

## The Influence of a Therapeutic Programme on the Segmentary Body Composition in over - and Underweight Children at the Early-School Age: Pilot Studies

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### Abstract

**Background:** Underweight and obesity are important factors affecting the level of physical fitness.

**Aim:** The objective of the work was the assessment of the change in body composition and physical fitness in early-school-age children participating in a 6-week therapeutic programme aimed at children with low body mass and those overweight.

**Methods:** Examined were 175 children of 7-10 years of age from Wrocław. Their body composition (before and after the therapeutic programme) being marked with the 8-electrode body composition analyzer BC-418 MA Tanita. On the basis of BMI under and overweight children were selected to take part in a 6-week therapeutic programme (2 × 45 min/week).

**Results:** Underweight and overweight was found in 12% of the 175 children examined. Twenty children participated in the therapeutic programme (9 underweight, 11 overweight). No body mass change in overweight children was observed with a simultaneous decrease in body fat. Statistically significant changes in body composition were observed in underweight children.

**Conclusion:** The therapeutic programme lowered body mass (in underweight children only) and fat content along with an increase in muscle mass (FFM). It was observed that the 6-week programme needs to be prolonged to at least 10 weeks in order to obtain significant changes in body composition in the group of overweight children.

**Keywords:** Therapeutic programme for children; Fat free-fat index; Segmentary body composition; Underweight; Overweight

### Introduction

The problem of under and overweight is a very important one not only in Poland, but around the world. The IOTF report points to the occurrence of overweight and obesity as an increasing problem. According to the most recent data, every 5<sup>th</sup> child is overweight and every 7<sup>th</sup> is obese. At the same time, a 10% rise in the percentage of children with excessive body mass has been observed in the last decade. The problem affects most often 5 and 6 year old children [1-3]. It is recorded in the Polish literature that 5% of children are underweight and 20% of children overweight. From research conducted within the framework of OLAF ("OLAF" project 2007-10<sup>th</sup> programme of assessment of blood parameters, body mass and height as well as BMI within the Polish population at 7 and 18 of age) it is seen that excessive body mass is present most often among children at school age - 20%, [4]. The occurrence of the problem of excessive body mass at an early school and school age is connected with the child's lifestyle; from an active and playful to a sedentary. Physical Education in Polish early-age primary schools does not occupy sufficient time as there are only sport exercises three times per week (45 minutes long) prepared not by a professional Physical Education teacher, but by a

general form teacher [5]. In addition, extracurricular activity is dependent on the awareness of the parents as well as their organizational and financial capabilities. Moreover, after school activities organized at clubs are selected by the parents, who consider the interests of the child rather than abilities or predispositions. Access to the classes depends also on the age and place of residence. Such activities aimed at children at a certain age do not take into account their body structure and predispositions, but are oriented towards selection for a particular sporting discipline. The activity of overweight children is frequently led together with a group of more capable children with normative body mass and is not adjusted to individual requirements and as a consequence provides discouragement from training [6,7].

Limited daily physical activity in a child requires additional supplementation with customized preventive activities. Every year 20% of pupils at the ages of 6 and 7 begin learning at school. Some of these do not attend compulsory Physical Education classes by providing an unjustified medical certificate and most of the children are not aware of the principles of healthy nutrition. Programmes currently applied by the central and local governments largely focus on eating habits, not improving the physical activity of the child. Low physical activity and poor eating habits are primary factors influencing risk of overweight and obesity in adult life. Hence the significance of preventive-

therapeutic programs based on increased physical activity led by therapists [8,9]. The introduction to the curriculum of obligatory classes conducted by a physiotherapist may have a positive effect on proper development not only when it comes to remediation of body posture impairments, but also in prevention of overweight and obesity.

The objective of the work was an assessment of the change in body composition fat-free fat index in early-school-age children participating in a 6-week therapeutic programme which was aimed at children with low body mass and those overweight.

## Materials and Methods

Examined were 175 children (♀-n=95, ♂-n=80) of from 7 to 9 (7.8 ± 0.8, ♀-7.86 ± 0.77, ♂-7.75 ± 0.8; p=NS) years of age attending Primary School No 76 in Wrocław.

The average body mass of the subjects was 29.4 ± 6.9 kg, their average height 132.8 ± 7.7 cm and mean BMI 16.5 ± 2.5 kg/m<sup>2</sup>. The average fat mass in percentage (FatP) of the subjects was 19.99 ± 4.04%, their average fat mass in kilograms (FatM) 6.08 ± 2.81 kg and mean free fat mass in kilograms (FFM) 23.28 ± 4.39 kg (Table 1).

