THE FITNESS ASSESSMENT OF COMPETITIVE CYCLISTS

by

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Introduction

Although competitors in such sports as swimming and athletics, have been enrolled to help in studies of training techniques, physique, health and fitness, those in many other sports have received little attention in Britain. To the applied physiologist the racing cyclist provides an interesting study. His event can be simulated in the laboratory with the bicycle ergometer; training and competition are often solitary; the effects of gravity are largely eliminated; competitors and officials are anxious to co-operate and there is little problem concerning transport to the laboratory. To the average cyclist, training methods that are well known to the athlete and swimmer are entirely strange, but a few are now attempting circuit, weight and controlled interval training. Although these methods are still regarded with suspicion, they are at least being discussed widely. This paper presents an attempt to assess, prior to a training programme, twenty-four cyclists, selected by officials of the British Cycling Federation.

The work has been conducted as a joint project between various members of the Loughborough Colleges, and while the responsibility for the contents of this article is with the authors named above, the work has been carried out by several individuals. The somatotype and bodily measurements were conducted by P. R. M. Jones and P. G. Stone of the Physical Education and Industrial Fitness Unit; the work-output and oxygen-uptake measurements were made by E. J. Hamley and M. G. Parr of the Ergonomics Department in the College of Technology. The fitness tests used in calculating Roger's and other indices were carried out by J. Archer and J. Mallea; the supervision of the questionnaires and the handling of the assessment forms was by J. Archer and P. Mitchell, and the clinical information and orthopaedic assessment was collected by

H.E. Robson, all of the Physical Education Department of the Training College.

Material and Methods

Twenty-four cyclists were invited to participate in the initial testing, and to return for subsequent assessments. There were thirteen males and eleven females, all of whom had participated, or might be chosen for international competition. Ten men and ten women were classified as road-race competitors; one man and one woman specialised in Pursuit events; one man in cyclo-cross and one in tandem-sprint events.

The examinations carried out fall into five groups.

1. Clinical, orthopaedic and general.
2. Anthropometry.
3. General tests of physical fitness.
4. Work output studies on the bicycle ergometer
5. Questionnaire upon training methods, etc.

Group 1. Clinical, orthopaedic and general - subjective observations were specifically noted of the skin, especially for acne and evidence of allergic reactions, vertebral column, and deviations from the normally accepted posture, lower limb defects - knock knee, varicose veins, hallux valgus, flat foot, nervous system reflexes, co-ordination; further assessments were made from photographs posed especially to show up defects. Cardiovascular examination was of heart sounds, pulse blood-pressure, resting electrocardiograph, haemoglobin (M. R. C. Wedge haemoglobinometer). Respiratory examination comprised percussion, breath sounds, chest movements, smoking habits, vital capacity (Parkinson Cowell Dry meter). A general assessment was made of digestive system; condition of abdomen, hernial orifices; genito-urinary system:- urinalysis for the elimination of glycosuria and albuminuria (Amer. Co. test strips, "Clinistrix" and "Albustrix") and where appropriate, menstrual and obstetrical history was noted.

Group 2. Anthropometry - measurements were made of height, weight, fat-fold thicknesses and other parameters and the method described by Tanner 1964, for the calculation of the somatotype. This aspect of the work will be reported in detail in a later publication.

Group 3. General tests of Physical Fitness

The three main facets investigated were:-

- A. Strength
- B. Power
- C. Endurance

A. Roger's Physical Fitness Index. This is a standard test battery in many institutes in America. Absolute values in the constituent tests are calculated with allowances made for height, weight and age. The tests are:- number of "chins" to a horizontal bar, number of "dips" on the parallel bars, leg, back and grip strengths measured on dynamometers, and the vital capacity. Modifications are permitted in two tests, "chins" and "dips", to adapt these for females, but our results indicate these may not be necessary when examining female athletes.

B. Power. A standing vertical jump was measured; "reach-height" being assessed by touching the Sargent Jump board with both hands, the highest score out of three jumps being recorded.

C. Endurance. The Harvard Step Test, as modified for use in the Olympic Medical Archives, 1964, was used. All competitors except the three shortest women were tested on a 20" high bench, 150 steps in 5 minutes. Pulse counts were made during the recovery period from 1 - 1½, 2 - 2½, 3 - 3½ minutes.

$$\text{Harvard Fitness Index} = \frac{\text{Duration of Exercise (in seconds)}}{2 \times \text{Sum of three } \frac{1}{2} \text{ minute pulse counts}}$$

Group 4. Work Output on Bicycle Ergometer The standard Dortmund bicycle ergometer was used, with an automatic cam device to give increasing work loads commencing at 5 kilogram metres per second until the subject reached exhaustion, at about 25 kilograms per second. Cardiovascular changes were assessed before, during and after the exercise by a direct-writing electrocardiograph. Respiratory data were obtained simultaneously using a Max Planck Institute spirometer with face-mask, to measure expired air, coupled to a Beckman oxygen analyser. From these data the relationships of Work-load to Heart-rate and to Oxygen-uptake provided an indication of mechanical efficiency of work. This had an additional advantage of providing known Work-loads in a context similar to the sport being studied. Throughout these assessments the bicycle ergometer was set at a pedal rate of 90 r. p. m.

