EFFECTS OF PHYSICAL TRAINING ON WEIGHT REDUCTION, BODY COMPOSITION AND MOTOR FITNESS IN OVERWEIGHT WOMEN AGED 50–59 AND 60–69

by

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The main objective of this study was evaluation of the changes of basic somatic characteristics and motor fitness following the 18-day physical training with dietary intervention offered to women with moderate obesity. This program was carried out for 10 years for different groups of volunteers. 604 women aged 50-59 (BMI= 31,96 ± 4,46 kg/m^2) and 102 women 60–69 years (BMI = 30,34 ± 5,18 kg/m^2) were considered. The control group consisted of 2426 women aged 20-29 (BMI= 30,12 ± 5,00 kg/m^2). The exercise programme involved, first of all, a variety of aerobic activities (5,5 hours daily); supplemented by a controlled diet.

The following conclusions were drawn: 1) similar positive effects of the programme on the reduction of body mass, BMI, body circumference and thickness of skinfolds were found irrespective of age, 2) smaller but positive changes in motor performance were found in the groups of older women, 3) the effects of exercise treatment on individual elements of the body weight, body composition and the tested elements of motor performance were varied.

Key words: Obesity, physical training, physical fitness

Introduction

That regular, vigorous physical activity may prevent obesity had always been an attractive hypothesis. It was claimed that the overweight and obese persons are less physically active (Montoye 1975, Garrow 1986, Żak 1994). Yet other studies, using assessment methods (activity diaries, visual observations, and accelerometers devices), have not revealed a consistent picture of whether total daily physical activity differs between lean and obese individuals (Thompson et al. 1982, Pacy et al. 1986). Major part of available data suggest that determining the importance and type of the physical — training regimens in the obesity treatment seems a more complicated problem (Garrow 1981). The effects of programs which are to reduce the excess of body mass are varied. The researchers observed a decrease in the body

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mass, percentage of fat, insulin, LDL, triglycerides and the blood pressure in obese children who took on extensive physical activity. The children also showed an improvement in their sensitivity to insulin, tolerance for glucose, better mobilisation of the free fatty acids as well as the increase in the HDL level (Bar-Or 1993). Opposite opinion was given by Atkinson, and Walberg-Rankin (1994) who stated that contrary to most expectations, many studies did not reveal any considerable weight loss by exercise in severely obese population.

The role of physical activity depends on the degree of obesity. Physical activity is most important is as a preventive measure, at BMI about 25 kg/m^2. When BMI values exceed 40 kg/m^2, the obese cannot be active enough to influence their body composition. However, if they only limit themselves to keeping a diet, the decrease in the amount of the consumed food is hardly effective, because it leads to the decrease in the metabolism rate (Garrow 1986). There is a significant negative correlation between the percentage of body fat and its proportion on slow-twitch fibres in the muscle sample (Wade et al. 1990). These results are consistent with reports claiming that mainly the endurance — aerobic efforts are effective in the reduction of obesity (Girandola 1976). Moreover, this type of training induces a preferential mobilisation of abdominal fat stores (Després et al. 1991).

The aim of this study was to assess the reactivity of overweight and obese women from several age groups to physical training regimens, i.e. the combination of exercise and food restriction program. Such an approach is important because, according to literature on the subject, the response of human organisms to physical training activity may vary different periods of life. Some researchers (Hagberg 1987, Pollock 1973, Panton et al. 1990, Kohrt et al. 1994). Schwartz et al. (1991) reported that after the physical activity programmes significant losses of visceral fat were noted but the reduction was more marked in older men than in the groups of healthy young men. It can be assumed that in the later periods of life the sensitivity to impulses is very limited (Seals et al. 1984, Hagberg 1987). In this study the patient's reactivity to the physical training in relation to the individual morphological characteristics, body composition and different elements of motor fitness was examined.

