

# Anthropological Study of Dental Indices in Bulgarian Population

Zdravka Harizanova<sup>1</sup>, Atanas Baltadjiev<sup>1</sup>

<sup>1</sup> Department of Anatomy, Histology and Embryology, Faculty of Medicine, Medical University of Plovdiv, Plovdiv, Bulgaria

**Corresponding author:** Zdravka Harizanova, Department of Anatomy, Histology and Embryology, Faculty of Medicine, Medical University of Plovdiv, 15A Vassil Aprilov Blvd., 4002 Plovdiv, Bulgaria; Email: zarahar@abv.bg; Tel.: +359 887 104 040

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## Abstract

**Introduction:** A number of derived quantities (called dental indices) that characterize the shape and size of the teeth are calculated between the absolute dimensions of the teeth (mesiodistal, vestibulo-oral, and height of the dental crown).

**Aim:** The aim of the present study was to explore the degree of sexual dimorphism in dental indices in the Bulgarian population.

**Materials and methods:** The study included 232 Bulgarians aged 20–40. The vestibulo-oral and mesiodistal dimensions of the teeth were measured. The crown module and crown index were calculated.

**Results:** We found that male Bulgarians had a significantly greater crown module of the upper canines, first premolars, molars, and second molars than females. The crown module of the lower molars was found to be similar in this respect. The crown module of the lower lateral incisors also revealed statistically significant differences, although in females it had higher values. Only the upper and lower canines and upper molars displayed sexual dimorphism according to the crown index, and women's mean values were higher than men's were.

**Conclusions:** Our results suggest that some of the dental indices in the Bulgarian population were sexually dimorphic, which may contribute to defining sex.

## Keywords

Bulgarians, crown index, crown module, teeth

## INTRODUCTION

Odontometry and its application in anthropology originated in the last century.<sup>[1]</sup> Although the anthropological literature contains numerous scientific reports on tooth size, odontometric methodology is still being developed, supplemented, and improved upon. Between the absolute sizes of the teeth (the mesiodistal, vestibulo-oral, and height of the dental crown), a number of derived quantities called dental indices are calculated, characterizing the shape and size of the teeth. Their values give the best general characteristics of the absolute sizes of the dentition of the in-

dividual populations, and according to them, humanity is divided into certain groups. Studies on these indices can be used to compare dental variations, development, cultural and eating habits, adaptation processes between people from different populations, as well as between past and present populations. This explains the evolutionary processes of human dentition, the spread of the population in Africa, Europe, and Asia, the settlement of America and the formation of population clusters according to the size of the teeth. Tests on teeth are done by measuring the mesiodistal and vestibulo-oral dimensions, as well as the height of the dental crowns, which are linear dimensions.

Lund and Mörnstad [2], who studied people in the Swedish population, and Karaman [3], who studied people in the Turkish population, used diagonal measurements in which dimensions are taken diagonally from corner to corner. The dimensions obtained in this manner, in their opinion, permit the measurement of rotated, compressed, or proximally restored teeth.

An option that may be useful is the calculation of so-called dental indices. They are obtained from mathematical combinations between the linear dimensions of dental crowns.

## AIM

The aim of the present study was to explore the degree of sexual dimorphism of dental indices in Bulgarian population.

## MATERIALS AND METHODS

The present study included 121 males and 111 females of Bulgarian origin in the age group of 20-40 years. Patients were included based on the following criteria:

1. Presence of a complete set of fully erupted and periodontally healthy teeth
2. No periodontal disease
3. No spacing and crowding in anterior teeth
4. No history of orthodontic treatments

Mesiodistal and vestibulo-oral dimensions of the teeth were measured by Dentistry Sliding Vernier Caliper. We used the technique of direct anthropometry, modified by Prof. Y. Yordanov.[4] According to him, the mesiodistal dimension is the greatest distance between the most convex approximal points on the mesial and distal sides of the crowns, and usually it is in the upper or middle third of the coronal height. It is also called the dental width.

