SEASONAL CHANGES IN CYCLISTS' PERFORMANCE

PART II

THE BRITISH OLYMPIC TRACK SQUAD

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ABSTRACT

In Part II of the study, the British Olympic track (sprint) squad cyclists demonstrated reductions in body fat index, % body fat and endomorphy ($p > .05$), increased Hb and PCV % ($p > .05$), and lowered HR at rest and in warm-up exercise ($p > .05$), but no change in leg power. Repeated interval sprints of short duration, maximal exercise on an "ergowheel" ergometer, at standardised power output, showed increased anaerobic index ($p > .05$) and acceleratory power ($p > .01$) but no change in sustained power output.

Compared with "non-select" riders, a case study of the single "select" rider showed anthropometric differences in terms of lower height, weight, body fat index, % body fat and endomorphy, but enhanced mesomorphy and FEV %. Furthermore, the "select" rider demonstrated temporarily latent functional performance capabilities, in that increased anaerobic index, acceleratory and sustained power indices, as well as enhanced relative power output, were not identified until late in the competitive season.

Key Words: Seasonal changes, Performance, Track (sprint) cyclists.

INTRODUCTION

The early existing information concerning the usable external power output of the human body and its limitations has been reviewed by Wilkie, 1960(a) and (b). Furthermore, the study of short term human power generation has led to the development of various non-specific test protocols for the determination of optimal anaerobic power generation in man (Margaria et al, 1966; Margaria, 1966). Recently, more specific test protocols, designed to assess the maximal anaerobic capacity during cycle ergometry exercise, have been developed (Ayalon et al, 1974; Bar-Or and Inbar, 1978; Hagberg et al, 1979; De Bruyn-Prévost, 1980; Keren and Epstein, 1981). However, the fact that the power generation capacity in sprint cyclists has not been intensively studied, may be due in part to the technical and methodological difficulties of the assessment of the event-specific factors which limit performance in this group of athletes (Placheta et al, 1973). Moreover, with the exception of longitudinal studies in young cyclists (Placheta, 1980), there has been comparatively little attention devoted to the study of seasonal changes in both the general and specific performance characteristics of elite cyclists participating in track (sprint) cycle training and competition.

Initially, a total group of eight riders, comprising the squad, were tested during the January assessment, prior to the start of the competitive racing season. From the

GB Track Squad rider 200 m. sprint event.

total group, a sub-group of seven "non-select" riders was established, as well as one "select" rider, as a result of competitive selection procedures employed during the racing season and the need to meet Olympic qualifying standards in the event concerned. Subsequently, all eight riders were available for assessment during the

early season period of March, but only the one selected track (sprint) representative was re-assessed during the mid-season period of July. Therefore, trends in the performance profile associated with the one "select" rider represent a "case study" and, as such, did not allow for statistical evaluation in terms of the changes observed within the "non-select" group of riders. Nevertheless, for comparative purposes, the changes observed in the "select" rider were interpreted in the light of trends of mean responses observed in the "non-select" group of riders.

All riders included in the scheme were assessed on a variety of general anthropometric, lung function, personality, haematological and resting cardiovascular indices, before undertaking specific tests designed to assess the mechanical and temporal components related to the anaerobic power requirements of track sprint cycling.

METHOD

A. General measures

Measures relating to the anthropometric, lung function, personality, haematological, resting cardiovascular characteristics, as well as leg power indices, were determined according to the procedures described previously in Part I of the study (White et al, 1982).

B. Specific measures

The functional performance characteristics of the track squad (sprint) riders were assessed during warm-up and intermittent bouts of maximal exercise, using an "ergowheel" ergometer (Brooke and Firth, 1974). The system incorporated each rider's own track racing cycle, attached to a calibrated electro-magnetic ergometer which provided a calibratable resistive force, as illustrated in Fig. 1. The level of power output (watts) was pre-set on the calibrated scale by utilising a factor calculated from the chain ring size and the pedalling frequency. The test protocol is a modification of the procedure described by De Bruyn-Prévoist (1980) in which relative power output levels have been adjusted, to compensate for the enhanced capabilities of sprint racing cyclists over untrained subjects, while retaining the overall anaerobic performance characteristics of the procedure.

