MORPHOFUNCTIONAL MODIFICATION IN ELDERLY INDIVIDUALS PRACTICING COMPETITIVE ENDURANCE SPORT

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Summary: To investigate the modification of body composition and level of aerobic capacity in older athletes practicing competitive sport for two years consecutively, 20 elderly male endurance athletes (A) were compared with twenty elderly male subjects who practiced moderate exercise (C). Body composition analysis, physical activity and maximal aerobic power (VO_{2max}) were measured at the beginning of the study, after twelve months and after twenty-four months in both groups. We observed significant differences in group A: body fat was significantly lower in the subjects at the first and second year than at the beginning of the study; fat-free mass (FFM) was significantly higher in the subjects at the first and second year; VO_{2max} in every measurements was significantly higher in the subjects at the at the first and second year than at beginning of the study. Our data suggest that it is possible, even in the elderly, to reach a good level of physical fitness with appropriate training protocols for competitive sport.

Key words: *Body composition; Cardiovascular fitness; Physical training; Aerobic power; Older athletes*

Introduction

Several investigators have studied the effects of physical activity and aging (10,13,16). The marked benefits of moderate physical exercise on cardiovascular function, particularly in subjects of middle and advanced age, are well known, but serious worries on the effects of competitive sports activity in this age group have been reported (1,16,19).

The decreased physical performance in elderly it is due to various factors. One of these is the hipokinetic syndrome, a condition not well defined but seemingly caused by physical inactivity. Several investigators have studied the effects of training in elderly (2,20), and tried to ascertain the effects of training in contrast to the effects of deconditioning induced by ageing (3).

Aging is characterized by loss of fat-free mass (FFM). These age-related changes probably vary in rate, timing and extent between subjects according to differences in leisure or occupational physical activity, disease and several other factors (11). The effects of endurance training on aerobic power were studied longitudinally (7,12,14,15). These studies have suggested that endurance training could increase aerobic power in older subjects.

This study investigated the changes in body composition and aerobic power in a group of older athletes who practiced competitive sport for two consecutive years comparing them with a control group of subjects with similar characteristics who practiced moderate physical activity.

Material and Methods

All procedures were performed after local Ethics Committee approval had been granted. All patients taking part in this study gave written informed consent.

Subjects

Twenty elderly male endurance athletes aged 65±2.6 who attended our institution to obtain a medical certificates for eligibility to compete in their age group were included in this study (group A). These athletes were compared with twenty male subjects aged 66±1.3 who attended our institution for a sample control because they practiced moderate recreational exercise (control group).

All subjects completed a medical questionnaire. No subject had experienced significant changes in body weight, and had positive familiar and personal history for ischemic heart disease.

All the subjects (group A and C) at the first visit had a low aerobic power related to fat-free mass (FFM): (VO_{2max} < 55 ml*kg FFM^{-1}*min^{-1}).

Anthropometric measurements and body composition analysis

Body mass of each subject was measured with a Toledo Weight-Plate to the nearest 0.1 kilogram after an overnight fast immediately after morning micturition. Naked body mass was calculated as total body mass minus robe and hospital gown mass. The height of subjects was measured without shoes to the nearest 0.1 cm with a wall-mounted stadiometer. Body mass index (BMI) was calculated as wt/ht^2 (kg/m^2).

Body composition was measured by using bioelectrical impedance analysis (BIA) with a Xitron 4000 Bioimpedance Analyzer (Xitron Technologies, San Diego). BIA measurements were taken at the same time of the RMR measurements under the following conditions: subjects after 12 hours of fasting, immediately after morning micturition and after drinking 250 ml of water. With the subject supine, the receiving electrodes were placed on the dorsal parts of the right wrist and right ankle, while the stimulating electrodes were placed on the dorsum of the right foot and right hand. The resistance (R) was measured three times, and the mean of these three measurements was used for subsequent calculations. FFM was calculated by using the predictive Lohman equation (9). Fatty mass (FM) was calculated as the difference between the total body mass (BW) and FFM. The percentage of body fat (BF%) was evaluated as $(BM\text{-}FFM)*BM^{-1}$, and total body water (TBW) was calculated as FFM*0.73. Anthropometric measurements and body composition analysis of each subject were done at beginning of the study and for two consecutive years in occasion of visit to obtain a medical certificates for eligibility.

