

## CONTRIBUTION OF DENTAL DIMENSIONS IN SEX PREDICTION AND IDENTIFICATION

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### Abstract

The purpose of this research is to assess the differences of tooth measurements between Bulgarians and Spaniards. The survey included 232 Bulgarians aged 20–40 years. Vestibulo-lingual and mesio-distal dental diameters were obtained by a hand-held laser scanner (FastSCAN Cobra, Polhemus Inc., Colchester VT) and analyzed with SPSS 28.0. We detected significant differences in mesio-distal measurements of upper central incisors, premolars, and molars and mandibular first molars, vestibulo-lingual measurements of upper central incisors, canines and first molars and lower first molars between Bulgarians and Spaniards. Our findings revealed that tooth measurements vary in the populations and thus they can be reliable predictors in forensic identification.

**Key words:** odontometric dimensions, 3D-laser scanning, population specific

**Introduction.** Biological profile presents specific characteristics of an individual that can be identified or estimated from bone. Dental profile as a part of it includes all the individual dental traits and dimensions [1, 2]. They provide significant information on such human biological problems as the genetic relationships between populations and human environmental adaptation. Because

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of their durability, teeth and bones are the last structures to disintegrate after death. Hence, they contribute an inordinate body of evidence for the evolutionary anthropologist, the archaeologist or the forensic expert to rely on [3]. Dental material is much less destructible than osseous material.

Tooth size and morphology have been widely used in the assessment of population affinities and histories [1], genetics [4] and forensic applications. Odontometric analyses are useful and biologically meaningful in assessing worldwide inter-population relationships. The results from them (mesio-distal and vestibulo-lingual diameters) are consistent with those based on genetic and craniometrical data. From the 72 major populations, the authors were able to characterize human populations into three main streams using mesio-distal and vestibulo-lingual diameters as follows: microdontic, mesodontic and megadontic. Microdontic populations consist of Native Americans, Philippines, Negritos, and Western Eurasian while Polynesian and East/Southeast Asians are mesodontic and Australian Aborigines, Melanesians, Micronesians, sub-Saharan and Africans are megadontic.

Teeth can provide evidence about the nature and extent of diversity between human populations and examples of ethnic differences and geographic variability in tooth size have been documented for which probably environmental factors play an enormous role. On the other hand, a strong genetic contribution to variation in tooth size has also been shown [5].

Therefore, dentition of a person is useful for individual identification and comparison if preliminary records exist. Identification by dental means gains more importance because the dental tissues are often preserved even if the deceased person is skeletonized, decomposed, burnt, or dismembered. Dental tissues are often used to determine age, sex, and ethnicity of the person who can be either victim or a suspect. Many researchers postulate the differences in dental traits and measurements between women and men which reveals the necessity of defining average values for the specific population [6].

The purpose of this research is to compare some dental measurements of south Bulgarians with Spaniards and thus to prove the concept for population-specific anthropological dental traits.

**Materials and methods. Subjects.** The research included 232 individuals (121 men and 111 women) of Bulgarian origin from South Bulgaria in the age group 20–40 years. The tested people were included based on the following criteria: presence of complete set of fully erupted and periodontally healthy teeth, presence of non-carious and non-worn teeth, no dental history of any crown restorations or bridges, 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 Spanish population is collected from the international database where we found numerous studies conducted with similar laser scanner [7–9].

**Methods.** Vestibulo-lingual and mesio-distal 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 mesio-distal measurement was defined as being the maximum distance between the medial and lateral proximal surfaces of the dental crown, which is usually in the superior or middle third of coronal height. It is also termed the dental width. The maximum buccolingual (vestibulo-lingual) measurement, also defined as the dental thickness is the greatest distance between vestibular and lingual surfaces of crown, perpendicular and bisecting the line defining the mesio-distal dimension (Fig. 1).

