Global Advanced Research Journal of Medicine and Medical Sciences (ISSN: 2315-5159) Vol. 4(11) pp. 467-472, November, 2015
Available online http://garj.org/garjmms

Full Length Research Paper

Anthropometric Computed Tomography Study of Certain Craniofacial Parameters: Cephalic Length and Cranial width, Nasal Height, Width and Index of Adult Sudanese

Maisa Mohammed Elzaki[1], Caroline Edward Ayad[2*], Hussein Ahmed Hassan[2], and Elsafi Ahmed Abdalla[2]

[1]Alzaiem Alazhari University ,Faculty of Radiology Science and Medical Imaging, P.O. Box 1432 Khartoum North, Sudan
[2]Sudan University of Science and Technology, College of Medical Radiological Science, P.O.Box1908, Khartoum,Sudan Khartoum-Sudan

Accepted 15 November, 2015

Craniofacial anthropometry is critical in making a precise and organized measurement of human skull. The aim of this study is to document the mean cephalic width and length, nasal height, width and index of adult Sudanese from Khartoum State and to provide comprehensive data to be used by anthropologists and medical practitioners. A total of one hundred and ten (110) adults comprising 34 males and 76 females with mean age 40.88±16.39 and 38.89±12.36 years respectively were used for this study. All the subjects were drawn from Sudanese ethnic group in Khartoum State. The results showed that the Sudanese males and females had mean skull width of 126.38±7.99mm and 123.22±8.58 mm, mean nasal height of 43.29±3.4 mm and 40.75±3.68 mm, mean nasal width of 42.83±4.17 mm and 39.34±3.62 mm and mean nasal indices of 99.12±0.1 and 97.65±0.1 respectively. The t-test analysis indicates a sexual dimorphism, with significantly higher values of all the parameters in males compared to the females (p<0.05). No significant difference was detected according to age.This study is therefore recommended to forensic anthropologists, craniofacial surgeons and medical practitioners and also serves as the basis for future studies on other Sudanese ethnic groups.

Keywords: nasal height, nasal width, nasal index, anthropology

INTRODUCTION

The need for normative craniofacial data as reference standards for diagnosis, disease evaluation treatment of craniofacial abnormalities is widely acknowledged. Craniofacial norms are known to vary widely between different ethnic groups. Previous investigations have shown that there were differences in craniofacial form

*Corresponding Author E-mail: carolineayad@yahoo.com; Tel: 0922044764

between ethnic groups (Altemus, 1960;Harris et al., 1977). Researchers have indicated that findings from one ethnic group cannot be applied to other ethnic groups. Numerous previous studies have stressed the need to develop norms for different human populations, gender and ages. This is due to the observed differences in craniofacial form among human populations (Altemus, 1960; 1975b; Harris et al., 1977), between genders (Riolo et al., 1974; Bhatia and Leighton, 1993) and across different ages (Riolo et al., 1974; Broadbent et al., 1975; Bishara, 1981). Normative references for a number of craniofacial variables have been established for different populations compared with Caucasian populations (Riolo et al., 1974; Broadbent et al., 1975).It is now recognized that the use of a single standard of normative craniofacial data is not appropriate when making diagnostic and treatment planning decisions for patients from different ethnic backgrounds. More recently, computed tomography (CT) has allowed comprehensive imaging of the whole craniofacial complex. This technology is further enhanced by computer software that allows three-dimensional reconstructions of the (CT) slices, allowing life-like visualization of the skull and face for measuring purposes. (CT) has provided new tools for medical investigation and has been widely used for pre and post-operative imaging when evaluating patients with craniofacial abnormalities. Because of this, CT was used for more accurate diagnosis and treatment planning for affected patients. Most normative craniofacial data have been generated for people of European origin. As far as the Sudanese ethnic group is concerned, and to the best of our knowledge; no published craniofacial norms have been reported for Sudanese nasal bone measurements in the open literature. Because extra information and knowledge of nasal dimensions among Sudanese is important, especially in the treatment and also the effects of age, gender and race have to be understood; this study aimed to characterize the nasal anatomy among Sudanese through computed tomography scan in order to establish reference values of the normative measurements regarding the gender and age within the construction of a purely anatomic framework.

