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THE EFFECT OF PRIMARY CULTURAL DEFORMATION ON THE FREQUENCY OF CRANIAL NON-METRIC TRAITS

ABSTRACT: Forty-two non-metric cranial traits were recorded on 44 normal and 22 culturally deformed crania during the summers of 1995 and 1996. The population samples were excavated, beginning in 1961, from the 5th century Mözs-Icsei dülő cemetery near Szekszárd in the area known as Pannonia dating back to the late Roman period. These materials were analyzed in the Archaeological Institute of the Hungarian Academy of Science. Of special interest was the frequency difference of recorded non-metric cranial traits between "normal" crania and crania displaying "primary cultural deformation" – extensive in about a third of the Mözs collection. Results suggest that the frequencies of a number of non-metric cranial traits are significantly affected: mostly sutural traits. While a few non-metric traits showed differences between sub-samples, these differences often appeared random rather than directional as compared with sub-sample differences among other "normal" skeletal populations. The presence or absence of the cultural deformation seen in the Mözs samples is not a consideration when comparing this population with other earlier human populations.

KEY WORDS: Population distance – Deformed crania – Non-metric traits – 5th century – Pannonia

INTRODUCTION

There has been a significant interest in primary cultural cranial deformation for a long time. Beginning as early as Morton (1839), this interest in artificial deformation continues to the present day (Konigsberg *et al.* 1993). Significant published milestones (chronicled) have marked the progress of interest, description and later analysis of this cultural artifact (Dorsey 1897, Sullivan 1922). Differences in the morphological type and extent of expression were bases for the earlier analyses. Once metric analysis became popular, there was concern about the inclusion of cranial and undeformed crania in the same analysis. When non-metric analysis became popular (Berry, Berry 1967), interest in culturally deformed crania was rekindled (Ossenberg 1970). For example, it was questioned whether or not significant cultural deformation would increase (or decrease) the frequency of expression of many of the non-metric traits (El-Najjar, Dawson 1977). The results of these studies were mixed: some non-metric traits increased in frequency, some decreased in frequency and many appeared to be stable (Konigsberg *et al.* 1993). The increase or decrease of the frequency and which non-metric traits were susceptible appeared to be population dependent: one population reacted to the deformation stress differently than others. As well, different types of deformation appeared to differentially affect the non-metric traits involved or the region of the cranium.

The present study takes the differential effects of cranial deformation to a new level. We ask the question, given that non-metric trait frequencies may differ by trait, region, and type of deformation – will these differences significantly affect the analysis of biological distance among various populations?

FIGURE 1. Lateral view of a typical culturally deformed cranium from Mözs (grave 77).

FIGURE 2. Lateral view of a typical undeformed Mözs cranium (grave 46).

MATERIALS AND METHODS

Forty-two non-metric traits (Finnegan *et al.* 1993) were recorded on 22 culturally deformed (*Figure 1*) and 44 normal (*Figure 2*) crania originating from the Mözs cemetery. This cemetery was excavated by Salamon in the early 1960s (Salamon 1970). These materials are housed in the Department of Anthropology, Hungarian National Museum, Budapest. A smaller sample of these skeletal remains, representing a 5th century population, was analyzed by Salamon and Lengyel (1980) and Lengyel (1968) with respect to economic status, sex, deformation and family groupings. Later, a number of graves were excavated by Odor (1996 – pers. comm.) and these remains were added to our analysis. These remains are currently housed in the Archaeological Institute, Hungarian Academy of Science, Budapest.

Control samples representing populations of similar 5th century age and generally similar geographic location were also studied: Tác (N = 118), Csákvár (CSA, N = 55) and Dunaújváros Táborterület (DUN, N = 52). In the non-metric analysis, sample sizes of 2N were appreciated for the bilateral traits, and 1N sample size for single, mid-line traits.

