Analysis of the Italian National Training Program for Rowing

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In 1980, the Italian Rowing Federation initiated a systematic, national year-round training program which placed an emphasis on performance in the international competitive arena. The training program was designed to create rowing-specific technical, physiological and musculo-skeletal adaptations in the athletes. The program specifies training models which are the means to foster these adaptations, and is supplemented with close supervision of rowing technique, observation of physiological parameters and experience in international competition.

The majority of competitive rowers train throughout the year based on a periodisation of training models and intensities. Generally speaking, the autumn and winter are devoted to aerobic conditioning, strength training and technical skill enhancement. The spring and summer are devoted to anaerobic conditioning, technique refinement and model training for competitions which take place during this period. Because of these two diverse training objectives, a seasonal variability in rowing technique and fitness level has been observed (3,11). In the period since the introduction of this program, the Italian Rowing Federation has experienced significantly improved results, in terms of medals won, at the World Rowing Championships and the Olympic Games.

This study attempts to quantify the effects of the Italian program in order to increase the understanding of the emphases and adaptations affected. In addition, the training demands of long distance swimming were selected as a means of comparison because of its very similar competition and training demands. Certain assumptions were made to arrive at a standardised mode of analysis.

Assumptions

Assumptions have been made regarding the conditions of training which, when consistently applied, allow us to evaluate the physiological effects. We have assumed zero water movement and no wind conditions, and have selected a rowing shell that represents the average speed for the boat types rowed by senior men. The boat selected was a national level double scull. We assumed an average velocity over a one year period of training for 2,000 meters at 100% to be six minutes, 40 seconds or five meters per second. The boat can travel at a higher velocity over, for example, 500 meters. However, this would represent a velocity of greater than 100% because our reference velocity is that of the 2000 meter race distance.

Using the heart rate response to the various intensities of training and assuming a maximal heart rate of 200, the percentile relationship was developed. This relationship was very close to the percentile relationship between the percentage below maximum velocity of the boat at the various training velocities and

maximum boat velocity of five meters per second for 2,000 meters (see Conversion of Training Intensities in Table 1).

Table 1: Table of Conversation for Training Intensities

Principal Physiological Effects of Training	Percent of Boat Speed	Heart Rate	Stroke Rate		Boat Speed	
			Jan-April	May-Sept.	Min/km	Meters/min
Anaerobic	95% (+ or -)	190-200	30-36	32-40	3.55	282
Transportation	85-95%	180-190	26-30	28-32	3.90	256
Anaerobic Threshold	75-85%	170-180	24-26	25-28	4.25	235
Utilisation 1	65-75%	150-170	20-23	22-25	4.62	216
Utilisation 2	55-65%	130-150	18-22	20-22	5.00	200

Based on these two percentile relationships, the training models were evaluated for the number of minutes at each training intensity. Because the training models refer to many different means of effectuation (e.g., kilometres, strokes or minutes), velocity was estimated based on the given stroke rate or estimated heart rate range to estimate the amount of time spent at the given intensities. In cases of training models of varying rhythms, the amount of time spent in each range was estimated.

Training Models

The Italian training program is based on training models, each designed to create different physiologic adaptations (see models in Illustration 1). These models are placed into daily training sessions of a representative week which is to be followed for each week of the month (see example in Illustration 2).

The training year has been divided into two main periods: the preparation period and the competition period. The preparation period is considered to be from October to March (for the Northern Hemisphere) and the competition period is from April to September. Within this framework, a further division was made to separate land training from water training. In this model, water training includes training in the rowing motion, training performed in the boat and on a rowing ergometer (4).

Land training includes running, weight lifting and stretching (bicycling and cross-country skiing are acceptable alternative models). Running and endurance weight lifting were considered for their effect upon the cardiovascular system. Endurance strength is the athlete's tolerance level against fatigue in strength performances of longer duration (6). The training models for the boat, rowing ergometer, running and endurance weight lifting were considered for the training effects they produce on the cardiovascular and musculo-skeletal systems.

