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PROGRESS REPORT

Contract Number: NAS 9-14921 "Study of Optimal Training Protocols and Devices for Developing and Maintaining Physical Fitness in Females Prior to and During Space Flight."

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Sponsoring Institution: Harding College, Searcy, Arkansas

Period Covered by the Report: September 1, 1976-February 28, 1977

This report covers Experiment II of two experiments to be conducted during a 12-month period beginning March 1, 1976. In Experiment I three groups of females trained twenty minutes a day, three days a week for ten weeks. One group trained at 70% of their maximum pulse rate, another trained at 80% maximum and the third trained at 90% of their maximum pulse rate. There was no significant increase in overall strength for any group. Of the training groups, only those exercising at 80 and 90% of their maximum showed moderate increases in physical work capacity.

In Experiment II three groups of females trained three days a week for ten weeks at 85% of maximum pulse rate on a Monarch stationary bicycle ergometer. One group trained for ten minutes a day, another trained for twenty minutes a day and the third group trained for thirty minutes a day. All training groups had some gains in strength and physical work capacity; however, the longer training sessions produced greater increases in physical work capacity.

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Experiment II: Comparison of Different Lengths of Training Sessions on the Development of Physical Fitness in College Women

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I. Introduction

A number of physiological changes, which are in general referred to as deconditioning, result from living in the environment of space. Two possible ways to minimize the effects of deconditioning in space are to achieve a very high level of conditioning immediately prior to flight and provide a regimen in the capsule which will conserve pre-flight physical fitness and maintain a moderate degree of fitness. This laboratory has been investigating methods and equipment to determine how these two goals might be efficiently attained.

It was determined in this laboratory that running and riding a bicycle ergometer at comparable heart rates produced similar gains in physical fitness variables in college men. It was found that subjects who exercised at a 180 heart rate made greater gains in physical fitness than did those exercising at a 140 or 160 heart rate. When the length of the workout was varied, subjects exercising sixty minutes per day made greater gains than those exercising twenty or forty minutes per day. Greater gains on specified components of physical fitness also resulted when subjects exercised twelve times per week as compared to those who exercised three or six times a week. Subjects who discontinued training slowly deconditioned, but a moderate level of fitness was maintained by exercising at a pulse rate of 160 beats per minute for twenty-minute periods three times a week. Subjects who "overtrained" twice daily to near exhaustion increased in fitness.

Exercise programs involving four pieces of equipment, the Exer-Genie Exerciser, the Collins Pedal Mode Ergometer, the Universal Gym and the Super Mini-Gym, have been investigated. It was found that neither six- nor twelve-minute training periods each day involving isometric and isotonic exercises with an Exer-Genie resulted in significant increases in selected physical fitness variables. Training in a supine position on the Exer-Genie at a 160 pulse rate for twenty minutes per day showed no significant change in fitness. Three training programs involving the Collins Ergometer have been examined. One group of subjects exercised for twelve minutes per day with the heart rate programmed to increase during the training period. Another group exercised for ten minutes a day at 85 percent of their maximum heart rate while a third group exercised at a 160 heart rate for ten minutes a day. Each of these groups showed moderate increases in fitness.

Moderate gains in physical fitness were produced in three exercise groups of men 30-45 years old who were initially in poor to fair condition. One group exercised for ten minutes a day, three times a week on a bicycle ergometer at 85 percent maximum pulse rate. Another group exercised for ten minutes a day, five times a week on a bicycle ergometer at 85 percent maximum pulse rate. The third group exercised for ten minutes a day, three times a week on the bicycle ergometer at 85 percent maximum pulse rate and two times a week on an Exer-Genie circuit. These three exercise groups made comparable gains in fitness.

A combination of exercises has been investigated. One group of subjects exercised for twenty minutes a day, three days a week, on a foot-mode ergometer at 85 percent maximum pulse rate and twenty minutes a day, two days a week, on a hand-mode ergometer at 70 percent maximum pulse rate. A second group had the same schedule but worked on the hand-mode ergometer at 85 percent

maximum pulse rate. The third group exercised for twenty minutes a day, three days a week, on a foot-mode ergometer at 85 percent maximum pulse rate and two days a week on a seven-station Exer-Genie circuit. These groups made moderate gains in strength and cardiopulmonary fitness.

