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CORRELATION SYSTEM OF HEAD MEASUREMENTS AND THEIR INDICES

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Abstract

The correlation structure of head measurements and indices derived from them was analysed. The aim was to establish the prospective value of a joint investigation of measurements and indices in multivariate analysis. 9 head measurements on a North Hungarian sample (169 males and 211 females) and 9 indices derived from them were subjected to principal component analysis. This multivariate approach was found to yield indices which do not afford new information on population structure, since they do not compose an independent factor but are always related to the absolute measurements serving as the basis of their calculation. It seems that the use of several indices does not allow the detection of correlations existing among variables in an exact manner. There is no significant difference between the results yielded by the sexes. This observation may suggest a considerable change for generalization.

Key words: head measurements, indices, correlation

Introduction

A frequent question in the literature is whether, besides the analysis of a correlation system of measurements, it is worth analysing the correlation system of their indices; can this variant in the method provide new information on the structure of the population?

The present paper deals with the correlation system of absolute head measurements and the indices derived from them.

Material and method

The problem was investigated by using a sample from North Hungary (167 adult males and 211 adult females). The population originated from 10 villages in the Erdőhát region (Csaholc, Gacsály, Kishódos, Kisnamény, Kisszekeres, Méhtelek, Nagyhódos, Tisztaberek, Túrricse and Vámosoroszi), which include villages of both an endogamous and an exogamous character (SZILÁGY et al., 1993). The average sampling rate was 8.4%. The most widely used measurements and indices were chosen (Table 1). The correlation matrix of the total of 18 variables was analyzed by the principal component method for both sexes separately, by the varimax rotated method, omitting KAISER's normalization. The correlation system of these 18 variables is presented by hierarchic clustering as well; in accordance with the absolute values of the loadings of the rotated factor matrix, the system was prepared by the average linkage (within-group) method based on the Euclidean distance.

Table 1. Measurements and indices used.

Martin no.	Measurement	Martin no.	Index
1	head length	3/1	cephalic index
3	head width	3/16	height-width index of the head
4	least frontal breadth	4/3	forehead-head width index
6	bizygomatic breadth	4/6	forehead-face width index
8	bigonial breadth	6/3	face-head width index
13	nose breadth	8/6	mandible-face width index
16	total head height	13/21	height-width index of the nose
18	total face length	16/1	height-length index of the head
21	nose height	18/6	morphological face index

Results

Among males, the 18 variables formed 6 factors with an eigenvalue over 1.0, covering together 90.2 % of the total variance. Into the first factor, the absolute values (6, 8) and indices (8/6, 6/3, 4/6 and 18/6) describing the face width are loaded. The second factor is characterized by height dimensions (16, 18, 21 and 16/1). The third factor involves the head width (3, 3/1 and 3/16), the fourth the nose width (13/21 and 13), the fifth the forehead width (4/3 and 4) and the sixth the head length (Table 2).

Table 2. Rotated factor matrix for males.

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
8/6	.97908*	-.02532	.02924	.02348	.03980	-.04850
4/6	.95776*	-.12970	-.01112	-.01818	.16379	-.04993
6/3	-.93272*	.13387	-.14847	-.00477	.22353	.04697
6	-.90355*	.17841	.22903	.04184	.23431	.14365
18/6	.87693*	.20361	-.19092	-.20364	-.22052	-.04533
8	.76445*	.17413	.25735	.11321	.28123	.07270
16	-.06771	.85907*	.04711	.22266	.20642	.07076
18	-.11404	.79138*	.01768	-.31495	-.02547	.19746
16/1	.04949	.74083*	.00288	.04534	.04360	-.65161
21	-.20880	.52944*	-.02451	-.51447	-.11962	.16529
3	-.06990	.14150	.92540*	.12968	.08363	.26111
3/1	.03909	.05079	.89272*	-.03006	-.06799	-.42882
3/16	-.00245	-.56939	.77114*	-.05343	-.10152	.16897
13/21	-.03180	-.07026	.04057	.97367*	.04334	.09242
13	-.19236	.33971	.03412	.70550*	-.05609	.23162
4/3	-.07083	.02669	-.40542	-.02415	.88039*	.00064
4	-.12004	.14873	.42715	.08409	.83512*	.22963
1	-.14678	.11228	.04784	.20675	.19829	.88706*

Since we were interested in the degree of correlation between the variables, and not in the direction of the correlations, we clustered the absolute values of the loadings of the rotated factor matrix. The dendrogram is depicted in Fig. 1.

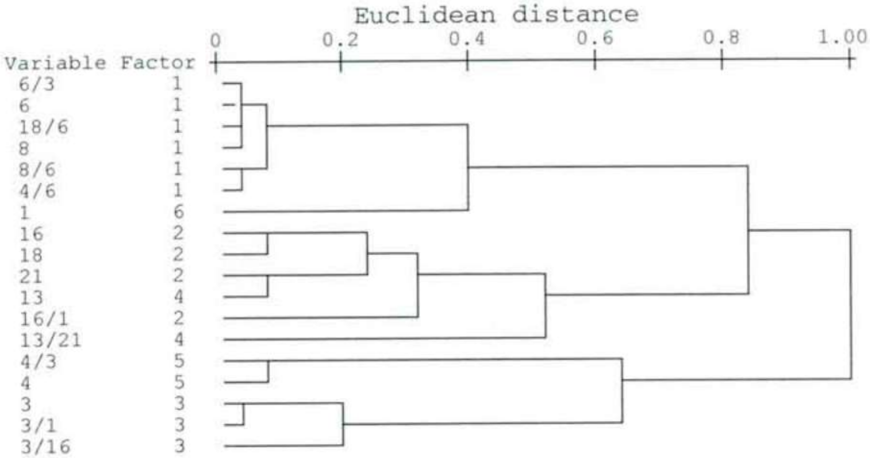

Fig. 1. Dendrogram using average linkage (within-group) for males.

