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UPPER AIR WAY TRACT NORMS FOR SAUDI ADULTS (JAZAN): A COMPUTERIZED TOMOGRAPHY BASED STUDY

Fathia Abd El Rahman Mohamed Alamin[1] and Caroline Edward Ayad*[2]

[1]Jazan University, Faculty of Medical Applied Science, Saudi Arabia.
[2]Sudan University of Science and Technology, College of Medical Radiological Science, Khartoum –Sudan.

***Correspondence for Author: Caroline Edward Ayad**

Sudan University of Science and Technology, College of Medical Radiological Science, Khartoum –Sudan.

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ABSTRACT

Objectives: To obtain normative data of upper airway in Saudi adult population in Jazan-South Saudi Arabia as local reference. **Materials and Methods:** Study included 64 healthy subjects, 43(67.2%) were males and 21 (32.8%) were females with (mean age: 25.69±6.6). All were with normal skeletal profile with no history of sleep-related disorders or trauma. The cephalometric parameters assessed were; SNA (^{o}) SNB (^{o}) and ANB (^{o}). Neck circumference (NC) and other upper air way measurement including linear distance between mandibular plane and hyoid bone (MP-H), upper airway length (UAL), the maximum thickness of the soft palate (SP max), soft palate length (PNS –U), linear distance between anterior and posterior nasal spine (ANS- PNS), retroglosal width (RS), retroplatal width (RP) were measured and evaluated in both genders. Statistical Analysis: Paired t-test was used P-value <0.05 was considered to be significant. **Results:** No significant gender dimorphisms results were observed in most of the parameters with the exception of the maximum thickness of the soft palate (SP max) and neck circumference (NC). A local reference of upper air way values for Saudi –Jazan population was recognized. New equations to predict the (ANS- PNS), (MP-H) and (NC) for Saudi population of known age were established. **Conclusions:** Saudi in Jazan has distinct cephalometric and upper air way tract features, for which specific norms should be used as a reference in treating orthodontic patients. Norms for the airway in the Saudi-Jazan population were established in this study. Data derived from this study can be used as a reference for assessment of obstructive sleep apnea for Saudi-Jazan if present.

KEYWORDS: upper air way tract, cephalometry, computerized tomography.

INTRODUCTION

Normal airway is one of the important factors for the normal growth of the craniofacial structures. The close relationship between the pharynx, dentofacial and craniofacial structures determines their relationship.[1] Clinical detection of structural narrowing of the upper airway may facilitate early recognition of obstructive sleep apnea (OSA) and snoring.[2] Snoring can be worsened by anatomical abnormalities, obesity, or other factors. In the aetiology of OSA both anatomical and pathophysiological factors seem concerned[3,4] and thus the radiographic examination of the face and airway has received considerable attention. It is essential to be considered to find the norms and detect the abnormalities and alternations that causing the OSA or snoring.

A variety of techniques including cephalograms, computed tomography, fluoroscopy, acoustic reflection, fibreoptic pharyngoscopy, magnetic resonance imaging have been employed for the assessment of upper airway.[5] Cephalometry enables examination of dental and skeletal anomalies as well as soft tissue structure character. Many studies have evaluated the anatomic conformation of the upper airway using computed tomography (CT).[6] Cephalometry and (CT) studies were carried out during wakefulness or sleep.[7,8] Cephalometric measurements of the posterior airway space, is two-dimensional analysis and the measurements using three-dimensional CT scan have proved to be reliable in diagnosing upper air way characteristics.[9,10]

The differences between populations character are due to complicated interaction of genetic and environmental factors.[11] Difference between races can be due to geographical location and other reasons.[12,13] Morphological and anthropological findings indicate that each racial group have its own standards[14,15] and within the same race, each subgroup had its own standards.[16,17] It is illogical to apply the standards of one racial group to another, or within the same race, or to apply the standards of one subgroup to another.[18] European-American norms are still used in the orthodontic treatment of Saudi patients, despite the different ethnic backgrounds of Saudis.[19]

