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THE EFFECTS OF A SIX-MONTH TRAINING PROGRAMME ON RUNNING ENDURANCE, MORPHOLOGICAL CHARACHERISTICS AND SOME AEROBIC ABILITY PARAMETERS OF ADULT WOMEN WITH DIFFERENT PHYSICAL ABILITIES

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ABSTRACT

This study reveals the results of a six-month training programme between a recreational group of previously physically inactive women (Group 1) and an already regularly active recreational group of female runners (Group 2). The sample consisted of 28 women, 13 in Group 1 (age (yr) = 41.7 ± 14.3, BMI = 26.8 ± 3.4) and 15 in Group 2 (age (yr) = 38.3 ± 7.8, BMI = 21.5 ± 1.7). Despite different initial values, the results in both groups showed an improvement in measured parameters that were more pronounced in Group 1; however, in comparisons carried out between the two groups, only Group 1 achieved a statistically significant improvement in relative maximal oxygen uptake (ml/min/kg). The results demonstrate that the recommendations of the World Health Organization (WHO), whose guidelines suggests at least 30 min of physical activity per day, are suitable for improving and maintaining functional abilities, including those of previously inactive groups (Group 1) as well as recreational groups (Group 2) of female runners.

Keywords: *recreation programme, endurance, untrained, trained*

VPLIV ŠESTMESEČNEGA VADBENEGA PROGRAMA NA TEKAŠKO VZDRŽLJIVOST, MORFOLOŠKE ZNAČILNOSTI IN NEKATERE KAZALCE AEROBNE ZMOGLJIVOSTI ODRASLIH ŽENSK Z RAZLIČNO ZAČETNO ZMOGLJIVOSTJO

IZVLEČEK

Študija predstavlja rezultate šestmesečnega vadbenega programa, v katerem so sodelovale odrasle ženske, ki so bile prej gibalno/športno neaktivne (Skupina 1) ter skupina že redno gibalno/športno aktivnih odraslih žensk (Skupina 2). V študiji je sodelovalo 28 merjenk, 13 v Skupini 1 (starost (let) = 41.7 ± 14.3, ITM = 26.8 ± 3.4) in 15 v Skupini 2 (starost (leta) = 38.3 ± 7.8, ITM = 21.5 ± 1.7). Učinek vadbe je opazen v napredku obeh skupin, izrazitejši pa je v Skupini 1, ki je tudi statistično značilno napredovala v vrednosti relativne maksimalne porabe kisika (ml/min/kg). Rezultati predstavljene študije nakazujejo, da so priporočila Svetovne zdravstvene organizacije, ki predvideva vsaj 30 minut gibalne/športne aktivnosti dnevno, ustrezna za izboljševanje kot tudi za ohranjanje funkcionalnih sposobnosti tako že gibalno/športno aktivnih kot tudi prej neaktivnih odraslih žensk.

Ključne besede: *vadbeni program, vzdržljivost, netrenirani, trenirani*

INTRODUCTION

Regular physical activity significantly reduces the risk of cardiovascular disease, type 2 diabetes, colon cancer, breast cancer, endometrial cancer and many other chronic diseases (Pratt, 1999; Bize, Johnson & Plotnikoff, 2007; McGavock, Anderson & Lewanczuk, 2006); it reduces depression and increases feelings of overall satisfaction (WHO, Blinc & Bresjanac, 2005); and it is also closely associated with the lifestyle of an individual (Bize et al., 2007). Exercise as a field of physical activity is a planned, organised and repetitive bodily movement carried out with the intention of improving and/or maintaining physical well-being. Most physiological adaptation to physical activity is beneficial for maintaining health. Physical activity increases insulin sensitivity, improves the metabolism of triglycerides and cholesterol and reduces the basal activity of the sympathetic nervous system, which in turn reduces atherothrombotic complications in coronary and cardiovascular disease. People who are regularly physically active extend their lives by approximately two years on average in comparison to inactive people (Blair, La Monte & Nichaman, 2004). Particularly, it is possible to maintain endurance and muscle strength in old age, which in turn maintains functional capability, enabling and extending the period of independent living (Blinc & Bresjanac, 2005).