Group 5. Questionnaire. Printed questionnaires, were designed in consultation with the British Cycling Federation and were sent out by the B.C.F. to all 24 subjects, and to selected additional cyclists of equivalent status and performance. A sample questionnaire appears as an appendix; the analysis of data obtained will be published later.

Results

The clinical examinations and orthopaedic assessments showed that the cyclists generally had poor posture; round shoulders and a forward head carriage were common, often amounting to slight but definite kyphosis, frequently with compensatory lumbar lordosis. Slight but detectable degrees of scoliosis were also common.

Table 1

Incidence of spinal defects amongst cyclists.

	Kyphosis and Round Shoulders	Lordosis	Scoliosis
MALE N = 13	9	5	8
FEMALE N = 11	6	2	4
TOTAL N = 24	15	7	12

Minor foot and leg conditions were also common. Four men and one woman had varicose veins, none of which had so far given rise to thrombosis or ulceration, but sometimes became painful or irritable after prolonged cycling.

Table 2

Incidence of leg and foot defects amongst cyclists

	Knock Knee	Bow Leg	Hallux Valgus	Flat Foot	Claw Foot
MALE N = 13	4	1	1	2	1
FEMALE N = 11	3	0	3	0	0
TOTAL N = 24	7	1	4	2	1

Smoking habits showed a change from the period of the 1958 Empire and Commonwealth Games (Robson, H. E. 1959). Only two of the present series smoked - one woman, less than five cigarettes a day; one man, classed as a heavy smoker (over eleven cigarettes daily), who has since given up smoking altogether.

Gross anthropometric data are summarized in Table 3, and illustrate the great range both of size and age of the sample group. This is normal in this sport.

Table 3

Age, Height and Weight of 24 cyclists - 13 Male, 11 Female.

		Range	Mean
AGE	Male	20 yr. 4 mths. - 32 yr. 7 mths	24 yr. 4 mths.
	Female	21 yr. 0 mths. - 31 yr. 11 mths.	25 yr. 4 mths.
HEIGHT	Male	67½ ins - 73½ ins.	70½ ins.
	Female	58 ins - 69½ ins.	64½ ins.
WEIGHT	Male	140 lbs. - 191 lbs.	160 lbs.
	Female	104 lbs. - 170 lbs.	131 lbs.

The various components of the Roger's Physical Fitness Indices showed the expected variations, and will not be presented in detail. There was some general weakness in the arm strength, but leg strength generally was nearer the average for athletes. The Harvard Step Test (Endurance) Index showed better results.

Table 4

Rogers (strength) and Harvard (endurance) Fitness Indices, and Sargent Jump (power)

	Components of Rogers P. F. I.			P F. I. Index	Sargent Jump in ins.	Harvard Index
	"Number" of "Chins"	"Number" of "Dips"	Leg strength in lbs.			
Male Range Average N = 13	0-13 Av. 4.	0-27 Av. 9.	690-1530 Av. 1157lbs.	65-116 Av. 90	14½-24½ Av. 19½ins	80-149 Av. 107.
Female Range Average N = 11	2-21 Av. 11	1-22 Av. 9½	410-1660 Av. 1013lbs.	91-174 Av. 127.	13-18½ Av. 15½ins	57-149 Av. 90.
	Modified for female subjects			Two components modified for female subjects		N = 8

A scatter gram, Fig. 1, showing the inter-relationship of the Rogers Physical Fitness Index (two components modified for women) and the Harvard Index shows no correlation. This may be due to the varied demands in the two tests and to the very wide differences in training progress of the performers.

Figure 1

INTER RELATIONSHIP BETWEEN ROGERS P.F.I. AND HARVARD
STEP TEST

Work-output and oxygen-uptake assessments; performances on the bicycle ergometer at the first visit showed two clear subgroups: those capable of higher work rates at better efficiency and those with poor work capacities. Poor work-capacities showed up in (1) lower maximum work-load values being reached: 21 kilograms per second instead of values over 25 kilograms per second, (2) higher heart-rates for given work-loads resulting in steeper slopes for the work-load for heart-rate correlation, and (3) higher expired-air oxygen analyses indicating less efficient oxygen-uptake: 17.3% oxygen is expired air compared to less than 16.3%. No differences in values were found to be related to sex or height of the performer but those performers who indicated in the questionnaires and in conversation that they had followed a detailed and intensive fitness programme gave values indicating not only higher efficiency in the correlations of work-load with heart-rate and oxygen-uptake but also reached maximum work-loads between 25 and 30 kilograms per second. Fig. 2 illustrates the average condition calculated from the 24 performers.