MATERIALS AND METHODS

A total of 110 patients were included in the study. Patient's ages were from≤ 20 ≥61 years. Patients were selected for facial scans. The patient's age and gender were recorded. For each patient, a prospective study was conducted on facial bone CT scans .Subjects with craniofacial defects were excluded. This study was done at Royal Care International Hospital and Antalya Medical Center in the Diagnostic Radiology Department during the period from 2013 up to 2014.

The CT scans for facial bones were performed using spiral CT (Aquilon ,Toshiba Medical System Corp-Tokyo, Japan, helical mode 64 slice) and (General Electric ,helical mode 16 slice bright speed). Acquisition was obtained with a slice thickness of 2 mm, 1.25mm and FOV of 250mm,240mm.Kvp of120,mA50 and 60 with images matrix size512X512 respectively.

Three nasal dimensions were measured in (mm): the nasal bone height, width, and index. The height was defined as the distance between the nasion to nasopinale of the nose. Nasal width was measure as the distance between the two alar. The nasal index was then calculated as nasal width distance /nasal height distance x100. Cranial width was measured in coronal view and was defined as the two points establish a line that representing the greatest width of the skull. Cephalic length was also measured and was defined as the distance between most anterior and posterior point of the skull Opisthocranion to glabila. All measurements were performed by the same observer.

Statistical analyses

All data obtained in the study were documented and analyzed using SPSS program version16. Descriptive statistics, including mean ± standard deviation, were calculated. ANOVA test was applied to test the significance of differences, *p*-value of less than 0.05 was considered to be statistically significant.

RESULTS

Table 1. Shows the descriptive statistics of the cranial width and cephalic length classified according to age (≤20≥61) years.

		N	Mean (mm)	Std. Deviation	Minimum (mm)	Maximum (mm)	P-value
Cranial width	≤20	8	123.3513	8.19084	107.04	132.53	.918
	21-30	24	124.6071	9.06433	109.95	156.60	
	31-40	31	123.8803	7.18918	108.35	142.95	
	41-50	24	122.9958	11.22503	110.98	168.32	
	51-60	13	125.8008	7.60824	115.43	136.65	
	>61	10	125.9300	4.74530	121.32	133.83	
	Total	109	124.2050	8.49326	107.04	168.32	
Cephalic length	≤20	8	177.3125	14.33777	156.88	202.64	.833
	21-30	24	174.6533	14.36868	153.91	200.68	
	31-40	31	173.6803	8.11918	158.73	197.49	
	41-50	24	174.1892	9.45635	157.20	188.85	
	51-60	13	177.8408	15.86555	156.28	201.38	
	>61	10	175.0660	6.05348	167.79	183.11	
	Total	110	174.9364	11.27125	153.91	202.64	

Table 2. Shows the descriptive statistics of the nasal bone height, width and index classified according to age (≤20≥61) years.

		N	Mean (mm)	Std. Deviation	Minimum (mm)	Maximum (mm)	P-value
Nasal Bone Height	≤20	8	40.3212	4.20567	35.25	47.93	.715
	21-30	24	41.1208	3.45396	35.40	48.22	
	31-40	31	41.5897	4.32834	32.13	51.90	
	41-50	24	41.5658	3.90258	33.35	48.50	
	51-60	13	41.6046	3.46304	36.63	48.80	
	>61	10	43.1510	2.50969	40.22	47.15	
	Total	110	41.5336	3.77501	32.13	51.90	
Nasal Bone Width	≤20	8	37.7125	2.80099	34.09	42.26	.144
	21-30	24	39.9371	4.64122	32.05	48.04	
	31-40	31	40.2597	4.02522	32.05	50.06	
	41-50	24	40.2950	3.89605	36.04	53.82	
	51-60	13	42.5515	4.82360	33.73	53.28	
	>61	10	42.3800	2.12289	39.49	45.26	
	Total	110	40.4163	4.11280	32.05	53.82	
Nasal Bone Index	≤20	8	93.95	06665	84	101	.652
	21-30	24	97.34	10562	82	129	
	31-40	31	97.15	07558	72	119	
	41-50	24	97.58	11657	81	127	
	51-60	13	101.22	09700	87	121	
	>61	10	98.37	05132	89	105	
	Total	110	97.65	09273	72	129	

Table 3. Shows the descriptive statistics of the cranial width and cephalic length classified according to gender.

