



# Sex determination of the Bosnian-Herzegovinian population based on odontometric characteristics of permanent lower canines

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## ABSTRACT

**Introduction:** Sex determination is one of first and most important steps in identifying disintegrated bodies and skeletal remains. During the exhumation of bodies from the mass graves and archaeological excavations, it is quite often the case that not all bones of one person are found, therefore, teeth and the skull are the only true identification material. Canines are teeth most appropriate for sex determination. The aim of the research was to determine sex identity of the Bosnian-Herzegovinian population based on odontometric characteristics of permanent lower canines.

**Methods:** The research sample included 180 patients of the Dental Office, of both sexes. All patients with permanent lower right and left canines, without caries, with healthy state of gingiva and periodontium, without crown restorations were included in the research. Measurement was done directly in the patients' mouth using a digital sliding caliper. Greatest mesiodistal width of the lower right and left canine and intercuspal distance of the lower jaw were measured.

**Results:** All parameters were higher in case of male, including Mandibular Canine Index (MCI) ( $p < 0.01$ ). The precision of appraising the sex identity for the Bosnian-Herzegovinian population, based on MCI on the right, amounts 68.89% and 68.54% on the left.

**Conclusions:** The study showed that right canines are significantly broader than the left ones and they are broader in case of males. Lower right canines, that is, MCI on the right, indicates greater accuracy in sex determination in relation to left lower canines. The accuracy in sex determination for all variables is higher for the female.

**Keywords:** identification, sex determination, canines, Mandibular Canine Index.

## INTRODUCTION

Sex determination is one of first and most important steps in identifying disintegrated bodies and skeletal remains. The past war in Bosnia and Herzegovina (1992-1995) took a large number of human lives and many families are still searching for their relatives. According to data of the Missing Persons In-

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stitute and International Commission for Missing Persons (ICMP), it is believed that during the war in Bosnia and Herzegovina, about 17.000 human remains were exhumed including many those still not identified. Around 9.000 persons have still not been found and identified (1). Therefore, there is a need to identify a large number of human remains exhumed from many mass graves on the territory of Bosnia and Herzegovina because it provides a discovery for survived family about the fate of their loved ones.

Pelvis and skull bones are most frequently used for sex determination based on skeleton although the measurement of humerus and femur head diameter enables highly credible sex determination (2,3). Very frequently, bones of one person cannot be found during exhumations of bodies from mass graves, especially secondary and tertiary, where death remains are quite mixed, and archaeological excavations, therefore, teeth and the skull are the only real material for identification (4).

The analysis of teeth and identification of discovered bodies using teeth characteristics showed as the first, irreplaceable and highly important procedure in determining the identity of unknown human remains (5-7).

Canines are teeth most appropriate for sex determination. Studies on permanent canines show that those are teeth that are less frequently taken out probably due to reduced caries incidence and they are the least affected by periodontal diseases and they are last teeth to be taken out in view of age. Moreover, those are teeth that can survive many traumas and disasters. All the aforementioned indicate that canines are teeth that can be used as key teeth for identification (8-10).

Sex determination using odontometric techniques is of great interest in cases of great disasters when bodies are severely damaged to the extent that identification is not possible. There are many methods for studying canines' dimensions such as Fourier analysis, Moire topography, measurement of linear teeth dimension such as mesiodistal width, buccolingual

width and incisio-cervical height (11-14). One of them is the method according to Rao et al that is simple, credible, inexpensive, easily performed and it provides satisfactory results and it is used on greater population. Method according to Rao includes the measurement of mesiodistal width of permanent lower jaw canines as well as the measurement of intercuspal distance, that is, measurement of distance between tips of canine cusps (15). The success rate of sex determination based on Rao's formula is up to 89% (16).

Aim of this study is to appraise the sex identity of the Bosnian-Herzegovinian population based on odontometric characteristics of lower jaw canines by applying the method according to Rao et al.

## METHODS

### Study sample

Research sample included patients of the Dental Office, of both sex, including the total of 180 patients, 90 male and 90 female patients. All patients with permanent lower right and left canines, without caries, with healthy state of gingiva and periodontium, without crown restorations were included in the research. All patients were explained the type of measurements, its method and purpose and they all signed voluntary acceptance for teeth measurement.

