# STATURE ESTIMATION USING SOME HAND VARIABLES BY X-RAY AID IN EGYPTIANS.

**Amro A. Saleh[1] and Wafaa Yousif Abdel Wahed[2]**

[1]Department of Forensic Medicine and Clinical Toxicology, Faculty of Medicine, Fayoum University
[2]Department of Public Health and community medicine, Faculty of Medicine, Fayoum University

Postal addresses: 1: Egypt –Fayoum- Fayoum University- Faculty of Medicine- Forensic medicine and Clinical Toxicology department - 4th floor. 2: Egypt –Fayoum- Fayoum University- Faculty of Medicine- Public Health department- 4th floor. wya00@fayoum.edu.eg.

Corresponding author: **Amro Saleh**

- E-mail address: saleh222008@gmail.com ,Address: Egypt –Fayoum- Fayoum University- Faculty of Medicine- Forensic medicine and Clinical Toxicology department - 4th floor. Mobile number: 00201005405895

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## ABSTRACT

**Objectives**: Stature estimation from different hand variables is vital in identifying the deceased in forensic practice. This study aims to find out if there is a correlation between a person's height and their handbreadth, length, and other measurements taken with an X-ray. **Methods:** A cross-sectional descriptive cohort study was conducted on 200 volunteers (100 males and 100 females) attending Fayoum University Hospital's radiology department from June 2021 to May 2022. The stature, hand length, and handbreadth of the left hand were measured. Finger bone length, metacarpophalangeal length, and distal phalanx length of the index, middle, ring, and little fingers were measured using X-ray films. The recorded data were analyzed by SPSS version 28. **Results:** All the measured variables of the left hand were significantly higher in males than in females. Stature was positively correlated with all measured hand variables in both sexes. Handlength, ring finger, and distal phalanx length of the ring finger showed the highest determination coefficient ($R^2$) and lowest standard error of estimate (SEE) by the linear regression model in males. However, in females, the handlength, index finger, and distal phalanx length of the index finger showed better values than other hand measurements by the linear regression model. **Conclusions:** Multiple regression equations are better than single linear regression equations for predicting stature. This finding suggests that the accuracy of stature estimation would be greater among males than females.

**Keywords:** Egyptian; Finger bone length; Hand length; Hand breadth; Stature.

## INTRODUCTION

Identification is one of the primary responsibilities of judicial research. Stature is seen as one of the essential values in forensic cases. In some murders, accidents and large-scale disasters, we discover fragmented bodies like soft tissue remains. Personal identification necessitates estimating height and identifying gender **(Akhlaghi et al., 2012).**

In medico-legal cases, stature is one of the remarkable key measures for personally identifiable information **(Warrier et al., 2022).** The relationship between various body dimensions can solve crimes without sufficient evidence. This relationship can assist a forensic scientist in determining stature from dismembered body parts **(Pal et al., 2016).**

Anthropometric methods have been utilized for height assessment from obscure and remaining skeletal parts by anthropologists and clinical researchers for quite a long time (**Kanchan et al., 2008).** It has been essential in recent times due to natural disasters like tsunamis and terror attacks, such as bomb blasts; in such cases, the forensics often opines on the deceased's identity **(Pal et al., 2016).**

Predicting the dimensions of various body segments is helpful in numerous fields of modern science. Aspects of the body and the sizes of various skeletal portions have been used for stature estimation (**Radoinova et al., 2002; Smith, 2007).**

Many studies have conducted state estimation from various body parts like the trunk, long and short bones **(Nagesh &Kumar, 2006; Rastogi et al., 2008; Giroux and Wescott, 2008; Bidmos et al., 2008).** Numerous studies have reported the relation between various upper limb dimensions and stature **(Srivastava and Sahai, 2010).**

The hand bones have been documented as suitable anthropometric parameters. In a different population, the morphometric parameters of the hand show a considerable degree of dimorphism **(Ibeachu et al., 2011)**.

