# SEX AND STATURE DETERMINATION FROM MAXILLO-FACIAL ANTHROPOMETRY IN AN ADULT EGYPTIAN POPULATION SAMPLE

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**ABSTRACT:**

**Background:** For establishing identity, sex and stature are important parameters in medico-legal examination. It becomes difficult to identify the deceased, when extremely decomposed and mutilated dead bodies with fragmentary remains are brought for postmortem examination. Sometimes, cephalo-facial remains are brought in for forensic examination. In such a situation, sex determination and stature estimation become equally essential along with other parameters like age and race.

**Aim:** The present research attempts to determine sex and estimate stature from various six maxillofacial anthropometric measurements in Egyptian individuals.

**Participants and methods:** The study was prospectively conducted from the start of September 2016 to the end of October 2016 in the Department of Forensic Medicine, Faculty of Medicine MUST University. A total of 227 healthy participants were Egyptian medical students and members of the university, comprising 118 males and 109 females, in the age group of 18 to 40 years. The height of all subjects was measured by an anthropometric rod, and facial measurements were taken using a sliding caliper. Data were subjected to statistical analysis like Indices of separation (d/s) and the probability of correct sex determination, Karl Pearson's correlation coefficient (r) and multiple regression analysis was done to calculate the best equation in the determination of sex and estimation of stature.

**Results:** The average height of males and females was 171.6 (± 6.3) cm and 159.2 (± 5.7) cm respectively. The results showed that the differences between all male and female variables exhibited statistically significant differences ($P < 0.001$). Also, it indicated that all the maxillo-facial measurements were positively correlated ($p < 0.001$) with stature.

**Conclusions:** Maxillofacial measurements were significantly related to gender and higher in males. Also, the use of measurements in stature estimation calculated by regression analysis was successful. So, we can conclude that regression models generated from facial measurements can be a supplementary approach for the prediction of sex and estimation of stature when extremities are not available.

**Keywords:** Forensic examination, Stature estimation, sex determination, maxillo-facial anthropometry, Egyptian individuals.

## INTRODUCTION

For establishing identity, sex and stature are crucial elements in forensic examination either in the living or dead. Highly decayed bodies or fragmentary remains may be subjected to medico-legal investigation **(Ozaslan, et al 2003).** Body parts exhibit constant ratios in relation to the stature. The body parts correlation with statue are age, sex and race dependable **(Jantz and Jantz, 1999; Williams et al.,**

**2000; Ozden et al., 2005 and Pelin et al. 2005).**

Many researchers used different bones of the human skeleton for stature reconstruction with varying degree of precision **(Raxter et al., 2008).**

Body parts such as extremities, arm, leg, fingers, toes, feet, and vertebral column have a definitive biological correlation with stature **(Mendonca,2000; Bidmos and Asala, 2005; Nagesh, and Pradeep 2006; Pal et al., 2016; and Ibrahim et al., 2018).** For forensic examination, all body parts and bones are not always accessible; therefore, it becomes mandatory to utilize other body parts like cranium and face region. Sometimes only the head or facial remains are brought for investigation. Under such circumstances, it is crucial to determine the identity of the decedent. Few researches have been done on the maxillo-facial region concerning the estimation of stature and to a lesser number of studies on face alone **(Turner et al., 2005; Iscan, 2005, Kumar and Chandra, 2006; Kalia et al., 2008).**

Craniofacial anthropometry comprises a fundamental part of forensic anthropology. Subsequently, it is used for the determination of the identity descriptions of the head and face. Sex, race, origin, weather, socio-economic, dietetic, and genetic factors are the determinant factors for face shape and size. Facial parameters determination is of colossal importance for the assessment of traumatic deformities of the face and congenital anomalies **(Oladipo et al., 2009).** Facial anthropometry has become a valuable tool used in identification, genetic counseling, reconstructive surgery, and forensic investigation **(Olotu et al., 2009).**

It is known that each race needs its verdict for stature estimation, hence findings of studies performed in one population cannot be employed on other populations completely. Researchers all around the world extensively used two methods, i.e., regression and multiplication methods, for the purpose of sex and stature estimation from body parts. Thus, it has been generally concluded that the regression analysis offers a better solution for sex determination and stature reconstruction. **(Krishan, 2008a).**

The improvement of models to predict sex and stature from anthropometric data in different ethnic groups are necessary because there is a great need for population-specific studies on stature estimations **(Celbis and Agritmis, 2006).** Considering this fact, there is a demand for maxillo-facial anthropometric measurements from this area.