The crown module (CM) is calculated as half of the sum of the mesiodistal (MD) and vestibulo-oral (VO) size. It characterizes the total mass of the crown. For each group of teeth, for each jaw separately, the average module for the group can be calculated by summing the modules of the teeth included in it and dividing the result by their number: it is 4 for incisors, 2 for premolars, and 3 for molars. In odontology, it is accepted that the average module for the crowns of the upper molars gives the best general characteristic of the absolute dimensions of the dentition. We calculated the crown module using the following formula:

$$CM=(MD+VO)/2$$

The mean crown module of the upper molars for the Bulgarian population was calculated using this formula:

$$(CM16+CM17+CM26+CM27)/4.$$

The crown index (CI) is the ratio of the vestibulo-oral size to the mesiodistal size. It characterizes the shape of the crown. The crown index for the upper molars is always greater than 100, and for the lower ones - always below 100. The average value of the index for the upper molars is about 120.[4] We also calculated the crown index using the following formula:

$$CI=(VO/MD)\times 100$$

and the mean crown index of the lower molars for the Bulgarian population:

$$(CI36+CI37+CI46+CI47)/4.$$

Ethical approval was granted to this study by the Ethics Committee of the Medical University of Plovdiv. Informed consents were obtained from all patients involved in the study. All methods were performed in accordance with the relevant guidelines and regulations.

The measurements were analyzed using SPSS v. 23.0 using the Student's *t*-test. The level of statistical significance was set at  $p<0.05$ . The degree of significance was considered weak ( $p<0.05$ ), moderate ( $0.01>p>0.001$ ) or high ( $p<0.001$ ).

## RESULTS

1. The crown module of the upper canines and the first molars shows differences of high degree of significance between men and women of the Bulgarian population. Similar results were found for the first premolars as well as the second molars but with low degree of significance. The mean values of women were lower than those of men (**Table 1**).

2. The crown module of the lower lateral incisors showed statistically significant differences with low degree of significance, with the mean values being higher in women than in men. We found that the crown module of the lower molars showed differences with high degree of significance, but the mean values in males were significantly higher than in females (**Table 2**).

3. The crown index for the upper canines showed statistically significant differences of high degree, for the upper molars the differences were of low significance. The mean values of women were higher than those of men (**Table 3**).

4. The crown index of the lower canines showed statistically significant differences with low degree of significance. The mean values of Bulgarian women were higher than those of men (**Tables 4**).

## DISCUSSION

Application of dental indices for sex determination in forensic medicine has not yet been fully studied. Townsend and Brown[5] presented statistics on such indices mea-

**Table 1.** Comparison of the crown module of the upper teeth between Bulgarian men and women

CM	Males				CM	Females				P
	N	Mean	SD	SE		N	Mean	SD	SE	
CM13	121	8.37	0.62	0.09	CM13	111	7.97	0.49	0.08	0.001
CM14	121	8.07	0.46	0.07	CM14	111	7.86	0.44	0.07	0.034
CM16	121	10.77	0.44	0.07	CM16	111	10.24	0.44	0.07	<0.001
CM17	121	10.23	0.43	0.07	CM17	111	9.90	0.43	0.07	0.016

**Table 2.** Comparison of the crown module of the lower teeth between Bulgarian men and women

CM	Males				CM	Females				P
	N	Mean	SD	SE		N	Mean	SD	SE	
CM32	121	5.55	0.47	0.07	CM32	111	5.73	0.37	0.06	0.045
CM36	121	10.72	0.49	0.07	CM36	111	10.23	0.49	0.08	<0.001

**Table 3.** Comparison of the crown index of the upper teeth between Bulgarian men and women

CI	Males				CI	Females				P
	N	Mean	SD	SE		N	Mean	SD	SE	
CI13	121	92.23	10.14	1.55	CI13	111	101.1	14.37	2.19	0.001
CI16	121	101.69	8.09	1.23	CI16	111	106.16	7.82	1.19	0.011