Bodily composition changes noticeably from youth to becoming older (Carter & Heath 1990; WHO Heyward & Wagner, 2004; Astrand & Rodahl, 1986). With age, the accumulation of abdominal and visceral fat in the abdominal cavity increases, which is an important factor associated with mortality in the elderly. Old age is also accompanied by a characteristic decline in muscle mass, which is associated with a decrease in functional ability and progressively leads to a loss of independence (Kemmler et al., 2010). Regular physical activity reduces many of the negative effects of aging on body composition while at the same time maintaining and evening improving functional capabilities. The World Health Organization (WHO) and most health-related professional associations recommend at least half an hour of moderate and vigorous physical activity daily for adults. This means intensity of approximately 3-6 Metabolic Equivalents (MET), respectively more than 6 METs. However, many of these groups have already pointed out that, due to a sedentary lifestyle, this amount of physical activity is not enough to prevent an unhealthy weight gain. In addition to ensuring a reasonable amount of physical activity, it is also necessary to control the caloric intake of food (Blair, Lamont & Nichaman, 2004).

Aerobic exercise has extremely positive effects on overall health and well-being (Ransford & Palisi, 1996). Aerobic capacity is demonstrated and evaluated by the parameter called the maximal oxygen consumption (VO2max). People with a VO2max value below 29.1 ml/kg/min are nearly seven times more likely to develop at least one of the factors of metabolic syndrome than those with a VO2max values equal to or greater than 35.5 ml/kg/min (Lakka et al., 2003). Despite a repeatedly proven strong connection between physical inactivity and susceptibilities for various diseases, more than half the population is still barely or completely physically inactive (Dunn et al., 1999). Understanding the consequences of physical inactivity is a great help in developing effective training programmes to achieve the recommendations of the World Health Organization (WHO) for at least 30 minutes of daily physical/sports activity. In practice, sports and recreation programmes have to be varied and interesting in order to attract and motivate people to exercise regularly over a long period of time. At the same time, trainers have to be prepared to objectively evaluate the effects of training programmes and progress (Bishop & Milic, 2009; Bishop & Milic, 2010). The study aimed to establish the effect of complex recreational exercise on the running preparedness of adult women and find out the extent to which individual mechanisms of aerobic capacity respond to a complex running exercise programme.

METHODS

The sample of subjects

The sample consisted of 28 women. Depending on the individual runner's willingness and on the results of functional tests, they were divided into two groups according to the experience of running over the previous five years. Group 1 was comprised of 13 individuals who had not been regularly physically active in the past five years, were without running experience and demonstrated poor physical performance. At the beginning of the programme, none of them was able to manage more than 3 minutes of continuous running. Group 2 consisted of 15 individuals who were recreational runners with running experience up to two years and who had previously independently trained 2 to 3 times a week in order to maintain their physical abilities without professional supervision. Basic group characteristics are described in Table 1.

Table 1: Basic characteristics of a sample (M ± SD)

	Group 1	Group 2	p
N	13	15	
Age (years)	41.7 ± 14.3	38.3 ± 7.8	n. s.
BH (cm)	163.7 ± 3.5	168.4 ± 4.8	*
BM (kg)	70.1 ± 8.0	60.7 ± 4.7	***
BMI	26.8 ± 3.4	21.5 ± 1.7	***
FM (%)	26.6 ± 3.7	20.3 ± 2.9	***
VO2max (ml/min)	2423 ± 428	2527 ± 371	n. s.
VO2max (ml/kg/min)	34,3 ± 5,9	41,7 ± 6,0	**

***p<0.001, **p<0.01, *p<0.05; p – statistical significance between groups, n. s. – statistical non-significant, BH – body height, BM – body mass, BMI – body mass index, FM – fat mass, VO_2max – maximal oxygen consumption

Experimental procedure

The objectives of the training programme, which was adapted to the specific requirements and needs of the runners in each group, were aimed at improving the abilities of runners and preparing them to compete in either the 10 km or 21 km International Ljubljana Marathon. Before inclusion in the training programme, the participants went to see a sports physician who performed anthropometric measurements and measurements of functional and biochemical parameters using stress tests on a treadmill. The same measurements were performed 7-10 days after completing the programme.

