Asian Journal of Advanced Research and Reports

14(4): 1-7, 2020; Article no.AJARR.61066
ISSN: 2582-3248

Angular Photometric Analysis of the Forehead in a Nigerian Population

Onyinye Mary Ozioko[1*], Uche Sebastine Ozioko[1], Ignatius Ikemefuna Ozor[1], Ifeanacho Ezeteonu Abireh[1], Okeke Emmanuel Ikechukwu[1] and Adaeze Hope Anike[1]

[1]Department of Anatomy, College of Medicine, Enugu State University of Science and Technology, Enugu, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author OMO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors OMO and AHA managed the analyses of the study. Authors USO, IEA and IIO managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJARR/2020/v14i430336
Editor(s):
(1) Dr. Weimin Gao, Arizona State University, USA.
(2) Dr. Shu-Lung Kuo, Open University of Kaohsiung, Taiwan.
Reviewers:
(1) Shaikh Mohammad, Somaiya Vidyavihar University, India.
(2) Tanveer Aslam, Islamia University of Bahawalpur, Pakistan.
(3) Shabnam Sayyad, Savitribai Phule Pune University (SPPU), India.
(4) S. Manjuanth, Global Academy of Technology, India.
(5) J. V. N. Lakshmi, Jain University, India.
Complete Peer review History: http://www.sdiarticle4.com/review-history/61066

Original Research Article

Received 07 August 2020
Accepted 12 October 2020
Published 11 November 2020

ABSTRACT

Facial data are used to ascertain deviations from norm, biological variability, assess phenotypic traits, precise determination of facial aesthetics, design of safety equipment, correctional tools, evolutionary analysis, civil and criminal identification purposes. This study was designed to analyze the morphometric dimensions of forehead from photographs taken at varying angles.
Materials and Methods: Two-hundred Yoruba subjects (10-30 years) were photographed and the following anthropometric parameters; 90° (FH90°), forehead height at 45°Right (FH45°R), forehead height at 45°Left (FH45°L), forehead width at 90° (FW90°), forehead width at 45°right (FW45°R) and forehead width at 45°left (FW45°L) was measured. Descriptive analysis of the forehead parameters was carried out and the relationships between different parameters were tested using Pearson correlation.

**Corresponding author: Email: oziokoonyinye@gmail.com;*

Results: All measured forehead parameters in our cohort were greater in males than in females except FW45°R and FH45°R. Significant relationship was also found to exist between forehead parameters at different angles.
Conclusion: Findings from this study indicates that forehead parameters at 90°, 45° Right and 45° Left, showed sexual dimorphism and are correlated hence can be used for individualization, biological profiling, facial recognition from security cameras, planning of reconstructive and aesthetic surgery.

Keywords: Forehead; facial recognition; sexual dimorphism, Yorubas.

1. INTRODUCTION

The forehead is an area of the head bounded by three features, two of the skull and one of the scalp. The top of the forehead is marked by the hairline, the edge of the area where hair on the scalp grows. The bottom of the forehead is marked by the supraorbital ridge, the bone feature of the skull above the eyes. The two sides of the forehead are marked by the temporal ridge, a bone feature that links the supraorbital ridge to the coronal suture line and beyond [1,2].

In facial evaluation and classification, the sex and race of an individual influences skeletal dimensions and muscle formation [3]. The neoclassical canons have been used to evaluate facial aesthetics by dividing the face horizontally into three regions [4] for planning of orthognathic, facial plastic surgery and orthodontic treatment. However these facial thirds are race dependent hence rarely equal. In Caucasians, the middle third is often less than the upper third and the middle and upper thirds are less than the lower third while for East Asians, the middle third of the face is often greater than the upper third and equal to the lower third, and the upper third is less than the lower third [5].

Personality identification from facial features such as ear, nose, forehead, interorbital distance has been explored with great efficiency as an analytic tool in determining the race/tribe of an individual [6]. The assessment of these facial dimension remains of utmost importance to artists, poets, manufacturers of orofacial devices, forensic scientist, medical and dental clinicians for diagnosis and planning of treatment options post diagnosis [7,8] in plastic surgery, oral surgery, pediatric medicine, dentistry.