Different studies focused on estimating the stature of the Egyptian population through other parameters of the body **(Abdel-Malek et al., 1990; Habib& Kamal, 2010; Paulis, 2015)**. The purpose of this study is to establish a relationship between a person's stature and their handbreadth, length, and various parameters taken with the aid of X-ray, as well as standard formulas for estimating a person's stature based on hand dimensions in residents of Fayoum, Egypt.

## MATERIALS AND METHODS:

Study design: A cross-sectional descriptive cohort study was conducted on 200 volunteers (100 males and 100 females) attending Fayoum University hospital's radiology department from June 2021 to May 2022. According to the commitment to standard operating procedure guidelines, ethical approval was obtained from the Medical Research Ethics Committee of the Faculty of Medicine – Fayoum University. Consent was obtained to follow all institutionally mandated guidelines for human-subject experimental research.

The left hands of the persons using their right hands were selected due to non-significant bilateral variation in both sexes **(Abdel-Malek et al., 1990; Krishan and Sharma, 2007)**.

**Inclusion criteria:**

- An Egyptian citizen from Fayoum city.
- Healthy males and females aged 20-35 years old.

**Exclusion criteria:**

- Any disease affects the hand.
- Trauma (recent or old) or tumours are affecting the hand.
- A current or old fracture involving the hand.
- Any deformity or amputation affecting the hand.
- Any deformity or amputation of the lower limb.
- Any deformity was affecting the vertical pattern.

**Measurements.**

The left hand: The left hand is measured in terms of its length and breadth. Handlength (HL) is the distance between the midpoints of the inter-styloid line and the middle fingertip. Handbreadth (HB) is the distance between the radial side of the second metacarpophalangeal joint (MCP) and the ulnar side of the fifth MCP joint across the palm. These measurements were taken with the hand placed on a flat surface with the palm facing upward and fingers extended and touching each other **(Ilayperuma et al., 2009; Hall et al., 2007).**

The left hand was radiographed in all subjects by a radiological technician. The subject was seated close to the X-ray table, where the forearm and hand were flat and prone on the cassette on the X-ray table with no angulations at the wrist joint.

The following parameters are measured on the X-ray film:

- ✓ The finger bone length (FBL) is the distance between the middle of the base of the proximal phalanx of the finger and the tip of the respective finger (equivalent to the end of the distal phalanx) and a medial line bisecting the finger.
- ✓ The distal phalanx length (DPL) is the distance from the base of the phalangeal bone to the centre of the tip of the same bone.
- ✓ Metacarpophalangeal bone length (MCPL): (distance from the base of the metacarpal bone to the middle of the tip of the distal phalanx), measured using an X-ray film.

All measurements were taken by steel measuring tape (cm), excluding the thumb finger.

Stature; was taken according to **Habib and Kamal, 2010** using an anthropometric rod.

Statistical analysis: The collected data were analyzed using SPSS software version 28. The correlation coefficient was used to find a significant correlation between stature and studied variables. Regression formulas were calculated for various combinations to reach the best estimate possible. For interpretation of results of significance, non-significance was adopted at $P>0.05$; significance was adopted at $P< 0.05$, and high significance was taken on at $P < 0.001$.

## RESULTS

**Table (1)** and **Table (2)** show the descriptive statistics of the stature and different anthropometric measures (cm.) the males were taller than females, with mean stature was 173.66 cm for males, vs 160.08 cm for females; these values were highly significant (P-value < 0.001). Other anthropometric measurements were more significant in males than females.

**Table (3)** demonstrates the Pearson correlation coefficient between the current study's stature and the anthropometric measurements in males and females. The correlation of the studied parameters was higher in males compared to females. It was significantly and positively correlated (P-value < 0.001) with all explanatory variables except for age, either in males or females. HL followed by FBL4, DPL4, and MCPL4 in males (r =.470, .428, .421, and .411 respectively). While, in females, HL followed by FBL2 and DPL2 (r = .343, .336, .326 respectively) showed a higher correlation than that of the other dimensions indicating a strong connection between the parameters.

