A COMPARISON OF TRAINING METHODS TO
DEVELOP MAXIMUM FITNESS FOR
BICYCLE ROLLER RACING

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PREFACE

The author gratefully acknowledges the assistance of his major advisor, Dr. A.B. Harrison, who has patiently directed the major aspects of this study and carefully examined the manuscript.

Sincere appreciation is expressed to the students who took part in the study for their faithfulness in exercising and for taking time from their busy schedules for the test periods.

I am grateful to Dr. John Bayless of Oklahoma State University for his suggestions concerning the statistical analysis of this study.

Appreciation is extended to Oscar Wastyn Custom and Imports of Chicago who supplied all bicycle equipment for this study; especially for his quick service during breakage periods when parts were desperately needed. A very special thanks to Mrs. Donna Dillard who efficiently typed this manuscript.

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CHAPTER I

INTRODUCTION

History

As a sport and a form of training, roller racing had its inception in Britain in 1931, when, at the first Cycling Best All-Rounder Concert, a race between eight of the leading riders of that period took place. Inspired by the popularity of what became an annual event, the man who introduced it, the late Herbert Goodwin, designed with the noted cycle manufacturer, F.H. Grubb, a set of eight rollers, geared to a giant dial carrying hands like a clock. These pointers went once round the dial for every quarter-mile ridden by the riders. Used for the first time in 1934, this equipment was the forerunner of the sets of "competition" rollers (four now normally make a set) in use throughout the country.

The rollers themself which had been previously known as "home-trainers," are quite simple. Three cylinders, with centre and spindles about 2 feet long and 8 inches in diameter, are mounted in bearings on a light frame which enable them to run freely off the ground. At the rear, two of the rollers are set close enough together to support the back wheel, and the front wheel rests on a single roller at the front which is adjustable to match the wheelbase of the bicycle. The front and middle rollers are linked by a leather driving belt. With practice the rollers are easily ridden, rhythmical momentum and confidence being all that is necessary.

Roller riding is different from road or track racing mainly in the speed that can be attained. The maximum speed of an unpaced cyclist riding on a flat track or good road is about 40 m.p.h. He is held back by wind or air resistance, and friction between tires and road. On the rollers, on an unrestricted gear, it is possible to achieve between 90 and 100 m.p.h., and to hold that speed for as long as 40 m.p.h. might be held on the road--about ten seconds. That road speed may be more than doubled on rollers is due to the absence of any air-drag and the great reduction of friction.

The officials for roller racing are much the same as those in track racing, but the machine examiner has an extra task. Gears for open races are restricted to 96 inches (48-14) and crank length to a minimum of 6½ inches. Speeds of around 90 m.p.h. can only be achieved on huge gears around 200 inches. Restrictions set forth by the American Bicycle League of America give all riders an equal chance; and, because it is easier to turn short cranks fast; obviously a like restriction must be placed an crank length.

In all other respects machines used for roller work are the same as track bikes. Some riders, however, find that breathing is helped by sitting almost upright, and to this end raise the bars and perhaps tilt them up, gripping the upended curves which are normally the drops.

There is some variety in the length and type of events included in the United States Roller Championship which stems from local and state championships. In part this is due to the limited number of rollers available and the exhaustive nature of the sport. Standard distances for men are one mile match races and one mile time trials; for juniors and girls, one-half mile match races and one-half mile time trials are conducted.

Whatever the races, and whoever the riders, a roller meeting is usually an enjoyable affair for spectators. Speeds are usually in the region of 60 m.p.h. There is plenty of colour, plenty of noise, nothing goes on too long; everyone seems to take sides in a friendly way, and most attractive of all, perhaps, the progress of the race is always apparant at a glance.

Statement of the Problems

Roller racing, a form of cycle sport, is rapidly becoming a popular sport here in the United States. From my personal experience over the past eight years in cycling and from discussions with fellow cycle enthusiasts, it seems essential that a proven method of training be devised in order to develop maximum fitness for roller competition. For this study three methods of training were chosen, using the interval system suggested by Frans Pouwels, former professional rider from Belgium, member of the Board of the American Bicycle League of America and coach of the United States Team for the Tour of Mexico.[1] The three interval methods were compared to determine which would develop one's maximal fitness for riding a one mile sprint for time. Specifically the three training methods were: Group A speed, Group B speed and endurance, and Group C endurance.

The subpurpose of this study was to compare the effect, if any, cycling has on specific fitness components.

