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STUDY OF THE FACIAL MORPHOLOGY OF YOUNG BULGARIANS WITH 3D LASER SCAN

Ts. Petleshkova[1], H. Manev[4], S. Sivkov[1], P. Timonov[2], A. Baltadjiev[1], R. Raycheva[3]

[1]Department of Anatomy, Histology and Embryology, Faculty of Medicine, Medical University of Plovdiv, Plovdiv, Bulgaria
[2]Department of Forensic Medicine and Deontology, Faculty of Medicine, Medical University of Plovdiv, Plovdiv, Bulgaria
[3]Department of Social Medicine and Public Health, Faculty of Medicine, Medical University of Plovdiv, Plovdiv, Bulgaria
[4]Department of Medical Informatics, Biostatistics and E-learning, Faculty of Medicine, Medical University of Plovdiv, Plovdiv, Bulgaria

ABSTRACT

AIM: The aim of study was to make a cephalometric characterization of young Bulgarians using 3D laser scan. MATERIALS AND METHODS: The study included 46 males and 49 females of Bulgarian origin aged 21-30 years. Three-dimensional images were obtained using a hand-held laser scanner (FastSCAN Cobra, Polhemus Inc., Colchester VT). A set of probing points on the obtained images were used to make certain facial measurements: morphological face height, physiognomical upper facial height, lower face height. The data were statistically analyzed in SPSS 17.0. RESULTS: The facial measurements were significantly greater in males than in females. For morphological facial height most of the individuals were in very high category. For physiognomical upper facial height majority of males were in category high and females in moderate high. Regarding lower facial height most of the individuals were assessed as metriognath. CONCLUSION: The data obtained characterizing facial morphology can be used as criteria in genetic disorders diagnosis and outcome assessment in aesthetic and reconstructive surgery.

Key words: Digital anthropometry, face, categorization

INTRODUCTION

Direct classical anthropometry is a basic method of cephalometric analysis of the face that continues to be used as a tool by many researchers. With the advent of new computer technologies, it is possible to create three-dimensional digital images of the face, in which it is possible to make a quantitative analysis of the volume and area of individual facial structures - eyes, nose, mouth and lips, chin and ears (1). Three-dimensional soft tissue analysis of the face is used for assessment of morphological changes and gender differences occurring during growth (2-5), generation of a worldwide database of measurements of a person of known chronological age, gender and ethnicity (6-9), providing useful information in facial reconstruction of unidentified persons and lost kids (10-11). Facial proportional analysis is an important component in the pre-operative evaluation in plastic and aesthetic surgery (12-14).

***Correspondence to**: *Tsvetanka Petleshkova, MD, Department of Anatomy, Histology and Embryology, Faculty of Medicine, Medical University of Plovdiv, 15A Vassil Aprilov Blvd.,4002 Plovdiv, Bulgaria, tel./fax: +359888007855, e-mail: cecka_pet@abv.bg*

AIM

The aim of the present study was to make a cephalometric characterization of young Bulgarian individuals using 3D laser scanning.

MATERIAL AND METHODS

The study included 46 males and 49 females of Bulgarian ancestry aged 21-30 years. Three-dimensional images were obtained using a

handheld laser scanner (FastSCAN Cobra, Polhemus Inc., Colchester VT). A set of probing points were placed on the obtained images: nasion, stomion and gnathion (15) **(Figure 1).** Using these points certain linear facial measurements were taken: morphological facial height (mm) – n-gn, physiognomical upper facial height (mm) – n-sto, lower facial height (mm) – sto-gn (16).

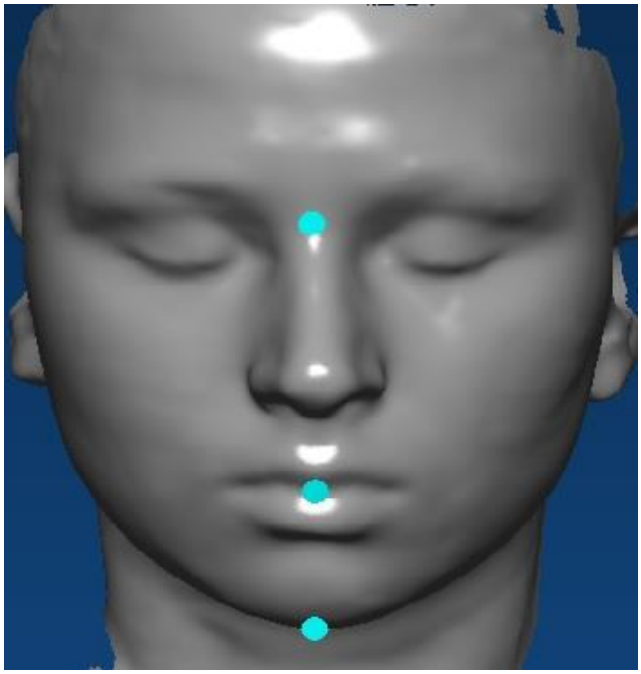

Figure 1. Landmarks placed on the obtained imagines

Descriptive statistics (mean±standard deviation / proportion±standard error), t-test (numeric variables) and z-test (categorical variables) were used for data analysis. Significance was set at $p<0.05$.

