An anthropometric study of facial height among four endogamous communities in the Sunsari district of Nepal

Baral P, Lobo S W, Menezes R G, Kanchan T, Krishan K, Bhattacharya S, Hiremath S S

Department of Anatomy, Manipal College of Medical Sciences, Pokhara, PO Box 155, Nepal

Baral P, MS
Assistant Professor

Department of Human Anatomy and Embryology, Saba University School of Medicine, Saba, PO Box 1000, Netherlands Antilles

Lobo SW, MSc, PhD
Assistant Professor

Department of Forensic Medicine and Toxicology, Kasturba Medical College, Mangalore 575001, India

Menezes RG, MD, DNB
Associate Professor

Kanchan T, DFM, MD
Assistant Professor

Department of Anthropology, Panjab University, Chandigarh 160014, India

Krishan K, MSc, PhD
Assistant Professor

Department of Anatomy, BP Koirala Institute of Health Sciences, Dharan, PO Box 7053, Nepal

Bhattacharya S, MS
Professor

Department of Pedodontics

Hiremath SS, MDS
Associate Professor

Correspondence to:
Dr Kewal Krishan
Tel: (91) 172 253 4230
Fax: (91) 172 2541998
Email: gargkk@yahoo.com

ABSTRACT

Introduction: Facial anthropometry has well-known implications in health-related fields and has been utilised for forensic purposes in the past. It provides an indication of the variations in facial shape in a population. The facial anthropometric profile of a population can characterise the distinctive features of a likely face in that population. The present study aimed to examine the differences in facial height proportions and facial growth patterns in different communities in the Sunsari district of Nepal.

Methods: The upper facial height (UFH) and lower facial height (LFH) proportions of 857 subjects (429 male and 428 female) aged between three and 18 years old from four communities (Brahmin, Chhetri, Rai and Limbu) in the Sunsari district of Nepal were calculated, and comparisons were made.

Results: Significant differences (p is less than 0.05) in the UFH and LFH percentages were observed between the Brahmin and Rai, Brahmin and Limbu, Chhetri and Rai, and Chhetri and Limbu communities.

Conclusion: The study concluded that there is evidence of statistically significant differences of the upper and lower face height proportions among the different racial groups. A change in the facial height proportions of the various age groups was evident. However, differences in facial height proportions between male and female were found to be insignificant.

Keywords: anthropometry, cephalometry, facial ergonomics, Nepal, upper and lower face height

Singapore Med J 2010; 51(3): 212-215

INTRODUCTION

Facial ergonomics deals with anatomical, physiological and psychological characteristics in a way that enhances human efficiency and wellbeing.[1] It is an area of anthropometry that, in recent years, has become increasingly important in health assessment across many countries.[2] It has ancillary importance in the determination of age, gender and race of an individual as applied in anthropology, archaeology, anatomy as well as in the forensic sciences.[3]

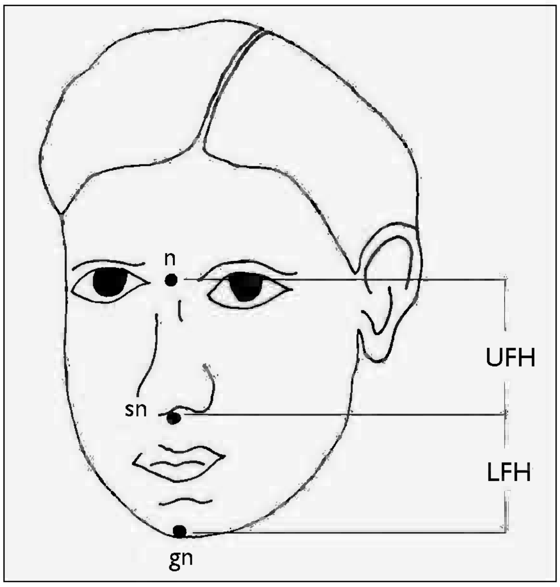

Fig. 1 Landmarks and measurements on the human face.

Anthropometric studies play an important role in distinguishing a pure race from the local mingling of races.[4] Facial anthropometric studies involving facial height have far-reaching implications in health-related fields.[5-10] The science of comparative racial anthropometry has shown that there are consistent differences in the body proportions of various human races.[11] Each race has different gene pools and even genetically different subgroups that exhibit different behaviours, characteristics and peculiarities.[12,13]

In the past, facial anthropometry has been successfully utilised for forensic purposes by some scientists.[14-17] However, only a few studies have been conducted on facial height proportions in different communities.[18,19] The external physical appearance

Table I. Facial parameters among male and female subjects in the communities studied.

