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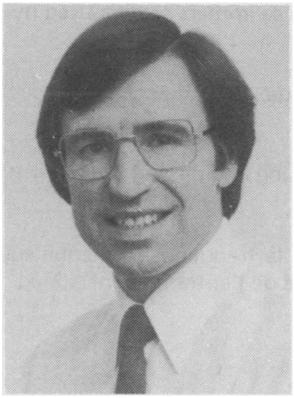

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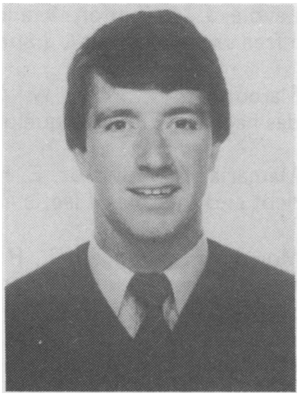

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PHYSICAL WORKING CAPACITY AND MILE RUN PERFORMANCE IN ADOLESCENT BOYS

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ABSTRACT

The degree of generality between the endurance characteristics of the one mile run and PWC170 tests was examined with a group of fifteen year old boys who performed both tests once a week for three weeks. A significant improvement in performance of both tests was found between trials 1 and 2, which was sustained between trials 2 and 3. These results suggest that norm scales regarding performance in both tests should be based on the average of at least two trials following a practice trial. The results of the present study also suggest that when average scores are used, rather than single scores, the amount of generality between the endurance characteristics of the one mile run and PWC170 test is high enough to allow physical working capacity to be predicted fairly accurately from performance in the one mile run.

Key words: Physical working capacity, Running, Boys.

INTRODUCTION

It is generally accepted that tests of maximum oxygen uptake ($M\dot{V}O_2$) and physical working capacity (PWC) are valid tests of cardiorespiratory or general endurance (Åstrand and Rodahl, 1977). However, these tests are impractical for mass testing in terms of the amount of time, equipment and administrative expertise which are required. Consequently, a number of attempts have been made to develop tests of general endurance based on running performance rather than physiological variables (Shephard, 1982). There is a wide variation in the correlations which have been reported between running performance (distance-based and time-based tests) and labo. atory tests of general endurance ($M\dot{V}O_2$ and PWC). A number of researchers have suggested that differences in the motivation of subjects and in the ability of subjects to pace themselves in running tests are largely responsible for the variation in the correlations which have been found between the two types of tests (Krahenbuhl et al, 1978; Martens, 1978; Johnson et al, 1979).

The problem of pacing in running tests can be overcome to a certain extent by allowing sufficient practice prior to testing. However, in any given testing situation, provided that the test environment and the amount of practice are similar for all subjects, there is one other factor, in addition to motivation and pacing ability which is likely to affect the observed relationship between the endurance characteristics of a running test and some other test, i.e., the nature of the scores which are used to derive the correlation between the tests. As Williams (1978) points out, with regard to any particular test, an average score over a number of trials is a more accurate measure of an individual's true performance than a single score (i.e., a single trial or best score over a number of trials). The use of a single score does not take into account the sampling error of an individual's performance about his own true score.

Consequently, the use of average scores rather than single scores should give a more accurate assessment of the relationship between any two performance variables. The purpose of the present investigation was to examine the relationship between physical working capacity and one mile run performance when average scores as well as single scores were used to assess the amount of generality between the endurance characteristics of the two tests.

METHODS

The subjects were 28 healthy boys from a local secondary school (age, 15.8 ± 0.25 yr; Wt, 59.8 ± 7.2 kg; Ht, 172.2 ± 7.4 cm). At the start of the study it was intended to use all the boys from two classes within a single year group (n = 32). However, two boys were excluded due to ill health before testing began, and two boys were unable to complete all phases of the study due to illness and injury unrelated to the experimental conditions.

Each week, for three weeks, the subjects were required to run one mile as quickly as possible and to undertake a PWC170 test. The one mile run was chosen in preference to other running tests since it is easy to administer and was recommended in 1980 by AAHPERD as a test of general endurance for use in schools. No practice was given in each test prior to testing so that the effect on performance of simply repeating each test could be examined. The one mile run and PWC170 test were carried out on separate days at approximately the same time each week. All testing was carried out at least two hours after the last meal and none of the subjects had participated in any strenuous physical activity earlier in the day prior to the testing sessions. The purpose of the project was fully explained to the subjects before any testing took place, and in terms of the interest shown in test results, the motivation of the majority of subjects seemed to be quite good throughout the testing period.

The one mile runs were performed on a 440 yards "blaes" artificial surface running track and all of the subjects started together. Four student teachers of physical education were involved in encouraging the subjects to keep running at a moderate pace and in counting the number of laps completed by the subjects. The finish was indicated by a roped tunnel erected on the outside of the track in order to separate the finishers from those who were still running. As each subject entered the tunnel his time was recorded and he was given a numbered card which showed the position in which he finished the run. When everyone had finished, the names of the subjects were entered onto the time sheet as the numbered cards were collected. During the three running trials, the running surface was firm and the weather conditions were similar, dry with the temperature ranging between 11° and 13° C.

