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Distribution of Craniofacial Variables in South Dalmatian and Middle Croatian Populations

V. Njemirovskij¹, Z. Radović², D. Komar¹, B. Lazić³ and Ti. Kuna⁴

¹ Department of Dental Anthropology, School of Dental Medicine, University of Zagreb, Zagreb, Croatia

² Medical Centre Dubrovnik, Dubrovnik, Croatia

³ Department of Prosthetics, School of Dental Medicine, University of Zagreb, Zagreb, Croatia

⁴ Department of Oral Surgery, School of Dental Medicine, University of Zagreb, Zagreb, Croatia

ABSTRACT

The objective of the present work was to determine some relevant craniofacial parameters, particularly in relation to sex, for the study of the distribution of basic head and face types, and to investigate craniofacial and morphological differences between two population samples. The study sample comprised 100 subjects of both sex aged 18 to 30 from South Dalmatia and 200 subjects from Middle Croatia. Eight basic craniofacial variables were measured to obtain head, forehead and face indexes. The data indicate that average values of all variables can be used as standard craniofacial parameters for the examined population groups. All the craniofacial variables are considerably higher in men than in women ($p < 0.05$). In the South Dalmatian population mesocephalia (48.0%) and leptoprosopia (82.0%) prevail, while in the Middle Croatian population the brachycephalia (62.0%), and euriprosopia (73.5%) are present to a greater degree. The most significant craniofacial and morphological differences between the examined study samples are head width (Eu–Eu), face width (Zy–Zy), and forehead height (Tr–N). They were found to be statistically significant in the examined Middle Croatian population ($p < 0.05$). The presented measurements are highly relevant to orthodontic diagnostics and therapy.

Introduction

The evaluation of morphological changes in the craniofacial complex has be-

come more sophisticated in the past three decades, as evidenced by progression

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from the subjectivity of anthroposcopy to the objectivity of anthropometry. In addition to the classic linear measurements of the head and face¹, new and modified craniofacial measurements have been formulated to analyze morphological changes and craniofacial variables^{2–5}. The correlation between cephalometric and gnathometric as well as odontometric variables was obvious; consequently, it became the basis of the orthodontic diagnosis. The growth and development of the craniofacial system was studied by the longitudinal method. The correlation between shapes, dimensions of the tooth arch, cranium and physiognomy was established as well as the correlation between numerous craniofacial and physical parameters.

The data concerning craniometric and gnathometric measurements in the analyzed population samples and especially those on changes in dynamics point to a secondary trend influencing the alterations in the head and face morphology^{6–8}. Connected with this, the head indexes have been decreasing mostly due to the elongation process and, consequently, a moderate transition from hyperbrachycephalia to brachycephalia has been noticed.

The objectives of the study were:

- to investigate and clarify the basic norms of craniofacial indicators in a South Dalmatian population sample and their variability related to sex; to compare the obtained values with those for a Middle Croatian population;
- having in mind the basic values of specific variables, to calculate the head, face and forehead indexes and determine the frequency of basic craniofacial types, and to compare them with those for the Middle Croatian population;
- on the basis of the head and face indexes to point to the basic craniofacial types in the South Dalmatian popula-

tion and compare them with the data obtained for the population in Middle Croatia.

Material and Methods

The study was carried out at the Department of Orthodonty, School of Dentistry at the Zagreb University and a Medical Centre in Dubrovnik. The consistency of measurements was tested by report examinations usually twice, over a brief period as recommended in the past⁹. The South Dalmatian sample (G1) included 100 objects aged 18 to 30 years (47 men and 53 women). The data on craniofacial measurements in 200 subjects from Middle Croatia aged 18 to 30 years served as controls (G2).

