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Cephalometric Measurements and Morphological Evaluation for Head and face of an Iraqis adult for cephalic x-ray

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ABSTRUCT

The aim of this study is to establish cephalometric norms using Jarabak's analysis for an Iraqi community sample and to compare these norms with the norms used by Jarabak's analysis. In this study mean values of Jarabak's cephalometric analysis for Iraqi was determined. There are no previous studies establishing cephalometric norms for Iraqi population according to Jarabak's analysis and there are no previous studies published about Cephalic Index (CI) of Iraqi community.the present study identified the shape of the head for Iraqi community.

The mean cephalic indices in Iraqi male and female were found to be 79.45 And 74.34 respectively, the shape of the head for Iraqi community is distinguished as **Mesocephalic.**The mean of Facial Proportion are significantly much less in Iraqi community (55.38%) compared with Saudi community(64.65%),and also was significantly much less compared with Jarabak's norms (63.5%).The numbers of cases used in this study were 100 for females and 120 for males of young adults; the ages were between 18-32 years. The results of this study will be of importance in forensic medicine, anthropology and in genetics.The present study, the cephalic algorithm, was conducted through application c++ programming.

Key word: Cephalometric Measurements, Morphological Evaluation, Jarabak's analysis

تحديد قياسات الراس والتقييم المورفولوجي للوجه والراس لعينة من المجتمع العراقي وباستخدام الاشعة السينية

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الخلاصة

الهدف من هذه الدراسة هو تحديد قياسات الرأس والوجه باستخدام تحليل Jarabak لعينة من المجتمع العراقي ومقارنة هذه القياسات مع الدراسات التي استخدمت ايضا معايير تحليل Jarabak لشعوب اخرى. ولعدم وجود دراسات سابقة لمثل هذا البحث وبالتحديد لسكان العراق وفقا لتحليل Jarabka. في هذه الدراسة تم تحديد متوسط القيم لقياسات الرأس من تحليل Jarabak للمجتمع العراقي. وايضا حدد مؤشر رأسي (CI) لشكل الرأس في المجتمع العراقي وكانت النتائج التي حصلنا عليها في هذه الدراسة بان متوسط المؤشر الراسي في الذكور والإناث العراقية لتكون 79.45 و 74.34 على التوالي، وان شكل الرأس للمجتمع العراقي أمتاز بـمعتدل القحف.وان متوسط نسبة الوجهFacial Proportion (وهي نسبة ارتفاع الوجه الخلفي على ارتفاع الوجه الأمامي) في المجتمع العراقي وكانت (٪ 55.38) أقل بكثير مقارنة مع المجتمع السعودي (٪ 64.65) ، وأيضا كانت أقل بكثير مقارنة مع معيار (Jarabak ٪63.5) .

وقد نم مقارنة النتائج من هذه الدراسة مع نتائج الشعب السعودي والشعب البرازيلي وايضا مع نتائج تحليل Jarabak, وذلك لايجاد الفرق في الدراسة المورفولجي للراس والوجه للشعب العراقي , وايضا تم تحديث القياسات الحاصة لتحليل Jarabak في بعض القياسات الخاصة بالراس والوجه وقد تم تثبيت هذه القياسات.بلغ عدد الحالات المستخدمة في هذه الدراسة 100 للإناث و 120 للذكور البالغين الشباب، وكانت أعمارهم بين 32-18 عاما .وان نتائج هذه الدراسة ذات أهمية في الطب الشرعي وعلم الإنسان وعلم الوراثة . وقد أجريت هذه الدراسة من خلال خوارزمية the cephalic .

INTRODUCTION

Cephalometry is the scientific measurement of the dimensions of the head, usually using standardized lateral skull radiographs or cephalograms.

The human body dimensions are affected by ecological, biological, geographical, racial, gender and age factors [1]. There are no previous studies establishing cephalometric norms for a Iraqi population according to Jarabak’s analysis. The evaluation and measurement of human body dimensions are achieved by physical anthropometry [3]. Cephalometry is one of the important parts of anthropometry in which dimensions of head and face are measured. Cephalometric results used in pediatrics, forensic medicine, plastic surgery, oral surgery dentistry, and diagnostic comprehension between patient and normal populations [4].

Other study has shown changes of head shape during 30 years on population [5].

Cephalic index is the percentage of breadth to length in any skull. The index calculated from measurement of the diameters of the skull. The length of the skull is the distance from the glabella(The glabella, in humans, is the space between the eyebrows and above the nose it also means the midpoint between the brows) and the most projecting point at the back of the head[6].

The breadth of the skull is the distance between the most projecting points at the sides of the head, usually a little above and behind the ears. The cephalic index is the breadth (width) multiplied by 100 divided by the length.An index of less than 75 means that the skull is long and narrow when seen from the top; such skulls are called dolichocephalic and are typical of Australian aborigines and native southern Africans[7]. An index of 75 to 80 means that the skull is nearly oval; such skulls are called mesaticephalic and are typical of Europeans and the Chinese. A skull having an index of over 80 is broad and short, and is called ***brachycephalic***; such skulls are common among Mongolians and the Andaman Islanders.

Cephalometry is one of the important branches of anthropometry in which dimensions of head and face are measured [8].

Cephalometric norms don't apply to all patients; because of racial characteristics and miscegenation, specific cephalo-metric standards are required for various ethnic groups [9].

Mathematical Model:

A mathematical model usually describes a system by a set of variables and a set of equations that establish relationships between the variables. The values of the variables can be practically anything; real or integer numbers, Boolean values or strings, for example. The actual model is the set of functions that describe the relations between the different variables [10].

The mathematical model used in this research includes the geometric analysis; the steps of this model are listed below:

The proposed system in this paper is composed of the following stages, as shown in figure (1).