The PWC170 test, including the calibration of the cycle ergometer and standardisation of saddle height was carried out according to the procedures established by Howell and McNab (1968). Each subject was required to pedal a Monarck cycle ergometer for twelve minutes, four minutes at each of three progressively heavier work loads. At the start of each testing period, the subject sat on the ergometer and, if necessary, the pendulum scale was adjusted to zero. A metronome was then set at 120 (60 revolutions of the pedals per minute) and the subject was allowed sufficient time to adjust to the pace with no load. When the correct pace was achieved the first work load was set and a stop clock was started simultaneously. At the end of the fourth and eight minutes of work, the work load was increased. Using a stethoscope placed on the chest wall and a stop watch, the heart rate of the subject was measured during the period of 3½ to 4 minutes at each work load by measuring the time taken for 30 heart beats. The size of the increases in work load for the different subjects were based upon the heart rate response to the first work load according to the recommendations of Howell and McNab (1968). The work load:heart rate data for each subject was used to calculate a least squares equation which was solved for a heart rate of 170 $b.min^{-1}$.

RESULTS

The means and standard deviations of the group performance in the one mile run and PWC170 test are shown in Tables I and II.

TABLE I

Means and standard deviations for one mile run performance (males)

Source	Age (yr)	n		One mile run (s)
Present study	15.8	28	week 1	403.7 ± 33.1
			week 2	381.9 ± 34.3
			week 3	374.0 ± 28.4
			average†	386.5 ± 30.1
AAHPERD (1980)*	15			434
	16			431
South Carolina*	15			426
AHPER (1977)	16			427

*50th percentile
†based on average of three trials

In the one mile run four subjects produced their best performance in week 2 and twenty-four subjects in week 3. The reliability coefficients obtained for the one mile run were r = 0.91 and r = 0.94 between the first two and last two weeks respectively. These coefficients are similar to those obtained by Maksud and Coutts (1971) with a group of 11-14 year old boys (r = 0.92) and by Doolittle and Bigbee (1968) with a group of 15 year old boys (r = 0.94) on a twelve minute run for distance. With respect to the PWC170 test, five subjects produced their best performance in week 1, twelve in week 2 and eleven in week 3. The reliability coefficients for the PWC170 test were r = 0.89 and r = 0.95 between the first two and the last two weeks respectively. These values are similar to those obtained by Mocellin and Wasmund (1971) with a group of 13-14 year old boys (r = 0.94) and by Watson and O'Donovan (1976) with a group of 12-18 year old boys (r = 0.98).

TABLE II

Means and standard deviations for performance in PWC170 test (males)

Source	Age (yr)	n		PWC170 (W)	PWC170 ($W.kg^{-1}$)
Present study	15.8	28	week 1	141.6 ± 29.0	2.38 ± 0.49
			week 2	149.4 ± 26.3	2.52 ± 0.48
			week 3	148.1 ± 24.3	2.48 ± 0.48
			average*	147.1 ± 26.3	2.47 ± 0.46
Howell & McNab (1968)	15	80		120.9 ± 29.1	2.09 ± 0.45
	16	92		139.3 ± 31.3	2.19 ± 0.48
Lockwood et al (1977)	15	139		142.7 ± 36.6	2.50 ± 0.58
	16	133		148.3 ± 37.8	2.38 ± 0.55

*based on average of three trials

Due to interindividual variations in body size, especially during puberty, it is a standard procedure to express values for physical working capacity in terms of unit body weight (Shepherd, 1982). Table II shows the results of applying this procedure to the present data. The intercorrelations between performance in the mile run and PWC170 test are shown in Table III. It is clear that the weekly correlations between the mile run and $PWC170.kg^{-1}$ were very similar to those between the mile run and the absolute PWC170 measures. All of the weekly correlations were higher than those reported in other studies in which the relationship between performance in various running tests and the PWC170 test was investigated; see Table III. The correlations between the mean performance of three trials of the subjects in the mile run and PWC170 test were r = –0.79 and r = –0.85 for the absolute and weight related PWC170 respectively.

DISCUSSION

It is necessary to proceed with caution when comparing results of physical fitness tests reported from different sources. Such comparisons are often very tentative since it is most unlikely that the compared studies will be similar with regard to the major variables which affect performance in a test, viz., the choice of subjects, the motivation of subjects, the test protocol, the environmental conditions, the amount of practice given prior to testing and the number of trials given. With these reservations in mind, the group mean one mile run performance in week 1 was higher than the results reported by South Carolina AHPER (1977) and AAHPERD (1980) for boys of similar age; see Table I. It is not possible to say whether these findings reflect a definite superiority of the present subjects over their American counterparts.