The Grewal-Smith statistic (Grewal 1962, Finnegan, Cooprider 1978, Finnegan *et al.* 1993) was used to transform the basic trait frequencies and generate biological distance, or a mean measure of divergence (MMD), among all population sample pairs in this analysis. In this matrix, distances are considered significant at the 0.05 level if the MMD is greater than three times the estimated variance, and significant at the 0.01 level if the MMD is greater than six times the estimated variance. In this research the primary concern is to test if significantly culturally deformed crania affect the larger population analysis. To these ends the MMD matrix was moved to a statistical package (Rohlf *et al.* 1974) which generates a phenogram and bivariate plot, helpful in determining the order of samples to be coalesced. Each matrix was subjected to a TAXON analysis. This is a sequential agglomerative hierarchical cluster analysis in which the unweighted pair-group method uses arithmetic averages and dictates that the lowest values are considered for similarity. MXCOMP, which computes the cophenetic values for each matrix position, was employed, and resultant cophenetic values were compared to the original matrix for congruence (Sokal, Sneath 1963).

RESULTS

The non-metric traits and their frequencies are listed for each population sample in *Table 1.* Chi-squared values are presented in *Table 3*. The frequency data transformed to the MMD matrix are seen in *Table 4*. A cluster plot of this MMD matrix is seen in *Figure 3,* with the cluster plot of the cophenetic matrix displayed in *Figure 4*.

The resultant MMD matrix has italic underwritten figures which represent estimates of the variance.

TABLE 1. Trait frequencies for the samples used in this study. Range represents the frequency range for each trait.

Cranial non-metric trait:	MözsA	MözsD	MözsN	TÁC	CSÁ	DUN	Range
1 Highest nuchal line	0.342	0.243	0.386	0.242	0.100	0.094	0.292
2 Coronal ossicles	0.071	0.122	0.042	0.036	0.031	0.032	0.091
3 Ossicle at bregma	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4 Sagittal ossicles	0.121	0.143	0.108	0.073	0.095	0.118	0.070
5 Ossicle at lambda	0.246	0.350	0.195	0.164	0.235	0.238	0.186
6 Lambdoid ossicles	0.653	0.659	0.650	0.448	0.505	0.610	0.6211
7 Os inca	0.000	0.000	0.000	0.009	0.000	0.000	0.009
8 Parietal for.	0.358	0.275	0.400	0.424	0.361	0.436	0.161
9 Parietal notch bone	0.118	0.143	0.104	0.105	0.118	0.056	0.087
10 Asterionic bone	0.190	0.100	0.237	0.095	0.050	0.091	0.187
11 Auditory torus	0.000	0.000	0.000	0.000	0.010	0.000	0.010
12 Malar tubercle	0.050	0.000	0.088	0.064	0.061	0.049	0.088
13 Os japon	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14 Pterion form	0.034	0.000	0.053	0.034	0.020	0.011	0.053
15 Epiteric bone	0.153	0.171	0.143	0.135	0.169	0.197	0.062
16 Infra-orbital for.	0.084	0.103	0.074	0.054	0.141	0.076	0.087
17 Supra-orbital for.	0.237	0.262	0.224	0.209	0.269	0.245	0.060
18 Frontal for. present	0.145	0.023	0.216	0.096	0.120	0.108	0.193
19 Metopic suture	0.230	0.409	0.128	0.077	0.019	0.115	0.390
20 Mandibular torus	0.061	0.077	0.053	0.075	0.158	0.067	0.105
21 Mylohyoid groove	0.097	0.027	0.132	0.055	0.061	0.105	0.105
22 Mandibular torus	0.041	0.000	0.061	0.029	0.000	0.000	0.061
23 Mental foramen	0.057	0.051	0.060	0.020	0.000	0.012	0.060
24 Palatine torus	0.237	0.143	0.289	0.295	0.346	0.225	0.203
25 Acc. les palate for.	0.084	0.056	0.102	0.125	0.140	0.063	0.084
26 For. of Vesalius	0.146	0.103	0.172	0.130	0.131	0.086	0.086
27 For. ovale	0.053	0.028	0.069	0.025	0.000	0.032	0.069
28 For. spinosum	0.147	0.139	0.153	0.043	0.067	0.048	0.110
29 For. of huschke	0.093	0.200	0.038	0.065	0.067	0.022	0.178
30 Condylar facet	0.000	0.000	0.000	0.023	0.014	0.016	0.023
31 Post. condy. for.	0.472	0.364	0.521	0.468	0.459	0.582	0.218
32 Precondy. tubercle	0.038	0.000	0.057	0.063	0.048	0.097	0.097
33 Anterior condy. for.	0.257	0.282	0.243	0.186	0.202	0.224	0.096
34 Mastoid for.	0.903	0.853	0.928	0.812	0.844	0.814	0.116
35 Mastoid for. exsut.	0.505	0.382	0.565	0.380	0.378	0.267	0.298
36 Paramastoid process	0.013	0.000	0.019	0.214	0.205	0.105	0.214
37 Digastric groove	0.391	0.586	0.302	0.259	0.170	0.195	0.416
38 Stylomastoid for.	0.000	0.000	0.000	0.004	0.010	0.000	0.010
39 Zygo-max tuberos.	0.197	0.195	0.197	0.364	0.408	0.456	0.261
40 Zygo-facial for.	0.203	0.116	0.250	0.251	0.262	0.202	0.146
41 Ant. eth. for. ex.	0.848	0.882	0.822	0.734	0.766	0.644	0.238
42 Post ethmoid for.	0.125	0.129	0.122	0.066	0.110	0.100	0.063