Figure 2

Correlation of Work-load with Heart-rate and with Oxygen-uptake

Discussion

This article presents a preview of information being collected on a select group of cyclists. Several aspects of this preview are not only parts of a continuing programme but are sufficiently specialised to require separate papers being presented later.

The clinical and orthopaedic data have been evaluated in greater detail than other data since these are not parts of a periodic series of tests. The high incidence of minor orthopaedic defects is of interest. Slight degrees of scoliosis are found frequently amongst athletes and it is without significance. Kyphosis appears to be of more significance, especially upon aesthetic grounds. The frequency of Lordosis is significant as it is associated with backache, and the development of osteoarthritis. Certainly backache is a frequent complaint in the groups of club competitors we have seen from time to time. While no attempt has been made to correlate this information with the various fitness indices it should be noted that this sport may be specifically associated with these postural characteristics. We suggest that a "sports medicine" programme might with advantage examine the orthopaedic aspects of this sport.

It is reasonable to raise a few points of interest from the results obtained at the initial tests. While no full analysis of the data is possible it has become obvious that in such standardized tests as the Rogers P. F. Index and the Harvard Index most of the female cyclists recorded misleadingly high scores. These tests provide many modifications in their schedules to make them easier for women. In a number of cases we have not used the modifications and yet obtained comparable results with both sexes. For example the highest leg strength was scored by a woman, and one of the highest Harvard Indices was scored by a woman using 20 inch bench as used by the men. The high scores of the women in the Rogers Index could not be attributed only to the modifications which we retained of the "chins" and "dips", as these account for not more than 15% of the index. According to other standards such as those set out for the Olympic Medical Archives, one man would be classified as "high average", one as "efficient" and the other eleven as "highly efficient". On this scale, two women would classify as "low average", two as "high average" two as "efficient" and two "highly efficient". In contrast the three women of short stature, finding the 20 inch bench too high were tested on the 14 inch bench recommended for women. With this modification, all three came into the "highly efficient" category, i. e. 90 or over. Since this is based on data collected early in the training season, it indicates the inadequacy of the scales suggested by the "Archives" for this type of athlete.

The information obtained from the respirometer and bicycle ergometer confirms this overall impression. At the first assessment oxygen-uptake was low; maximum work-loads reached were low and the efficiency curves for heart-rate to work-load were steep. These confirm the impression that 'fitness' was quite normal for what one expects in early training. Similarly the results collected in this assessment permit no simple division between the sexes. In general more women reached maximum work-loads below 25 kilogram meters per second but the other criteria showed no such bias. Accordingly, we feel that with athletes of this type and in this sport the tests should be used directly without modification for both men and women. Possible differences due to sex should be considered when interpreting the indices scored. Obviously this will require, in the long term, a thorough analysis of a sufficient mass of data from which to reconstruct and validate appropriate tables, but in the interim we see no justification for continuing with misleading results, nor of adopting a scale of scores related to percentages.

Although the questionnaire has yet to be analysed in detail, several points have emerged about the training habits of cyclists who returned forms to the British Cycling Federation. Generally, there is an empirical approach to training. Analysis of success, failure, or lack of progress is not based upon a critical assessment of the training routine. The cyclist appears to be more concerned with the machine, technique and supplements to diet than with the hardcore of basic fitness and specific fitness for the various distances. Training does not appear to be based upon the principle of progressive over-load and the work-output for a given session varies greatly and frequently is an unknown quantity; only rarely is a detailed log kept of work done. Training off the bicycle for basic fitness (circuit/weight training) does not seem to take place in the winter season lay-off. 'Miles covered' appears to dominate the approach to training and although this has an important place miles per hour are seldom considered. There is too much overlap between club cycling as a social activity and the specific training required for competition. Obviously tactics are a vital element in racing but they are confused with training for fitness. In most other sports fitness training for competition is an individual activity.

These points guide us to suggest that cyclists and their coaches could learn much by studying the training methods of other sports where there are many basically similar problems. The adoption of such athletic training techniques as interval training and progressive heavy work-load sessions could be very rewarding. At the competition level of cycling it would appear that there still persists the outmoded idea of conservation of effort in training, of saving 'something' for the race. There is insufficient awareness that the training session is the place for progressively

increasing work-output and stress: the race should seem relatively easy!

Summary and Abstract:

A review is presented of the various fitness tests, measurements and examinations being carried out on a small group of competition cyclists, men and women selected by the British Cycling Federation. From the data available an attempt is made to evaluate various scores in such standard Physical Fitness Indices as the Rogers and Harvard types, and to compare these scores with other physiological assessments more easily applied to this particular sport. Other information, derived from a clinical examination and a questionnaire is also outlined.

References

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