Limitations of the Study

The subjects for this study were not a random sample but were volunteers who responded to an advertisement in the Daily O'Collegian. The original 30 subjects were reduced to 24 due to personal withdrawal. As in most statistical studies, a large sample provides a better replica of the entire population.

The initial learning period of riding rollers cut valuable time from the interval training program.

For measuring distances covered in a one mile sprint, a standard bicycle speedometer was used. However, in order to measure this distance accurately, a precise instrument would be of value. In future studies a striker that counts each wheel revolution should be considered.

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[1]Finley P. Gibbs, "Winter Training," American Cycling, December, 1966, p. 26.

This study had its discouragement and frustrations along with many enlightening moments. It can be stated that because of the subjects innate desire to sprint while lacking sufficient skill in riding rollers caused repair damages to be high. There were no relaxation periods for the examiner, and the difficulty of one person managing both subjects and equipment was occasionally an almost insurmountable handicap. The examiner felt, however, that to have an objective and reliable experiment it was essential to have one person do all measurements and recording of results.

Definition of Terms

Interval Training: a form of training featuring fast and slow pedalling. It involves five variable factors including: (1) the distance of the training ride, (2) the number of the repetitions of the training distance, (3) the speed of the training rides, (4) the duration of recovery period after each training ride, and (5) the type of activity (slow pedalling or stopping) during the recovery period after each training ride. Interval training involves repeatedly riding a specific distance at a predetermined speed, resting a specific period of time following each fast ride.[2]

Sprint: means to ride at full speed. Sprinting is

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[2]Fred Wilt, "How They Train," Run Run Run (California, 1964), p. 259.

riding at maximum possible speed. Since sprinting involves riding at maximum speed, there can be no such phenomenon as an "easy sprint."[3]

Physical Fitness: is the development of the body to a state or condition which permits the performance of a given amount of physical work, when desired, with a minimum of physical effort. The efficiency of physical effort depends upon the mutual development of the muscular respiratory, and circulatory systems integrated and coordinated by the activity of the central nervous system.[4]

Rollers: are three cylinders, each about 2 feet long and 8 inches in diameter mounted in bearings on a light frame which enables them to run freely off the ground. At the rear, two of the rollers are set close enough together to support the back wheel, and the front wheel rests on a single roller at the front which is adjustable to match the wheelbase of the bicycle.[5]

Track Bike. The primary requirement for this type of machine is maximum acceleration and control under near constant conditions: That is, level terrain, smooth pavements, banked board, cement or asphalt tracks. A single fixed gear is used which is predetermined by the competitor. The weight of the machine is approximately 18 to 20 pounds.

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[3]Ibid., p. 258.

[4]Ibid., p. 264.

[5]Kenneth Bowdan, Cycle Racing (London, 1958), p. 79.

Frame angles vary from approximately 75 degrees head and 73 degrees post with a slight rake in the fork. Frames of the professional class machines are constructed from the finest grade seamless steel, double butted tubing and are low temperature brazed. Wheelbase is approximately 39 to 40 inches. Wheels are tightly spoked with the finest grade high tensile spokes, and occasionally tied and soldered for additional rigidity. Tubular tires of 4 to 8 ounces carrying air pressures of approximately 125 pounds per square inch are utilized. These tires are constructed from either very high grade cotton or natural silk. No brakes are utilized, the cycle being stopped by counter pedalling and the use of the gloved hand on the front tire. Road clearance of the bottom bracket is approximately 10½ inches or fractionally more with cranks of 6½ inches commonly used. (High hanger clearance is necessary so the pedals will not hit the track banking). When comparing these specifications with other models, you will note the rigidity of frame design which has the primary purpose of getting the most efficient forward motion from each thrust of the pedals.[6]

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[6]Gene Portuesi, "The Bicycle for You," <u>Cyclo-Pedia</u> (Michigan, 1966), p. 8.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

In years past the prime objective of roller riding has been to maintain fitness during the off season winter months. Until now, it has never been looked at as a strict means of training for a local, state, or national championship. As such, we will consider related literature from other disciplines.

Related Information

Keeping our problem in light focuses on the all important fact that training is important. But what type? Frans Pouwels, former professional rider from Belgium, member of the Board of the American Bicycle League of America and coach of the United States Team for the Tour of Mexico is a firm believer in interval training. He states "interval type training is the best for riding the rollers, especially if you want to compete in roller races.[1] Nick Zeller, the Pacific Northwest Roller Racing Champion,

[1]Finley P. Gibbs, "Winter Training," American Cycling, December, 1966, p. 26.

with a 2:55 4,000 meter to his credit is a user of the interval method.

