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RESPONSES OF ADULT WOMEN TO PROGRAMMED EXERCISE

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ABSTRACT

A group of eight healthy women was studied following two months of programmed exercise (3 x 15 mins/per week) at 60 to 80 percent of age-predicted maximum heart rate. Physical work capacity corresponding to a heartrate of 170 bts. (PWC-170) was determined using a bicycle ergometer. Anthropometric and lung function variables were also ascertained prior to (T1) and following training (T2). The post training measurements of this exercise group, compared with measurements of a sedentary control group, displayed significant changes in PWC-170, resting systolic blood pressure and fat index. There were no significant changes in vital capacity, forced expiratory volume in one second (FEV_1), strength and perceived exertion measures (RPE). The implication of these findings are discussed.

INTRODUCTION

There has recently been an increased emphasis on physical fitness programmes for women, and it has been established that there are no major sex differences in their physiological responses to training (Flint, 1974; Kilbom, 1971; and Roskamm, 1967). At present there is limited knowledge regarding intensity frequency and duration of women's exercise and many programme leaders fail to recognize the need for specificity during training (Burwitz and Davies 1976).

Improvements in cardiorespiratory fitness have been observed with a variety of activities such as cycling, treadmill running, skipping, and jogging (Kilbom, 1971; Edwards, 1974; Getchell and Moore, 1975; Jackson and Sharkey, et al., 1968 and Smith and Stransky, 1975). These studies displayed significant cardiorespiratory changes at frequencies and intensities ranging from 10 minute sessions daily at 125 bpm to 15 minutes, three times per week at 150 bpm.

There is a need to derive a training regimen which will effect beneficial changes with a minimum amount of intensity and time. This study was designed to examine the effects of an eight week programme of calisthenics and running, using three 15 minute sessions per week.

PROCEDURES

Twenty-one women participated in the project, eight (mean age 29.2 years) participated in the exercise group and nine (mean age 31.1 years) composed the control. The subjects were members of the administrative staff at Preston Polytechnic and were classified as sedentary from questionnaire information given by the subjects. Initially, the exercise group comprised twelve subjects, however, failure to meet the criteria of 70% attendance of training sessions led to eight returning for post-training tests. Each subject was encouraged to maintain normal dietary and exercising habits.

Testing

A preliminary six minutes acclimatization session was performed on a cycle ergometer (Monark) by all subjects at a work load of 50 watts. All subjects were tested twice prior to the start and immediately following the training programme and the average of these two tests used for T1 and T2 respectively. The following measurements were made on each subject.

Height, weight, resting heartrate and blood pressure were recorded following ten minutes of supine rest.

The physical work capacity corresponding to a heart-rate of 170 bt/min (PWC-170) was arrived at by increasing increments from 50 watts/min until a pulse rate of approximately 170 was attained during a nine minute ergometer ride. The results were then graphed and extrapolated to obtain the work load corresponding to 170 bt/min. This was a modified version of the method used by Sjostrand (1960).

Systolic blood pressure (SBP) were obtained by brachial auscultation with a BONN-SP electronic sphygomomanometer during the sixth and ninth minutes of the exercise test. The rate pressure products were computed using the heart rates recorded in conjunction with the systolic blood pressures (HR x SBP). Ratings of perceived exertion were also obtained at the sixth and ninth minute using the method of Borg (1962).

Skinfolds were measured according to the technique described by Durnin and Womersley (1974) the thickness of the four sites measured — triceps, biceps, sub-

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scapula and suprailiac were added together to provide a fat index. Vital capacity (VC) and forced expiratory volume in the first second of expiration (FEV 1) were determined using a single breath wedge spirometer (vitalograph). Right and left grip strength was measured with a hand grip dynamometer (Takeikiki). During the laboratory tests the room temperature remained constant at 20°C ± 2°C.