	Mean ± SD (cm)					
	Male		Female		Total	
Community	UFH%	LFH%	UFH%	LFH%	UFH%	LFH%
Brahmin	44.4 ± 1.6	55.6 ± 1.1	44.2 ± 1.4	55.8 ± 1.5	44.3 ± 1.5	55.7 ± 1.3
Chhetri	44.6 ± 1.2	55.4 ± 1.2	44.4 ± 1.1	55.6 ± 1.1	44.5 ± 1.1	55.5 ± 1.2
Rai	43.2 ± 1.4	56.8 ± 1.5	43.1 ± 1.6	56.9 ± 1.6	43.1 ± 1.6	56.9 ± 1.6
Limbu	43.3 ± 1.7	56.7 ± 1.8	43.2 ± 1.8	56.8 ± 1.7	43.2 ± 1.8	56.8 ± 1.8
Total	43.6 ± 1.6	56.4 ± 1.7	43.8 ± 1.7	56.2 ± 1.6	43.7 ± 1.7	56.3 ± 1.7

SD: standard deviation; UFH: upper facial height; LFH: lower facial height proportion

is very important in the personal identification of any individual or race. Although Nepal is a relatively small country, it is a conglomeration of different religious, linguistic and ethnic groups. Although these groups look different in terms of their physical characteristics, there is no recorded data in the literature that provides evidence of their physical differences. Thus, the present study was designed to document the differences, if any, in facial height proportions and facial growth patterns among the Brahmin, Chhetri, Rai and Limbu communities in the Sunsari district of Nepal.

The objectives of this study were to compare facial height proportions among the four endogamous communities (Brahmin, Chhetri, Rai and Limbu) in the Sunsari district of Nepal in order to study population differences, among the male and female population in order to study gender differences, and among various age groups in order to study facial growth patterns.

METHODS

A total of 857 subjects (429 male and 428 female) aged between three and 18 years old belonging to the Brahmin (n = 201), Chhetri (n = 224), Rai (n = 208) and Limbu (n = 224) communities in the Sunsari district of Nepal participated in this study. The subjects were examined after informed verbal consent from their parents was obtained. Sunsari is a Terai (low flat land) district in southeast Nepal. It is densely populated with a wide range of ethnic groups.[20] All four communities are endogamous (genetically homogeneous) in nature. The subjects were grouped based on their community, gender and age. A stratified random sampling method was adopted. Individuals with any cranio-facial abnormalities, growth-related disorders, genetic abnormalities, prolonged diseases such as congenital heart diseases, endocrine, renal and intestinal disorders, facial trauma, and those belonging to intermingling communities (i.e. children whose parents and grandparents had inter-caste marriages) were excluded from the study.

The landmarks in the study were defined as follows: (1) Nasion, the point on the root of the nose where the mid-sagittal plane cuts the nasofrontal suture; (2) Subnasale, the point at which the nasal septum merges with the upper cutaneous lip in the mid-sagittal plane; (3) Ganthion, the lowest point on the lower border of the mandible in the mid-sagittal plane.

The subjects were each made to sit on a wooden chair with a head rest. The anthropometric landmarks, the nasion (n), subnasale (sn) and ganthion (gn), were marked on the subject's face. With the help of a sliding caliper, the measurements were taken in millimetres (Fig. 1) using standard procedures recommended by Lohman et al[21] and Hall et al.[22]

The upper facial height (UFH) was the distance between "n" and "sn", the lower facial height (LFH) was the distance between "sn" and "gn", and the total facial height (TFH) was the arithmetic addition of UFH and LFH. The percentage of UFH to the TFH was calculated as:

$$\text{UFH proportion (UFH\%)} = \frac{\text{UFH} \times 100}{\text{TFH}}$$

The percentage of LFH to TFH was calculated as:

$$\text{LFH proportion (LFH\%)} = \frac{\text{LFH} \times 100}{\text{TFH}}$$

The data was analysed using the Statistical Package for the Social Sciences version 10.1 (SPSS Inc, Chicago, IL USA). The significant difference in UFH, LFH and TFH in the study group was tested using the student's *t*-test. A p-value < 0.05 was considered to be significant.

RESULTS

Table I provides a descriptive analysis of the upper and lower face height proportions among males and females in the different communities. A significant difference ($p < 0.05$) was found in the percentages of UFH and LFH between the Brahmin and Rai, Brahmin and Limbu, Chhetri and Rai, and Chhetri and Limbu communities. However, there was no significant difference between the Brahmin and Chhetri and between the Rai and Limbu

Table II. Facial parameters of the study group based on age (n = 857).