The principle of interval training which forms the basis of developing speed and endurance evolved in 1920 by Lauri Pikhala, a Finish track coach.

The specific effect created in fast and slow interval training is in the rate itself: the high speed is the real stimulus on the muscular system, or more exactly on the muscle-metabolism. The lower speed itself is merely the pre-condition which triggers off the active stimulus in the recovery interval (i.e., in the power) as the reaction in the recovery pause leads to a markedly greater heart capacity. This large heart capacity results in the heart itself becoming bigger. Thus the conditioning of the heart and the circulation is brought about in interval training mainly in the recovery pauses. Thus, by choosing fast and slow speeds for training, one can condition the heart as well as the muscles; at slow speeds it is clearly the heart and the circulation that are affected and the effect is transferred to the recovery pause. At high speeds, however, (resulting in a very high heart rate), the training mainly affects the muscular system and stimulus takes effect during the run itself, the recovery pause being valuable only as a "period of respite."[2]

With this in mind, training with repeated short, fast

[2]Fred Wilt, "How They Train," Run, Run, Run (California, 1964) p. 229.

runs is an excellent method of developing endurance in addition to producing the ability to tolerate the stress of pace at a very fast rate over middle-distances.[3]

Saddle Position

The bicycle, properly fitted to its rider, can be a marvellously efficient means to translate your energy into motion. To effectively use its advantages the bicycle must fit you. Each individual varies in his proportions--his leg length and foot length. To make proper use of the entire team of muscles, the body weight must be placed to assist propulsion, arms and legs positioned so that muscles are used naturally and effectively. The saddle should be positioned, its top level, its nose about 2 inches behind a vertical line through the crank center. With the pedal at its lowest point, the heel placed on the pedal, the saddle should be raised until the leg is straight. Avoid, like the plague, the common tendency to place the saddle lower, since this uses leg muscles in an inefficient and fatiguing manner.[4] For many years the ranks of international cyclists have used this method as a means of efficient cycling. As such, the writer used the recommendation in his study.

Vaughn Thomas, who is presently doing research for his

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[3]Ibid., p. 45.

[4]Kenneth Bowden, Cycle Racing (London, 1958), p. 96.

doctorate at Longhborough University in England, has completed a study on "Scientific Setting of Saddle Position." The saddle heights were respectively 105, 109, 113, and 117 per cent of inside leg, the measurements being obtained of saddle height from pedal spindle to top of saddle, along the line of the seat tube of inside leg from floor to the bone in the crouch, known as pubic symphasis palpation, subject standing without shoes. The experiment showed very conclusively (significance level of better than 0.1 per cent) that for a short duration task of power output on a bicycle, alterations in saddle height of 4 per cent of inside leg measurement affected output by approximately 5 per cent. The most efficient saddle height in this study is 109 per cent of inside leg measurement.[5]

The recommendations above appear applicable for both racing and touring and deserve careful attention, rereading, and filing for future reference.

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[5]Vaughn Thomas, "Scientific Setting of Saddle Position," American Cycling, June, 1967, p. 12.

CHAPTER III

METHODOLOGY

Selection of Subjects

The data for this study was obtained from 24 volunteer subjects who were trained, observed, and tested at intervals during the first eight weeks of the 1966 fall semester. These subjects were secured from an advertisement which was placed in the Oklahoma State University paper, The Daily O'Collegian, asking for male volunteers to participate in a cycling fitness experiment. Volunteers were required to ride a bicycle three days per week, ten minutes per day, for eight weeks. Thirty male subjects ranging in ages from 19 to 27 responded and were scheduled so that each subject would be given identical conditions under which to proceed.

Administrative Procedures

Subjects were instructed to dress in typical gym attire: sneakers, shorts, and T-shirts. The first two weeks were devoted to learning how to ride rollers as well as testing individual fitness. The following physical fitness tests were administered at the beginning and end of the program in order to determine the effect bicycle riding had on these specific fitness components.

Fifty Yard Dash. Testing for the fifty yard dash, a measure of speed was conducted on the indoor 160 yard dirt track at Oklahoma State University. Students dressed as previously stated; no track shoes were allowed. The equipment used was a stopwatch and a clip-board for recording individual times. The starter positioned himself at the finish line with his hand raised high above his head, while the student started from a position behind the starting line. On the command "take your mark . . . get set . . . go!" and the quick movement of the starters hand down, the runner sprinted as fast as possible. As the subject crossed the finish line, the tester stopped the clock, both noting and recording the student's time.

