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RESPIRATORY RESPONSE TO WALKING TRAINING IN OVERWEIGHT MEN

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Abstract. The aim of the study was to follow up changes in physiological responses to incremental exercise after 4 weeks of moderate-intensity training in overweight men. Prior to the training, all subjects underwent 2 identical control tests (C1 and C2). Each test included three treadmill running exercises, starting at the treadmill speed of 4 km/h, and increased by 1 km/h at the end of each 4 min stage. The same protocol was repeated after 4 weeks of training (T1). The subjects' body mass index was not changed after the training. Heart rate, oxygen uptake and blood pressure were significantly reduced in C2 as compared with C1 test. After 4 weeks of training the respiratory frequency ($R_{f)}$, was lower than that in the C2 but a significant difference was noted only at the running speeds of 4 and 6km·hr^{-1} (P<0.04). Tidal volume (TV) increased after training in comparison with C2. A significant difference was found at the running speeds of 5 and 6 km/h (P<0.03 and P<0.04, respectively). Minute ventilation (V_E) was not significantly different between the tests. The present study showed that in obese subjects 4 weeks of moderate uncontrolled walking training is advantageous for changes in the respiratory pattern. However, it is too short for the cardiovascular adaptation and body weight loss. Familiarization of the subjects with the experimental procedure diminished activation of the sympathetic nervous system and has a important role for the results interpretation.

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Key words: Breathing pattern - Aerobic training - Familiarization

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Introduction

Regular physical exercise is one of the most important recommendations in treatment of obesity and it appears to be one of the major factors determining the long-term success in the weight loss programs [4,5} An inverse relationship was found between the amount of daily physical activity and body mass [13]. Unfortunately, from two thirds of over-weight persons trying to lose weight using physical activity as a strategy for weight loss, only one fifth reported to be active at the recommended levels [12]. Overweight subjects often find the exercise prescription difficult to follow, since they get extremely tired, while walking at the pace recommended by doctors [11], since the energetic cost of their work is enhanced in comparison with leaner subjects [8,13]. At comfortable pace the normal-weight subjects reach approx. 35% VO_2max, whereas the obese ones as much as 56% VO_2max [1]. Moreover, in obese subjects breathing frequency is higher, and their tidal volume lower than in lean subjects [17]. Therefore, the low-intensity weight loss programs, resulting in a slow but steady body mass reduction, seems to be more effective than the more intensive exercise [16].

The aim of this investigation was to follow up changes in physiological responses to a very early phase of moderate-intensity training programs in overweight men. For this purpose, the cardiovascular and respiratory responses to incremental treadmill exercise were controlled before and after training. To find out whether familiarization with the laboratory testing procedure has any influence on the investigated variables, two control treadmill tests were performed.

Material and Methods

Subjects: Twenty four moderately obese subjects, not participating in any regular physical activity or sport, gave their written informed consent to participate in this study. The project was approved by the Ethics Committee of the Kuopio University (Finland). The physical characteristics (mean±SD) of the subjects were: age - 45.7±7.0 years, body mass - 90.9±9.4 kg, and height - 177.9±6.9 cm.

Experimental procedure: The subjects were submitted to 4 weeks of uncontrolled, moderate-intensity walking training program (without any changes in their usual diet) consisting of 45 min daily walk, at the heart rate of 130 beats/min. An accuracy of recommended training was controlled only by the subjects themselves. Prior to the training, all subjects underwent 2 identical control exercise tests 2-3 days apart (C1 and C2). Each test included three treadmill running exercises, starting at the treadmill speed of 4 km/h, and increased by 1 km/h at the end of each 4 min stage. During all tests the respiratory gas exchange was analyzed continuously with Oxycon 4 (Mijnhardt) and computed every 30 s. Besides, the tidal volume (TV), respiratory frequency (R_f) and minute ventilation (V_E) were recorded. Heart rate (HR) was measured using Sport Tester (PE 3000, Oulu, Finland) before and during the whole test. Blood pressure (BP) was measured before and after termination of the test by auscultation method. The rate of perceived exertion (RPE) was registered at the end of each running speed. The same protocol was repeated with the subjects after 4 weeks of training (T1). Before the C1 and T1 tests the anthropometric measurements were made, including height (H), body mass (M), and thickness of four skin-folds (biceps, triceps, sub-scapular and abdominal) on the left body side.

Statistics: Statistical significance of differences was compared by depended *t* test of means. Significance was set at the $P<0.05$ level of confidence. All data are reported as means±SE.

Results

Body mass index and body fat percentage: The subjects' body mass index was maintained on a similar level during the whole experimental period and it was: 28.9±0.5 and 28.7±0.5 (N.S.) before and after the training, respectively. Similarly, no differences were found in their body fat percentage. These values varied from 24.4**±**0.6 % before training to 24.5**±**0.6 % after it (N.S.).

