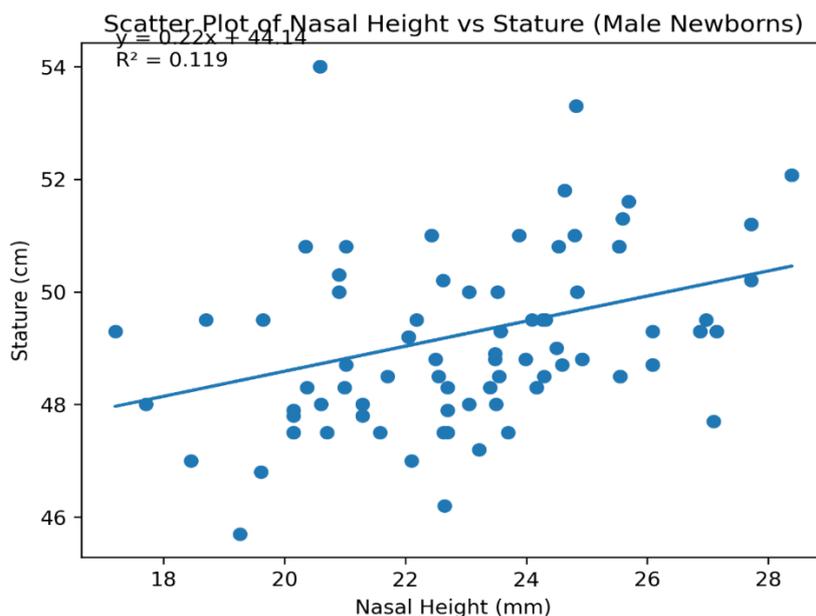

Figure 2: Scatter Plot Showing Correlation between Nasal Height and Stature in Male Newborns

Scatter plot illustrating the association between nasal height (mm) and stature (cm) among female newborns from the Himalayan region of Himachal Pradesh (Figure-3). A statistically significant positive correlation was observed. The regression line indicates the predictive linear relationship. The regression equation and R^2 value are shown in the figure.

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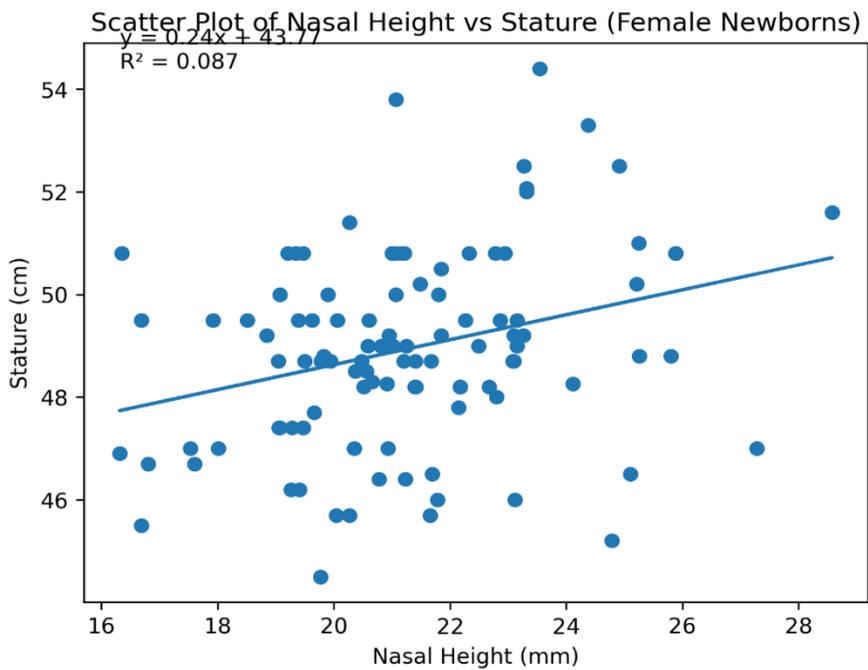
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Figure 3: Scatter Plot Showing Correlation between Nasal Height and Stature in Female Newborns