The subjects ran the fifty yard dash twice with a rest period which varied in length according to when the individual felt he recuperated and was ready for his final trial. The best time was noted, recorded, and used in further statistical analysis.[1]

Leg Strength. The dynamometer used for this test was devised by Dr. A.B. Harrison of Oklahoma State University. Original plans were developed in 1959 by Mary A. Heintz, who showed a reliability of .90 (test-retest method) and

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[1]Edwin A. Fleishman, The Structure and Measurement of Physical Fitness (New Jersey, 1964), p. 174.

validity of .75 (criterion Narrangansett back dynomometer).[2] The equipment called the tennometer consisted of a homemade apparatus which was constructed from a 2 inch by 12 inch board 6 feet long for the base or platform. The lever section was a 4 inch by 4 inch by 5 feet board connected with a metal hinge to the fulcrum, a 4 inch by 4 inch block bolted to the platform. Near the fulcrum and under the lever were the bathroom scales which were read in pounds. At the end opposite the scales the subject stood, straddling the lever with his feet on the edge of the platform. Attached to this end of the lever was a chain which was, in turn, attached to a padded bar that rested across the subject's thighs. The length of the chain was adjusted to fit each subject, determined by the distance from the platform to the top side of the subject's thighs when he bent his knees to an approximate 115 degree to 120 degree angle. To prevent the padded bar from slipping off the subject's thighs, the bar was secured by cotton webbing tied around the subject's waist.

When in the bent knee position and ready, the subject applied pulling force to the bar by extending the knees, thus exerting force on the lever. Force was measured in pounds on the scales at the opposite end of the lever. The subject had three recorded trials with his best showing of leg strength used for computing. Since there was a 3-1

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[2]Mary A. Heintz, "Device for Testing Back Strength," Research Quarterly, XXXIII, December, 1962, p. 638.

ratio between the fulcrum and the lever the scale reading was multiplied by three to get leg strength. The above procedures have been suggested by Dr. Cureton.[3]

Grip Strengh. A Cable Tensiometer manufactured by Pacific Scientific Company was used for this test. In performing this test the tensiometer was placed into the palm facing up. The squeeze was even with the thumb touching or overlaping the first finger upon maximum squeeze. The subjects were allowed three trials with each hand, the best score being recorded.[4]

Vital Capacity. For testing lung capacity, a wet spirometer was used for measuring in cubic inches. The subject stood erect and took one or two deep breaths before the test. Having inhaled fully, he placed the mouthpiece in his mouth, and slowly expelled all the air in his lungs. All air was expelled as he bent slowly forward as he finished. The tester watched the cubic inch indicator as it rose and recorded the highest point. Each subject was given three trials with his best noted and recorded for future statistical analysis.[5]

Reaction Time Test. This test utilized a device known as the Athletic Performance Analyzer (APA) manufactured by

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[3]Thomas Cureton, Physical Fitness Appraisal and Guidance (St. Louis, 1947), p. 364.

[4]Ibid., p. 361.

[5]Carl Willgoose, Evaluation in Health Education and Physical Education (New York, 1961), p. 133.

the Dekan Timing Device Company of Glen Ellyn, Illinois. It consists of a control switch, a response key, and an electronic chronoscope used in measuring subject's reaction time to a sound stimulus to the nearest one hundredth of a second. For testing procedure, the subject placed his hand around the target handle with thumb gently on the button. The tester proceeded to set the timer rheostat which in this study controls the auditory stimuli (sound). As soon as the subject heard the sound, he depressed the button which stopped the clock. The subject made fifteen trials of which the mean was computed and considered to be each subject's reaction time.

Vertical Jump Test. Procedures for testing subject's vertical jumping ability is taken from the Indiana Physical Fitness Test. In the jump and reach test a blackened 1/4 inch board about 6 feet long and 1 foot wide was mounted up against a wall. The board was marked off in 1/2 inches and was powdered with chalk. The index fingers of both hands were wet by the tongue. The subject reached as high as possible with heels kept on the floor and made a mark on the board with his wet fingers. He next executed three jumps from a crouched position, making a mark each time on the board. The distance from the top of the reach mark to the top of the highest jump mark were recorded as his score.[6]

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[6] Ibid., p. 146.