		N	Mean (mm)	Std. Deviation	Minimum (mm)	Maximum (mm)	p-value
Cranial width	Male	34	126.3829	7.98796	107.04	156.60	.051
	Female	76	123.2177	8.58236	108.35	168.32	
	Total	110	124.2050	8.49326	107.04	168.32	
Cephalic length	Male	34	181.3274	10.58898	167.79	202.64	.000
	Female	76	172.0772	10.41621	153.91	197.49	
	Total	110	174.9364	11.27125	153.91	202.64	

Table 4. Shows the descriptive statistics of the nasal bone height, width and index classified according to gender.

		N	Mean (mm)	Std. Deviation	Minimum (mm)	Maximum (mm)	p-value
Nasal Bone Height	Male	34	43.2956	3.41144	36.89	51.90	.001
	Female	76	40.7454	3.68148	32.13	48.80	
	Total	110	41.5336	3.77501	32.13	51.90	
Nasal Bone Width	Male	34	42.8279	4.17415	34.09	53.82	.000
	Female	76	39.3374	3.61950	32.05	48.04	
	Total	110	40.4163	4.11280	32.05	53.82	
Nasal Bone Index	Male	34	99.12	.08636	84	127	.056
	Female	76	96.98	.09524	72	129	
	Total	110	97.65	.09273	72	129	

Table 5. Shows the t-test and the Pearson correlation between the of the nasal bone height, width and index with the cranial width and cephalic length

		Cranial Width	*Cephalic Length*
Nasal Bone Height	Pearson Correlation	.073	.137
	Sig. (2-tailed)	.451	.154
Nasal Bone Width	Pearson Correlation	.068	.222(*)
	Sig. (2-tailed)	.485	.020
Nasal Bone Index	Pearson Correlation	.025	.112
	Sig. (2-tailed)	.798	.243

Table 6. Shows the comparison between the nasal index in the present study and some other populations

Author /year	*Population*	*Nasal Bone index*
Herskovites (1937)	African Negroes	92.2
Niswander *et al.* (1967)	Brazilian Indians	72.3
Farkas *et al.* (1989)	Caucasians	69.9
Erika *et al.*(2006)	Latvians	70.9
Oladipo *et al.* (2009b)	Nigerians	94.1
Muhammad H. Muhammad et al . (2011)	Upper Egyptians	74.0
Present Study(2015)	Sudanese	97.65

DISCUSSION

Craniofacial anthropometry is important in the evaluation of facial trauma, defects, and identification of congenital malformation and diagnosis of different diseases (Oladipo *et al*., 2008a; Oladipo *et al*., 2008b; Oladipo *et al.,* 2009a). It is necessary to have local data of these parameters since these standards reflect the potentially different pattern of craniofacial growth resulting from racial, ethic,and sexual differences (Oladipo *et al.,* 2009b). There are different racial groups including Asians, Blacks and Whites, their differences are based on physical characteristics (Montagu, 1960). On the other hand, there are critical genetic differences between different races. It is acknowledged that utilizing a standard for craniofacial structures is not appropriate when making diagnostic and treatment planning decisions for patients from diverse ethnic backgrounds. Craniofacial analyses studies were based mainly on people of European ancestry but most investigators have noted that there were significant differences between diverse ethnic groups. As a result, a large number of cephalometric references have been developed for different ethnic groups (Altemus, 1960; Riolo et at., 1974; Broadbent et at., 1975; el-Batouti et at., 1994; Johannsdottir et at., 1999). Craniofacial data for the Sudanese ethnic group as Africans are still limited. There has been a study of craniofacial morphology from Asian performed utilizing cephalometric analyses (Lew, 1994). To the best of our knowledge; there is no information about whether there are differences between the genders or how craniofacial dimensions change with increasing age in Sudanese, additionally; no research has been performed in the open literature using CT scans to produce normative reference data. Therefore, the aims of this study were to utilize CT scans to quantify the differences of craniofacial morphology of Sudanese with well-known published data for other populations as well as to observe whether the differences change with age or gender.

The descriptive statistics of cephalic length and width and the nasal bone height, width and index

classified according to age (≤20≥61) years and according to gender were measured for 110 norm Sudanese subjects these were presented in (Tables 1-4). This study showed that the mean values in males were significantly larger than those of females ($p<0.05$).The result were in agreement with Franciscus and Long, (1991) and Oladipo *et al.,(*2010) who reported larger values for nasal height, nasal width and nasal index in males than females. Nasal index of Igbos (Oladipo *et al.,* 2009a) was larger than that of Ijaws. It can be justified that the genetics and environmental factors are responsible for the variation in craniofacial dimension between and within populations (Cem *et al*., 2001; Kasai *et al.,*1993).