Strength training included maximal and power weight lifting which are not considered to have a measurable effect on the physiology. Maximal strength is defined as the greatest force an athlete is able to exert for a given contraction of muscles (6). Power strength is the ability of an athlete to overcome resistances by a high speed of contraction (6). Flexibility training (also called stretching) is also considered a type of training activity. Stretching is included in the training program for 10 to 15 minutes before and after each training session.

Strength training was restricted to the preparation period because of the necessity of devoting training time to water training in the competition period. Maximal and power strength training took place once a week in October, twice a week in November, December and January and once a week in February.

Illustration 1: Training Models

Model	Recov minutes	Heart Rate	Stroke Rate	Km	Primary Training Effect
Boat Training					
Steady state					
1. Low	-	130-150	18-22	16-20	Utilisation 2
2. High	-	140-160	20-24	16-24	Utilisation 1
3. Alternative 20+20+20 min	-	160-170	24-28	16-20	Anaerobic Threshold
Anaerobic Threshold					
1. 3x12 min.	8'-10'	160-180	26-30	16-20	Anaerobic Threshold
Interval Training - Long					
1. 3-5x10 min.	6'-8'	150-170	24-28	16-20	Transportation
2. 3-8x5 min.	4'-6'	160-190	27-32	12-16	Transportation
3. 8-10x3 min.	2'-4'	160-190	26-34	12-16	Transportation
Rhythm Variations					
1. Long 4'-3'-2'-1' x 3 (24-30), (26-32) or (28-34)	8'-10'	160-190	24-34	14-20	Transportation Anaerobic Threshold Utilisation
2. Short 3'-2'-1'-1' x 3 (26-32), (28-34) or (30-36)	6'-8'	160-190	26-36	12-14	Transportation Anaerobic Threshold Utilisation
Interval Training - Short					
1. 30/20 or 30/15 strokes x 12 (2 series)	6'-8'	170-190	30-36	12-14	Transportation
2. 17/5 strokes x 10-20 (2 series)	8'-10'	170-190	32-34	12-14	Transportation
Interval Training - Race					
1. 2 x 2000m	6'-8'	170-190	32-34	8-10	Transportation
Super Compensation					
1. 6x500m	2'-3'	Max	Max	8-10	Anaerobic
2. 3x1000m	4'-6'	Max	Max	8-10	Anaerobic
Speed Training					
1. 1x1000 and 1x500m	10'-15'	Max	Max	6-8	Anaerobic
Land Training					
Running					
1. Steady state	-	130-160	-	4-12	Utilisation 2
2. Uphill	4'-7'	170-190	-	8-10	Transportation
3. In spurts 20/10 secx10-12	4'-6'	170-190	-	8-10	Transportation
4. Anaerobic threshold 3x2 km	4'-6'	160-180	-	8-12	Anaerobic Threshold

Model	Repetitions	Series	Exercises	Primary Training Effect
Weight Lifting				
1. Max strength	1-8	4-8	4-6	Strength
2. Power Strength	1-8	3-5	8-10	Strength
3. Endurance Strength	60-80	2-3	5-6	Utilisation 2
4. Circuit Training	30-90 seconds	1-3	8-10	Utilisation 2

Flexibility: 10 to 15 minutes before and after each training session.