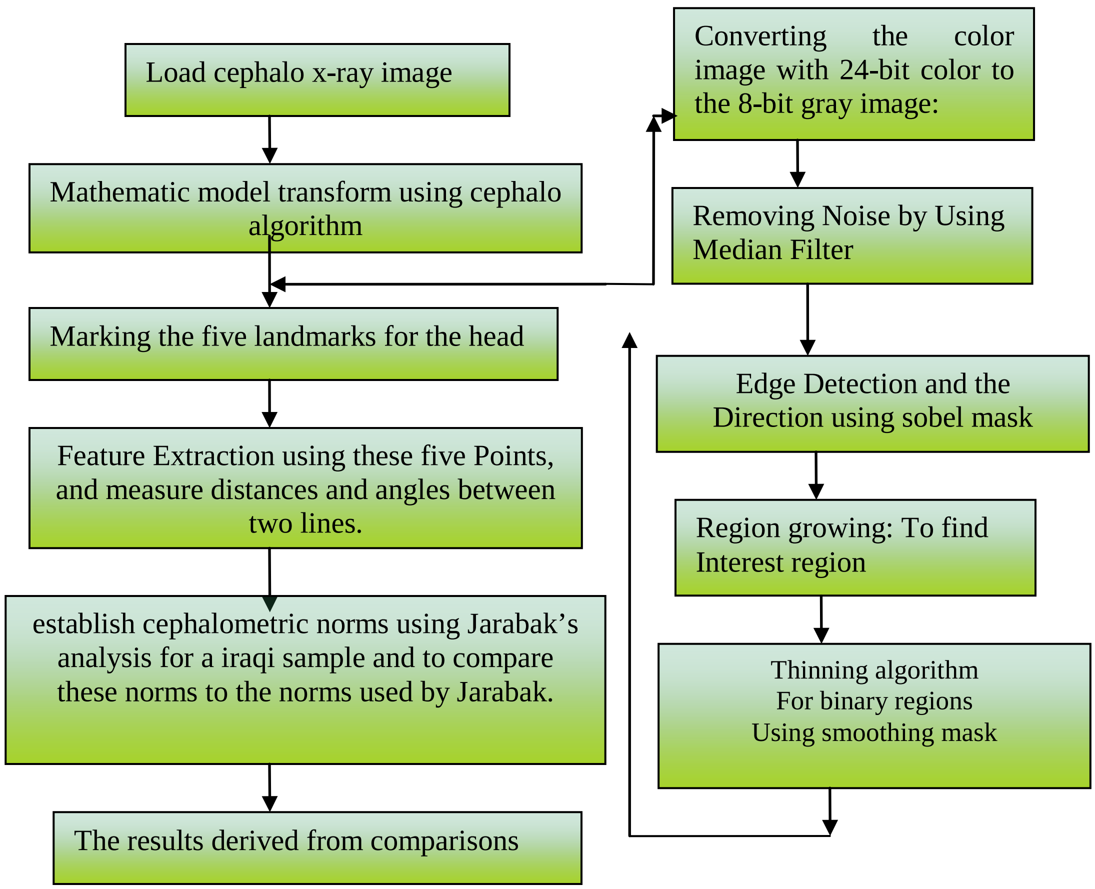
Converting the color image with 24-bit color to the 8-bit gray image:

Converting the color image with 24-bit color to the 8-bit gray image and the luminance Y can be determined from the RGB model and the effective luminance of a pixel is calculated by using the Eq.(1)

Color in an image may be converted to a shade of gray by luminance of a pixel is calculated with the effective brightness or luminance of color and using this value to create a shade of gray that matches the desired brightness[11].

$$Y = 0.299R + 0.5587G + 0.114B \qquad ...(1)$$

This luminance value can be turned in to a grayscale pixel [12].



Figure(1): The Proposed cephalic x-ray image system

(1) (2)

Figure(2) : two images for Cephalo x- ray ,(1) color image showing the soft and hard lateral cephalometry X-ray..(2) Cephalo x- ray gray image after the removal of soft and hard tissue.

Remove some of the pixels for improving the image using median filter. The median filter is a non-linear digital filtering technique, often used to remove noise from images or other signals [13].The median filter is an effective method that can suppress isolated noise without blurring sharp edges. Specifically, the median filter replaces a pixel by the median of all pixels in the neighborhood as shown as in Eq(2):

$$y[m,n] = median\{x[i,j],(i,j) \in w\} \quad \ldots(2)$$

Where

$w[m,n]$

represents a neighborhood centered around location (m,n) in the image.

Edge Detection and the Direction:

The edge and line detection operators are implemented with convolution masks. Edge detection operators are based on the idea that edge information in an image is found by looking at the relationship a pixel has with its neighbors. If a pixel's gray-level value is similar to those around it, there is probably not an edge at that point. However, if a pixel has neighbors with widely varying gray levels, it may represent an edge point. In other words, an edge is defined by a discontinuity in gray-level vales.

The sobel edge detection masks look for edges in both the horizontal and vertical directions and then combine this information in to a single metric. At each pixel location, we now have two numbers: *s1*, corresponding to the result from the row mask, and *s2*, corresponding to the result from the column mask [14].

For obtaining, the edges of the contours of the skull have implemented sobel filter in order to find the edges as the equation (Eq.3)

The sobel operator consists of a pair of 3×3 convolution kernels as shown in Figure 3. One kernel is simply the other rotated by 90°[15].

Row mask			**Column mask**		
−1	−2	−1	−1	0	1
0	0	0	−2	0	2
1	2	1	−1	0	1

Figure (3) : Sobel Operators

By using these numbers to compute two metrics, the edge magnitude and the edge direction [16], which are defined as follows:

$$EDGE\ MAGNITUDE = \sqrt{S^2{}_1 + S^2{}_2} \quad \ldots(3)$$

$$EDGE\ DIRECTION = \tan^{-1}\left|\frac{S_1}{S_2}\right| \qquad \ldots (4)$$

The edge direction is perpendicular to the edge itself because the direction specified is the direction of the gradient, along which the gray levels are changing**,** Using the equation (4)

Threshold is the simplest method of image segmentation. From a grayscale image, threshold can be used to create binary images.

Using the equation (5) to get binary image of the head with all the edges and features of the skull and the points required in measurements.

The Results which obtained from the application of the equations (5) are shown in Figure (3).We have used several values of threshold when using the threshold method to obtain a binary image. and detecting all the edges then we fix the value of threshold, with high definition to the details of the head to be used in the subsequent phase to calculate the measurement of lengths, distance and angles that depend on a features for the purpose of comparison with the results of the peoples of non-Iraqis were used by Jarabak's analysis.

Region Growing

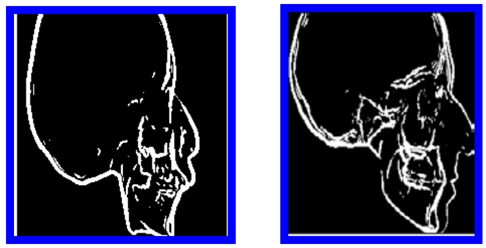
At first, justifying the choice of seed points is done having a white pixel element, and then the location of that pixel is estimated as the beginning of the object (head region). The second step is to grow a region from a seed point. The growing filter compares white color value with the eight neighborhoods of the seed point according to a characteristic threshold, as shown in equation (5). If the value of the neighborhood is located within the upper and lower threshold, this neighborhood will merge into the head region; else, this neighborhood would reject. This step repeated from one pixel to another, after reaching a new white pixel surrounded by four neighborhood black pixels then the end of the head region reached. When find the first pixels for the region of head, which have the Value "1". Perform process for detect 8-neighbors of pixels, Where contour point is any pixels with value "1" and having at least one 8- neighbors valued "0" , if this Pixels belong to the region of head then changing its Value to "0". The location of the head should specify. From this point, the scan continues if there are no white pixels within the scanning region then the head is specified.

$$I(x,y) = \begin{Bmatrix} 1 \quad if \quad T_{min} \langle I(x,y) \langle T_{max} \quad else \\ 0 \end{Bmatrix} \qquad \ldots (5)$$

Where

T_{max} and T_{min} are the lower and upper threshold[17].