Orthodontic treatment is best when the facial and cephalometric characteristics of the ethnic background of patients are considered. The orthodontic literature contains many studies involving cephalometric and report standards of European-American, African-American, Asian populations[20-24] but little for Arabs and Saudis in specific.[25-29] As well, forensic norms have been set up for many ethnic and racial groups in many studies; differences among races and ethnic groups have been proven and standard norms have been developed.[30-34] Information on norms for a population has great value. Standards allow identification of race and gender for craniofacial measurements, dentofacial models and air way tract characteristics of different ethnic groups.[35,36] Knowledge of the norms are useful in planning and estimating impact of orthodontic treatment on hard and soft tissue.[37]

To the best of our knowledge no norms are yet available for Saudi (Jazan) population in the open literature; the aims of this study are to establish norms for upper air way tract to be used for forensic and orthodontic purposes using measures obtained on sagittal 3D reconstructed images, in addition to identify age and gender related differences.

2. MATERIALS AND METHODS

2.1. Sample and Technique

64 patients undergoing CT scanning for head and neck were included in the study. 43(67.2%) were males and 21 (32.8%) were females. (mean age: 25.6875±6.6). All patients were from Jazan –Saudi Arabia region. The CT scans of patients without snoring or any sleep related symptoms or changes affected the upper air way tract were evaluated as normal subjects, all participants were non traumatic. Verbal consent was firstly obtained from all potential participants. The aims, benefits of the present study were explained to all participants in details. Individuals who snore and those with conditions that may in any way, alter the findings of the current study were excluded. MDCT scanner was (Toshiba Aquilion (TSX-101A) 16 slice, (Jizan General Hospital, KSA). The study span during the period from 2014-2015. The examinations were performed with all patients in the supine position with their heads and neck in a neutral position, lateral scout view was taken first to determine the level of the scans, Scanning was done from the lower portion of the upper cervical spine to the upper facial orbit. The conditions of scanning were 120 kVp, 300 mA with slice thickness of 1, 1.5 and 2 mm. pixel size 512x512. Measurements were done on the lateral scout view and sagittal views, using special computer soft ware (Radi Ant DICOM viewer 32 BIT). Neck circumference (NC) at the level of coricthyroid membrane, ages and 10 standard bony and soft-tissue measurements were obtained and evaluated.

2.1.1 Identifying Variables

a- Soft palate length (PNS-U)that is the distance between posterior nasal spine and the uvula
b- Maximum thickness of soft palate (SP max),
c- Upper airway length (UAL)is vertical distance from the hard palate to the hyoid bone,
d- Retroplatal width(RP) behind the soft palate
e- Retroglosal width (RS) behind the tongue.
f- MP-H is the distance between mandibular plane and hyoid bone
g- ANS-PNS is the linear distance between anterior nasal spine (ANS) and posterior nasal spine(PNS)
h- SNA deg the angle between the nasion(N) – sella(S) line and the line from A
i- SNB deg the angle between the nasion (N)–sella(S) line and the line from B to NA
j- ANB deg the angle can be calculated from the formula (ANB = SNA – SNB)

(Point A (A) – the deepest point on the contour of the alveolar projection, between the spinal point and prosthion; point B (B) – the deepest midline point on the mandible between infradentale and pogonion).

2.2. Data Analyses

Data were analyzed using Statistical Package of Social Sciences (SPSS) (Inc., Chicago, Illinois version 16). The data obtained were analyzed statistically by computing descriptive statistics: Mean, ± SD values and percentages. Paired t- test was used for testing the differences between the formulae results. The difference at value of $P<0.05$ was considered significant.

3. RESULTS

The following tables presented the data obtained from normal Saudi-Jazan subjects. Mean age of the males was 25.00 ±7.08 years and the mean female's age was27.09 ± 5.61. the ages ranged between 15-24 constituting (45.30%), 25-34 were (43.8%), ages between 35-44 (9.40%) and ages > 45 were 1.60%.

