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Original article

Sex determination from hand dimensions and index/ring finger length ratio in North Saudi population: Medico-legal view

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ABSTRACT

Background: Sex determination using human commingled remains is one of the most important components in forensic identification.

Aim: Getting a reliable and accurate method for sex determination through hand dimensions among Saudi population.

Subjects and methods: A cross sectional study was carried out on 600 volunteers. Hand length, breadth and hand index, also index and ring finger ratio were estimated.

Results: The average hand length, breadth and index were found to be 1.3, 0.96 and 2.93 cm greater in males than females, respectively ($p < 0.05$), with no significant difference between right and left hand in the same sex. A cut-off point index of ≤ 41.23 for the right hand and of ≤ 41.30 for the left hand is suggestive of the female sex, while that of > 41.23 for right hand and > 41.30 for left hand is suggestive of male.

The index and ring finger ratio is found to be higher in females than males. Index and ring finger ratio ≤ 0.920 for the right hand and ≤ 0.913 for the left hand suggestive of male while Index and ring finger ratio < 0.920 for the right hand and < 0.913 for the left hand suggestive of female.

Conclusion: By using the anthropometric measurements of hand dimensions, sex can be estimated with a high accuracy. It is, therefore, an important tool to be included in forensic identification when a hand is detected at the scene in mass disasters and criminal situations.

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1. Introduction

Anthropometry represents the technique of statement the shape of the human body quantitatively. Also, it means the measurement of living, dead or skeletal material of human beings.¹

Establishment of the identity of the deceased is of the greatest significance to the forensic examiner in situations where cadavers are violently distorted.² Identification of victims using dismem-

bered human remains has constantly been a challenge in medico-legal investigation,¹ whether in situations of traumatic calamities where tremendous trauma is involved (e.g. car accidents, aircraft crashes, fire catastrophes), or in definite situations of murder, where deceased bodies have been dismembered to suppress the identity of the murdered.³

Examination of anonymous skeletal and incorporated remnants in legal conditions is covered by forensic anthropology, which mainly focuses on fixing the profile of diversity through assessment of the age, sex, stature and race.⁴ Sex identification using anthropometric measurements is a topic that is currently covered in a multitude of studies; including anthropometric measurements of the upper and lower extremities,^{5,6} the long bones of the extremities,^{7,8} hands and feet small bones,^{9,10} as well as other bones of the body.^{11,12}

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Hands are the most preferable and shrewd part of the body for anthropometric measurement, comprising hand dimension (hand length and breadth). Hand index which is acquired from hand dimensions could be used to assess variation concerning sex, age and race in forensic and legal sciences.² Importance of morphometric and skeletal examination of hand and foot dimensions in identification was mentioned previously.^{13,14} Studies using hand measurements for sex determination have been performed in several races.^{15,16}

Recent researches were carried out for sex estimation from ratio of index and ring finger in adults and young inhabitants in South India which reported relative statistically significance concerning sex differences.^{17,18}

The situation is more complicated in developing human beings, since the age of the subject is a sensitive identifying element. Males and females have different epiphyseal integration age; fusion of the epiphyses takes place later in males than in females. Valid sex precision in adults has contracted directly on a range of potential murdered consistent that by providing a special priority for age assessment that exactly established on the predicted sex.¹²

The work load of the forensic investigator is usually reduced by half whenever the sex of the suspicious could be concluded from the dimensions of the hand found at the crime scene, thereby explaining the necessity of the ongoing research on identification of sex from hand dimensions.

The current study examines the scope of sexual dimorphism in hand dimensions among inhabitants from Aljouf region, Saudi Arabia using statistical considerations and assesses whether the hand dimension measurements and index finger length/ring finger length (IFL/RFL) ratio can be dependably used as a forensic identification tool when only incorporate remains are brought for identification.

Sample selection in this study is unique as regards to homogeneity of the study population, and selection of a rare tribe.

To the best of our knowledge, this is the first study that examines anthropological data for sex identification from measurements of the hands in this tribal group of population of Aljouf Province, Saudi Arabia.

