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Mandible Dimensions in the Context of Sexual Dimorphism of Craniometric Characters

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ABSTRACT

This study was carried out to study gender differences in the mandibles of Azerbaijani skulls. The study material was 50 male and 50 female mandibles from the museum collection. On each lower jaw, 13 parameters were studied. Some of these mandible parameters have clear signs of sexual dimorphism, which manifests itself in the predominance of overall parameters of male mandibles over female ones. The results of the discriminant analysis showed that 4 parameters of the mandible (condylar width, angular width, length from the corners and height of the branch) have a good predictive potential for sex diagnosis.

Keywords: Mandible parameters, Sexual dimorphism, Discriminant analysis, Sex diagnostics

INTRODUCTION

Many questions that relate to various aspects of the sexual dimorphism of the skull are still relevant. The results of relevant research always have an applied perspective, both in human anatomy and related disciplines (anthropology, forensic medicine, etc.). In particular, in forensic medicine, these results are used for personal identification [1,2]. In one of our previous papers, we reported on our work on craniometry in the context of determining the length of the human body [3]. In this paper, we present the results of studying the parameters of the mandible on the skulls of Azerbaijanis. This study was carried out in order to identify metric signs of sexual dimorphism on the mandible.

MATERIALS AND METHODS

The material of the study was 100 osteological preparations of the mandible (50 male and 50 female) from the museum collection, which is found in the archives of the Person of Public Law Association of the FME and PA of the Ministry of Health of the Republic of Azerbaijan. We have published in detail about this collection in our previous publications [3,4]. According to the museum's registry, we have information about the gender and age (from 25 to 55 years) of the individuals whose bones were examined. On each preparation, we measure 13 different parameters of the mandible. When taking measurements, we adhered to generally accepted standards recommended by Rudolf Martin [5]. Various tools and devices were used: digital caliper (accuracy 0.01 mm), caliper (accuracy 0.1 mm), measuring tape, goniometer, mandibulometer (accuracy 1.0 mm; 1°), coordinate caliper (accuracy 0.1 mm). The measurement results were analyzed using standard statistical procedures [6], as well as discriminant analysis [7]. Mathematical modeling and calculations were carried out using the Microsoft Excel (version 2016) and MATLAB (version 8.6) software package.

RESULTS OF THE STUDY AND THEIR DISCUSSION

As we noted above, the main part of our work was carried out as part of a large project to study the craniological and craniometric features of Azerbaijanis. Therefore, we note that even on the mandible, we studied much more features than those presented in this publication. A link to our previous work is available in the publication [3], which is presented in the bibliography. In this article, we present the

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basic statistical characteristics, 13 parameters of the mandible studied by us, separately in the male **(Table. 1)** and separately in the female **(Table 2)** samples.

Table 1. Statistical parameters of mandible sizes in the male sample.

Mandible parameters (number and names according to Martin)	N	x	σ	Sx
65. Condylar width	50	119,7	3,95	0,4721
66. Corner Width	50	100,6	5,64	0,6741
68. Mandible length from corners	50	79	6,4	0,8552
68(1). Length of mandible from condyles	50	107,2	5,24	0,6263
70. Branch height	50	63,9	5,5	0,6574
71a. Smallest branch width	50	31,5	2,83	0,3963
67. Front width	50	44,9	2,45	0,2928
69. Height of mandible symphysis	50	31,6	3,15	0,3765
69(1). Mandible body height	50	31	4,95	0,7071
69(3). Mandible body thickness	50	10,5	1,35	0,1929
79. Angle of mandible branch	50	120	5,93	0,8471
IMC. Mandible notch length	50	27,1	3,07	0,4854
IMS. Mandible cutting depth	50	6,77	1,42	0,2245

Table 2. Statistical parameters of mandible sizes in the female sample.

