Institute of Experimental Morphology and Anthropology with Museum
Bulgarian Anatomical Society

Acta morphologica et anthropologica, 12
Sofia • 2007

Sex Determination of Human Humerus in Bones and Bone Fragments — New Suggested Formula

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Sex determination of bones in findings is essential for the anthropological and forensic investigations. It is possible only with adolescent or adult skeletons because there is not so well expressed sexual dimorphism in preadolescent children.

In present study we suggest new formula for sex determination of bones based on the measuring of distal humerus.

Key words: determination, sex, distal humerus, bones, formula.

Introduction

Bone remains give us the possibility to determine the age, sex and even body posture. Undoubtedly if we make detailed morphometric characteristic of the contemporary human skeleton we can create standards leading us in evaluation of bone remains from the past.

The problem of sex determination of bone remains, especially when it is connected with sex determination of the humerus or parts of it, is still disputable.

If the investigated bones belong to contemporary people the possibility for exact sex determination is more significant than in bone findings from the ancient times or those belonging to evolutionary relatives [5].

Many authors present different methods of sex determination of humeral bone remains and for its distal part [2, 4].

Most of them think that there are no significant differences in applying these methods of investigating in contemporary remains and fossils. Others have different opinion [1, 3].

These different methods of sex determination are based on statistic calculations. Most used are the Discriminant and Cluster Analysis.

Step Discriminant Analysis is statistical method used to determine which variables discriminate between two or more naturally occurring groups.

Computationally, discriminant function analysis is very similar to analysis of variance (ANOVA).

Material and Methods

Our study is based on the measuring of 218 distal humera. A number of 138 bones are taken from cadavers and 80 bones from the ossuary of the Military Museum - Sofia.

Bones are cut at 15 cm proximally from the distal part of the humerus. At the time of the study we determined more than 30 linear and 10 angular signs. We also created 20 indexes divided into two big groups — common and special.

Results

Measurements are done by conventional anthropometric measuring devices.

First step of our study is to define the signs of division of men and women. Fig.1 is a point diagram of the signs which differs most of all the groups in common. Canonic variables I and II are shown at the axes of the diagram. It is seen higher level of differentiation of cases at the right side of the graphic Where the distance between the separate frequencies is bigger.

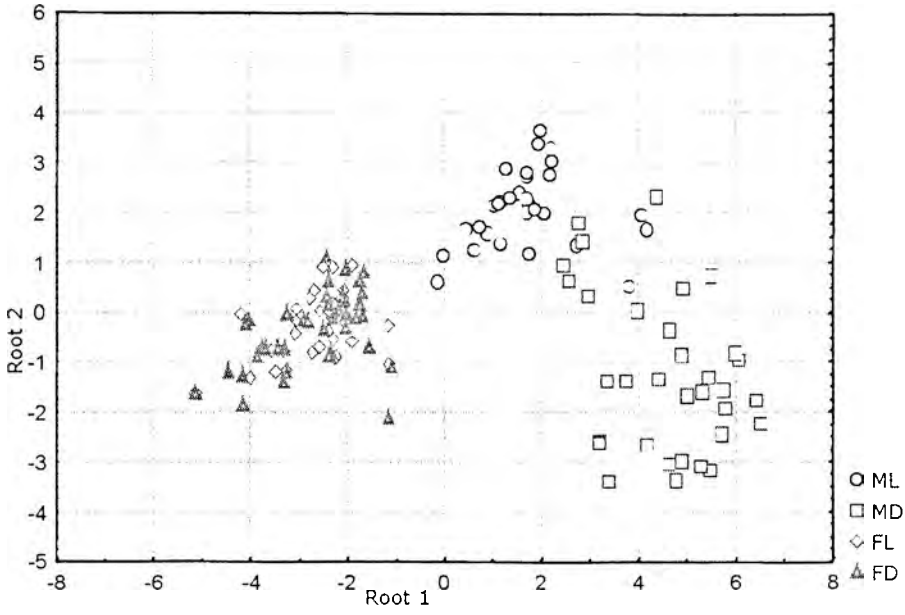

Fig. 1. Spatial distribution of the frequences by sex and lateralization for man-left (ML), men-right (MD), women-left (FL), women-right (FD)

The data from the point diagram are confirmed absolutely by the 3 D graphic of the first three canonic variables (Fig. 2). The difference here is abrupt which confirms 100% the distribution of the signs in the classification matrix.