Dietary analysis

Each subject recorded his weighed intake of food for 7 consecutive days after having received formal training by one of the researchers involved in the study (AS). Food composition was calculated with a computer program using the information provided by L.A.R.N. (8).

Dietary analysis of each subject was measured at beginning of the study and for two consecutive years.

Physical activity

To describe the physical activity of the subjects during the year before the study, we collected information about the type, duration, intensity and frequency (daily and monthly) of the exercise regime that each subject followed.

The physical stress induced by each activity was classified by using a scale with 5 levels, where the first level was very low activity (calm breathing) and the fifth level very heavy activity (heavy breathing).

Physical activity of each subject was measured at beginning of the study and for two consecutive years.

Determination of VO_{2max}

VO_{2max} was determined using an electrically driven treadmill and an open circuit gas analysis system (Radiometer Copenaghen). After a 10- to 15-min warm up at a self-selected comfortable running speed, each subject started the test running horizontally at 15 $km*h^{-1}$. Running speed was kept constant, and the slope was increased by 1° every min until exhaustion. During the test, heart rate was monitored using a commercially available heart rate monitor (Esaote).

Determination of VO_2max of each subject was measured at beginning of the study and for two consecutive years.

Statistical analysis

Descriptive statistics is reported. Values are given as means ± SEM. The analysis of differences among the three groups was performed by analysis of variance (ANOVA). Tukey post hoc test was used to determine significant differences for $p<0.05$.

Results

The subjects' characteristics in the three visits for eligibility (group A) are presented in Tab. 1. There were significant differences among the three measurements: body fat was significantly lower in the first and second year ($p<0.05$); FFM was significantly higher in the subjects at the first and second year than at beginning of the study ($p<0.05$); Resting heart rate (RHR) was significantly lower in the subjects at the first and second year than at the at beginning of the study ($p<0.05$); VO_2max in every measurement was significantly higher in the subjects at the first and second year than at beginning of the study ($p<0.01$). There were no significant differences among the three year measurements for BMI and maximal heart rate (MHR). No significant differences were found between the measurement of body fat, FFM, RHR, MHR and VO_{2max} in every measurement in the subjects at the first and second year.

Tab. 2 shows the characteristics the of control group for the duration of the study. No significant differences were found in VO_{2max}, BMI, BF% and FFM in the period of observation while also in this group found a significant decrease ($p<0.05$) of RHR.

Dietary analysis of daily total energy intake and daily mean macronutrients intake of group A are reported in Tab. 3. After two years, the athletes in group A reported a daily energy intake about 500 kcal higher than those of first years and at beginning of the study ($p<0.05$). The higher energy intake resulted from higher carbohydrate and protein consumption. Owing to the higher total energy intake, there are no significant differences among the three measurement for carbohydrate and protein intake when they are reported as percentage of total energy intake.

Dietary analysis of daily total energy intake and daily mean macronutrients intake of the control group are shown

Tab. 1: Physical characteristics of the athletes of Group A (X ± SEM).

VARIABLE	Baseline	I year	II year
Body Mass Index ($Wt*(Ht^2)^{-1}$)	25.7±1.7	24.7±0.9	24.2±1.8
Body fat (%)[a]	27.1±0.9	24.3±1.8	22.5±2.0
Fat free mass (kg) [b]	53.1±2.0	58.4±2.8	60.3±3.3
Resting heart rate ($beat*min^{-1}$) [a]	77.1±2.3	62.3±1.3	58.3±1.6
Maximal heart rate ($beat*min^{-1}$)	174.43±3.6	170.13±4.0	169.1±3.5
VO_{2max} ($l*min^{-1}$) [c]	2.6±0.12	3.02±0.12	3.3±0.13
VO_{2max} ($ml*min^{-1}*kg^{-1}$) [c]	39.8±2.4	44.9±1.5	52.0±4.0
VO_{2max} ($ml*kg^{-1}$ $FFM*min^{-1}$) [c]	49.6±1.7	57.8±1.4	61.8±3.0
Physical activity ($kcal*day^{-1}$)	630±152	752±98	825±154

[a] Baseline > I and II years ($p<0.05$); [b] Baseline<I and II years ($p<0.05$)
[c] Baseline < I and II years ($p<0.01$)

Tab. 2: Physical characteristics of the subjects of Group C (control) (X ± SEM).