Illustration 2: Example Training Program for the Month of April - Italian Rowing Federation, National Rowing Centre, Piediluco

Category - Senior Open and Lightweight
Period: April

Day	Program	Recov minutes	Heart Rate	Stroke Rate	Km
Monday	A) Steady state rowing	-	130-150	20-22	20
Tuesday	A) Warm-up: Steady state rowing	-	130-140	18-22	4-6
	B) Rowing interval training 4x5 min.	4'-6'	170-180	28-32	10-12
Wednesday	A) Warm-up: Steady state rowing	-	130-150	18-22	4-6
	B) Rowing interval training 30/20 strokes x 10 - 2 series	6'-8'	170-190	30-34	14-16
Thursday	A) Warm-up: Steady state rowing	-	130-150	18-22	4-6
	B) Rowing "rhythm variations" 4'-3'-2'-1' x 3	6'-8'	160-190	26-28 30-32	14-16
Friday	A) Warm-up: Steady state rowing	-	130-150	18-22	4-6
	B) Rowing interval training 8 x 3 min.	2'-3'	160-190	30-32	12-14
Saturday	A) Warm-up: Steady state rowing	-	130-150	18-22	4-6
	B) Rowing "rhythm variations" 3'-2'-1'-1' x 4	6'-8'	160-190	28-30 32-34	12-14
Sunday	A) Warm-up: Steady state rowing	-	130-150	18-22	4-6
	B) Rowing interval training 2 x 2000 meters	15'-20'	170-190	32-34	8-10

Note: Flexibility training should be performed 10 to 15 minutes before and after each training session. Heart rates indicated are suggested for an individual with a maximum heart rate of 200.

Primary Training Effects

The training models have been assessed for the physiological effects they induce. They have been placed into one of five intensity levels. The primary physiological adaptation of each training model was examined by analysing the percent of maximal heart rate, the content of lactic acid in the blood stream and the type of intracellular fuel used for energy production (see Energy Sources for Training Intensities in Table 2).

Table 2: Table of Energy Sources for Training Intensities

Principal Physiological Effects of Training	Energy Type Used	Percent of Maximal Heart Rate	Lactic Acid Produced (mMol/l)
Anaerobic	Glycogen	95-100%	Above 6.0
Transportation	Glycogen	90-95%	4.0 to 6.0
Anaerobic Threshold	Essentially glycogen with fatty acids	85-90%	4.0
Utilisation 1	Glycogen with fatty acids	75-85%	2.0 to 4.0
Utilisation 2	Essentially fatty acids with glycogen	65-75%	0 - 2.0

The following abbreviations have been given to the primary training effects or levels of intensity:
AN = Anaerobic
TR = Transportation
AT = Anaerobic Threshold U1 = Utilisation 1 U2 = Utilisation 2

The physiological parameters for these intensity levels are presented in Table 2.

Results

The results of the analysis are presented in minutes spent per category and percentage of total training in Tables 3 and 4. The results are presented in two basic formats: Table 3 presents all training during the preparation period and the competition period while Table 4 separates land training from water training in the preparation and competition periods.

Table 3: Training Time Divided Between Yearly Periods (minutes at training intensities, assuming an individual with a maximum heart rate of 200 beats per minute)

Principal Physiological Effects of Training	Preparation Period		Competition Period		Total	
	minutes	%	minutes	%	Minutes	%
Anaerobic	0	0	439	1.6	439	0.9
Transportation	600	3.0	1,946	7.3	2,546	5.4
Anaerobic Threshold	611	3.0	716	2.7	1,327	2.8
Utilisation 1	1,122	5.4	6,044	22.6	7,166	15.1
Utilisation 2	11,550	56.0	10,382	38.9	21,932	46.3
Recovery	3,226	15.6	3,857	14.4	7,083	15.0
Strength	1,265	6.1	0	0	1,265	2.7
Flexibility	2,250	10.9	3,322	12.5	5,572	11.8
Total	**20,624**	**100**	**26,706**	**100**	**47,330**	**100**

Discussion

Prior to the 1976 Olympics no national training program had been circulated, and the most popular training emphasis was interval training. In the period following the 1976 Olympics, the first attempt was made to distribute a national training program which failed. The program was based on the program of a middle distance track athlete and was untested for rowing. Upon the change in technical leadership, the present program was adopted in 1980.