TABLE 2. Trait numbers for the samples used in this study.

Cranial non-metric trait:	MözsA	MözsD	MözsN	TÁC	CSÁ	DUN
1 Highest nuchal line	120	37	83	1127	110	96
2 Coronal ossicles	113	41	72	225	98	95
3 Ossicle at bregma	57	22	35	111	51	42
4 Sagittal ossicles	58	21	37	96	42	34
5 Ossicle at lambda	61	20	41	110	51	42
6 Lambdoid ossicles	121	41	80	221	97	82
7 Os inca	63	21	42	116	55	50
8 Parietal for.	120	40	80	229	108	101
9 Parietal notch bone	119	42	77	228	102	89
10 Asterionic bone	116	40	76	220	101	88
11 Auditory torus	123	41	82	234	103	98
12 Malar tubercle	101	44	57	204	99	81
13 Os japon	120	43	77	221	107	90
14 Pterion form	119	44	75	232	98	93
15 Epiteric bone	98	35	63	192	83	66
16 Infra-orbital for.	107	39	68	221	99	79
17 Supra-orbital for.	118	42	76	235	108	98
18 Frontal for. present	117	43	74	230	108	102
19 Metopic suture	61	22	39	117	54	52
20 Mandibular torus	114	39	75	200	95	75
21 Mylohyoid groove	113	37	76	199	98	76
22 Mandibular torus	123	41	82	209	104	79
23 Mental foramen	123	39	84	204	105	80
24 Palatine torus	59	21	38	105	52	40
25 Acc. les palate for.	95	36	59	176	93	64
26 For. of Vesalius	103	39	64	184	84	58
27 For. ovale	94	36	58	201	86	62
28 For. spinosum	95	36	59	208	90	62
29 For. of huschke	118	40	78	216	104	93
30 Condylar facet	94	28	66	175	74	64
31 Post. condy. for.	106	33	73	186	74	67
32 Precondy. tubercle	53	18	35	95	42	31
33 Anterior condy. for.	113	39	74	188	84	67
34 Mastoid for.	103	34	69	213	90	86
35 Mastoid for. exsut.	103	34	69	213	90	86
36 Paramastoid process	78	26	52	192	78	57
37 Digastric groove	92	29	63	220	94	87
38 Stylomastoid for.	116	41	75	232	103	96
39 Zygo-max tuberos.	117	41	76	225	103	90
40 Zygo-facial for.	123	43	80	223	107	89
41 Ant. eth. for. ex.	79	34	45	188	64	45
42 Post ethmoid for.	72	31	41	183	73	50

TABLE 3. Chi-squared values for Mözs subsample comparisons.

