

CR-134046

FINAL PROGRESS REPORT

Grant Number: NAS-9-9433 "An Evaluation of the Exer-Genie Exerciser and the Collins Pedal Mode Ergometer for Developing Physical Fitness."

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Period Covered by the Report: May 1, 1969 - August 31, 1973

This final summary report covers seven experiments that were conducted over a 52-month period beginning May 1, 1969 and ending August 31, 1973. Experiment I showed that isometric and isotonic training on the Exer-Genie gave negligible increases in cardiorespiratory fitness whereas training on the ergometer at a programmed pulse rate increased fitness moderately. In Experiment II it was found that either (a) exercising on the Collins Pedal Mode Ergometer at 160 pulse rate, ten minutes a day, five days a week, or (b) exercising on the ergometer at 85% maximum pulse rate, ten minutes a day, five days a week would promote moderate increases in fitness. Training in a supine position on the Exer-Genie at 160 pulse rate, twenty minutes a day, five days a week showed no significant change in fitness. In Experiment III, men 30-45 years old made moderate gains in fitness by exercising three or five days a week for ten minutes a day on a bicycle ergometer at a pulse rate of 85% maximum. A group which worked at this level on the ergometer for three days a week and two days a week on an Exer-Genie circuit made similar gains. In Experiment IV three exercise groups worked on a foot-mode ergometer for twenty minutes a day, three days a week at 85% maximum pulse rate. On the alternate days one group worked on a hand-mode ergometer for twenty minutes a day at 70% maximum pulse rate, a second group had the same schedule on a hand-mode ergometer at 85% maximum pulse rate, and a third group worked for twenty minutes a day on an Exer-Genie circuit. These groups made slight gains in strength and moderate gains in cardiopulmonary fitness. All the exercise groups in Experiment V made moderate gains in cardiopulmonary fitness. One group worked thirty minutes a day, three days a week on a hand-mode ergometer at 85% maximum pulse rate. A second group worked thirty minutes a day, three days a week on a foot-mode ergometer at 85% maximum pulse rate. A third group worked thirty minutes a day, three days a week on a Universal Gym. The subjects exercising on the Universal Gym gained in arm and shoulder girdle strength and the subjects exercising on the foot-mode ergometer gained in leg strength. A training program to increase both strength and cardiopulmonary fitness was the design of Experiment VI. The three exercise groups worked fifteen minutes a day, three days a week on a foot-mode ergometer at 85% of their maximum heart rate. Each group immediately followed this with an additional fifteen minutes of exercise: one group on a hand-mode ergometer, a second group on an Exer-Genie circuit, and the third on a Super Mini-Gym circuit. All groups made moderate cardiopulmonary gains but only the Exer-Genie and Mini-Gym effectively increased

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strength. Experiment VII showed that five days of bed rest or fifty hours of sleep deprivation caused drastic decreases in the cardiopulmonary fitness of highly trained subjects. Highly trained subjects who discontinued training lost fitness more gradually over a period of several weeks.

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Subjects used in these experiments were male volunteers. Baselines were determined on physiological variables by administering the following: (a) a medical examination, (b) anthropometric measurements, (c) a Physical Fitness Index Test, and (d) a stress test.

Each subject had a thorough medical examination including a six-lead EKG, a vital capacity test, and blood and urine analysis. The following anthropometrical measurements were taken: neck, chest, bicep, forearm, waist, thigh, and calf. A Physical Fitness Index (PFI) was obtained for each subject based on his: age, height, weight, vital capacity, grip strength, back strength, leg strength, and arm strength. In addition to the PFI, a strength quotient was derived from cable tension tests of shoulder extension, knee extension, and ankle plantar flexion.

Subjects were stress tested on a treadmill or bicycle ergometer at the beginning and end of each experiment. The physical work capacity of the subjects was monitored during the experiments by stress testing. During the stress test, the work load was increased at predetermined intervals. Pulse rate and blood pressure (systolic and diastolic) were measured manually at one-minute intervals. Pulmonary ventilation was measured and expired gas samples were collected at designated times throughout the test in order to determine cardio-pulmonary variables. The test was terminated at a predetermined pulse rate.

The twenty subjects in each experiment were divided into four groups of five each. In each experiment there were three groups that trained and a control group with subjects engaging in their normal daily activities without training. The data were analyzed statistically by analysis of variance and Duncan's Multiple Range tests on selected contrasts where indicated.

The treatment which the subjects received in each experiment and the results that were obtained are described below.