Thresholding used to change pixel values above or below a certain intensity value *T* (threshold) as shown as in Figure (4):



(1) (2)

Figure (4): convert gray scale image to binary image: - (1) the threshold value is 80, (2) the threshold value is 100

Thinning algorithm for binary regions Using smoothing mask:

Thinning is a morphological operation that is used to remove selected foreground pixels from binary images. In this mode, it is commonly used to tidy up the output of edge detectors by reducing all lines to single pixel thickness. Thinning is normally only applied to binary images, and produces another binary image as output. Edge thinning is a technique used to remove the unwanted spurious points on the edge of an image. This technique is employed after the image has been filtered for noise (using median), the edge operator has been applied to detect the edges and after the edges have been smoothed using an appropriate threshold value. This removes all the unwanted points and if applied carefully, results in ***one-pixel*** thick edge elements [18]. The thinning method consists of successive passes of two steps applied to the contour points as shown as in Figure (5).

P_9	P_2	P_3
P_8	P_1	P_4
P_7	P_6	P_5

Figure (5): Neighborhood arrangement used by the thinning algorithm.

Where

$N(p_1)$ is the number of nonzero neighbors of P_1

The Results that obtained from the Thinning algorithm are shown as in Figure (6).

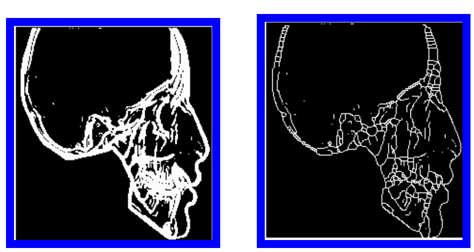


Figure (6): shows the Results that obtained from the Thinning algorithm for cephalo x-image.

Distance Between Two Pixels (with known coordinates)**:**

In analytic geometry, geometric notions such as distance and angle measure, these definitions are design to be consistent with the underlying Euclidean geometry. For example, using Cartesian coordinates in the x-y plane, the distance (D) between two points (x_1, y_1) and (x_2, y_2) is defined by Eq. (6)

$$\boldsymbol{D} = \sqrt{\boldsymbol{dx}^2 + \boldsymbol{dy}^2} \qquad \ldots(6)$$

Where

dx is the difference between the x-coordinates of the points, *dy* is the difference between the y-coordinates of the points [19].

The Slope and the Angle between Two Lines:

In mathematics, the angle from the first to the second coordinate axis of a coordinate system is considered as positive. Therefore, angles given a sign are positive angles if measured anticlockwise, and negative angles if measured clockwise, from a given line. If no line is specified, it can be assumed to be the first coordinate axis (x-axis) in the Cartesian plane. In many geometrical situations, a negative angle of $-\theta$ is effectively equivalent to a positive angle of "one full rotation less θ". For example, a clockwise rotation of 45° (that is, an angle of −45°) is often effectively equivalent to an anticlockwise rotation of 360° − 45° (that is, an angle of 315°). In three dimensional geometry, "clockwise" and "anticlockwise" have no absolute meaning, so the direction of positive and negative angles must be defined relative to some reference, which is typically a vector passing through the angle's vertex and perpendicular to the plane in which the rays of the angle lie.

Consider a line *L* in the *xy* plane. It forms an angle of inclination α $(0 \le \alpha \prec \pi)$, with the positive *x axis*. The slope *m* of *L* is $\tan\alpha$. (If $\alpha = \pi/2$, the slope is not defined) as shown in figure (7). Consider two lines L and L', with angles of inclination α and α', and slopes *m* and m' , respectively, as shown in figure (8)

The angle between these lines can be computed according to the Eq. (7)

$$\theta = \alpha - \alpha' \qquad \ldots(7)$$

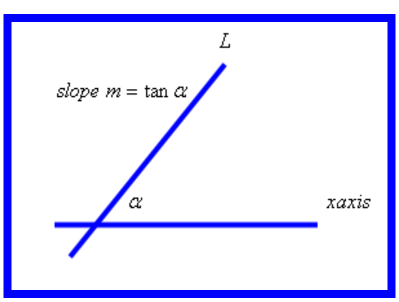


Figure (7): show the slop equation for line

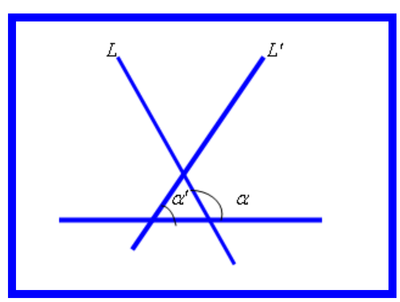


Figure (8): show the angle equation between two

If L and L' are parallel, define (θ) to be 0.

Figure (9) shows the angle (θ) for some typical L and L'. In each case (θ) is the counterclockwise angle from L' to L. note that (θ) depends on the choice of the x-axis that $0 \leq \theta \prec \pi$ [20].

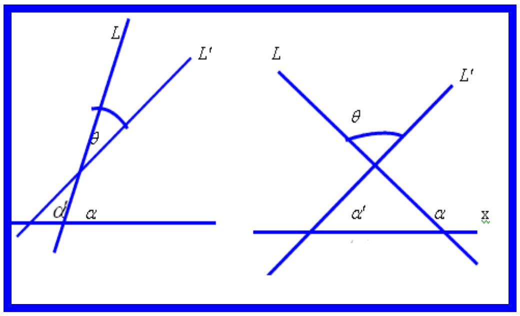


Figure (9): shows (θ) for some typical L and L'

The Formula for obtaining the slope of a straight line going through the points (x_1, y_1) and (x_2, y_2) is given by the Eq. (8)[21].

$$m = \frac{y_2 - y_1}{x_2 - x_1} \qquad \ldots(8)$$

Materials And Methods:-

This study carried out on 220 cephalometric x-ray belonging to a group of Iraqi adults aged between 17-32. That group divided into two categories by gender, the first consist of 47 females and the other of 47 males.

All lateral cephalometric x-rays were taken while the patients were relaxed in a sitting position, with the head in the natural position and lips in the rest position. This study aimed at applying well-know international cephalometric methods to assess and compare cranio cephalo morphological characteristics of adults, who live in the central regions in Iraq. The x-ray images used in this study were taken from orthodontics clinics located in different parts of Baghdad city. The Cephalometric measurement of Jarabak's analysis is illustrated in Figure (10).

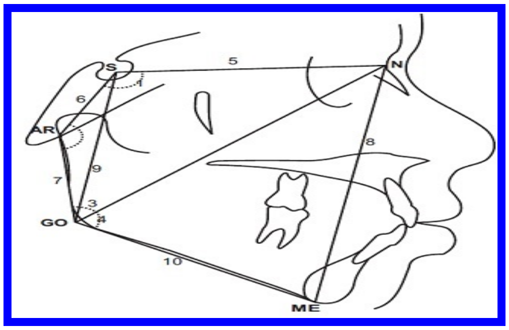


Figure (10): Cephalometric measurements of Jarabak's analysis. Angular measurements: (1.) N-S-AR (saddle angle); (2.) S-AR-GO (articular angle); 3 & 4. AR-GO-ME (gonial angle); (3.) AR-GO-N (upper gonial angle); (4.) N-GO-ME (lower gonial angle) and 1+2+3+4 (Jarabak-sum).Linear measurements: (5.) S-N (anterior cranial base); (6.) S-AR (posterior cranial base); (7.) AR-GO (ramus height); (8.) N-ME (anterior facial height); (9.) S-GO (posterior facial height), And (10.) GO-ME (mandibular corpus).