Scatter plot illustrating the relationship between nasal width (mm) and stature (cm) among male newborns (Figure-4). Linear regression analysis demonstrates the predictive association, with regression equation and coefficient of determination (R^2) displayed.
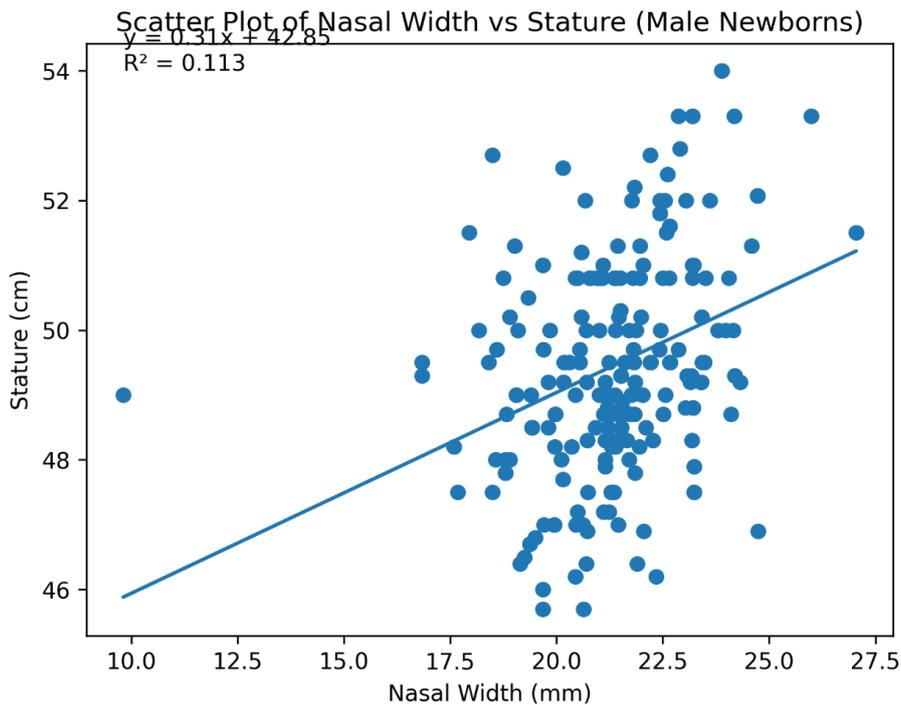

Figure 4: Scatter Plot Showing Correlation between Nasal Width and Stature in Male Newborns

Scatter plot demonstrating the correlation between nasal width (mm) and stature (cm) among female newborns (Figure-5). The regression line indicates the linear relationship, with the regression equation and R^2 value shown within the figure.
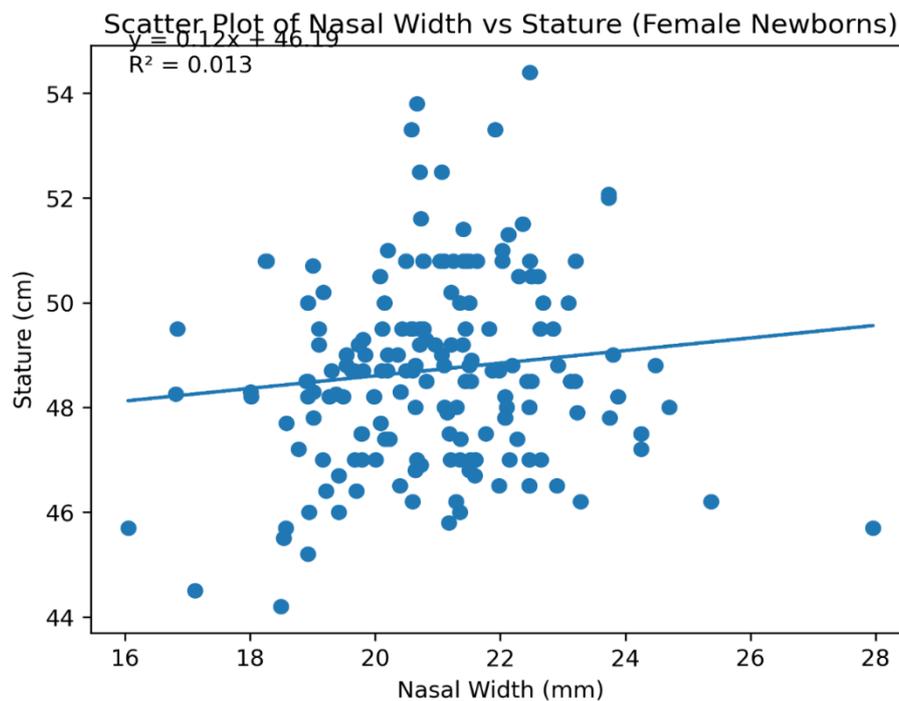
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Scatter Plot of Nasal Width vs Stature (Female Newborns)
$y = 0.12x + 46.19$
$R^2 = 0.013$

Figure 5: Scatter Plot Showing Correlation between Nasal Width and Stature in Female Newborns.