Based on the initial results of the stress test, a six-month training programme was prepared for each participant, in which we considered the guidelines of periodisation development for endurance and muscular strength. It was divided into a period of basic training and a period of specific preparation for participation for the race. Training was held four times a week from 90 to 120 minutes. Training sessions were conducted twice a week under the guidance of qualified coaches; however, individual programmes also included a runner's individual or other aerobic exercises at home 1 to 2 times a week. All running training was monitored with Polar S400 and S800 heart rate monitors. Each participant carefully filled out her own training diary, which formed a basis for the trainers' supervision of the whole training programme.

Description of training programme

The content, scope and intensity of the recreational training programme were adapted to the specific needs of each group of runners. The most important part consisted of running exercise - exercises to develop aerobic endurance and improving the techniques of running. The programme of Group 1 consisted of a 2 - to 3 - training units of run or walk and run. An important component of the programme was also training for the development of muscular strength and flexibility of all major muscle groups in the range of two exercise units per week. Participants performed 10 to 12 exercises (for five or six muscle groups – for each two series of the same work) in one training unit. They completed one exercise from 30 to 45 seconds or 15 to 25 repetitions. The pause between repetitions lasted between 60 to 90 seconds, with a rest of 2 minutes between sets. Power exercises were carried out in the open using participants' own body weight with elastic bands and without additional loads. Common exercises were completed by ten minutes of stretching of all major muscle groups. In addition to running training, a once-per-week walk up a hill (a short, approximately 40-minute walk) as well as a once-per-week, long, low-intensity mountain or biking trip was included in their regimen.

The training programme for Group 1 included two running/walking training sessions per week during the initial period and three per week during the following period. These training units were comprised of 2-to-3 minute cycles, with alternating walking and talk-running (intensity between 80-85% of HR max) ranging from 30 to 60 minutes. Intervals of walking were progressively reduced and the running intervals were extended so that all participants were able to run for at least 45 minutes without the intermediate walking interval after a 12-week period. In addition to running, a longer, low-intensity mountain or biking trip was carried out once a week.

The training programme for Group 2 consisted of three running units and two training units with additional aerobic exercise content per week. The major part of the run was carried out at an intensity of 75% to 85% of HR max. One exercise unit per week was held in the form of fartlek (interval training) or tempo run with an intensity of 80% to 95% of HR max. Volume and intensity were gradually increased. In addition to running, a walk up a hill (a short, approximately 40-minute walk) and one long mountain or cycling trip was taken once a week. The exercise programme for power and flexibility was very similar to that of Group 1.

Table 2: Exercise programme – a weekly example

	Group 1	Group 2
Monday	30-45 min run and walk (3 min set) 25 min strength exercises 10 min stretching	45-55 min run (6 min/km; 75-85 % HR max) 25 min strength exercises 10 min stretching
Tuesday	Rest	35-35 min continual walk in slope (height difference 300m to 400m); stretching
Wednesday	20-35 min run and walk (2 min set); 20 min of light continual run 25 min strength exercises 10 min stretching	50 min fartlek (75-95 % HR max) 25 min strength exercises 10 min stretching
Thursday	Rest	Rest
Friday	30-45 min run and walk (3 min set) 25 min strength exercises 10 min stretching	50-60 min run (6 min/km; 75-85 % HR max) 25 min strength exercises 10 min stretching
Saturday	120-180 min light intensive cycling or mountain trip (with stops)	120-180 min light intensive cycling or mountain trip (with stops)
Sunday	Rest	Rest

Exercise realization

In 24 weeks, each participant went through 57 to 80 training sessions for running (an average of 2.7 per week) with an average time of 137 minutes of running per week. The total running time was on average 53.5 hours per woman (Table 2). They were active once a week (average 82 min) with other aerobic activity (walking, bicycle). Exercise output, except for a few participants, did not fully achieve the planned volume. The groups varied less than 30 minutes per week over the extent of the whole physical/sports activity (Table 3).