More enhanced ergonomic products, such as helmets, masks, ear phones, eyeglasses and respirators can also be designed using the normogramic designs derived from facial anthropometric analysis [9].

Photogrammetry has been employed in recent times as a more objective option of obtaining normative facial data because it is less examiner dependent, has been in use as a facial image comparison technique in U.K courts for over15 years [10] and in clinical medical genetics long before digital photography was implemented [11]. It further ensures unbiased assessment and quick transfer to other colleagues for interdisciplinary discussion [11] and also plays a major role in the comparison of images from a closed circuit television (CCTV) crime footage and forensic identification of missing individuals.

A number of studies have investigated angular facial profiles and soft tissues separation using cephalographs, two-dimensional photo-anthropommetry or direct measurements [12,13,14].

However normative angular facial data for the Yoruba tribe in Nigeria for civil and criminal identification remains lacking.

2. MATERIALS AND METHODS

2.1 Study Population

A total of 200 males and females subjects of Yoruba descent between the ages of 10 – 30 years were recruited for this study.

2.2 Sampling Technique

Yoruba's who met the inclusive criteria were selected using purposive convenient sampling technique.

2.3 Inclusion Criteria

Healthy Yoruba individuals within 10-30 years of age with no evidence of forehead anomalies.

2.4 Exclusion Criteria

1. Individuals whose forehead morphology has been altered by trauma, surgery,

accident or congenital anomalies was excluded from this study.

2.5 Protocol of Procedure

2.5.1 Pre-image acquisition

Before photography was taken, the subject's age, height, weight, gender and origin were recorded along with identification numbers. This number was replicated on self-adhesive tags of known length (4.5 cm which was to calibrate the ImageJ software in order to get the actual measurement from the photographs) and placed on the side of the subjects face [12].

Female subjects were asked to clip back their hair using hair clips to prevent it from obscuring the face [12].

2.5.2 Image acquisition

- Images were acquired using Nikon D90 digital single lens reflex camera with a constant camera settings, image distance and illumination to ensure uniformity, productivity and rule out bias. Lateral forehead views were photographed keeping the mid vertical grid line of the camera aligned to the top of the mid sagittal plane of the face, while the mid horizontal pass through the frakfurt horizontal plane.
- Each subject was asked to relax with both upper limbs placed beside the trunk.
- Subjects were positioned on a line marked 100 cm from the tripod supporting the camera [15,16].
- Digital single reflex lens camera was used for high quality pictures from 3 angles (90°, 45° right, 45° left) with 12.3 mega pixel, 600Dpi resolution.
- The tripod supporting the Camera was rotated to either side in order to have photographs at 90°, 45° angles while the subject changed positions so as to stand parallel to the camera.

2.5.3 Image processing

- The images obtained from this camera downloaded into Adobe illustrator version 10. They were further cropped and sharpened for a crisp appearance [9].
- Forehead height and width at 90°, 45° left, 45° right photographs were transformed to match physically measured values using the transform option of adobe illustrator and finally each image was converted into actual size.
- Images with incorrect lightening or with unnoticed hairs concealing actual forehead dimensions were discarded [6].
- Image editing software (Image J 1.48 software j (v.j.48 ava 1.6.0 2064 bits) was used to enhance brightness, contrast and size to produce a clear image. Furthermore, using the dimension tool to create a vertical dimension line that measures vertical distance between any 2 marked landmarks.

Thus forehead dimension could be precisely calculated while comparing landmarks [7].

2.5.4 Methodology of measurements

Various soft tissues landmarks were identified and marked on the subject's forehead images and measurements were taken to correspond to methods and anthropometry described in previous similar literatures [15,16]. Forehead measurements were taken using mouse, and results were given to 2 decimal points. The present study included the following parameters for the measurements of the forehead.

Forehead Height (FH): It is the distance located at the midpoint between the trichion (hairline) and the glabella.