**Table (4) and Table (5)** demonstrate the simple linear equations for estimating stature from all studied parameters in both sexes. The values of the standard error of estimate (SEE) are conversely corresponding to the exactness of the stature assessment model. SEE showed a slight difference between different measured variables; the highest value was HB, and the lowest was HL in both sexes (±5.55cm, ±5.02 cm for males VS ±6.44 cm, ±6.21 cm for females).

**Table (6)** presented the multiple stepwise regression equation for estimating stature from different studied parameters by x-ray in both sexes. There was much improvement in stature estimation when using more than one variable in males. Male stature could be estimated with SEE at ±4.17 cm when five measurements were used and a higher value of $R^2$ as 0.432, which was higher than any correlation coefficient by simple analysis. While in females, the DPL2 was sufficient for stature estimation.

## DISCUSSION:

Anthropometry is concerned with quantitatively assessing the human body the human body and skeleton and the correlations of height and intralimb or hand proportions. This method is broadly acknowledged for legal applications, as it is financially savvy and noninvasive **(Ahmed, 2016).** Nevertheless, its application requires normalized techniques and distinct milestones to guarantee that the information is solid and reproducible, particularly for calculating different body part parameters **(Krishan et al., 2012).**

**Wilson et al., 2010** expressed that it is fundamental for stature assessment to utilize equations based on forensic models as well as equations in view of modern examples. Subsequently, the present study aims to find a relation between the stature of a person with their handbreadth, length, and various parameters taken with the aid of X-ray, as well as standard formulas for estimating a person's stature based on hand dimensions in residents of Fayoum, Egypt.

**Table (1):** Descriptive statistics of stature and anthropometric parameters (cm) of the left Hand in both genders (Hand Length, Hand Breadth and Distal Phalanx Length).

| Left Hand | | Mean± SD | 95% Confidence Interval for Mean | | Minimum | Maximum | P value |
|---|---|---|---|---|---|---|---|
| | | | Lower Bound | Upper Bound | | | |
| Stature | Male | 173.6±5.6 | 172.5 | 174.7 | 156 | 187 | <0.001 * |
| | Female | 160.08±6.5 | 158.7 | 161.3 | 132 | 173 | |
| HL | Male | 19.1±.946 | 18.9 | 19.3 | 17.2 | 21.2 | <0.001 * |
| | Female | 17.6±.763 | 17.4 | 17.7 | 16.0 | 19.6 | |
| HB | Male | 8.9±.464 | 8.8 | 9.0 | 8.0 | 10.0 | <0.001 * |
| | Female | 8.04±.345 | 7.9 | 8.1 | 7.2 | 8.8 | |
| DPL2 | Male | 1.8±.133 | 1.8 | 1.8 | 1.6 | 2.2 | <0.001 * |
| | Female | 1.6±.115 | 1.6 | 1.6 | 1.4 | 1.9 | |
| DPL3 | Male | 1.9±.137 | 1.9 | 2.0 | 1.7 | 2.4 | <0.001 * |
| | Female | 1.7±.118 | 1.7 | 1.7 | 1.5 | 2.0 | |
| DPL4 | Male | 2.02±.156 | 1.99 | 2.0 | 1.7 | 2.5 | <0.001 * |
| | Female | 1.8±.117 | 1.7 | 1.8 | 1.5 | 2.0 | |
| DFL5 | Male | 1.8±.141 | 1.7 | 1.8 | 1.6 | 2.2 | <0.001 * |
| | Female | 1.6±.103 | 1.6 | 1.6 | 1.4 | 1.8 | |

HL= Hand length HB= Hand breadth *: Highly significant SD: Standard Deviation
DPL2= distal phalanx Index finger DPL3= distal phalanx Middle finger DPL4= distal phalanx Ring finger
distal phalanx little finger

**Table (2):** Descriptive statistics of anthropometric parameters (cm) of the left Hand in both genders (Finger Bone Length and Metacarpophalangeal Length).