RESULTS AND DISCUSSION

The males have greater facial measurements than the females with difference reaching statistical significance for all variables ($p<0.001$) **(Table 1).**

Table 1. *Linear measurements of the face.*

Variable (mm)	sex	N	mean	SD	SEM	Absolute difference	min	max	p
n-gn	males	46	126,18	6,73	0,99	8,19	113,46	139,56	p<0,001
	females	49	117,99	7,18	1,03		103,99	134,04	
sto-gn	males	46	48,41	4,82	0,71	4,33	37,22	63,09	p<0,001
	females	49	44,08	4,15	0,59		37,10	53,12	
n-sto	males	46	79,74	4,07	0,60	3,56	73,33	88,98	p<0,001
	females	49	76,18	5,24	0,75		67,52	94,55	

To verify the results obtained by 3D laser scanning, these were compared with literature data obtained by classical direct anthropometry, finding similar values in males and females in terms of the three facial sizes examined **(Table 2, Table 3).**

Table 2. *Comparison between the facial measurements in Bulgarians obtained using 3D laser scanning with literature data obtained using classical anthropometry.*

Variable (mm)	Author	Method	Males mean/SD	P
n-gn	Present study	3D laser scanning	126,18±6,73	p>0,05
	Yordanov, 2006	Direct anthropometry	126,6±6,7	
n-sto	Present study	3D laser scanning	79.74±4.07	p>0,05
	Yordanov, 2006	Direct anthropometry	78,8±4,9	
sto-gn	Present study	3D laser scanning	48.41±4.82	p>0,05
	Yordanov, 2006	Direct anthropometry	47,8±4,5	

Table 3. *Comparison between the facial measurements in Bulgarians obtained using 3D laser scanning with literature data obtained using classical anthropometry.*

Variable (mm)	Authors	Method	Females mean/SD	P
n-gn	Present study	3D laser scanning	117,99±7,18	P<0,05
	Yordanov, 2006	Direct anthropometry	116,2±6,1	
n-sto	Present study	3D laser scanning	76.18±5.24	P<0,001
	Yordanov, 2006	Direct anthropometry	73,4±4,6	
sto-gn	Present study	3D laser scanning	44.08±4.15	P<0,05
	Yordanov, 2006	Direct anthropometry	42,8±3,9	

For morphological facial height most of the males fell in the category very high - 73.9%. In the categories low and moderate high males presented with close percentages - 15.2% and 10.9%, respectively. No individuals fell in the categories - very low face and high face. In the females most of the subjects were in the category very high - 38.8%. Close percentages were found for categories high and moderate high - 28.6% and 26.5%, respectively. Only 6.1% of the females fell in the category low face, and none in the category very low face **(Table 4).** Statistically significant between sex differences were found in two of the categories – high face and very high face ($p<0.001$). In the physiognomic upper facial height, most of the males were in the categories high and moderate high - 63.0% and 30.4%, respectively. In the category very high face males presented with low percent - 6.5%, whereas no individuals were found in the categories very low and low. The females, unlike the males, showed the highest percentage in the categories moderate high and high - 53.1% and 44.9% respectively. The percentage in the category very high was insignificant - 2%, and no females were found in the categories low and very low **(Table 5)**. Statistically significant between sex difference was found in the category moderate high ($p<0.05$). For the lower facial height, the highest percentage of the males was found in the categories metriognath - 56.5% and hypsignath - 37.0%. The percentage of the males in the categories tapeinognath and hyperhypsignath was insignificant - 4.3% and 2.2%, respectively. Hypertapeinognath were not found. In the females most of the subjects were in the category metriognath - 67.3%, being significantly higher than the females in the categories hypsignath -14.3% and tapeinognath - 18.4%. None of the females in our sample fell in the categories hypertapeinognath and hyperhypsignath **(Table 6)**. Between sex differences in the category distribution reached statistical significance ($p<0.05$) for two of the categories – tapeinognath and hypsignath.