Age (years)	Mean ± SD (cm)	
	UFH%	LFH%
3–5 (n = 249)	43.1 ± 1.8	56.9 ± 1.8
5–9 (n = 204)	44.1 ± 1.3	55.9 ± 1.5
9–15 (n = 198)	44.5 ± 1.3	55.5 ± 1.4
15–18 (n = 206)	43.5 ± 1.6	56.5 ± 1.5

SD: standard deviation, UFH: upper face height proportion, LFH: lower face height proportion.

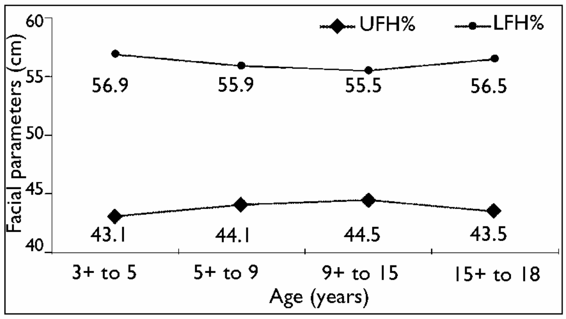

Fig. 2 Age-wise changes in the upper and lower face height proportions.

communities ($p > 0.05$). No significant difference was found in the facial height proportions between the male and female subjects in the different population groups ($p > 0.05$).

Table II presents the mean and standard deviation of the upper and lower face height proportions for the different age groups. It was found that there was significant difference in the UFH and LFH proportions ($p < 0.05$) between subjects aged 3–5 years old and 5–9 years old, as well as between those aged 9–15 years old and 15–18 years old. However, there was no significant difference between subjects aged 5–9 years old and 9–15 years old, as well as between those aged 3–5 years old and 15–18 years old. The data analysis shows that the UFH proportion increased and the LFH proportion decreased initially from 3–15 years of age, after which the UFH proportion decreased and the LFH proportion increased from 15–18 years of age; the adult proportions were found to be similar to those observed in the 3–5 year age group (Fig. 2).

DISCUSSION

The measurement of the upper, lower and total facial height is a routine aspect of clinical examination in orthodontic practice. Such measurements are also employed in facial anthropometric studies. The measurements are often used to carry out a comparative study of facial ergonomics among various communities. Prior to the advent of cephalometric radiography, dentists and orthodontists often used anthropometric measurements (i.e. measurements made directly during a clinical examination) to assist in establishing facial proportions.

Clinical anthropometry has recently undergone a revival because of current data provided by Farkas in his studies of Canadians of Northern European origin, where he found that LFH constitutes 59.5% of the TFH.[23] In the present study, LFH was found to be comparatively lower (56.3% of TFH). The ideal proportions of UFH and LFH have been found to be 45% and 55% of the TFH, respectively.[23] In another study, Farkas et al found a lower face/face height ratio of 59.2% ± 2.7% in male and 58.6% ± 2.9% in female subjects.[24] LFH constituted 56.3% ± 1.7% of the TFH in male and 56.1% ± 1.6% in female subjects in the present study. Thus, although the percentage of LFH was found to be higher in males, the mean male-female differences in our study were not significant and lower when compared to the findings of Farkas et al's study.[24] These differences may be attributed to differences in the study populations.

Significant differences in facial height proportions were found between the Brahmin and Rai, Brahmin and Limbu, Chhetri and Rai, and Chhetri and Limbu communities. On the other hand, insignificant differences between the Brahmin and Chhetri, and Rai and Limbu communities were observed. These differences may be attributed to the differences in the racial groups to which these communities belong. The Brahmins and Chhetri belong to the Aryan race, while the Rai and Limbu belong to the Mongolian racial group. Thus, this is suggestive of the inter-racial differences found in their respective facial height proportions.

Among the Hausa-Fulani children in northern Nigeria, UFH has been found to constitute 44.1% of the TFH and LFH to constitute 55.8%.[25] These findings are comparable with our results. Fok et al have suggested that the face grows in a constant fashion.[26] However, this study found that the upper face grows from 3–15 years of age, while the lower face grows from 15–18 years of age. Changes in the upper and lower face height proportions may be attributed to the fact that mandibular growth, which is responsible for LFH, recedes maxillary growth in 5–9 year olds more than in 3–5 year olds. There is an equal proportional growth in 5–9 year olds and 9–15 year olds. However, mandibular growth supersedes maxillary growth in 15–18 year olds as compared to 9–15 year olds. Thus, it is clear that there is a change in facial height proportion in the various age groups. However, the upper and lower facial heights attain the same proportion in adulthood, as was the case during childhood.

Facial anthropometric studies have vast implications in health-related fields and are useful for orthodontists, plastic surgeons, maxillofacial surgeons for their treatment plans, as well as for physical anthropologists and forensic facial reconstruction experts. This study concluded that race differences are evident for upper and lower face height proportions, that differences in facial height proportions between male and female are not significant and that there is a change in facial height proportion in various age groups, although the upper and lower facial heights attain the same proportion in adulthood, as was the case during childhood.

