



COMPARATIVE ANALYSIS OF DENTAL INDICES: BULGARIAN AND SOME INTERNATIONAL POPULATIONS

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ABSTRACT

Purpose. Dental indices are ratios between the absolute sizes of the teeth: mesiodistal, vestibulolingual, and height of the dental crown. They characterize the shape and size of the teeth, providing an option for measurements of rotated or compressed teeth. This study aims to explore the degree of their population specificity between Bulgarian and other population.

Material and Method. The study included 311 Bulgarians aged 20 – 40 years. Vestibulolingual and mesiodistal dimensions of teeth were measured. The crown module for maxillary teeth and the crown index for mandibular teeth were calculated.

Results. We found that the crown module did not exhibit a statistically significant difference between Bulgarians and the other populations. However, the differences in the crown index of lower molars were statistically significant. Mean values in Bulgarians were higher, except for the Iranians, who showed greater mean values.

Conclusion. Therefore, we think the crown index may contribute to differentiating Bulgarians from other populations. Specific dimensions for our population need to be defined.

Keywords: Bulgarians, dental indices, crown index, crown module, population specificity,

INTRODUCTION

Race suggests a biological basis for socially constructed categories and implies genetic homogeneity within broadly defined heterogeneous population groups. [1] One of the problems among scientists is that the number of races is often not easily agreed upon. Some people were not easily classified into a certain group because their features suggested overlapping of several racial groups. Generally, human races were clustered into three major groups, namely Europeans, Africans and Asians, also referred to as “Caucasoid”, “Negroid” and “Mongoloid”. [2] Another group of native Australians, which does not belong to any other group, was introduced as “Australoid”. [3] Due to the possibility of overlapping of features between these groups, there can never be a clear separation among them. Other researchers proposed clustering based roughly on the geographical division of human beings. This led to the division of sub-Saharan Africans, Europeans, western Asians, northern Africans, eastern Asians, Polynesians and other inhabitants of Oceania, Native Americans. [4]

Observed dental morphological variations have also led to the identification of specific dental complexes. The term dental complex is based on non-metric features found on teeth. The expression of these dental traits may be observed more frequently in one population compared with another. For instance, Mongoloid ethnic groups have been noted to have frequencies of shovel shape or shoveling of incisor teeth, entoconid (cusp 6), and metaconid (cusp 7). On the other hand, Caucasians have been observed to have low frequencies of shoveling, cusp 6 and 7, but high frequencies of Carabelli trait and bilateral counter winging of central incisors. [5]

Tooth size and morphology have been widely used to assess population affinities and histories, genetics and forensic applications. [6] It was hypothesized that groups of people who shared the same genetic background have approximately the same frequencies and expressions of dental traits. The working tenet is that people who have similar frequencies of occurrence of particular dental complexes could be identified as belonging to a particular race or group of people. Hanihara proposed the Mongoloid dental complex, which consists of six primary crown morphologies that occur at high frequency, namely shovel

shape on the upper central and lateral incisors, deflecting wrinkle, seventh cusp on the lower second molar. These traits are believed to be characteristics of Mongoloid people, and Hanihara suggested further exploration and application of the notion of dental complexes in other racial complexes. [7]

Identification through dental means becomes more important because dental tissues are often preserved even if the body is skeletonized, decomposed, burned, or dismembered. Dental tissues are frequently used to determine a person's age, sex, and ethnicity, whether they are a victim or a suspect. Many researchers suggest that differences in dental traits and measurements between women and men highlight the need to establish average values for specific populations. [8, 9]

However, accurate measurement of teeth that are rotated, compressed, or proximally restored presents significant challenges. A potentially valuable approach involves the calculation of dental indices, which are derived through mathematical combinations of the linear dimensions of dental crowns. The purpose of the present study is to explore the degree of dental indices population specificity between Bulgarians and other populations, thus to prove the concept of population-specific dental traits.

MATERIALS AND METHODS

Subjects.