Mandible parameters (number and names according to Martin)	N	x	σ	Sx
65. Condylar width	50	114,5	5,17	0,9661
66. Corner Width	50	94,2	4,1	0,5798
68. Mandible length from corners	50	74,7	5,33	0,7255
68(1). Length of mandible from condyles	50	104,4	5,7	0,8739
70. Branch height	50	55	5,87	0,9411
71a. Smallest branch width	50	29,3	3,14	0,4526
67. Front width	50	43,2	2,08	0,2942
69. Height of mandible symphysis	50	30,5	4,33	0,6564
69(1). Mandible body height	50	28,8	3,87	0,6483
69(3). Mandible body thickness	50	9,9	1,22	0,1933
79. Angle of mandible branch	50	121	7,2	1,1245
IMC. Mandible notch length	50	26,4	3,39	0,6718
IMS. Mandible cutting depth	50	6,08	1,49	0,2913

The statistical indicators of the studied parameters did not reveal any noticeable fluctuations in the context of interpopulation differences. Our data are in good agreement with the data obtained on other Caucasoid series [8,9]. Using numerical indicators, we analyzed the differences between male and female mandibles. The results show the presence of higher mean values in men compared to women in all parameters of the mandible. The most pronounced imbalance is between the mean values of the following mandible dimensions: condylar width, angular width, mandible length from the corners, branch height. These results showed certain prospects that would make it possible to build a mathematical model for predicting the sex of a person according to the parameters of the mandible.

Thus, the possibility of determining the sex of the subject in any way based on the parameters of his mandible appeared logically. Based on these assumptions, we decided to use univariate ANOVA to evaluate the feasibility of creating a diagnostic model for mandible sex determination (based on univariate discriminant analysis). To do this, we first clarified the categories of values of those parameters of the mandible that were associated with sex. Then the boundaries of 5 gradations for these parameters were determined and a diagram of the corresponding diagnostic table was built. Our gradations included intervals (range of change in mandible size), the presence of the mandible parameter in one of which made it possible to diagnose 5 outcomes: reliably male, probably male, indeterminate result, probably female, reliably female. Note that these are still preliminary data that have not been implemented in the working methodology (we are also considering other metric features of the mandible, and the final results have not yet been obtained). In **Table 3**, we present a preliminary plan-scheme, which may form the basis of a methodology for diagnosing sex by the parameters of the mandible on the skulls of Azerbaijanis.

Table 3. Sex diagnosis by mandible size based on one-dimensional discriminant analysis.

Mandible parameters (number and names according to Martin)	Male		No diagnostics	Female	
	Reliable	Probably	Indefinitely	Probably	Reliable
65. Condylar width	132 or more	123-131.9	114.1-122.9	104.1-114	104 or less
66. Corner Width	110 or more	101-109.9	94.1-100.9	83.6-94	83.5 or less
68. Mandible length from corners	86 or more	78.8-85.9	75-78.7	68-74.9	67.9 or less
70. Branch height	69 or more	61-68.9	55.1-60.9	43.9-55	43.8 or less

Thus, statistical processing of the results of measuring various parameters of the mandible shows that in the population of Azerbaijanis, certain craniometric features (mandible parameters) have pronounced sexual dimorphism. Morphologically, dimorphism is expressed in the difference in some total parameters of the mandible.

With the help of discriminant analysis, we revealed a fairly strong predictor (for predicting sex) potential of some mandible sizes. This fact opens up opportunities for creating a future diagnostic model for determining sex by mandible size. However, an important condition for the implementation of this task is an increase in the amount of material studied (at least 100 preparations of the mandible from male and female skulls). In addition, it is necessary to search for additional metric features on the mandible, which will have a good predictive potential for predicting sex. It is quite possible that the found number of parameters with sexual dimorphism will not be sufficient for the indicated purpose. In this scenario, to create a diagnostic model, we plan to test algorithms based on the apparatus of fuzzy logic (this does not require a large array of differentiating elements).

CONCLUSIONS

Separate parameters of the mandible on the skulls of modern Azerbaijanis have signs of clearly expressed sexual dimorphism. This is manifested in the predominance of the total parameters of male mandibles over female ones. The obtained results show the possibility of constructing diagnostic models that will allow predicting the sex of a person according to the parameters of the mandible. In addition, the results concerning the average dimensions of the mandible may be of interest for comparative studies by craniologists and anthropologists.

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