Training

An individual training regimen was devised for each subject, based on age-predicted maximal heart rate. Maximal heart rate for this group was estimated to be between 180 and 190 bt/min. (Drinkwater and Horvath, 1972; Higgs, 1973). Each fifteen minute work session (three times per week) was comprised of three minutes of calisthenics and twelve minutes of walking and jogging. The exercise commenced at 60% of maximum heart rate (Karvonen, 1957) for the first three weeks and was increased to 80% of maximum heart rate for the last five weeks. This approximated training heart rates of (140-165 bt/min). During each session the investigators periodically checked the heart rates by palpaltion at the carotid artery.

Statistical Analyses

Standard statistical procedures were adapted with the Pearson Product Moment correlation and Students "t" test being used to determine test/retest reliability coefficients, and within group differences respectively. On the assumption that the data before and after conditioning could be considered as replicate samples the "t" test for paired samples was applied to the differences.

RESULTS

The reliability coefficients ranged from .78 to .99. Tables I and II display the measurements at the beginning and following completion of the training programme for the exercise and control groups respectively.

At T1 there were no significant differences between the exercise and control groups with respect to age, weight and PWC-170, but the exercise group demonstrated significantly lower resting heart rates and skinfolds.

Following the exercise programme the most prominent changes were in those variables indicating an improvement in cardiorespiratory function. There was a significant increase in the work capacity prior to reaching a heart rate of 170 bt/min (PWC-170) and a corresponding decrease in the rate pressure product during the 6th and 9th minute of the physical work capacity test.

A feature of this particular sample was their relatively low resting blood pressures at T1. At T2 there were significant decreases in the mean difference of resting systolic blood pressure of the exercise group and the resting diastolic pressure of the contról group.

There were no significant differences in either group at T1 or T2 between the heart rates recorded at the sixth and ninth minute of exercise and the ráting of perceived exertion (RPE).

There were no significant changes in body weight in either group but both groups demonstrated significant changes in skinfold measures at T2.

Strength and pulmonary function measures remained relatively stable throughout the study, and were within the norms quoted by other investigators (Brown and Shephard, 1967; Getchell, 1975).

DISCUSSION

The significant (13%) increase of PWC-170 and the decrease in rate pressure products of the exercise group are evidence of the efficacy of the exercise programme in developing cardiovascular fitness. The decrease in exercising rate pressure product (RPP) was brought about primarily by bradycardia, the exercising systolic pressures remaining relatively unaffected by the training. These RPP changes do suggest a decrease in the oxygen consumption of the heart for a given work load.

Following training the mean difference of the resting systolic blood pressure in the exercise group and the resting diastolic blood pressure in the control group were significantly reduced. The latter finding is difficult to explain but the former findings have been documented previously. (Hanson and Nedde, 1970).

The increase in PWC-170 in the present study was smaller than the 19% found by Hanson and Nedde (1974) following 10 months of jogging and calisthenics. These investigators exercised their subjects five one hour sessions per week, and it is probable that this greater frequency and intensity influenced their greater changes. It is interesting to note that when they extended their training a further four months the PWC remained relatively stable. There were no significant decreases in the resting heart rates of either group. This is in agreement with Getchell and Moore (1975) but not with Smith and Stransky (1975). The pretraining heart rates of the latter study were considerably higher than the former two suggesting that their subjects were initially of lower cardiovascular fitness.

The lack of significant changes in body weight are in agreement with previous studies of the same length. (Girandola, 1975; Katch *et al.,* 1969). This, in conjunc-

Means, Standard Deviations and t Ratios for Exercise Subjects (N = 8) and Control Subjects (N = 9) at (T1) and (T2)

