

A MODIFIED PACK TEST OF PHYSICAL FITNESS

By Richard A. Kenney

(Professor of Physiology, Faculty of Medicine, University of Singapore)

Of the methods of testing physical fitness which are suitable for field use, the Harvard Pack Test (HPT) (Johnson, Brouha & Darling, 1942; Consolazio, C.F., Johnson, R.E. & Marek, E., 1951) and the Harvard Step Test (HST) (Brouha, Graybiel & Health, 1943) are the most popular. The work load imposed by the HPT is severe producing exhaustion in many subjects. The severity of the test limits its applicability and various modifications have been suggested to make it suitable for a wider range of subjects in particular women and young people. The HST is a less severe test in that no load is carried but the height of the step imposes a disability on subjects of short leg length or small stature. For application to women and boys, various modifications of step height have been proposed (Sloan, 1958; Gallacher & Brouha, 1943; Cullumbine, 1949; Weld, 1946).

The routine application of the HPT to fit young males in Singapore gave surprisingly poor results. The majority were unable to complete the required 5 minutes of work at the standard rate and those completing the test gave fitness indices quite out of keeping with the values expected from other objective tests of fitness. The subjects tested were Chinese, Indian and Malay and ranged in height and conformation from the tall rangy individual to the short and stocky. It appeared that if the test were to be made suitable for subjects of all races of the Singapore community, a considerable degree of modification would be required. The factors leading to the poor results were as follows:—

1. The 16" step height was too great for the majority of subjects and, in order to step at the required rate, many had to use a hopping type of "take-off".
2. The 16" step required stabilization of most subjects by hand grips and led to the adoption of a variety of techniques of getting on to the stool by using arm movements.
3. The load of 1/3 of the body weight approached the limiting value for muscle

force in extension of the leg as measured isometrically by dynamometers.

4. The motivational element was of considerable influence as the majority of subjects had reached a limiting heart rate after approximately 3 minutes of work and the fitness index derived reflected rather the subject's determination to continue than any physiological parameter.

It was decided therefore to attempt to devise a test which would be suitable for use in a multi-racial community. The following criteria for such a test were adopted:—

1. The test should require no special skill or training.
2. It should enable one to test a wide variety of subjects (in respect of age, sex, race, body size and conformation).

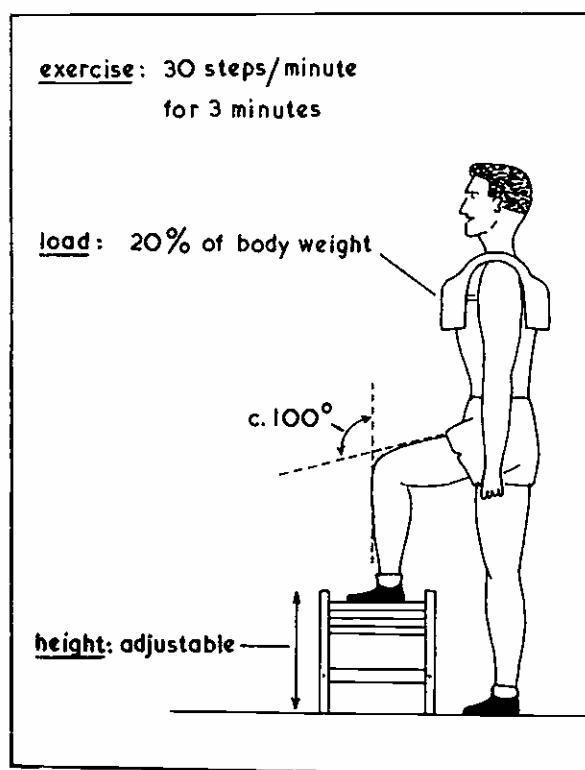


Fig. 1. Illustrating the salient features of the modified pack test.

3. It should be of a severity sufficient to produce an easily measured change in the heart rate yet not so severe as to prevent the "average" person from completing the test.
4. It should produce indices in general agreement with other objective assessments of fitness.
5. It should be capable of differentiating relatively small degrees of difference of fitness.
6. It should require the minimum of simple equipment.