Another combination included endurance and strength training in the same workout. The three exercise groups worked fifteen minutes a day, three days a week on a foot-mode ergometer at 85 percent of their maximum heart rate. Each group immediately followed this with an additional fifteen minutes of exercise. One group completed two circuits on a seven-station Exer-Genie circuit at each exercise session. One group exercised on a hand-mode ergometer. The third group completed two circuits on a seven-station Super Mini-Gym circuit during each exercise session. All groups made moderate cardiopulmonary gains but only the Exer-Genie and the Mini-Gym were effective in increasing strength.

An experiment was performed to compare exercise on equipment designed solely to produce strength, exercise of the lower torso only to produce cardiopulmonary fitness and exercise of the upper torso only so as to produce cardiopulmonary fitness. One group worked thirty minutes a day, three days a week, on a Universal Gym. Another group worked thirty minutes a day, three days a week, on a foot-mode ergometer at 85 percent of their maximum pulse rate. A third group worked thirty minutes a day, three days a week, on a hand-mode ergometer at 85 percent of their maximum pulse rate. The group exercising on the Universal Gym gained in arm and shoulder girdle strength. The subjects exercising on the foot-mode ergometer gained in leg strength and all groups made moderate gains in cardiorespiratory fitness.

The effect of stress on highly trained subjects has been investigated by confining one group in bed for five days and depriving a second group

of sleep for fifty hours. The pre-stress training, which lasted twelve weeks, consisted of a three-mile run three days a week and working on a Universal Gym for thirty minutes a day, twice a week. Good increases in strength and cardiopulmonary fitness were obtained. Both stresses caused negligible decreases in strength variables but drastic decreases in cardiopulmonary fitness. Two weeks post-stress the subjects had recovered about half of the conditioning they lost.

In an experiment comparing the Super Mini-Gym, the Universal Gym and calisthenics, subjects trained twenty minutes a day three days a week. The training programs produced comparable results, negligible increases in cardiopulmonary fitness and good gains in strength.

The Super Mini-Gym bicycle was evaluated and compared with the floor model. The bicycle was found to have serious mechanical faults. One group on the bicycle trained at high resistance while the second group on the bicycle trained at a low resistance. Pedal speed was adjusted so that pulse rates were comparable. Slight gains in strength and cardiopulmonary fitness resulted. However, the floor model produced good gains in strength.

The effects of bodily posture were investigated by training one group in an upright position at a pulse rate of 160 beats per minute, a second group in a supine position at the same pulse rate and a third group trained in a supine position at a work intensity equal to the group training in an upright posture. All training groups made moderate increases in cardiopulmonary fitness and slight increases in strength.

Two experiments have been performed with college females. Training by pedalling on a stationary bicycle, jogging on a track, and walking on a treadmill produced increases in strength and physical work capacity. However, larger increases occurred in the bicycling and walking groups. Among groups

of females training at 70, 80 and 90% of their maximum pulse rates, only the two groups training at the higher pulse rates showed moderate increases in physical work capacity.

II. Purpose

The purpose of this experiment was to determine what length of training is sufficient to effect significant increases in physical work capacity in college-age females.

III. Methods

The subjects in this experiment were twenty college-age female volunteers whose physical work capacity was average for the Harding College coed. Base lines were determined on specified variables by administering the following: (a) a medical examination, (b) anthropometrical measurements, (c) skinfold measurements, (d) body composition measurements, (e) three cable tensiometer strength measurements, and (f) a treadmill test.