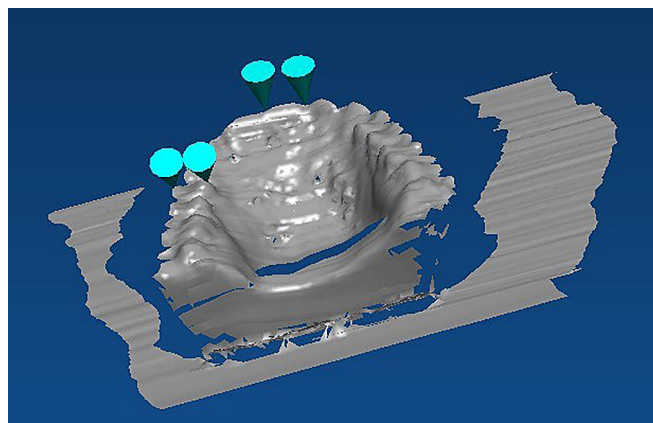
The research included 311 individuals (161 men and 150 women) of Bulgarian origin from South Bulgaria aged 20-40 years. The examined people were included based on the following criteria: a complete set of fully erupted teeth with healthy periodontium, presence of non-carious and non-worn teeth, no dental history of any crown restorations or bridges, and normal occlusion. Patients with orthognathic surgery or trauma, history or clinical evidence of cleft palate, history or clinical features suggestive of endocranial disorders, metabolic disorders, developmental disorders, and history of prolonged illness were excluded.

Data for the dental dimensions of the other populations is collected from the international database, where we found numerous studies conducted with similar laser scanners. [10, 11, 12]

Methods.

Vestibulolingual and mesiodistal dimensions of teeth were obtained using a hand-held laser scanner (FastSCAN Cobra, Polhemus Inc., Colchester, VT). The scanner incorporates motion-tracking technology to achieve a 3D computer image of the measurements. Captured data is postprocessed to produce a single surface dataset. The greatest mesiodistal measurement is defined as the maximum distance between the medial and lateral proximal surfaces of the dental crown, which is usually located in the superior or middle third of coronal height. It is also termed dental width. The maximum buccolingual (vestibulolingual) measurement, also defined as the dental thickness, is the greatest distance between vestibular and lingual surfaces of the crown, perpendicular and bisecting the line defining the mesiodistal dimension. (Fig.1)

Fig. 1. Laser-scanned mesiodistal and vestibulolingual dimensions.



The crown module is a metric used in dental anthropological studies to represent the overall mass of the tooth crown. It is calculated as the average of the mesiodistal (MD) and buccolingual (or vestibulolingual, VL) dimensions using the formula: $CM = (MD + VL) / 2$. The mean crown module can be determined separately for different groups of teeth and for each jaw by summing the individual tooth modules and dividing by the number of teeth considered: four for incisors, two for premolars, and three for molars. In odontological research, the mean crown module of the maxillary (upper) molars is regarded as the most reliable indicator of the absolute dimensions of the dentition.

Accordingly, in the present study, we calculated the mean crown module for the upper molars in the Bulgarian population using the following formula: $Mean\ CM = (CM16 + CM17 + CM26 + CM27) / 4$, where CM16, CM17, CM26, and CM27 represent the crown modules of the respective first and second maxillary molars.

The crown index (CI), on the other hand, reflects the shape rather than the size of the crown. It is defined as the ratio of the buccolingual (vestibulolingual) to the mesiodistal dimension, expressed as a percentage: $CI = (VL / MD) \times 100$. Typically, the crown index values for maxillary molars exceed 100, while those for mandibular (lower) molars fall below this threshold.

In our study, we calculated the mean crown index for the mandibular molars in the Bulgarian sample using the formula: $Mean\ CI = (CI36 + CI37 + CI46 + CI47) / 4$, where CI36, CI37, CI46, and CI47 denote the crown indices of the respective mandibular first and second molars.

Statistics. The dimensions were analyzed with SPSS 28.0 using Student's t-test. The level of statistical significance was set at $P < 0.05$. The strength of the significance level was considered weak ($P < 0.05$), average ($0.01 > P > 0.001$) or high ($P < 0.001$).