	A vs D	A vs N	D vs N
Malar tubercle	6.235++	0.834	9.010**
Pterion form (X,k)	4.419+	0.404	5.986++
Frontal foramen	7.149*	1.559	11.927**
Metopic suture	2.427	1.716	6.053++
Mylohyoid groove closed	2.564	0.552	4.255+
Mandibular torus	5.113++	0.410	6.810*
Foramen of huschke	2.825	2.428	7.565*
Digastric groove double	3.399	1.313	6.681*

All other trait comparisons were not significant. + (p< .05); ++ (p< .025); * (p< .01); ** (p< .005); A = all individuals; D = Deformed crania only; N = Normal crania only.

TABLE 4. Measures of divergence between samples used in this study.

	MözsA	**MözsD**	**MözsN**	**TÁC**	**CSÁ**
MözsD	0.006 *0.009*				
MözsN	-0.018 *0.006*	0.050+ *0.011*			
TÁC	0.035* *0.004*	0.081* *0.008*	0.029+ *0.005*		
CSÁ	0.060* *0.005*	0.095* *0.010*	0.056* *0.007*	0.007 *0.004*	
DUN	0.038* *0.006*	0.068* *0.010*	0.037+ *0.007*	0.007 *0.005*	0.004 *0.006*

Underwritten figures in italics are estimates of the variance. (p<.05)+ and (p<.01)*.

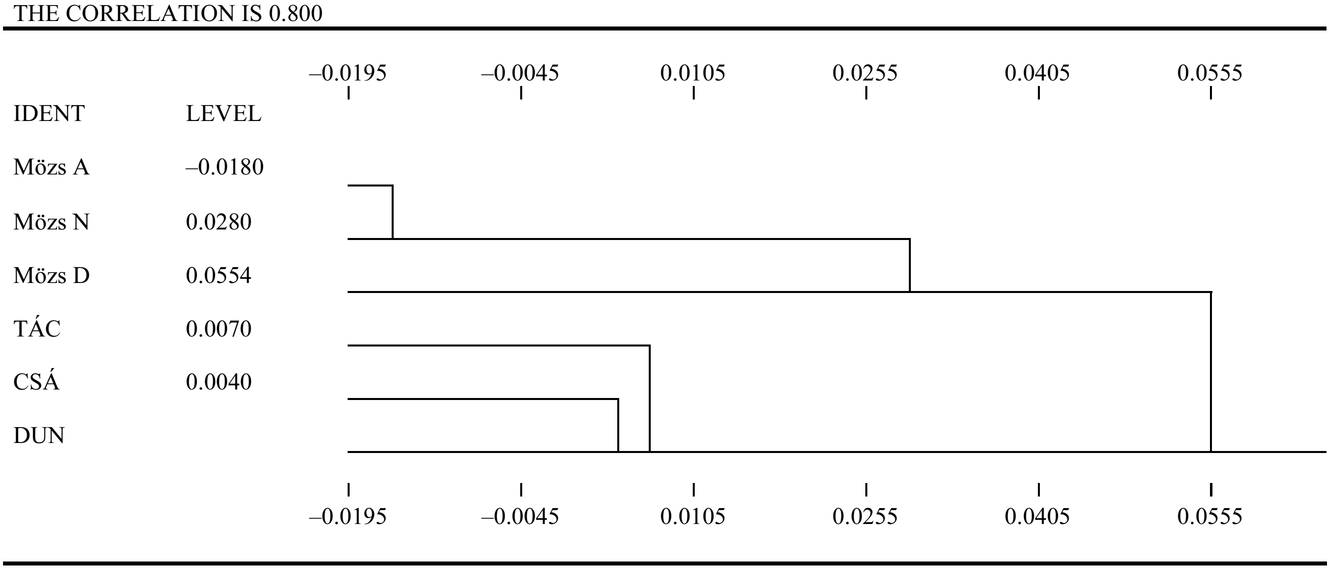

FIGURE 3. A phenogram based on the cluster distance matrix using the unweighted pair-group method with arithmetic averages. Low values were specified to indicate corresponding distance similarities. Abscissa is scaled in relative population distances.