Materials and methods

The control group included 604 women aged 50–59 and 102 women aged 60–69. The reference group consisted of 2426 women aged 20–29. All these women participated in specialist treatment programmes organised for the overweight and obese women always in the same locality and always during summer months. These treatments were conducted for 10 years, from 1974 to 1983; but the publications on the results were scarce (Mieczkowski 1981). The examined persons volunteered for the successive periods of treatment and the degree of their overweight and their obesity varied. We can only inform that before the treatment, the BMI among the

Table 1. Baseline characteristics of body mass, BMI, skinfolds and body circumferences „before" and „after" the specialistic program of the physical-training in the examined age groups of women

Variable		Age group (years)					
		20–29 (n=2426)		50–59 (n=604)		60–69 (n=102)	
		Before	After	Before	After	Before	After
Weight [kg]	$\bar{x}$	77,95	74,08	79,61	75,24	80,75	77,17
	SD	13,04	11,15	10,67	11,86	11,32	12,10
	V	16,73	15,05	13,41	15,76	14,06	15,69
	d	–3,87***		–4,07***		–3,58**	
BMI [kg/m^2]	$\bar{x}$	30,12	28,62	31,96	30,35	30,34	28,68
	SD	5,00	4,28	4,02	4,46	5,18	5,54
	V	16,60	14,95	12,57	14,69	17,07	19,32
	d	– 1,50***		– 1,61***		– 1,66**	
Σ Biceps, triceps, subscapular i suprailiac skinfolds [mm]	$\bar{x}$	105,10	89,14	107,14	92,00	100,38	92,70
	SD	33,29	31,30	36,57	33,45	30,28	26,55
	V	31,67	35,11	34,41	36,35	30,16	28,64
	d	–15,96***		–15,14***		–15,68***	
Waist circumference [cm]	$\bar{x}$	84,42	80,42	88,37	84,10	87,10	82,44
	SD	8,36	7,76	8,67	8,55	9,06	9,10
	V	9,90	9,65	10,20	10,15	10,20	11,06
	d	– 4,00***		– 4,27**		– 4,66**	
Hip circumference [cm]	$\bar{x}$	109,28	105,65	111,32	107,32	110,28	107,05
	SD	8,20	7,83	11,42	10,87	9,60	8,84
	V	7,64	7,51	10,26	10,13	9,64	8,52
	d	– 3,63**		– 4,10***		– 3,23**	
Waist – hip ratio	$\bar{x}$	0,773	0,761	0,794	0,784	0,790	0,770
	SD	0,068	0,065	0,081	0,080	0,078	0,075
	V	8,77	8,58	10,23	10,15	9,82	9,79
	d	–0,012**		–0,010*		–0,020*	

* – $p < 0{,}05$
** – $p < 0{,}01$
*** – $p < 0{,}001$

women aged 50–59 ranged from 31.96 to 4.02, among the women aged 60–69, the BMI reached 30.34 ± 5.18, while in the reference group of youngest women its was 30,12 ± 5,00 (tabl. 1).

The treatment programmes and the system of control over their correctness and efficiency were developed and directly supervised throughout the whole period of their duration by the co-author of this work (professor T. Mieczkowski).

Doctor's approval, allowing for the increased physical activity, was the initial condition for participation in the treatment. Each period of treatment lasted 18 days. The activities were carried on in age groups. The program of training was unified and as a rule included 20 minutes' warm-up activities in the morning as well as 7 sessions of about 45 minutes of physical activities. Four sessions were scheduled for the mornings and three sessions in the afternoons (with 15 minutes' breaks between the sessions). The typical daily structure of physical activities was as follows:

Nr.	Type of physical activity	Duration of session
1.	Morning warm-up	20 minutes
2.	Gymnastic exercises (callisthenics)	45 minutes
3.	Games and recreations involving motion	45 minutes
4.	Marches, hikes, outdoor athletics	45 minutes
5.	Bicycle ride	45 minutes
6.	Learning or improving swimming	45 minutes
7.	Dances, aerobics	90 minutes
	Total	5 hrs, 35 min.

On the fifth day of the treatment a daylong outing was organised, instead of scheduled activities. All physical training activities were run by qualified and trained specialists in physical education.

