

# THE USE OF THE PHYSICAL EFFICIENCY TESTS IN THE EVALUATION OF PHYSICAL IMPROVEMENT AFTER A MILITARY COURSE INVOLVING SEVERE PHYSICAL STRAIN

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Recently some precision has been introduced in the rather vague concept of physical fitness. Gallagher and Brouha (1) considered physical fitness in the following three categories :—

(a) Static fitness (b) Dynamic fitness (c) Motor skill fitness

Static fitness is simply absence of any disabling deformity or disease. Dynamic fitness is ability to perform strenuous physical work of an unskilled nature. Motor fitness is the ability to perform particular coordinated movements such as those involved in swimming, rope climbing, jumping and running and is measured by skilled performance tests.

Medical Laboratory workers recently defined physical fitness as cardiovascular, respiratory and chemical fitness in terms of the measurements usually obtained in the laboratory, without caring for ability to perform learned skills or muscular strength. To this group belong ventilatory tests such as Maximal Oxygen uptake, Vital capacity, Maximum Breathing Capacity and the recently introduced Expiratory Flow Rate.

The object of the present work was to see which of above mentioned criteria *viz* (a) Dynamic fitness test (b) Skilled performance tests and (c) Ventilatory measurements should be employed preferably for assessment of improvement in physical fitness after a strenuous military training programme of officers.

## Materials and Methods

35 officers between age of 21 to 27 years with high motivation and competitive spirit were selected for this study. They were examined before the start of the military course involving severe physical strain in March 1965 and at the end of the course in April 1965. The duration of the course was from 8th March 1965 to 9th April 1965 (34 days). Before the course a thorough clinical examination was done to see their Static fitness. Routine physiological data *i.e.* age, height, weight, chest expansion and abdominal girth were recorded for each subject before and at the end of course.

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For Dynamic fitness the step test developed by Brouha, Graybiel and Heath (2), in the Fatigue Laboratory of Harvard University, was selected. This test fulfills the criteria of a good test of Dynamic fitness and has the merit of simplicity. The subject steps up and down a platform 20" high, 30 times a minute for 5 minutes. Immediately after the exercise he sits down and his pulse rate is counted for the period 1 to 1 1/2 minute after the exercise. The rapid fatigue index (R.F.I) is calculated by following modification of the formula recommended by Johnson, Brouha and Darling (3)

Duration of exercise in secs. X 100

R.F.I. —————

5.5 X pulse count 1 to 1 1/2 minute after exercise.

Following ventilatory tests were employed :—

- (a) Vital capacity measured by dry flow meter.
- (b) Maximum expiratory flow rate measured by Wright peak flow meter.
- (c) Maximum breathing capacity measured by dry flow meter.
- (d) Maximum oxygen consumption. For this test subject was made to step up and down a platform 20" high 30 times a minute for 5 minutes. Total ventilation during the last two minutes of exercise was measured by dry flow meter and a sample of mixed expiratory air during this period was analysed by Beckman's Oxygen Analyser. The total amount of oxygen consumed per minute during this period was taken as maximum oxygen consumption.

For Motor skill fitness following performance tests were employed :—

- (a) Fireman's lift—In this test a subject has to carry another subject of equal weight for a distance of 100 meters as fast as he can.
- (b) Monkey Crawl—In it a subject has to climb a 12 feet vertical rope using hands and feet, traverse a 200 feet horizontal rope and descend a vertical rope using hands, legs and feet. Time taken for completion of the whole test is recorded.
- (c) Robber's Climb—In this the subject has to climb up on one side and then to descend down the other side of a ladder 30 meters high as quickly as possible. This test measures manual dexterity and strength.
- (d) Two mile run.
- (e) Eight mile walk.

For statistical analysis paired 't' test has been used to see any significant difference between the mean scores of individual tests before and after the course.

#### RESULTS

Rapid Fatigue Index, results of ventilatory tests and scores of performance tests before and after the course are shown in Tables I, II and III respectively.

