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The joint influence of diet and increased physical activity in obese children

M Peja[1], L Velkey[2]

[1]Department of Rehabilitation Miskolc, Hungary [2]County Hospital of Borsod-A.-Z. County Medical Centre for Children's Diseases Post-Graduate School of Medicine Miskolc, Hungary

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The authors performed a three week treatment and examination of 20 children with obesity of non-endocrine origin, and they compared the examination results with those of healthy children.

The treatment of the obese children consisted of a diet and an individually determined training programme.

In the course of the examinations it was established that the weight of the obese children decreased, their physical working capacity increased, their glucose and fat metabolism showed a tendency to improve.

On the basis of all their findings authors wish to stress the importance of the primary and secondary prevention of cardio-vascular diseases as early as in childhood.

Early recognition of the risk factors of arteriosclerosis determines the success of primary prophylaxis to a great extent. This is why the responsibility of pediatricians in early diagnosis, screening and treatment of the risk factors — obesity, hyperlipoproteinaemia, hypertonia — has been more and more stressed in recent years [6, 8, 12, 14].

The frequency of childhood obesity, as one of the most frequent and most easily recognizable factors is the following according to the literature: Kelly et al [14] report that 25 per cent of American children are obese, in England 2—20% of the children are reported to be obese and in Hungary the figures are 6.1—15% [20, 25].

Obesity is not only a cardio-vascular risk factor and not only involves changes in metabolism, but may cause orthopedic diseases, has a psychosocial influence and decreases the physical working capacity as well.

The abbreviations used in the study are as follows:

HDL-C:	high density lipoprotein cholesterin
LDL-C:	low density lipoprotein cholesterin
VLDL-C:	very low density lipoprotein cholesterin
PWC:	physical working capacity index

The change in carbohydrate metabolism with obesity is well known. Obesity is inversely proportional to the level of physical activity. Low level physical activity leads to glucose intolerance, insulin resistance and hyperinsulinaemia [16].

When speaking about obesity we must also take into account that it involves a more and more decreasing physical working capacity [8], due to which as well as to their body structure obese persons have a growing disadvantage concerning their social integration.

All these set pediatricians the task to start the treatment of obese children as soon as possible. On the basis of our present knowledge the joint application of diet and increased physical activity is the most promising in treating obesity [3, 5, 8, 13, 21].

At the Department of Children's Rehabilitation in Miskolc we also have organized the treatment of obese children following foreign and domestic examples and in the course of the treatment we also applied diet and set up individually determined training programmes [5, 9, 13, 21].

Patients and Method

We performed the examination and treatment of 20 obese children, in whose case endocrine origin had been precluded beforehand.

The results of the examinations performed before and after treatment of the obese children were compared with the results of 20 healthy, not obese children living a normal way of life, not engaged in sports. The obese group consisted of 12 girls and 8 boys. Their mean age was 11.3 ± 1.6 years.

The control group also consisted of 12 girls and 8 boys, their mean age being 12.6 ± 0.8 years.

For the obese excess body weight was given in percentage. Subtracting the ideal body weight from the measured weight of the children, we groupped them according to the amount of excess weight: children with 10—20% excess weight fell into mild category, children with 20—30% excess weight fell into medium category and children with 30% or above fell into serious category.

Obese children were admitted to our department for a period of three weeks. We measured their weight, height, determined their physical working capacity, their blood pressure at various strain levels under bicycle-ergometric strain, measured their vital capacity, made a glucose tolerance test and determined the total serum lipid, triglycerid, cholesterin, LDL-C and HDL-C from among the fat parameters on admission and before release. We applied submaximal load for determining the physical working capacity and determined PWC_{170}, that is the maximum working capacity with a pulse of 170.

A bicycle-ergometer type Medicor K 11 was used for this examination, to which a direct-display electrocardiograph can be attached registering the Nehb chest leads.

The load was applied at a revolution of 60/min starting at 0.5 W/kg and increased by 0.5 W/kg every 2 min until a pulse of 170 was reached. An electrocardiogram was made every minute of the load and the blood pressure was taken every 2 min.

