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POST-COMPETITION BLOOD LACTATE CONCENTRATIONS IN COMPETITIVE TRACK CYCLISTS

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ABSTRACT

Blood lactate (BL) concentrations were measured in 19 competitive cyclists after 4 competitive track events (kilometre, individual and team pursuit, and match sprints) during the US National Championships. A total of 34 samples were drawn. Our purpose was to investigate the share of anaerobic metabolism in the various events. The greatest mean BL concentration (16.94 mM/l) was found after the kilometre, with one individual recording a value of 18.22 mM/l. A low correlation coefficient for BL versus total riding time was found in the 6 samples drawn during the kilometre ($r = 0.51$) and the 12 samples drawn during the individual pursuit ($r = 0.44$). BL concentrations in all four events were not significantly different ($p < 0.05$) from each other. High values for BL were found in the match sprints (7 samples, mean 13.65 mM/l) an event lasting approximately 11 seconds. The mean BL in the kilometre (6 samples, 16.94 mM/l), individual pursuit (12 samples, 15.18 mM/l), and team pursuit (5 samples, 12.08 mM/l) compare favourably to the values reported for a variety of exercise modes of similar time, except running. While there is increased muscle mass in running, this fact alone may not explain the lower BL values in cycling. It is suggested that lower BL levels may be attributed to prolonged contraction-relaxation phase during cycling causing decreased blood flow to the leg.

INTRODUCTION

Competitive track cyclists are a unique population for the study of the physiological responses to the stress of exercise. Several investigators have reported data on highly trained endurance cyclists including Burke (1980) whereas, there is an apparent lack of such data on nationally ranked track cyclists.

The energy cost of cycling has been found to be dependent upon air resistance, pedal cadance (Hagberg et al, 1978), and body weight and speed. Competitive cycling requires intense activity from a large muscle mass and restricted breathing patterns. These requirements favour the involvement of aerobic and anaerobic energy release with the subsequent accumulation of lactic acid in the blood.

The purpose of the present investigation was to record the blood lactate concentrations of well-trained competitive track cyclists under extreme conditions of competition at the United States National Championships. It is well known that high levels of blood lactate can be expected after the brief, high intensity events

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(Karlsson, 1971; Osnes and Hermandsen, 1972). Several investigations have documented post-competition lactate responses in swimmers (Sawka and Knowlton, 1979) and track runners (Kindermann and Keul, 1972). Competitive track cycling is similar to these activities in terms of time and effort, therefore, it will be of interest to determine if track cycling produces comparable peak blood lactate accumulation.

METHODS

The subjects for this investigation were 19 male competitive cyclists competing at the 1980 United States National Championships. Thirteen of the subjects were either present or past members of Olympic, Pan American, World or National cycling teams.

Venous blood samples were withdrawn from an antecubital vein after 5 minutes passive recovery (1-2 minutes easy riding, 3-4 minutes sitting) from exercise and then assayed in duplicate for serum lactate concentration by enzyme analysis according to the technique developed by the Sigma Chemical Co. (1968). Resting samples were obtained on four of the subjects.

Blood samples were taken after four of the championship events. Six samples were drawn after the one-kilometre time trial (mean time, 70.86 seconds), and seven measurements were completed after the match sprints (mean time, approximately, 11 seconds). One cyclist was tested twice in the match sprints. In the team pursuit (mean time, 288.0 seconds), five samples were drawn.

Likewise, 12 samples were drawn during various rounds of the individual 4,000 metre pursuit (mean time, 303.1 sec). Two cyclists had 3 samples drawn, 1 cyclist had 2 samples taken and 4 cyclists had one sample drawn.

For individual events, means and standard deviations were determined. Analysis of variance was used to determine if difference existed between events.

RESULTS

The mean and standard deviations for the different events are shown in Table I. The highest mean value for lactate, 16.94 mM/l, occurred in the kilometre race, an event which lasts approximately 70 seconds. The highest individual lactate was found in subject L.B. (18.2 mM/l) who finished fourth in the kilometre with a time of 1:11:17 minutes. There was a correlation coefficient of $r = 0.51$ for riding time versus blood lactate for the 6 samples drawn in the kilometre.

In the case of the four different events, there was no significant difference ($p < 0.05$) in the level of blood lactate concentration. Small differences were found

TABLE I

Maximal values (mean and standard deviations) for 34 blood lactate samples (mM/l) associated with different events

Blood Lactate	Rest	Team Pursuit	Match Sprints	Individual Pursuit	Kilometre
N.	4	5	7	12	6
x	1.95	12.08	13.65	15.18	16.94
S.D.	0.20	2.17	1.45	1.67	0.87
Range	1.80— 2.23	9.79— 15.25	11.40— 15.11	13.55— 17.31	15.69— 18.22
x Time (sec)		288.0	11.0	303.1	70.9

among the various events. There was a tendency to have lower maximal lactate concentrations after the 4,000 metre individual and team pursuit. Furthermore, in the match sprints, lasting approximately 11 seconds, there was a high mean level of lactate, 13.65 mM/l.

