

Physiological Characteristics of Competitive Cyclists

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Like other endurance athletes, competitive cyclists have exceptionally high maximal oxygen consumption values. But the author feels $\dot{V}O_2$ max shouldn't stand alone as a predictor of success.

Few sports are as varied and physiologically challenging as competitive cycling. The races range from a 200-meter match sprint that lasts approximately ten seconds, to the grueling Tour de France, which lasts 23 days and covers 5,000 km. It combines racing over high passes in the Alps with the possibility of sprints at the end of each stage.

Recent publications have described the physiological profiles of successful athletes.¹⁻⁴ However, since Zuntz⁵ originally measured the oxygen consumption in relation to speed of riding on a 200-meter track, little physiological information has been published about the competitive cyclist.

The goals of this four-year study were to evaluate the metabolic and body composition characteristics of national and international male and female competitive cyclists and determine if a significant difference in oxygen consumption exists among the Senior Men's National Team, the Junior Men's National Team, and the category 1 cyclists. All of these cyclists were actively engaged in endurance training and competition.

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Table 1. Physical Characteristics of Competitive Cyclists (Mean \pm SD)

Group	No. of Subjects	Height (cm)	Weight (kg)	Body Fat (%)
Men's national team	12	180.9 \pm 5.2	67.5 \pm 7.7	8.6 \pm 2.0
Category 1 men	8	180.6 \pm 6.0	70.8 \pm 6.8	8.4 \pm 3.3
Junior national team	25	178.0 \pm 5.2	68.4 \pm 6.4	10.3 \pm 3.4
Women's national team	7	167.7 \pm 10.7	61.6 \pm 8.5	15.4 \pm 4.7

senior men's team. They represent the United States in international competition, including world cycling championships and Olympic Games. Seniors who have been successful but have failed to qualify for the national teams are category 1 cyclists. The top 15 to 20 men ages 17 and 18 are the junior men's team. The top women cyclists who represent the United States in international competition are the Women's National Team.

Methods

Cardiovascular fitness was determined by having the athlete pedal to exhaustion on a Monark ergometer, specially adapted with toe clips, racing saddle, and dropped handlebars. After a warm-up at 2.5 kiloponds (kp) at 80 rpm for three to five minutes, the work load was increased 0.5 kp every minute. The test was terminated when the athlete's pedal revolutions dropped below 75 rpm or when the $\dot{V}O_2$ leveled off or declined. Oxygen consumption was recorded continuously using the semiautomated system as described by Wilmore⁶ or by the Erich Jaeger metabolic cart. Heart rate was monitored electrocardiographically during all tests.

Hydrostatic weighing was conducted, and the two weights were averaged and used in the calculation of percent body fat.⁷ Residual volume was calculated by multiplying the vital capacity by 0.24 for males and 0.28 for the females.⁸

One-way analysis of variance was used to determine if mean maximal oxygen consumption varied among classifications. The results were interpreted at the $p < .05$ level of significance.

Results and Discussion

Physical Characteristics. Anthropometric data for the subjects appear in table 1. These cyclists are taller and heavier than distance runners,^{1,9} but similar to canoeists, ice hockey players, speed skaters, soccer players, etc.¹⁰ They are similar to the 40 road cyclists at the 1969 World Championships,¹¹ who had a

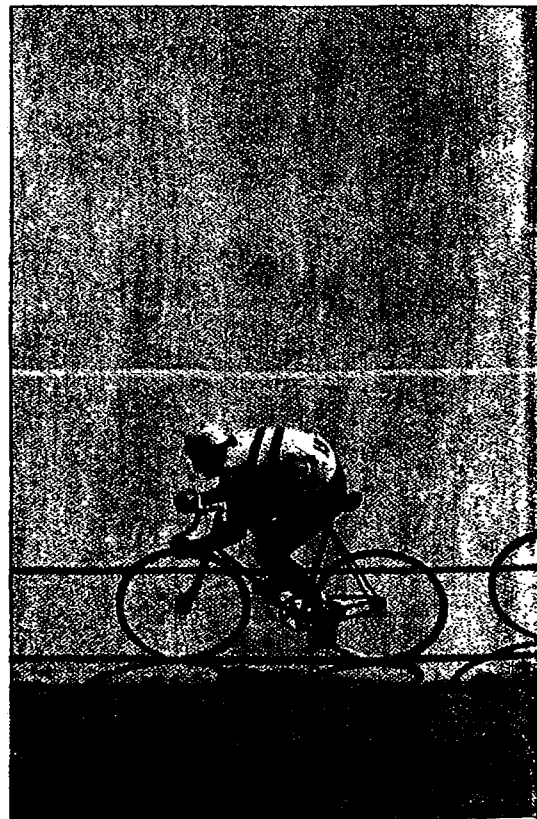
mean height of 175 cm and a mean weight of 70 kg.

No recorded vital data are available on female competitive cyclists, but they are similar to other well-trained female athletes in height and weight.³

The average height and weight for the juniors is comparable to the ten junior cyclists studied by Placheta.¹² His cyclists were 17 and 18 years old and had a mean height of 180.4 cm and a mean weight of 72.1 kg.