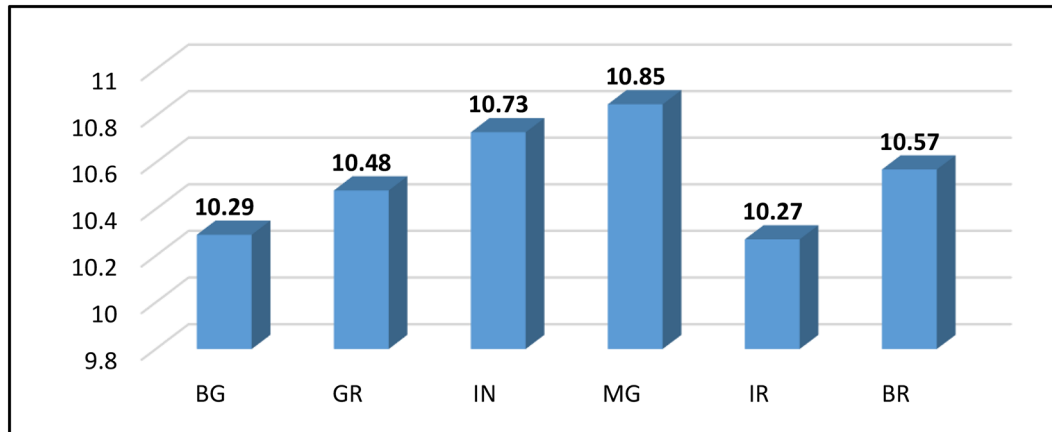
Ethics statement. Ethical approval for this study

was obtained by the Ethics Committee of Medical University-Plovdiv (Protocol 2/27.02.2025). Written informed consents were taken from all patients involved in the study. All methods were performed in accordance with the relevant guidelines and regulations.

RESULTS

1. Crown module of maxillary teeth did not exhibit statistically significant differences between Bulgarian and Indian, Mongolian, Iranian, Brazilian and Greek populations ($P>0.05$). (Diagram 1)

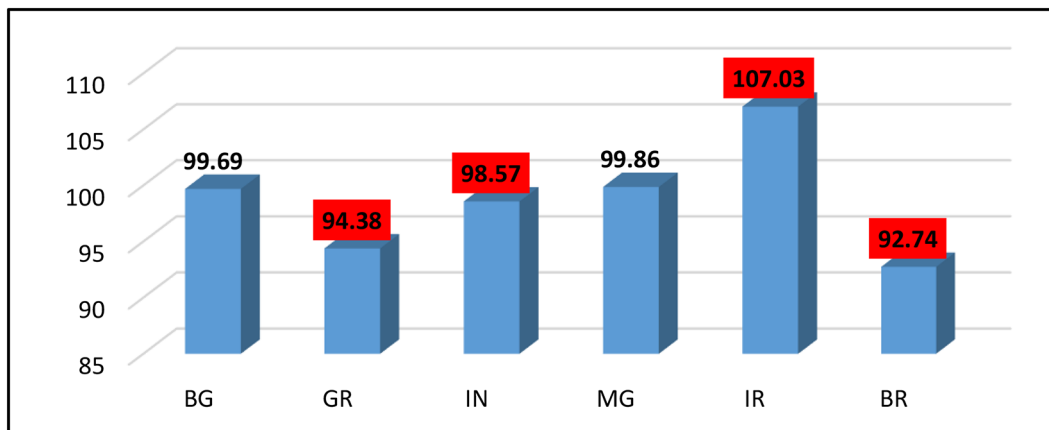
Diagram 1. Comparison of maxillary teeth crown module between Bulgarian and Indian, Mongolian, Iranian, Brazilian and Greek populations.



2. We did not find a statistically significant difference in the crown index of mandibular teeth between Bulgarians and Mongolians ($P>0.05$). However, there were statistically significant differences in the crown index be-

tween Bulgarians and Indians, Iranians, Brazilians, and Greeks ($P<0.0001$). Mean values in Bulgarians were higher, except for Iranians, whose values were statistically higher than the Bulgarian ones. (Diagram 2)

Diagram 2. Comparison of mandibular teeth crown index between Bulgarian and Indian, Mongolian, Iranian, Brazilian and Greek populations.



DISCUSSION

Numerous researchers have proposed that dental indices can serve as valuable tools for assessing biological relationships among human populations. These indices are believed to reflect the outcomes of historical, cultural, and both macro- and micro-evolutionary processes, thereby contributing to a more comprehensive understanding of population origins, development, interactions, and migration patterns. [13] Traditional racial classifications have generally relied on observable physical traits, such as skin pigmentation, craniofacial morphology, body size and proportions, and skeletal characteristics. One of the earli-

est racial taxonomies divided humanity into three main groups: Europeans (Caucasoids), Africans (Negroids), and Asians (Mongoloids). [14] Latered, Townsend and colleagues proposed including a fourth group – Australoids, who do not fit into the original tripartite classification. [15] Variation in dental crown dimensions forms the basis of hypotheses concerning the uniqueness of human dentition. Traits such as crown size, tooth shape, cusp number, fissure patterns, and other morphological features are considered diagnostic characteristics that can distinguish between population groups.