	Average ± SD			p
	All groups n=175	Girls n=95	Boys n=80	
Age (years)	7.8 ± 0.8	7.86 ± 0.77	7.75 ± 0.8	NS
Height (cm)	132.8 ± 7.7	132.48 ± 7.45	133.09 ± 7.98	NS
Weight (kg)	29.4 ± 6.9	28.85 ± 6.44	29.95 ± 7.44	NS
BMI (kg/m <sup>2</sup> )	16.5 ± 2.5	16.28 ± 2.42	16.69 ± 2.62	NS
FatP (%)	19.99 ± 4.04	20.87 ± 3.76	18.96 ± 4.13	p<0.01
FatM (kg)	6.08 ± 2.81	6.21 ± 2.57	5.94 ± 3.09	NS
FFM (kg)	23.28 ± 4.39	22.65 ± 4.10	24.02 ± 4.63	p<0.05
TBW (kg)	17.05 ± 3.22	16.59 ± 3.01	17.59 ± 3.39	p<0.05
PMM (kg)	22.34 ± 4.18	21.62 ± 3.88	23.19 ± 4.39	p<0.05

**Table 1:** Anthropometric characteristics of the studied groups.

No statistically significant differences in body mass, height or BMI were observed between girls and boys. Statistically significant differences were observed in fat mass in percentage and free fat mass in kilograms depending on the sex of the subjects.

Of all the children examined 12% had a BMI below the 5<sup>th</sup> percentile, 76% between the 5<sup>th</sup> and 85<sup>th</sup> percentile and 12% over the 85<sup>th</sup> percentile.

On the basis of BMI under and overweight children were selected in order to take part in a 6-week therapeutic program (2 × 45 minutes per week).

The 8-electrode body composition analyzer TANITA BC-418MA, made in Japan, was used to check the body composition of the children.

In this examination information about fat (in percentage and kilograms), and fat free mass was obtained [10]. Body composition was checked twice-before the therapeutic programme and after the 6<sup>th</sup> week.

For the assessment of the effects of the therapeutic programme general and segmental Fat/Fat-free indices were calculated with the use of the 8-electrode body composition analyzer.

FFF: FatM/FFM; FFF: Fat/Fat-free Mass Index; FatM: Fat Mass; FFM: Fat-free Mass; FFF1: Right leg Fat/Fat-free Mass Index (FFF1=RLFatM/RLFFM); FFF2: Left leg Fat/Fat-free Mass Index (FFF2=LLFatM/LLFFM); FFF3: Right arm Fat/Fat-free Mass Index (FFF3=RAFatM/RAFFM); FFF4: Left arm Fat/Fat-free Mass Index (FFF4=LAFatM/LAFFM); FFF5: Trunk Fat/Fat-free Mass Index (FFF5=TRFatM/TRFFM) [11].

### Six-week therapeutic programme

This is a multistage therapeutic program prepared for a period of at least 12 months in order to improve quality of life in under- and overweight children.

The first stage 6 weeks long - aimed at increasing the physical activity of the children.

The exercises were held twice a week: 45 min in a gym room, 45 minutes at the swimming pool.

Descriptive statistics was applied in order to describe the group (average, SD). For the assessment of changes the Wilcoxon signed rank test was used and the Kolmogorov-Smirnov test for the comparisons between the groups. The interdependency of the values was defined by the Spearman's rank correlation. Statistical significance was accepted at the level of p ≤ 0.05.

## Results

As shown in Table 2 the overweight group was statistically significant older, taller and heavier than the underweight group.

In the group examined statistically significant differences were observed in fat tissue distribution between the over - and underweight children as well as overweight and with normative body mass in all segments of the body (Table 2). No statistically significant differences in the case of fat tissue percentage in the limbs and trunk were observed in children with insufficient and normative body mass. Observed in the children studied was a circumferential fat distribution.

Statistically significant differences were observed in all Fat/Fat-free indices between the over and underweight children. In all subjects the lowest indices proving the lowest mass of fat tissue were observed in the trunk. The total and segmental Fat/Fat-free index of examined children is presented in Table 3.