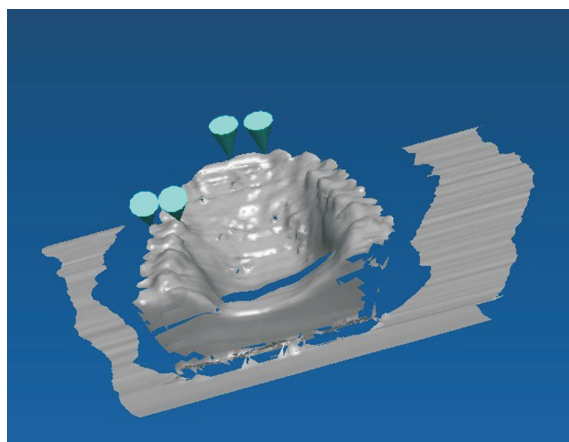


Fig. 1. 3D computer image of the mesio-distal and vestibulo-lingual measurements on a dental cast

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

**Ethics statement.** An ethical approval was taken for this study by the Ethics committee in Medical University-Plovdiv. 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. We detected statistically significant differences between the **mesio-distal measurements of upper central incisors**, first premolars and second premolars and first molars and vestibulo-lingual measurements of upper cen-

T a b l e 1

Comparison of mesio-distal and vestibulo-lingual measurements of upper and lower teeth between Bulgarian and Spanish males

| Teeth | Bulgarian men |       |      | Spanish men |       |      |          |
|-------|---------------|-------|------|-------------|-------|------|----------|
|       | <i>N</i>      | Mean  | SD   | <i>N</i>    | Mean  | SD   | <i>P</i> |
| I11VL | 121           | 6.74  | 1.18 | 72          | 8.58  | 1.38 | < 0.001  |
| I11MD | 121           | 8.47  | 0.74 | 72          | 7.46  | 0.80 | < 0.001  |
| C13VL | 121           | 8.02  | 0.87 | 72          | 8.53  | 0.58 | < 0.001  |
| P14MD | 121           | 6.72  | 0.59 | 72          | 7.92  | 0.81 | < 0.001  |
| P15MD | 121           | 6.40  | 0.62 | 72          | 7.23  | 0.46 | < 0.001  |
| M16MD | 121           | 10.70 | 0.67 | 72          | 11.26 | 0.50 | < 0.001  |
| M16VL | 121           | 10.84 | 0.53 | 72          | 11.56 | 0.65 | < 0.001  |
| M46VL | 121           | 10.65 | 0.72 | 72          | 11.78 | 0.40 | < 0.001  |

T a b l e 2

Comparison of mesio-distal and vestibulo-lingual measurements of upper and lower teeth between Bulgarian and Spanish females

| Teeth | Bulgarian women |       |      | Spanish women |       |      |          |
|-------|-----------------|-------|------|---------------|-------|------|----------|
|       | <i>N</i>        | Mean  | SD   | <i>N</i>      | Mean  | SD   | <i>P</i> |
| I11MD | 111             | 8.42  | 0.59 | 68            | 8.87  | 0.60 | < 0.001  |
| P14MD | 111             | 6.49  | 0.67 | 68            | 7.36  | 0.50 | < 0.001  |
| M16MD | 111             | 9.95  | 0.62 | 68            | 10.73 | 0.52 | < 0.001  |
| M16VL | 111             | 10.53 | 0.59 | 68            | 11.23 | 0.51 | < 0.001  |
| M46MD | 111             | 10.36 | 0.76 | 68            | 11.35 | 0.66 | < 0.001  |
| M46VL | 111             | 10.05 | 0.49 | 68            | 10.58 | 0.43 | < 0.001  |

tral incisors, canines and first molars of the Bulgarian and Spanish men with high extent of significance ( $P < 0.001$ ). The average values in Spaniards were significantly higher than those in Bulgarians except for the mesio-distal dimension of the central incisor (Table 1).

- Only one significant difference was detected in the **vestibulo-lingual measurements of lower first molars** again with high extent of significance in favour of Spaniards ( $P < 0.001$ ) (Table 1).
- Mesio-distal measurements of the upper central incisors**, first premolars and molars in Bulgarian females revealed significantly lower values than those of Spanish females. Similar differences with high extent of significance ( $P < 0.001$ ) were detected in the vestibulo-lingual measurements of upper first molars (Table 2).
- We detected statistically significant differences between the **mesio-distal measurements of lower first molars** with high extent of significance ( $P < 0.001$ ). The average values in Spanish females were significantly higher than those in Bulgarian females (Table 2).