In this study, the region of head in images of X-rays was identified, with known x-y coordinates for five points having all the features needed in the calculations. Which include distances, angles and some measurements. These results are used for analyzing; a comparison was made with the procedure used in the Jarabak's analysis method and with previous researches used the same method in other countris [22]. This approach is used for the first time in this area.

A survey was conducted in order to grasp objects needed in calculations. The algorithm in this approach scans the x-ray to reach the region of interest starting from the bottom of the image moving upward. When the target point is reached where adjacent points having a value of "0", the body found with its coordinates is considered as the biggest body needed, which represents the head in this research.

The algorithm have been applied for identifying the five points and saved in a separate field for each patient, then these data will be analyzed in the next phase. The work illustrated in this research was only for binary images, but in presenting the results, the main gray image was used to show interesting points. Five landmark points are marked on each image then using these five landmark points features were extracted from each image. The explanation of the cephalic algorithm illustrated in the paragraphs as shown below:-

1. The image is divided into 16 portions each portion have the dimensions of 264 * 224, the latter is also divided into 16 portions each one have the dimensions of 66 * 56. Table (1) shows an example that demonstrates the determination of the locations for the target points in the head.

Table (1): Example shows the image to find the coordinates of the points in the skull.

1	5	9	13
2	6	10	14
3	7	11	15
4	8	12	16

2. To find the coordinates of the (N) point by using two boxes (14,15) in our example, Because of the (N) point is located in the middle of image (be either in the box (14) or (15)). beginning the search from the bottom to top of the image for the x-axis .looking for the X-min per Rate boxes and then registering only the less value for the X-min of all the values, it means its value is "1" then determine the coordinates of Y, thus identified N point coordinates(x,y).

3. To find the coordinates of the point (me), start searching in the area of the four squares ((16 ،12 ،8 ،4 in our example beginning the search from the bottom to top of the image for the x-axis. The search direction from left to right for x-axis, when reaching the first point which its value is "1” then registering its coordinates (x, y) as desired point (me).

4. To capture coordinates of the point (go) start searching in the area of the four squares (8,7,4,3) and from the bottom to the top in the x-axis and to find less coordinate values of x-mini and when reaching the first effective point its value is "1" registering its coordinates (x, y)) and considered is the point (go).

5. To find the coordinates of the point (AR) start searching in the area of the four squares which it is located in boxes (7,6,3,2) . Start searching from the center of the image and from the left to the right in the x-axis. To find the x-min in the region that have been identified by finding all the coordinates of x-min for the four boxes and recording the highest value between them and be the desired point (AR) and registering the coordinates (X, Y) to this point.

6. To find the coordinates of the point (S) by searching in the area of the four squares namely (6, 5, 2, 1), and consider it as one area of the rectangle, The search direction from left to the right of image. Re-divided four boxes to the (8 * 8) boxes on the x-axis and y-axis, and will be the total number of boxes (16 * 16) then be 256 boxes. Searching for a box that contains the largest number of hotspots that the value is"1" in the All of these boxes and when reaching this box must determine the center of this box, it means in the location point (4 * 4), then be the desired point (S) is reached and registering the coordinates (X, Y) to this point.

7. We find distances between points using the law of the distances as shown in equation (6).

8. To find the angles we apply the following equation (9, 10, 11, 12), where *Tm* just the name of the variable, And *Dis* symbolizes the value of distances.

9.

$$Tm = (((Dis\_N\_GO * Dis\_N\_GO) + (Dis\_GO\_ME * Dis\_GO\_ME) - (Dis\_N\_ME * Dis\_N\_ME)) / (2.0 * Dis\_N\_GO * Dis\_GO\_ME)); \quad \ldots(9)$$

$$Theta\_N\_GO\_ME = Cos^{-1}(Tm) \quad \ldots(10)$$

$$Dg = \tan^{-1}(1)/45 \quad \ldots(11)$$

$$Theta\_N\_GO\_ME \quad /= Dg \quad \ldots(12)$$

The all Definitions of Cephalometric Measurements of Jarabak's Analysis as shown as in table(2).The table (3) shown the Mean and standard deviations measured by age parameter for Iraqi community (males and females).

Table(2): Definition of Cephalometric Measurements of Jarabak's Analysis

Measurement	Definition
Angular measurements(°)	
N-S-AR	Saddle angle: Measured at the angle between anterior and posterior cranial base.
S-AR-GO	Articular angle: Measured at the angle between posterior cranial base and ramus Height
AR-GO-ME	Gonial angle: Measured at the angle between ramus height and mandibular plane.
AR-GO-N	Upper gonial angle: Measured at the angle between ramus height and Gonion constructed- Nasion line
N-GO-ME	Lower gonial angle: Measured at the angle between Gonion constructed-Nasion line and mandibular plane
Jarabak Sum	Sum of angles (Saddle angle + Articular angle + Gonial angle)
Linear measurements(mm)	
S-N	Anterior cranial base: A linear distance from Sella to Nasion.
S-AR	Posterior cranial base: A linear distance from Sella to Articulare.
AR-GO	Ramus height: A linear distance from Articulare to Gonion constructed.
N-ME	Anterior facial height: A linear distance from Nasion to Menton.
S – GO	Posterior facial heigth: A linear distance from Sella to Gonion constructed.
GO-ME	A linear distance from Gonion to Menton (mandibular corpus).
Proportional measurements (%)	
% Jarabak	Facial Proportion: A ratio of the Posterior facial heigth to Anterior facial height (S –GO/N-ME).

The means and standard deviations of angular and linear measurements for Iraqi males and females according to Jarabak's analysis are presented in Table (4 and 5).
Figures (11-12) Shows all the values of lengths, angles and distances that obtained when the algorithm applied on two different samples within this study.

Table(3): Mean and SD of measured parameters by age

age	16	18	20	23	25
N_S (MEAN) N_S (SD)	216.29465 29.51395	132.20000 8.79084	90.50000 7.96372	154.91667 17.44366	160.87609
N_ME(MEAN) N_ME (SD)	231.09723 2.99857	120.80000 23.25804	100.71429 8.05933	145.33333 28.87411	153.45032
N_GO(MEAN) N_GO(SD)	233.18033 3.31238	137.00000 12.70235	100.50000 3.29507	143.50000 22.25424	148.81230
AR_N(MEAN) AR_N(SD)	236.29370 9.82049	172.36813 35.82592	207.85793 36.14031	188.95322 35.552048	182.45120 34.90650
GO_ME(MEAN) GO_ME(SD)	212.88542 18.46611	121.96774 36.11602	124.13492 43.56610	149.37837 39.95191	149.78341 42.75120
AR_S(MEAN) AR_S(SD)	226.16667 14.26044	207.42000 32.24040	234.00000 27.61423	227.33333 19.33289	227.3421 18.45310
AR_GO(MEAN) AR_GO(SD)	241.33333 26.51276	221.26315 27.32618	223.53731 29.47872	225.87097 17.33957	225.90321 16.90672
S_GO(MEAN) S_GO(SD)	237.20561 3.91675	193.78873 15.83979	186.19672 13.12964	196.31250 13.44302	198.803561 13.20617