Warm-up exercise

Warm-up exercise consisted of a 3 minute work bout with alternate intervals of 30 s of cycling at 130 rpm, followed by 30 s of cycling at 60 rpm, against an unloaded ergometer, in order to facilitate the neuromuscular preparation for adaptation to a high revolution, high power output task which followed in the subsequent interval sprint trial series.

Ergowheel Assembly

Fig. 1.

Maximal exercise (interval sprint trial series)

Maximal exercise consisted of five interval sprint trials interspersed by three min "steady-state" recovery periods. Each interval sprint trial required the rider to maintain a pre-determined power output demand of $\geq 86 \text{ m.kg.min}^{-1}.\text{kg}^{-1}$ body weight generated at 130 rpm on the ergometer. Subjects were instructed to achieve the specified power output as quickly as possible, and to sustain the level of power output for as long as possible. Temporal parameters recorded, included delay time in seconds to achieve the specified power output, and total time in seconds of maintenance of the specified power output, and thus reflected the optimal acceleratory power and sustained power components of sprint capabilities. Furthermore, since the temporal parameters of the test have been related primarily to the anaerobically-derived energy release mechanisms, an anaerobic working capacity index was calculated from the ratio:

$$\frac{\text{Total Time}}{\text{Delay Time}} = \text{Anaerobic Index (De Bruyn-Prévoist, 1980)}$$

Recovery exercise

Following each interval sprint trial, the subject was required to perform a 3 minute "steady state" exercise at a pre-determined power output of $12.5 \text{ m.kg.min}^{-1} \cdot \text{kg}^{-1}$ body weight generated at 60 rpm on the ergometer, in order to facilitate recovery between successive interval sprint trials.

Performance characteristics of track (sprint) squad

Upon completion of the interval sprint trial series, the following analyses were performed in order to assess the performance characteristics of members of the track (sprint) squad:

(a) *Mechanical analyses* in which the power output was assessed in both absolute terms (m.kg.min^{-1}), as well as relative terms ($\text{m.kg.min}^{-1} \cdot \text{kg}^{-1}$ body weight) during each interval sprint trial, in order to determine the influence of successive sprint trials on power output.

(b) *Temporal analyses* in which the time components of delay time, total time and anaerobic index were derived for each successive interval sprint trial.

C. Statistical measures

Inferential statistics (Student's t-test with the appropriate degrees of freedom) were used to detect changes in the general and performance characteristics of the total and sub-groups of riders during the various assessment

phases of the racing season. Obviously, no statistical analysis was possible in the case of the individual S rider.

RESULTS

The laboratory findings of the riders during the January, March and July assessments of the 1980 racing season may be reported in terms of:

A. The *general (longitudinal) findings* observed within the total group of riders tested in the January and March assessments.

B. The *comparative (cross-sectional) findings* observed between the sub-group of "non-select" (NS) riders and the "select" (S) rider during the January and March assessments, as well as the subsequent changes observed in the S rider during the final July assessment.

(1) Anthropometric data (Table I)

In the total group, there was a trend towards a small increase in body weight during the racing season, although this was accompanied by a reduction in body fat index ($p > .01$), estimated percentage of body fat ($p > .05$), and endomorphy ($p > .05$), along with a trend towards elevated mesomorphy but reduced ectomorphy from January to March (Fig. 2), although these changes were not statistically significant.