The medical examination included a six-lead ECG, a vital capacity test (1), a maximum breathing capacity test (1), and serum and urine analyses for glucose. The following anthropometrical measurements were taken: neck, bicep, forearm, wrist, thigh and calf. The following skinfold measurements (2) were taken: axilla, tricep, subscapular, abdominal, suprailiac, and thigh. A sum of the values for these six sites was calculated. Body composition measurements (3) were determined by hydrostatic weighing with the subject sitting. Cable tensiometer measurements (4) of shoulder flexion, hip flexion, and ankle plantar flexion were taken. Each subject was given a treadmill test (5) in which the speed of the belt was constant at 90 meters per minute with an increment in grade of one percent per minute. Pulse rate and blood pressure (systolic and diastolic) were measured manually on

alternate minutes until a pulse rate of 160 beats per minute was attained. Thereafter, the pulse and pressure were monitored each minute. The test was terminated when the subject reached a near maximum pulse rate. Expired gas samples were collected at a 180 pulse rate and the last minute to determine several measurements of cardiorespiratory fitness. Pulse and pressure were monitored post-test for three minutes with the subject sitting.

By using a table of random numbers the twenty subjects were divided into four groups of five each. Subjects in Groups A, B, and C trained and Group D served as a control, engaging in their normal daily activities without any specified training program.

The training lasted ten weeks during which the groups exercised on a stationary bicycle ergometer at a work load adjusted to maintain 85% of the maximum pulse rate attained during the treadmill test. Pulse rates were monitored on alternate minutes during workouts. The groups trained three times per week on non-consecutive days. Group A trained ten minutes per session, Group B trained twenty minutes per session, and Group C trained thirty minutes per session.

The effects of the training program were evaluated at the end of the experiment by readministering the initial baseline tests.

The data were analyzed by analysis of covariance and Duncan's Multiple Range tests on selected variables where indicated. The covariant was the initial or baseline value.

IV. Results and Discussion

The average age, height, and weight for each group prior to the beginning of the training are given in Table I.

TABLE I

MEAN AGE, HEIGHT, AND WEIGHT OF SUBJECTS

GROUP	AGE (yr)	HEIGHT (cm)	WEIGHT (kg)
A - 10 minute	20.2	171.5	63.4
B - 20 minute	21.2	165.8	63.8
C - 30 minute	20.8	162.4	64.5
D - Control	20.2	165.4	61.6
ALL	20.6	166.0	63.3

The significant changes that were found for all variables that were measured pre- and post-training are listed in Table II. The significance level is indicated (p 0.05, 0.01 or 0.001). A significant decrease is indicated by a minus sign in front of the significance level and a significant increase is indicated by the lack of a sign.

Table III contains the mean pre- and post-training values of all the variables that were measured.

TABLE II

SIGNIFICANCE LEVELS OF CHANGES IN VARIABLES MEASURED
PRE- AND POST-TRAINING

VARIABLE	GROUP			
	A 10 min.	B 20 min.	C 30 min.	D Control
ANTHROPOMETRIC MEASUREMENTS				
Neck				
Right Bicep				
Left Bicep				
Right Forearm				
Left Forearm				
Waist				
Right Thigh				
Left Thigh				
Right Calf				
Left Calf				-.05
SKINFOLD MEASUREMENTS				
Axilla				
Tricep				
Subscapular				
Abdominal				
Suprailiac	-.01	-.05	-.05	
Thigh				
Sum of sites				
STRENGTH MEASUREMENTS				
Shoulder Flexion, Cable				
Hip Flexion, Cable				
Ankle Plantar Flexion, Cable	.001	.01	.001	.01

TABLE II ...SIGNIFICANCE LEVELS OF CHANGES IN VARIABLES MEASURED PRE- AND POST-TRAINING, CONT.

VARIABLE	GROUP			
	A 10 min.	B 20 min.	C 30 min.	D Control
Strength Measurements Continued				
Strength Quotient	.05	.01	.05	
T Score	.01	.05	.001	
PHYSIOLOGICAL VARIABLES				
One Second Expiratory Capacity				
Vital Capacity	.05			
Maximum Breathing Capacity	.05	.05	.05	
Respiratory Rate at MBC	.01			
Tidal Volume at MBC				
Body Composition				
Weight				
TREADMILL TEST VARIABLES				
Time on Treadmill to 180 P.R.		.01	.01	
Time on Treadmill to Max P.R.	.05	.05	.01	
Systolic Blood Pressure at Rest				
Systolic Blood Pressure at 180 P.R.				
Systolic Blood Pressure at Max P.R.			.05	
Systolic Blood Pressure at 3rd Minute Recovery	.05			
Diastolic Blood Pressure at Rest				
Diastolic Blood Pressure at 180 P.R.			-.05	
Diastolic Blood Pressure at Max P.R.				
Diastolic Blood Pressure at 3rd Minute Recovery				
Pulse Rate at Rest				.05

TABLE II ...SIGNIFICANCE LEVELS OF CHANGES IN VARIABLES MEASURED PRE- AND POST-TRAINING, CONT.