## AIM OF THE STUDY

The current research designed, to determine sex and estimate stature of Egyptian individuals by measuring six maxillo-facial variables with the help of regression function analysis.

## MATERIALS & METHODS

### Ethical Approval

In order to carry out this study, ethical approval was obtained from the Ethics Committee of the Medicine College at MUST. (Misr University for Science and technology).

### Oral Consent

First, the measurements procedures and the research purpose were explained to the participants through conversation, and they were free to accept or refuse. All participants received a guarantee of preservation of their personal information, anonymity throughout the measurements and the right to withdraw, at any stage for any reason.

### Study Design

The current study was a prospective cross-sectional study, conducted on 227 medical students and members (doctors and employee) of the university.

The study was accomplished at Misr University for Science and Technology during the study day, and measurements were performed at the forensic department, Faculty of Medicine. It was a prospective study lasted two month period (from the first of September 2016 to the end of October 2016). For the purpose of eliminating differences, as a result of diurnal variation, the three authors took the whole measurements two times (in the same manner and under the same settings) at a fixed period between 12 to 3 pm. The mean value was recorded as a final measurement.

**Study population**

The participants randomly selected were in the age group between 18 and 40 years, included 118 adult males and 109 adult females. Exclusion criteria included past and present maxillofacial injuries, head deformities or facial scars. Healthy people only without physical bodily deformity were enrolled into the research study.

**Study tools**

The stature measurements were performed with the aid of manual anthropometric rod attached to the weight scale. The six maxillofacial measurements were obtained by the use of the sliding digital caliper to the nearest 0.1 cm without ruling out soft tissue thickness (permissible error of 1 mm).

Anthropometric measurement protocol:

The participant was asked to stand barefoot in the erect posture on the flat base of the weight scale with her\his heels together. The head oriented in the Frankfurt Horizontal Plane (The anatomical skull position, based on a path passing through the lower margin of the orbit and the upper margin of external auditory meatus). Also, the participant was asked to stretch upward to the fullest extent, the person’s back must be as straight as possible. The anthropometer bar transverse arm is dropped down on to the person's head. Then, the measurement was taken as the vertical distance between the vertex to the flat base of the weight scale in centimeters. The six maxillo-facial measurements were recorded for each participant. The entrants were in a relaxed sitting position, with the head in the anatomical plane. The whole measurements were taken according to the landmarks and procedures. (Lohman et al., 1988, Ulijaszek and Kerr 1999; Hall et al., 2003 and Krishan, 2007)

Landmark points used in measuring (Fig. 1):

- N– Nasion: the midpoint of the nasofrontal suture;
- Sn--Naso-spinal is the point where the line drawn between the inferior margins of the right and left nostrils intersects the midsagittal plane (Point of the nasal septum and the upper lip Junction).
- Gn – gnation: the lowest median point on the inferior margin of the mandible.
- Zygion: the maximum lateral point on the zygomatic arch.

**Vertical Parameters (Table 1):**

1- Morphological facial height (MFH): It is the straight vertical distance between the root of the nose (nasion) and the lowest point on the inferior border of the chin in the midsagittal plane (gnathion). The fixed end of the caliper was positioned at the person's gnathion, and the movable end was relocated and placed on the nasion. The subject should be looking straight ahead. (also called total facial height =TFH).

2- Nasal height (NH): The vertical straight distance between the Nasion and the Nasospinale.

3- Physiognomic ear height: It was standardized dimension from the upper aspect (supra-aurale) of the external ear to its lower aspect (sub-aurale).

**Horizontal Parameters (Table 1):**

1- Nasal breadth: It is the distance between the two most lateral points of the ala nasi.

2- Physiognomic ear breadth; It is the maximum width, measured from the front aspect (pre-aurale) to the backside aspect (post-aurale) of the external ear.

3- The bizygomatic breadth of the face: it is the horizontal distance between the two zygomatic prominences (zy-zy). (Also called maximum facial breadth (MFB)).

After palpation (by fingers) to locate the most lateral point of the zygomatic arch (arcus zygomaticus) on both sides of the face, both ends of the digital spreading caliper were placed at these points, with sufficient pressure to feel the bone under it. The caliper was then slightly moved up and down until the maximum value indicated. (Weiner and Lourie, 1981; Williams et al. 2000; and Krishan and Kumar, 2007).

