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Three Serum Enzymes in Twins

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In a previous study (Hosenfeld and Schröter, 1970) we were able to demonstrate the activity of three serum enzymes, cholinesterase (EC 3.1.1.8), ceruloplasmin (EC 1.10.3.2.) and alkaline phosphatase (EC 3.1.3.1) as individual characteristics which in healthy adults remain fairly constant for several months. For the purpose of investigating whether these quantitative features are genetically determined, we carried out similar studies on twins.

The twins were traced in the Birth Register of Kiel. A certain amount of selection could have been caused by the willingness to have blood samples taken and by the interest in obtaining Accident Cards. We examined 30 MZ and 30 same-sexed DZ twin pairs, aged 8-20 years. The average age of the two groups of twins was about 15 years. Among the MZ 15 pairs were female; among the DZ, 11 pairs.

Zygosity was established by polysymptomatic comparison of similarity. For documentation, color slides were made. ABO and Rh blood groups of all twins were determined, and in most cases further erythrocytic and serum properties. Blood samples were usually obtained in the afternoon about three to four hours after the last meal. The serum was centrifuged off and frozen. Enzyme determination was carried out during the next one to three weeks. Following substrates were used for estimation of the three enzymes: benzoylcholine, paraphenylendiamine and paranitrophenylphosphate. Acording to the methods of Richterich (1968), all measurements were carried out kinetically, employing a recording spectrophotometer (Beckman DB).

In the evaluation of the measured values we tested first the frequency distribution. While cholinesterase was approximately normally distributed, a log-normal distribution resulted for ceruloplasmin and alkaline phosphatase.

To illustrate the correlations between MZ and DZ twins, the regression slopes of the three enzymes are demonstrated in the following graphs.

Fig. 1 shows the cholinesterase values. Each MZ pair is symbolized by one solid circle, each DZ pair by one triangle. On abscissa and ordinate the same enzyme activities are plotted, on the vertical axis member A of each pair, on the horizontal axis member B of each pair. The continuous line is the regression slope of the MZ, the broken line the regression slope of the DZ.
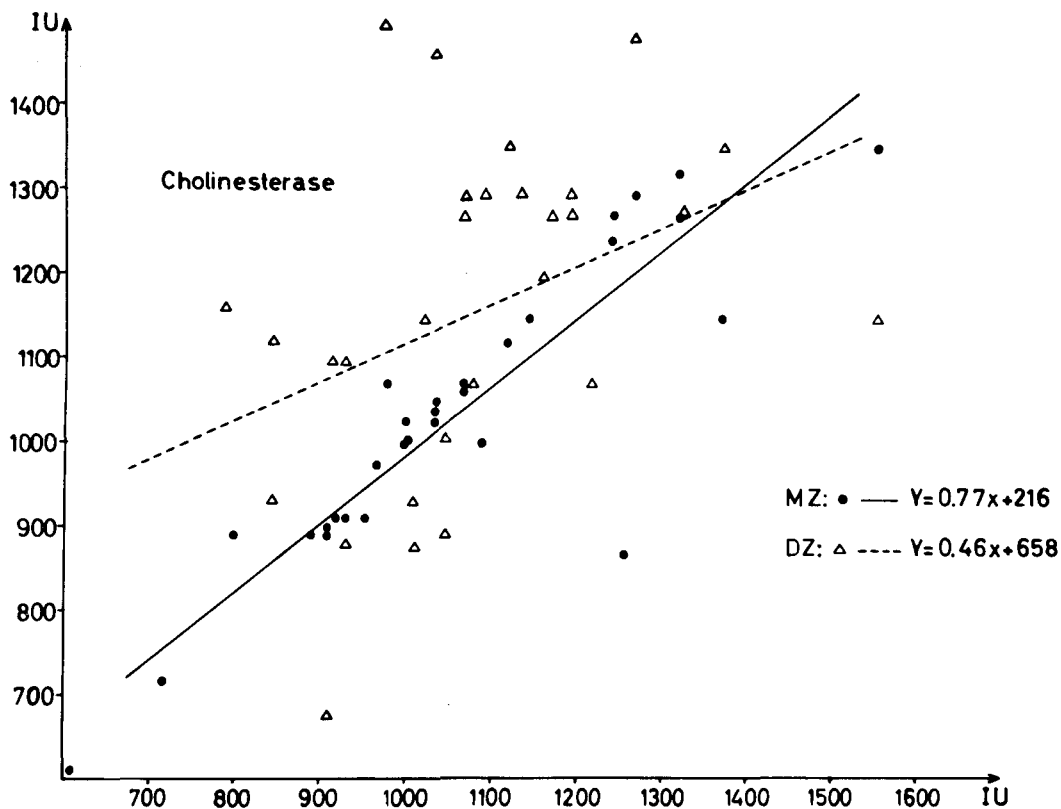
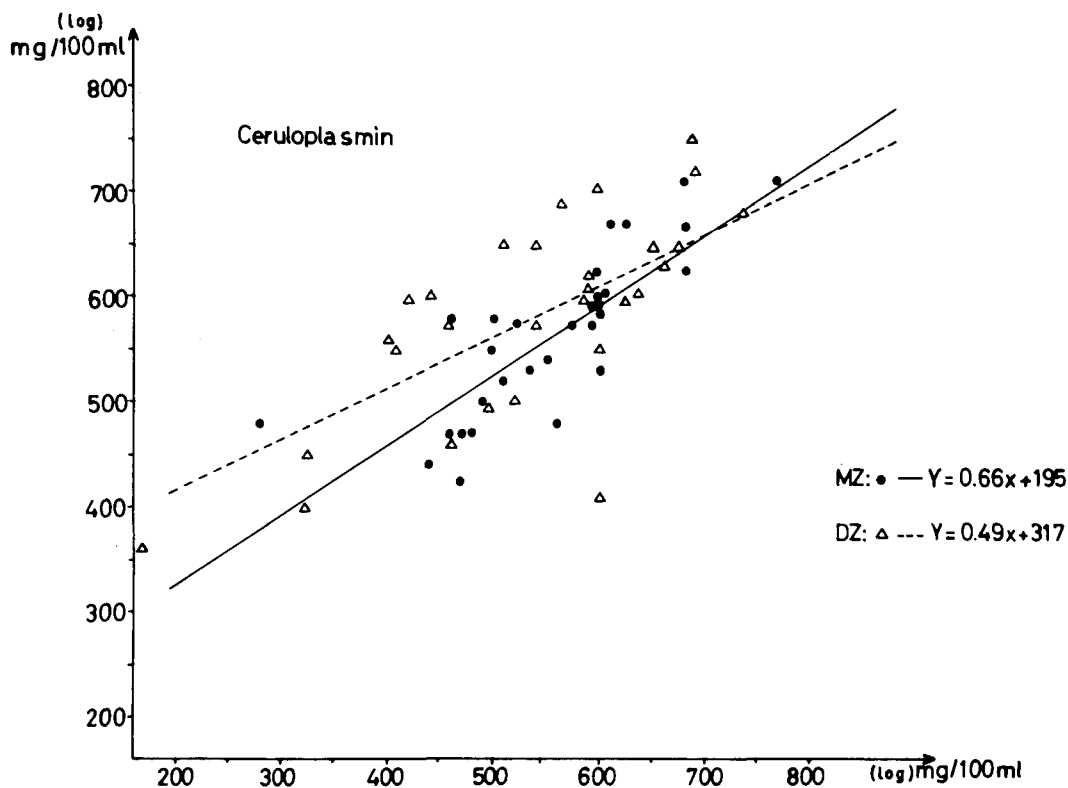Fig. 1. Regression slopes of cholinesterase.