Relationship between Nasal Dimensions and Stature

Pearson correlation analysis revealed a positive association between nasal dimensions and stature in full-term newborns. Nasal height showed a stronger and more consistent correlation with stature compared to nasal width. Linear regression analysis further demonstrated that nasal height served as a better predictor of stature than nasal width. Regression models derived from nasal dimensions provided equations for estimation of crown–heel length in newborns, with nasal height contributing more significantly to stature prediction.

DISCUSSION

The present study was undertaken to evaluate nasal dimensions in full-term newborns of Himachal Pradesh and to assess their utility in the estimation of stature. Anthropometric parameters of the nose have long been considered reliable indicators of population variability due to their strong genetic control and relative resistance to postnatal environmental modification. However, data on neonatal nasal dimensions and their relationship with stature remain scarce, particularly from hilly regions of India.

Sexual Dimorphism

Male newborns exhibited higher mean values of nasal height, nasal width, and stature compared to females, with statistically significant differences observed for nasal width (p = 0.036) and stature (p = 0.001). Although nasal height was higher in males, the difference did not reach statistical significance (p = 0.063).

These findings are consistent with the work of Farkas LG et al.[8], who demonstrated early sex-based differences in craniofacial anthropometry across various ethnic populations. Similarly, El Ella S.S.A et al.[9] reported significant sex variations in mid-facial dimensions in pediatric populations, suggesting that sexual dimorphism in craniofacial parameters is established early in life.

The presence of sex differences at birth indicates that genetic determinants of craniofacial growth operate prenatally and are not solely the result of postnatal hormonal influences.

Regional Variation and Climatic Adaptation

The present study demonstrated significantly greater nasal height in newborns from the inner Himalayan region (p = 0.013), whereas nasal width and stature did not show significant regional differences.

These findings align with anthropological principles describing nasal morphology as a climate-sensitive structure. Dhulqarnain A.O. et al.[10] reported inter-population differences in nasal index between Nigerian and Iranian populations, attributing variation to environmental and climatic influences. Longer and narrower nasal structures are commonly observed in colder, drier climates, which is consistent with the higher nasal height observed in inner Himalayan newborns.

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Such morphological adaptations may reflect evolutionary responses aimed at optimizing air conditioning within the nasal cavity.

Correlation between Nasal Dimensions and Stature

A statistically significant positive correlation was observed between nasal dimensions and stature in both sexes. Regression analysis revealed that nasal height demonstrated stronger predictive value compared to nasal width.

Comparable findings were reported by Elrewieny N.M. et al.[11], who found that nasal index and craniofacial parameters could significantly predict stature in adult Egyptian populations. Although their study involved adults, the biological principle that craniofacial dimensions correlate with overall body length is consistent with the present neonatal findings. The stronger predictive value of nasal height in our study suggests that vertical facial growth parallels longitudinal somatic growth more closely than transverse nasal dimensions. This observation supports the concept that skeletal linear growth patterns are proportionately reflected in midline craniofacial measurements.

Forensic and Clinical Implications

The derivation of sex-specific regression equations enhances the accuracy of stature estimation in neonatal populations. Establishing region-specific regression models reduces potential error due to ethnic variability, as emphasized in international craniofacial studies by Farkas LG et al [8].

The findings of the present study may have practical applications in:
• Neonatal forensic identification
• Medico-legal investigations involving unidentified newborns
• Disaster victim identification
• Population-specific neonatal anthropometric assessment

Given the scarcity of neonatal anthropometric data from Himalayan populations, this study contributes valuable baseline reference data.

Strengths

The strengths of the study include a relatively large sample size (n = 409), inclusion of newborns from distinct Himalayan zones, and standardized measurements performed within the early neonatal period to minimize postnatal growth influence.

CONCLUSION

Nasal dimensions, particularly nasal height, demonstrate a significant positive correlation with stature in full-term newborns of Himachal Pradesh. Sexual dimorphism and regional variation are evident at birth. Regression models derived from nasal measurements may serve as useful tools for neonatal stature estimation in forensic and anthropometric applications. These findings provide important baseline data for Himalayan populations and emphasize the need for region-specific standards.

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Conflict of interest: None.

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