Vital capacity showing the level of training, was determined by using a Eutest-2 set, after previous practice. The glucose tolerance test was performed with 1.75 g/kg glucose, the maximum value was 100 g. Serum glucose was determined by enzymatic method. We took blood sample after 12 h fasting to determine fat parameters. The total serum lipid was determined by the phosphor-vanillin-acid method, the total serum cholesterin, HDL-C, LDL-C, and triglycerid were determined by the Boehringer enzymatic test.

The children were given a diet of 1000 calories, which contained 50% carbohydrates, 30% fat and 20% protein. Their

increased physical activity was provided by a strict routine: half an hour's jogging and one hour gymnastics early in the morning, one hour in the swimming-pool later in the morning, cycling on the bicycle-ergometer early in the afternoon and games in the open air later in the afternoon.

Trainings in the gym hall included gradual and periodical loads. The maximum pulse to be reached was determined individually, together with its duration as well as with the alternation of load and rest periods.

As a starting point the results of bicycle-ergometer load and blood pressure values during the load were used. A maximum load of 3×5 minutes, 3×8 minutes was used in the first, second and third week, respectively. If the child's PWC_{170} value was 0.5 W/kg, we aimed at a maximum pulse of 120—130 in the first week. With a value of 1 W/kg we aimed at a pulse of 130—140, with a value of 1.5 W/kg at a pulse of 140—150 and with a value of 2 W/kg we aimed at a pulse of 150—160, and these pulse values were increased by 10 in the second and the third week, as well.

If the systole blood pressure rose in the course of the load test to 160 Hgmm or exceeded it and/or the diastole blood pressure rose to 100 Hgmm or exceeded it, the maximum permitted pulse number during training was 20 below the pulse number taken at the above blood pressure [7].

Trainings were always held in groups containing a small number of children pulses were always taken by an expert.

Training in the swimming pool included teaching swimming, underwater gymnastics and games, as none of the children was able to swim long distances properly.

Cycling on the bicycle-ergometer for the purpose of training was performed with a load of 0.5 W/kg, 60 rev/min for 10 minutes.

Exercises in the gym hall were performed to music on different gymnastic appliances and starting from different positions. Games were played without a competitive character, avoiding peak performance so as to avoid sudden rises in blood pressure.

Results

As a result of the three week treatment the weight of each child decreased, on average by 5.43 ± 1.6 kg. (Fig. 1) Fig. 2 shows the change of the patients' weight category.

The mean value of the physical working capacity increased from 1.07 ± 0.31 W/kg to 1.50 ± 0.47 W/kg and nearly equalled the mean value of the healthy control group, which was 1.59 ± 0.39 W/kg. (Fig. 3) Evaluating the cases individually: PWC rose in case of 17 children and remained unchanged in 3.

The blood pressure value at rest was in average 119 ± 7.30 ($72 \pm \pm 7.36$ Hgmm in the control group, in the obese group the mean value before treatment was 129.55 ± 10.27 (86.84 ± 8.89 Hgmm, and after treatment it was 120.47 ± 14.65) 75.64 ± 5.68 Hgmm. (Table I)

Before treatment we registered a systole blood pressure of 160 mm Hg or higher and/or a diastole blood pressure of 100 mm Hg or higher in 11 children during the load test on the bicycle-ergometer, after three weeks 10 children registered the above mentioned blood pressure values.

Vital capacity showing fitness in the group of children with normal weight was in average 2911 ± 563.42ml. In the group of overweight children it was 2376 ± 450.61 ml before treatment and rose to 2635 ± 380.70ml after treatment. (Fig. 4)