Table 3: An average weekly extent of exercise realization (EU – exercise Unit)

	Group 1	Group 2
Number of running EU/week	2.43 / 58 / 90% [1] (planned 64 EU)	2.46 / 57 / 85% [1] (planned 67 EU)
Number of EU with other sport content /week	0.9 / 22 / 78% [1] (planned 28 EU)	1.22 / 28 / 75% [1] (planned 37 EU)
The extent of run/week (min.)	109.5	115.7
The extent of total physical activity /week (min)	201.8	229.5

[1] an average number of EU per week / number of EU in total exercise period / per cent of realized EU in comparison to planned

The experimental procedure was approved by the Ethics Commission of the Faculty of Sport at the University of Ljubljana. The procedure and possible complications were presented to the women in accordance with the Helsinki Declaration. The study was approved by the National Medical Ethics Committee.

Variables and procedure

Measurement of morphological characteristics

Measurement of anthropometric characteristics was carried out in accordance to the instructions of the International Biological Programme – IBP (Weiner & Lourie, 1969). From the measured values we calculated body composition variables: body mass index (BMI), percentage of fat mass (FM) and the percentage of muscle mass (MM), using Matiegka method (Matiegka, 1921). Somatotype was calculated according to the Heath and Carter protocol (Carter & Heath, 1990).

Description of the stress test protocol on the treadmill

A spiro-ergometric parameter, which presents model variables for the assessment of aerobic and anaerobic energy capacity was measured with a stress test on the treadmill. To measure these parameters, we used spiro-ergometric equipment with related software K4 b^2 (Cosmed). For data obtained by the method of Breath-by-Breath during the stress test, the average of the five-second interval was calculated. A protocol was started with ventilation and metabolic parameters monitoring after 1 minute of complete rest. After a warm up (3 min walk at a speed of 5 km/h and 3 min at a speed of 6 km/h at 0% slope), the slope of the treadmill was increased to 2%. Initial running speed was 6 km/h and was increased by 1 km/h every 2 min until exhaustion. For monitoring the reconstruction after the effort, women continued with a 5-minute walk at a speed of 5 km/h.

For the purposes of this study the following variables were selected.

Running endurance variables

test duration (D), running distance in the test on the treadmill (RD), top speed - maximum speed of individuals (vFIN).

Variables of capacity of the cardiovascular system

maximum heart rate (HR max), stroke volume at maximum load (SV max) and minute heart volume at max load (MHV). Stroke volume was calculated by the method of Stringer-Wasserman (Stringer, Hansen & Wasserman, 1997). The calculation was implemented by the computer programme K4 b^2, Cosmed.

Characteristics of respiratory function

breathing frequency (BF), breath volume (BV) and maximum minute ventilation (VE max), VE/VO2 – equivalent for oxygen.

Metabolic variables

the maximum absolute value of oxygen consumption (VO2max), maximum relative value of oxygen consumption (VO2maxR), respiratory quotient (RQ-VCO2/VO2) and maximum levels of blood lactate (LA max).

Somatotype variables

ectomorph, mesomorph and endomorph component (Carter & Heath, 1990).

Data analysis

The data was analysed with the statistical programme SPSS 17.0 for Windows. We used following methods: descriptive statistics to identify differences in individual parameters between the initial and final positions within the group and method of analysis differences for repeated measurements (rANOVA). Differences between groups were analysed using the covariance analysis method (ANCOVA), in which assumptions had been previously tested. The threshold of statistical significance was defined at 5%. Results are presented as mean ± standard deviation (M ± SD).

RESULTS

The results show that the training programme affected morphological characteristics, runner's endurance and also the aerobic abilities of participants in both groups. In comparison between groups, Group 1 achieved a statistically significant greater improvement in VO2max (ml/min/kg).

The exercise influence on running endurance

The six-month recreational training programme was expected to improve some parameters of running endurance in both groups. The time of the stress test was improved by 18.4% in Group 1 ($p<0.001$) and 5.7% in Group 2. Maximum top speed was similarly increased. Group 1 increased it by 15.8% ($p<0.001$) and group 2 for 7.3% ($p<0.01$). Distance on stress test increased for the highest percentage, namely in Group 1 by 27.3% ($p<0.001$) and in group 2 by 17.1% ($p<0.01$); but better absolute values were preserved by Group 2. Statistically significant changes are mark in Table 4. We expected to make significant progress within Group 1 because of a lower initial fitness level, which has already been found by Cunningham and Hill (1975).