In comparison with the NS group the S rider was con-

TABLE I

General characteristics of the BCF Olympic track squad (sprint) cyclists during the 1980 racing season

	JANUARY							MARCH			JULY
	N = 8		N = 7		N = 1	N = 8		N = 7		N = 1	N = 1
Variables	$\bar{x} \pm \text{SE}$		$\bar{x} \pm \text{SE}$			$\bar{x} \pm \text{SE}$		$\bar{x} \pm \text{SE}$			
Anthropometric											
Age (yrs)	20.9	0.1	21.5	1.0	22.0	21.1	0.1	21.8	1.0	22.3	22.6
Height (cm)	175.7	2.1	176.1	2.4	172.8	175.4	2.0	175.8	2.3	173.2	173.1
Weight (kg)	74.0	2.6	74.8	2.9	68.9	74.0	2.5	74.6	2.6	70.1	70.2
Body Fat Index (mm)	28.8	1.2	28.8	1.4	28.8	25.1**	1.0	25.5*	1.0	22.3	22.0
% Body Fat (Est)	12.2	0.5	12.2	0.6	12.2	10.6*	0.5	10.8*	0.5	9.1	9.0
Endomorphy Factor	2.4	0.2	2.5	0.2	2.5	2.1*	0.1	2.1*	0.1	2.0	2.0
Mesomorphy Factor	5.1	0.3	5.1	0.4	5.0	5.3	0.4	5.1	0.4	6.0	5.5
Ectomorphy Factor	2.4	0.4	2.4	0.4	2.5	2.1	0.3	2.1	0.4	2.0	2.0
Lung Function											
FVC (L)	5.88	0.26	5.87	0.30	4.92	5.81	0.30	5.95	0.31	4.86	4.78
FEV 1.0 (L)	5.16	0.25	5.08	0.27	4.72	5.04	0.26	5.12	0.29	4.46	4.50
FEV %	87.8	1.9	86.4	1.5	95.9	86.8	2.0	86.1	2.2	91.8	94.1

*Significant at the 0.05 level

**Significant at the 0.01 level

Test procedure: Track Squad anaerobic power (sprint) test.

siderably smaller and lighter, but demonstrated a more pronounced tendency to increase body weight and reduce body fat. These trends were matched by marked somatotype changes involving lowered endomorphy and elevated mesomorphy between January and March and maintained in the July assessment (Fig. 2).

(2) Lung function data (Table I)

There were no significant changes in lung function parameters in the total group during the racing season. Likewise, the S rider showed little or no change in lung function parameters during the period of assessment, although compared with the NS group he demonstrated substantially lower lung volumes, but such differences were related to body size difference since FEV 1.0% was substantially higher than values observed in the NS group.

(3) Personality data

In the total group there were no significant changes in EPI scores during the racing season. However, compared with the NS group, the S rider displayed characteristics close to mean values of the neuroticism-stability scale, but elevated extraversion during the racing season, whereas EPI scores of the NS group remained relatively unchanged (see Fig. 3).

(4) Haematological data (Table II)

In the total group there were increased haemoglobin levels ($p > .05$) and packed cell volumes ($p > .01$) between January and March. Likewise, the NS group

Fig. 2: Anthropometric characteristics of the BCF Olympic track squad (sprint) cyclists during the 1980 racing season.

showed similar significant increments in haematological parameters, whereas the S rider showed relative stability of these two indices. However, compared with the NS group, the S rider showed elevated haemoglobin and packed cell volume values in January, but these differences were eliminated by March, and the S rider demonstrated a stability of haemoglobin level, but a small decline in packed cell volume in the July assessment.

(5) Resting cardiovascular data (Table II)

In the total group, together with the NS group, there was a decline in heart rate (both $p > .05$), but no significant change in resting blood pressure parameters between January and March. Likewise, the S rider showed a pronounced decrease in heart rate, but a slight elevation of blood pressure during the same period; however, there were no apparent differences between the NS group and the S rider in the January and March assessments. Finally, the S rider demonstrated a small elevation in heart rate but a large unexplained increase in both systolic and diastolic blood pressures in the July assessment.