REFERENCES

1. Thomas CL, Ed. Tabers Cyclopedic Medical Dictionary. 16th ed. Singapore: PG Publishing, 1990: 669.
2. Ulijaszek SJ, Lourie JA. Anthropometry in health assessment: the importance of measurement error. Coll Antropol 1997; 21:429-38.
3. Brothwell DR. The Skeletal Biology of Earlier Human Population (Symposia of the Society for the Study of Human Biology). Oxford: Pergamon, 1968: 8.
4. Gray H. Gray's Anatomy. 38th ed. London: Churchill and Livingstone, 1995: 432-5.
5. Profit WR, Fields HW. Contemporary Orthodontics. 2nd ed. St Louis: Mosby, 1993: 144-5.
6. Shah H, McDonald F, Lucas V, Ashley P, Roberts G. A cephalometric analysis of patients with recessive dystrophic epidermolysis bullosa. Angle Orthod 2002; 72:55-60.
7. Segal DG, Pescovitz OH, Schaefer GB, DiMeglio LA. Craniofacial and acral growth responses in growth hormone-deficient children treated with growth hormone. J Pediatr 2004; 144:437-43.
8. Kau CH, Zhurov A, Richmond S, et al. Facial templates: a new perspective in three dimensions. Orthod Craniofac Res 2006; 9:10-7.
9. Matoula S, Pancherz H. Skeletofacial morphology of attractive and nonattractive faces. Angle Orthod 2006; 76:204-10.
10. Birgfeld CB, Glick P, Singh D, LaRossa D, Bartlett S. Midface growth in patients with ectrodactyly-ectodermal dysplasia-clefting syndrome. Plast Reconstr Surg 2007; 120:144-50.
11. Glaister J, Brash JC. Medico-Legal Aspects of the Ruxton Case. Edinburgh: Livingstone, 1937.
12. Nussbaum RL, McInnes RR, Willard HF, Thompson MW, eds. Thompson and Thompson Genetics in Medicine. 5th Ed. St Louis: WB Saunders, 2004:143-5.
13. Azoulay KG. Reflections on race and the biologization of difference. Patterns Prejudice 2006; 40:353-79.
14. Stephan CN, Norris RM, Henneberg M. Does sexual dimorphism in facial soft tissue depths justify sex distinction in craniofacial identification? J Forensic Sci 2005; 50:513-8.
15. Swan LK, Stephan CN. Estimating eyeball protrusion from body height, interpupillary distance, and inter-orbital distance in adults. J Forensic Sci 2005; 50:774-6.
16. Krishan K. Estimation of stature from cephalo-facial anthropometry in north Indian population. Forensic Sci Int 2008; 181:52, e1-6.
17. Kleinberg KF, Vanezis P. Variation in proportion indices and angles between selected facial landmarks with rotation in the Frankfort plane. Med Sci Law 2007; 47:107-16.
18. Gulsen A, Okay C, Aslan BI, Uner O, Yavuzer R. The relationship between craniofacial structures and the nose in Anatolia Turkish adults: a cephalometric evaluation. Am J Orthod Dentofacial Orthop 2006; 130:131.
19. de Freitas LM, Pinzan A, Janson G, et al. Facial height comparison in young white and black Brazilian subjects with normal occlusion. Am J Orthod Dentofacial Orthop 2007; 131:706.
20. United Mission to Nepal. Available at: www.umn.org.np/main.php?m=clusters&a=sunsari_dp. Accessed October 13, 2008.
21. Lohman TG, Roche AF, Martorell R, eds. Anthropometric Standardization Reference Manual. Champaign: Human Kinetics Publications Inc, 1988.
22. Hall JG, Froster-Iskenius UG, Allanson JE. Handbook of Normal Physical Measurements. Oxford, New York, Toronto: Oxford University Press, 2003.
23. Farkas LG. Facial anthropometric measurements and facial indices. In: Profit WR, Fields HW, Ackerman JI, et al, eds. Contemporary Orthodontics. 2nd ed. St Louis: Mosby, 1993:144-5.
24. Farkas LG, Katic MJ, Forrest CR. Age related changes in anthropometric measurements in the craniofacial regions and in height in Down's syndrome. J Craniofac Surg 2002; 13:614-22.
25. Utomi IL. Vertical facial height and proportions of face in Hausa-Fulani children in Northern Nigeria. Niger Postgrad Med J 2004; 11:32-6.
26. Fok TF, Hon KL, So HK, et al. Facial anthropometry of Hong Kong Chinese babies. Orthod Craniofac Res 2003; 6:164-72.