MZ: ● ── Y = 0.77x + 216

DZ: △ ---- Y = 0.46x + 658

Fig. 2. Regression slopes of ceruloplasmin.

MZ: ● ── Y = 0.66x + 195

DZ: △ --- Y = 0.49x + 317

The ceruloplasmin data are shown in Fig. 2. Transformed values have been plotted on both axes. As in the case of cholinesterase, the regression slope of MZ is steeper than that of DZ twins, due to the greater regression coefficient. Nevertheless, there is less of a difference between the regression slopes in ceruloplasmin than in cholinesterase.

Fig. 3 shows the alkaline phosphatase, also in transformed values. In this case, the small difference in the steepness of the two regression slopes is notable.

For a more exact evaluation of our data, we applied the method of variance analysis, the results of which are summarized in Tab. I.

Cholinesterase and ceruloplasmin behave similarly in terms of h^2 values, but differently in terms of the intraclass correlations regarding the difference between MZ and DZ pairs. In the case of alkaline phosphatase, MZ twin values show a strong
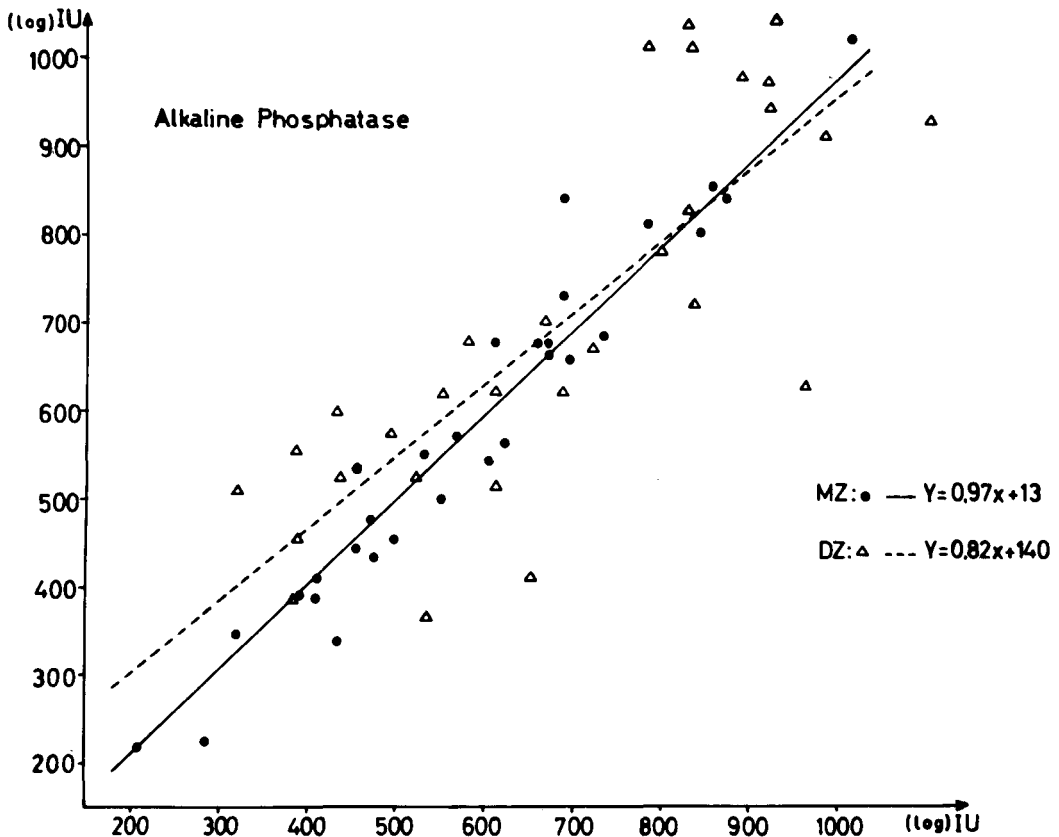

Fig. 3. Regression slopes of alkaline phosphatase.

Tab. I. Analysis of variance

Group	Intrapair variance	F ratio DZ/MZ intrap. var.	h²	F ratio interp./ intrap. var.	Intraclass correlations	
Cholinesterase						
MZ	5054			13.36**	0.86	
		4.94**	0.80			P<0.005
DZ	24956			2.70*	0.46	
Ceruloplasmin						
MZ	1564			8.14**	0.78	
		4.80**	0.79			P<0.05
DZ	7571			2.66*	0.45	
Alkaline phosphatase						
MZ	1323			58.85**	0.97	
		6.78**	0.85			P<0.005
DZ	8977			9.13**	0.80	

* P<0.01   ** P<0.001.

correlation, and a marked correlation also exists for DZ twins. The intraclass correlation coefficients are nevertheless significantly different at 0.5% level.

Three publications by other authors on quantitative serum cholinesterase determinations in twins state differing results. Simpson and Kalow (1963) found no difference in intraclass correlation. Schloot et al (1966) observed significant differences of the variability between MZ and DZ twins, but no differences of the intraclass correlation coefficients. Wetstone et al (1965), on the other hand, found a significantly higher intraclass correlation in MZ than DZ twin pairs.

Our own results also reveal a significant difference of the intraclass correlation coefficients. The h² value, a parameter introduced by Holzinger (1929) for heritability, indicates a comparatively slight environmental effect. On the basis of these results, a marked genetic influence on the regulation of the enzymatic activity of cholinesterase can be assumed for the twins we have examined.

According to our experience, importance has to be attached to the composition of the DZ group. We found that similar twins, frequently those with equal ABO blood groups, showed smaller differences in cholinesterase than nonsimilar twins. It probably explains the different results of various investigators, especially when the number of DZ pairs was relatively small.

Regarding ceruloplasmin, there exists some degree of genetic control of the enzyme activity, too. An involvement of hereditary factors in the determination of the enzyme activity is also indicated by the observations of a dominant heredity of low enzyme levels in two healthy families (Cox, 1966).

With respect to alkaline phosphatase, the high intraclass correlation coefficients,

125

especially for DZ pairs, are remarkable. We tend to consider, as the cause of this fact, mainly the age distribution of our test persons. A great proportion of twins were in early puberty, a period of life when bone growth is particularly intensive, and hence osteoblastic phosphatase greatly increases in the serum.

The conclusion to be drawn from this investigation would be that there is a prevailing genetic influence on the quantitative regulation of the activities of these three different serum enzymes.

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