VARIABLE	GROUP			
	A 10 min.	B 20 min.	C 30 min.	D Control
Treadmill Test Variables, cont.				
Pulse Rate at 180 P.R.				
Pulse Rate at Max. P.R.		-.05		
Pulse Rate at 3rd Minute Recovery				
$\dot{V}_E$ BTPS at 180 P.R.		.01	.05	
$\dot{V}_E$ BTPS at Max. P.R.			.05	
$\dot{V}_E$ STPD at 180 P.R.		.01	.05	
$\dot{V}_E$ STPD at Max. P.R.			.05	
Respiratory Rate at 180 P.R.				
Respiratory Rate at Max. P.R.				
Tidal Volume at 180 P.R.				
Tidal Volume at Max. P.R.				
$\dot{V}_{CO2}$ at 180 P.R.	.05	.01	.01	
$\dot{V}_{CO2}$ at Max. P.R.	.05	.05	.05	
$\dot{V}_{O2}$ at 180 P.R.	.05	.01	.001	
$\dot{V}_{O2}$ at Max. P.R.			.05	
$\dot{V}_{O2}$/Pulse at 180 P.R.		.05	.01	
$\dot{V}_{O2}$/Pulse at Max. P.R.		.05	.01	
$\dot{V}_{O2}$/kgbw·min. at 180 P.R.		.05	.001	
$\dot{V}_{O2}$/kgbw·min. at Max. P.R.			.01	
$\dot{V}_E/V_{O2}$ at 180 P.R.				
$\dot{V}_E/V_{O2}$ at Max. P.R.				
Respiratory Exchange Ratio at 180 P.R.	.05	.01		
Respiratory Exchange Ratio at Max. P.R.	.05	.05		.05

No significant changes in anthropometrical variables were obtained for the training groups (Table II).

All training groups had a significant decrease in Suprailiac Skinfold thickness (Table II). This result has not been observed in the two previous experiments involving females.

All training groups had significant increases in Strength Quotient and T Score which are indicators of overall body strength (Table II). There were significant increases in maximum breathing capacity for all training groups (Table II).

The variables which are most indicative of physical work capacity are Time on the Treadmill, carbon dioxide output variables, and oxygen uptake variables. Groups B and C had significant increases in Time on the Treadmill to 180 pulse rate while all training groups had significant increases in Time on the Treadmill to maximum Pulse Rate (Table II).

All training groups had significant increases in $\dot{V}_{CO_2}$ at 180 Pulse Rate and in $\dot{V}_{CO_2}$ at Maximum Pulse Rate (Table II). All training groups had significant increases in $\dot{V}_{O_2}$ at 180 Pulse Rate but only Group C had a significant increase in $\dot{V}_{O_2}$ at Maximum Pulse Rate (Table II). Only the two groups with the longer training sessions, Groups B and C, had significant increases in $\dot{V}_{O_2}$/Pulse at 180 Pulse Rate, $\dot{V}_{O_2}$/Pulse at Maximum Pulse Rate and $\dot{V}_{O_2}$/kgbw·min. at 180 Pulse Rate. However, only Group C had a significant increase in $\dot{V}_{O_2}$/kgbw·min. at Maximum Pulse Rate.

It is apparent from these treadmill test variables that Group C, working the greatest length of time per training session, obtained the greatest increase in physical work capacity. Group A, working the least amount of time per session, obtained the smallest increase in physical work capacity.