- Following the definitions of Martin and Saler¹ the measurements were taken by an anthropological cephalometer GMP, with measurement interval of 300 mm and accuracy of 1 mm, and a sliding rule modified for cephalometric and gnathometric measurements. The following variables were measured:
- maximum head length (glabella-opistocranium, G–Op),
- the greatest head width (eurion-aurion, Eu–Eu),
- forehead width (frontotemporale-frontotemporale, Ft–Ft),
- face width (zygion-zygion, Zy–Zy),
- inferior face width (gonion-gonion, Go–Go),
- face height (nasion-gnation, N–Gn),
- inferior face segment height (nasion-prosthion, N–Pr),
- forehead height (trichion-nasion, Tr–N).

Head indexes were calculated by

$$HI = \frac{Eu - Eu}{G - Op} \times 100, \text{ forehead index after}$$

$$FI = \frac{Tn - N}{Ft - Ft} \times 100, \text{ and face index after}$$

$$FOI = \frac{N - Gn}{Zy - Zy} \times 100.$$

In the category of head types the distribution of the basic head indexes was as follows:

Hyperdolicocephalic	x-70.9	x-71.9
Dolichocephal	71.0-75.9	72.0-76.9
Mesocephalic	76.0-80.9	77.0-81.9
Brachycephalic	81.0-85.4	82.0-86.4
Hyperbrachycephalic	85.5-90.9	86.5-91.9
Ultrabrachycephalic	91.0-x	92.0-x

In the category of the facial types the distribution of the mean basic face indexes was as follows:

Hypereuriprosop	x-78.9	x-76.9
Euryprosop	79.0-83.9	77.0-80.9
Mesoprosop	84.0-87.9	81.0-84.9
Leptoprosop	88.0-92.9	85.0-89.9
Hyperleptoprosop	93.0-x	90.0-x

The obtained data were analyzed in terms of basic statistical parameters. All the variables were tested with regard to sex and their correlations were analyzed. The distribution of the basic craniofacial types was calculated in both absolute and relative values. The evaluation of arithmetic mean for both population groups was made by t-test. The discriminant analysis was made to identify the variables that best differentiate the two study groups.

Results

General statistical analysis of basic parameters, correlation analyses, arithmetic means and discriminant analysis indicated differences between the compared population groups. The results are shown in Tables 1–4.

The correlation analysis pointed at different relationships between the craniofacial variables. The complete review

of mean values and standard deviations by sex and for the total number of study subjects is presented in Table 1. The data for both population groups show that the most significant differences are those referring to the forehead width (Ft–Ft), face width (Zy–Zy), and forehead height (Tr–N). In the South Dalmatian sample the forehead width is lower than in the Middle Croatian population sample.

The distribution of the common head shapes based on cephalic indexes of the investigated population samples is expressed in both absolute and relative values (Table 2).

Table 3 shows the distribution of the main facial types based on facial indexes, also shown in both absolute and relative frequencies for both population samples. In South Dalmatians leptoprosopia is dominant, while in Middle Croatians euriprosopia is more frequent.

It is important to stress here that the South Dalmatian population sample is characterized by mesocephalia, while in the Middle Croatian population brachycephalia prevails.

The purpose of the discriminant analysis is to show the variables that best discriminate the study groups (Table 4).

Discussion and Conclusions

The obtained results are discussed in view of the performed statistical analysis. The mean values and variables of the selected parameters in both population groups show the following characteristics:

Mean values of all basic parameters in both study groups are higher in men and the differences are statistically significant ($p < 0.05$). Many authors have noticed quantitative differences between sexes for particular craniofacial measurements^{10–14}.