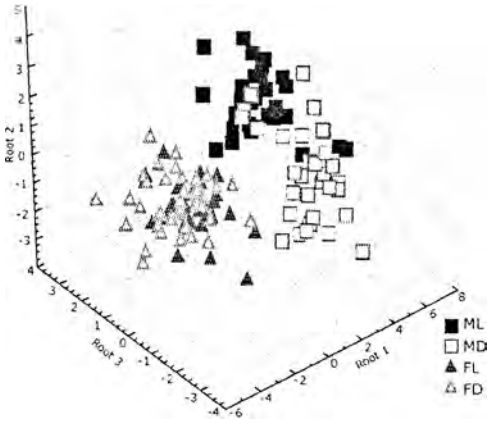

Fig. 2. Spatial distribution of the groups male left (ML), male-right (MD), women-left (FL), women-right (FD) in the frame of reference of the first 3 canonic variables

Fig. 3 presents the distribution of the group middle values in the frame of reference of the first three canonic variables.

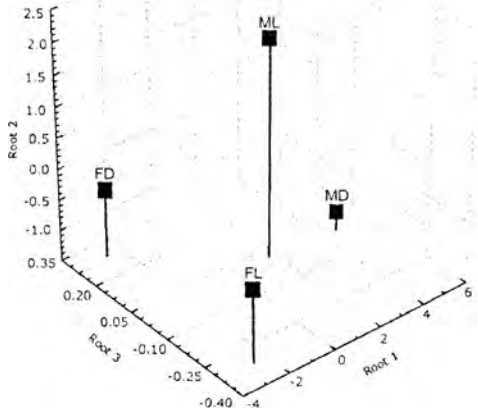

Fig. 3. Spatial distribution of the group middle values in the frame of reference of the first 3 canonic variables for groups male left (ML), male-right (MD), women-left (FL), women-right (FD)

In the study concerning division of the signs and indexes by sex, 100% division is find out in 2 signs — Length of the Lateral Column (LCL), Length of the Medial Column (MCL) and 5 indexes — Index of the Lateral Trochlear Ridge (LPI), Index of the Medial

Trochlear Ridge (MPI), Length - Thickness Index of the Lateral Column (LLI), Length - Thickness Index of the Medial Column (MLI) High — Length Index of Capitulum (HCI) (Fig. 4).

SIGN	M	F
INDEX	p=0.45652	p=0.54348
LCL	31.91133	28.38091
LPI	251.3068	352.8643
MCL1	14.53383	13.03371
LLI	293.5373	255.6207
HCI	299.5184	280.4488
MPI	1774.45	1710.998
MLI	436.3304	395.6075
CONSTANT	−2118.08	−1827.34

Fig. 4. Signs and indexes of 100% division by sex

Such distribution is positive and confirms the division by sex, because as much as the listed signs are, the bigger is the similarity and more difficult is the division.

Even the first sign divides man and women in 100% in such division.

Additional calculations only of anthropologic signs, with the help of software program, showed significant percentage of reliability of the study. This fact gave us the possibility to suggest a formula for sex determination of the individual which bones are found, using the sign Length of the Lateral Column (LCL) of the distal humerus.

This anthropometric sign is measured with the help of gliding caliper at the dorsal surface of the distal humerus. The longitudinal axis of the column needs to be determined first. LCL is the distance from the top of the lateral epicondyle with the cross point of the corresponding longitudinal axis of the medial column.

If a bone or a bone fragment is found and we need a sex determination, we measure the LCL sign of the bone. The measured value is multiplied with 38.52956009 and added with −1046.280762 (constant for males). If the result is nearer to the group constant, the conclusion is that the bone or the fragment belongs to male (X*38.52956009—1046.280762).

By analogy the value of LCL is multiplied with 34.86389923 and added with — 856.6347046. If the result is nearer to the group constant for women, the conclusion is that the bone or the fragment belongs to female (X*34.86389923—856.6347046).

For example – the measured value of LCL is 55.00 mm.

1. LCL = 55 mm — the initial value.

2. 55*38.52956009—1046.280762 = 1072 — multiplication with the constant for male and addition.

3. 55*34.86389923—856.6347046 = 1060 — multiplication with the constant for female and addition.

The bigger from two values is closer to the value of the constant for males, therefore the bone belongs to male.

It is possible to create formulas with all the signs and indexes listed above (MCL, LPI, LLI, HCI, MPI, MLI), having in mind the calculated constants.

Discussion

Determination of sex is crucial for any analysis of unidentified human remains, because all techniques of assessment of age and calculation of stature are different for male and females.

Suggested formula could take place in sex determination of individuals by found humeral bones and is of importance in fragment bone findings of the distal humerus.

With the help of Step Discriminant Analysis of signs inclusion in the discriminant functions it is shown the statistical significance of the discrimination of the aggregates. The classification matrices are the percentage of right determined variations by the chosen model.

Classification functions are used exceptionally in creating formulas for sex determination.

The reliability of the suggested formula is more than 95%. It depends on the correct determination of the column axes.

We believe that it could be used in sex determination of skeletal remains and bone fragments and could have applications in archaeology, anatomy, paleontology and forensic medicine.

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