In the present study, the ages ranged from (≤20≥61) years. The choice of the study population was calculated since the age of 18 years, is the age of physical maturation and majority (Abigail, 2006), we divided adult's subjects into six age groups, as shown in (tables 1and 2) Zankl *et al,* (2002) reported that reference data for anthropometric characteristics of normal, healthy individuals should be provided in age ranges as wide as possible. The set of data offered by present study probably covers the largest age range with a considerable number of subjects in each gender and age group. The results of the present study indicated that adult males had higher values than adult females. The highest value nasal bone height, width and index classified were observed in the 51 to 60 years of age group. Similarly, the highest value for cranial width and cephalic length was observed in the 51-to-60 years of age group in Sudanese adults. The mean values of the variables computed in the present subjects were lesser in females than in males for all age groups. The observed differences between genders were statistically significant for both cranial length and cephalic width (p=0.051, 0.000) (Table 3) and for nasal bone height, width and index (P= 0.001, 0. 000&0.056) respectively (Table 4).

The results of this study agree with many other studies that compare anthropometric characteristics of males and females. Most of such authors have concluded the presence of sexual dimorphism in their studied sample. Oladipo *et al.* (2007) on the facial measurements among major ethnic group in Nigeria where sexual dimorphism was observed in all the ethnic groups studied with males having significantly higher facial indices than females. In the present study, the cranial width and cephalic length were restricted to the dimensions and indices of Sudanese adults. The t-test and the Pearson correlation between the nasal bone height, width and index with the cranial width and cephalic length were obtained and presented in (table5), the results showed that there were significant relation between the cephalic length and nasal bone width. The importance of this study is that, this study will provide the anatomical data on Sudanese represented in Khartoum state which could be used as anthropometric reference values in clinical practices and in forensic medicine and also set the base for further investigations.

Comparing the measurements mentioned in (Table 6) with that of the present study could reflect that the Sudanese population is belonging to African origin of the fore-mentioned ethnic groups and may be considered as a special ethnic group as the measurements were larger than the other groups. Given our present understanding of nasal physiological morpho-function, these results support and demonstrate an adaptive role for human nasal index variation. It has been suggested that the association of variability in the human nasal index for Sudanese may be due to climatic variation which is considered as an important element in Sudan. The study firmed general anthropometric form which can be established in addition to the race-specific growth criteria. To this end, we tested race/ethnic, age and gender effects on growth during the age's between ≤20≥61 years of four variables measured for the nasal region; the findings for all variables examined continued to show race effect when compared with other population. Thus, our results support gender and race-dependent anthropometric Sudanese growth form. Such an outcome is suggestive of universal applicability. This is consistent with the World Health Organization (2006) report on growth standards documenting growth to be remarkably similar during early childhood across human populations from diverse continental groups. Although we did not find age effects in this particular study, as our ages were between (≤20≥61) years old this does not imply that there are no specific individual age group differences.

The design of this study focused on age/gender anatomic differences in adults, this study assessed the effect of age/gender on development. However, it is possible that different sampling strategies and study designs with a larger proportion of racial/ethnic diversity may show significant race differences in growth trend. Thus, our findings and approach need to embrace a study design that includes all Sudanese ethnic groups, to assess race effects and determine whether the findings are generalizable.

CONCLUSION

The present study was able to confirm the feasibility of advancing general anthropometric growth models by assessing racial/ethnic anatomic effects on growth within the construction of a purely anatomic framework, as well as to establish the nasal dimensions of adults in Central Sudan represented in Khartoum state. It also established that as in other populations nasal parameters are sexually dimorphic among the Sudanese represented in Khartoum state and that male nasal dimensions are greater than those of females ($p<0.05$). Knowledge of mean nasal dimensions is important in evaluation of age, gender and racial differences, in clinical applications and in forensic application.

REFERENCES

Abigail AB (2006). Anatomical changes in the emerging adult brain: A voxel-based morphometry study. Hum. Brain Mapp. 27 : 766–777.

Bhatia SN, Leighton BC (1993). A manual of Facial Growth, Oxford University Press,.