Criterion 1 above can best be met by using stepping on and off a stool as the basis for the test. Criterion 3 can be met by using a load of 20% of the body weight; a load of this magnitude can be carried by women and young children as well as by men. With the subjects carrying 20% of their body weight, 3 minutes of exercise produces adequate changes of heart rate without producing such exhaustion as to make intense motivation essential for completion of the test. It was decided to define the height of the stool by the angle of flexion at knee and hip during stepping. An angle of 80° of flexion was chosen so that the extensor muscles would be working at mechanical advantage. With the stool height so defined, the subject is able to step with a flat-footed technique (*i.e.* does not *need* to "kick" off when stepping on to the stool) and the stepping can be done without hand holds for stabilization.

THE TEST

Equipment required:—

1. A stool of adjustable height. This is conveniently constructed of 4 corner pieces of angle iron, mounted solidly on a base, into which can be dropped boards, one inch thick, to give the required height of step.
2. A "pack" consisting of a strip of canvas with a hole through which the head can pass and fitted with a pocket at each end so that weights may carry fore and aft. Small pads of foam rubber under the shoulder-pieces prevent chafing and discomfort.
3. A set of iron weights; circular weight-lifters weights are suitable with the

addition of small weights of one pound denomination.

4. A "blackboard" type protractor fitted with a movable arm of perspex for measuring the angle of flexion at the knee. Both the base-line of the protractor and the movable arm are fitted with flat plates for application to the anterior surfaces of the leg.
5. A stop watch.
6. A tally counter.
7. A bathroom type weighing machine.

PROCEDURE

The subject stands erect in front of the stool and places one foot flat on the top surface so that the lower leg is perpendicular to the stool. The angle between the anterior surfaces of upper and lower leg is measured by the protractor and boards added to or removed from the stool until the external angle at the knee is as near to 100° as possible.

The subject is then weighed and the load to be carried (20% of the body weight) calculated to the nearest pound. Weights to make up this total load are divided between the front and rear pockets of the "pack".

The subject dons the pack and then steps on and off the stool at the rate of 30 times per minute for 3 minutes. The cadence is counted by the observer and the subject instructed that he must straighten his legs when he steps onto the stool. At the end of the 3 minutes of exercise or when the subject can no longer maintain the required rate of stepping, he sits down and the pack is quickly removed. The number of steps completed is noted. 90 seconds after the completion of exercise, pulse counting begins and the heart rate for the minute beginning at 90 seconds after exercise is recorded.

The index is calculated as:—

$$\frac{\text{Steps taken (90)} \times 100}{\text{Heart rate 90-150 secs}}$$

A nomogram is given (Fig. 2) relating heart rate observed and steps taken to index. Table I giving values for the index at observed heart rates from 60-149 can be used for subjects who complete the required 90 steps.

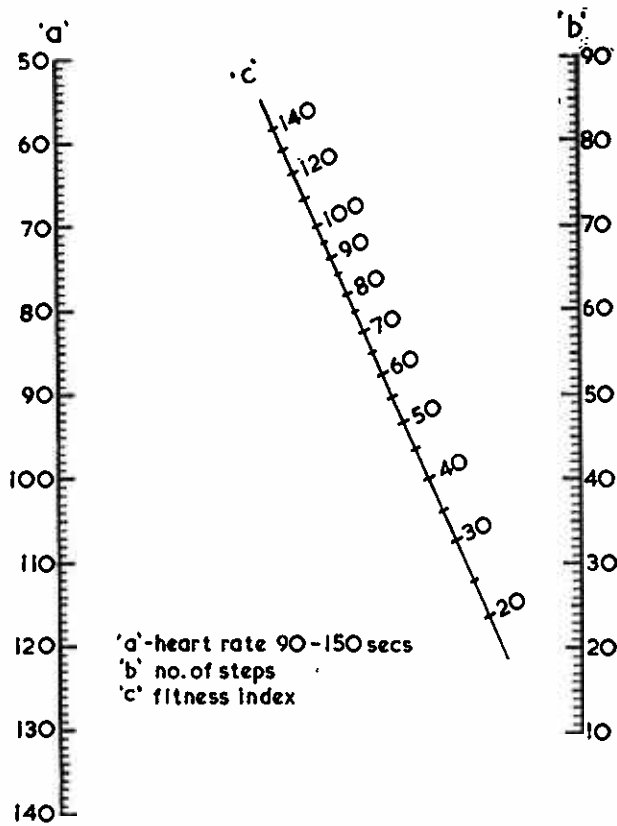


Fig. 2. A nomogram for the calculation of 'fitness index' from the number of steps Taken (scale b) and the heart rate measured over the period 90 — 150 seconds after completion of the exercise (scale a). A straight line joining the observed values on 'a' and 'b' cuts scale 'c' at the value of fitness index.

