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Changes in cardiovascular risk factors in diabetic children during a camping holiday

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Diabetic children in a holiday camp were divided into two groups according to physical activity. In the active group a significant elevation of HDL-cholesterol and a highly significant decrease in total/HDL-cholesterol ratio were observed. In the inactive group similar but non-significant changes occurred.

No appreciable changes were observed in the serum albumin level but the fasting FFA level decreased in both groups, more markedly in the active group. Therefore, the FFA/albumin quotient and also body fat percent decreased considerably in the active group while in the inactive group there were no significant changes.

Micro- and macroangiopathy is a well-known complication of diabetes. Hyperlipoproteinaemia [1] caused by high triglyceride and variable cholesterol levels and accompanied by a low high density lipoprotein (HDL) cholesterol level in the plasma [11] is a common finding in juvenile, insulin-dependent diabetes. An important role has been attributed to the deranged lipid and lipoprotein status, especially to the high total/HDL cholesterol quotient in the pathogenesis of atherosclerosis [2, 6, 10, 11].

The angiopathy is also related to well-documented changes in haemostasis, developing by altered functioning of the prostacyclin (PGI_2) system. On platelets, PGI_2 has an antiaggregatory effect enhanced by albumin and inhibited by free fatty acids (FFA). The FFA/albumin quotient is a good indicator of this process; a high value represents an increased risk of vascular complications [7, 9].

In this study we describe observations on changes of the FFA/albumin and total/HDL cholesterol quotients in diabetic children participating in a holiday camp.

Materials and Methods

During summer 1982, a three-week holiday camp for diabetic children was organized in Hungary. Of the children 26 (15 boys and 11 girls) were selected for study. Their mean age was 13.22 ± 1.27 years. The mean duration of diabetes was 4.32 ± 2.63 years. They were on a regulated but flexible diet consisting of 50% carbohydrate, 20% protein and 30% fat; the diet contained saturated and unsaturated fatty acids in the desirable ratio (1:1.76).

Skinfold thickness was measured with Holtain caliper at five different sites of the body's right side in all children on the first and last day of camping. From these values percent body fat content was calculated by the method of Parizkova and Roth [8]. The children were grouped

as active or inactive according to the opinion of the physician and the pedagogue leading the camp. As active, 13 boys and 3 girls were qualified; these children participated in all physical activity programmes offered while 2 boys and 8 girls with much less physical activity were regarded as inactive.

On the first and last mornings of the camping holiday, before the injection of insulin, untreated and heparinized blood samples were taken and immediately transported to the laboratory in a portable refrigerator.

Triglycerides were determined by the method of Laurell, total and HDL-cholesterol enzymatically, FFA by the method of Dole, and albumin by radial immune diffusion. All concentrations were expressed in mmol/l.

From the data the quotients of total/HDL-cholesterol and FFA/albumin were calculated. The mean values obtained for the first and last days were compared by the *t*-test.

Results

Table I shows the means and standard deviations obtained on the first and last day, separately for the active and the inactive group. As reported earlier [2] no appreciable changes in the level of HbA_{1c} occurred in the course of the holiday. In the majority of cases insulin dosage had to be reduced because of hypoglycaemia. The diet was flexible, and this allowed a certain liberalism. For all children there were days with glycosuria exceeding 20 g/day.

The mean triglyceride level decreased in the active group, the difference was, however, not significant statistically. In the inactive children there was a statistically significant increase ($p < 0.01$). Total cholesterol exhibited a slight, statistically insignificant increase in both groups, a finding expected on the basis of data in the literature, HDL-cholesterol increased in both groups as expected [6, 11]. In the active group this latter change attained the level of high significance ($p < 0.001$) while for the inactive children it remained insignificant. Since a relationship between HDL-cholesterol and physical activity had been shown previously [9, 10], our grouping of the children seemed justified.

Consequently, similar changes were encountered in the total/HDL-cholesterol quotient: an insignificant increase in the inactive and a significant increase ($p < 0.05$) in the active group.

The fasting FFA levels decreased in both groups significantly, the change was, however, more pronounced in the active group ($p < 0.001$) than in the inactive children ($p < 0.05$).