| Left Hand | | Mean± SD | 95% Confidence Interval for Mean | | Minimum | Maximum | P value |
|---|---|---|---|---|---|---|---|
| | | | Lower Bound | Upper Bound | | | |
| FBL2 | Male | 8.3±.474 | 8.2 | 8.4 | 7.4 | 9.3 | <0.001* |
| | Female | 7.7±.454 | 7.6 | 7.7 | 6.7 | 8.8 | |
| FBL3 | Male | 9.5±.548 | 9.3 | 9.6 | 8.2 | 10.5 | <0.001* |
| | Female | 8.7±.491 | 8.6 | 8.8 | 7.6 | 9.7 | |
| FBL4 | Male | 9.2±.543 | 9.0 | 9.3 | 8.1 | 10.2 | <0.001* |
| | Female | 8.4±.479 | 8.3 | 8.5 | 7.4 | 9.5 | |
| FBL5 | Male | 7.3±.527 | 7.2 | 7.4 | 6.4 | 9.3 | <0.001* |
| | Female | 6.64±.423 | 6.5 | 6.7 | 5.6 | 7.9 | |
| MCPL2 | Male | 15.3±.885 | 15.2 | 15.5 | 13.8 | 17.1 | <0.001* |
| | Female | 14.3±.734 | 14.1 | 14.4 | 12.8 | 15.9 | |
| MCPL3 | Male | 16.3±.903 | 16.1 | 16.4 | 14.6 | 18.0 | <0.001* |
| | Female | 15.1±.747 | 14.9 | 15.2 | 13.3 | 16.6 | |
| MCPL4 | Male | 15.3±.907 | 15.1 | 15.4 | 13.6 | 17.2 | <0.001* |
| | Female | 14.0±.672 | 13.9 | 14.2 | 12.6 | 15.9 | |
| MCPL5 | Male | 12.8±.753 | 12.7 | 13.0 | 11.3 | 14.1 | <0.001* |
| | Female | 11.8±.576 | 11.7 | 11.9 | 10.6 | 13.1 | |

**FBL2**= Finger bone Index finger, **FBL3**= Finger bone Middle finger, **FBL4**= Finger bone Ring finger, **FBL5**= Finger bone Little finger, ***:** Highly significant, **SD:** Standard Deviation **MCPL2**= Metacarpophalangeal bone Index finger **MCPL3**= Metacarpophalangeal bone Middle finger, **MCPL4**= Metacarpophalangeal bone Ring finger **MCPL5**= Metacarpophalangeal bone Little finger.

**Table (3): Pearson correlation coefficient between stature and anthropometric measurements in the study with its significance in males and females.**

| | | Male | Female | | | Male | Female |
|---|---|---|---|---|---|---|---|
| **Age** | r | .187 | .163 | FBL2 | r | .318** | .336** |
| | P value | .062 | .104 | | P value | .000 | .000 |
| **HL** | r | .470** | .343** | FBL3 | r | .380** | .297* |
| | P value | .000 | .000 | | P value | .000 | .003 |
| **HB** | r | .218* | .221* | FBL4 | r | .428** | .281* |
| | P value | .028 | .027 | | P value | .000 | .005 |
| **DPL2** | r | .345** | .326** | FBL5 | r | .357** | .227* |
| | P value | .000 | .000 | | P value | .000 | .023 |
| **DPL3** | r | .393** | .287* | MCPL2 | r | .314** | .293* |
| | P value | .000 | .004 | | P value | .000 | .003 |
| **DPL4** | r | .421** | .257* | MCPL3 | r | .394** | .285* |
| | P value | .000 | .012 | | P value | .000 | .004 |
| **DPL5** | r | .372** | .251* | MCPL4 | r | .411** | .287* |
| | | | | | P value | .000 | .004 |
| | P value | .000 | .013 | MCPL5 | r | .319** | .267* |
| | | | | | P value | .000 | .007 |

**HL**= Hand length **HB**= Hand breadth **DPL2**= distal phalanx Index finger **DPL3**= distal phalanx Middle finger **DPL4**= distal phalanx Ring finger **DPL5**= distal phalanx Little finger **FBL2**= Finger bone Index finger **FBL3**= Finger bone Middle finger **FBL4**= Finger bone Ring finger **FBL5**= Finger bone little finger **MCPL2**=Metacarpophalangeal bone Index finger **MCPL3**= Metacarpophalangeal bone Middle finger **MCPL4**= Metacarpophalangeal bone Ring finger **MCPL5**= Metacarpophalangeal bone Little finger ****:** Significant at 0.001 level (2 tailed). *****: Significant at 0.05 level (2-tailed).