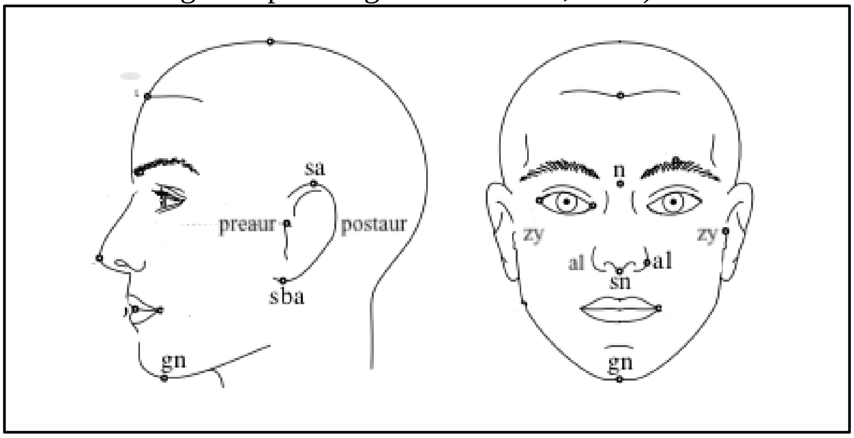


**Figure 1:** Anthropometric land marks of the face. (Farkas, 1994).

**Table 1:** Anthropometric measurements and landmarks used in the study

| Measurements | Landmarks | | |
|---|---|---|---|
| | Beginning | Ending | |
| Morphological facial height (MFH) | Nasion | gnathion | N-Gn |
| Nasal height (NH) | Nasion | Nasospinale subnasale | N--Sn |
| Physiognomic ear height | Supra aurale | subaurale | Sa – sba |
| Nasal breadth | Left ala nasi | Right ala nasi | Lt al- rt al |
| Physiognomic ear breadth | preaurale | Postaurale | Preaur- postaur |
| bizygomatic facial breadth (BFB) | Left zygoma | Right zygoma | Zy- Zy |

**Statistical consideration:**

After data collection, all records were analyzed by the Statistical Package for Social Sciences (SPSS) software on Windows XP-Professional. The variables subjected to statistics like:

1. Descriptive statistics were done and presented as means, standard deviations, and pooled standard deviations.

2. The index of separation (d/s) between males and females was calculated using the formula: d/s = $\frac{Male\ mean - \ female\ mean}{Pooled\ standard\ deviation}$

3. The probability of correct sex determination.

4. Karl Pearson's correlation coefficient (r) were analyzed to know the relationship between stature and the maxillofacial measurements.

5. In order to increase the degree of separation as much as possible, some of the variables were combined with multiple regression. This was done, both using all

the measurements on any one individual measure and by using a single measurement on all the different items.

To predict the stature of the subject multiple logistic regression analysis was done to calculate the best equation in the estimation of stature.

## RESULTS

**Gender-based Descriptive statistics:**

The study entails of 227 healthy participants consisting of 118 males and 109 females. **Table (2)** represents the descriptive statistics for the six data measurements (means, standard deviations, the value of stature and maxillo-facial anthropometric measurements and t-test of the adult males and females.

**Anthropometric measurements and Gender determination results:**

In the sample, the average height of the males and females was 171.6 (± 6.3) cm and 159.2 (± 5.7) cm respectively. The findings displayed that the differences between all male and female variables exhibited statistically significant differences ($P < 0.001$). Also, measurements were significantly higher in males as compared to females. **(Table: 2)**

By using Indices of separation (d/s) and the probability of correct sex determination p (CSD) produced by regression analysis for each of the six measurements, it was found that best measurement for sex determination was ear breadth. Coming next was nasal breadth then ear height and nasal height with the same rank, maximum facial breadth, and morphological facial height respectively in order. **(Table: 3)**

Moreover, by using regression analysis, it was found that there were four regression models for different measurement in sex determination as shown in **Table (4).**

The best equation was:

Y = 5.596 – (0.017* nasal Breadth)-(0.022* Morph. Facial1)-(0.015*ear ht)

If Y < 1.5 it was male

If Y > 1.5 it was female

With Accuracy 82.5%.

**Anthropometric measurements and Stature detailed findings:**

**Table (5) showing the** comparison of correlation coefficient (r) value of different variables with stature. It was found that morphological facial height and bizygomatic facial breadth were the highly correlated parameter to stature estimation in males. While the morphological facial height and nasal height showed the highest correlated parameters in females.

**The regression equations** for stature estimation in males and females were derived and shown in **Table (6) & (7).** Multiple equations were generated using more than one facial parameter.