Table 4: Comparison of differences between groups by initial and final testing (M ± SD)

	Group 1			Group 2			p
	Before	After	Change (%)	Before	After	Change (%)	
D (s)	867 ± 132	1025 ± 159	18.4 ±7.2***	1012 ± 119	1054 ± 132	5.7 ± 19.9	n. s.
RD (m)	1636 ± 349	2080 ± 488	27.3 ± 12.2***	2106 ± 269	2438 ± 270	17.1 ± 16.7**	n. s.
v FIN (km/h)	9.6 ± 1.24	11.08 ± 1.34	15.8 ± 7.9***	11.3 ± 1.0	12.1 ± 0.6	7.3 ± 7.8**	n. s.

****p<0.001, **p<0.01; p – statistical significance between groups, n. s. – non significant, D (s) – test duration, RD (m) – running distance, v FIN (km/h) – max test speed*

Exercise influence on morphological characteristics

The six-month training programme also affected the morphological characteristics of participants. Individual somatotype components, calculated by Heath and Carter protocol (Carter & Heath, 1990), reflecting changes in the direction of increasing ectomorphy and reducing the endomorph component, which decreased in Group 1 to a statistically significant extent (p<0.05). All changes in somatotype components were shown on changing of anthropometric characteristics under the influence of exercise (Table 5). Mesomorph components retained their values with the exception of the minimal reduction in Group 1.

Table 5: Changes in somatotype component (M ± SD)

		Ectomorph component	Mesomorph component	Endomorph component
Group 1	Before	0.6 ± 1.5	5.8 ± 1.4	5.2 ± 1.0
	After	1.0 ± 1.1	5.8 ± 1.3	4.8 ± 0.7*
Group 2	Before	2.8 ± 1.0	3.8 ± 1.2	3.2 ± 0.8
	After	2.9 ± 1.0	3.8 ± 1.1	3.1 ± 0.8

**p<0.05*

The participants experienced significantly altered body composition after the six-month exercise period. Both groups reduced their body weight – an average of 1.9% in Group 1 and 0.9% in Group 2 (Table 6). Weight reduction resulted in a reduction of fat mass (p<0.05 in Group 1); the proportion of muscle mass correspondingly increased in both groups. Average body mass index was reduced by 1% in Group 2 and by 3.1% in Group 1, which is also statistically significant at p<0.01.

Table 6: Changes in basic morphological characteristics (M ± SD)

	Group 1			Group 2			p
	Before	After	Change (%)	Before	After	Change (%)	
BM	70.1±8.0	68.6±5.9	-1.9±3.7	60.7±4.7	60.1±4.0	-0.9±2.3	n. s.
FM %	26.6±3.7	24.9±2.6	-5.6±5.4**	20.3±2.9	19.8±2.7	-2.2±6.0	n. s.
MM %	40.4±3.7	42.7±2.7	6.7±13.1	42.4±5.3	43.5±1.6	4.7±19.6	n. s.
BMI	26.8±3.4	25.9±2.7	-3.1±4.0*	21.5±1.7	21.2±1.6	-1.0±2.1	n. s.

***p<0.01; *p<0.05; p – statistical significance between groups, n. s. – non significant, BM – body mass, FM % – fat mass, MM % – muscle mass, BMI – body mass index*

Exercise influence on aerobic abilities

Table 7 shows differences in some respiratory parameters, the parameters of cardiac function and metabolic indicators during the initial and final state and a comparison between Group 1 and Group 2. After the six-month period of exercise, the participants improved the absolute value of VO2max (ml/min) by 15.3% in Group 1 and by 4.4% in Group 2 and the relative value of VO2max (ml/kg/min) by 17.9% in Group 1 and by 5.6% in Group 2. All changes are statistically significant. Maximum minute ventilation (VEmax) went up for 20.1% of the women in Group 1 ($p<0.05$) and only 5.1% in Group 2. The increase in VE in Group 1 is result of an increase both in the volume of breath and breathing frequency, as both parameters increased.