TABLE 1
MEAN VALUES AND STANDARD DEVIATION DISTRIBUTION BY SEX AND FOR TOTAL NUMBER
OF STUDY SUBJECTS (GROUP 1 AND GROUP 2)

G1												
	n	G–OP	Eu–Eu	Zy–Zy	Go–Go	N–Gn	N–Pr	Ft–Ft	Tr–N	HI	FI	FOI
S	100	186.67	150.54	124.09	105.91	115.45	68.77	119.75	62.40	80.81	93.37	52.23
		7.76	5.99	8.63	7.32	7.48	4.47	8.36	7.78	3.34	6.86	5.72
M	47	191.23	153.65	128.49	109.13	120.51	71.55	123.34	66.89	80.63	94.12	54.31
		7.07	5.42	8.60	7.47	5.72	3.11	7.61	7.50	3.49	7.0	5.91
F	53	182.62	147.77	120.18	103.05	110.96	66.30	116.56	54.41	80.97	92.70	50.38
		5.91	5.09	6.59	5.91	5.83	4.45	7.73	5.57	3.22	6.72	4.89

G2												
	n	G–OP	Eu–Eu	Zy–Zy	Go–Go	N–Gn	N–Pr	Ft–Ft	Tr–N	HI	FI	FOI
S	200	188.80	155.47	137.07	104.75	109.87	65.95	104.84	70.36	82.26	80.08	70.00
		8.43	7.23	7.42	6.41	7.22	4.56	5.99	6.91	4.49	5.53	4.25
M	100	194.20	159.82	141.41	107.63	114.08	68.13	110.05	72.36	82.00	80.82	68.76
		6.69	6.09	6.78	6.29	6.47	4.55	6.34	6.94	4.95	6.07	4.68
F	100	183.40	151.13	113.34	101.88	105.67	63.79	107.63	68.37	82.51	79.34	71.24
		6.25	5.46	5.64	5.14	5.23	3.41	5.38	6.31	3.98	4.85	3.35

In the Middle Croatian sample slightly higher values were registered for the head length (G–Op) in both sexes than in the South Dalmatian sample. The values were 194.20 vs. 191.23 in men, and 183.40 vs. 182.62 in women. The interpretation of these results should include their comparison with the data obtained in previous investigations of Croatian authors in order to find out possible differences within close localities. The values of the head length (G–Op) e.g. obtained by Gaži-Čoklica¹⁵ were lower because of younger study subjects.

The mean head width value (Eu–Eu) differs significantly in the investigated populations: e.g. in the Middle Croatian sample a higher value of this variable was found for both sexes and the differences are statistically significant ($p < 0.05$), as also confirmed by most authors^{16–20}.

The face width (Zy–Zy) displays significant differences in arithmetic means of both study groups and definitely shows a smaller face width in the South Dalmatian sample than in the Middle Croatian one (124.09 vs. 137.07). On the other hand, the values obtained by measurements in an American population sample are significantly higher than those from both Croatian populations¹⁶.

The mean values of the mandible width (Go–Go) were lower in the Middle Croatian group (104.75 vs. 105.91), but the differences in arithmetic means were not statistically significant. Similar results were obtained also by Gaži-Čoklica¹⁵ and Pilic²¹.

The mean value of the total face height (N–Gn) in the sample from South Dalmatia amounted to 120.51 in men and 110.96 in women showing a significant increase in their face height when com-

TABLE 2
DISTRIBUTION OF BASIC HEAD TYPES IN BOTH STUDY GROUPS

	Sex	n	D	M	B
G1	M	47	4 8.5%	23 48.9%	20 42.6%
	F	53	6 11.13%	25 47.2%	22 41.5%
	M&F	100	10 10%	48 48%	42 42%
G2	M	100	11 11%	20 20%	69 69%
	F	100	8 8%	37 37%	55 55%
	M&F	200	19 9.5%	57 28.5%	124 62%

Legend: D – dolichocephalic, M – mesocephalic, B – brachycephalic.

TABLE 3
DISTRIBUTION OF BASIC SHAPES OF FACE IN BOTH STUDY GROUPS

	Sex	n	E	M	L
G1	M	47	3 6.4%	8 17%	36 17.6%
	F	53	1 1.9%	6 11.3%	46 86.8%
	M&F	100	4 4%	14 14%	82 82%
G2	M	100	76 76%	10 10%	14 14%
	F	100	71 71%	18 18%	11 11%
	M&F	200	147 73.5%	28 14%	25 12.5%

Legend: E – euriprosops, M – mesoprosops, L – leptoprosops.

pared with 114.08 vs. 105.67 values obtained from the Middle Croatian sample.

