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DISCRIMINANT ANALYSIS OF BODY MEASUREMENTS IN PATIENTS WITH DOWN SYNDROME

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Abstract: *The aim of this study was to differentiate the patients with Down syndrome from the normal control group based only on the body sizes. 16 measurements of 740 patients and a control group with 2040 children were analysed by discriminant analysis. The calculations were carried out in three groups of age. As it was expected, both of the direct and indirect influences of length measurements were the highest.*

Key words: *Down-syndrome patients; Discriminant analysis.*

Introduction

There are only a few number of multivariate analysis published on Down syndrome patients' data. The result of body measurements and those of personality and socialization traits were analyzed by Kääriäinen (1975). His anthropological data were referred to five factors; the head, the studiness, the index factor, the vertical height, and the widths. The first and the fifth factors had the greatest weight in the discriminant analysis.

The characteristics of growth and the development of cognitive functions of patients with Down syndrome were studied by Cronk (1981) using longitudinal factor analysis. She found, that the first factor was the magnitude of growth data and the mental age. The second one characterized the growth changes of the body sizes. Data of different nature have been used in this analysis, therefore it is difficult to interpret results on a common basis.

There are no data on the multivariate analysis only of body sizes for patients with Down syndrome. The aim of this work was to study the influences of body measurements on the discrimination of Down syndrome and control groups, if this discrimination is possible on the basic of body measurements only.

Material and method

464 male and 276 female patients with Down syndrome whose age ranged from 4 years to adulthood have been examined. They represent the trisomic and the translocation form of the syndrome, the mosaic patients were excluded from the study. The control was randomly selected from the Hungarian National Growth Study (Eiben and Pantó 1986).

A detailed anthropometric program of 32 body measures was carried out. The data were evaluated from several points of view, considering the growth, body proportions, physique and they were analyzed by the multivariate method, too. The principal components analysis and the discriminant analysis were used.

Discriminant analysis is a method to distinguish two or more groups according qualitative or quantitative characteristics, based on quantitative data. In the analysis, the Z individual discriminator value is computed from the original p variables (Sváb 1971):

$$Z = w_1X_1 + w_2X_2 + ... + w_iX_i + ... + w_pX_p,$$

where w_i = the discriminant coefficient of ith variable, and X_i = the standard form of ith individual variable.

The difference of group means of the discriminator is the Mahalanobis D^2:

$$D^2 = Z_A - Z_B,$$

where Z_A = mean of individual discriminators in group A, and Z_B = mean of individual discriminators in group B.

As the first step, principal component analysis was carried out for the evaluation of our data. Two additional principal components concerning the extremities can be found for the Down syndrome group compared to the normal one.

Results and Discussion

Drawing the Down and the control groups together, the data are clearly separated into two groups according to the first two individual principal components (Fig. 1). Encouraged by this fact, discriminant analysis was used to decide weather it is possible to distinguish a patient with Down syndrome from a "normal" child, based on the body sizes only.

The results of analysis are shown in Table 1. The F values of Mahalanobis D^2 are highly significant in all age groups. The percent of correct classification increases by the age and in the two elder groups it is higher than 95%. It is worth to note, that these values are less than 70% if the Down syndrome patients are compared with severe mentally retarded ones, even if there are no genetically disturbed children in the last group.

Table 1. **Discriminant analysis**

	Age groups (year)		
	–10	11–17	18–
D^2	2.7127	2.1090	3.9161
F	103.02	203.22	123.81
DF	13;1180	11;1207	9;290
Percent of correct classification:			
Down-control	87.7	95.8	97.5
Control-down	92.7	95.7	99.3

The discriminant coefficients of the different body measures (Table 2) can be used for diagnostical purpose. We multiply the body measures of a child by the appropriate

coefficients, then reduce the products and the constant. If the result has positive sign, the child belongs to the Down syndrome group. If the sign is negative, the child is so called "normal".