Table 1: Cephalometric measures applied in the sagittal 3D CT images

	SNB(^{0})	SNA(^{0})	ANB(^{0})
N	64	64	64
Mean	82.4766	84.1172	1.7125
Std. Deviation	4.07753	3.51760	1.36609
Minimum	71.20	74.00	0.10
Maximum	88.40	89.30	5.40

Table 2: Anatomical measures applied in the sagittal 3D CT images for upper air way tract

	RS (mm)	RP (mm)	ANS-PNS (mm)	NC (mm)	UAL (mm)	SP-MAX (mm)	PNS-U (mm)	MP-H (mm)
N	64	64	64	64	64	64	64	64
Mean	13.18	8.65	49.06	109.02	54.65	8.61	34.63	11.31
Std. Deviation	3.35	6.18	4.78	10.43	6.67	1.58	5.41	4.77
Minimum	7.50	3.10	41.70	84.50	39.90	5.30	23.70	4.10
Maximum	22.30	53.50	62.60	126.00	72.40	11.80	49.70	31.80

Table 3: Independent Samples Test for the anatomical and cephalometric measures applied in the sagittal 3D CT images classified according to gender

Variable	Gender	N	Mean	Std. Deviation	P-value
RS(mm)	Male	43	13.5744	3.50300	0.188
	Female	21	12.3952	2.93641	
RP(mm)	Male	43	9.1558	7.33181	0.357
	Female	21	7.6238	2.47506	
ANS-PNS (mm)	Male	43	49.5442	5.16911	0.251
	Female	21	48.0714	3.81197	
NC	Male	43	111.179	9.77890	.017
	Female	21	104.609	10.58130	
UAL(mm)	Male	43	55.1860	6.35046	0.362
	Female	21	53.5524	7.33435	
ANB(^{0})	Male	43	1.6860	1.36479	0.827
	Female	21	1.7667	1.40083	
SNB(^{0})	Male	43	81.9116	4.35213	0.113
	Female	21	83.6333	3.24119	
SNA(^{0})	Male	43	83.6209	3.82358	0.107
	Female	21	85.1333	2.58096	
SP-MAX (mm)	Male	43	9.1000	1.55456	.000
	Female	21	7.6190	1.11965	
PNS-U (mm)	Male	43	35.4860	5.42387	.073
	Female	21	32.9000	5.09657	
MP-H (mm)	Male	43	10.7581	4.67996	0.181
	Female	21	12.4667	4.88655	

Table 4: Correlation coefficient between the neck circumference and age.

Coefficients[a]				
Model		Unstandardized Coefficients		Sig.
		B	Std. Error	
1	(Constant)	97.557	5.054	.000
	age	.446	.191	.022
a. Dependent Variable: NC				

Established equation to predict the neck circumference for Saudi –Jazan population of known age. Correlation is significant at $p \leq 0.005$, $R^2=0.081$.

Neck Circumference (NC) = 97.55 + 0.446 *Age.

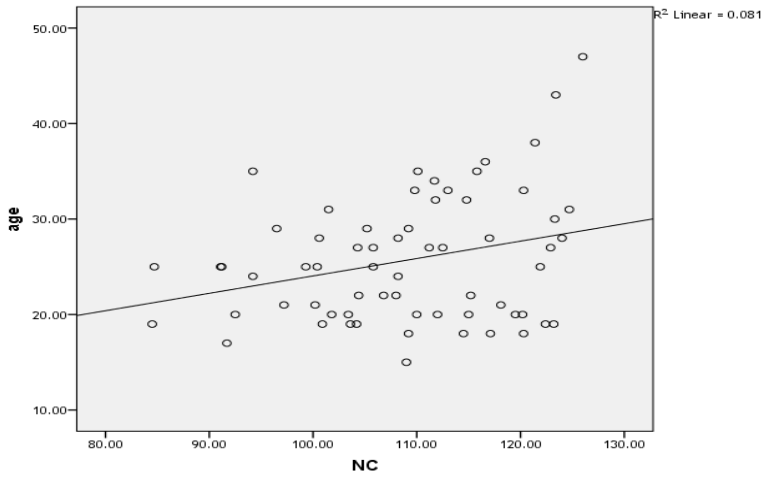

Figure 1: A scatter plot diagram shows the positive linear relationship between the neck circumference and age.