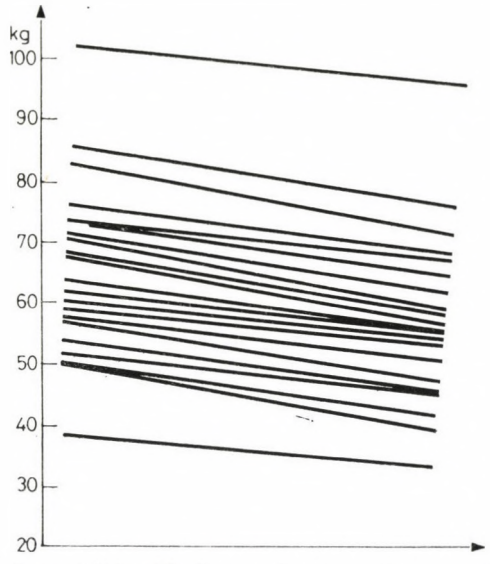

FIG. 1. Weight of obese children before and after a three-week-long treatment

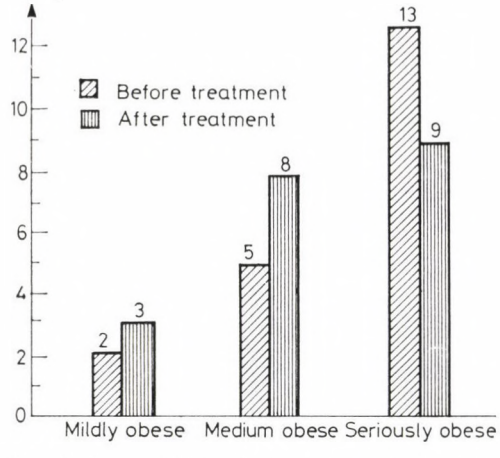

FIG. 2. Weight categories of obese children before and after a three-week-long treatment

TABLE I

Mean rest blood pressure values for children with normal weight and for obese children (mean ± SD)

Healthy control group	Obese group	
	before treatment	after treatment
119,00 ± 7.30/72 ± 7.36 mm Hg	129.55±10.27/ 86.84±8.89 mm Hg	120.47±14.65/ 75.64±5.68 mm Hg
	n.s.	

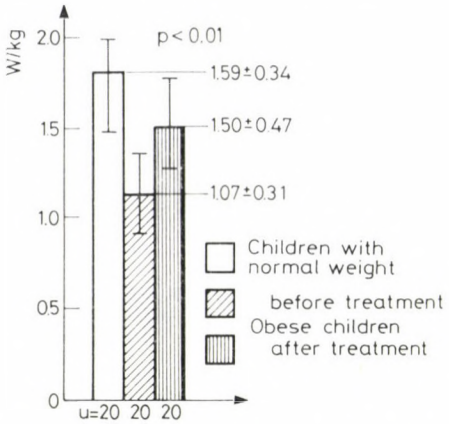

FIG. 3. PWC_{170} mean values for children with normal weight and for obese children (mean ± SD)

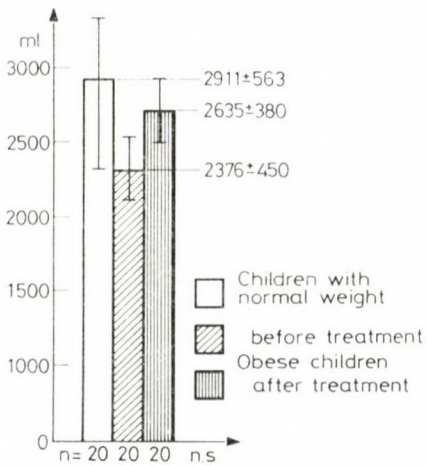

FIG. 4. VC mean values for children with normal weight and for obese children (mean ± SD)

Evaluating the vital capacity individually: it rose in 16 children and remained unchanged in 4.

The following changes were registered in fat parameters: (Table II) the average value of the total serum lipid in obese children was 7.97 ± 0.70 g/l at admission, after three weeks it decreased to 6.95 ± 0.43 g/l; the mean value of the control group was 6.12 ± 1.54 g/l. It decreased in 16 children, no increase was registered in any children.

Serum triglycerid in the obese group decreased in 10 children after treatment, remained unchanged in 9 and one showed increased value. In average the above value before treatment was 0.94 ± 0.05 mmol/l, after treatment it was 0.92 ± 0.05 mmol/l, it is

TABLE II

Serum lipid and lipoprotein values (mean ± SD) for obese children and for healthy controls

	Healthy controls	Obese children		
		before treatment	after treatment	
Case number	20	20	20	
Total serum lipid (g/l)	6.12±1.54	7.97±0.70	6.95±0.43	$p < 0.01$
Total serum cholesterin (mmol/l)	4.34±0.66	4.56±0.57	4.44±0.65	n.s.
Total serum triglycerid (mmol/l)	1.05±0.15	0.94±0.07	0.92±0.05	n.s.
LDL-C (mmol/l)	3.05±0.68	3.40±0.41	3.23±0.73	$p < 0.01$
HDL-C (mmol/l)	1.09±0.50	0.96±0.31	1.17±0.14	$p < 0.01$

interesting to observe that in the control group we had a higher value, 1.05 ± 0.15 mmol/l.