Table 2. **Discriminant coefficients**

Body measurements	Age groups (year)		
	–10	11–17	18–
Body height	0.10805	-0.06553	-0.09771
Upper extremity length	0.14441	0.03486	–
Widths biacromial	-0.29145	-0.16779	-0.18924
bi-iliocristal	0.50964	0.36708	0.19230
humerus	-0.49975	–	0.70965
femur	-1.21243	-0.60242	-0.61609
Girths chest	0.08763	–	–
upper arm (flex)	1.43852	0.85137	0.23059
upper arm (ext.)	-1.44984	-0.69121	–
calf	-0.10417	-0.06123	–
Skinfolds subscapular	1.28384	0.72339	0.79340
tricep	-0.71053	-0.68371	-0.79431
suprailiac	-0.67740	-0.45203	-0.72642
Constant	6.33491	13.00219	13.18861
Mean Down	0.90	1.38	1.82749
Mean control	-1.82	-2.07	-2.08856

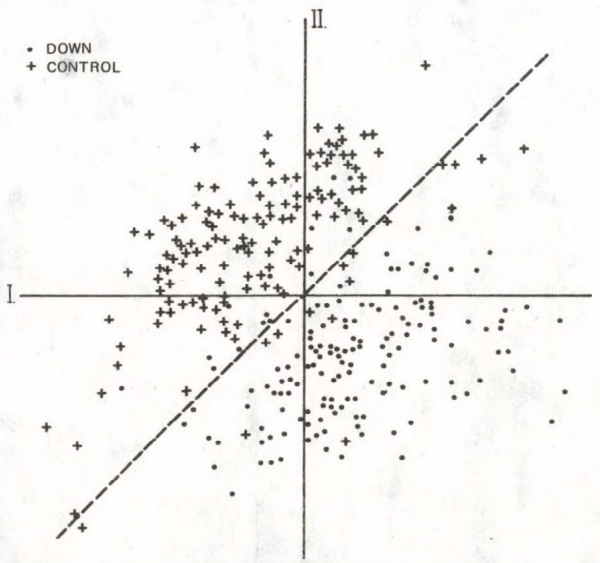

Fig. 1: Distribution of Down syndrome and control group on function of the I. and II. individual principal components

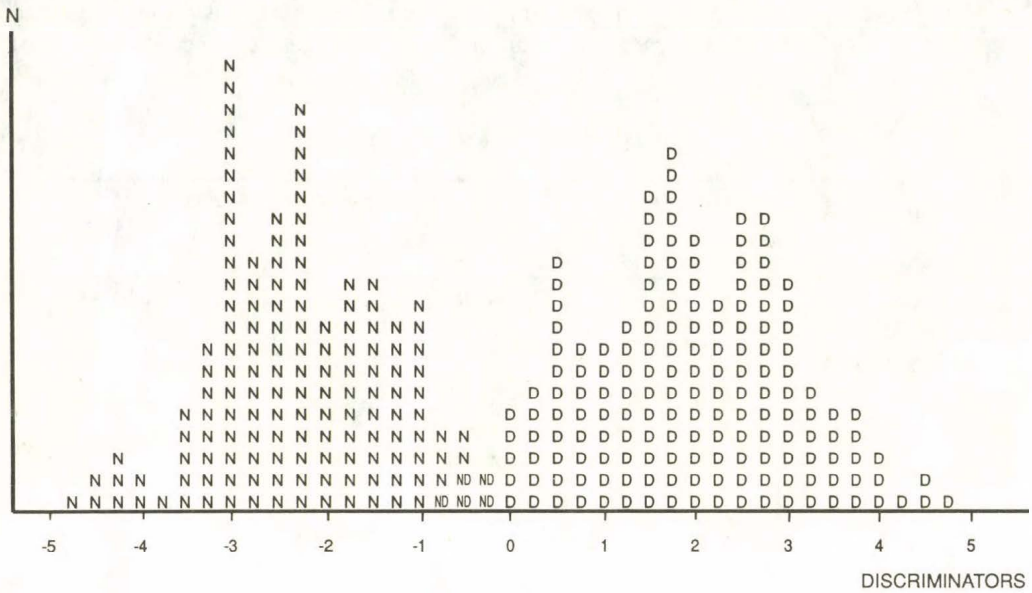

Fig. 2: Distribution of the eldest group on the function of individual discriminators