No appreciable changes in serum albumin were observed; a modest increase occurred in the active group. The FFA/albumin quotient exhibited a marked decrease ($p < 0.001$) in the active group while there were no significant changes in the inactive group.

Body fat percent calculated from the skinfold measurements showed no change in the inactive children while in the active group it decreased markedly ($p < 0.001$). This points to a sharp increase in lean body mass in the active group, which may be

TABLE I

Means and standard deviation in the active and inactive group

	Active		Inactive	
	Before camping	After camping	Before camping	After camping
Triglyceride	1.05 ±0.27	0.89±0.30	0.96 ±0.17*	1.42 ±0.59
Total cholesterol	4.70 ±0.66	4.96 ±1.21	4.94 ±0.40	5.51 ±0.98
HDL-cholesterol	0.86 ±0.19***	1.03 ±0.21	0.98 ±0.12	1.11 ±0.26
Total/HDL-cholesterol	5.73 ±1.50**	4.87 ±1.09	5.10 ±0.84	5.13 ±1.18
FFA	0.816±0.156***	0.588±0.127	0.822±0.141**	0.662±0.221
Albumin	0.607±0.059	0.636±0.067	0.667±0.071	0.667±0.083
FFA/albumin	1.35 ±0.23***	0.88 ±0.21	1.23 ±0.19	0.98 ±0.25
Percent body fat	24.78 ±4.12***	21.87 ±4.43	27.03 ±6.39	25.69 ±6.93

* $p < 0.01$, ** $p < 0.05$, *** $p < 0.001$

ascribed to the physical activity. This too showed that our grouping was adequate.

DISCUSSION

For the pathogenesis of arteriosclerosis there are two theories. The older hypothesis emphasizes the role of blood lipids and lipoproteins. There are nowadays doubts about the importance of hypertriglyceridaemia while the pathogenetic role of very low density lipoprotein and low density lipoprotein and the protective effect of HDL-cholesterol have been fully established [10, 11]. Therefore, an elevation of the total/HDL-cholesterol ratio is a well-based risk factor predicting angiopathy. The haemostasis hypothesis underlines the role of platelet aggregation, the first step of coagulation provoked by endothelial damage. The process may be influenced by prostaglandins, oxygenated derivatives of arachidonic acid; thromboxane A_2 liberated in platelets, promotes aggregation while it is inhibited by prostacyclin (PGI_2). Equilibrium between the two compounds is the basis of the regulation of clotting [7].

It has been shown both in vitro [7] and in vivo [4] and in also morphological studies that the catabolism of PGI_2 is enhanced by FFA and inhibited by albumin. As a consequence, the FFA/albumin quotient is an appropriate indicator in this respect, and a high value foretells angiological complications [10].

In a previous paper we have described the favourable effect of a holiday camp on the working capacity of diabetic children. The two

quotients improved much in the active group while in the inactive diabetic children total/HDL-cholesterol remained unchanged and only an insignificant improvement ensued in the FFA/albumin quotient.

Unfavourable fasting FFA and cholesterol levels may also be attributed to poor insulin dosage. When insulin doses are adequate, a high level of HDL-cholesterol and albumin reflect a favourable metabolic and vascular situation. Metabolic alterations provoke rapid changes in the FFA and HDL-cholesterol level while serum cholesterol and albumin are less sensitive and follow the changes more sluggishly.

In these children, physical activity increased the level of HDL-cholesterol and reduced the body fat content. The improvement of the total/HDL-cholesterol quotient is attributed exclusively to the favourable changes in HDL-cholesterol.

Favourable changes of the FFA/albumin quotient were encountered in both groups. The more important factor was the decrease in FFA concentration. Here also, the better result was achieved in the active group.

There was a certain parallelism in behaviour between the two quotients. This suggests that the FFA/albumin quotient or, since the serum albumin level remained unchanged, the FFA concentration too is a good indicator of the condition of the diabetic patient.

In the active group a slight decrease in the mean triglyceride level was seen while an insignificant increase occurred in the inactive group. Systematic estimation of the triglyceride levels is of outstanding importance in the management of diabetes. If the insulin action comes short, lipoproteinase activity decreases, thus leading to an increase in the very low density lipoprotein triglyceride level [5]. This explains why we found significantly higher levels in the inactive group.

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