Forehead width (FW): It is a horizontal distance that is measure from frontotemporale to frontotemporale of the other side.

2.6 Statistical Analysis

Data obtained from all the measurements in the source of this study was analyzed using IBM SPSS statistical software (IBM®, New York, USA). The age of the participants were grouped and their frequency of occurrence taken. Descriptive analysis of the forehead parameters and other variables such as age, height and weight of both sexes from were analyzed and compared using the independent sample t-test and was reported as mean ± standard deviation. One way ANOVA was used to test for the statistical significance of the comparisons at a significance level of $P<0.05$. Pearson correlation was used to test for the relationship between different parameters at two levels of significance: $p = 0.01$ and $p = 0.05$. Regression analysis was used to predict forehead parameters from age

Fig. 1. Measurement of Forehead height and width at 90° Front, 45° Right and 45° Left

and height, and also to predict forehead parameters at 90 using forehead parameters at other angles.

3. RESULTS

Table 1 shows the distribution of the samples used for the study according to the frequency in which they occur in their age category and the percentages in which they occurred.

Table 2 shows that the all the measured forehead parameters mean values was greater in Yoruba males than they are in females except forehead height and forehead width at 45° right.

Table 3 shows the comparison between the overall respective forehead dimension for male and female subjects. It indicates that mean values for forehead height was longest at 90° and forehead width was also widest at 90°.

Table 1. Distribution of age and tribe in the study

Age	**Frequency of age groups (years)**				**Total**
Tribe	**10 - 15**	**16 - 21**	**22 – 27**	**28 - 33**	
Yoruba	12 (3.0%)	107 (26.8%)	52 (13.0%)	29 (7.3%)	200 (100%)

Table 2. Descriptive statistics of forehead parameters across cohort

Forehead parameters	**Male**	**Female**	**p-value**
	Mean ±SD	**Mean ±SD**	
FH90°	5.48 ± 0.64	5.45 ± 0.60	0.769
FH45°_ R	5.43 ± 0.34	5.48 ± 0.60	0.533
FH45°_ L	5.51 ± 0.38	5.44 ± 0.37	0.182
FW90°	12.80 ± 0.71	12.79 ± 0.85	0.967
FW45°_ R	6.29 ± 0.68	6.62 ± 0.85	0.003
FW45°_ L	6.58 ± 0.68	5.76 ± 0.85	0.004

** P<0.05 (Significant)*

Table 3. Angular comparison of forehead dimensions across cohort

Forehead parameters	**Mean ±SD**
FH90°	5.48 ± 0.64
FH45°_ R	**5.46 ± 0.48**
FH45°_ L	**5.47 ± 0.38**
FW90°	**12.79 ± 0.78**
FW45°_ R	**5.46 ± 0.79**
FW45°_ L	6.72 ± 0.77

Table 4. Correlation analysis between known anthropometric variables (Age, Weight and Height) on measured forehead parameters across cohort

Correlation	Age_Yoruba	Weight Yoruba	Height Yoruba
FH90°_YORUBA	-0.011	0.070	-0.144*
FH45°R _YORUBA	0.079	0.140*	-0.070
FH45°L _YORUBA	0.112	-0.017	-0.174
FW90°_YORUBA	-0.080	0.127	0.062
FW45°R _YORUBA	-0.003	0.062	-0.114
FW45°L _YORUBA	0.152*	0.67	-0.129

*** Correlation is significant at the 0.01 level (2-tailed)*

** Correlation is significant at the 0.05 level (2-tailed)*

Table 4 shows that there is weak significant correlation between age of Yoruba subjects and forehead width at 45° left, Weight of Yoruba subjects and forehead height at 45° R. Weak negative significant correlation between height and forehead height at 90° of Yoruba subjects was also observed.