Comparing the current results with those done in the Egyptian population, the mean stature in this study (173.66 cm for males, vs 160.08 cm for females) was lower than that reported by **Habib & Kamal, 2010** (174.61 ± 7.34, 160 ± 5.45 cm), while it was more extensive than that of **Paulis, 2015** (167.89 ± 5.86 cm for males and 156.96 ± 6.64 cm for females). The main reason for this variation is that the values of various body parts, including the hand, vary from one population to the next, and nutrition status could control body proportions.

In this study, it was found that men were taller and had higher all-hand measurements than women did for the same variables. Identical results were recorded in other studies on the Egyptian population **(Paulis, 2015; Sharaf El-Din et al., 2016; Ghaleb et al., 2019)** and worldwide **(Manolis et al., 2009; MC Fadden &Bracht, 2009; Ahmed, 2021).** In disagreement with this study **(Alicioglu et al., 2009),** in Turkish population found that female distal phalanges were longer than males. The differences between males and females might be ascribed to the earlier development of girls before boys; consequently, the boys have two more years of physical growth **(Krishan and Sharma, 2007).**

Egypt has many people who are not originally Egyptians. Its location has caused many tribes and races to move there over the years. Fayoum governorate is one of the highest places in Egypt, inhabited by many people who immigrated there from Libya, the Maghreb countries, and the Arabian Peninsula. Therefore, diversity and differences in the measured hand variables were present compared to other Egyptian studies and worldwide. According to that fact, **Okunribido, 2000** reported a wide variation in the hand dimension of Nigerian females compared to other populations. Similar findings were found in four ethnic groups, Chinese, Japanese, Koreans, and Taiwanese **(Lin et al., 2004).** The population's racial and ethnic diversity, diet, genetics, sex, landscape, age, and activity level all have an impact on stature. Consequently, a model that works for one population may not work for another (**Galofré-Vilà et al., 2018**).

The current study reported that stature was strongly connected to all measured hand variables in both sexes. The handlength and stature correlation coefficients were more significant than the handbreadth. This result proves that handlength is more solid than handbreadth for stature estimation in Egyptian males and females. Also, this finding was documented by a lower SEE and a higher $R^2$ in the case of handlength in both sexes. Similar results were reported by different studies in Egypt (**Paulis, 2015; Sharaf El-Din et al., 2016; Foad et al., 2018; Ghaleb et al., 2019);** Iran **(Akhlaghi et al., 2012);** Indi **(Krishan and Sharma, 2007; Pal et al., 2016);** Sudan (**Ahmed, 2016);** Saudi Arabia (**Ahmed, 2021);** and Sabahan (**Khazri et al., 2022).** On the contrary, **Hossain et al., 2022** reported that stature is strongly connected with the ulnar length than hand parameters.

**Table (4): Simple linear regression equations for stature (cm) estimation using anthropometric parameters of left hand in males.**

| | Males | ± SEE (cm) | $R^2$ | P value |
|---|---|---|---|---|
| **HL** | S= 127.488+2.380× HL | ±5.02 | .220 | <0.001** |
| **HB** | S= 152.289+2.441× HB | ±5.55 | .048 | 0.27* |
| **FBL2** | S= 143.116+3.630×FBL2 | ±5.39 | .101 | <0.001** |
| **FBL3** | S= 142.639+3.263×FBL3 | ±5.26 | .144 | <0.001** |
| **FBL4** | S= 132.929+4.411×FBL4 | ±5.14 | .183 | <0.001** |
| **FBL5** | S= 140.758+4.488×FBL5 | ±5.31 | .128 | <0.001** |
| **DPL2** | S= 145.55+14.745×DPL2 | ±5.33 | .119 | <0.001** |
| **DPL3** | S= 144.39+14.590×DPL3 | ±5.23 | .154 | <0.001** |
| **DPL4** | S= 143.408+14.700×DPL4 | ±5.15 | .177 | <0.001** |
| **DPL5** | S= 144.832+15.566×DPL5 | ±5.27 | .138 | <0.001** |
| **MCPL2** | S= 140.416+2.157× MCPL2 | ±5.40 | .098 | <0.001** |
| **MCPL3** | S= 131.251+2.591× MCPL3 | ±5.22 | .155 | <0.001** |
| **MCPL4** | S= 133.748+2.606×MCPL4 | ±5.18 | .169 | <0.001** |
| **MCPL5** | S= 141.657+2.485× MCPL5 | ±5.39 | .101 | <0.001** |