Table 7: Changes in physiological and biochemical parameters at maximal effort during initial and final state

	Group 1			Group 2			p
	Before	After	Change (%)	Before	After	Change (%)	
VO2maxR (ml/kg/min)	34.3±5.9	39.8±5.1	17.9±13.8***	41.7±6.0	43.7±4.7	5.6±12.5**	n. s.
VO2maxA (ml/min)	2423±428	2763±392	15.3±12.1***	2527±371	2618±310	4.4±11.0**	*
VE (l)	81.6±14.3	96.3±12.8	20.1±19.4*	85.0±17.0	86.6±13.4	5.1±22.5	n. s.
BV (l)	1.97±0.43	2.15±0.35	10.7±15.1**	1.90±0.4	1.94±0.4	3.1±15.5***	n. s.
BF (b/min)	42.6±8.6	47.6±6.2	17.1±35.5	45.3±6.8	45.8±7.9	2.4±18.8	n. s.
VE/VO2	34.8±4.8	34.0±4.0	-1.7±10.4*	32.3±4.3	31.9±3.7	-1.1±15.9	n. s.
RQ	0.95±0.09	1.05±0.1	11.1±12.4	0.97±0.11	1.02±0.08	6.1±15.2	n. s.
LA max (mmol/l)	6.1±2.2	6.6±1.9	13.3±30.6*	6.3±2.0	7.0±1.0	21.4±44.3	n. s.
HR max (beat/min)	169±10.9	175±14.3	3.1±5.8*	177±9.3	175±10.1	-0.8±6.0	n. s.

HBV max (ml/beat)	85.2±13.8	95.1±12.6	13.0±15.9*	87.6±10.8	91.9±12.5	5.2±10.3**	n. s.
MHV (l/min)	14.6±2.5	16.8±2.9	16.1±13.6***	15.4±2.0	16.1±1.7	5.3±12.3	n. s.

****p<0.001, **p<0.01,*p<0,05; p – statistical significance of difference between groups. n. s. – non significant , VO_2max – maximal oxygen consumption (R – relative, A – absolute), VE – maximal minute ventilation, BV – breath volume, BF – breathing frequency, VE/VO_2 – equivalent for oxygen, RQ – respiratory quotient, LA max – maximal value of lactate, HR max – maximal heart rate, HBV max – maximal heartbeat volume, MHV – minute heart volume*

In Group 1, the exercise programme also caused a 1.7% decrease in the ventilation equivalent for oxygen – VE/VO2 ($p < 0.05$) and an increase in lactate levels between the maximum effort for 13.3% ($p < 0.05$). Parameters did not change significantly in Group 2. Respiratory quotient increased by a statistically nonsignificant amount in both groups. Under the influence of the training programme, some parameters of cardiac function in Group 2 and all in Group 1 changed significantly. Minute heart volume (MHV) increased by a statistically significant amount ($p < 0.001$) at maximum load of 16.1% in Group 1, owing to increase of heart rate, but mostly because of an increase in maximal heartbeat volume, since this increased by as much as 13%. Because of increasing HBV, MHV in Group 1 also increased, despite heartbeat frequency having decreased.

DISCUSSION

Endurance of long-term loads is largely dependent on the efficiency of aerobic metabolic processes. These provide cells with energy for work and for long-term performance of exercise at a level of intensity close to VO2max. Improving the aerobic capacity of humans depends on many factors: in addition to type of exercise, intensity and extent it also involves the physical condition and age of subjects (Fitzgerald, Tanaka, Tran & Seals, 1997; Mamen & Martins, 2010). Exercise caused a higher relative progress in Group 1; in VO2max (ml/kg) parameter participants from Group 1 exceeded values from Group 2.

Running progress was largely due to improvement of aerobic capacity. The duration of the test was extended to almost the same percentage as the relative improvement in oxygen consumption in both groups (18.4% improvement in test duration and increase in relative VO2max for 17.9% in Group 1 and 5.7% improvement in duration of test and the rise in the relative oxygen consumption for 5.6% in Group 2). In parameters of the stress test duration and the achievement of the final velocity, a statistically greater relative percentage of progress was achieved by Group 1. A result of the maximum minute ventilation progress matched the largest relative increases in oxygen consumption and prolonged the duration of the stress test on treadmill. The distance test was statistically significantly increased by 17% for Group 1 and by 27% for Group 2. Progress was the outcome of cardiovascular and respiratory capacity improvement.