(6) Warm-up exercise data (Table II)

In the total group, together with the NS group, there was a decrease in heart rate response to warm-up exercise (both $p > .05$), a non-significant elevation of

TABLE II
General characteristics of the BCF Olympic track squad (sprint) cyclists during the 1980 racing season

	JANUARY						MARCH			JULY	
	N = 8		N = 7		N = 1	N = 8		N = 7		N = 1	N = 1
Variables	$\bar{x} \pm SE$		$\bar{x} \pm SE$			$\bar{x} \pm SE$		$\bar{x} \pm SE$			
Haematology											
Haemoglobin (g.dl)	14.6	0.2	14.5	0.2	15.3	15.2*	0.3	15.1*	0.4	15.8	15.4
PCV (%)	44.0	0.7	43.4	0.4	48.0	46.0**	0.4	45.7**	0.3	48.0	45.0
Cardiovascular (Rest)											
Heart Rate (b.min ⁻¹)	63.6	4.4	62.9	5.0	69.0	54.5*	2.7	54.9*	3.1	52.0	57.0
Systolic BP (mmHg)	124	2	124	2	125	126	1	126	1	130	148
Diastolic BP (mmHg)	78	3	79	3	70	73	3	73	3	75	85
Warm-up Exercise											
Heart Rate (b.min ⁻¹)	138.0	3.7	136.9	4.0	147.0	122.0**	3.6	123.0*	4.0	117.0	114.0
Systolic BP (mmHg)	158	6	156	6	170	169	6	172	5	145	160
Cardiovascular Index	21.9	1.3	21.5	1.4	24.5	20.7	1.1	21.2	1.1	17.0	18.2
Leg Power											
Vertical Jump (cm)	46	1	46	2	40	45	2	45	2	42	40
Leg Power (m.kg.s ⁻¹)	109.2	4.6	110.0	5.4	96.9	110.0	4.6	110.8	5.4	100.0	99.2

*Significant at the 0.05 level

**Significant at the 0.01 level

Fig. 3: Personality characteristics (EPI dimensions) of the BCF Olympic track (sprint) squad cyclists during the 1980 racing season.

systolic blood pressure, and stable cardiovascular index between January and March. Likewise, the S rider demonstrated a large decline in heart rate response to warm-up exercise, as well as a marked reduction in systolic blood pressure and resultant cardiovascular index during the same period. However, compared with the NS group, the S rider displayed larger and more dramatic reductions in cardiovascular responses to warm-up exercise between January and March and, subsequently, maintained relative stability of cardiovascular demands to warm-up exercise in the July assessment.

(7) Maximal exercise data (Table III)

The power and temporal performance characteristics of the track (sprint) squad cyclists during the racing season are presented in Table III and illustrated graphically in Figs. 4 and 5, respectively. In the total group and the NS group, there were no changes in absolute (m.kg.min⁻¹) and relative (m.kg.min⁻¹.kg⁻¹) power during the interval sprint trial series between January and March, which confirmed that a standardised power sprint exercise protocol had been applied in each assessment (Fig. 4). However, the S rider demonstrated a clear trend towards increased absolute and relative power during the same period, and further enhanced his power in the July assessment. This trend reflected the S rider's low absolute and relative power compared with the NS group in the January assessment, and the subsequent improvement in power indices made during the racing season.

TABLE III

Performance characteristics of the BCF Olympic track squad (sprint) cyclists during the 1980 racing season
(interval sprint series)