### Methods

Research was retrospective, clinical and descriptive. It was done directly in the patients' mouth using a digital sliding caliper and values were expressed up to the hundredth part of millimeter. Parameters that were measured include: greatest mesiodistal width of the lower right and left canine and intercuspal distance of the lower jaw. Mesiodistal width of canines is measured in the manner that the greatest span between the mesial and distal approximate surface on vestibular tooth surface is measured using a digital sliding caliper. Intercuspal distance is measured in the manner that the distance between the tips of canine cusps of the right and left canine is measured

$$\text{MCI} = \frac{\text{Mesiodistal crown width of permanent lower jaw canine}}{\text{Intercuspal distance of the lower jaw}}$$

$$\text{Std.MCI} = \frac{(\text{Mean male MCI} - \text{SD}) + (\text{Mean female MCI} + \text{SD})}{2}$$

SD – standard deviation

using a digital sliding caliper. On grounds of the aforementioned, using formulas developed according to Rao et al, Mandibular Canine Index (index of lower canines / MCI) and Standard Mandibular Canine Index (standard index of lower canines / Std. MCI) have been calculated (15).

Standard Mandibular Canine Index (Std.MCI) is used as a key point for differentiating male versus female. If obtained Mandibular Canine Index (MCI) for individual is higher than the Standard Mandibular Canine Index (Std. MCI), then it is believed that it is the case of male and if it is smaller, then it is the case of a female (15).

**Statistical analysis**

Data were processed with application of descriptive statistics, t-tests for independent samples and chi-squared test. P-value was considered statistically significant if it was lower than 0.01. A statistical software IBM statistics SPSS V19.0 was used for data analysis.

**RESULTS**

The analysis of sample according to sex identity and age indicated that the group is homogenous according to age and that average age of male amounted 35.01±13.18 years, and female 35.47±13.11 years.

TABLE 1. Parameters of descriptive statistics of analyzed upper and lower jaw variables

		N	Mean	SD	SEM	Min.	Max.	t-stat	p-value
Mesiodistal width of permanent lower canine - right	Male	90	7.41	0.40	0.04	6.24	8.63	95.87	<0.001
	Female	90	6.87	0.32	0.03	6.12	7.68		
	Total	180	7.14	0.45	0.03	6.12	8.63		
Mesiodistal width of permanent lower canine - left	Male	90	7.14	0.38	0.04	6.12	8.28	98.65	<0.001
	Female	90	6.62	0.31	0.03	6.01	7.42		
	Total	180	6.88	0.43	0.03	6.01	8.28		
Intercuspal distance of the lower jaw	Male	90	28.57	1.41	0.14	25.52	32.62	50.12	<0.001
	Female	90	26.86	1.80	0.19	21.28	31.01		
	Total	180	27.72	1.82	0.13	21.28	32.62		

N: Number of samples; All values are expressed in millimeters; SD: standard deviation; SEM: standard error

TABLE 2. Standard Mandibular Canine Index

		N	Mean	SD	SEM	Min.	Max.	t-stat	p-value
MCI - Right	Male	90	0.259	0.015	0.001	0.23	0.32	29.30	<0.01
	Female	90	0.247	0.014	0.001	0.21	0.29		
	Total	180	0.253	0.016	0.001	0.21	0.32		
MCI - Left	Male	90	0.250	0.014	0.001	0.22	0.30	27.43	<0.01
	Female	90	0.238	0.015	0.001	0.20	0.27		
	Total	180	0.244	0.016	0.001	0.20	0.30		
MCI	Male	90	0.250	0.014	0.001	0.22	0.30	27.43	<0.01
	Female	90	0.238	0.015	0.001	0.20	0.27		
	Total	180	0.244	0.016	0.001	0.20	0.30		

MCI: Mandibular Canine Index (index of lower canines); SD: standard deviation; SEM: standard error

TABLE 3. Rate of incorrectly classified individuals on grounds of Mandibular Canine Index

		Sex		Total	Rate of incorrectly classified
		Male	Female		
MCI	Male	N 59	28	87	28
		% 65.6	31.5	48.6	31.5
MCI	Female	N 31	61	92	31
		% 34.4	68.5	51.4	34.4
Total	N	90	89	179	59
	%	100.0	100.0	100.0	32.95

Std. MCI =0.244; MCI: Mandibular Canine Index (index of lower canines); N: Number of samples; Std. MCI: Standard Mandibular Canine Index (Standard index of lower canines)

TABLE 4. Percentage of probability of exact identification

	MCI
Right	68.89
Left	68.54
Total	68.54

MCI: Mandibular Canine Index (Lower Canines Index)

No statistically significant difference was identified ( $p > 0.05$ ), and it could be considered that the age shall not affect research results. Mesiodistal widths of permanent lower canines as well as the width of intercuspal distance, set forth in Table 1, indicate that they were higher with male in relation to female, with statistically highly significant difference according to sex of all observed parameters ( $p < 0.001$ ).