**HL**= Hand length; **HB**= Hand breadth; **DPL2**= distal phalanx Index finger; **DPL3**= distal phalanx Middle finger; **DPL4**= distal phalanx Ring finger; **DPL5**= distal phalanx Little finger; **FBL2**= Finger bone Index finger; **FBL3**= Finger bone Middle finger; **FBL4**= Finger bone Ring finger; **FBL5**= Finger bone little finger; **MCPL2**=Metacarpophalangeal bone Index finger; **MCPL3**= Metacarpophalangeal bone Middle finger; **MCPL4**= Metacarpophalangeal bone Ring finger; **MCPL5**= Metacarpophalangeal bone Little finger; **SEE**= standard error of estimate; **S**= Stature; **$R^2$**: determination coefficient ****:** Significant at 0.001 level (2 tailed). *****: Significant at 0.05 level (2-tailed).

**Table (5): Simple linear regression equations for stature (cm) estimation using anthropometric parameters of left hand in females.**

| | **Females** | **± SEE (cm)** | **$R^2$** | **P- Value** |
|---|---|---|---|---|
| **HL** | S= 103.397+3.169×HL | ± 6.21 | .117 | <0.001** |
| **HB** | S= 127.895+4.088× HB | ± 6.44 | .049 | 0.27* |
| **FBL2** | S= 119.555+5.232×FBL2 | ± 6.22 | .113 | <0.001** |
| **FBL3** | S= 123.966+4.116×FBL3 | ± 6.31 | .088 | 0.003* |
| **FBL4** | S= 125.130+4.145×FBL2 | ± 6.34 | .079 | 0.005* |
| **FBL5** | S= 133.470+4.001×FBL5 | ± 6.43 | .051 | 0.023* |
| **DPL2** | S= 125.058+20.797×DPL2 | ± 6.24 | .106 | <0.001** |
| **DPL3** | S= 129.487+17.091×DPL3 | ± 6.33 | .083 | 0.004* |
| **DPL4** | S= 133.230+14.917×DPL4 | ± 6.40 | .062 | 0.012* |
| **DPL5** | S= 138.448+13.370×DPL5 | ± 6.39 | .063 | 0.012* |
| **MCPL2** | S= 123.809+2.530×MCPL2 | ± 6.32 | .086 | 0.003* |
| **MCPL3** | S= 121.836+2.530×MCPL3 | ± 6.336 | .081 | 0.004* |
| **MCPL4** | S= 121.190+2.775×MCPL4 | ± 6.333 | .082 | 0.004* |
| **MCPL5** | S= 128.202+2.686×MCPL5 | ± 6.37 | .071 | 0.007* |

**HL**= Hand length; **HB**= Hand breadth; **DPL2**= distal phalanx Index finger; **DPL3**= distal phalanx Middle finger; **DPL4**= distal phalanx Ring finger **DPL5**= distal phalanx Little finger **FBL2**= Finger bone Index finger **FBL3**= Finger bone Middle finger; **FBL4**= Finger bone Ring finger; **FBL5**= Finger bone little finger; **MCPL2**=Metacarpophalangeal bone Index finger; **MCPL3**= Metacarpophalangeal bone Middle finger; **MCPL4**= Metacarpophalangeal bone Ring finger; **MCPL5**= Metacarpophalangeal bone Little finger; **SEE**= standard error of estimate; **S**= Stature; **$R^2$**: determination coefficient ****:** Significant at 0.001 level (2 tailed). *****: Significant at 0.05 level (2-tailed).