		Underweight Mean $\pm$ SD n=20	Normative Mean $\pm$ SD n=133	Overweight Mean $\pm$ SD n=20	P N v. U	P N v. O	P U v. O
Total body	Fat P (%)	16.40 $\pm$ 2.21	19.35 $\pm$ 2.98	27.48 $\pm$ 4.39	p<0.001	p<0.001	p<0.001
	FatM (kg)	3.28 $\pm$ 0.66	5.53 $\pm$ 1.46	11.73 $\pm$ 4.55	p<0.001	p<0.001	p<0.001
	FFM (g)	16.58 $\pm$ 1.14	22.73 $\pm$ 3.20	29.77 $\pm$ 5.12	p<0.001	p<0.001	p<0.001
Segmental body composition							
RL (right leg)	FatP	26.01 $\pm$ 1.83	28.27 $\pm$ 3.12	35.04 $\pm$ 4.06	p<0.05	p<0.001	p<0.001
	FatM	0.99 $\pm$ 0.21	1.36 $\pm$ 0.34	2.84 $\pm$ 1.04	p<0.001	p<0.001	p<0.001
	FFM	2.80 $\pm$ 0.53	3.44 $\pm$ 0.65	5.11 $\pm$ 0.87	p<0.001	p<0.001	p<0.001
LL (left leg)	FatP	26.14 $\pm$ 1.72	28.58 $\pm$ 3.16	35.63 $\pm$ 3.93	p<0.05	p<0.001	p<0.001
	FatM	0.98 $\pm$ 0.20	1.34 $\pm$ 0.33	2.81 $\pm$ 1.01	p<0.001	p<0.001	p<0.001
	FFM	2.69 $\pm$ 0.50	3.32 $\pm$ 0.62	4.94 $\pm$ 0.88	p<0.001	p<0.001	p<0.001
RA (right arm)	FatP	28.54 $\pm$ 1.66	29.63 $\pm$ 3.62	35.51 $\pm$ 4.01	NS	p<0.001	p<0.001
	FatM	0.27 $\pm$ 0.05	0.38 $\pm$ 0.09	0.73 $\pm$ 0.20	p<0.001	p<0.001	p<0.001
	FFM	0.71 $\pm$ 0.13	0.88 $\pm$ 0.17	1.31 $\pm$ 0.21	p<0.001	p<0.001	p<0.001
LA (left arm)	FatP	28.19 $\pm$ 1.84	29.91 $\pm$ 3.63	37.55 $\pm$ 4.65	NS	p<0.001	p<0.001
	FatM	0.29 $\pm$ 0.05	0.40 $\pm$ 0.11	0.84 $\pm$ 0.28	p<0.001	p<0.001	p<0.001
	FFM	0.71 $\pm$ 0.13	0.93 $\pm$ 0.18	1.36 $\pm$ 0.24	p<0.001	p<0.001	p<0.001
TR (trunk)	FatP	10.17 $\pm$ 1.59	12.53 $\pm$ 3.11	19.94 $\pm$ 4.17	NS	p<0.001	p<0.001
	FatM	1.37 $\pm$ 0.27	2.07 $\pm$ 0.68	4.68 $\pm$ 1.51	p<0.001	p<0.001	p<0.001
	FFM	12.01 $\pm$ 1.43	14.19 $\pm$ 1.67	18.27 $\pm$ 1.79	p<0.001	p<0.001	p<0.001

**Table 2:** Body composition and segmental distribution depending on the BMI classification in children examined before the 6-week therapeutic programme.

	Underweight Mean $\pm$ SD n=20	Normative Mean $\pm$ SD n=133	Overweight Mean $\pm$ SD n=20	P N v. U	P N v. O	P U v. O
FFF	0.197 $\pm$ 0.032	0.242 $\pm$ 0.047	0.384 $\pm$ 0.087	p<0.001	p<0.001	p<0.001
FFF1	0.346 $\pm$ 0.049	0.397 $\pm$ 0.061	0.562 $\pm$ 0.110	p<0.01	p<0.001	p<0.001
FFF2	0.353 $\pm$ 0.037	0.404 $\pm$ 0.062	0.573 $\pm$ 0.106	p<0.01	p<0.001	p<0.001
FFF3	0.399 $\pm$ 0.063	0.427 $\pm$ 0.075	0.555 $\pm$ 0.110	p<0.025	p<0.001	p<0.025
FFF4	0.388 $\pm$ 0.068	0.428 $\pm$ 0.088	0.621 $\pm$ 0.149	NS	p<0.001	p<0.025
FFF5	0.117 $\pm$ 0.018	0.145 $\pm$ 0.041	0.259 $\pm$ 0.067	p<0.01	p<0.001	p<0.001

**Table 3:** Comparison of Fat/Fat-free indexes (general and segmental) in children examined before the therapeutic program.

Establishing general FFF index as 100%, the ratio of segmental to general indices was calculated. Observed in children with underweight in the group studied was a twice higher FFF index in the upper limbs in relation to the general FFF index (%FFF3-202, %FFF4 - 198). The smallest differentiation between segmental indices compared with the general one was observed in the group of overweight children. Fat

tissue distribution in the children examined on the basis of the FFF index is shown in Figure 1.