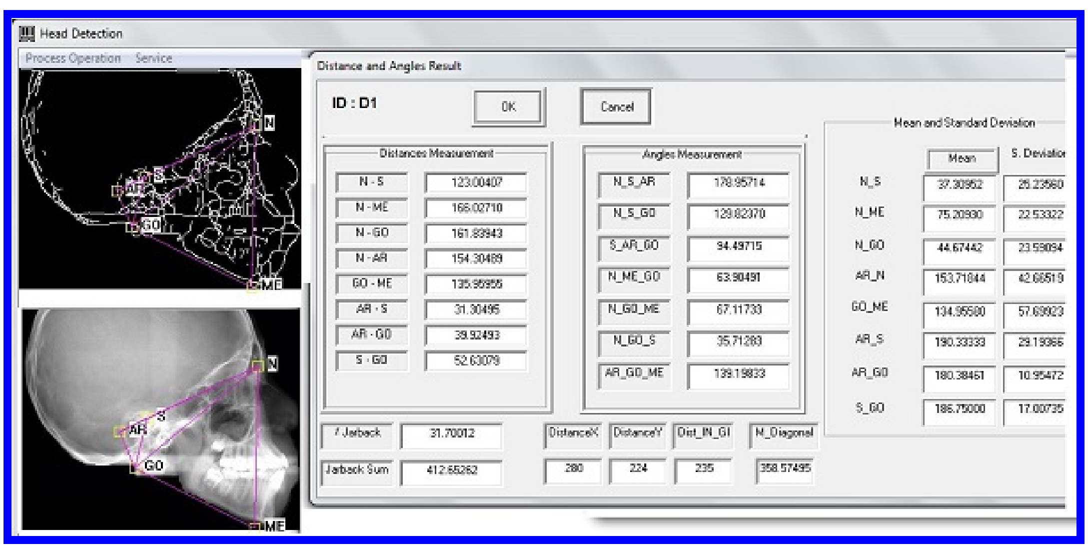


Figure (11): show the results, including the landmark points and all the measurements used in present study for sample D1 .

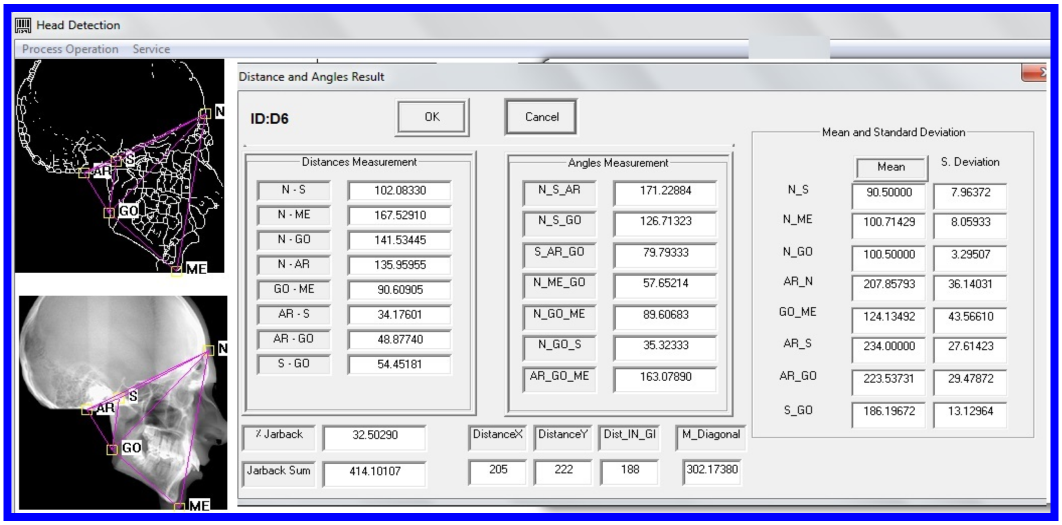


Figure (12): show the results, including the landmark points and all the measurements Used in present study for sample D6.

Table (4): Comparison Of Cephalometric Means between Iraqi Males and Jarabak's Analysis

Measurement	Jarabak Analysis		Iraqi males	
	Mean	SD	Mean	SD
S-N (mm)	71	3	101.57	12.20
N-ME(mm)	112.5	7.5	150.77	18.431
N-GO(mm)	No reading in Jarabak Analysis			10.24
N-AR(mm)			123.68	7.1
GO-ME(mm)	71	5	85.18	12.18
S-AR(mm)	32	3	39.74	7.63
AR-GO(mm)	44	5	54.88	14.21
S-GO(mm)	77.5	7.5	70.30	13.49
N-S-AR(˚)	123	6	164.95	8.1
S-AR-GO(˚)	143	5	102.86	6.4
AR-GO-ME(˚)	130	7	140.37	16.8
Jarabak sum (˚) SUM OF ANGLE S+AR+GO	396	6	408.18	17.7
AR-GO-N (˚)	53.5	1.5	56.99	4.4
N-GO-ME (˚)	72.5	2.5	94.66	5.2
% JARABAK	63.5	1.5	46.6273	2.3

cephalometric measurements for the Iraqi males sample as compared to Jarabak's norms, An increase in the values for each of the following lengths and angles :-in the anterior cranial base (S-N) length, in the mandibular length(GO-ME) , in the lower gonial angle (N-GO-ME) , in the posterior cranial base length S-AR, in the ramus height AR-GO, and anterior facial height N-ME . in iraqi males norm were significantly greater than Jarabak's norms .The posterior facial height (S-GO), the (articular angle) S-AR-GO,and the Jarback% (Facial Proportion) in iraqi males was significantly lower than Jarabak's norms, as shown as in Table-[4 and6].

cephalometric measurements for the iraqi female sample as compared to Jarabak's norms , An increase in the values for each of the following lengths and angles :-

in the anterior cranial base (S-N) length, in the mandibular length(GO-ME) , in the upper gonial angle AR-GO-N, in the lower gonial angle (N-GO-ME) , in the posterior cranial base length S-AR , in the saddle angle (N-S-AR) and anterior facial height N-ME, in iraqi females were significantly greater than Jarabak's norms as shown as in Table-[5 and 6]. The ramus height AR-GO,posterior facial height (S-GO), articular angle (S-AR-GO), gonial angle(AR-GO-ME), and the Jarback% (Facial Proportion) in Iraqi females was significantly lower than Jarabak's norms as shown as in Tables - [5 and 6] .