**Table (6)** shows that there were five models with different combination measurements used to determine stature in males. The best equation used in the calculation of stature was:

Stature = 77.721+ (0.263* Morphological facial height) + (0.571* bizygomatic facial breadth)

With accuracy 92.8%

**Table (7)** demonstrates that there were also five models for different measurements in the determination of stature in females. The best equation in the detection of stature was:

Stature = 89.267+ (0.563* Morphological Facial height) + (0.121* Ear Height)

With accuracy 95.8%.

**Table (2):** Gender-based Descriptive statistics regarding different measurements among adult Egyptians sample.

| | | N | Mean | S.D. | Min. | Max. | t-test | p |
|---|---|---|---|---|---|---|---|---|
| Nasal Height | Male | 118 | 52.4 | 4.9 | 41.9 | 66.9 | 6.720 | .0001* |
| | Female | 109 | 49.3 | 5.0 | 34.4 | 57.1 | | |
| | Total | 227 | 50.9 | 5.2 | 34.4 | 66.9 | | |
| Nasal Breadth | Male | 118 | 38.7 | 3.7 | 23.4 | 47.4 | 4.349 | .001* |
| | Female | 109 | 37.2 | 3.4 | 30.1 | 44.5 | | |
| | Total | 227 | 38.0 | 3.6 | 23.4 | 47.4 | | |
| Morph. Facial Height | Male | 118 | 119.1 | 8.4 | 97.6 | 136.4 | 8.288 | .0001* |
| | Female | 109 | 110.7 | 8.6 | 64.0 | 124.9 | | |
| | Total | 227 | 115.1 | 9.5 | 64.0 | 136.4 | | |
| Ear Height | Male | 118 | 64.9 | 5.6 | 55.0 | 84.5 | 3.630 | .001* |
| | Female | 109 | 62.7 | 4.5 | 45.5 | 72.0 | | |
| | Total | 227 | 63.9 | 5.2 | 45.5 | 84.5 | | |
| Ear breadth | Male | 118 | 31.2 | 3.3 | 22.5 | 38.5 | 1.895 | .016* |
| | Female | 109 | 30.1 | 3.3 | 20.6 | 37.1 | | |
| | Total | 227 | 30.7 | 3.3 | 20.6 | 38.5 | | |
| Bizy. fac. breadth | Male | 118 | 109.7 | 7.1 | 94.6 | 126.1 | 8.768 | .0001* |
| | Female | 109 | 104.9 | 5.8 | 88.5 | 121.5 | | |
| | Total | 227 | 107.4 | 6.9 | 88.5 | 126.1 | | |
| Stature | Male | 118 | 171.6 | 6.3 | 160.0 | 184.0 | 12.209 | .0001* |
| | Female | 109 | 159.2 | 5.7 | 143.0 | 175.0 | | |
| | Total | 227 | 165.6 | 8.7 | 143.0 | 184.0 | | |

*: Statistically significant at $p \leq 0.001$

**Table (3):** Indices of separation (d/s) and the probability of correct sex determination P (CSD) produced by regression analysis for each measurement.

| | d/s | P (CSD)% |
|---|---|---|
| Nasal Height | 1.73 | 89.0 |
| Nasal Breadth | 2.50 | 92.00 |
| Morph. Facial Height | 0.95 | 68.0 |
| Ear Height | 1.73 | 89.0 |
| Ear breadth | 2.73 | 100.0 |
| Bizy. facial breadth | 1.30 | 77.0 |