Empirical studies have revealed differences in

crown dimensions among populations, particularly in the upper molars. [16] Based on crown size, populations are generally categorized into three groups: microdonts, mesodonts, and macrodonts. Typically, the southern branches of the European population tend to be microdontic; the largest crown sizes are observed in populations of African descent (macrodonts), while Mongoloid populations and northern European groups are usually classified as mesodonts. Hanihara's research indicates that Australian Aboriginal populations are more similar in dental features to Caucasians and white Americans than to Mongoloid populations. [7]

In our study, we calculated the mean crown module of the upper molars in a Bulgarian sample and obtained a value of 10.29, classifying the population as mesodontic. Additionally, the mean crown index of the mandibular molars in the Bulgarian population was found to be 99.69, classifying Bulgarians again as mesodonts, in agreement with the results of Yordanov, who analyzed archaeological skeletal remains from South Bulgaria. [17] When comparing the mean crown module of maxillary molars, with that of other populations, we did not find statistically significant differences. On the other hand, when we compared the mean crown index of mandibular molars between Bulgarians and Greeks, Iranians, Brazilians, and Indians, we observed statistically significant differences with a high level of significance. However, such a difference was not observed between Bulgarians and Mongolians.

Bulgarians belong to the South Slavic ethnic group and are characterized by a predominant genetic substrate distinct from that of the Western and Eastern Slavs. Approximately 55% of the genetic components in the Bulgarian population are of Eastern Mediterranean origin, primarily resembling those of Greek, Cypriot, and Levantine populations. It should also be noted that about 2% of Bulgarian genetic material can be traced to Central Asian origins.

According to various autosomal DNA analyses, contemporary Bulgarians exhibit closer genetic affinity to certain Balkan populations—including Macedonians, Gagauz, Romanians, inhabitants of Northern Greece, Montenegrins, Serbs, and Kosovars—than to other European groups. The strongest genetic clustering is observed with Romanians, Macedonians, and Gagauz, forming a shared subcluster. This observation is further supported by our own findings, which indicate no statistically significant difference in the mean crown module of the maxillary molars between Bulgarians and Greeks. Unlike the majority of European populations, the Balkan peoples demonstrate a higher degree of genetic diversity, especially when compared to populations from other regions of Europe. Similarly, we found no significant differences in the crown module when comparing Bulgarians to Ira-

nians, Brazilians, Mongolians, and Indians. This may be attributed to historical population migrations, the increasing prevalence of interethnic marriages, and the declining impact of environmental factors such as climate, food preparation practices (e.g., thermal processing), and overall human social development.

In line with the conclusions of other scholars, we believe that genetic factors play a predominant role in shaping dental traits and tooth size. [18, 19] The observed variability in dental morphology among populations, as well as patterns of human dental evolution, is largely determined by genetic inheritance. The concept of the individualized human dentition, reflected in the diversity of dental phenotypes, is best understood as the outcome of complex genetic-environmental interactions.

CONCLUSION

Based on both indicators - the crown module and the crown index - the Bulgarian population can be classified within the mesodontic dental group. Our findings suggest that, while the crown index may serve as a valuable marker for determining population affiliation, the crown module appears to be a less reliable indicator in this regard. We consider the collected data to be significant for advancing the understanding of the origin, formation, interrelationships, and migration patterns of various populations, thereby contributing to the broader study of ethnic diversity in human populations. Furthermore, these dental measurements have potential applicability in forensic science, where they may serve as reliable predictors for human identification.

Abbreviations

CM – crown module
CI – crown index
MD – mesiodistal dimension
VL – vestibulolingual dimension
CM16 – crown module of maxillary right first molar
CM17 – crown module of maxillary right second molar
CM26 – crown module of maxillary left first molar
CM27 – crown module of maxillary left second molar
CI36 – crown index of mandibular left first molar
CI37 – crown index of mandibular left second molar
CI46 – crown index of mandibular right first molar
CI47 – crown index of mandibular right second molar

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