		JANUARY						MARCH				JULY	
		N = 8		N = 7		N = 1		N = 8		N = 7		N = 1	N = 1
Variables		$\bar{x} \pm SE$		$\bar{x} \pm SE$				$\bar{x} \pm SE$		$\bar{x} \pm SE$			
T R I A L 1	Delay Time (s)	2.7	0.1	2.7	0.1	2.8	2.3*	0.1	2.3*	0.1	2.2	2.2	
	Total Time (s)	29.8	3.3	29.7	3.8	30.1	30.1	1.4	30.5	1.5	27.0	22.9	
	Anaerobic Index	11.5	1.5	11.6	1.7	10.8	13.5	0.8	13.7	0.9	12.1	10.2	
	POWER												
	m.kg.min ⁻¹	6760	380	6930	390	5540	7000	330	7020	390	6900	7050	
	m.kg.min ⁻¹ .kg ⁻¹	91.2	4.1	93.0	4.3	80.4	94.2	2.3	93.6	2.6	98.5	100.3	
T R I A L 2	Delay Time (s)	2.7	0.1	2.7	0.1	2.9	2.1**	0.1	2.1*	0.1	2.0	1.9	
	Total Time (s)	29.3	1.4	29.3	1.4	29.3	29.8	1.6	30.4	1.7	25.5	22.6	
	Anaerobic Index	11.2	1.2	11.4	1.4	10.3	14.3*	1.0	14.5*	1.1	12.5	11.8	
	POWER												
	m.kg.min ⁻¹	6540	340	6680	360	5560	6690	280	6630	310	7070	6680	
	m.kg.min ⁻¹ .kg ⁻¹	88.1	2.6	89.3	2.4	80.8	90.5	2.2	88.7	1.8	100.9	92.4	
T R I A L 3	Delay Time (s)	2.9	0.2	2.9	0.3	3.0	2.2**	0.1	2.2**	0.1	2.1	1.7	
	Total Time (s)	28.6	1.6	28.6	1.9	29.0	28.3	1.7	28.4	2.0	26.9	22.4	
	Anaerobic Index	10.5	1.2	10.6	1.3	9.8	13.1*	0.8	13.2*	0.9	12.8	12.9	
	POWER												
	m.kg.min ⁻¹	6540	300	6680	310	5650	6600	300	6610	340	6490	6500	
	m.kg.min ⁻¹ .kg ⁻¹	88.7	2.6	89.2	2.8	82.0	89.1	1.9	88.6	2.0	92.4	92.6	
T R I A L 4	Delay Time (s)	3.1	0.5	3.1	0.2	2.6	2.5	0.1	2.4*	0.1	2.6	1.7	
	Total Time (s)	25.6	1.3	25.1	1.4	28.6	26.3	2.0	27.1	2.1	20.8	21.7	
	Anaerobic Index	9.5	1.4	9.4	1.6	10.8	11.1	1.2	11.5	1.3	8.0	12.5	
	POWER												
	m.kg.min ⁻¹	6500	300	6570	340	5860	6600	380	6690	420	5890	6660	
	m.kg.min ⁻¹ .kg ⁻¹	87.5	2.3	88.1	2.6	85.0	89.1	2.5	89.3	2.8	83.8	94.8	
T R I A L 5	Delay Time (s)	3.0	0.4	3.1	0.5	3.0	2.2*	0.1	2.2*	0.1	2.3	1.8	
	Total Time (s)	26.5	1.7	25.9	1.9	30.9	26.0	1.7	26.2	2.0	24.7	23.7	
	Anaerobic Index	9.9	1.5	9.8	1.7	10.5	11.4	0.9	12.1	1.0	10.7	13.4	
	POWER												
	m.kg.min ⁻¹	6720	380	6810	280	5900	6500	320	6590	350	5950	7620	
	m.kg.min ⁻¹ .kg ⁻¹	90.5	2.4	91.2	2.4	85.7	87.5	2.0	88.1	2.3	85.0	108.9	

*Significant at the 0.05 level

**Significant at the 0.01 level

In the total group and the NS group, there was a reduction in the delay time (acceleratory power) component of the anaerobic index between January and March (Fig. 5) during sprint trials 1 ($p > .05$), 2, 3 ($p > .01$) and 5 ($p > .05$) for the total group, and trials 1, 2 ($p > .05$), 3 ($p > .01$), 4, 5 ($p > .05$) for the NS group. However, there was no apparent change in the total time (sustained power) component of the anaerobic index during the same period. Consequently, the

changing ratio of the two temporal components of the anaerobic index resulted in a significant increase in the index observed in sprint trials 2 and 3 (both $p > .05$) in both the total group and the NS group between January and March. Furthermore, there was a clear, but non-significant, trend towards elevated anaerobic indices in trials 1, 4 and 5, during the same period in both groups of riders.