During each fixed period of treatment the participants had the medical attendance from a doctor and a nurse, while an expert in the area of nourishment was responsible for the diet. The amount of daily nourishment for the participants of succeeding sojourns was limited to 1100–1200 kcal. The participants were also informed how to reduce their body weight with the help of their own diet and systematic physical activity and, in general, how they should modify their lifestyle.

In each age group, the structure of physical activity included much aerobic exercise, with lower intensity. The intensity of activities varied with regard to the age and the individual abilities of the practising females.

On the second and the seventeenth day of treatment the following measurements were taken:

1. Anthropometry parameters: a) height, b) weight, c) biceps skinfold, d) triceps skinfold, e) subscapular skinfold, f) suprailiac skinfold, g) waist circumference, h) hip circumference.
2. Motor fitness tests (Mieczkowski 1981): a) Running speed-agility: time of running with special exercises, b) Explosive power – vertical jump, c) Static strength – hand grip, d) Dynamic strength – medicine ball (2 kg) throw.

Using the statistic techniques, the researchers estimated the value of arithmetic mean ($\bar{x}$), standard deviation (SD), variation coefficient (v). Using the Student's t-test the they checked the significance of differences between the results from the end ($\bar{x}_{II}$) and from the beginning ($\bar{x}_{I}$) of the treatment. Additionally, the normalised values „z" were calculated in order to obtain the comparable date of changes for different items and for different groups. The values of differences ($\bar{x}_{IIi}-\bar{x}_{Ii}$) were normalised with regard to the standard deviation (SD_{I}) of a given item at the moment when the program began, i.e.: $z=\bar{x}_{IIi}-\bar{x}_{Ii}/SD_{Ii}$.

Results

Table 1 shows the basic anthropometric characteristics of the controlled variables „before" and „after" the physical — training regimens for the following items: body mass, BMI, skinfolds and body circumference. Should we attempt to characterise the whole group of women from all three age groups, we notice that the body mass decreased by 3.58 to 4.07 kg on the average, and the BMI decreased by 1.50 up to 1.66 kg/m^2 (all these are statistically significant differences $p<0.01$ or $p<0.001$).

Table 2. Baseline characteristics of elements of motor fitness "before" and "after" the specialistic program of the physical-training in the examined age groups of women

Variable		Age group (years)					
		20–29 (n=2426)		50–59 (n=604)		60–69 (n=102)	
		Before	After	Before	After	Before	After
Agility run [s]	$\bar{x}$	34,80	32,09	38,68	36,39	46,48	44,24
	SD	4,72	4,31	5,27	5,32	6,37	5,82
	V	13,56	13,43	13,62	14,62	13,70	13,15
	d	–2,71***		–2,29**		–2,24**	
Vertical jump [cm]	$\bar{x}$	26,18	29,04	21,12	22,41	19,23	20,30
	SD	5,49	6,14	4,71	3,35	4,22	4,83
	V	20,97	21,14	12,83	14,95	21,94	23,79
	d	2,86***		1,29***		1,07*	
Hand grip [kG]	$\bar{x}$	36,01	38,17	28,97	30,46	24,73	26,02
	SD	6,29	6,97	6,26	4,92	4,51	5,14
	V	17,47	18,26	21,61	16,15	18,24	19,75,83
	d	2,16***		1,49**		1,29*	
Medicine ball throw 2 kg [m]	$\bar{x}$	5,99	6,22	5,08	5,23	5,03	5,17
	SD	0,93	1,15	0,78	0,77	0,92	0,91
	V	15,60	18,49	15,35	14,72	18,29	17,60
	d	0,26***		0,15*		0,14*	

* – $p < 0,05$
** – $p < 0,01$
*** – $p < 0,001$

The thickness of skinfolds underwent noticeable considerable changes, too. Biceps skinfold, triceps skinfold, subscapular skinfold, suprailiac skinfold were reduced in all age groups. Altogether, the averaged sum of thickness of the mentioned above skinfolds in succeeding age groups decreased and ranged from 15.14 to 15.68 mm ($p<0.001$). The following parameters also decreased after the program: waist circumference by 4.00 cm to 4.66 cm and hip circumference by 3.23cm to 4.10cm ($p<0.01$ or $p<0.001$). Waist — hip ratio decreased from 0,012 to 0,020 ($p<0,05$ or 0,01).