	EXERCISE				CONTROL			
	Test 1 (T1)	Test 2 (T2)	Mean Differences	t Ratio	Test 1 (T1)	Test 2 (T2)	Mean Differences	t Ratio
Weight (kg)	120.3 ± 7.1	120.2 ± 7.6	0.1	0.10	126.1 ± 16.3	126.2 ± 15.5	–0.1	0.17
Age (years)	29.5 ± 6.9				31.1 ± 7.07			
Resting Heart Rate (bt/min)	64.9 ± 10.5	64.8 ± 7.8	0.1	0.06	79.3 ± 8.8	76.4 ± 10.3	2.9	2.00
Systolic B.P. (mm.Hg.)	119 ± 4	116 ± 6	3.0	2.60**	118 ± 8	118 ± 9	0	0.52
Diastolic B.P. (mm.Hg.)	75 ± 4	72 ± 6	3.0	1.98	78 ± 5	73 ± 4	5.0	3.03**
Physical Work Capacity (watts)	105.0 ± 10.4	118.1 ± 15.2	–13.1	4.46**	95.8 ± 17.5	99.8 ± 20.4	–4.0	1.23
Grip R (kg)	34.6 ± 2.9	34.3 ± 2.0	0.3	0.44	32.3 ± 4.6	34.6 ± 2.2	–2.3	1.37
Grip L (kg)	32.3 ± 1.7	33.2 ± 1.9	– 0.9	0.95	33.8 ± 1.8	33.6 ± 2.2	0.2	0.41
Ex Systolic B.P. (3′)	156 ± 8	151 ± 13	5.0	1.53	153 ± 11	151 ± 13	2.0	0.57
Ex Systolic B.P. (6′)	159 ± 10	156 ± 13	3.0	1.22	154 ± 11	154 ± 13	0	0.15
Ex Systolic B.P. (9′)	166 ± 10	163 ± 13	3.0	1.02	160 ± 10	160 ± 13	0	0.14
Skinfolds (mm)	54.9 ± 13.4	52.3 ± 14.7	2.6	3.38**	69.2 ± 15.6	67.2 ± 14.9	2.0	3.21**
Forced Vital Capacity Litres BTPS*	3.91 ± 0.80	3.95 ± 0.92	– 0.04	0.80	3.80 ± 0.58	3.74 ± 0.57	0.06	1.14
Forced Expiratory Volume 1 sec Litres BTPS*	3.38 ± 0.68	3.40 ± 0.80	– 0.02	0.16	3.29 ± 0.49	3.24 ± 0.49	0.05	1.17
Rate Pressure Product (6′)	222.1 ± 21.1	205.3 ± 22.3	16.8	2.44**	204.3 ± 25.2	209.0 ± 28.0	–4.7	0.45
Rate Pressure Product (9′)	281.0 ± 16.6	252.4 ± 19.0	29.0	4.20**	249.5 ± 31.2	253.4 ± 32.0	–3.9	0.29

*BTPS – at body temperature and pressure saturated with water vapour ** Significant at .05 level tion with a significant decrease in total skinfold measurements would suggest an increase in lean body weight (LBW) and a decrease in total body fat. The decrease in skinfolds of the control group was unexpected and could be the result of a change in dietary and exercise patterns, or systematic measuring errors. Another consideration is that skinfold measurements are not an accurate representation of the changes that occur in total body fat. This has been suggested by Wilmore *et al.,* (1970) and Moody *et al.,* (1972), who reported subcutaneous fat losses in subjects who had gains in total body fat.

The failure to increase strength in this study emphasizes the need for specificity. This particular programme did not provide the necessary overload required to stimulate strength changes. Lack of significant strength gain was also documented by Fardy *et al.,* (1976) following a season of competitive volleyball. If strength is a desired acquisition then it seems it can only be obtained by specific programme planning.

The stability of vital capacity was not unexpected, and it would seem that this characteristic is most likely influenced by specific activity such as swimming during the growth years (Engstrom *et al.,* 1971).

The present study clearly documents significant training effects with increased physical work capacity following three 15 minute sessions per week for eight weeks. When the findings of Jackson *et al.,* (1968), Baker (1968) and Edwards (1974) are considered it is evident that cardiovascular improvements can be attained with a time involvement as minimal as 10-15 minutes per session and a heart rate as low as 125 bt/min. Further investigations are required to ascertain the absolute minimum time and intensity required for beneficial improvements.

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