**Table 4.** Comparison of the crown index of the lower teeth between Bulgarian men and women

CI	Males				CI	Females				P
	N	Mean	SD	SE		N	Mean	SD	SE	
CI33	121	107.34	17.33	2.64	CI33	111	115.60	17.32	2.64	0.030

sured in Australian aborigines, but they did not comment on sexual dimorphism in them. Garn et al. also presented a descriptive analysis of dental proportions.<sup>[6]</sup> In fact, some authors believe that sex differences in certain teeth will not coincide with the indices calculated for these teeth, and that in determining sex, it would be more useful to use dental indices, because they serve as a measure of the entire surface on the dental crown.

In odontology, it is accepted that the mean crown module of the upper molars gives the best general characteristic of the absolute size of the dentition.<sup>[4]</sup> Based on its value, the following groups are distinguished:

- microdontism ( $x-10.19$ )
- mesodontism (10.20–0.49)
- macrodontism (10.50– $x$ )

The following rubrication has been introduced for the crown index of the lower molars:

- dolichodontism ( $x-89.9$ )
- mesodontism (90.0–99.9)
- brachyodontism (100.0)

In our study, we calculated the crown module and crown index for the patients we examined, divided them into upper and lower jaws, as well as into men and women.

The results we obtained were summarized in four tables. The results on sexual dimorphism for the crown module were similar to the linear measurements of the same teeth, i.e. again canines and molars showed the greatest sexual dimorphism.<sup>[7]</sup> The first upper premolar also showed statistically significant differences. We observed that the significant differences in the upper jaw were more than those in the lower. For the lower jaw, we have significant differences only in the lateral incisor and the first molar. Significant differences between the sexes were much greater when comparing the linear sizes of dental crowns, which is most likely due to the fact that we compare individual teeth between men and women, without taking into consideration the relationship between these sizes or with other teeth. For this reason, a tooth may not show statistically significant differences in its individual size but may contribute to sex determination when its size is examined in combination or in combination with other teeth.

When calculating the crown index, we found even less statistically significant differences between the two sexes. We found such differences only in the upper and lower canines and upper molars, which is unique in our study, given the fact that the lower molars are also teeth with high

sexual dimorphism. These findings call into question the use of the crown index in sex determination. According to Kondo and Townsend, this index expresses the percentage of one linear size to another, i.e. the fact that men usually have higher linear dimensions does not mean that this will be the case when we take them in combination.<sup>[8]</sup>

Acharya and Mainali obtained similar results for the group of Nepalese they studied. They thought that since the crown index expressed the percentage ratio between two linear sizes, it was influenced by the difference between them.<sup>[9]</sup> This means that the higher values for men or women are not the result of higher values for the individual linear dimensions in them, unlike the module of the crown, where we have the sum of the linear dimensions. We believe that the crown index does not compare the sizes of dental crowns between men and women, as well as the linear dimensions or the module of the crown.

This is in accordance with the opinion of Goose, who also claimed that the crown index was an expression of the shape of the tooth rather than the size of the tooth.<sup>[10]</sup> Because of this, it is believed that the shape of the tooth is more likely to be an expression of variations between different populations rather than differences between the sexes.<sup>[11]</sup>

According to many authors, dental indices can be used to determine the biological relationships between populations, as they are an expression of historical, cultural and biological macro and micro-evolutionary processes, which would help to fully understand the origin, formation, contacts, and migration of the population.<sup>[5]</sup> The division of population into races is based on visible characteristics such as skin color, facial features, body size and shape, and skeletal features. The earliest classification of human races separates them into three major subgroups: Caucasians, Negroids, and Mongoloids; respectively, Europeans, Africans, and Asians.<sup>[12]</sup> Later, Townsend et al. introduced another group that does not belong to these three, namely the Australoids.<sup>[13]</sup> The theories about the uniqueness of human dentition are based on the variations in dental crown size. The size of the crowns, the shape of the teeth, the number of tubercles, the type of fissures, as well as other distinctive features of the tooth surfaces can serve to differentiate the different populations.