The test has been applied to subjects ranging in age from 12-45, of various races (Malay, Indian, Chinese, Gurkha, European) and of

various degrees of activity and training. The results obtained are illustrated in Fig. 3. The subjects, regardless of race, have been classified as *athletic* (those taking part in regular organized sports), *active* (those who play games or take other exercise regularly but do not train specially) and *inactive* (those who play no games nor take regular exercise).

TABLE I

	0	1	2	3	4	5	6	7	8	9
60	150	148	145	143	141	138	136	134	132	130
70	129	127	125	123	122	120	118	117	115	114
80	113	111	110	108	107	106	105	103	102	101
90	100	99	98	97	96	95	94	93	92	91
100	90	89	88	87	87	86	85	84	83	83
110	82	81	80	80	79	78	78	77	76	76
120	75	74	74	73	73	72	71	71	70	70
130	69	69	68	68	67	67	66	66	65	65
140	64	64	63	63	63	62	62	61	61	60

Relating observed heart rate (90 — 150 seconds after exercise) to fitness index. The heart rate values on the extreme left-hand column and the top row of figures locate the 'box' containing the fitness index value.

Results obtained on 140 subjects suggest that the test provides a valid indication of relative fitness over a wide variety of subjects and appears to meet criteria 2, 4 and 5 set out above.

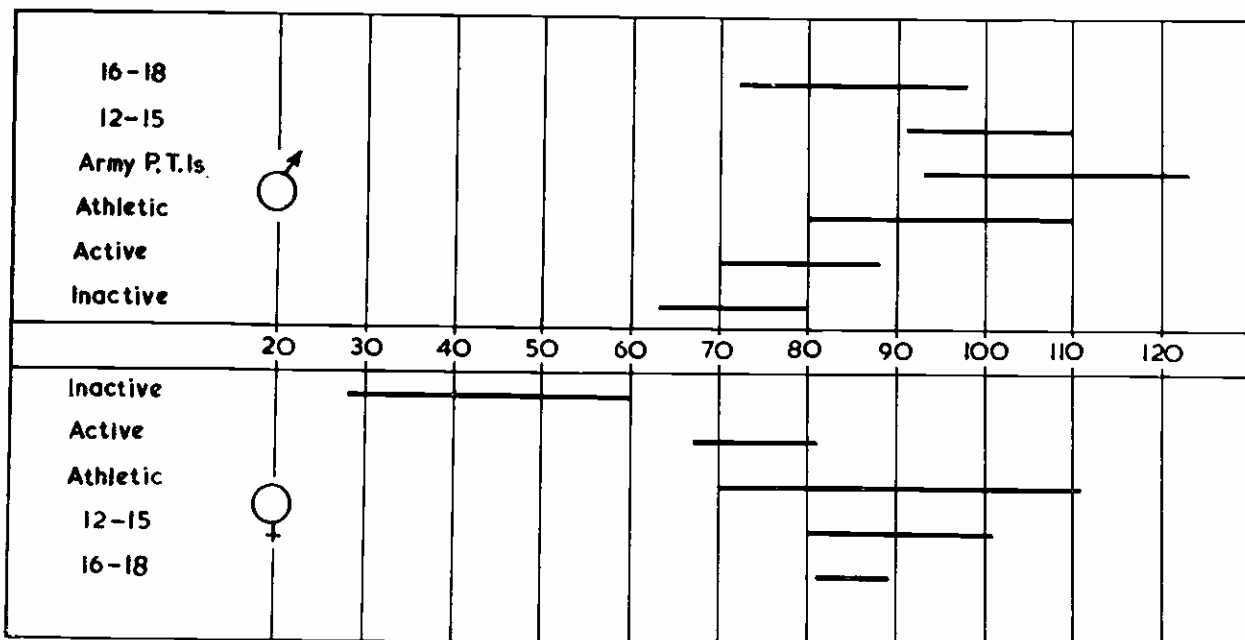


Fig. 3. Illustrating the values obtained on a multi-racial group of subjects classified by age (12-18 years) and by activity for older subjects (age range 19-45 years).

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