The results of Gaži-Čoklica¹⁵ show that the Middle Croatian population has significantly smaller face height than the South Dalmatian one. The investigations carried out by Salzman¹⁶ indicate that the American children have larger face

height in relation to South Dalmatians, while Moss²² states that the growth of face width continues in the third and also in the fifth decade of life.

The mean value of the middle face height (N-Pr) is significantly higher in the South Dalmatian sample than in the Middle Croatian one, indicating an in-

TABLE 4
DISCRIMINANT ANALYSIS – STANDARDISED
COEFFICIENTS OF DISCRIMINANT FUNC-
TIONS

Variables	All Dfc	M Dfc	F Dfc
G–Op	–.12	.21	.18
Eu–Eu	–.02	.16	.03
Ft–Ft	.91	–.96	–.85
Zy–Zy	–.94	.74	.86
Go–Go	.25	–.12	–.28
N–Gn	.19	.01	–.21
N–Pr	.23	–.25	–.08
Tr–N	–.43	.38	.45

crease in the face height in South Dalmatia. The arithmetic mean of the face width in the examinees from South Dalmatia is significantly higher than that from the Middle Croatian population sample (119.79 vs.108.84). This variable also exhibits the most significant differences between the two populations.

The mean values for the forehead height (Tr–N) obtained in the Middle Croatian sample are significantly higher (70.36 vs. 62.40), and the same goes for the head indexes (HI), (782.26 vs. 80.81). Cipruš²³ also noticed in the population sample from Rijeka and Gorski Kotar district significantly higher values than those in the South Dalmatian population and similar to those of the Middle Croatian population.

The mean value of the face index (FI) is statistically significantly lower in the examinees of the Middle Croatian region (80.08 vs. 93.37), which was also confirmed by Cipruš²³ and Homan-Dukić²⁴.

The forehead index (FOI) for the South Dalmatian region was 54.31 in men and 50.38 in women, and the values in the Middle Croatian examinees amounted to 71.24 in men and 68.76 in women. Such significant differences are due to a considerably wider and lower

forehead in the sample from South Dalmatia.

The analysis of the distribution of basic head and face types shows the following:

According to the head index (HI) in South Dalmatia 48% was mesocephalia, 42% brachycephalia and 10% dolichocephalia. The distribution was similar for both men and women. This type of the distribution is entirely different from the one obtained in the Middle Croatian population, where brachycephalia prevails, followed by mesocephalia while the percentage of dolichocephalia is similar to that for the South Dalmatian population. The differences in the distribution by sex do not deviate significantly from total differences. The head indexes in the Middle Croatian sample decrease with time and show a tendency of transition from hyperbrachycephalia to brachycephalia. Both Cipruš²³ and Homan-Dukić²⁴ reported similar results to those obtained for the Middle Croatian population.

According to the face index (FI) leptoprosopia is the most frequent feature in the sample from South Dalmatia, followed by mesoprosopia and euriprosopia, the pattern being mostly prominent in women. The comparative distribution of basic face types with those obtained in the Middle Croatian sample, where euriprosopia dominates and is followed by mesoprosopia and leptoprosopia, shows highly significant differences between the two populations. Homan-Dukić²⁴ and Muretić⁴⁵ report about a decrease in the value of the face index, i.e. the so-called secondary trend, suggesting a tendency toward transition from euriprosopia to hypereuriprosopia in the Croatian population. The discriminant analysis was done with the purpose of defining the variables that discriminate both study groups. Taking into account the discriminant function coefficient of all examined subjects it can be said that both pop-

ulation groups clearly differ in the face width ($Zy-Zy$), the size of which is smaller in South Dalmatians, then in the forehead width ($Ft-Ft$) which is larger in South Dalmatians and in the forehead height which is smaller in the same population group. The discriminant analysis for men shows the greatest difference in the forehead width ($Ft-Ft$), the face width ($Zy-Zy$) and the forehead height.