Table(5): Comparison Of Cephalometric Means between Iraqi females and Jarabak's Analysis

Measurement	Jarabak Analysis		Iraqi females	
	Mean	SD	Mean	SD
S-N (mm)	71	3	94.24	17.4
N-ME(mm)	112.5	7.5	142.74	28.8
N-GO(mm)	No reading in Jarabak Analysis		104.39	22.2
N-AR(mm)			127.85	35.5
GO-ME(mm)	71	5	92.33	39.9
S-AR(mm)	32	3	50.39	19.27
AR-GO(mm)	44	5	39.25	17.32
S-GO(mm)	77.5	7.5	61.40	13.45
N-S-AR(˚)	123	6	159.12	6.48
S-AR-GO(˚)	143	5	100.00	5.33
AR-GO-ME(˚)	130	72.5	83.60	4.81
Jarabak sum (˚) SUM OF ANGLE S+AR+GO	396	6	342.72	16.62
AR-GO-N (˚)	53.5	1.5	56.99	2.23
N-GO-ME (˚)	72.5	2.5	100.66	4.47
% JARABAK	63.5	1.5	43.015	3.81

Table(6): Comparison Of Cephalometric Means between Iraqi males and females according to Jarabak's Analysis

Measurement	Iraqi males		Iraqi females	
	Mean	SD	Mean	SD
S-N (mm)	101.57	12.20	94.24	17.4
N-ME(mm)	150.77	18.431	142.74	28.8
N-GO(mm)	132.78	10.24	104.39	22.2
N-AR(mm)	123.68	7.1	127.85	35.5
GO-ME(mm)	85.18	12.18	92.33	39.9
S-AR (mm)	39.74	7.63	50.39	19.27
AR-GO(mm)	54.88	14.21	39.25	17.32
S-GO(mm)	70.30	13.49	61.40	13.45
N-S-AR(^{0})	164.95	8.1	159.12	6.48
S-AR-GO(^{0})	102.86	6.4	100.00	5.33
AR-GO-ME(^{0})	140.37	16.8	83.60	4.81
Jarabak sum (^{0}) SUM OF ANGLES	408.18	17.7	342.72	16.62
AR-GO-N (^{0})	56.99	4.4	56.99	2.23
N-GO-ME (^{0})	94.66	5.2	100.66	4.47
% JARABAK	46.6273	2.3	43.015	3.81

Table- 7: Comparison Of Cephalometric Means between Iraqi males and Brazilian community according to Jarabak's Analysis

Measurement	Analysis of the Brazilian people		Iraqi males	
	Mean	SD	Mean	SD
N-S (mm)	68.44	2.56	101.57	12.20
N-ME(mm)	112.38	7.46	150.77	18.431
N-GO(mm)	No reading in Brazilian Analysis		132.78	10.24
N-AR(mm)			123.68	7.1
GO-ME(mm)	73.25	3.89	85.18	12.18
S-AR(mm)	33.56	2.39	39.74	7.63
AR-GO(mm)	44.44	5	54.88	14.21
S-GO(mm)	74.81	4.52	70.30	13.49
N-S-AR(°)	121.56	6.91	164.95	8.1
S-AR-GO(°)	148.00	8.21	102.86	6.4
AR-GO-ME(°)	122.19	4.15	140.37	16.8
Jarabak sum (°) SUM OF ANGLES S+AR+GO	391.75	6.02	408.18	17.7
AR-GO-N (°)	50.63	4.15	56.99	4.4
N-GO-ME (°)	71.56	4.82	94.66	5.2
% JARABAK	66.83	1.5	46.6273	2.3

cephalometric measurements for the iraqi males sample as compared to Brazilian people according to Jarabak's norms differences in the :-
anterior cranial base (S-N) length, mandibular length(GO-ME) , lower gonial angle (N-GO-ME) , (Tables 3, 4). The posterior cranial base length S-AR , ramus height AR-GO , and anterior facial height N-ME in iraqi males were significantly greater than Jarabak's norms as shown as in (Table- 7).
The Comparison of cephalometric measurements between adults' Iraqis males sample and with the results of the Saudi Arabian males analysis according to Jarabak's norms , they were differences in the:-
lower gonial angle (N- GO-ME, gonial angle (AR-GO-ME), anterior cranial base (S-N) , anterior facial height N-ME , length ramus height AR-GO, the upper gonial angle AR-GO-N, saddle angle (N-S-AR), in iraqi males were significantly greater than Saudi Arabian males as shown as in (Table- 8).

Table (8): The means and standard deviations of angular and linear measurements for Iraqi males and with the results of the Saudi Arabian males according to Jarabak's analysis.

Measurement	Saudi males		Iraqi males	
	Mean	SD	Mean	SD
S-N (mm)	74.37	4.26	101.57	4.8
N-ME(mm)	127.65	5.85	150.77	12.9
N-GO(mm)	No reading in Saudi Analysis		132.78	9.1
N-AR(mm)			123.68	7.1
GO-ME(mm)	86.32	5.19	85.18	6.4
S-AR(mm)	36.78	3.46	39.74	4.2
AR-GO(mm)	51.37	5.38	54.88	7.7
S-GO(mm)	83.03	5.99	70.30	6.6
N-S-AR(˚)	125.81	5.22	164.95	8.1
S-AR-GO(˚)	140.90	8.01	102.86	6.4
AR-GO-ME(˚)	127.28	6.58	140.37	53.8
Jarabak sum (˚) SUM OF ANGLES S+AR+GO	393.99	3.78	408.18	43.7
AR-GO-N (˚)	52.16	4.58	56.99	2.4
N-GO-ME (˚)	75.10	4.01	94.66	3.2
% JARABAK	65.04	3.70	46.6273	2.3

Facial Proportion

A biological norm for the facial heights of Iraqis has been established by cephalometric measurements, are not age dependent.
The aim of this study was to compare anterior and posterior facial heights in young Iraqi males and females.

This study showed that Iraqis do not have the emergence of the teeth in the jaws, both anterior facial height (N-Me) and Posterior facial height (S-Go), were significantly increased in Iraqi males compared with Iraqi females.
Jarback% = Facial Proportion: A ratio of the Posterior facial height (dis _s-go) to Anterior facial height (dis_N-ME)[23] as shown as in the equation (13).

$$Jarback\% = \frac{S-GO}{N-M} \quad \ldots(13)$$

Measured face dimensions are slightly increased in males more than in females of the Iraqi community. The characteristics of the Iraqi society shows that the mean of anterior facial height (N-Me) are Increases in Iraqi community(164.34 mm) and the mean of posterior facial height (S-GO) in Iraqi community (56 mm) are less than Saudi community as shown as in table-9.The mean of Facial Proportion are significantly much less in Iraqi community (44.8211%) compared with Saudi community(65.04%), and also was significantly much less compared with Jarabak's norms (63.5%) as shown as in (Table- 9).
The purpose of this study is to determine the changes in the posterior and anterior facial heights as well as in their proportions that occurred .The landmarks were identified on each X-ray film, from these landmarks; the following linear measurements were derived as shown as in table -10:-

Table (9): show the Jarback% ((Facial Proportion) (mm() measurement for Iraqi community .

No of Cases	Jarback% (Facial Proportion) (mm)	No of Cases	Jarback% Facial Proportion (mm)
No.3	37.415	No .33	47.654
No .5	33.185	No .35	48.980
No .6	32.502	No .46	46.851
No .7	35.311	No .47	39.076
No .8	35.111	No .48	44.142
No .9	36.163	No .49	38.097
No .10	45.901	No .50	48.012
No .11	39.070	No .51	50.601
No .12	38.099	No .52	52.093
No .13	43.658	No .53	54.801
No .14	31.028	No .74	47.012
No .15	44.121	No .75	46.012
No .16	43.512	No .716	45.012
No .17	46.019	No .97	51.901
No .18	36.810	No .98	46.450
No .19	34.787	No .99	45.106
No .20	33.562	No .100	44.012
The mean for Jarback% (Facial Proportion) (mm) for \Iraqi community(Male &Femal) is 44.8211%			

Table (10): show the linear measurements and face height ratio were derived from X-ray cephalic

Variable No.	Distance (mm)	meaning
Variable 1	s-go	posterior face height
Variable 2	n-m	anterior face height
Variable 3	s-go/n-m %	face height ratio

Cephalic Index:

The most important of cephalometric dimension are length and width of head that with them determine cephalic indexas shown as in figure (13). On basis of cephalic index head shapes group to four international categories, that including Dolichocephalic , Brachycephalic,Mesochepalic and Hyperbrachycphalic[25]. Although some investigations carried out to determine the type of head shape in various ages in iraq. The aim of this study was to establish cephalometric norms of iraqi adults according to Jarabak's analysis and to evaluate whether a significant difference exists between Iraqi measurements and Jarabak's norms [26].