**Discussion.** The available data for the dental measurements in Bulgarians is collected through the classic method of direct anthropology and has not been up-

graded recently [10]. No referent values have been defined using three-dimensional digital technology.

According to our study there were statistically significant differences in 8 dental measurements between Bulgarian and Spanish males. Mesio-distal diameters of upper premolars (7.92, 7.23) and first molars (11.26) were greater in Spaniards than those in Bulgarians (6.72, 6.40, 10.70), while mesiodistal dimension of first maxillary incisor in Bulgarians (8.47) was greater than that in Spaniards (7.46). Also, vestibulo-lingual measurements in upper central incisors (6.47), canines (8.02), first molars (10.87) and mandibular first molars (10.65) in Bulgarians were lower than those in Spaniards (8.58, 8.53, 11.56, 11.78). We detected statistically significant differences in 6 measurements between Bulgarian and Spanish females. Mesio-distal measurements of maxillary central incisors (8.42), first premolars (6.49) and molars (9.95), mandibular first molars (10.36) and vestibulo-lingual dimensions of maxillary (10.53) and mandibular (10.05) first molars in Bulgarians were lower than those in Spaniards (8.87, 7.36, 10.73, 11.35, 11.23, 10.58). Similar results were revealed by ASTETE et al. [11] who conducted a study of teeth in Spanish population. Though we detected statistically significant differences between the two nations, there was some extent of similarity, probably due to common features in lifestyle. For example, other researchers also postulated that environmental factors such as nutrition can play a role in the size of teeth [12]. According to DEEPAK et al. [13], meat food demands more prolonged chewing, therefore tooth measurements in these nations are smaller while nations eating plant food have larger dental dimensions. Other authors postulate that the smaller dental dimensions in Western Eurasians are associated with the lower influence of climate and lifestyle [1].

Other researchers postulated that there is high genetic contribution in dental dimensions as well. They highlighted the significance of the role of genetic impact on dental traits and measurements [14].

Our findings highlighted more significant differences in the measurements of the upper teeth than in the lower teeth probably because of the difference in the period of the maxillary and mandibular embryonic development and the different mechanism of growth. The upper jaw ceases its development earlier than the lower jaw while the mandible's growing proceeds to adolescence. According to our study there were fewer differences between females than between males and the majority of them were in the vestibulo-lingual measurements for the females. This can contribute to the thesis that not only dental measurements are population-specific but the extent of sexual dimorphism exhibits differences among the populations as well.

According to numerous studies the average values in men are greater than in women. The possible reasons for the greater dental size in men are the differences in the differentiation of the dentition in males and females. Some authors [15] postulated that the concentration of the sexual hormones during the development

of the dental germ is connected with that. Mitotic activity of the cells in the internal dental epithelium and the dental papilla are considered to be under the impact of the Y-chromosome and to be a defining factor for the dentin-enamel junction size and the dentin thickness [16].

Our findings revealed that dental diameters of the upper and lower molars have the greatest extent of sexual dimorphism with statistical significance of high degree ( $P < 0.001$ ). They are in contrast with other studies which reported that canines are the most sexually dimorphic teeth [17].

Other researchers postulate that there is difference between the degree of sexual dimorphism in vestibulo-lingual and mesio-distal measurements [18–20].

These findings reveal that teeth show different degree of sexual dimorphism among the different populations which proves the necessity of defining certain dental values for each population.

**Conclusion.** Dental measurements can facilitate defining the phylogenetical and biological connections between populations and also for enlightening macro- and micro-evolutionary processes. We believe the gathered data will be useful for comprehension of the origin, formation, relations, migration pathways of the different nations contributing to ethnic variation of mankind. This means they can be reliable predictors in forensic identification and anthropology.