**Table (4):** Regression analysis models for sex determination among the studied group by using different measurements.

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 5.467 | .589 | | 9.283 | .0001 |
| | nasal HT | -.008- | .007 | -.086- | -1.141- | .255 |
| | nasal Breadth | -.018- | .008 | -.129- | -2.098- | .037 |
| | Morph. Facial ht | -.024- | .006 | -.461- | -4.391- | .0001 |
| | Ear Ht | -.018- | .006 | -.186- | -3.088- | .002 |
| | Ear breadth | .019 | .010 | .125 | 1.809 | .072 |
| | bizy fac | .004 | .007 | .060 | .615 | .539 |
| 2 | (Constant) | 5.621 | .532 | | 10.571 | .0001 |
| | nasal HT | -.008- | .007 | -.083- | -1.111- | .268 |
| | nasal Breadth | -.017- | .008 | -.125- | -2.049- | .042 |
| | Morph. Facial ht | -.022- | .004 | -.414- | -5.710- | .0001 |
| | Ear Ht | -.018- | .006 | -.186- | -3.088- | .002 |
| | Ear breadth | .019 | .010 | .125 | 1.806 | .072 |
| 3 | (Constant) | 5.546 | .528 | | 10.510 | .0001 |
| | nasal Breadth | -.019- | .008 | -.139- | -2.308- | .022 |
| | Morph. Facial ht | -.024- | .003 | -.451- | -6.981- | .0001 |
| | Ear Ht | -.017- | .006 | -.177- | -2.970- | .003 |
| | Ear breadth | .016 | .010 | .104 | 1.567 | .119 |
| 4 | (Constant) | 5.596 | .529 | | 10.588 | .0001 |
| | nasal Breadth | -.017- | .008 | -.123- | -2.075- | .039 |
| | Morph. Facial Ht | -.022- | .003 | -.410- | -6.919- | .0001 |
| | Ear Ht | -.015- | .006 | -.161- | -2.728- | .007 |

**Table (5):** Correlation coefficient of different measurement used for sex determination.

| Stature# | **Male** | | **Female** | |
|---|---|---|---|---|
| | **r** | **p** | **r** | **p** |
| Nasal HT | .291** | .001 | .660** | .000 |
| Nasal Breadth | .060 | .517 | .211* | .028 |
| Morph. Facial Ht | .976** | .000 | .864** | .000 |
| Ear Ht | -.152- | .101 | .248** | .009 |
| Ear breadth | .371** | .000 | .427** | .000 |
| Bizy fac. breadth | .981** | .000 | .424** | .000 |

**Correlation is significant

**Table (6):** Regression analysis models for stature determination in males.

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 77.994 | 2.831 | | 27.546 | .0001 |
| | Nasal HT | -.031- | .027 | -.024- | -1.173- | .243 |
| | Nasal Breadth | .045 | .033 | .026 | 1.358 | .177 |
| | Morph. Facial ht | .303 | .077 | .404 | 3.927 | .0001 |
| | Ear Ht | -.010- | .021 | -.009- | -.458- | .648 |
| | Ear breadth | .017 | .042 | .009 | .394 | .694 |
| | Bizy. fac breadth | .524 | .093 | .585 | 5.614 | .0001 |
| 2 | (Constant) | 77.700 | 2.721 | | 28.559 | .0001 |
| | Nasal HT | -.028- | .025 | -.022- | -1.109- | .270 |
| | Nasal Breadth | .049 | .032 | .028 | 1.553 | .123 |
| | Morph. Facial ht | .296 | .074 | .394 | 3.974 | .0001 |
| | Ear Ht | -.008- | .020 | -.007- | -.371- | .711 |
| | Bizy. fac breadth | .536 | .088 | .598 | 6.076 | .0001 |
| 3 | (Constant) | 77.066 | 2.109 | | 36.546 | .0001 |
| | Nasal HT | -.026- | .024 | -.020- | -1.053- | .294 |
| | Nasal Breadth | .048 | .031 | .028 | 1.526 | .130 |
| | Morph. Facial ht | .294 | .074 | .391 | 3.972 | .0001 |
| | Bizy. fac breadth | .538 | .087 | .601 | 6.157 | .0001 |
| 4 | (Constant) | 76.516 | 2.044 | | 37.434 | .0001 |
| | Nasal Breadth | .038 | .030 | .022 | 1.277 | .204 |
| | Morph. Facial ht | .280 | .073 | .372 | 3.844 | .0001 |
| | Bizy fac breadth | .550 | .087 | .614 | 6.328 | .0001 |
| 5 | (Constant) | 77.721 | 1.818 | | 42.753 | .0001 |
| | Morph. Facial ht | .263 | .072 | .350 | 3.662 | .0001 |
| | Bizy. fac breadth | .571 | .086 | .637 | 6.673 | .0001 |