Broadbent B Sr, Broadbent B Jr, Golden W Bolton (1975). Standards of Dentofacial Developmental Growth. St. Louis: The C.V. Mosby Company;

Cem E, Cengiz Y, Hamdi E, Selim D, Yasar D (2001). Normative values of craniofacial measurements in idiopathic benign microcephalic children. The cleft palate. Craniofacial J. 38(3):260-263.

El-Batouti A, Øgaard B, Bishara SE (1994). Longitudinal cephalometric standards for Norwegians between 6 and 18 years of age. Eur. J. Orthodontics 16:501–509

Erika N, Uldis T, Dzintra K (2005). Craniofacial Anthropometry in a group of healthy Latvian residents. Acta Medica Lituanica. 12: 47-53.

Farkas LG, Hreczko TA, Kolar JC, Munro IR (1989). Vertical and horizontal proportions of the face in adult North American Caucasians: revision of neoclassical canons. Plast. Reconstr. Surg. 1985 75:328-38

Franciscus RG, Long JC (1991). Variation in human nasal height and breadth,Am J Phys Anthropol. 85(4):419-427.

Harris JE, Kowalski CJ, LeVasseur FA, Nasjleti CE, Walker GF (1977). Age and race as factors in craniofacial growth and development. J. Dent. Res. 56:266–274.

Herskovits MJ (1937). Physical types of West African Negroes. Hum Biol. 9: 483.

Johannsdottir B, Thordarson A, Magnusson TE (1999). Craniofacial morphology in 6-year-old Icelandic children. Eur. J. Orthodontics 21: 283–290

Kasai K, Richards LC, Brown T (1993). Comparative study of Craniofacial Morphology in Japanese and Australian Aboriginal Populations. Human Biol. 65: 821-834

Leonard A Altemus (*1960*). A Comparison Of Cephalofacial Relationships. The Angle Orthodontist: 30(4): 223-240.

Lew KK (1994). Cephalometric ideals in Chinese, Malay and Indian ethnic groups. Asian J. Aesthet. Dent. 2: 135-138

Montagu Ashley (1960). *A Handbook of Anthropometry,* Springfield, IL: Thomas.

Muhammad H Muhammad, Hazem A Sayed (2011). Vertical Facial Dimensions and Indices in Adult Upper Egyptians J. Am. Sci. 7(10)

Niswander JD, Keiter F, Nee1 JV (1967). Further studies on the Xavante Indians. Some anthropometric, dermatoglyphic and no quantitative morphological traits of the Xavantes of Simoes Lopes. Amer. J. Hum. Genet. 19: 490-501.

Oladipo GS, Chinagorom E, Iruoghene GO (2010). Craniofacial dimension of Ijaw children of Nigeria. Biomed. Int. 1(2):25-29.

Oladipo GS, Didia BC, Okoh PD, Hart JS (2008a). Sexual dimorphism in facial dimensions of adults Ijaw.J. *Expt. Clin. Anat.* 7(2):10-14.

Oladipo GS, Fawehinmi HB, Okoh PD (2009a). Canthal indices of Urhobo and Itsekiri eyhnic groups. Australian J. Basic and Appl. Sci. 3(4):3093-3096.

Oladipo GS, Fawehinmi HB, Suleiman YA (2009b). The study of nasal parameters (nasal height, width and nasal index) among the Yorubas of Nigeria. The Internet J. Biol. Anthropol. 3(2):1-19

Oladipo GS, Olotu E, Guinireama IU (2008b). Anthropometric comparision of canthal indices between the Ijaw and Igbo tribes. *Sci. Afri.* 7(1):141-144.

Oladipo GS, Olotu JE, Didia BC (2007). Anthropometric study of nasal parameters of the Ogonis in Nigeria. *Sci. Afr.* 6(1): 69-71

Riolo ML, Moyers RE, McNamara JA, Hunter WS (1974). An Atlas of Craniofacial Growth. Ann Arbor: Center For Human Growth and Development, University of Michigan.

World Health Organization (2006). WHO child growth standards: length/height-for-age, weight-forage, weight-for-length, weight-forheightand body mass index-for-age: methods and development. Geneva, Switzerland: WHO Press.

Zankl A, Eberle L, Molinari L, Schinzel A (2002). Growth charts for nose length, nasal protrusion, and philtrum length from birth to 97 years. Am. J. Med. Genet.111:388-391.