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Study of the Facial Index in Young Bulgarians by 3D laser Scanning

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The aim of the present study was to provide information about the type of face in young Bulgarian adults. The three-dimensional coordinates of several soft-tissue landmarks on the face were obtained using hand-held laser scanner in 95 healthy individuals (46 males and 49 females) of Bulgarian origin aged 21-30 years. From the landmarks bizygomatic breadth and morphological face height were calculated and averaged for sex. The face was classified into five different types based on the values of facial index, according to the categories of Garson. For morphological facial index most of the males fell in the categories mesoprosop – 30.43 % and leptoprosop – 26.09 % and females in the category leptoprosop - 38.78%. Equal percentages of the females fell in the categories mesoprosop and hyperleptoprosop - 26.53%. The data obtained in the present study can be used in aesthetic and maxillofacial surgery, forensic anthropology.

***Key words**:* 3D laser scanning, facial index, Bulgarians

Introduction

The quantitative facial characteristics have been subject of research in many studies of gender differences and ethnic characteristics in different populations [2, 17, 21].

Data providing information on the shape, size and proportions of the face are used in fields of medicine - rhinoplasty, maxillofacial and aesthetic surgery. The methods of identification in forensic medicine are based on the anthropological characteristics of the subject and must be based on reliable comparative measurements [7, 12, 14].

The data on the facial morphology in different age groups of the Bulgarian population obtained so far have been compiled by the methods of classical direct cephalometry [10, 11, 20]. With the development of new computer technologies, creation of three-dimensional digital images of the face became possible. Digital cephalometry is a fast and non-invasive method that avoids the compression of soft tissues, the possibility of making mistakes when repeatedly collecting data from the subjects [15].

The **aim** of this study was to evaluate the facial index in young Bulgarians and to determine the dominant facial type using 3D laser scanning.

Material and Methods

Subjects: The sample included 95 healthy Bulgarians (46 males and 49 females) aged 21-30 years, who had no history of surgery, facial injury, craniofacial anomalies, and mental disorders. Subjects with different ethnicity were excluded from the study. The study was conducted in accordance with the **Declaration of Helsinki Ethical** Principles for research involving human subjects. The participants gave their informed consent to participate in the study after the aim and procedures had been priorly explained.

Collection of three-dimensional landmarks*:* Three-dimensional images were obtained from each subject using a hand-held laser scanner (FastSCAN Cobra, Polhemus Inc., Colchester VT). The scanner incorporates motion tracking technology to achieve 3D computer reconstruction of the subject's face. Two sensors, one attached to the optics and another to a headband, are used to track both the position of the optics and any movement of the subject's head. Following instruction to keep eyes (for safety) and mouth (for uniformity) closed and to maintain a blank expression, the stripe of low intensity laser light is manually swept smoothly over the subject's face. Four vertical sweeps are generally used to record the entire facial surface. Captured data are postprocessed to produce a single surface dataset; postprocessing parameters can be varied to alter the resolution of the final surface [4].

On each of the obtained images a set of anthropometric landmarks were placed: nasion (n); gnathion (gn); zygion (zy_r, zy_l) [18]. The procedure was performed by a single operator (**Fig. 1**). Using these three-dimensional landmarks, the bizygomatic breadth (zy_r-zy_l) and morphological facial height (n-gn) were measured (**Table 1**). The measurements were used to calculate **the morphological facial index** = morphological facial height (n-gn) / bizygomatic breadth (zy_r-zy_l) × 100. According to the values obtained for morphological facial index the subjects were divided into categories after Garson [Cited by 20].

Males	*Females*
Hypereuriprosop = x – 78.9	**Hypereuriprosop** = x – 76.9
Euriprosop = 79.0 – 83.9	**Euriprosop** = 77.0 – 80.9
Mesoprosop = 84.0 – 87.9	**Mesoprosop** = 81.0 – 84.9
Leptoprosop = 88.0 – 92.9	**Leptoprosop** = 85.0 – 89.9
Hyperleptoprosop = 93.0 – x	**Hyperleptoprosop** = 90.0 – x

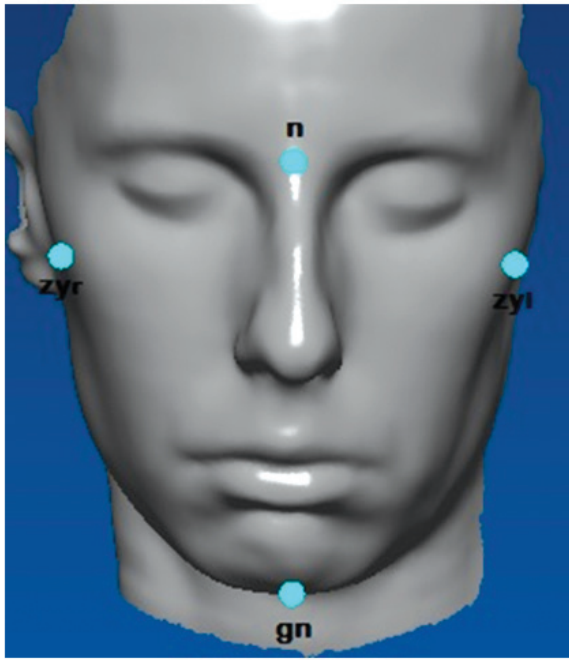

Fig. 1. Facial landmarks on three-dimensional image**.**

Table 1. Description of the facial landmarks and measurements

Landmarks/ Measurements	**Description**
Nasion (n)	A point located on the soft tissue contour at the base of the root of the nose at the level of the frontonasal suture.
Gnathion (gn)	The lowest point in the middle of the lower border of the chin.
Zygion (zy_r, zy_l)	The most lateral point of the soft tissue contour on each of the zygomatic arches.
Bizygomatic breadth	The linear distance between the two points zygion (zy_r-zy_l)
Morphological face height	The linear distance between nasion to gnation (n-gn)