But by regarding the effect of racial/ethnic and geographical factors on head dimensions and lack of documented research about iraqi people in this area. This study aimed at applying well-known international cephalometric methods to assess and compare cranio cephal morphological characteristics of Iraqi adults (17-32 years old), in central Iraq. Significance of cephalic index regarding our population is to identify the category of our race, into which type of cephalic index does it fall [27].

To categorize our community into a type of population, whether they fall into dolicocephalic, mesocephalic or brachycephalic cranial index.

The cephalic index (CI) is a value calculated using two parameters . First parameter measure the maximum length (from the bump on the back of your head to between your eyebrows)[28]. In addition, the second parameter will measure the maximum breadth. By dividing the maximum breadth by the maximum length, and multiplying that number by 100 as shown as in the equation (14).the value of cephalic index score is obtained. By this score, the shape of the head can be distinguished, as shown as in table -11.

$$cephalic\ index(CI) = \frac{\max imum\ head\ breath}{\max imum\ head\ length} * 100 \qquad \ldots \qquad (14)$$

Depending upon the ranges of these indices, head types are classified according to Williams et al., 1995 and Panero, 1979(14)[29] .

The most important dimensions of cephalometric are length and width of the head; these dimensions are used to determine cephalic index. Tables (8 and 9) show the results obtained through this study for males and females of the Iraqi community.

the frequency and percentage % of head phenotypes for males and females of the Iraqi community as shown in table- (12 and 13).

By applying the algorithm used in this study on all samples, accurate results were obtained.The rate of cephalic index is slightly more in males than females of Iraqi community as shown in table- (14 and 15).

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The cephalic index score for the shape of the head of Iraqi community is distinguished as ***Mesocephalic.***

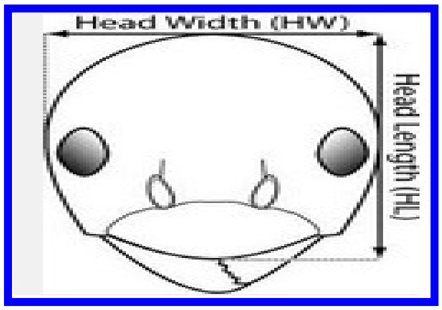

Figure (13): shows how to calculate the length and width for the head from which the cephalic index score is obtained

Table(11): show the score of cephalic index and with definitions, Index was determined on the basis of international descriptions (Williams et al., 1995).

Head shape	Range of Cephalic Index (CI) (%)	Meaning
dolichocephalic	< 74.9	Long head type: An index of less than 75 means that the skull is long and narrow when seen from the top; such skulls are called dolichocephalic and are typical of Australian aborigines and native southern Africans.
mesocephalic	75 - 79.9	Medium head type: An index of 75 to 80 means that the skull is nearly oval; such skulls are called mesaticephalic and are typical of Europeans and the Chinese.
brachycephalic	80 - 84.9	Short head type: skull having an index of over 80 to 85 is short, and is called brachycephalic;
Hyperbrachycephalic	85 - 89.9	Very short broad head type: such skulls are common among Mongolians and the Andaman Islanders.

Table (12) : Show The Frequency And Percentage (%)of Head Phenotypes Among The 120 Iraqi Males (17- 32) Years .

Head shape	Frequency	%
Dolichocephalic	22	18.4
Mesocephalic	85	70.8
Brachycephalic	12	10
Hyperbrachycephalic	1	0.8
TOTAL	120	100

Table (13): Show the Frequency And Percentage (%) of Head Phenotypes Among The 100 Iraqi females (17- 32) Years.

Head shape	Frequency	%
Dolichocephalic	8	8
Mesocephalic	67	67
Brachycephalic	24	24
Hyperbrachycephalic	1	1
TOTAL	100	100

Table(14): showing the incidence of Cephalic Index for Iraqi females

No.	Cephalic Index	No.	Cephalic Index
N0.1	73	N0.41	80
N0.4	79	N0.43	75
N0.6	73	N0.46	69
N0.10	77	N0.47	76
N0.12	76	N0.48	75
N0.14	67	N0.49	76
N0.16	78	N0.50	68
N0. 18	77	N0.53	82
N0.20	80	N0.56	80
N0.21	71	N0.58	79
N0.23	75	N0.60	77
N0.25	73	N0.63	75
N0.27	74	N0.66	74
N0.28	74	N0.69	81
N0.30	82	N0.72	75
N0.32	66	N0.78	76
N0.34	74	N0.80	77
N0.35	75	N0.89	79
N0.37	75	N0.92	72
N0.39	71	N0.94	75
N0.40	82	N0.99	77
The mean of cephalic index for Iraqi females was 75.15			

Table (15): showing the incidence of Cephalic Index for Iraqi males

No.	Cephalic Index	No.	Cephalic Index
N0.1	65	N0.36	93
N0.2	92	N0.37	91
N0.3	72	N0.38	80
N0.4	90	N0.40	79
N0.5	88	N0.44	78
N0.6	82	N0.48	73
N0.7	95	N0.50	68
N0. 8	70	N0.55	84
N0.9	81	N0.58	88
N0.10	80	N0.60	79
N0.11	77	N0.63	77
N0.12	73	N0.66	75
N0.13	74	N0.69	65
N0.14	71	N0.70	88
N0.15	85	N0.75	92
N0.16	66	N0.80	84
N0.30	71	N0.87	81
N0.31	75	N0.90	77
N0.32	73	N0.93	72
N0.33	64	N0.97	75
N0.35	82	N0.102	77
The mean of cephalic index for Iraqi males was 79.01			

CONCLUSIONS:

From the results obtained of this research, the following are concluded:

1. Comparision results with this study for Iraqi population according to Jarabak's analysis

- cephalometric measurements for the iraqi males sample as compared to Jarabak's norms differences in the anterior cranial base (S-N) length, mandibular length(GO-ME) , lower gonial angle (N-GO-ME) , The posterior cranial base length S-AR, ramus height AR-GO, and anterior facial height N-ME in iraqi males were significantly greater than Jarabak's norms .
- The standard division in Iraqi males were significantly greater than Jarabak's norms .
- The posterior facial height (S-GO),the (articular angle) S-AR-GO, Jarback% (Facial Proportion), in iraqi males was significantly lower than Jarabak's norms .
- cephalometric measurements for the iraqi female sample as compared to Jarabak's norms , An increase in the values for each of the following lengths and angles :-

In the anterior cranial base (S-N) length, in the mandibular length(GO-ME) , in the upper gonial angle AR-GO-N, in the lower gonial angle (N-GO-ME) , in the posterior cranial base length S-AR,in the saddle angle (N-S-AR) and anterior facial height N-ME. in iraqi females were significantly greater than Jarabak's norms .