CONCLUSIONS

1. Pedalling a bicycle at least ten minutes a day at 85% of maximum pulse rate, three days a week for ten weeks will produce moderate increases in overall strength in college-age females.
2. Pedalling a bicycle at least ten minutes a day at 85% of maximum pulse rate, three days a week for ten weeks will produce moderate increases in physical work capacity in college-age females.
3. The longer the training session, up to thirty minutes per session, the greater the increases in physical work capacity that will result when college-age females are trained three days a week for ten weeks at 85% of their maximum heart rate.

TABLE III

MEAN PRE- AND POST-TRAINING VALUES OF THE MEASURED VARIABLES BY GROUPS

VARIABLE		GROUP			
		A 10 min.	B 20 min.	C 30 min.	D Control
ANTHROPOMETRIC MEASUREMENTS					
Neck (cm)	Pre	31.25	30.92	30.56	30.52
	Post	31.075	31.08	30.44	30.34
	Difference	-.175	.16	-.12	-.18
Right Bicep (cm)	Pre	27.8	27.4	28.32	28.38
	Post	27.425	26.78	28.08	28.16
	Difference	-.375	-.62	-.24	-.22
Left Bicep (cm)	Pre	26.7	26.98	27.3	27.64
	Post	26.15	26.42	27.06	27.62
	Difference	-.55	-.56	-.24	-.02
Right Forearm (cm)	Pre	24.125	23.64	25.22	24.14
	Post	23.85	23.60	24.08	24.00
	Difference	-.275	-.04	-1.14	-.14
Left Forearm (cm)	Pre	23.15	23.28	23.56	23.5
	Post	22.775	22.98	23.34	23.4
	Difference	-.375	-.30	-.22	-.1
Waist (cm)	Pre	70.95	72.08	72.5	68.42
	Post	69.75	72.04	70.64	68.22
	Difference	-1.2	-.04	-1.86	-.2
Right Thigh (cm)	Pre	54.90	57.08	58.02	56.06
	Post	55.05	57.82	57.40	54.80
	Difference	.15	.74	-.62	-1.26
Left Thigh (cm)	Pre	53.35	56.64	57.14	55.20
	Post	54.025	56.96	57.32	55.32
	Difference	.675	.32	.18	.12
Right Calf (cm)	Pre	34.875	34.94	36.16	36.24
	Post	34.85	35.10	36.40	35.82
	Difference	-.025	.16	.24	-.42

TABLE III... MEAN PRE AND POST TRAINING VALUES OF THE MEASURED VARIABLES BY GROUPS, CONT.

VARIABLE		GROUP A 10 min.	GROUP B 20 min.	GROUP C 30 min.	GROUP D Control
Anthropometric Measurements Continued					
Left Calf (cm)	Pre	34.475	35.12	36.18	36.16
	Post	34.475	35.40	36.30	35.56
	Difference	0	.28	.12	-.60
SKINFOLD MEASUREMENTS					
Axilla (mm)	Pre	12.65	12.68	11.08	12.60
	Post	11.55	12.60	11.32	12.36
	Difference	-1.10	-.08	.24	-.24
Tricep (mm)	Pre	16.70	15.56	15.24	15.44
	Post	17.45	15.28	16.12	16.72
	Difference	.75	-.28	.88	1.28
Subscapular (mm)	Pre	12.45	13.80	15.28	11.96
	Post	12.15	12.44	15.12	12.16
	Difference	-.30	-1.36	-.16	.20
Abdominal (mm)	Pre	22.50	17.72	18.72	20.00
	Post	21.35	17.08	18.80	20.80
	Difference	-1.15	-.64	.08	.80
Suprailiac (mm)	Pre	16.40	16.36	15.20	14.08
	Post	12.60	14.16	12.92	13.04
	Difference	-3.80	-2.20	-2.28	-1.04
Thigh (mm)	Pre	23.20	24.84	28.52	23.56
	Post	25.30	28.60	29.32	23.88
	Difference	2.10	3.76	.80	.32
Sum of Six (mm)	Pre	103.8	102.96	104.76	98.72
	Post	100.4	100.16	103.60	98.96
	Difference	-3.4	-2.8	-1.16	.24
STRENGTH MEASUREMENTS					
Shoulder Flexion, Cable (lb)	Pre	47.75	43.20	48.0	49.8
	Post	47.25	43.80	49.0	48.8
	Difference	-.50	.60	1.0	-1.0
Hip Flexion, Cable (lb)	Pre	101.75	99.4	86.8	103.6
	Post	105.0	110.4	98.2	102.0
	Difference	3.25	11.0	11.4	-1.6

TABLE III... MEAN PRE- AND POST-TRAINING VALUES OF THE MEASURED VARIABLES BY GROUPS, CONT.