Body Composition. Extensive studies of male athletes have shown the following mean percent body fat: college wrestlers, 9%; dis-

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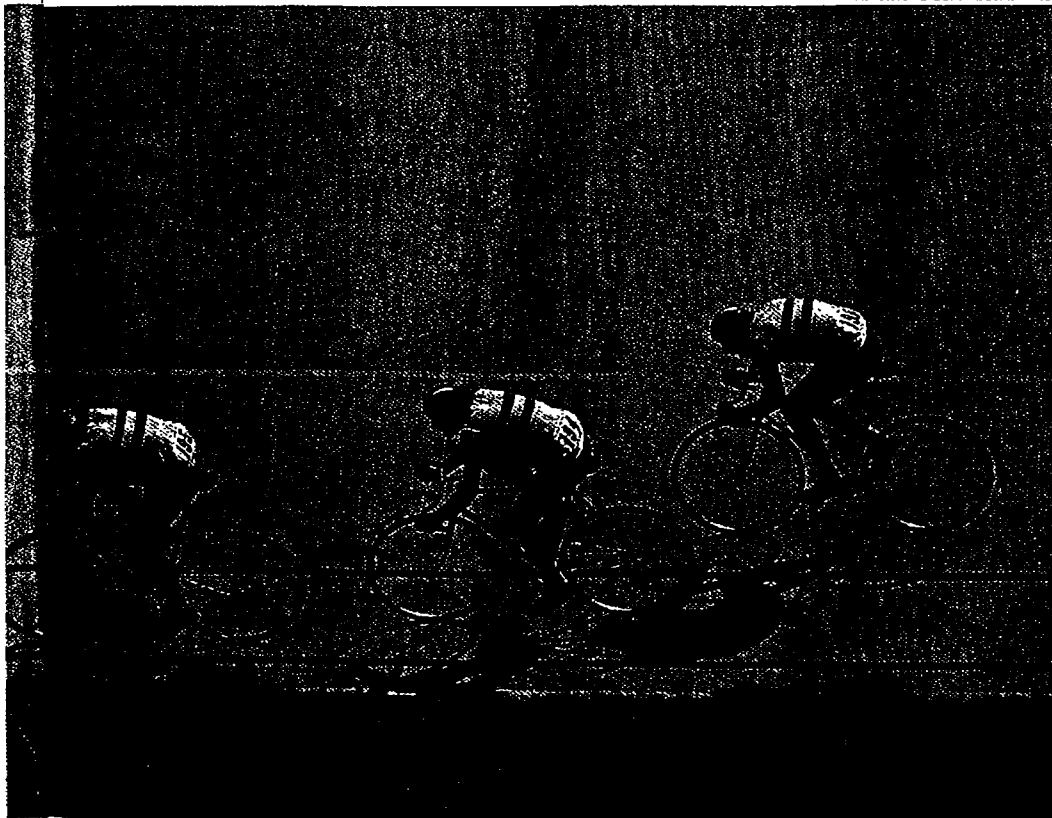
Table 2. Team $\dot{V}O_2$ Max Data (Mean \pm SD)

Study	No. of Subjects	$\dot{V}O_2$ Max (ml·kg ⁻¹ ·min ⁻¹)	Notes
Swedish national team	6	74.0	1966 Swedish national team
Norwegian national team	16	73.0	Norwegian national team
National class road and track cyclists	11	87.1	National class road and track cyclists
Swedish national team	5	69.1	1975 Swedish national team
Men's national team	23	74.0 \pm 8.9	
Category time	8	70.6 \pm 9.5	
Men's national team	18	64.0 \pm 5.5	
Women's national team	6	57.4 \pm 6.6	

Table 3. Individual $\dot{V}O_2$ Max Values

Study	Cyclist	$\dot{V}O_2$ Max (ml·kg ⁻¹ ·min ⁻¹)	Notes
1		77.0	5-time winner of Tour de France
2		80.0	1970 winner of Tour of Italy
3		82.7	1976-1979 Pan-American road team 1976 Olympic road team
4		79.8	1972, 1976 Olympic road team 1976-1977 National road champion 1975-1979 Pan-American road team

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tance runners, 4%; college runners, 8%; elite heavyweight crew, 11%; and lightweight crew, 8.5%.¹³ The senior men have similar values. Vank¹¹ reported 7.1% for road cyclists using skinfold measurements.

While the mean of 10.3% body fat may seem high for the junior team, the average age for the group was only 17 years, and some may not have reached full body maturity. These juniors are several percentage points lower than the average population of similar age.¹⁴

The Women's National Team averaged 15.4% body fat. In studies of other female athletes, the following values were reported: basketball, 20.8%; gymnastics, 15.5%; a group of unidentified varsity athletes, 20.6%;³ and elite distance runners, 15.2%.¹⁴

From these results, the following recommendations can be given for percent body fat for competitive cyclists: seniors, 5% to 9%; juniors, 9% to 12%; and women, 12% to 15%. These figures depend on event, time of the season, and body build.