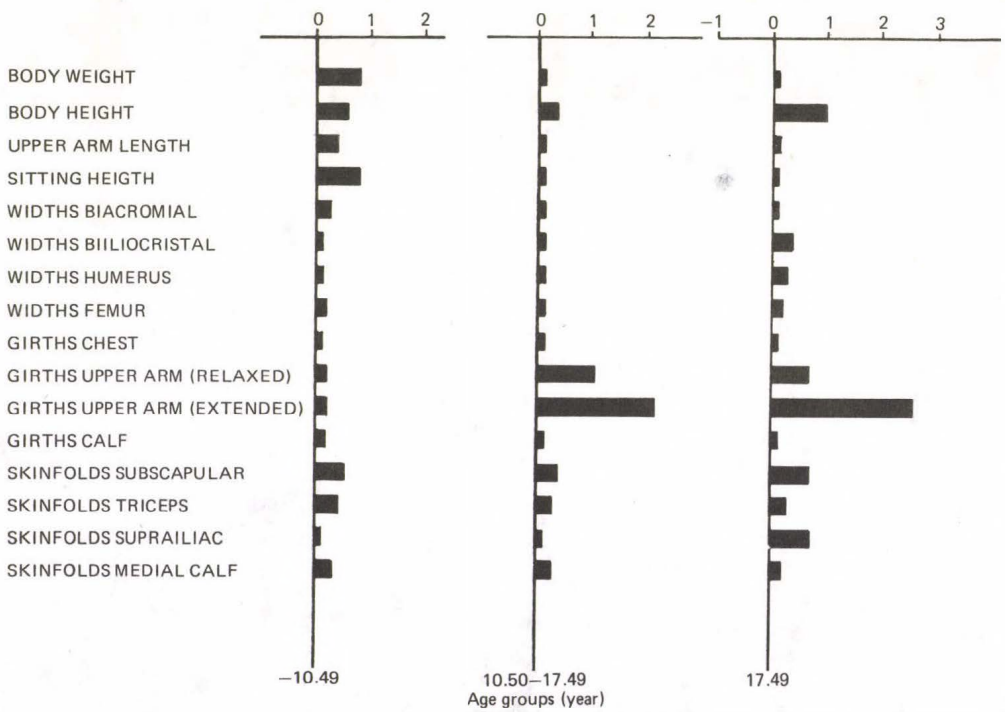

Fig. 3: Direct influences of body measurements

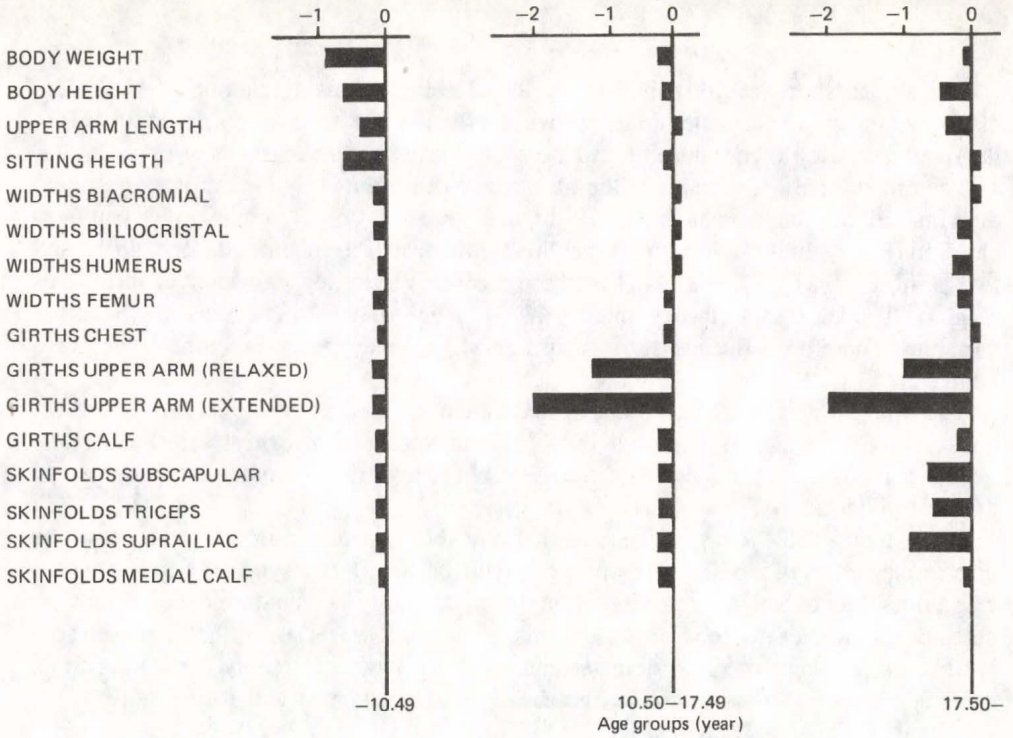

Fig. 4: Indirect influences of body measurements

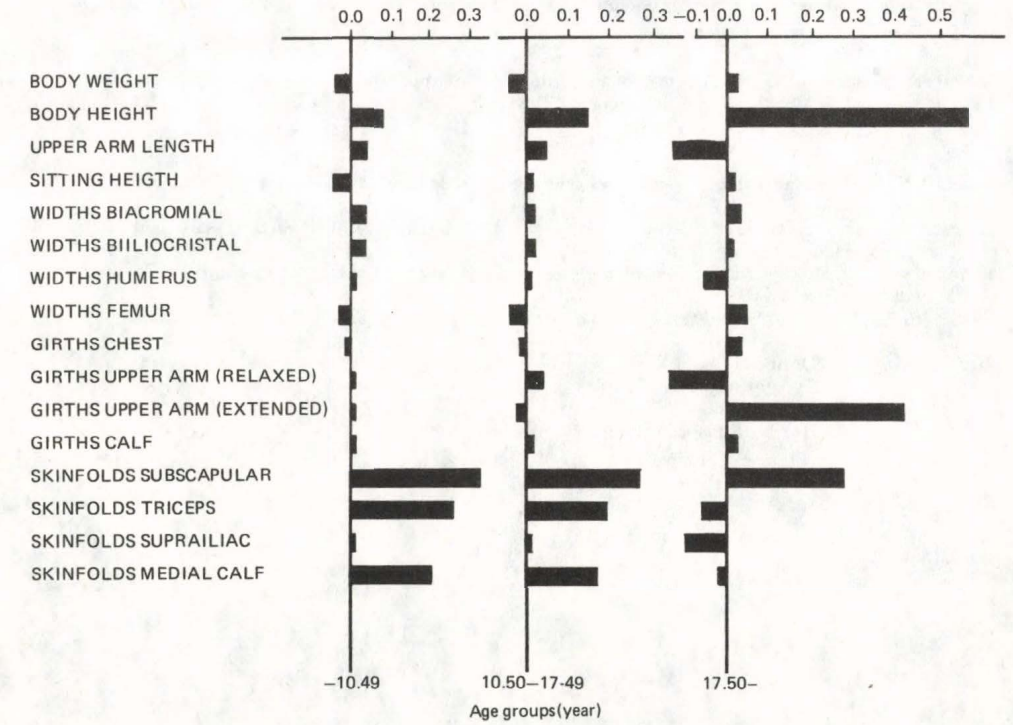

Fig. 5: Total influences of body measurements

The Fig 2. shows the distribution for the eldest group as a function of individual discriminators. As it was mentioned above, this is the best separated sample, therefore the overlap of the Down syndrome and the control groups is the least.

The most important question is the importance of certain body measures at the group discrimination. The lengths have the highest direct influence among the youngest children (Fig 3). In the oldest group the direct influence of the stature, the arm girths and two skinfolds was the highest. All of these measures have negative indirect influences (Fig 4). The indirect influence means the influence of a variable through the other variables. Therefore influence of the measures which have highest direct influence, were depreciated by other ones.

The total influences are one order of magnitude less than either direct or the indirect ones (Fig 5). As it was expected those measures have the highest direct and total influences which have the highest differences between the Down syndrome patients and the control ones.

24 patients (3.24%) were excluded from the Down syndrome group by the discriminant analysis. These persons proved to be the Down syndrome group at the reexamination, although some important symptoms of the syndrome could not be detected as muscle hypotony or loose joints. However it was striking that most of these patients have taken part in systematic and intensive physical activity for a long time. Due to this work, the physique of these children has changed and it differs from the physique of a "regular" patients.

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