**Table (7):** Regression analysis models for stature determination in females

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 92.287 | 6.015 | | 15.343 | .0001 |
| | Nasal HT | .165 | .085 | .145 | 1.945 | .055 |
| | Nasal Breadth | .126 | .083 | .076 | 1.515 | .133 |
| | Morph. Facial1 | .535 | .046 | .805 | 11.640 | .0001 |
| | Ear Ht | .129 | .065 | .102 | 1.973 | .051 |
| | Ear breadth | -.055- | .103 | -.031- | -.534- | .595 |
| | Bizy. fac | -.110- | .062 | -.112- | -1.792- | .076 |
| 2 | (Constant) | 91.851 | 5.938 | | 15.468 | .0001 |
| | Nasal HT | .154 | .082 | .136 | 1.878 | .063 |
| | Nasal Breadth | .134 | .082 | .080 | 1.631 | .106 |
| | Morph. Facial1 | .529 | .044 | .795 | 11.943 | .0001 |
| | Ear Ht | .119 | .062 | .094 | 1.906 | .059 |
| | Bizy. fac | -.107- | .061 | -.108- | -1.751- | .083 |
| 3 | (Constant) | 94.296 | 5.791 | | 16.282 | .0001 |
| | Nasal HT | .158 | .083 | .139 | 1.916 | .058 |
| | Morph. Facial1 | .528 | .045 | .795 | 11.839 | .0001 |
| | Ear Ht | .128 | .062 | .102 | 2.055 | .042 |
| | Bizy. fac | -.090- | .061 | -.091- | -1.487- | .140 |
| 4 | (Constant) | 89.345 | 4.766 | | 18.748 | .0001 |
| | Nasal HT | .110 | .076 | .097 | 1.438 | .153 |
| | Morph. Facial1 | .519 | .044 | .781 | 11.679 | .0001 |
| | Ear Ht | .111 | .062 | .088 | 1.803 | .074 |
| 5 | (Constant) | 89.267 | 4.789 | | 18.639 | .0001 |
| | Morph. Facial1 | .563 | .032 | .847 | 17.331 | .0001 |
| | Ear Ht | .121 | .062 | .096 | 1.972 | .05 |

## DISCUSSION

Occasionally only the head or facial remains are carried for medico-legal investigation, and it produces obstacles in identification. Under such conditions, it is vital to ascertain the identity of the decedent. For determining the individuality at crime or disaster scene, sex and stature are essential parameters. **(Jasuja and Singh, 2004 ; Zeybek et al., 2008 and Ruff et al., 2012)**

While many research articles have been done for gender and stature evaluation from percutaneous measurements of multiple body parts such as fingers, arms, legs, feet, and toes, few studies are available for the same aim from face alone. **(Kumar and Chandra.2006; Eftekhar-Vaghefi et al., 2014 and Mohammed et al., 2018)**

Thus, there was a crucial necessity to explore whether any possible significant correlation exists between stature and maxillofacial anthropometric measurements. Considering this fact, the existent study aimed to determine sex and estimate stature from maxillofacial measurements in a sample of Egyptians. In an attempt to provide regression equations that are particular for Egyptian people to be used whenever stature reconstruction is needed as a means of human identification in cases of disasters for victim profiling.

**The findings of the current study** showed that there was a statistically significant difference between all male and female variables, where, the whole measurements were significantly higher in males than females. Moreover, the correct sex determination was best done using ear breadth and nasal breadth. The regression model used the nasal breadth, morphological facial height, and ear height with high success rate.

The present findings could be explained by sexual dimorphism, which usually relates to the differences in morphology (size and shape), physiology and behavior between both sexes. Significant gender differences pervade human anthropometry from the chromosomal elements that dictate phenotypic expression, to the apparent differences in anatomical structure and adipose tissue distribution. **(Byers, 2005)**

In forensic anthropology, morphological and metric differences are beneficial for sex determination. Differences in size, shape, and skeletal robusticity display a degree of sexual dimorphism. These differences reflect the fact that females are smaller, less muscular and more gracile, while males usually have more muscle mass. Also, these findings explained that the overall size of female faces is smaller than males. However, methods based on morphometry are more objective and accurate than the morphological methods, therefore can be used in the sex determination to limit the probability of identification to 50% **(Sumati et al. 2010; Spradley and Jantz, 2011; Aleman et al., 2013)**.

There are substantial works of literature that describe sex determination by the anthropometric method in diverse regions of the world. These studies described a significant difference in size of the skull among both sexes, and therefore all discriminant function models for sex assessment were population-specific **( Kaptanoglu and Ozedmir, 2001; Patil and Mody, 2005; Jeremić et al., 2012; Ali and Al-Nakib, 2013; Amin and Othman, 2015).** However, sex determination studies from maxillofacial parameters in Egyptian population were insufficient.

By the same token for sex determination, **Altayeb et al., (2001),** selected three variables as the best discriminant between both sexes: the glabello-occipital length, the basion-nasion height, and basion-bregma length. Their findings differed with **the present study**, where ear breadth and nasal breadth were selected for correct sex determination while in the regression model together with morphological facial height formed the best equation. Also, **Altayeb et al. (2001**) used complete cranium, not percutaneous measurements as done in this study.