In women the same variables are distributed in the same manner, but with somewhat different distribution of discriminant functional coefficients ($Ft-Ft = 85$; $Zy-Zy = 86$; $Tr-N = 45$).

The results of the discriminant analysis completely agree with those obtained by the classical method of arithmetic differences for all the variables in both population groups. The best analysis of craniofacial characteristics of a given population is provided by longitudinal studies, as described in reference literature^{26–29}. These studies enable the follow-up of growth and development of craniofacial structures and identification of correlation between shapes and dimensions of the skull and physiognomic and somatic features.

The following conclusions can be drawn from the obtained results and their analysis:

- The values of all craniofacial variables can serve as standards for defined population groups.
- The arithmetic mean test of differences for all variables and both study sam-

ples in relation to sex show that craniofacial variables are considerably higher in men than in women, particularly with respect to the forehead index (FOI).

- In the South Dalmatian region the mean value of the head index (HI) for the total sample is 80.81 mm with insignificant differences by sex, indicating the prevalence of mesocephalia. The mean value of the face index (FI) is 93.37 mm often occurring in leptoprosopia. The mean value of the forehead index (FOI) is 52.23 mm. In the Middle Croatian population the mean value of the head index (HI) is 82.26 mm with insignificant differences in relation to sex, indicating the prevalence of brachycephalia. The mean value of the face index (FI) is 80.08 mm, the characteristic feature of euriprosops is 73.55 mm, and the mean value of the forehead index (FOI) is 70.00 mm.
- The testing of differences in arithmetic means of common craniofacial variables between the two population samples shows a statistically significant difference in all variables ($p < 0.05$) except for the head length ($G-Op$) and the mandible width in which the differences are accidental.
- The discriminant analysis has shown that both population samples differ in the forehead width: it is greater in the South Dalmatian population, while the face width is narrower and the forehead height smaller in the same population group.

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V. Njemirovskij

Department of Dental Anthropology, School of Dental Medicine, University of Zagreb, Gundulićeva 5, 10000 Zagreb, Croatia

RASPODJELA KRANIOFACIJALNIH OBILJEŽJA U POPULACIJAMA JUŽNE DALMACIJE I SREDIŠNJE HRVATSKE

SAŽETAK

U radu su ispitane i uspoređene kraniofacijalne varijable u populacijama južne Dalmacije i središnje Hrvatske. Utvrđena je distribucija osnovnih tipova glave i lica te morfološke i kraniofacijalne razlike. Obraden je uzorak od 100 ispitanika iz južne Dalmacije i 200 ispitanika iz središnje Hrvatske, oba spola u dobi od 18 do 30 godina. Mjereno je osam osnovnih kraniofacijalnih varijabli te indeksi glave, čela i lica. Dobiveni podaci ukazuju da prosjek svih varijabli može biti uporabljen kao standard za kraniofacijalne parametre za obje skupine ispitanika. Sve kraniofacijalne varijable su znatno veće u muškaraca nego u žena ($p < 0,05$). U južnoj Dalmaciji prevladavaju *me-socephalia* (48,0%) i *leptoprosopia* (82,0%), dok su u središnjoj Hrvatskoj u većem stupnju zastupljene *brachicephalia* (62,0%) i *euriprosopia* (73,5%). Najznačajnije kraniofacijalne i morfološke razlike kod ispitanika pokazuju širina glave (Eu–Eu), širina lica (Zy–Zy) i visina čela (Tr–N). Ove vrijednosti su statistički značajne u uzorku populacije središnje Hrvatske ($p < 0,05$). Sve su dobivene vrijednosti važne u ortodontskoj dijagnostici i terapiji.