We had higher values for serum cholesterin in average in the obese group both before and after treatment as compared with those of normal weight children. The mean value in the healthy group was 4.34 ± 0.66 mmol/l, in the obese group it was 4.56 ± 0.57 mmol/l at admission and 4.44 ± 0.65 mmol/l after treatment.

Evaluating the values individually serum cholesterin decreased in 15 children remained unchanged in 3 and increased in 2. The mean value of LDL-C in the obese group was 3.40 ± ± 0.44 mmol/l before treatment, it decreased to 3.23 ± 0.73 mmol/l after treatment, the mean value of the healthy control group, however, was even less, 3.05 ± 0.68 mmol/l. In the obese group it decreased after treatment in 12 children, remained unchanged in 6 and increased values were found in 2.

HDL-C values were as follows: the mean value in the healthy group was 1.09 ± 0.50 mmol/l. The average HDL-C in the obese group was 0.96 ± ± 0.31 mmol %1 before treatment and after treatment the average value exceeded that of the control group, rising in average to 1.17 ±0.14 mmol/l; it increased in everybody with the exception of 2 cases.

Before the three week treatment a blood sugar curve showing a tendency to decreased glucose tolerance in the glucose tolerance test was found when the test was repeated after treatment only two children showed this tendency.

DISCUSSION

An appropriate way of life and physical activity are of ever increasing importance in the primary and secondary prevention of cardiovascular diseases.

Adult obesity depends on the way of life and habits, on nutrition, which habits are formed in childhood [2].

That is why we considered it important to organize the treatment of obese children by means of admission

to hospital; the treatment aimed at teaching and education, as well.

As a result of the three-week treatment the weight of each child decreased.

In obesity the aim of treatment is to decrease body weight as well as to increase physical working capacity.

Ylitalo [26] achieved by means of diet and physical training that the physical working capacity of obese children reached a normal level. In literature published in Hungary Czinner et al [8] and Blatniczky et al [5] report about the increase in the working capacity of obese children during a camping holiday.

According to our results, too, the mean PWC_{170} value of obese children increased after treatment.

Obesity and hypertonia often occur together [19]. Kovács [15] noticed a connection between obesity and hypertonia, however, only in the case of high weight percentage.

The physical, gymnastics therapy of boundary value hypertonia is essential and effective [6, 18, 23]. However, these patients must avoid excess load. That is why we considered it necessary to take into account the individual blood pressure value taken at the different load levels and pulse values, resp., in the ergometric test when determining the maximum pulse value during training.

In our examinations, however, decrease in the blood pressure value at rest was measured in obese children and no decrease in the blood pressure value at loading. This can be accounted for by the fact that, on the one hand, the duration of the treatment was short, and on the other, no child reached its ideal weight even after the treatment.

It has been known for a long time that training increases peripheral glucose intake and decreases the insulin level. After the three-week treatment, like other authors, we also registered an improved glucose tolerance [5, 9, 11].

Obesity is often connected with changes in the levels of total fat cholesterin, triglycerid, LDL-C and HDL-C.

Berenson [1] reports about the examination of 1598 obese children, aged 5—12; according to his findings a positive relationship can be established between a high value of total cholesterin, triglycerid, LDL-C and VLDL-C and obesity, whereas a negative relationship can be established between HDL-C and obesity.

Ylitalo [26] examined 61 obese children and found that triglycerid had increased and HDL-C had decreased.

In Hungary, examinations by Czinner have proved that in obese children serum cholesterin is higher similarly to the fasting value of triglycerid [10].

In our patients an improvement in the change of fat parameters, most characteristically in the HDL-C level was found. Our findings also prove that the treatment of obese children by means of diet and increased physical activity may be efficient, this may influence the cardio-vascular risk factors, increase their physical working capacity, which enhances their

self-confidence and improves their mental status.

Setting up an individually determined training programme, was considered necessary so as to avoid physical, mental and metabolic side-effets.

A hospital treatment of several weeks is however, not sufficient to maintain and improve the results, so obese children keep coming back to our department even after the hospital treatment to do their gymnastics and swimming.

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Márta Peja, MD
P.O.Box 188
H-3501 Miskolc, Hungary