VARIABLE		GROUP A 10 min.	GROUP B 20 min.	GROUP C 30 min.	GROUP D Control
Strength Measurements Continued					
Ankle Plantar Flexion, Cable (lb)	Pre	300.0	310.2	289.0	320.2
	Post	341.25	344.0	325.4	353.0
	Difference	41.25	33.8	36.4	32.8
Strength Quotient	Pre	.93	1.062	.964	1.002
	Post	1.0675	1.220	1.072	1.066
	Difference	.1375	.158	.108	.064
T Score	Pre	61.5	62.6	59.2	65.4
	Post	67.0	66.4	66.8	68.4
	Difference	5.5	3.8	7.6	3.0
PHYSIOLOGICAL VARIABLES					
One Second Expiratory Capacity (l)	Pre	3.15	3.08	2.80	2.9
	Post	3.25	3.00	2.72	2.9
	Difference	.1	-.08	-.08	0
Vital Capacity (l)	Pre	3.65	3.54	3.16	3.18
	Post	3.675	3.56	3.16	3.26
	Difference	.025	.02	0	.08
Maximum Breathing Capacity (liters/min.)	Pre	158.75	136.0	137.4	138.2
	Post	168.50	148.8	148.2	146.2
	Difference	9.75	12.8	10.8	8.0
Respiratory Rate at MBC	Pre	101.25	101.4	97.8	109.8
	Post	115.50	103.2	98.4	105.0
	Difference	14.25	1.8	.6	-4.8
Tidal Volume at MBC (l)	Pre	1.55	1.58	1.40	1.24
	Post	1.45	1.44	1.50	1.40
	Difference	-.10	-.14	.10	.16
Body Composition (percent fat)	Pre	26.825	27.48	30.28	27.58
	Post	26.350	27.70	29.54	27.10
	Difference	-.475	.22	-.74	-.48
Weight (kg)	Pre	63.45	63.76	64.46	61.58
	Post	63.475	63.44	63.82	61.72
	Difference	.025	-.32	-.64	.14

TABLE III...MEAN PRE- AND POST-TRAINING VALUES OF THE MEASURED VARIABLES BY GROUPS, CONT.

VARIABLE		GROUP			
		A 10 min.	B 20 min.	C 30 min.	D Control
TREADMILL TEST VARIABLES					
Time on Treadmill to 180 P.R. (min.)	Pre	11.25	9.6	9.2	9.8
	Post	12.5	11.8	11.4	9.4
	Difference	1.25	2.2	2.2	-.4
Time on Treadmill to Max P.R. (min.)	Pre	13.75	12.6	12.4	13.2
	Post	15.50	14.2	14.6	12.8
	Difference	1.75	1.6	2.2	-.4
Systolic Blood Pressure at Rest (mm Hg)	Pre	118.75	120.0	119.0	117.0
	Post	111.25	115.0	115.0	118.0
	Difference	-7.5	-5.0	-4.0	1.0
Systolic Blood Pressure at 180 P.R. (mm Hg)	Pre	168.75	166.0	163.0	166.0
	Post	171.25	167.0	169.0	162.0
	Difference	2.5	1.0	6.0	-4.0
Systolic Blood Pressure at Max P.R. (mm Hg)	Pre	175.0	169.0	168.0	170.0
	Post	181.25	171.0	179.0	168.0
	Difference	6.25	2.0	11.0	-2.0
Systolic Blood Pressure at 3rd Minute Recovery (mm Hg)	Pre	136.25	133.0	139.0	142.0
	Post	151.25	127.0	146.0	143.0
	Difference	15.0	-6.0	7.0	1.0
Diastolic Blood Pressure at Rest (mm Hg)	Pre	83.75	78.0	75.0	75.0
	Post	75.0	77.0	76.0	78.0
	Difference	-8.75	-1.0	1.0	3.0
Diastolic Blood Pressure at 180 P.R. (mm Hg)	Pre	71.25	80.0	65.0	75.0
	Post	71.25	71.0	62.0	70.0
	Difference	0	-9.0	-3.0	-5.0
Diastolic Blood Pressure at Max P.R. (mm Hg)	Pre	67.5	78.0	65.0	74.0
	Post	68.75	69.0	63.0	69.0
	Difference	1.25	-9.0	-2.0	-5.0
Diastolic Blood Pressure at 3rd Minute Recovery (mm Hg)	Pre	75.0	76.0	76.0	80.0
	Post	78.75	75.0	74.0	76.0
	Difference	3.75	-1.0	-2.0	-4.0