Table 2 shows the characteristics of motor fitness components before and after the program of the physical training. On the average, the examined women improved their motor fitness (all the differences are statistically significant at $p<0.001$; 0.01 or 0.05). The agility — run time shortened by 1.24 to 2.71s, and the vertical jump improved by 1.07 to 2.86 cm, hand grip increased by 1.29 to 2.16 kG and the range of the medicine ball throw improved by 0.14 m to 0.26 m.

Table 3. Changes ("d") in the range of body mass, BMI, skinfolds, body circumferences, and waist – hip ratio after the specialistic program of the physical-training as well as the estimation of the statistical significance of differences between the following age groups: A (20–29 years), B (50–59 years) and C (60–69 years)

Variable	Age group	p value			
		"d"	A – B	A – C	B – C
Weight [kg]	A B C	–3,87 –4,07 –3,58	0,283	0,126	0,158
BMI [kg/m^2]	A B C	–1,50 –1,61 –1,66	0,059	0,047*	0,112
Σ Biceps, triceps, subscapular, and suprailiac skinfolds[mm]	A B C	–15,96 –15,14 –15,68	0,097	0,257	0,109
Waist circumference [cm]	A B C	–4,00 –4,27 –4,66	0,085	0,072	0,192
Hip circumference [cm]	A B C	–3,63 –4,10 –3,23	0,071	0,094	0,064
Waist – hip ratio	A B C	–0,012 –0,010 –0,020	0,332	0,128	0,111

* – $p<0,05$

The researchers analysed whether the value of changes ("d") occurring after the physical treatment programme in the range of the body mass parameters, BMI, skinfolds and circumferences should depend on age (tabl. 3 and fig. 1). In vast ma-

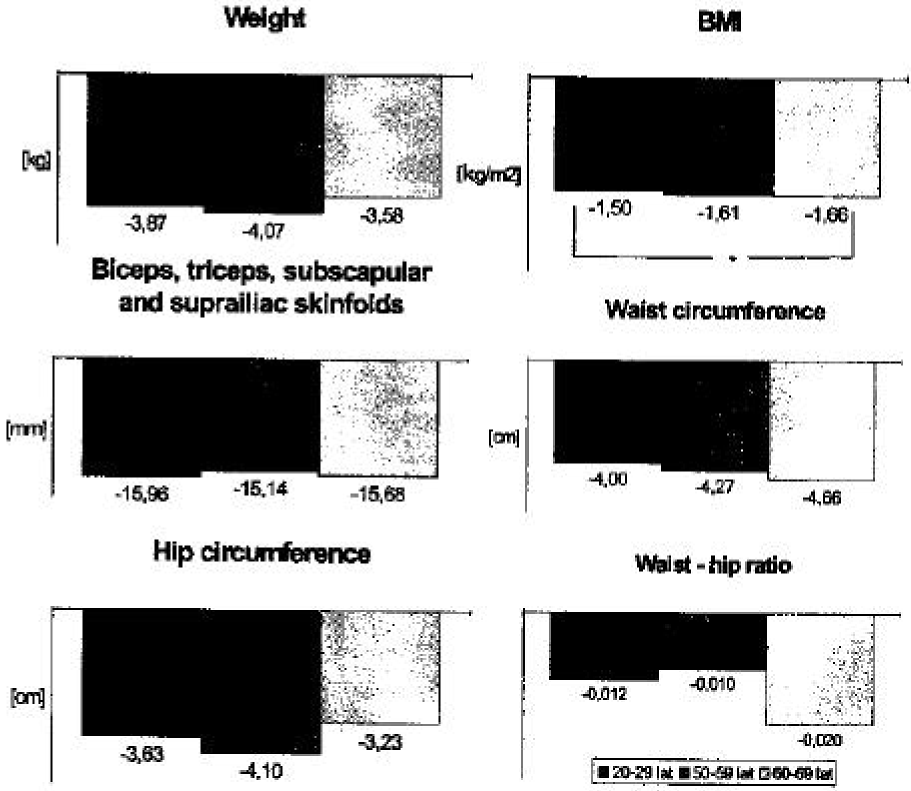

Figure 1. Changes in the results of body mass, BMI, skinfolds, body circumferences, and waist – hip ratio, „before" and „after" the specialistic program of the physical – training in the examined groups of women (* - $p < 0,05$)