VARIABLE	Baseline	I year	II year
Body Mass Index ($Wt*(Ht^2)^{-1}$)	25.7±0.7	25.4±0.9	25.0±0.8
Body fat (%)	26.1±0.9	26.0±1.8	25.2±2.0
Fat free mass (kg)	54.9±2.0	55.4±2.8	56.3±3.3
Resting heart rate ($beat*min^{-1}$)[a]	75.1±2.3	64.3±1.3	63.3±1.6
Maximal heart rate ($beat*min^{-1}$) [a]	184.43±3.6	170.13±4.0	159.1±3.51
VO_{2max} ($l*min^{-1}$)	2.4±0.12	2.3±1.12	2.4±0.13
VO_{2max} ($ml*min^{-1}*kg^{-1}$)	38.8±2.4	38.4±1.5	39.0±4.0
VO_{2max} ($ml*kg^{-1}$ $FFM*min^{-1}$)	50.6±1.7	49.8±1.4	51.8±3.0
Physical activity ($kcal*day^{-1}$)	630±172	650±205	625±124

[a] Baseline > I and II years ($p<0.05$)

Tab. 3: Intake of macronutrients in Group A (X ± SEM).

VARIABLE	**Baseline**	**I year**	**II year**
$Kcal*day^{-1}$	1598±125	1608±112	2084±182
Carbohydrates (g)	220.5±31.1	240.5±23.1	348.8±44.3
Carbohydrates (%)	56.1±1.2	58.1±2.5	61.2±1.2
Fats (g)	54.1±7.2	52.8±6.1	50.8±8.0
Fats (%)	30.7±2.0	26.3±3.0	21.9±2.5
Proteins (g)	57.0±6.1	68.6±5.0	91.5±7.0
Proteins (%)	14.8±1.9	15.9±2.3	16.3±2.1

Baseline < I and II years ($p<0.05$)

Tab. 4: Intake of macronutrients in Group C (X ± SEM).

VARIABLE	**Baseline**	**I year**	**II year**
$Kcal*day^{-1}$	1602±125	1588±135	1612±115
Carbohydrates (g)	220.5±31.1	223.5±31.1	222.5±31.1
Carbohydrates (%)	57.1±1.2	56.1±1.2	54.1±1.2
Fats (g)	54.1±7.2	54.1±7.2	54.1±7.2
Fats (%)	31.7±2.0	30.7±2.0	31.7±2.0
Proteins (g)	57.2±6.1	58.0±4.1	57.0±7.1
Proteins (%)	14.7±2.2	15.8±0.9	13.8±2.4

in Tab. 4. No significant differences were found for the control group for daily Kcal or percentage intake of macronutrients.

Discussion and Conclusion

Physical training in the age range considered has not been widely researched, and may represent a challenge for sport physicians. Our results are in accordance with other investigations (4,17,18). Zeppilli et al. (21) demonstrated that training improved cardiovascular fitness both in young and elderly people. This improvement was proportional to the intensity of endurance training, and was more evident when pre-training VO_{2max} was lower. In our study, no significant differences were found in the control group between the beginning and the end of the observation period, as the subjects in this group were not sedentary, but practiced moderate recreational physical activity.

Other investigations showed that an increase in VO_{2max} was already evident after six months of moderate physical activity (4,17,18). Steinhaus et al. (17) evaluated the effects of a four month aerobic conditioning program in old previously sedentary individuals, finding an increase of 27% in VO_{2max} similarly to other authors (4,18). Others authors studied longitudinally the effects of endurance training on aerobic power suggesting that endurance training could increase aerobic power in older subjects (7,12,14,15).

This study shows that endurance training in elderly individuals produces cardiovascular adaptation (5). In normal subjects, training shows three stages of progression: initial conditioning, improvement, and maintenance. The initial stage of conditioning provides for an aerobic activity of low intensity for evaluation of cardiorespiratory fitness (first year, control group). At the end of the observation period, the subjects had a high level of cardiorespiratory fitness. During the stage of improvement, the subjects in the first year increased their aerobic power, reaching in percentage the same improvements as a young athlete.

Our data suggest that it is possible, also in the elderly, to reach a good level of physical fitness with appropriate training protocols for competitive sport. This finding supports the hypothesis that the progressive reduction in physical activity with aging is a main reason for the decreased functional capacity in the elderly.

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Submitted August 2003.
Accepted October 2003.

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