Statistics: Descriptive statistics (mean±standard deviation / proportion±standard error), independent samples t-test (to compare the means between two unrelated groups on the same continuous normally distributed variables), Mann-Whitney U test (to compare two distributions in independent samples) and two-samples z-test (to compare two independent proportions) were used for the data analysis. Statistical significance was set at $\alpha \leq 0.05$. Intra-rater reliability was measured with Cohen's kappa coefficient (κ) in SPSS (Kappa value = 0.823.3).

Results

The measurements of the bizygomatic breadth (zy_r-zy_l) and morphological facial height (n-gn) of the sample subjects are presented on **Table 2.** These were used to determine the morphological facial index in males and females (**Table 2**). The values of the morphological facial index allowed to define the incidence of the facial phenotypes. The results from the categorization of males and females according to the morphological facial index are shown in **Table 3**.

Table 2. The craniofacial parameters of the examined subjects

Variable	Sex	Mean	SD	Min	Max	Statistical significance
Morphological face height (mm)	males	126.18	6.73	113.46	136.56	p<0.001
	females	117.99	7.18	103.99	134.04	
Bizygomatic breadth (mm)	males	146.25*	11.24**	129.68	168.07	p<0.001***
	females	135.41*	7.16**	123.47	151.26	
Morphological facial index	males	85.90	6.08	72.45	101.82	p>0.05
	females	87.20	4.80	76.68	101.48	

* median – in case of incorrect distribution of data
** interquartile range
*** Mann-Whitney U test

Table 3. Morphological facial index. Distribution of the individuals into categories (after Garson)

Categories	Males n, (%)	Females n, (%)	Statistical significance
hypereuriprosop	6, (13.04)	1, (2.04)	**p<0.05**
euriprosop	9, (19.57)	3, (6.12)	**p<0.05**
mesoprosop	14, (30.43)	13, (26.53)	p>0.05
leptoprosop	12, (26.09)	19, (38.78)	p>0.05
hyperleptoprosop	5, (10.87)	13, (26.53)	p>0.05
Total	**46 (100)**	**49 (100)**	

Most of the males fell into the categories mesoprosop – 30.43 % and leptoprosop – 26.09%. In the categories euriprosop, hypereuriprosop and hyperleptoprosop the males were at lower percentages – 19.57%, 13.04% and 10.87%, respectively. Most of the female subjects were in the category leptoprosop – 38.78%. Equal percentages

were found for categories mesoprosop and hyperleptoprosop – 26.53%. Only 6.12% and 2.04% of the females fell into the categories euriprosop and hypereuriprosop. Statistically significant differences between genders were found in two of the categories – hypereuriprosop (z=2.1, p=0.040) and euriprosop (z=2.0, p=0.049).

Discussion

The morphological facial index gives an idea of the length-width proportions of the face. So far, the study of the faces of Bulgarian males and females has been carried out using the methods of classical direct cephalometry. The results obtained by us through this new three-dimensional method for analysis of facial morphology are close to those obtained in previous studies [20]. The largest percentage of males in both studies fall into the categories of mesoprosop and leptoprosop. In the previous study, the highest percentage of males was with medium, long and very long faces. In our results, the highest percentage of males was with medium, long and wide faces. In both studies, the largest percentage of females has long, very long and medium faces.

In a study of the morphological facial index in Serbian males and females, the highest percentage of subjects were in the category leptoprosop – 76.6% and 87.06%, respectively. Mesoprosop and hyperleptoprosop facial types (medium and very long narrow faces) presented at low percentage. No euriprosops and hypereuriprosops (short broad face and very short broad face) were found [6]. In a study of the facial shape types in the Turkish population mesoprosops and euriprosops were found to be the dominant facial types (medium and short broad face). Hypereuriprosops (very short broad faces) occurred at a lower but still relatively high percentage [13]. In a study of Chinese students most of the females had leptoprosop facial type, while males presented mostly as mesopropops [1]. In a study of Nepalese males and females the dominant facial types were leptoprosop and hyperleptoprosop (long narrow face and very long narrow faces) [16]. The same dominant facial type was found in Indian males [3]. In a study evaluating the sexual difference and variation of facial index among Kashmiri population males were mostly with leptoprosopic face, while females with mesoprosopic face [8]. In Malaysian males and females, the dominant facial type was mesoprosop [19]. A research of three ethnic groups in Nigeria found that the dominant facial type in both genders was hyperleptoprosop (very long narrow faces), occurring at very high percentage in females [9]. In a study of Japanese students, the dominant facial type in females was euriprosop and mesoprosop [5]. These studies indicate that considerable ethnic and racial variation exists in facial index and in most populations significant sexual difference is present.

Conclusion

The results obtained in our study show that the most common facial type in males is mesoprosop and in females is leptoprosop. The second common facial type in males is leptoprosop and in females mesoprosop and hyperleptoprosop. The data for the facial proportional analysis in the different populations can be used in the planning and reporting the results in the aesthetic and maxillofacial surgery.

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