***By Comparing the present results*** with those of **Sagar and Nath (2014)**, who conducted a study on Jatavs population of Delhi and using the same sliding caliper, it was found that Jatavs males exhibit greater dimensions for nasal breadth, head length, and head breadth than the females. This was consistent with our results. However, in contrast to the present study, the remaining measurements as nasal height and ear length, the females have greater dimensions. Also, it was observed that the sex difference was significant only for the head breadth and ear Length whereas the remaining measurement exhibited non-significant sex difference.

***In the light of the current findings***, regarding stature estimation and by comparing correlation coefficient (r) values for the whole measurements, results revealed that morphological facial height and bizygomatic facial breadth in males and together with nasal height in females were the highly correlated parameters to stature.

This correlation could be explained on the ground that the local epigenetic factors, such as the brain growth, genetically control and determine the growth of the skull (related to the maxillo-facial measurements). Moreover, these measurements are varied from one person to another due to several factors such as age, sex, ethnicity, nutrition, environmental conditions, and soft-tissue matrices. As the stature of an individual is also genetically determined by the same factors; therefore, there must be some correlation between the maxillo-facial measurements and the stature. (**Rexhepi and Brestovci, 2015)**

The technique of facial anthropometric parameters usage has some benefits as the method is simple; the anatomical points are standard, distinct and need no effort to find with the simplest instrument. The drawback is that the variables may have an irrelevant relationship in comparison with bare bony measurements since the study is conducted with intact soft tissues covering the face **(Kanchankumar et al., 2012).** However, this study assumes implication when the body is fragmented into various segments, or only isolated head and face is offered for forensic examination. Concerning old studies done about stature estimation from cephalometry of skull bones, literature showed many studies relating skull dimensions to stature. **(Introna et al., 1993; Chiba and Terazawa 1998; Ryan and Bidmos, 2007).**

***The current findings*** are supported by **Pelin et al., (2005),** who observed that out of 14 measurements, only three cephalo-facial variables such as horizontal head circumference, nasal width, and morphological facial height observed as significant predictors for stature estimation among males in agreement with the current study except for the nasal height for males. While among females, the stature was best calculated by morphological facial height, bizygomatic facial width, and horizontal head circumference in descendant order. These are similar to the current results which revealed that morphological facial height (MFH) and bizygomatic facial breadth in males together with nasal height in females were the highly correlated parameters to the stature.

In contrast, earlier research by **Kumar and Chandra , (2006),** studied stature estimation by using facial variables and discovered that the highest correlation with bigonial breadth. They noted that Total Facial Height (=MFH) coming next in rank after bigonial breadth, but it was still a useful parameter to estimate stature as in the present study.

**Krishan and Kumar, (2007**), calculated regression formulations for assessment of stature from cephalo-facial measurements in adult males in north India. They observed that horizontal head circumference, maximum head height, and maximum head width give a better prediction of stature. The highest correlation coefficient is exhibited by maximum head length and the lowest by the morphological facial length in contradiction with the results of the present study where morphological facial height (MFH) showed higher correlation coefficient, but we did not corporate horizontal head circumference in our study measurements nor maximum head length. In their study, a separate equation for each cephalo-facial dimension was calculated, while we used multiple parameters for each model.

In Sri Lankans, a similar study using a digital sliding caliper designed to investigate the relationship between the cranial length and breadth, with the stature **(Ilayperuma, 2010)**. ***In agreement with the present study***, significant correlations between cranial dimensions and stature were observed, and linear regression equations for the calculation of stature were also formulated.

Similar findings to the current research were documented by **Krishan (2008b); Kharyal and Nath (2008) and Agnihotri et al. (2011)**. Their studies also demonstrated that morphological facial height (TFH) is a better parameter in males than nasal height whereas NH is a better parameter than TFH in females for estimation of stature, while in the current study morphological facial height was highly correlated in both sexes and nasal height was second in rank in the female group. The environmental, climatic or ethnic variation could be blamed for this difference.

In agreement with the present study, another research in central India provides anthropometric correlation of maxillo-facial dimensions with stature and also develops regression formulations for stature reconstruction. The findings showed that the average height of males and females were similar to our study values. Also, it was observed that in males the morphological facial height had a more significant correlation with stature. In females, nasal height had a more significant correlation with stature in agreement with the current study results, but there was a separate equation for each maxillofacial parameter **(Wankhede et al., 2012).**

***In accordance with the study results***, **Navaei et al., (2018),** recorded same three maxillofacial measurements (bizygomatic facial breadth, morphological facial height and upper facial height (equal to nasal height) in medical students from Tehran University. They found that the mean values in males were higher than females. As well, there were significant correlations between stature and all three measured variables in all subjects, males and females.