TABLE III...MEAN PRE AND POST TRAINING VALUES OF THE MEASURED VARIABLES BY GROUPS, CONT.

VARIABLE		GROUP A 10 min.	B 20 min.	C 30 min.	D Control
Treadmill Test Variables Continued					
Pulse Rate at Rest (beats/min.)	Pre	67.0	78.4	76.0	79.2
	Post	74.0	76.0	73.6	88.8
	Difference	7.0	-2.4	-2.4	9.6
Pulse Rate at 180 P.R. (beats/min.)	Pre	181.0	180.0	181.6	180.8
	Post	182.0	181.6	180.8	181.6
	Difference	1.0	1.6	-.8	.8
Pulse Rate at Max. P.R. (beats/min.)	Pre	193.0	196.8	196.0	192.0
	Post	194.0	188.0	192.8	192.8
	Difference	1.0	-8.8	-3.2	.8
Pulse Rate at 3rd Minute Recovery (beats/min.)	Pre	100.0	113.6	119.2	122.8
	Post	107.0	108.0	112.0	120.8
	Difference	7.0	-5.6	-7.2	-2.0
$\dot{V}_E$ BTPS at 180 P.R. (1)	Pre	62.5	64.0	56.8	57.0
	Post	69.75	77.8	68.4	55.8
	Difference	7.25	13.8	11.6	-1.2
$\dot{V}_E$ BTPS at Max. P.R. (1)	Pre	72.5	82.8	71.4	68.4
	Post	79.5	85.6	81.0	75.6
	Difference	7.0	2.8	9.6	7.2
$\dot{V}_E$ STPD at 180 P.R. (1)	Pre	51.5	53.2	47.2	47.2
	Post	58.25	65.2	57.2	46.4
	Difference	6.75	12.0	10.0	-.8
$\dot{V}_E$ STPD at Max P.R. (1)	Pre	60.25	68.8	59.4	56.8
	Post	66.75	71.4	68.0	62.8
	Difference	6.50	2.6	8.6	6.0
Respiratory Rate at 180 P.R. (breaths/min.)	Pre	30.25	33.6	35.4	28.4
	Post	36.25	40.6	37.0	28.4
	Difference	6.0	7.0	1.6	0
Respiratory Rate at Max. P.R. (breaths/min.)	Pre	36.0	43.4	38.2	33.0
	Post	38.0	41.6	42.2	38.4
	Difference	2.0	-1.8	4.0	5.4

TABLE III...MEAN PRE AND POST TRAINING VALUES OF THE MEASURED VARIABLES BY GROUPS, CONT.