Table 4. *Morphological face height (n-gn). Distribution of the studies individuals after Lebzelter-Saller' categories.*

Categories	Males %	Females %	p
very low	0	0	P > 0,05
low	15,2	6,1	P > 0,05
moderate high	10,9	26,5	P > 0,05
high	0	28,6	P < 0,001
very high	73,9	38,8	P < 0,001

Table 5. *Physiognomical upper facial height (n-sto).Distribution of the studied individuals after Lebzelter-Saller'categories.*

Categories	Males %	Females %	p
very low	0	0	P > 0,05
low	0	0	P > 0,05
moderate high	30,4	53,1	P < 0,05
high	63,0	44,9	P > 0,05
very high	6,5	2,0	P > 0,05

Table 6. *Lower facial height (sto-gn). Distribution of the investigated individuals after Schlaginhaufen' categories.*

Categories	Males %	Females %	p
hypertapeinognath	0	0	P > 0,05
tapeinognath	4,3	18,4	P < 0,05
metriognath	56,5	67,3	P >0,05
hypsignath	37,0	14,3	P < 0,05
hyperhypsignath	2,2	0	P > 0,05

The results obtained were compared with the results of a national study (17) including adult individuals from both sexes of Bulgarian origin aged between 30 and 40 years. With respect to the morphological facial height the results showed statistically significant differences ($p<0.05$) for males in four of the categories - high, very high, low and moderate high. In our study, the highest percentage of males fell in the category very high - 73.9%, while in the control study the males fell almost equally in the categories very high and high were close, respectively 33.6% and 33.5% **(Table 7).** In females no statistically significant difference ($p> 0.05$) was found in the categories between the two studies. In our study most of the females were in the category very high - 38.8%, while in the control one most were in the category high - 38.5% **(Table 8).** For the physiognomic facial height, the males from the two studies presented with similar category distribution ($p>0.05$). In both studies, most of the males were in the category high, 63.0% and 60.6% respectively **(Table 9).** In females, statistically significant difference ($p<0,05$) was found in two of the categories – moderate high and high. The highest percentage of them falls into the category of moderate high - 53.1% in our study and 69.1% in the control study **(Table 10)**. No statistically significant differences ($p>0.05$) were found in the category distribution of physiognomic lower facial height between males from the two studies. Most of the males were metriognath, with the percentage being 56.5% in our study and 62.2% in the control one **(Table 11).** Regarding this indicator, the differences in category distribution between the females from the two studies were statistically significant ($p<0.05$) in the hypsignath category. Most of the females fell in metriognath category - 67.3% in our study and 78.3% in the control one **(Table 12).**

Table 7. *Morphological face height (n-gn). Comparison of the categorization between the present study and the study by Yordanov et al., 2006*[*]

Categories	Males %	Males* %	p
very low	0	1,2	P > 0,05
low	15,2	7,4	P < 0,05
moderate high	10,9	24,3	P < 0,05
high	0	33,5	P < 0,05
very high	73,9	33,6	P < 0,05

Table 8. *Morphological face height (n-gn). Comparison of the categorization between the present study and the study by Yordanov et al., 2006**

Categories	Females %	Females* %	p
very low	0	1,2	P > 0,05
low	6,1	5,9	P > 0,05
moderate high	26,5	25,2	P > 0,05
high	28,6	38,5	P > 0,05
very high	38,8	29,2	P > 0,05

Table 9. *Physiognomical upper face height (n-sto). Comparison of the categorization between the present study and the study by Yordanov et al., 2006**

Categories	Males %	Males* %	p
very low	0	0	P > 0,05
low	0	0,5	P > 0,05
moderate high	30,4	32,4	P > 0,05
high	63,0	60,6	P > 0,05
very high	6,5	6,4	P > 0,05

Table 10. *Physiognomical upper face height (n-sto). Comparison of the categorization between the present study and the study by Yordanov et al., 2006**

Categories	Females %	Females* %	p
very low	0	0	P > 0,05
low	0	6,6	P > 0,05
moderate high	53,1	69,1	P < 0,05
high	44,9	23,9	P < 0,05
very high	2,0	0,5	P > 0,05

Table 11. *Lower face height (sto-gn). Comparison of the categorization between the present study and the study by Yordanov et al., 2006**

Categories	Males %	Males* %	p
hypertapeinognath	0	0	P > 0,05
tapeinognath	4,3	3,3	P > 0,05
metriognath	56,5	62,2	P >0,05
hypsignath	37,0	33,9	P >0,05
hyperhypsignath	2,2	0,7	P > 0,05