Table 5: Correlation coefficient between the MP-H and age

Coefficients[a]				
Model		**Unstandardized Coefficients**		**Sig.**
		B	**Std. Error**	
1	(Constant)	6.871	2.342	.005
	age	.173	.088	.054
a. Dependent Variable: MP-H				

Established equation to predict the distance between mandibular plane and hyoid bone (MP-H) for Saudi-Jazan population of known age. Correlation is significant at $p \leq 0.005$, $R^2=0.058$.

MP-H =6.871 + 0.173 *Age.

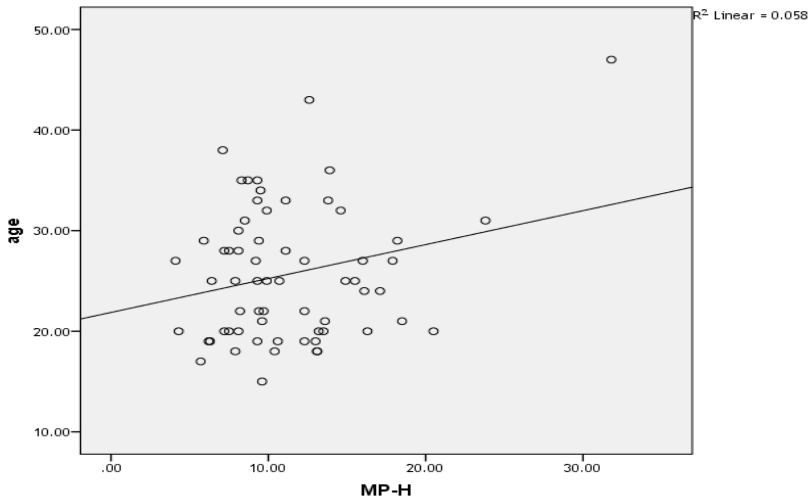

Figure 2: A scatter plot diagram shows the positive linear relationship between the MP-H and age.

Table 6: Correlation coefficient between the ANS-PNS and age

Coefficients[a]				
Model		**Unstandardized Coefficients**		**Sig.**
		B	**Std. Error**	
1	(Constant)	54.686	2.303	.000
	age	-.219	.087	.014
a.Dependent Variable: ANS-PNS				

Established equation to predict the linear distance between anterior nasal spine (ANS) and posterior nasal spine(PNS) (ANS-PNS) for Saudi population of known age. Correlation is significant at $p \leq 0.005$, $R^2=0.093$.

ANS-PNS = 54.686 + (-0.219) *Age.

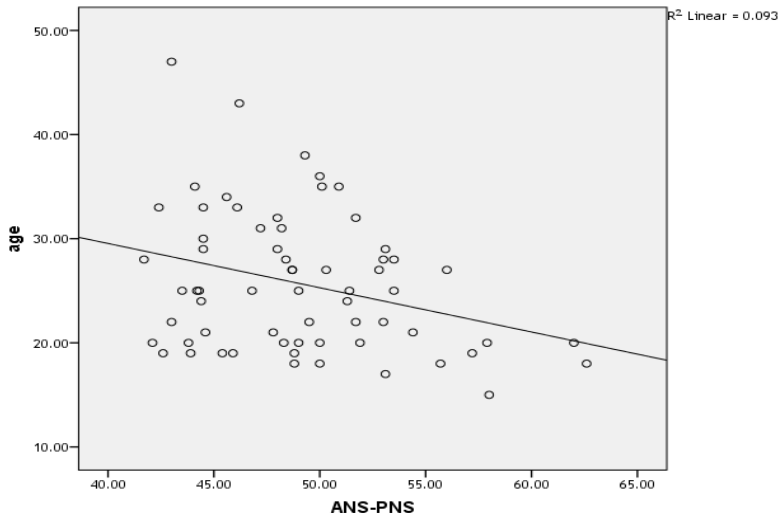

Figure 3: A scatter plot diagram shows the negative linear relationship between the ANS-PNS and age.

DISCUSSION

The present study included a group of South Saudi - Arabian subjects who were living in Jazan area. They were clinically of normal facial profile, without any reported abnormality of the upper airway tract or complaining of snoring. Similar studies have been conducted on normal adults in various populations.[5-38] All the measured norms values including cephalometric and upper air way tract measurements were presented in tables 1 and 2.