Table II shows the individual values for subjects who had multiple samples drawn after the individual pursuit. A correlation coefficient of $r = 0.44$ was found between riding time and lactate concentration for the 12 samples drawn from the 7 athletes. In addition, concentration of 14.58 and 11.40 mM/l were found in subject M.D. after two rounds of the match sprints.

TABLE II

Blood lactate concentrations and performance times for individual cyclists in various rounds of the individual 4,000 metre pursuit

Cyclist	Round	Blood Lactate (mM/l)	Time (s)
J.B.	Qualifying	13.73	298.8
	Quarter Finals	13.55	298.3
	Final	15.66	298.0
K.L.	Qualifying	14.25	301.3
	Quarter Finals	14.07	301.3
	Semi Finals	15.99	303.3
D.G.	Qualifying	16.09	301.2
	Quarter Finals	16.13	301.2
P.D.	Qualifying	17.13	314.2
E.H.	Qualifying	14.88	314.0
B.D.	Qualifying	15.93	308.4
G.P.	Qualifying	14.56	308.2

DISCUSSION

The mean lactate values for the kilometre, individual and team pursuit compare favourably with the values reported for a variety of exercise modes of similar time;

except for running (Kindermann and Keul, 1972; Sawka and Knowlton, 1979). As shown by several authors including Karlsson (1971), work intensity, duration and type of work, and the amount of muscle mass involved play an important role in the amount of lactate that is produced per unit of time. Muscle mass used during exercise is probably larger during running than in cycling. Whether this fact alone can explain the results in the present study is unclear as there is no difference in maximal values of oxygen consumption (Reybrouck et al, 1975) and cardiac output (Stenberg and Åstrand, 1967) when leg cycling is compared with that of arm and legs together.

Blood flow to the leg may be a crucial factor in measuring blood lactate concentrations after exercise. Matsui et al (1978) found that blood flow was significantly higher in maximum treadmill running than in bicycle ergometer exercise. From these results, he suggested that the lower maximum oxygen uptake observed during bicycle exercise as compared with treadmill exercise seem to be due to the lower blood flow in the lower limb. While Cobb and his co-workers (1969) did show a significant correlation between blood flow during and after bicycle exercise, the workload was submaximal. Heart rate averaged only 106 beats/minute during the work periods. Furthermore, in about two-thirds of the subjects heart rate began to fall immediately after exercise; in the other third, there was a brief rebound effect in excess of exercising levels observed.

In cycling, the contraction phase of the contraction-relaxation cycle is quite prolonged and peaks at approximately twice the load setting (Hoes et al, 1968). Running is a much more ballistic movement with a very short contraction phase, and these biomechanical factors may contribute in the venous return during and after exercise as suggested by Faulkner and colleagues (1971). While muscle lactate may be high after intense exercise, the incidence of decreased blood flow after exercise and the increased contraction phase during exercise may reflect in lower blood lactate concentration in maximal cycling.

The relatively high lactate levels found in the blood after the match sprints, an event lasting approximately

11 seconds compared with resting values should be noted. Osnes et al (1972) and Hollman et al (1980) noted in athletes if work intensity is sufficiently high, lactate is produced within 10 seconds of work. They attribute anaerobic glycolysis as playing an important role in energy production also during very short work periods. On the other hand Kindermann and Keul (1972) point out that the stress involved in high intensity exercise of this type may cause increased lactate levels. Portions of the relatively high levels of lactate may be attributed to elevated tone of the sympathetic nervous system and an increase in the secretion of catecholamines which promote glycogenolysis.

The lower value for blood lactate in the team pursuit compared with the other three events could be attributed to the short time an individual cyclist spends breaking through air resistance at the front of the pace line. Kyle and Mastropaolo (1976) have attributed wind resistance as being responsible for 80-90% of the metabolic cost of cycling. For racing cyclists, travelling at 48 kph, the required mean power output was reduced to 29, 32 and 33% for positions two, three and four in the pace line respectively. By rotating turns at the front, everyone, on the average, uses less energy.

The low correlation coefficient between individual pursuit time and blood lactate concentration (Table II) shows that other variables besides time of the event may be important in predicting performance. Finishing lap effort, wind condition and aerobic conditioning, may all be of importance. These conclusions for individual pursuit should be viewed with discretion when consideration is given to sample size.

SUMMARY

Nineteen competitive cyclists were studied in four competitive track cycling events relative to their maximal blood lactate concentrations. The results show that anaerobic metabolism contributes a large part of the energy production. The greatest mean blood lactate concentration was found in the one kilometre event (16.94 mM/l) with one individual recording a value of 18.22 mM/l. Furthermore, competition as short as 11 seconds in the match sprints was found to increase blood lactate significantly over resting levels.

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