## REFERENCES

- [1] HANIHARA T., H ISHIDA (2005) Metric dental variation of major human populations, *Am. J. Phys. Anthropol.*, **128**(2), 287–298.
- [2] JENSEN E., Y. P. KAI-JEN YEN, C. F. MOORREES, S. O. THOMSEN (1957) Mesiodistal crown diameters of the deciduous and permanent teeth in individuals, *J. Dent. Res.*, **36**(1), 39–47.
- [3] MOORREES C. (1959) The dentition of the growing child: A longitudinal study of dental development between 3 and 18 years of age, Cambridge, Harvard University Press, **138**(4), 496–499.
- [4] TOWNSEND G. C., N. G. MARTIN (1992) Fitting Genetic Models to Carabelli Trait Data in South Australian Twins, *J. Dent. Res.*, **71**(2), 403–409.
- [5] GARN S. M., A. B. LEWIS, D. R. SWINDLER, R. S. KERESKY (1967) Genetic control of sexual dimorphism in tooth size, *J. Dent. Res.*, **46**(5), 963–972.
- [6] BROOK A. H., J. JERNVALL, R. N. SMITH et al. (2014) The dentition: the outcomes of morphogenesis leading to variations of tooth number, size and shape, *Aust. Dent. J.*, **59**, 131–142.
- [7] JIALIN L., L. YANSHI, W. JIAN et al. (2021) Dental measurements based on a three-dimensional digital technique: A comparative study on reliability and validity, *Archives of Oral Biology*, **124**, 105059.
- [8] NUGRAHANI F. (2017) Comparison of conventional study model measurements and 3D digital study model measurements from laser scanned dental impressions, *J. Phys.: Conf. Ser.*, 884 012060.

- [9] JABER S. T., M. Y. HAJEER, K. W. ALKHOULI et al. (2024) Evaluation of Three-Dimensional Digital Models Formulated from Direct Intra-oral Scanning of Dental Arches in Comparison with Extra-oral Scanning of Poured Dental Models in Terms of Dimensional Accuracy and Reliability, *Cureus*, **16**(2), e54869.
- [10] YORDANOV Y. A. (2017) *Anthropology Guide for Medicine, Dental medicine and Biology, "Classic and style" OOD*, ISBN: 978-954-327-105-4, (in Bulgarian).
- [11] ASTETE J. C., V. J. SAN PEDRO, G. I. SUAZO (2009) Sexual Dimorphism in the Tooth Dimensions of Spanish and Chilean peoples, *Int. J. Odontostomat.*, **3**(1), 47–50.
- [12] ATEŞ M., F. KARAMAN, M. Y. İSCAN, T. L. ERDEM (2006) Sexual differences in Turkish dentition, *Leg. Med. Tokyo*, **8**, 288–292.
- [13] DEEPAK V., S. N. GORYAWALA, Y. REDDY et al. (2015) Assessment of Ethnicity in Indian Population using Tooth Crown Metric Dental Traits, *JIOH*, **7**(9), 83–87.
- [14] BROOK A. H. (1984) A unifying aetiological explanation for anomalies of human tooth number and size, *Arch. Oral Biol.*, **29**(5), 373–378.
- [15] SMITH T. M., A. J. OLEJNICZAK, D. J. REID et al. (2006) Modern human molar enamel thickness and enamel-dentine junction shape, *Arch. Oral Biol.*, **51**(11), 974–995.
- [16] SAUNDERS S. R., A. H. CHAN, B. KAHNEN et al. (2007) Sexual dimorphism of the dental tissues in human permanent mandibular canines and third premolars, *Am. J. Phys. Anthropol.*, **133**, 735–740.
- [17] LAKHANPAL M., N. GUPTA, N. C. RAO, S. VASHISTH (2013) Tooth dimension variations as a gender determinant in permanent maxillary teeth, *JSM Dentistry*, **1**(1), 1014–1017.
- [18] NARANG S. R., S. A. MANCHANDA, S. BALWINDER (2015) Sex assessment by molar odontometrics in North Indian population, *J. Forensic Dent. Sci.*, **7**, 54–58.
- [19] NIKOLA M. T. (1992) Sexual dimorphism of tooth crown diameters. A contribution to the determination of the sex of subadult individuals from the early bronze age graveyard of Franzhausen I, lower Austria, *Anthropol. Anz.*, **50**(1–2), 51–65.
- [20] PECKMANN T. R., C. LOGAR, C. E. GARRIDO-VARAS et al. (2015) Sex determination using the mesio-distal dimension of permanent maxillary incisors and canines in a modern Chilean population, *Science and Justice*, **56**(2), 84–89.

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