jority of cases no such differences were observed. However, it was observed that only the value of BMI decreased in the group of the oldest women (60–69 years) in a larger extent ($p<0,05$) than in the reference group of women aged 20–29.

Table 4 and fig. 2 present the analysed changes in the range of individual results of motor fitness tests. In all cases the changes proved to be most pronounced ($p<0.001$; $p<0.01$ or $p<0.05$) in the reference group of youngest women. The comparison between the women aged 20-29 with the groups of women aged 50–59 and 60-69 would yield the following results: the improvement in the range of agility run by 2.71 and 2.29, 2.24 s, vertical jump 2.86 and 1.29, 1.07 cm, hand grip 2.16 and 1.49, 1.29 kG, medicine ball throw 0.26 and 0.15, 0.14 m. However, while compar-

Table 4. Changes ("d") in the range of the results of motor fitness tests after the specialistic program of the physical-training fitness as well as the estimation of the statistical significance of differences between the following age groups: A (20–29 years), B (50–59 years) and C (60-69 years)

Variable	Age group	"d"	p value		
			A – B	A – C	B – C
Agility run [s]	A B C	–2,71 –2,29 –2,24	<0,001***	0,003**	0,087
Vertical jump [cm]	A B C	+2,86 +1,29 +1,07	0,002**	<0,001***	0,254
Hand grip [kG]	A B C	+2,16 +1,49 +1,29	0,025**	0,019*	0,153
Medicine ball throw [m]	A B C	+0,26 +0,15 +0,14	0,008**	0,009**	0,853

* – p < 0,05
** – p < 0,01
*** – p < 0,001

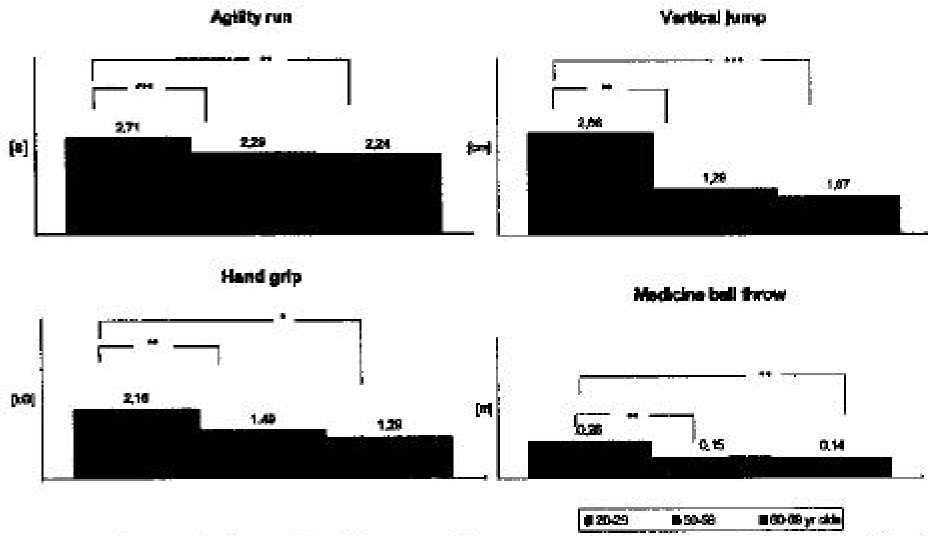

Figure 2. Changes in the results of the motor fitness tests „before" and „after" the specialistic program of the physical-training in the examined age groups of women (* – p <0.05, ** – p <0.001, *** – p <0.001)
Notice: The changes in the range of results of agility run [s] inversely was shown