Experiment I

Two of the exercise groups trained on the Exer-Genie and the third exercise group trained on the Collins Pedal Mode Ergometric System. Group A trained six minutes a day, five days a week on a specified Exer-Genie circuit, Group B performed the same exercises on the Exer-Genie for twelve minutes a day, five days a week, but doubled the number of repetitions. Group C exercised on the ergometer at a programmed pulse rate increase for twelve minutes per day, five days a week. The training was not sufficiently strenuous to be very beneficial in increasing cardiopulmonary fitness; however, the subjects who trained on the ergometer made moderate gains. Strength measurements were not taken.

Experiment II

Group A trained on the Collins Pedal Mode Ergometer at a pulse rate of 160 beats per minute for ten minutes per day, five days per week. Group B also trained on the ergometer for ten minutes per day, five days a week, but at a pulse rate which was 85% of their maximum (mean, 169 beats/minute). Subjects in Group C, while lying on their backs, performed bicycling exercises with the Exer-Genie at a pulse rate of 160 beats per minute for twenty minutes per day, five days a week. The two groups exercising on the ergometer made moderate but comparable gains in cardiopulmonary fitness. The subjects exercising on the Exer-Genie in a supine position made negligible gains which were not significant at the 0.05 level.

Experiment III

The subjects in this experiment were 30-45 years of age. The subjects in all the other experiments herein reported were of college age. The groups trained as follows: (a) ten minutes a day, three times a week on a bicycle

ergometer at 85% maximum pulse rate, (b) ten minutes a day, five times a week on a bicycle ergometer at 85% maximum pulse rate, and (c) ten minutes a day, three times a week on a bicycle ergometer at 35% maximum pulse rate and two times a week on a specified Exer-Genie circuit. All training groups made similar moderate gains in cardiopulmonary fitness. A stress test administered 18 weeks post-training indicated that all training groups had reverted to their pretraining levels of cardiopulmonary fitness. Only one man was continuing to vigorously exercise on a regular basis.

Experiment IV

The three exercise groups trained on a foot-mode ergometer for twenty minutes a day, three days a week at 85% maximum pulse rate. For twenty minutes a day on the alternate two days of the work week, Group A exercised on a hand-mode ergometer at 70% maximum pulse rate, Group B exercised on a hand-mode ergometer at 85% maximum pulse rate, and Group C exercised on a seven-station Exer-Genie circuit. All training groups made moderate gains in cardiopulmonary fitness but only slight gains in strength variables. The post-training group means for time on the treadmill, oxygen consumption, and carbon dioxide production were comparable to those obtained in previous experiments.

Experiment V

All training groups exercised for thirty minutes per day, three days per week. Group A exercised predominantly the arm and shoulder girdle muscles on a hand-mode ergometer at 85% maximum pulse rate. Group B exercised predominantly the leg and trunk muscles on a foot-mode ergometer at 85% maximum pulse rate. Group C exercised all the major skeletal muscle groups on a Universal Gym. The subjects in this group completed a ten-station circuit three times during a training session. All training groups made moderate gains in cardiopulmonary

fitness and the training programs were found to be approximately equal in effectiveness. The group training on the foot-mode ergometer made a good gain in leg strength and the subjects exercising on the Universal Gym showed good gains in arm and shoulder girdle strength. As in previous experiments, cardiopulmonary variables tended to reach a peak at the end of the fifth week.

Experiment VI

The three training groups exercised fifteen minutes per day, three times per week on a foot-mode ergometer at 85% maximum pulse rate. Each of the groups immediately followed this with an additional fifteen minutes of exercise. Group A exercised on a hand-mode ergometer at 85% maximum pulse rate. Group B exercised on a seven-station Exer-Genie circuit and Group C exercised on a seven-station Super Mini-Gym. All three training programs were equally effective in giving moderate increases in cardiopulmonary fitness. The Exer-Genie and Mini-Gym gave increases in strength variables but the hand-mode and foot-mode ergometers had no significant effect on strength.

Experiment VII

The experiment consisted of two parts, training and stress. The training phase which lasted twelve weeks consisted of running approximately three miles per day, three days per week and working on a Universal Gym for thirty minutes per day, twice a week. The subjects were encouraged to exercise more than this and many did. The group means showed moderate increases in strength variables and highly significant increases in specific bicycle variables indicating good increases in cardiopulmonary fitness. Group A was stressed by being confined to bed for five days, Group B discontinued training, and Group C was deprived of sleep for fifty hours. A bicycle ergometer test indicated drastic decreases in cardiopulmonary fitness as a result of bed rest or sleep deprivation;

however, after two weeks post-stress these subjects had recovered about half of what they lost. Discontinuance of training caused a moderate and continued decline in cardiopulmonary fitness. Stress produced a negligible effect in strength variables. Cardiac output was found to remain relatively constant, regardless of the physical fitness of the subject, when the work load was held constant but stroke volume increased with training and decreased with deconditioning due to bed rest or sleep deprivation.

Detailed progress reports were filed with the National Aeronautics and Space Administration at the conclusion of each experiment.