Table 12. *Lower face height (sto-gn). Comparison of the categorization between the present study and the study by Yordanov et al., 2006**

Categories	Females %	Females* %	p
hypertapeinognath	0	0,2	P > 0,05
tapeinognath	18,4	17,5	P > 0,05
metriognath	67,3	78,3	P > 0,05
hypsignath	14,3	4,0	P < 0,05
hyperhypsignath	0	0	P > 0,05

CONCLUSION

Males present with greater values than females in the three studied facial measurements. The categorization shows that most of males and females have very high morphological facial height. The physiognomical upper facial height in mostly high in males is moderate high in females. In terms of lower facial height, subjects from both sexes fall into the metriognath category. Compared to literature data, the most significant differences are found in the morphological facial height categorization in males. Comparing the data obtained with 3D laser scanning and classical anthropometry, close values of the facial measurements are found in both sexes.

The data obtained characterizing facial morphology can serve as criteria for dysmorphological distinctions in genetic diseases and assessment in surgical interventions in aesthetic and reconstructive surgery.

REFERENCES

1. Sforza Ch. and Ferrario V. Soft-tissue facial anthropometry in three dimensions: from anatomical landmarks to digital morphology in research, clinics and forensic anthropology. *Journal of Anthropological Sciences* , 84:97-124, 2006
2. Nute S. J. and Moss J. P. Three-dimensional facial growth studied by optical surface scanning. *J Orthod*, 27(1):31-38, 2000
3. Kau C. H., Zhurov A., Richmond S. et al. The 3-dimensional construction of the average 11-year-old child face: a clinical evaluation and application. *J Oral MaxillofacSurg*, 64(7):1086-1092, 2006
4. Toma A.M., Zhurov A.I., Playle R. et al. The assessment of facial variation in 4747 British school children. *Eur J Orthod*, 34(6):655-664, 2012
5. Bugaighis I., Mattick C. R., Tiddeman B., Hobson R. Three-dimensional gender differences in facial form of children in the North East of England. *Eur J Orthod*, 35(3):295-304, 2013
6. Kau C. H., Richmond S., Zhurov A. et al. Use of 3-dimensional surface acquisition to study facial morphology in 5 populations. *Am J OrthodDentofacialOrthop*, 137(4 Suppl):S56.e1-9, 2010
7. Wirthlin J., Kau C.H., English J.D. et al. Comparison of facial morphologies between adult Chinese and Houstonian Caucasian populations using three-dimensional imaging. *Int J Oral MaxillofacSurg*, 42(9):1100-1107, 2013
8. Talbert L., Kau C.H., Christou T. et al. A 3D analysis of Caucasian and African American facial morphologies in a US population. *J Orthod*, 41(1):19-29, 2014
9. daSilvaA., Andrade L. and Da Silva M. Three-dimensional analysis of facial morphology in Brazilian population with Caucasian, Asian, and Black ethnicity. *Journal of Oral Research and Review*, 9 (1):1-7, 2017
10. Koudelová J., Dupej J., Brůžek J. et al. Modelling of facial growth in Czech children based on longitudinal data: Age progression from 12 to 15 years using 3D surface models. *Forensic SciInt*, 248:33-40, 2015
11. Cummaudo M., Guerzoni M., Gibelli D. et al. Towards a method for determining age ranges from faces of juveniles on photographs, *Forensic SciInt*, 239:107, 2014
12. Al-Sebaei M.O. The validity of three neo-classical facial canons in young adults originating from the Arabian Peninsula. *Head Face Med*, 11:14, 2015;
13. Zacharopoulos G.V., Manios A., De Bree E. et al. Neoclassical facial canons in young adults. *J CraniofacSurg*, 23(6):1693-1698, 2012
14. Jayaratne Y. S., Deutsch C. K., McGrath C. P., Zwahlen R. A. Are neoclassical canons valid for southern Chinese faces? *PLoS One*, 7(12):e52593, 2012
15. Swennen G.R.J., Schutyser F., Hausamen J.E. Three-Dimensional Cephalometry: a Color Atlas and Manual. Heidelberg: Springer; 2006.
16. Йорданов Й. Антропология, Класика и стил, София, 2017.
17. Yordanov Y., Nacheva A., Tornjova-Randelova S., Kondova N., Dimitrova B., Paskova-Topalova D., Anthropology of the Bulgarian population at the end of the 20th century (30-40 years old persons). Professor Marin Drinov Academic publishing house, Sofia, 2006