Table 3. Rotated factor matrix for females.

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
8/6	.96050*	-.00725	.08582	.11520	-.01605	-.02812	.01922
6/3	-.94072*	-.15274	.09426	.02846	.17470	.01120	.02911
4/6	.93413*	-.02874	-.02639	.01431	.31721	.00928	-.01170
6	-.91102*	.24884	.10517	.18054	.18128	.04895	.03295
18/6	.87822*	-.15313	.13914	.06530	-.12595	.33851	-.01751
8	.74780*	.16937	.22798	.30280	.11917	.01194	.08733
3	-.03208	.92253*	.04258	.35407	.05257	.08122	.01041
3/1	-.06580	.86602*	.03904	-.48001	-.09450	-.04896	-.03859
16/1	-.00720	.07829	.93057*	-.34337	.02297	-.00241	-.05591
16	.03420	.05570	.84893*	.45841	.15917	.11209	-.00452
3/16	-.04654	.66222	-.72359*	-.13154	-.09689	-.03609	.01205
1	.04557	-.02059	.00190	.96379*	.16924	.14605	.05654
4/3	-.04171	-.36301	.08508	.00943	.92001*	.06121	.04623
4	-.05727	.33175	.10951	.26524	.88364*	.11993	.04892
21	.02702	.00675	-.05108	.05922	.15294	.93101*	-.03804
18	.14053	.05502	.39151	.31938	.02370	.71997*	.02945
13	-.00172	-.00926	-.04634	.05986	.09461	.25965	.94866*
13/21	-.01953	-.00673	-.01085	.01066	-.01890	-.46531	.87524*

For the females, 95.1% of the total variance can be explained by 7 factors with eigenvalues over 1.0. In the first factor, the same variables are loaded as among males (6, 8, 6/3, 4/6, 8/6 and 18/6), in the second the head width (3 and 3/1,), and in the third the head height (16) and its indices (16/1 and 3/16). The fourth factor, like the sixth factor of males, represents only the head length (1), the fifth the forehead width (4 and 4/3), the sixth the height of the face and of the nose (18 and 21), and the seventh the nose width (13 and 13/21) (Table 3).

Clustering the variables in accordance with the principles used to study the males and described above afforded the results represented in the dendrogram to be seen in Fig. 2.

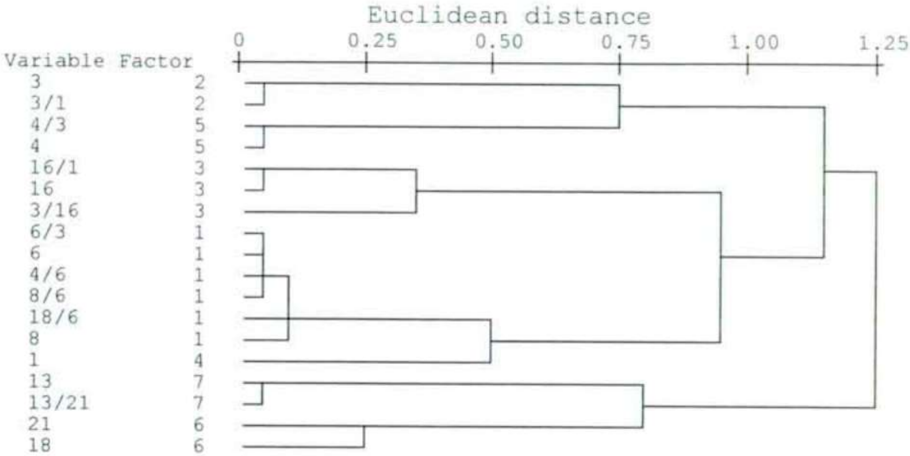

Fig. 2. Dendrogram using average linkage (within-group) for females.

Overall, our opinion on the correlation system of variables within the population investigated can be summarized as follows:

The indices created from measurement no. 6 were situated in the same factors as for measurements no. 6. The correlation between variables 4-4/3 and 13-13/21 was very close within both sexes. Measurement no. 1 has an independent position for both sexes. Among males, index 3/16 shows a correlation rather with the head width; among females, it is correlated the head height. The dendrograms in Figs 1 and 2 demostrate the groups of variables described above. Among males, measurement no. 13, belonging to factor 4, is interpolated in the group of variables of factor 2. This is due to the loading of measurement no. 13 being relatively high (0.34) for factor 2 as well (Table 2).

Conclusions

An analysis of the correlation structure of head measurements and head indices revealed that the indices never formed an independent factor, but rather formed groups related to the absolute values which served as the basis for their calculation. This probably means that the correlation between the indices, describing similar relations, is not closer than the correlation with the absolute measurements. This is true even if an attempt is made to analyse several indices derived from the same measurement in the manner applied to measurement 6 and the indices related to it (6/3, 4/6, 8/6 and 18/6). Thus, if the original measurements and their indices are investigated together, the same information is repeatedly inserted into the system via several variables, and, without a knowledge of the correlation conditions, this may lead to significant distortion. At the same time, in the knowledge of the correlation conditions, the indices become unnecessary, because they do not contain essential new information on the system. Different applications of the indices may conceal or distort the correlation system among measurements - obviously probably because the correlation between the different dimensions and the indices derived from them is closer than the simple correlation of the measurements. There is no significant difference between the results yielded by the two sexes. This may suggest that the phenomenon observed here is not an individual one, but rather a more general one.

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