Table 5. Standardised differences „z" between the values of body mass, BMI, skinfolds, body circumferences, and waist – hip ratio „before" and „after" the specialistic program of the physical-training in the examined age groups of women

Variable	Age group (years)		
	20–29 (n=2426)	50–59 (n=604)	60–69 (n=102)
Weight	–0,30	–0,41	–0,32
Body Mass Index	–0,30	–0,40	–0,32
Σ Biceps, triceps subscapular, suprailiac skinfolds	–0,49	–0,44	–0,52
Waist circumference	–0,48	–0,49	–0,51
Hip circumference	–0,32	–0,19	–0,29
Waist – hip ratio	–0,18	–0,12	–0,26

Notice: $Z = \frac{\bar{x}_{IIi} - \bar{x}_{Ii}}{SD_{Ii}}$; where: $\bar{x}_{IIi}$, $\bar{x}_{Ii}$ — arithmetic mean „after" and „before" the program, respectively
SD_{I} — standard deviation – „before" program

ing the changes in motor fitness in the age group of 50–59 year — old with the changes in the group of women aged 60–69, no statistically significant differences were found.

Table 6. Standardised differences „z" between the results of the motor fitness tests „before" and „after" the program of the physical-training activity in the examined age groups of women

Variable	Age group		
	20-29 (n=2426)	50-59 (n=604)	60-69 (n=102)
Agility run	0,57	0,43	0,35
Vertical jump	0,52	0,27	0,25
Hand grip	0,34	0,24	0,28
Medicine ball throw	0,28	0,19	0,15

Table 5 shows the normalised differences "z" between the values of body mass, BMI, skinfolds and circumferences in the examined age groups before and after the physical activity programme. Such presentation allows for a direct comparison between the changes of relevant characteristics. Noticeable changes were observed in the range of the sum of the four skinfolds, i.e. from –0.44 to –0.52 SD. It was also noticed that the waist circumference was reduced more (from –0.48 to –0.51 SD) than the hip circumference (from –0.19 to –0.32 SD). The smallest normalised difference was observed in waist — hip ratio from: 0,12 to 0,26.

Table 6 presents the normalised changes „z" in the range of motor fitness tests. In the consequence of the physical activity program, the best improvement was observed in agility run (from 0.35 to 0.57 SD) while the least in the medicine ball throw (from 0.15 to 0.28 SD).

Discussion

The approved specialist program combining the 18 days' physical training and controlled diet, designed for women with overweight and obesity problems gave, as it was expected, most positive effects in terms of the somatic characteristics, i.e. body mass, BMI, skinfolds and body circumferences, the effects being statistically significant ($p<0.05$; 0.01 or 0.001). For instance, body mass decreased by 3.58 to 4.07 kg, BMI by 1.50 to 1.60 kg/m^2. The sum of biceps, triceps, subscapular and supriliac skinfolds was smaller by 15.14 to 15.69 mm and waist circumference was reduced by 4.00 to 4.66 cm. It was observed that in each group of the examined women (aged 50–59 or 60–69) the physical training regimens produced desirable changes. However, the additional studies (not referred to earlier) reveal that the reactivity of an individual to the physical training might vary. For instance, in one woman participating in the whole 18 days' training the researchers observed even the increase in the body mass by 3.2 kg, while another woman lost 11.0 kg as a result of the same physical training programme. The reasons for such far-reaching individual differences may result from the differences in the genetic determination and hence produce different reaction to training among individuals (Bouchard et al. 1984). However they can also be the result of individual motivation, different previous experience as well as the impossibility of individual control of the dose training aspects. The level of dietary restrictions, approved by individual persons, could be also of particular importance. Earlier research (Després 1994) showed that in obese women the weight loss that can be achieved by exercise training alone is rather small and sometimes not significant. However, even the slightest change in body fatness thanks to training may improve the carbohydrate metabolism and plasma lipid transport (Krotkiewski 1983, Després et al. 1988), which helps to reduce the risk of diabetes and cardiovascular disease.