**Table (6):** Multiple stepwise regression equations predicting the stature (cm) from different variables.

| | Regression model | ±SEE (cm) | R | $R^2$ | P value |
|---|---|---|---|---|---|
| **Male** | S=143.949+ 8.440×FBL5+ 4.469×MCPL2+ 4.250×MCPL3+6.106×MCPL4+9.813×MCPL5 | ±4.17 | 0.658 | 0.432 | <0.001* |
| **Female** | S=125.058+ 20.797×DPL2 | ±6.24 | 0.326 | 0.106 | <0.001* |

S: Stature SEE: standard error of estimate $R^2$: determination coefficient *: Highly significant

Using X-rays, the current study found that height was positively linked to all measured variables. The highest male correlation was presented in FBL4, followed by DPL4 and MCPL4. This finding was supported by higher $R^2$ and lower SEE ($R^2$=0.183, 0.177, and 0.169, respectively; SEE= 5.14, 5.15, and 5.18, respectively). While, in females, FBL2 and DPL2 showed a correlation coefficient more remarkable than that of the other measured variables ($R^2$=0. 133 and 0.106 respectively; SEE= 6.22 and 6.24 respectively). Meanwhile, the index and ring fingers' variables had a stronger correlation with stature than other fingers' variables in males and females. In agreement with the current results, **Rhiu and Kim, 2019** reported that the index finger ($R^2$ = .591, SEE = 4.308 cm) and ring finger ($R^2$ = .536, SEE = 4.588 cm) showed the highest determining variables in the Korean population. Similarly, **Ahmed, 2021** reported that stature could be accurately estimated in the Saudi population through index length. Moreover, **Saadat et al., 2022** found a strong positive connection between stature and the ring finger's length. On the other hand, **Sharaf El-Din et al., 2016 and Akhlaghi et al., 2012** reported that the third finger had a more solid correlation with stature in both sexes in the Egyptian and Iranian populations, respectively. Similarly, **Sen et al., 2014** reported that the third finger would give the person's optimum height among all fingers. This result proposes a hereditary distinction among males and females; thus, formulas for one gender cannot be applied to another while assessing height.

A simple linear regression model was used for stature estimation from a single variable. The precision of stature assessment utilizing regression equations is uncovered by the standard error of estimate (SEE), which estimates the divergence of assessed stature from real stature. SEE is considered a proportion of the equations' exactness. In the current work, the lowest SEE was 5.02 cm in males and 6.21 cm in females. These results differed from other studies using the linear model's hand measurements for stature estimation. Our values were higher than those presented by **Sharaf El-Din et al. (2016), Ahmed (2016), and Khazri et al. (2022).** On the contrary, it was lower than **Ozaslan et al. (2006)** in the Turkish population. **Ahmed, 2021,** agreed with our findings that the lowest SEE was HL while the maximum SEE was for the little finger, which disagreed with the current results.

The variability between the current and previous results could be related to the variance in the number of the studied population. The primary measurement method in the present study is X-rays. Furthermore, ethnic variation between Egyptians and others may play an essential role in such studies.

Hand parameters are significant components for the examiners in the medico-legal examinations and forensic anthropologists in identifying mass disaster cases. Numerous specialists have found tremendous contrasts in the hand estimation of various populaces, which show that the hand factors have versatile importance and are impacted by climate, nourishment, and the nature of work. It has been demonstrated that hand aspects are valuable for similar anthropological exploration **(Ali and Sehrawat, 2019).**

Multiple stepwise regression equations were developed using different variables of hand measurements. In males, the measured parameters were more precise than the equations produced using a single parameter with a lower SEE (SEE= 4.17cm) and a more remarkable value of $R^2$ ($R^2$= 0.432). Meanwhile, multiple regression equations are better than single linear regression equations for predicting stature. However, in females, only one variable was sufficient to predict stature. This finding proposes that the precision in stature estimation would be more significant in males than in females. The current results agreed with different studies in Egypt (**Habib & Kamal, 2010; Paulis, 2015; Sharaf El-Din et al., 2016),** Iran **(Akhlaghi et**