After the programme body composition in both groups was examined again. In the case of the underweight children both body mass and individual body components such as weight and fat tissue percentage increased. This increase was statistically significant and it proved this short programme to be very effective (Figure 2). The

change in body composition after a six week therapeutic program is shown in Figure 2.

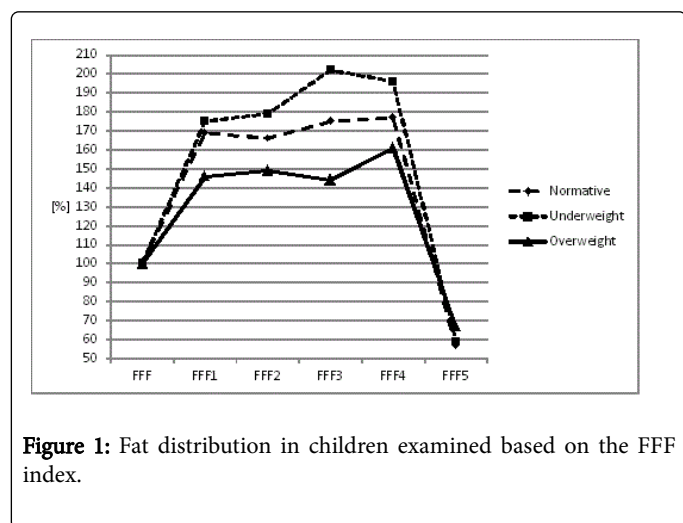


Figure 1: Fat distribution in children examined based on the FFF index.

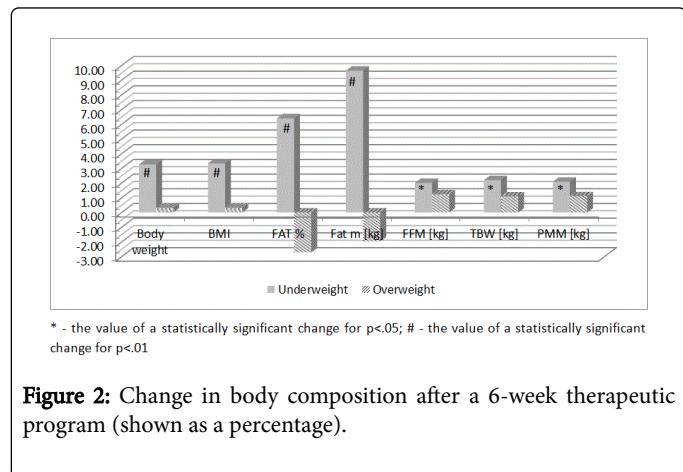


Figure 2: Change in body composition after a 6-week therapeutic program (shown as a percentage).

Changes in the Fat/Fat-Free index under the influence of the 6-week therapeutic program in the examined children are presented in Table 4.

In underweight children examined statistically significant changes were observed in general Fat/fat-free index and FFF index for the trunk marked before and after the therapeutic programme. In overweight the children the positive value of the change indicates a lower index after the therapeutic programme, which proves a lower level of fat tissue.

Overweight children maintained a stable level of body mass. However, the body components altered (some fat turned into muscle tissue). This is not a statistically significant change, but it is a successful first step.

	Underweight		Overweight	
	Mean± SD	p	Mean ± SD	p
FFF before & FFF after	-0.015 ± 0.008	p<0.05	0.012 ± 0.033	NS
FFF1 before & FFF1 after	-0.015 ± 0.030	NS	0.007 ± 0.034	NS

FFF2 before & FFF2 after	-0.024 ± 0.032	NS	0.007 ± 0.033	NS
FFF3 before & FFF3 after	-0.016 ± 0.090	NS	-0.001 ± 0.054	NS
FFF4 before & FFF4 after	-0.028 ± 0.082	NS	0.005 ± 0.067	NS
FFF5 before & FFF5 after	-0.012 ± 0.008	p<0.05	0.012 ± 0.041	NS

Table 4: Changes in Fat/Fat-free index after a 6-week therapeutic programme.

## Discussion

Overweight and obesity is not only an aesthetic problem, but also one of the primary factors influencing the risk of many diseases in adult life [12]. Nevertheless, as early as childhood and teenage years it is possible to observe problems with physical activity, skin changes, joint overstrain syndrome, body posture impairments or endocrine disruptions. Particular attention should be paid to cardiovascular diseases which beginning at an early age may develop in young adults. Overweight and obesity in childhood constitutes a psycho-social problem as well. Low self-esteem and social isolation are only the tip of the iceberg of complications related to body mass disorders [10,13,14].