Physiological variables (Fig. 1):

Heart rate (HR). At each successive running speeds HR was significantly lower in C2 than in C1 ($P<0.01$, $P<0.01$ and $P<0.03$, respectively).

Oxygen uptake (VO_2). In the first two of running speeds (4 and 5 km·hr^{-1}), VO_2 was significantly reduced in C2 in comparison with C1 ($P<0.01$ and $P<0.02$, respectively). This tendency $P<0.09$) was maintained to the end of the test.

Respiratory quotient (RQ) was significantly lower in the C2 than in C1 test but only at the running speed of 4 km·hr^{-1} ($P<0.03$).

Respiratory frequency (R_f) During the C2 test, R_f was significantly decreased in comparison with C1 at each running speed ($P<0.01$, $P<0.004$ and $P<0.003$, respectively). After 4 weeks of training R_f, decreased further and it was lower than that in the C2 at the running speeds of 4 and 6km·hr^{-1} ($P<0.04$).

Tidal volume (TV) was similar in two control tests (C1 and C2). After training it increased and a significant difference was found at the running speed of 5 and 6 km/h ($P<0.03$ and $P<0.04$, respectively).

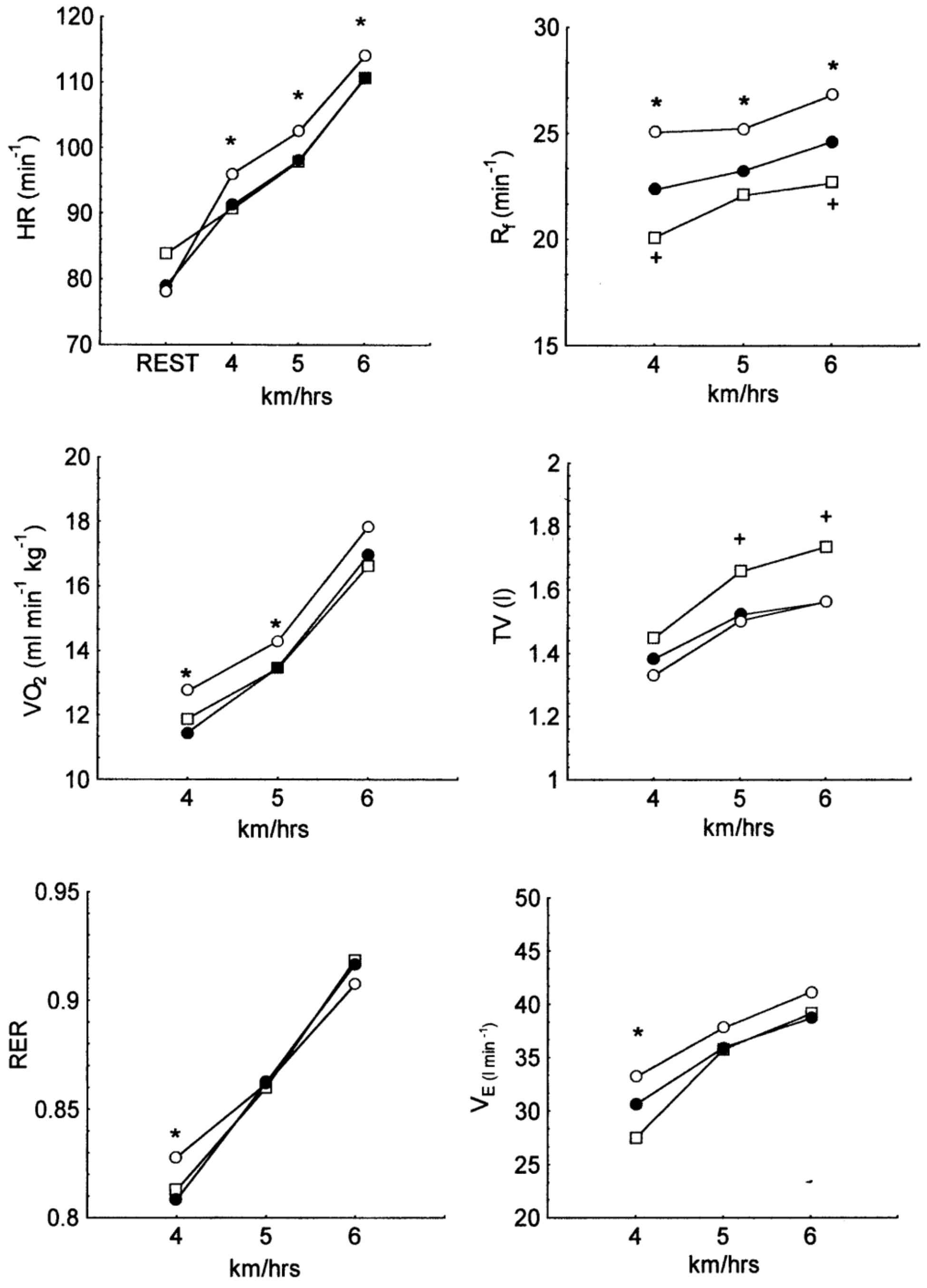
HR (min-1)
120
110
100
90
80
70
REST 4 5 6
km/hrs
Rf (min-1)
30
25
20
15
4 5 6
km/hrs
VO2 (ml min-1 kg-1)
20
18
16
14
12
10
4 5 6
km/hrs
TV (l)
2
1.8
1.6
1.4
1.2
1
4 5 6
km/hrs
RER
0.95
0.9
0.85
0.8
4 5 6
km/hrs
VE (l min-1)
50
45
40
35
30
25
20
4 5 6
km/hrs