- The ramus height AR-GO,posterior facial height (S-GO), articular angle (S-AR-GO),gonial angle(AR-GO-ME), Jarback% (Facial Proportion) in Iraqi females was significantly lower than Jarabak's norms .
- Comparison of cephalometric measurements between males and females adults' Iraqis sample according to Jarabak's norms , they were differences in the, mandibular length(GO-ME) , The posterior cranial base length S-AR , articular angle (S-AR-GO) and lower gonial angle (N-GO-ME) , in iraqi females were significantly greater than Iraqi males .
- The anterior cranial base (S-N) , anterior facial height N-ME ,length ramus height AR-GO,posterior facial height (S-GO), saddle angle (N-S-AR) , gonial angle (AR-GO-ME) and Jarback% (Facial Proportion) in Iraqi Females was significantly lower than Iraqi males .
- There was no difference on the value of the upper gonial angle (AR-GO-N) Between males and females adults' Iraqis sample according to Jarabak's Norms and remained on what value it.
- The comparisons of iraqi male and female measurements showed significant differences in the anterior and posterior cranial base lengths. Additionally, iraqi males have significantly greater anterior and posterior facial height. There are no gender differences in reading.This study confirms the notion that iraqi males and females have distinct craniofacial features. The comparisons showed that Iraqis do not have the emergence of the teeth in the jaws.
- The posterior facial height (S-GO) , the articular angle(S-AR-GO), Jarback% (Facial Proportion), in iraqi males was significantly lower than Brazilian people according to Jarabak's norms .
- The rate of cephalic index for Iraqi males simple Increase than the rate of cephalic index for females.The mean cephalic indices in Iraqi male and Iraqi females were found to be 79.45 And 74.34 respectively as shown as in Tables 8 - 9.Thus, we get the value of cephalic index score and through him; we can distinguish the shape of the head for Iraqi community was ***Mesocephalic.***

2. Comparision results with this study for iraqi males with the results of the Saudi Arabian males

- The Comparison of cephalometric measurements between adults' Iraqis males sample with the results of the Saudi Arabian males analysis according to Jarabak's norms . they were differences in the:-

lower gonial angle (N- GO-ME, gonial angle (AR-GO-ME), anterior cranial base (S-N) , anterior facial height N-ME , length ramus height AR-GO, the upper gonial angle AR-GO-N, saddle angle (N-S-AR), in iraqi males were significantly greater than Saudi Arabian males .

- The posterior cranial base length S-AR, posterior facial height (S-GO), articular angle (S-AR-GO), Jarback%(Facial Proportion) in Iraqi Females was significantly lower than Iraqi males .There was no difference on the value of mandibular length (GO-ME), and remained on what value it.
- The high values of standard deviations for the Iraqi people, compared with the Saudi people.
- The measurements for anterior and posterior facial heights Iraqi population much less (face height ratio 44.8211%) than Jarabak's analysis(face height ratio 65.039%) . The result of the measurement for anterior and posterior facial heights differs from the measurements of the Saudi population, where the results of the Iraqi population (face height ratio 44.8211%) were much lower than the Saudi population (face height ratio 64.281%).

3. Compare the results of this study for iraqi males with the results of the Brazilian people community

- cephalometric measurements for the iraqi males sample as compared to Brazilian people according to Jarabak's norms differences in the anterior cranial base (S-N) length, mandibular length(GO-ME) , lower gonial angle (N-GO-ME) .

Analysis of the results and explained by charts

- An analysis of the results that have been obtained from Table (6) Comparison between Iraqi males and females according to Jarabak's Analysis. As shown as in Figure (15).

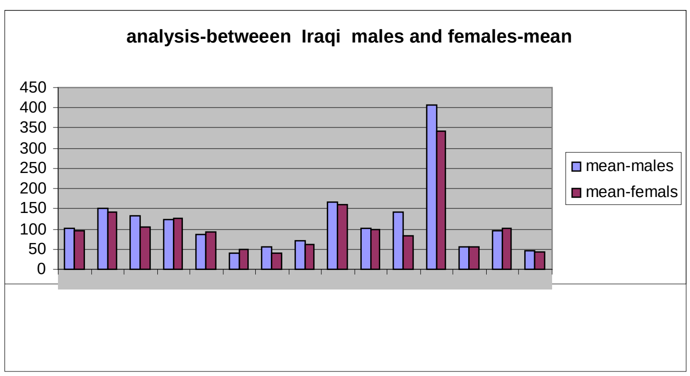

Figure (15): shows Cephalometric Means between Iraqi males and females according to Jarabak's Analysis

- An analysis of the results that have been obtained from Table (8) Comparison between Iraqi males and the results of the Saudi Arabian males according to Jarabak's analysis.As shown as in Figure (16).

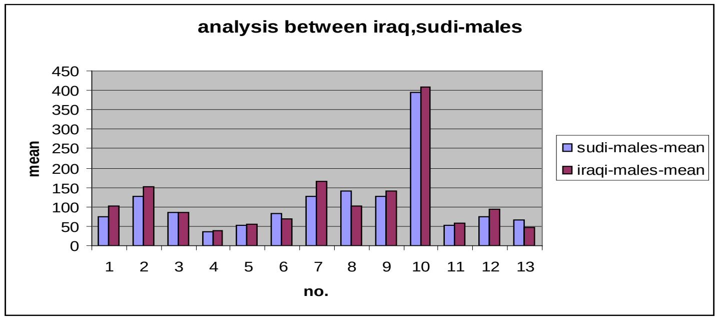

Figure (16): Cephalometric Means between Iraqi males and the results of the Saudi Arabian males according to Jarabak's analysis.

- An analysis of the results that have been obtained from Table (7). Comparison Of
- Cephalometric Means between Iraqi males and Brazilian community according to Jarabak's Analysis..As shown as in Figure (17).

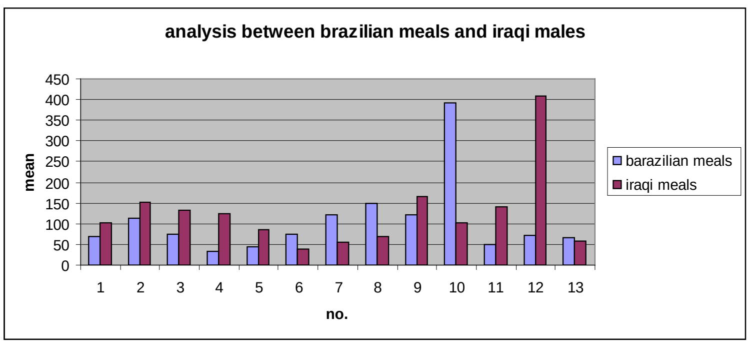

Figure (17): Cephalometric Means between Iraqi males and the results of Brazilian community according to Jarabak's analysis.

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