Metabolic Data. Like many other trained endurance athletes,^{2,4} road cyclists possess exceptionally high $\dot{V}O_2$ max values. Table 2 compares the maximal oxygen consumption values for cyclists reported by several investigators.

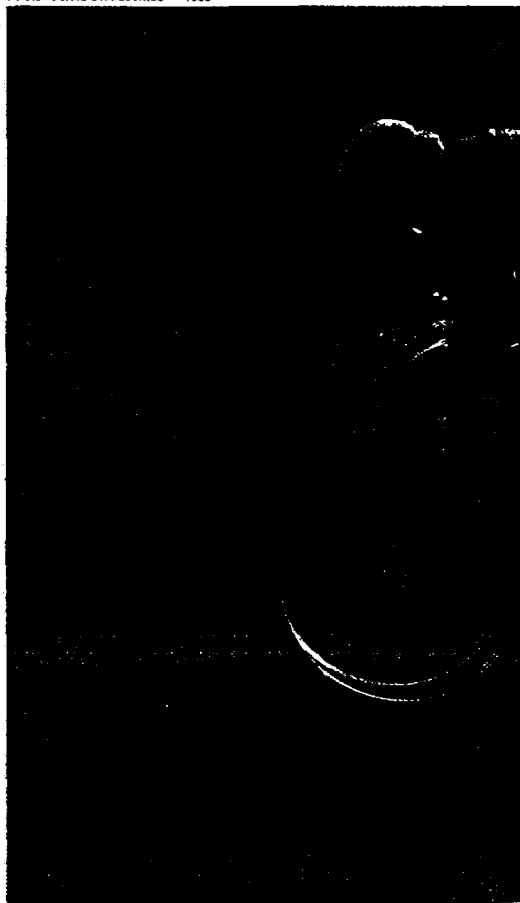
While the mean group $\dot{V}O_2$ max is not quite as high as other elite athletes,⁴ several factors may be involved. $\dot{V}O_2$ max recorded on a bicycle ergometer has been reported to be 5% to 8% lower when compared to running on the treadmill.^{4,15} However, Stromme¹⁶ and associates demonstrated that athletes reached higher levels of maximal oxygen uptake when tested in natural working conditions. For example, cyclists in his study rode their own bicycles on a treadmill. Speed was kept constant at 29.8 km/hour and uphill inclination was individually changed from 2.5° to 4.5° in order to maintain a suitable pedaling frequency during the test. He also had them run to exhaustion at a 3% grade on a treadmill. The entire group of bicyclists, all national performers, reached higher levels of $\dot{V}O_2$ max during bicycling. The mean difference was 5.6%, or 0.31 liters. Trained cyclists report feeling better on an ergometer when it is equipped with narrow seat, dropped handlebars, adjustable stem, and toe clips.

Table 3 reports the values for maximal oxygen consumption for individual cyclists as recorded in the literature. Cyclists 1 and 2

were professionals in Europe. The other cyclists were world-class amateurs. It is apparent that well-trained cyclists have the metabolic characteristics of high-caliber endurance-trained athletes. Over a three-year period, the $\dot{V}O_2$ max of the third cyclist was 79.6, 82.8, and 82.2 ml·kg⁻¹·min⁻¹, and his maximal heart rate was 187, 189, and 189 beats·min⁻¹.

The mean value for $\dot{V}O_2$ max in the women's team is considerably higher than that found for the average woman (table 2). When compared to values for other women athletes, the present values are also high. Hermansen reported a mean value of 3.65 liters·min⁻¹ for six Norwegian women orienteers, reportedly the best orienteers in Norway at the time, which is comparable to the 3.58 liters·min⁻¹ for the six women tested in this study. Cross-country skiers have demonstrated consistently higher mean $\dot{V}O_2$ max values than any other sport.¹⁷

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values found among many of the cyclists make interpretation complex. Multivariate analysis may elicit more definitive results and make it possible to predict success in well-trained cyclists.

Summary

This report investigated selected physical performance characteristics of male and female national- and international-class competitive cyclists. Measurements of body composition and maximal oxygen consumption compared favorably with those of other highly trained athletes.

$\dot{V}O_2$ max may be an indicator of success in competitive cycling, but it is always difficult to separate cause from effect. Is the successful athlete successful because he or she possesses a specific oxygen consumption or is oxygen consumption a result of training for the sport? Unless combined with other criteria, $\dot{V}O_2$ max may be most useful only for making relatively gross separations of talent. Still, a high $\dot{V}O_2$ max is one of the characteristics of a competitive cyclist.

Furthermore, in an effort to open channels of communication among athlete, coach, and sports scientist, a model of cooperation has been established. The results of the tests have helped some of the cyclists determine their physiological strengths, weaknesses, and limitations, and helped the national coaches plan individual training programs.

Further research with more subjects is being conducted on submaximal work (efficiency), anaerobic threshold, and biomechanical studies. These data, along with the objective and subjective data obtained by coaches, could provide the criteria for selection of future national teams. **PCSM**

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