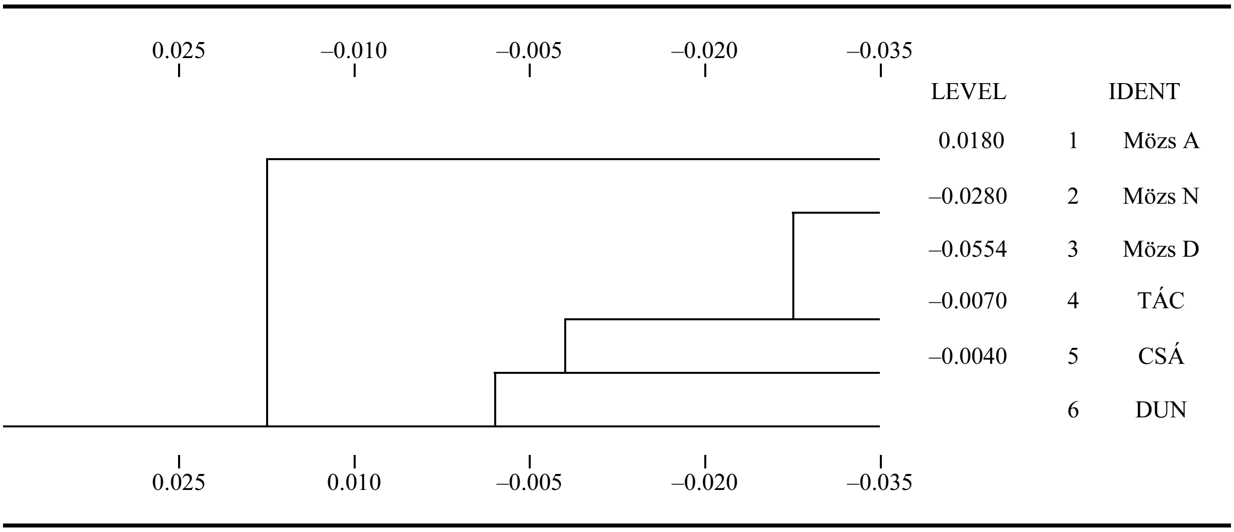

FIGURE 4. A phenogram derived from the matrix of cophenetic values. When comparing this with *Figure 3*, we find little distortion and a cophenetic correlation of 0.800. Abscissa is scaled in relative population distances.

Significant levels are marked by a (+) for p<0.05 and with an (*) for p<0.01. Not all population pairs are significant at the 0.05 level. It can be assumed that when MMDs between sample pairs are not significantly different, they probably represent two subsamples from a larger population and should be coalesced into one sample. In this instance, significance is lacking between the combined and undeformed Mözs samples (MözsA–MözsN) as well as Tác–Csákvár, Tác–Dunaújváros Táborterület and Csákvár–Dunaújváros Táborterület samples. Significant distances are generated between all other sample pairs. Any of the three Mözs subsamples is significantly different from each of the other three cemetery samples. While neither Mözs subsample is significantly different from the parent sample (all crania), deformed and undeformed crania samples are significantly different ($p < 0.05$). This suggests that while individual non-metric trait frequency differences may be significant by chi-square analysis or within sample comparisons, these differences are masked or lost when using the Grewal-Smith statistic in population comparisons. This is adequately expressed in the MMD matrix.

When the cophenetic values for each matrix position were compared to the original matrix for congruence, a cophenetic correlation of 0.800 was attained. The integrity of the MMD plots can be judged by the significance of the cophenetic correlations which, according to Derish, Sokal (1988), should be in the neighbourhood of 0.85 to be highly significant. In this case we consider a cophenetic correlation of $r = 0.800$ as significant.

While there is no significant difference between Mözs A and Mözs D nor between Mözs A and Mözs N, there is a significant difference ($p < 0.05$) between Mözs D and Mözs N, all within subsamples of the population. However, these differences are lost when we compare Mözs A, Mözs D and Mözs N individually with the other major samples: Tác, Csákvár and Dunaújváros Táborterület population samples. We therefore conclude that the primary cultural deformation seen in the Mözs sample has a negative effect on comparisons among the Mözs subsamples, but seems not to affect significant differences between Mözs and the other population samples. Therefore, the presence or absence of the cultural deformation seen in the Mözs samples is not a consideration when comparing this population with other earlier human populations.

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