Examination of Mandibular Canine Index (index of lower canines/MCI) in Table 2 indicates that its values were greater with male in relation to female, with statistically significant difference according to sex of all observed parameters ( $p < 0.01$ ). Based on Mandibular Canine Index, 31.5% of male persons were classified as females by error and 34.4% of females were classified as males, which is set forth in Table 3.

Table 4 indicates that Mandibular Canine Index (MCI) is useful for appraising the sex identity of the Bosnian-Herzegovinian population since precision of appraising the sex identity amounts 68.89% based on the right Mandibular Canine Index and 68.54% on the left.

## DISCUSSION

Mesiodistal widths of permanent lower canines in this research as well as the width of intercuspal distance, were statistically significant higher with male in relation to female. Mesiodistal widths of permanent lower canines were greater on right side in relation to left side. Mandibular Canine Index was greater with male in relation to female, with statistically significant difference according to sex of all observed parameters. Values were greater on right side in relation to left side. Arya et al (17), then Staley and Hoag (18) in their research with American Caucasians and Rao et al (15), Sherfudhin et al (13) and Khangura et al with Indian population (19) also confirmed that male have higher dimensions for all variables. In their research on skeletal remains coming from archeological site of Bijelo Brdo near Osijek, Vodanović et al have also determined that male have larger teeth dimensions in comparison to female (20).

This research presented that accuracy of sex determination of Bosnian-Herzegovinian population amounts 68.89% based on the right Mandibular Canine Index and 68.54% based on the left. The study of Anderson established that sex classification on grounds of measuring the width of lower canines and intercuspal distance of the Canadian population is correct in 74.3% cases. Al-Rifaiy determined that accuracy of sex determination with Saudi population amounts 65.5% (14). Rao et al, by measuring mesiodistal widths of lower canines as well as intercuspal distance with South-Indian population, concluded that 84.3% of male and 87.5% of female can be exactly differentiated in terms of sex (15). Prabhu determined that in 76.2% cases, it is possible do identify the sex based on measurements of mesiodistal widths of upper and lower canines also with Indian population, 72.4% if measurement is done only on lower teeth or 67.6% if only upper teeth are considered (21). Khangura et al, by measuring mesiodistal widths of upper canines and intercuspal distance of the North-Indian population, determined that 64% of female and 58% of male are properly classified (19). Yadav determined that in 83.3% of cases it is possible to accurately identify the sex with male and 81% with female, also by measuring mesiodistal widths of lower canines and intercuspal distance of the Indian population (22). Mughal et al determined that based on lower ca-

nines in 75.97 % of cases it is possible to determine sex with Pakistani population including 71.67% of male and 78.72% of female (23). Reddy et al, on grounds of lower canines and Mandibular Canine Index with the Indian population exactly identified the sex in 70% of cases (24). Vodanović et al have determined the accuracy of sex determination of 86% if craniofacial and odontometric features are combined (20).

The percentage of accuracy of determining sex of the Bosnian-Herzegovinian population based on odontometric characteristics of permanent lower canines obtained with this research is somewhat smaller in relation to presented research for most other populations. One of possible reasons is the size of sample for this study since the research was performed on the sample of only 180 patients of both sexes. The examination of intraobserver and extraobserver error would provide answer whether the method itself has impact on obtained results. It is also possible that there are differences between populations in application of the method itself. For more precise results, it is necessary to perform research on a larger sample of patients.

However, the measurement of mesiodistal width of permanent lower jaw canines as well as the measurement of intercuspal distance, is simple, quick, credible, inexpensive, easily performed, noninvasive method which provides satisfactory results in sex determination of the Bosnian-Herzegovinian population, which was the overall aim of this research.

This study shall have its practical value in sex identification during anthropological processing and identification of victims from the past war in Bosnia and Herzegovina, considering the fact that a large number of death remains is found in secondary or tertiary mass graves where death remains were greatly mixed or whereby only some body parts are found on the surface (25). Therefore, it is not uncommon to find only damaged skull and/or lower jaw and thereby, results of this research might provide one of methods to choose for sex determination.

## CONCLUSIONS

The study showed that right canines are significantly broader than the left ones and that they are broader for male than for female. Lower right canines, that is, Mandibular Canine Index on the right indicates

greater accuracy in sex determination in relation to left lower canines. Accuracy in sex determination is higher for the female for all variables. Research established specific standards for sex determination, in population terms, for used sample of the Bosnian-Herzegovinian population but further research is needed for more precise values.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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