Ultimately Stature and sex can be predicted from different body measurements by using statistical models. The improvement of models to predict sex and stature from anthropometric data in different ethnic groups are necessary because there is a great need for population-specific studies on stature estimations. Forensic scientists and anthropologists can use from these findings to identify cases which just their remains are head, face or skull in Iranian population. **(Celbis, and Agritmis, 2006**)

## CONCLUSION

From the finding obtained some conclusions can be drawn as maxillofacial parameters are significantly related to gender and are higher in males. Also, stature can be predicted from numerous maxillofacial measurements similar to stature calculation from other human body parts. Thus we can infer that, when extremities are not available, regression equations produced from maxillofacial dimensions can be a supplementary approach for the stature estimation.

## RECOMMENDATIONS

Studies on a larger scale are recommended to verify whether the maxillo-facial measurements can be used for correct sex and stature determination in Egypt. The population based, gender, and age-specific regression models proposed will be of immense practical use in medico-legal, and anthropological studies if proved effectiveness

## LIMITATION OF STUDY

It must be kept in mind that the exact estimation of stature from maxillo-facial dimensions may be unattainable; there would always be an approximation inaccuracy of a few millimeters. Also this study has been conducted in Egypt that is of the same ethnic group. Therefore these formulae cannot be used on other populations of the world with a different racial group

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# تحديد الجنس والطول من قياسات الوجه والفكين للبالغين في عينة من المجتمع المصري

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**الخلفية:** لتحديد الهوية ، فان الجنس والقامة تعتبر من الضروريات في الفحص الطبي الشرعي ، عندما يتم إحضار جثث متحللة مع بقايا مجزأة لفحص ما بعد الوفاة ، يصبح من الصعب تحديد المتوفى. في بعض الأحيان ، يتم إحضار بقايا رأسيات الوجه إلى الطبيب الشرعي وفحصها بعد الوفاة. في مثل هذه الحالة ، يصبح تحديد الجنس وتقدير القامة بنفس القدر من الأهمية جنبا إلى جنب مع غيرها من المعالم مثل العمر ، العرق ، وما إلى ذلك.

**الهدف:** يحاول البحث الحالي تحديد الجنس وتقدير المكانة من القياسات البشرية الستة المختلفة في الأفراد المصريين.

**المشاركون والأساليب:** هي دراسة استباقية أجريت من بداية سبتمبر 2016 حتى نهاية أكتوبر 2016 في قسم الطب الشرعي ، كلية الطب جامعة ماست. تم أخذ ما مجموعة أصحاء 227 من طلاب الطب والعاملين بالجامعة ، من بينهم 118 من الذكور و 109 من الإناث في الفئة العمرية من 18 إلى 40 سنة. تم قياس ارتفاع القامة بواسطة قضيب جهاز القياسات الأنثروبومترية وتم أخذ قياسات الوجه باستخدام الفرجار المنزلق الالكتروني. خضعت البيانات للتحليل الإحصائي مثل مؤشرات الانفصال (D / S) واحتمالية تحديد الجنس الصحيح ، معامل ارتباط كارل بيرسون (R) وتحليل الانحدار المتعدد الذي تم القيام به لحساب أفضل معادلة في تحديد الجنس وتقدير القامة.

**النتائج:** كان متوسط الطول للذكور والإناث 171.6 (6.3 ±) سم و 159.2 (5.7 ±) سم على التوالي. أظهرت النتائج أن الفروق بين جميع المتغيرات الذكورية والانثوية أظهرت فروق ذات دلالة إحصائية .(P <0.001) كما أنه يشير إلى أن جميع قياسات الوجه تكون مرتبطة بقوة وإيجابية (P <0.001) مع القامة.

**الاستنتاجات:** كان تقدير القامة المحسوبة عن طريق تحليل الانحدار لستة قياسات للوجه مشابهًا تقريبًا للمركز الفعلي لكل من الذكور والإناث. وهكذا يمكننا أن نستنتج أن معادلات الانحدار الناتجة عن قياسات الوجه يمكن أن تكون مقاربة تكميلية لتقدير القامة عندما تكون الأطراف غير متوفرة.