2. Material and methods

The present study was conducted at the Department of Forensic Medicine & Clinical Toxicology, College of Medicine, Aljouf University, Saudi Arabia. A cross sectional descriptive study was carried out randomly on 500 volunteers' students (250 males and 250 females) studying at Aljouf University. In addition, 100 further participants (50 males and 50 females) were examined to test our results. The ages of the students ranged between 18 and 30 years. The purpose of the study was elucidated to the Principal of the College and the participants, and informed consent was obtained before carrying out the study. The study protocol runs in compliance with the Helsinki Declaration and according to the standard ethics drawn by Aljouf University Ethical Committee for Human Experimentation.

All the measurements were taken between April, 2015 and June, 2015. Only right-handed persons were included in this study to avoid the influence of handedness on data standards. Students with deformities, injuries, fractures, amputations or history of surgical intervention for the hands or ring or index fingers of both hands, were excluded.

All participants were natives and inhabitants of Aljouf region. To confirm nativity, the father and grandfather of each of the participants should have been born and lived in Aljouf region. The subjects from any other regions were excluded from the study.

Aljouf region represents a dynamic location of the North Syrian and Arabian Desert. Sakaka and Dumat Al Jandal are the main towns of Aljouf region.

Hand length, breadth and hand index (breadth divided by length \times 100), index finger length (IFL), ring finger length (RFL) as well as IFL/RFL ratio had been estimated. Measurement technique for measuring the hand length, IFL, RFL hand breadth was taken following the methods described by Weiner and Lourie.¹⁹

These measurements were taken in cm and were measured to two decimal places, with the help of an Anthropometer and a Sliding Caliper, respectively. Necessary precautions were taken while measuring the subjects. The instruments were calibrated regularly for accurate readings. All measurements were obtained in a well-lit room.

The readings and measurements for every participant had been possessed twice and registered and the average was taken as the best assess for the correct value if the two readings and measurements for every parameter agreed within 0.4 ranges. When the two initial measures did not satisfy the 0.4 range criteria, two further measurements were taken and the mean of the closest readings was used as the best estimate.²⁰

Each participant placed his/her hand on a regular surface with the forehand directed upwards and the fingers outstretched and close to each other. Precautions were taken to prevent adduction and abduction at the wrist joint, i.e., the palm and the middle finger were directly in the same line.

- The hand length was measured as it is the projected distance between the midpoint of a line joining the styloid process of radius and ulna bones of forearm, passing through the distal crease of wrist joint and the middle finger tip (Fig. 1).
- The hand breadth was taken as straight distance from the most laterally set point on the head of 2nd metacarpal bone to the most medially set point located on the head of 5th metacarpal bone, while digits were outstretched (Fig. 1).
- Hand index: hand breadth divided by hand length, multiplied by 100.
- IFL: the distance between the tip of the index finger and the metacarpophalangeal crease (Fig. 2).
- RFL: the distance between the tip of the ring finger and the distal metacarpophalangeal crease (Fig. 2).
- The IFL/RFL ratio was calculated by dividing the index finger length by the ring finger length.

Before the beginning of the study, all measurements were obtained for 30 participants independently by two researchers, and the measurements were assessed for inter-observer error. Two days later, the measurements were taken again by one of the two previous researchers to assess intra-observer error. Paired *t*-test had been used to assess both intra-observer and inter-observer error. The results were non-significant for inter-observer error ($t = 0.688$, $p = 0.265$ for 'hand length', $t = 0.711$, $p = 0.323$ for 'hand breadth', $t = 0.743$, $p = 0.367$ for 'IFL', and $t = -0.421$, $p = 0.688$ for 'RFL') and intra-observer error ($t = -0.412$, $p = 0.173$ for 'hand length', $t = -0.622$, $p = 0.139$ for 'hand breadth', $t = -1.776$, $p = 0.091$ for 'IFL', and $t = -0.475$, $p = 0.671$ for 'RFL'). The results denoted that the measurements are valid and reliable without significant error in the measurements.

2.1. Statistical analysis

The collected data were statistically analyzed by using SPSS computer software (SPSS; Statistical program for Social Sciences, Inc., Chicago, IL, USA) version 22.0 and MedCalc statistical (Mariakerke, Belgium) computer software Version 11.0. Mean, standard

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