TABLE I  
*Rapid Fatigue Index before and after the course*

Mean score before the course	Mean score after the course	Mean of difference	Standard error of difference	Value of 't'	Level of significance of difference
79.180	90.021	10.838	1.599	t 31=7.42	P < .001

TABLE II  
*Results of Ventilatory Test before and after the course.*

Test	Mean value before the course in litres	Mean value after the course in litres	Mean difference	Standard error of difference	Value of 't'	Level of significance of difference
Vital capacity (per sq.M)	2.2143	2.167	0.061	0.061	t 33=0.77	not significant.
Peak flow rate	333.2	334.9	1.79	2.344	t 33=0.145	not significant.
Max. Oxygen consumption.	3.381	3.443	0.067	0.125	t 22=0.536	not significant

TABLE III  
*Scores of performance Tests before and after the course*

Test	Mean time before the course in secs.	Mean time after the course in secs.	Mean of difference	Standard error of difference	Value 't'	Level of significance of difference
Fireman's Lift	25.426	20.033	5.393	.435	t 30=12.398	P < .001
Monkey's Crawl	25.825	12.85	12.975	1.289	t 23=10.066	P < .001
Robber's Climb	38.25	22.65	14.394	1.374	t 31=10.47	P < .001

*Two Mile race* : Before the start of course the mean time taken was 18 minutes. At the end of course the mean time of the race was 15.3 minutes. The difference is significant at  $p < 0.05$ .

*Eight Mile Walk* : The mean time before the course was two hours and after the course one hour twenty seven minutes. The difference is significant at  $p < .01$ .

### Discussion

Our subjects before the start of the training belonged to a group specially selected to undergo a tough course requiring highest degree of physical fitness, dexterity and coordination of muscles and mental alertness. For assessment of physical improvement after the course a battery of tests were used. Ventilatory tests consisting of vital capacity, peak flow rate and maximum  $O_2$  consumption performed in field before and after the course did not show significant change. The rapid fatigue index depending on recovery pulse rate after severe exercise of 5 minutes showed a significant change. Recovery pulse is a better criterion for assessment of physical fitness than ventilation rate, ventilation equivalent and metabolic ratio has been already shown in ordinary subjects by Gupta, *et al* (4). It appears that respiratory tests depending on pulmonary ventilation become still less useful in subjects who before the course were achieving high scores. Under these circumstances tests depending on recovery pulse after exercise proved more discriminative to assess improvement within and between subjects.

One possible cause is that peak and recovery pulse in early phase after severe exercise is wholly a function of haemodynamics and is beyond voluntary control. Ventilatory tests depend to some extent on motivation of the subject and the individual's technique of breathing. Some persons are averse to putting on masks on face, rubber piece in mouth or clip on the nose and as soon as these experimental procedures are applied to them their performance is affected and accurate estimation is difficult. In them recovery pulse test like one as has been used in this study is free from all such defects and has great advantage of being extremely simple and can be performed in the field.

Results of performance tests such as Monkey crawl, Robber's Climb, two mile run and eight mile walks showed highly significant results. This improvement is expected as the course consisted of tasks such as crossing the river on rope, climbing a steep precipice, jumping over deep ditches, which not only improve physical stamina but also help in increasing the dexterity and coordination of various groups of muscles. Needless to say that performance tests are much more interesting than the drudgery of climbing up and down the steps or blowing into various tubes and valves. These tests excite the competitive spirit of the candidates and bring out the best that they are capable of. Hence in evaluation of a course involving physical

strain of a few days or weeks such tests appear to be of great value.

### Summary

35 officers were subjected to step test, ventilatory tests and various performances tests before and after a strenuous military course. Results of Rapid Fatigue Index as computed by step test and various performance tests showed highly significant increase while no significant change was found in results of ventilatory tests. It has been concluded that physical fitness test based on recovery pulse after exercise and performance test can give better assessment of physical improvement than ventilatory tests in groups of persons, who at the start of a training programme already possess high degree of physical fitness.

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