Table 4: Training Time Divided Between Land and Water Training (minutes at training intensity)

Principal Physiological Effects of Training	Land Training				Water Training				Total	
	Preparation Period		Competition Period		Preparation Period		Competition Period			
	minutes	%	minutes	%	minutes	%	minutes	%	minutes	%
Anaerobic	0	0	0	0	0	0	439	2	439	0.9
Transportation	385	4	0	0	215	2	1,946	8	2,546	5.4
Anaerobic Threshold	232	2	0	0	379	4	716	3	1,327	2.8
Utilisation 1	0	0	0	0	1,122	11	6,044	26	7,166	15.1
Utilisation 2	4,050	38	0	0	7,500	75	10,382	44	21,932	46.3
Recovery	2,480	23	0	0	746	7	3,857	16	7,083	15.0
Strength	1,265	12	0	0	0	0	0	0	1,265	2.7
Flexibility	2,250	21	3,322	100	0	0	0	0	5,572	11.8
Total	**10,662**	**100**	**3,322**	**100**	**9,962**	**100**	**23,384**	**100**	**47,330**	**100**

Land training is 13,984 minutes, which is 29.5% of total yearly training time.
Water training is 33,346 minutes, which is 70.5% of total yearly training time.

In the present Italian national training program there is no mistaking the attention given to aerobic conditioning. The clear emphasis of the training program, revealed by the analysis, is on utilisation training. Rowing is considered to be 70 to 75 percent fuelled by the aerobic metabolism which this analysis confirms (3).

The peripheral adaptation achieved from utilisation training, however, is not the only reason for the extensive amount of training within that intensity range. The other reason is the necessity to automatise the rowing motion and, therefore, the rowing technique of the athletes.

Furthermore, to train the muscles to contract at the velocity used in 2,000-meter rowing races, most of the training within the transportation training models is intended to automates proper technique at approximately the contraction speed of racing velocity. Thus, biomechanical and neurological needs are served at the same time as physiological needs in the most effective way. The emphasis on the dual mission of training is, perhaps, one of the underlying reasons behind the success of the Italian system.

While training emphasis is not exactly the same, it is interesting to compare rowing's training emphasis to that in other aerobic sports. In a paper by Madsen and Lohberg (see Table 5), a brief analysis of training intensities is made for the long distance swimmer. This was selected because of the similar training and competition demands and the similarity in workout patterns. By converting the data of this paper into a compatible format to that of the swimming study (percentage of meters at each training intensity to total meters of training), we can compare use of energy sources in the two sports. We look also at the preparation and the competition periods of the training year (7). The training of the swimmer and the rower are very similar in the lower intensity ranges taken as a whole but differ in emphasis within those ranges.

One possible explanation for these differences in lower intensity training emphases can lie in the difference of the speed of muscle contraction between the two sports. In swimming, the contraction speed can approach 40 or 50 contractions per arm per minute combined with leg kicks. Rowing has a much lower contraction speed of approximately 35 per minute using all the major muscle groups in the body.

Table 5: Comparison Between Training Emphases in Swimming and Rowing (Percent of total meters of training)

Principal Physiological Effects of Training	Preparation Period		Competition Period	
	Long distance Swimmer	Rower	Long distance Swimmer	Rower
Anaerobic	0	0	3	1
Transportation	10	11	7	12
Anaerobic Threshold	40	27	40	4
Utilisation 1	30	8	25	50
Utilisation 2	20	54	25	33

Swimming research from O. Madsen and M. Lohberg, Germany, 1987.

Conclusion

This study has quantified the emphases of the physiological adaptations defined by the Italian national training program for rowing. While such a study could not be completed from the years before 1980, it is widely known that the primary training method utilised in leading Italian clubs was interval training. The reliance of the present Italian program on the peripheral adaptation of the utilisation intensity is striking. Close observation of the Italian coaches also reveals the dual purpose use of the lower intensity training to also automatise and perfect the technique of the stroke. The improved performance of Italian crews at the international level since 1981 is clear as is the highly disciplined technique exhibited by the rowers.

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