The aim of this research work was also to examine the influence of exercise treatment on the effects of individual motor fitness tests. The positive effects were noted in the range of agility run (average improvement by 2.24 to 2.71 s), vertical jump (by 1.07 to 2.86 cm), hand grip (by 1.29 to 2.16 kG) and medicine ball throw (by 0.14 to 0.26 m), regardless of the age of the practising women. Thus, the results fully corroborate the observations made by Szopa and Prus (1997) that each stage of development is characterised by specific sensitivity to training. While making a survey of research work relating to the significance of training in the older men's an women's development, Hagberg (1994) indicated that in that case the adaptational effects were similar to those found in younger subjects. Further analysis showed that the level of reactivity to motor impulses seems to depend on the period of development and will already decrease in women over 50. In all motor fitness tests in the group of women aged 50–59, as well as in the group of 60–69 years-old, the researchers established statistically smaller changes than in the group of women aged 20–29. However, the problem of a potential limited influence on possible changes in older age is complicated. Panton et al. (1990) claimed that 6 months' endurance or resistive exercise training did not produce any smallest change in simple response time and its component pre-motor and motor time among 70–79-year-old men. Some earlier studies reported that older men did not increase their muscular strength with resistive training (Larsson 1982). However, other studies indicated a substantial increase in the muscular strength in the consequence of resistive training, both in older men and women (Agre et al. 1994, Brown et al. 1990, Brown and Holloszy 1991, Cress et al. 1991). Szopa and Prus (1997) indicated that the barrier to the training effects in older people is their general health condition and limited tolerance to physical training that appears with age.

The value of adaptational changes produced by definite impulses in relation to different anthropometric and motor fitness characteristics is the next problem. Different level of genetic control of a given characteristic and the adequacy of selecting the training impulses create the conditions (Bouchard and Malina 1991). In this place it is worth mentioning that in accordance with the current theories (Bouchard and Shephard 1994), the subcutaneous fatness is directly included in health-related fitness. After Andres (1990), we have already indicated the importance of BMI in forecasting the mortality risk. The waist circumference and the hip circumference, in turn, allow us to determine another index, so-called WHR (waist to hip ratio), which is considered to be important in predicting many diseases (Bray and Gray 1998). In this light, we should also positively estimate the relatively greater changes of „z" in waist circumference (0.48 SD–0.51 SD) than in hip circumference (0.19–0.32 SD). Weits et al. (1988) proved that waist circumference alone would be a better predictor of visceral fat deposition than WHR. Similar effects of training were observed by Després et al. (1991) who ascertained a preferential mobilisation of abdominal adipose tissue during weight loss in comparison with femoral fat.

The present analysis of the normalised effects of training (values „z") recorded in examined women shows that the greater changes were in the range of agility run (0.35–0.57 SD) and vertical jump (0.25–0.52 SD), than in the range of hand grip (0.24–0.34 SD) and medicine ball throw (0.15–0.28 SD). Hence we can claim a greater trainability of parameters connected with the speed and dynamic abilities, where the maximal anaerobic power (MAP) is the dominant predisposition. This value measures the efficiency of anaerobic energetic mechanism (phosphagen — nonlactacid components). The second group of characteristics of smaller trainability is related to the amount of muscle mass, and hence with the strength abilities. This proportionally small trainability of strength abilities is seemingly contradictory to Prus and Szopa's (1997) statements, who, in this case, observed exceptionally great (exceeding even 2SD) increase due to training. Similarly, Frontera et al. (1988) after the application of 8 to 12 weeks' of specific leg extension training to men aged 60 to 96 noted the increase in the level in leg flexor and extensor muscle strength by 107 and 227%, respectively. However, this distinction seems to indicate that the problem of trainability can be only analysed in the context of a definite type of adequate training stimuli (dynamic versus static, the amount of muscle mass used, intensity, duration and frequency of session etc.), not in the context of some inadequately defined general endurance training.

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