4. DISCUSSION

Aesthetic surgeries require accurate and proportional reconstruction to maintain well balanced and harmonic features [17]. Previous studies have already reported that race, culture, and ethnicity affect the expectation and perception of an individual / patient on the definition of beauty [18] hence the surgeon ought to design a comprehensive and pre-planned scheme for each patient in accordance with the aesthetic principles in tandem with their different racial and cultural features. In our study (Table 2) forehead height mean values was significantly greater in Yoruba males subjects than in females ($P<0.05$) except forehead height at 45° right. This concurs with the results of other researchers [19], Northwest Indians study, Du [20] study of Chinese workers, Asghari [21] study on Iranians and Virdi [22] in a Kenyan population who all reported statistically significant sexual differences in the forehead height with higher males mean values .Statistical analysis in our study (Table 2) shows that at 90° Forehead width of Yoruba males was higher than females this concurs with the finding of [23,20,21]. Results of the present study (Table 3) indicates that mean values for forehead height was higher at 90° and forehead width was also widest at 90° across cohort.

Increased scrutiny placed on facial appearance at the completion of maxillofacial and cosmetic surgeries, has necessitated a great deal of emphasis to factors that contribute to facial esthetics naturally through growth as well as through treatment [8]. Table 4 of the present study shows that there is weak significant correlation between age of Yoruba subjects and forehead width at 45° left, in addition, there was corresponding weak significant correlation between weight of Yoruba subjects and forehead height at 45° R. in contrast to the negative weak significant correlation between height and forehead height at 90° observed in our cohort. This findings support/reaffirmed the study of [24] on boys of Fars ethnicity living in Mashhad which revealed that most facial measurements, including the width of the forehead, increased gradually with age.

Du et al. [20] also reported that as body mass index increased, facial width increased significantly and that regression model of age had the least influence on facial anthropometric measurements, while gender and BMI had the most influence in concordance with the results of this study (Table 4). It is however recommended that similar study should be carried out on other Nigeria ethnic groups to create a comprehensive facial data base for the Nigerian population.

5. CONCLUSION

Findings from this study indicates that forehead parameters at 90°, 45° Right and 45° Left, showed sexual dimorphism and are correlated hence can be used for individualization, biological profiling, facial recognition from security cameras, planning of reconstructive and aesthetic surgery.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for