According to these studies, there are differences in the sizes of dental crowns between the different populations and according to the module of the upper molars, they are divided into three main groups: microdonts, mesodonts, and macrodonts. In general, microdonts are the southern branches of the European race, the most macrodontic are the representatives of the Negroid race, and the Mongoloids and the northern branches of the European race are most often mesodonts. According to Hanihara, Australian aborigines are closer to Caucasians and white Americans than to Mongoloids.<sup>[4]</sup> We calculated the mean crown module of the upper molars for Bulgarians. Its value was 10.29, which means that according to our results, Bulgarian population is mesodontic. The mean crown index for the Bulgarians, which we found was 99.69, i.e. according to this indicator, we are

also mesodonts. Similar results were obtained by Yordanov who examined skeletal material from South Bulgaria.<sup>[14]</sup>

## CONCLUSIONS

We found that the crown module of upper canines, first premolars and molars were significantly higher in Bulgarian males than females. Similar results were found for the crown module of the lower molars. Crown module of lower lateral incisors also showed statistically significant differences but females showed higher values. The crown index showed sexual dimorphism only in upper and lower canines and upper molars and the mean values of women were higher than in men. According to both indicators (crown module and crown index), the Bulgarian population belongs to the mesodontic teeth group. We believe that crown module can successfully help defining sex while crown index is not so reliable.

## Declaration of interest

The authors declare that there is no conflict of interest.

## Author contributions

Z.H. and A.B. performed the research and drafted the manuscript, worked on the tables and English translation. All authors have seen and approved the manuscript and have contributed significantly for the paper.

## Ethical approval

This study was granted approval by the Ethics Committee of the Medical University of Plovdiv. Informed consents were obtained from all patients involved in the study.

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## Антропологическое исследование стоматологических показателей болгарского населения

Здравка Харизанова<sup>1</sup>, Атанас Балтаджиев<sup>1</sup>

<sup>1</sup> Кафедра анатомии, гистологии и эмбриологии, Факультет медицины, Медицинский университет – Пловдив, Пловдив, България

**Адрес для корреспонденции:** Здравка Харизанова, Кафедра анатомии, гистологии и эмбриологии, Факультет медицины, Медицинский университет – Пловдив, бул. „Васил Априлов“ № 15А, 4002 Пловдив, България; Email: zarahar@abv.bg; тел.: +359 887 104 040

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### Резюме

**Введение:** Ряд производных величин (называемых стоматологическими индексами), характеризующих форму и размеры зубов, рассчитывают между абсолютными размерами зубов (мезиодистальный, вестибуло-оральный и высотой зубной коронки).

**Цель:** Целью настоящего исследования было изучить степень полового диморфизма в зубных индексах в болгарской популяции.

**Материалы и методы:** В исследование были включены 232 болгарина в возрасте 20–40 лет. Измеряли вестибуло-оральный и мезиодистальный размеры зубов. Рассчитывали кроновый модуль и кроновый индекс.

**Результаты:** Мы установили, что болгары мужского пола имели значительно больший модуль коронки верхних клыков, первых премоляров, моляров и вторых моляров, чем женщины. В этом отношении модуль коронки нижних моляров оказался сходным. Коронковый модуль нижних боковых резцов также выявил статистически значимые различия, хотя у женщин он имел более высокие значения. Только верхние и нижние клыки и верхние моляры демонстрировали половой диморфизм по индексу коронки, причем средние значения у женщин были выше, чем у мужчин.

**Заключение:** Наши результаты показывают, что некоторые стоматологические индексы в болгарской популяции имели половой диморфизм, что может способствовать определению пола.

### Ключевые слова

болгары, короночный индекс, короночный модуль, зубы