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ORIGINAL ARTICLE

# A model for stature estimation and sex prediction using percutaneous ulnar and radial lengths in autopsied adult Egyptians

**Sahar Y. Issa** [a,*], **Ayman A. Khanfour** [b], **Magdy Kharoshah** [c]

[a] *Department of Forensic Medicine and Clinical Toxicology, Faculty of Medicine, Alexandria University, Egypt*
[b] *Department of Anatomy, Faculty of Medicine, Alexandria University, Egypt*
[c] *Forensic Medicine, MOH, Dammam, Saudi Arabia*

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**KEYWORDS**

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**Abstract** Identification of unknown cadavers by constructing a biological profile from their skeletal remains is one of the main aims of any forensic pathologist. Many researches tend to focus on the formulation of sex estimation standards using measurements taken from long bones of the appendicular skeleton, rather than the traditionally favored skeletal remains namely; pelvis and cranium. But yet, there are no organized studies are yet available for gender and height estimation in adult Egyptians. *Objective:* To formulate a model for stature construction and sex prediction the Maximal Radial and ulnar lengths in adult Egyptians. *Materials and methods:* Maximal lengths of the radius and ulna bones, taken from adult Egyptian cadavers presented to Forensic medicine mortuary for pathological or medico-legal reasons during the period from the start of January 2014 till the end of December 2014 were recorded, studied and statistically analyzed. Ethical pre-study acceptance was ensured and guidelines were respected. No conflict of interest existed for all researchers. *Results:* Maximal Radial and ulnar lengths in 122 Egyptian cadavers (85 males and 37 females) in the age range between 18 and 65 years old were statistically analyzed. Mathematical regression formulae, were constructed to determine the stature in the studied subjects. The accuracy of both radial and ulnar lengths in sex determination was 98%, while it was 97.5%, and 92.3% consecutively, in case of using radial or ulnar lengths alone. *Conclusion:* Radius and ulna bones, can help in sex prediction as well as stature estimation with high accuracy in unknown cadavers or remains.


## 1. Introduction

The use of forensic anthropology in medico-legal investigations has developed to be more common over time, with an escalating number of cases involving human remains

* Corresponding author.
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including, partially fleshed, charred or dismembered remains.[1] Although metric studies may appear repetitive in principle and technique, such forensic studies must attempt to answer key questions related to age, sex, stature and race after examining incomplete or fragmentary remains. The forensic investigator must work with a checklist of the available bones and their accessible measurements, which could then be used altogether to optimize the determination of identity from such existing data.[2]

Sexual dimorphism is the biological base for sex estimation based on the physical and behavioral differences existing between males and females.[1] Sex differences determined in the shape, size and appearance of bones usually arise during development and are consequences of individual genetic markers and response to sex hormones during puberty. Bone development in either sex is dependent on a combination of genetic markers and hormone exposure.[3] The age at which these sex-specific morphological changes start to appear is dependent on a number of population specific genetic and environmental factors.[4] As the degree of sexual dimorphism, and the age at which it occurs in males and females, varies between different populations, sex estimation standards are necessary to be population specific.[5] The lower end (epiphysis) of radius and ulna fuses with their respective diaphysis in the age group of 16–20 years. Standards used to analyze morphometric data are most precise when applied to the population from which they were derived.[6]

The radius and ulna may be smaller and more fragile than other long bones as the femur; however, estimating their power to differentiate between the sexes will provide alternative markers for sex identification when more accurate bones such as the pelvis or femur are absent or damaged.[7]

## 2. Aim of the work

To formulate a model for stature construction and gender prediction using radius and ulna bones in adult Egyptians.

## 3. Materials and methods

This study was performed on 122 Egyptian cadavers (85 males and 37 females) presented to the Forensic medicine mortuary for pathological or medico-legal reasons in the period between first of January to end of December, 2014. All cadavers had intact and unharmed left forearms. Cadavers with severe rigor mortis, severe burning, and incomplete or charred skeleton, and advanced post mortem changes, history of fracture or deformities in upper and lower extremities as well as anonymous cadavers, were excluded from the study.

Ethical guidelines were respected and, written consents were obtained. The cadavers were placed in supine position in full extension, on the autopsy table and the stature was measured using a steel tape with millimetric divisions. Wooden wedges were placed touching the cranial vertex and the heels, and body length, was determined by subtracting the sum of the heel-table and vertex-table distance from the autopsy table length. Cross incisions on forearm and wrist were done, soft tissues were removed and the adjacent joints were exposed. The radial styloid, and head, in addition to ulnar styloid and olecranon were marked. The left radial length was measured as a straight line distance from the most antero-proximal point of the head to the most distal end of the styloid process of the radius bone. The left ulnar length was measured as a straight-line distance from the most postero-proximal point of the olecranon to the most distal end of the styloid process of the ulna. Measurements were done using a Vernier calliper reading to 0.05 mm. All values were recorded in millimeters.

For more accurate results the same measurements were taken by two evaluators; the examiner and the recorder and each one took the measurements twice for the same cadaver, using the same unit and instrument. Technical error of measurement (TEM) was calculated. The method of differences was adopted for the attainment of TEM, which is expressed through the standard deviation between repeated measurements. Within and between observer measurement errors were consistently less than 1 mm.

For the determination of sex and estimation of stature, discriminant function analysis and linear regression were used, respectively. Finally the skin and joints were reconstructed.

## 4. Results

Results were analyzed with SPSS 20.0 version for Windows. Relation between height and all measurements taken were determined by Pearson Correlation Analysis. For the determination of sex and estimation of stature, correlation and regression coefficients were used. 85 of the studied subjects (69.7%) were males, and 37 (30.3%) were females. The cadavers of both genders were divided into 3 age groups according to the different ages examined during the study period for easier classification of the results:

(I) Less than 25 years old,
(II) 25–44 years old,
(III) 45 to more than 65 years old.

Descriptive data for each sex according to age, stature, radial and ulnar lengths were indicated in Table 1. The mean

**Table 1** Descriptive data for both genders.

| Values | Males ($n$ = 85, 69.7%) | | | | Females ($n$ = 37, 30.3%) | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | S.D. | Minimum | Maximum | Mean | S.D. | Minimum | Maximum |
| Age | 40.94 | 10.1 | 18 | 65 | 34.36 | 11.1 | 20 | 49 |
| Stature | 1723 | 114 | 1573 | 1874 | 1585 | 149 | 1482 | 1633 |
| Radial length | 256* | 14.1 | 247 | 261 | 253 | 13.7 | 248 | 260 |
| Ulnar length | 274** | 14.9 | 268 | 312 | 260 | 14.0 | 257 | 274 |

* Statistically significant difference ($P < 0.01$).
** Statistically significant difference ($P < 0.0005$).