any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

ETHICAL APPROVAL AND CONSENT

Ethical approval was gotten from the Ethical and Research committee of Faculty of Basic Medical Sciences, College of Medicine, Enugu state University of Science and Technology. Consent was sought and obtained from subjects before data acquisition.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. David M. Knize, Mel Drisko. The forehead and temporal fossa: Anatomy and technique. Lippincott Williams & Wilkins. 2001;4.
2. Valencia D. Thomas, Wendy Long Mitchell, Neil A. Swanson, Thomas E. Rohrer, Ken K. Lee. Reconstructive surgery of skin cancer defects. In Keyvan Nouri (Ed.). Skin Cancer. McGraw-Hill Professional. 2007;523.
3. Bryan M, Chin-Ho W. Changes in the facial skeleton with aging: Implications and clinical applications in facial rejuvenation. Aesthetic Plastic Surgery. 2012;4:753–760.
4. Fang FF, Clapham PJ, Chung KCA. Systematic review of inter-ethnic variability in facial dimensions. Plast Reconstr Surg. 2011;127(2):874–881.
5. Anic-Milosevic A, Mestrovic S, Prlic A, et al. Proportions in the upper lip–lower lip–chin area of the lower face as determined by photogrammetric method. J Cranio Maxilla Facial Surg. 2010;38(2):90–95.
6. Ozioko OM, Egwu OA, Ozioko US, Egwuatu IA, Atuadu VO, Ameh M. Photomorphometric pinna variations in Yoruba and Igbo ethnic groups in Nigeria. JETIR. 2020;7(5):937-947.
7. Ozioko OM, Egwu OA, Ozioko US, Egwuatu IA, Ameh M. Photogrammetric auricular analysis in a Nigerian population. World Journal of Pharmaceutical Research. 2020;9(6):143-157.
8. Siti AO, Lynnora PM, Wan NW, Mang CW, Roziana MR. Anthropometric study of three-dimensional facial morphology in Malay adults. Public Library of Science Journals. 2016;11(10):164-180.
9. Ozioko OM, Egwu OA, Ozioko US. Photometric analysis of the human pinna: A forensic study among Southeast Nigerians. IOSR Journal of Nursing and Health Science (IOSR-JNHS). 2020;9(3): 06-13.
10. Moreton R, Morley J. Investigation into the use of photoanthropometry in facial image comparison. Forensic Sci Int. 2011; 212(1-3):231-7.
11. HeidrunSchaff, Jan-Falco, Wilbrand Rolf-HassoBeodeker, Hans-Peter Howaldt. Accuracy of photographic assessment compared with standard anthropometric measurement in nonsynostotic cranial deformities. Cleft Palate-Craniofacial Journal. 2010;47(5).
12. Ozioko OM, Egwu OA, Ozioko US. Photoanalytic auricular assymetry in Southeast Nigerians. EPRA International Journal of Research and Development (IJRD). 2020;5(5):501-508.
13. Porter JP, Olson KL. Anthropometric facial analysis of the African American woman. Arch Facial Plast Surg. 2001;3:191–197.
14. Emirzeoğlu M, Şahin B, Uzun A, Bilgiç S. Evaluation of the volumetric relation between cranial cavity and orbits. Turkiye Klinikleri J Med Sci. 2011;31(2):297-299.
15. Ukoha UU, Udemezue OO, Oranusi CK, Asomugha AL, Dimkpa U, Nzeukwu LC. Photometric facial analysis of the Igbo Nigerian adult male. Nigerian Medical Journal: Journal of the Nigeria Medical Association. 2012;53(4):240.
16. Akhter Z, Banu MLA, Alam MM, Hossain S, Nazneen M. Photo-anthropometric study on face among Garo adult females of Bangladesh. Bangladesh Medical Research Council Bulletin. 2013;39(2):61-64.
17. Shamaladurairajanayagam. Anthropometric measurement of the lip-nose complex among young adults in Kualalumpur, Malaysia. Dissertation Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Surgery (Plastic Surgery) University Sains Malaysia; 2011.
18. Iglesias-Linares A, Yanez-Vico RM, Moreno-Manteca B, Moreno-Fernández AM, Mendoza-Mendoza A, SolanoReina E. Common standards in facial esthetics: Craniofacial analysis of most attractive

black and white subjects according to people magazine during previous 10 years. 2011;69(6):e216–224J.
19. Sahni D, Jaggi S, Aggarwal A. Sexual and ethnic differences in facial anthropometry of Northwest Indians. Journal of Postgraduate Medicine, Education and Research. 2014;48(4):171.
20. Du L, Zhuang Z, Guan H, Xing J, Tang X, Wang L, Wang Z, Wang H, Liu Y, Su W, Benson S. Head-and-face anthropometric survey of Chinese workers. Annals of Occupational Hygiene. 2008;52(8):773-782.
21. Asghari A, Rajaeih S, Hassannia F, Tavakolifard N, Neisyani HF, Kamrava SK, Jalessi M, Omidian P. Photographic facial soft tissue analysis of healthy Iranian young adults: Anthropometric and angular measurements. Medical Journal of the Islamic Republic of Iran. 2014;28:49.
22. Virdi SS, Wertheim D, Naini FB. Normative anthropometry and proportions of the Kenyan-African face and comparative anthropometry in relation to African Americans and North American Whites. Maxillofacial Plastic and Reconstructive Surgery. 2019;41(1):9.
23. Karaca Ö, Gülcen B, Kuş MA, Elmalı F, Kuş İ. Morphometric facial analysis of Turkish adults. Balıkesir Sağlık Bilimleri Dergisi. 2012;1(1):7-11.
24. Jahanbin A, Mahdavishahri N, Baghayeripour M, Esmaily H, Eslami N. Evaluation of facial anthropometric parameters in 11-17 year old boys. Journal of Clinical Pediatric Dentistry. 2012;37(1): 95-101.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/61066