The WHO and experts dealing with treatment of overweight and obesity in children claim proper eating and physical activity to be more important than pursuing the appropriate body mass [15]. Of great significance in the prevention of improper body mass are the adults surrounding a child? The knowledge of parents and good patterns recurring at school provide a basis for development of good eating habits and active forms of spending free time. An example of good practices may be programmes realised in primary schools such as “A Glass of Milk”, “Fruits and Vegetables at School” and “School in Shape”. Teaching proper behaviour patterns in educational institutions is a crucial element in raising children. Children are not able to think long-term about the consequences of their obesity [16], which is why the WHO and bodies responsible for education introduced recommendations concerning prevention of body mass disorders (WHO and MEN guidelines). Guidelines on the physical activity of children and teenagers were devised and introduced for realization in the school system (MEN guidelines) [7]. However, as the results of our own screening prove 20% of children at school age have an above-normative body mass, the amount and form of physical activity proposed by the curriculum is insufficient. In selecting an appropriate activity it is essential to bear in mind that a child can focus only for a few minutes, which is why the activities should be interesting, motivating and encouraging of further co-operation [17,18]. The programme imposed by the National Ministry of Education provides only an overall and general approach to physical education for children, not taking into consideration potential body mass disorders such as under- and overweight or obesity. Our own research shows that even slight modifications of physical activity aimed at combating body mass disorders bring results. This is an element of school education which ought to be led by a physiotherapist. The programme proposed in the work was based on extra activities twice a week just for the period of 6 weeks. Osinski points to therapeutic programmes not shorter than 8 weeks which aim at body composition improvement to have an optimum effect on overweight and obesity prevention. Thanks to the application of aerobic and strength training fat tissue mass may



be successfully lowered with a simultaneous increase in fat-free tissue [6]. Faigenbaum et al. [19] confirm the positive but not statistically significant influence of an 8-week intervention affecting an increase of muscle strength. The growth did not translate into an improvement in physical fitness (handgrip strength, flexibility, vertical jump, and long jump). Other authors in turn noted statistically significant results of short-term interventions an increase in strength as well as improvement in cardiovascular endurance and flexibility [20-22]. Observed in the research presented were slight changes in fat/fat-free index, which was used for the assessment of body composition alterations resulting from a therapeutic programme [11]. In the group of underweight children examined, observed were statistically significant changes in BMI, percentage of fat and fat-free tissue as an outcome of a 6-week therapeutic programme. The changes proved body mass increase. In the group of overweight children stabilization in general body mass was observed accompanied by a decrease in fat/fat free indices.

The FFF index calculated as the ratio of fat tissue mass to fat-free tissue mass reacts to even a slight change in an individual constituent of body composition. Its negative value in underweight children indicates a greater growth in fat compared with fat-free tissue, which is a positive effect in the case of this group. In overweight children the change in indices after the therapeutic programme is negative so the indices FFF (1-5) after are lower than FFF (1-5) before the programme. This proves the change of fat to fat-free tissue mass ratio, thus a desired result of additional physical activity aimed at the improvement of physical fitness in under- and overweight children. However, the changes observed in children with above- normative body mass are not statistically significant, which may be caused by too short a duration of the programme. Results obtained suggest the necessity of further study with a prolonged duration of therapeutic programme.

The programme introduced was intended not only to change the body mass of the subjects, but also to draw parents' attention to an existing problem of body mass disorders. The actions should be aimed at a change in lifestyle to a healthy and rational one showing that physical activity may be pleasurable and beneficial. The changes ought to be introduced at the beginning of the educational path in order to initiate and strengthen proper habits in children. A child who becomes aware early enough of the positive aspects of healthy lifestyle will become a healthy, conscious adult who values health-promoting attitudes and active leisure time [23,24]. This intervention presents a positive direction in body composition changes in over- and underweight children. The programme was accepted well by the children and their parents, which enables further research. The introduction of properly adjusted physical activity into the curriculum seems eminently suitable. It is important to bear in mind that a generally available educational programme is always adjusted to population norms and does not take into consideration such anomalies as under- and overweight in early-school-age children. The role of a physiotherapist is in this case invaluable and additional bio monitoring enables the tracking of changes and early recognition of body mass disorders.

## Conclusions

1. Improper body mass was indicated in the case of 22% of the children examined.
2. A statistically significant body mass increase was observed only in the underweight group of children.

3. In the group of overweight children, however, the body weight remained stable, but body composition was changed.

4. The 6-week programme proves to be too short to observe significant changes especially in the group of overweight children.

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