VARIABLE		GROUP A 10 min.	GROUP B 20 min.	GROUP C 30 min.	GROUP D Control
Treadmill Test Variables Continued					
Tidal Volume at 180 P.R. (1)	Pre	2.075	1.90	1.58	1.98
	Post	1.925	2.00	1.82	2.00
	Difference	-.15	.10	.24	.02
Tidal Volume at Max. P.R. (1)	Pre	2.025	1.98	1.86	2.06
	Post	2.100	2.12	1.92	1.98
	Difference	.075	.14	.06	-.08
$\dot{V}_{CO_2}$ at 180 P.R. (1)	Pre	1.6650	1.654	1.512	1.494
	Post	1.9075	1.934	1.856	1.578
	Difference	.2425	.280	.344	.084
$\dot{V}_{CO_2}$ at Max. P.R. (1)	Pre	1.855	1.898	1.872	1.776
	Post	2.130	2.096	2.016	1.980
	Difference	.275	.198	.234	.204
$\dot{V}_{O_2}$ at 180 P.R. (1)	Pre	1.745	1.646	1.578	1.596
	Post	1.900	1.888	1.932	1.678
	Difference	.155	.242	.354	.082
$\dot{V}_{O_2}$ at Max. P.R. (1)	Pre	1.8575	1.854	1.858	1.81
	Post	2.0325	2.018	2.086	1.91
	Difference	.175	.164	.228	.10
$\dot{V}_{O_2}$/Pulse at 180 P.R. (ml)	Pre	9.65	9.12	8.70	8.82
	Post	10.45	10.40	10.68	9.24
	Difference	.80	1.28	1.98	.42
$\dot{V}_{O_2}$/Pulse at Max. P.R. (ml)	Pre	9.625	9.48	9.48	9.44
	Post	10.500	10.74	10.84	9.92
	Difference	.875	1.26	1.36	.48
$\dot{V}_{O_2}$/kgbw·min. at 180 P.R. (ml)	Pre	27.575	26.14	24.80	26.20
	Post	30.025	29.98	30.84	27.44
	Difference	2.45	3.84	6.04	1.24
$\dot{V}_{O_2}$/kgbw·min. at Max. P.R.	Pre	29.40	29.48	29.32	29.68
	Post	32.00	31.96	33.24	31.26
	Difference	2.60	2.48	3.92	1.58

TABLE III...MEAN PRE- AND POST-TRAINING VALUES OF THE MEASURED VARIABLES BY GROUPS, CONT.

VARIABLE		GROUP A 10 min.	GROUP B 20 min.	GROUP C 30 min.	GROUP D Control
Treadmill Test Variables Continued					
$\dot{V}_E/\dot{V}_{O_2}$ at 180 P.R. (1)	Pre	35.50	38.82	35.30	35.56
	Post	36.65	41.28	35.24	33.46
	Difference	1.15	2.46	-.06	-2.10
$\dot{V}_E/\dot{V}_{O_2}$ at Max. P.R. (1)	Pre	38.925	44.48	38.38	38.02
	Post	39.150	42.64	38.92	39.80
	Difference	.225	-1.84	.54	1.78
Respiratory Exchange Ratio at 180 P.R.	Pre	.9475	1.004	.942	.934
	Post	1.0025	1.026	.962	.940
	Difference	.0550	.022	.020	.006
Respiratory Exchange Ratio at Max. P.R.	Pre	.9975	1.018	1.004	.982
	Post	1.0450	1.042	1.010	1.034
	Difference	.0475	.024	.006	.052

References

1. Consolazio, C. F.; R. E. Johnson; and L. J. Pecors, Physiological Measurements of Metabolic Functions in Man, McGraw-Hill Book Company: New York, 1963, pp. 220-228.

2. Pollock, M. L.; Loughridge, E. E.; Coleman, B., Linnerud, A. C.; and Jackson, A. "Prediction of Body Density in Young and Middle-Aged Women," J. Appl. Physiol., 6:74 (1974).

3. Brozek, J.; Grande, F.; Anderson, J. R.; and Keys, A., "Densitometric Analysis of Body Composition; Revision of Some Quantitative Assumptions," N. Y. Acad. Sci., 110:113-40 (1963).

4. Clarke, H. H. and R. A. Munroe, Test Manual. Oregon Cable-Tension Strength Test Batteries for Boys and Girls From Fourth Grade Through College, University of Oregon: Eugene, Oregon, 1970, pp. 13-30, 55061.

5. Balke, B. and Ware, R., "An experimental study of physical fitness of Air Force personnel," U.S. Armed Forces Medical Journal 10:675-88 (1959).