TABLE III

Correlations between performance in the PWC170 test and various running tests (males)

Source	Age (yr)	n		r a	r b	Running test
Present Study	15.8	28	week 1	–0.67	–0.71	1 mile
			week 2	–0.62	–0.77	1 mile
			week 3	–0.69	–0.70	1 mile
			average*	–0.79	–0.85	1 mile
Thompson et al (1975)	12-14	261			–0.29	600 yd
					0.32	12 min
Burke (1976)	17-30	44			–0.44	1 mile
					0.60	12 min
Martens (1978)	10-12	17			–0.30	1 mile

a PWC170
b $PWC170\ kg^{-1}$
* based on average of three trials

With regard to performance in the PWC170 test, no significant differences ($p < 0.05$) were found between the results obtained in week 1 and the figures reported by Howell and McNab (1968) for 16 year olds and those reported by Lockwood et al (1977) for 15 and 16 year olds. It should be pointed out that in these studies, no practice was given prior to testing and the same PWC170 test protocol was used as in the present study.

A significant improvement in performance ($p < 0.05$) in both the mile run and PWC170 test was found between weeks 1 and 2, and between weeks 1 and 3. However, no significant difference in performance was found between weeks 2 and 3 for both tests. The sustained improvement of the subjects in both tests in weeks 2 and 3 was presumably due to habituation and learning, since it is most unlikely to have been due to any fitness training effect between weeks 1 and 2 (Mocellin and Wasmund, 1972; Shephard, 1982).

The intercorrelations between the one mile run and PWC170 results were higher than those reported in other studies; see Table III. Since the weekly correlations in the present study were all greater than r = 0.6, the low correlations found in the other studies are difficult to explain. As mentioned earlier, differences in motivation and pacing ability may account for the low correlations found in some studies. In addition, there is a tendency to find low correlations when the subjects are fairly homogeneous with respect to the variables under consideration. Another possible reason for the low correlations in the other studies may be due to the fact that only one trial was given in each test. As mentioned earlier, by using single scores, no account is taken of an individual's sampling error about his own true score. Furthermore, there is little doubt that in a one trial the factors of habituation and learning will affect the performance of some individuals more than others to the extent that the true relationship between variables may be masked. In the present study the weekly correlations between PWC170.kg^{-1} and mile run were fairly consistent, i.e., between $r = -0.70$ and $r = -0.77$ but the correlation between the mean performances over three trials was $r = -0.85$ which represents a high proportion (72%) of shared variance, i.e., generality, between the endurance characteristics of the two tests. The least squares regression equation based on the correlation of 0.85 was $Y = 7.495 - 0.0129X$ where Y = predicted PWC170.kg^{-1} (W.kg^{-1}) and X = performance in mile run (mean of three trials, sec). The standard error of the estimate was 0.2435 W.kg^{-1}, i.e., 9.8% of the mean PWC170.kg^{-1}. On this basis, the degree of accuracy in predicting PWC170.kg^{-1} from performance in a one mile run would seem to be acceptable, at least for the purposes of placing individuals into fairly broad fitness categories.

To summarise, the one mile run and PWC170 tests were found to be fairly reliable and in agreement with the findings of earlier studies. The sustained improvement in performance of the present subjects on both tests in weeks 2 and 3 suggests that normative scales regarding performance in these tests should be based on the average of at least two trials following a practice trial. Finally, the present results suggest that when average scores over a number of trials are used, rather than single scores (single trial or best score), the amount of generality between the endurance characteristics of the one mile run and PWC170 test is high enough to allow physical working capacity to be predicted fairly accurately from performance in the one mile run.

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To the Editor:

Dear Sir,

HOMEOPATHY IN SPORTS INJURIES?

Earlier this year I went to a meeting in Liverpool, where the use of homeopathic medicine in the sporting context was discussed.

I was interested if sceptical in the ideas presented, but since then a personally conducted if limited trial has given surprisingly good clinical results, and a uniformly enthusiastic response from the sportsmen (and women) involved as regards efficacy and lack of side effects.

More recently, after a talk on the Problem of Drug Abuse in Sport, at our local hospital, I raised the question of using homeopathic preparations for sportsmen with the Speaker, the Assistant Director of the Drug Control Centre in London.

The suggestion was met with some amusement, but I was assured that such treatment would not contravene any of the present Drug Control regulations.

The preparations I have found most useful are Gelsemium (or Argent.Nit. if there is an element of "tummy upset") for pre-match nerves; Arnica for intra-match or immediate post match bruising and soft tissue damage; and Rhus.Tox. for "next day" aches and pains.

Cuprum Metallicum is good for cramp either during or just after the event.

All these preparations in potencies of 6 or 30 (equivalent to dilutions of 10^{-12} and 10^{-60}) are quite safe for use by non-medical personnel, and could be part of a club's First Aid Kit.

I cannot find reference to a trial of this sort of "drug" in a sports context and I wondered if any of your readers would be interested in taking part in such a trial. The homeopathic treatment (which is inexpensive and easily obtained) would of course, be combined with the usual ICE treatment and/or physiotherapy but no other "conventional" drugs would be used.

Yours sincerely,

H. SELCON, MB, ChB