Fig. 4: Power performance characteristics of the BCF Olympic track squad (sprint) cyclists during the 1980 racing season (interval sprint trial series — maximal exercise).

Compared with the NS group, the S rider displayed a more dramatic reduction in the delay time (acceleratory power) component, but a decrease in total time (sustained power) component of the anaerobic index between January and March (Fig. 5). Nevertheless, the resultant effect was similar to the NS group, namely, a clear trend towards increased anaerobic indices in repeated sprint trials during the same period. However, it was noted that both temporal performance parameters and the derived anaerobic index of the S rider were markedly lower than the NS group in January and, although performance in March approached that of the NS group, it was not until the final July assessment, that the S rider demonstrated enhanced sprint capability principally related to the acceleratory power component of the anaerobic index. However, it should be noted that this enhanced sprint capability, based upon the temporal criteria employed, resulted from higher relative power output levels achieved by the S rider during the latter part of the racing season (Fig. 4).

Finally, in the total group and the NS group of riders, together with the S rider, there was no significant change in leg power during the racing season (Table III). However, compared with the NS group, the S rider demonstrated somewhat lower leg power, which improved marginally during the course of the racing season.

DISCUSSION

The anthropometric and somatotype characteristics of the track (sprint) squad cyclists contrasted with the

findings of the road squad cyclists in Part I of the study, in that the physique characteristics were typical of highly trained power athletes (Carter, 1978). However, lung function and haematological parameters were similar to those observed in the Part I findings, although the importance of such parameters may be of questionable significance in the performance requirements of sprint cycling. The decline in resting and warm-up exercise heart rate, during the racing season, was similar to the response observed in the road squad cyclists and represented characteristic functional cardiovascular changes with training; features which were particularly evident in the S rider.

Personality characteristics of the track squad were divergent from adult norms (Eysenck and Eysenck, 1962) and from cyclists in general (Hagberg et al, 1979), with the exception of the S rider who demonstrated EPI characteristics similar to other elite athletic groups (Morgan and Costill, 1972).

In the sprint trials, absolute power achieved by the sprint squad was similar to levels reported for an equivalent duration "all out" work effort in specifically trained sprint cyclists (Wilkie, 1960(a) and (b)), but considerably higher than reported in non-specifically trained sprint cyclists performing "all out" work of longer durations (Hagberg et al, 1979). Furthermore, since a standardised anaerobic power protocol was applied (De Bruyn-Prévost, 1980), the changes observed in the delay time component of the test suggest improvements in either neuromuscular recruitment or rate of

Fig. 5: Temporal performance characteristics of the BCF Olympic track squad (sprint) cyclists during the 1980 racing season (interval sprint trial series – maximal exercise).

release of stored energy, or both, were responsible for the associated enhanced acceleratory power capability. Moreover, the change in this component produced an increase in the anaerobic index, rather than a gain in total time or sustained power component. The importance of acceleratory power may be in the use of this parameter to differentiate amongst elite sprint cyclists, who may have similar optimal velocities, but differ markedly in the acceleratory component of sprinting. Thus, enhanced acceleratory power exhibited by the S rider, although latent until the mid-racing season, underpinned his enhanced sprint capability compared with the NS group.

Overall, leg power remained relatively stable during the racing season and, in contrast to the enhanced acceleratory power displayed in the sprint tests, the S rider demonstrated somewhat lower leg power than the NS group. However this finding was not inconsistent since the power tests employed constituted different specific skill tasks. Furthermore, whilst power indices of the sprint cyclists were relatively low compared with other

“power” athletes (Margaria, 1966; Margaria et al, 1966), this resulted from the modified vertical jump test protocol employed; nevertheless, scores were higher than those observed in road race cyclists (White et al, 1981) and confirm the results observed in sprinters compared with other event-specific cyclists (White, J. A. unpublished data).

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