**al., 2012),** Indi **(Krishan and Sharma, 2007; Pal et al., 2016),** Sudan (**Ahmed, 2016),** and Saudi Arabia (**Ahmed, 2021);** that recorded a lower SEE and a higher $R^2$. On the contrary, **Habib & Kamal, 2010** concluded that the stature estimation was more accurate in females than males. Also, **Ishak et al., 2012** demonstrated similar prediction accuracy (SEE= 4.74 cm) in multiple equations compared to simple equations.

## CONCLUSION:

All the measured variables were significantly higher in males than females. Stature was positively correlated with all measured hand variables in both sexes. Hand length, ring finger length, and distal phalanx length of the ring finger showed the highest determination coefficient ($R^2$) and lowest standard error of estimate (SEE) by the linear regression model in males. However, the linear regression model found that hand length, index finger length, and distal phalanx length of the index finger had higher values in females than in other hand measurements. Subsequently, these measurements could be used for stature estimation. Multiple regression equations are better than single linear regression equations for predicting stature.

## RECOMMENDATION:

- The use of x-ray to detect stature from other skeletal parts of the body such as the foot.
- The use of other parameters in addition to finger length to detect sex.

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## CONFLICT OF INTEREST:

NONE.

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## الملخص العربي

**تقدير طول القامة باستخدام بعض متغيرات اليد بمساعدة الأشعة السينية في المصريين.**

**عمرو عبد الغني صالح [1] و [2] وفاء يوسف عبد الواحد**

**قسم الطب الشرعي والسموم، كلية الطب، جامعة الفيوم [1] ،قسم الصحة العامة وطب المجتمع، كلية الطب، جامعة الفيوم [2]**

**المقدمة:** تقدير طول القامة من مختلف المتغيرات اليدوية له دور حيوي في تحديد المتوفى في ممارسة الطب الشرعي.

**الهدف من البحث:** تهدف هذه الدراسة إلى تحديد العلاقة بين طول قامة الفرد واتساع يده وطولها والمعايير المختلفة التي يتم أخذها بمساعدة الأشعة السينية.

**الطرق:** أجريت دراسة جماعية وصفية مقطعية على 200 متطوع (100 ذكر و100 أنثى) حضروا الي قسم الأشعة في مستشفى الفيوم الجامعي من يونيو 2021 إلى مايو 2022. تم قياس القامة وطول اليد وعرض اليد اليسرى. في فيلم الأشعة السينية، تم قياس طول عظام الإصبع وطول المفاصل السلامية وطول الكتيبة البعيدة في أصابع السبابة، الوسطى، الخنصر والبنصر. تم تحليل البيانات بواسطة حزمة تحليل الأحصاء الأصدار 28.

**النتائج:** كانت جميع المتغيرات المقاسة لليد اليسرى أعلى بكثير لدى الذكور من الإناث. كانت القامة مرتبطة بشكل إيجابي بجميع متغيرات اليد المقاسة في كلا الجنسين. أظهر طول اليد وإصبع الخنصر وطول الكتيبة البعيدة لإصبع الخنصر أعلى معامل تحديد (R2) وأقل خطأ قياسي في التقدير (SEE) بواسطة نموذج الانحدار الخطي عند الذكور. ومع ذلك، في الإناث، أظهر طول اليد والسبابة وطول الكتائب البعيدة لإصبع السبابة قيمًا أفضل من القياسات اليدوية الأخرى بواسطة نموذج الانحدار الخطي.

**الاستنتاجات:** معادلات الانحدار المتعددة أفضل من معادلات الانحدار الخطي الفردي للتنبؤ بالمكانة. تشير هذه النتيجة إلى أن الدقة في تقدير القامة ستكون أكبر بين الذكور منها لدى الإناث.

**الكلمات الدالة:** المصريين؛ طول عظام الإصبع ؛ طول اليد ؛ اتساع اليد ؛ طول القامة.