The content of lactate in the blood is dependent on its production and consumption. The value tells us how and with what intensity work is done (Astrand & Rodahl, 1986). The content of lactate in the blood at maximum stress on a load test; after six-months of exercise, it had significantly increased (by 13.3% in Group 1 and 21.4% in Group 2). Achieving a higher final speed and longer distance on the stress test also made improvements in the glycolytic function possible. It can be concluded that lactate anaerobic ability of participants improved, due to more intense exercise sessions. It appears that both two groups were exposed to a level of effort that raised their anaerobic capacity.

Because of differences in basic physical condition between Groups 1 and 2, the different progress in improving cardiovascular and respiratory capacity was expected. Greater improvements in aerobic capacity can be expected in people who have lower levels of initial values; this has already been stated by Cunningham and Hill (1975). After 9 weeks of aerobic training, previously inactive participants found their VO2max increased by an average of 34%; after a further 52 weeks, the increase was only 5%. They also found that aerobic exercise first causes central adaptation of the organism, especially cardiac and respiratory function. From this fact they concluded that women with low fitness levels (VO2max less than 28 ml/kg/min) respond on the aerobic load initially by a central adaptation of the organism; after a longer period of exercise, this is followed by a significant adaptation of peripheral factors. The ability to reach maximum oxygen consumption decreases with age. Nevertheless, Group 1, which is not older by a statistically significant amount, increased oxygen consumption significantly in comparison to Group 2. The fact is that, by means of exercise interventions, we can influence the maintenance and even increase of VO2max, which significantly decreases with age in physically inactive individuals (Fitzgerald et al., 1997).

A six-month training programme was also able to bring about a significant change in the physical characteristics of individuals. A higher degree of overall progress, as in the other parameters, occurred in Group 1. Total body weight decreased in both groups; Group 1 also significantly decreased its average fat percentage (5.6%). Seiler et al (1998) established that there exists a more than 25% significant difference in muscle strength between trained and untrained men; a difference which rapidly increases over the years. Changes in morphological features are also reflected in changes in individual somatotype components. Group 1 statistically significantly reduced the average endomorph component of its members. A high endomorph component value is an indicator of heart failure, diabetes, cardiovascular and many other diseases (Heyward & Wagner, 2004, Carter & Heath, 1990). Both groups maintained mesomorph component at the same value, which, despite decrease of total body weight, reflects maintenance of muscle mass. The values of somatotype components show that the anthropometric status of Group 1 significantly improved in the direction of reduced likelihood for various illnesses and a better optimisation of physical performance. In our study we did not monitor food intake – something that it would be reasonable to do in the future in order to obtain a better result interpretation. Many functional changes that are the consequences of ageing, correspond to the consequences of physical inactivity. The results confirm the necessity of regular physical activity – not only in order to avoid the negative effects of aging, but also to counter a decline in functional abilities as a result of physical inactivity.

The training programme was carried out for six months. Regretfully, we could not monitor the parameters during the programme, which would be certainly have been beneficial to assist with further interpretation of the effects of the exercise. Significant changes in Group 1 were partially expected; however, surprises were found in the changes in the VO2max parameter, in which Group 1 achieved a statistically significant better absolute value. These results may also result in greater intrinsic motivation, more consistent implementation of the proposed programme and greater willingness to work. Detailed analysis of the diaries of the participants will provide us with more insights into this part of the background, which can significantly affect the final results.

CONCLUSION

The results show that a six-month recreational training programme, consisting of running workouts and strength and flexibility training, caused a marked improvement of the cardiovascular and respiratory system and an improvement in the value of VO2max. The World Health Organization recommends at least 30 minutes of daily physical activity and our study shows what results may be achieved if the exercise is regular and professionally designed. A similar training programme, in spite of different initial values in two groups, caused an improvement of all indicators of the cardiovascular and respiratory functions and consequently on running abilities. The results show that with training interventions individuals can, despite earlier physical inactivity, greatly improve their physical performance as well as significantly alter their body composition. Regular daily exercise can also improve the abilities of already active women. With the changes in morphological characteristics and aerobic abilities, individuals are able to improve their overall functional capacity and significantly reduce their susceptibility for many diseases. This has a significant impact on maintaining and improving overall health and well-being.

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