Fig. 1
Mean values (±SE) of heart rate (HR), oxygen uptake (VO_2), respiratory exchange ratio (RER), respiratory frequency (R_f), tidal volume (TV) and minute ventilation (V_E) in 24 subjects performing 3 graded incremental tests on the treadmill; The first control test (C1) - open circles; the second control test (C2) – close circles; after training (T1) – squares.
*Significance differences between C1 and C2 tests; $^+$Significant differences between C2 and T1 tests

Minute ventilation (V_E) was lower in C2 than that in C1 at the first running speeds (4 km·hr.$^{-1}$).

Mean arterial blood pressure (MAP). Under resting conditions MAP was significantly lower in C2 than in C1 test (109.7±2.5 mmHg vs.114.5±3.1 mmHg, P<0.01). Similarly, after exercise MAP values were lower in C2 than in C1 test (111.6±2.8 mmHg and 116.2±3.2 mmHg, P<0.02). As compared to C2 the training did not change either the resting or the exercise induced changes in MAP.

Perceive exertion: The subjects' subjective rating of perceive exertion (measured by Borg's scale) tended to be diminished from test to test. At the running speed of 5 km·hr^{-1} it significantly decreased from 10.7±0.4 points in the C1 test to 10.1±0.4 points in the C2 test (P<0.05). This tendency was also evident after training (P<0.07).

Discussion

It was found that the earliest and most prominent effect induced by the moderate-intensity training applied in the present study were changes in the breathing pattern. After training the breathing frequency of the subjects decreased, while tidal volume increased at the similar minute ventilation. Thus, after the training the subjects could breath in the way more similar to leaner person, although their body mass did not be change. Such advantageous changes in the breathing pattern after a short-lasting training seem important because it is known, that in obesity the relationships between the lungs, chest walls, and diaphragram are disadvantageous for respiratory function [2,3]. Markov et al. [10] found that in healthy men the respiratory muscle training improves breathing and cycling similarly to the effects observed after endurance training. The above authors suggested that these changes were not due to cardiovascular adaptation but that fatigue of the respiratory muscles might have been reduced by their training, allowing the subjects to cycle for longer time. In the light of these results our finding seems very interesting because we have found that walking endurance training in obese subjects improves their respiratory functions. Moreover, it can be assumed that the improvement in the subjective rating of perceive exertion could have a psychological meaning stimulating the obese subjects for continuation of the training, the more so as the some obese subjects have a poor adherence to prescribed exercise [5,6].

It should be emphasized that other physiological variables measured in our study did not change significantly during 4 weeks of training. However, these results have delivered some proofs concerning the importance of familiarization with exercise testing procedure for valuation of early effects of training. In our previous study [18] it was hypothesized that familiarization might reduce intra-individual variability of some physiological responses because of physiological stress limitation. Our conclusion was based on the observation, that the early post-training decrease in HR might be due to familiarization of subjects to the experimental protocol. Thus, the lack of the second control in the above mentioned study could change interpretation of our training effects. Similarly, in the present investigation, oxygen uptake, BP and HR responses to the treadmill test were significantly attenuated during the 2nd control test in comparison with the 1st one. Since after 4 weeks of walking training, these responses were similar to those found in the 2nd control test it seems justified to suggest that the uncontrolled walking training by itself does not affect the above mentioned variables. Therefore, it may be assumed that familiarization with the experimental procedure causes attenuation of HR and BP responses to the treadmill test, probably though the lesser activation of the sympathetic nervous system already during the second control test. We consider that there is a similarity between exercise- and mental-induced stress in reactivity of HR and BP [9]. A transient sympathetic arousal in response to the mental stress, characterized by excessive reactions to the stress were described by many authors. [7,9,14].

Summarizing. The present study showed that in obese subjects 4 weeks of moderate uncontrolled walking training is advantageous for changes in the respiratory pattern. Familiarization of the subjects with the experimental procedure diminished activation of sympathetic nervous system and has a important role for the results interpretation.

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