It has become apparent that there is the need to determine what comprises the normal face for the Saudi-Jazan population. Treatment plans and clinical procedure should not be freely switched without consideration of the racial group involved and without thorough understanding of the differences between races and their normal ranges.[39]

Studies on different ethnic groups including those of Chan's[40] on Chinese, Garcia's[41] on Mexican Americans and Park's[42] on Korean adults have indicated that normal measurements of one group cannot be considered normal for other racial groups.

The current study is an attempt to establish a norm or standard for the skeletal and upper air way pattern of Saudi-Jazan adults. The results for the selected Saudi-Jazan population were compared with the other norms. A comparison was also done between Saudi-Jazan male and female adult subjects. (Table3) The present study revealed that the means for the Saudi –Jazan sample were similar in most measurement items from the means of Bangladesh and Caucasians. Similarly, when comparison was done between male and female subjects to find out any significant gender difference of cephalometric craniofacial parameters, there was no significant difference between both genders except in 2 parameters NC and SP-MAX at $p \leq 0.000$.

When evaluating SNA and SNB angles, it is interesting to note that both exhibited a significantly greater value in Saudi -Jazan subjects than in the Caucasians. It indicated that the maxillary and mandibular apical bases were more prognathic. ANB angle indicates an antero-posterior relationship between the mandibular and maxillary apical bases relative to the cranial base. There was no significant difference in ANB angle between male and female Saudi-Jazan subjects.

Hassan, 2006 has reported that Saudis living in the western area represented a new Saudi race established through interbreeding among the different communities and the multiracial population settled in the western province for a long period. When the results of normal cephalometric evaluation obtained by Hassan were compared with the other studies, significant differences were found in SNA, SNB, ANB measurements when compare to Caucasian.[19] The current study results showed that Saudi –Jazan results differ from the western area. In Saudi- Jazan subjects; the SNB was found to be greater and the ANB was found to be less than the western population.

Significant gender dimorphism in airway measurements was evident in both the study done on Chinese[5] and Shen et al's study,[43] although slightly different patterns were observed. Bacon et al[44] reported the mean soft palate length in the male was found to be 38.7 ± 3.2 mm. Riley et al[10] reported a normal soft palate length in Caucasian males of 37.0 mm, while Chinese[5] results indicate a soft palate length of 34.3 ±3.9 mm. Hochban and Brandenburg[45] reported the measurements of Caucasian males length of the soft palate was 45.1 mm; thickness of the soft palate was 12.2 mm.

Cephalometric norms measurements were also reported by Poole et al.[46] Norms were calculated for various ages and both sexes and found to vary according to age and sex. Our study found that only the neck circumference

and MP-H and (ANS-PNS) have significant relationship with age, this were presented in figures (1-3).

The implication of the present study include vertical distances of hyoid bone were bigger in males than in females implying more inferiorly and anteriorly positioned hyoid bone in men. Also, retroglossal and retro palatal spaces were larger in males.

In establishing norms, the researchers used regression equations to predict the measurements of upper air way tract for the Saudi-Jazan of known ages, tables (4,5 and 6). Thus, although a small number of studies have made analyses of upper airway measurements, these had notable limitations and reported results are not directly comparable to the current study for the fact that the majority of investigations did not use ordinary subjects and hence lacked reference measurements for the norms. Rather, comparisons between normal and abnormal groups were made (OSA or snoring) in order to identify changes in upper airway measurements.

CONCLUSION

In the current study, detailed computerized tomography analysis of the upper airway was conducted, with due consideration of small sample size. The findings showed that there were no significant differences between males and females except in NC, SP-MAX.

We can predict the measurements of the upper air way tract (ANS-PNS, MP-H and NC) for the Saudi-Jazan of known ages. Saudis-Jazan have distinct cephalometric and upper air way tract features, for which specific norms should be used as a reference in treating orthodontic patients. Norms for the airway in the Saudi-Jazan population have been established in this study. Data derived from this study should thus prove useful as a reference for assessment of obstructive sleep apnea for Saudi-Jazan if present. Further correlations can be drawn with the studies comparing airway dimensions in normal individuals and in subjects with sleep-related disorders.

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