Bicycle Ergometer Test. The Monark Ergometer determines the amount of work which the subject can do in a given period of time and is directly associated with measurements of muscle endurance and circulo-respiratory endurance. For testing purposes the following procedures were employed with the main objective of correlating the rate of the unconditioned heart, to the rate conditioned by the interval training program:

A. Adjust the height of the saddle and handle-bars.

B. With the subject seated on the bicycle, but without touching the pedals, set the mark on the pendulum weight at "0" on the scale.

C. Begin the work, start the clock, set the desired load (2 1/2 or 3 kiloponds) and check the load at minute intervals.

D. At the end of each minute take the time for 30 heart beats.

E. Normally, six minutes will suffice to give relatively constant pulse values. After that time, either discontinue the test or continue testing until a constant heart rate is determined.

F. Note and record constant heart rate.[7]

Grouping. The last day of a two week learning period was devoted to testing subjects in order to determine their ability in riding a one mile sprint. Procedure can be

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[2]Per Olaf Astrand, Work Tests With the Bicycle Ergometer (Sweden), p. 26.

noted under Mile Sprint Test. Times recorded were examined and subjects were placed randomly into three different interval training groups so as to equalize initial mile ride times. These groups are designated Group A with emphasis on speed, Group B emphasizing speed and endurance, and Group C emphasizing endurance. By equalizing these groups at the start of six weeks of specific training it may be possible to determine the best training method for roller racing.

Training Programs.

Group A

1½ minute warm up at 50 rpm.

1 minute flat out ride and a 1 minute rest - repeat.

30 seconds flat out ride and a 30 second rest - repeat.

15 seconds flat out ride and a 30 second rest - repeat.

30 seconds of 5 second sprints followed by 5 second rests.

30 seconds taper off period.

Group B

1½ minute warm up at 50 rpm.

2 minute ride at 7/8 effort - rest 1 minute.

2 minute ride at 7/8 effort - rest 2 minutes.

60 seconds of 10 second sprints followed by 10 second rests.

30 second taper off period.

Group C

1½ minute warm up at 50 rpm.

3 minute ride at 3/4 effort - rest 1½ minutes

1 minute ride at 7/8 effort - rest 1 minute.

10 seconds all out sprint - rest 30 seconds - repeat.

10 seconds all out sprint.

30 seconds taper off period.

Training Procedure. All three training groups were designed with a total time element of 10 minutes. Main differences lie in the duration and intensity of each effort.

Since each subject trained 10 minutes per day, two days per week with the third day being mile sprint day the general procedures were as follows:

1. Each subject dressed as previously stated.
2. Each subject adjusted saddle height to his specifics.
3. Each subject mounted and warmed up for 1 1/2 minutes.
4. Each subject worked according to his specific training program (a clock was easily seen).
5. Each subject tapered off (warmed down) for 30 seconds.

Equipment. The equipment must be set up properly for testing as it is an important function of roller racing. Because of the lack of wind resistance and rolling friction, standardized gear and crank sizes are set forth by the American Bicycle League of America.[8] With this in mind,

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[8]Racing Rules and Regulations (New York, 1966), p. 18.

all tests were made with a 48 X 14 gear (1 1/2 inch pitch) and a 6 1/2 inch crank. Tires chosen were Hutchinson of heavy 13 1/4 ounce quality, to maximize rolling friction. They can be purchased through Hutchinson, Via Nerviano, 31-P.O. Box N. 1 Lainate (Milano) Italy.

In order that maximum efficiency is employed, the saddle height was adjusted to suit the individual. "Extending the leg fully, you should just be taking the weight off your leg with the heel of your shoe on the pedal. This is the maximum height permitted even for racing."[9]

Mile Sprint Test. Determining the amount of improvement from each interval training program was conducted by means of riding a one mile sprint on the third (last) riding day of each week. In all, six times were recorded for each subject. Testing was as follows:

1. Each rider received a 1/4 mile warm-up period.
2. At a predetermined speed of 20 m.p.h., the administer gave the command, "ready, go!"
3. Speeds and distances at each 1/4 mile were given so that the rider was able to judge maximum effort output.
4. At the completion of the mile, riders were told to stop.
5. Five minutes of riding was allowed for cooling off.

In conducting the above test, a speedometer and stop

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[9]Ron Kitching, Everything Cycling (England, 1964), p. 4.

watch were used to determine the time consumed in covering the one mile ride. Results were noted and recorded as to date, timed ride, and general feeling of the rider. Riding time was computed into miles per hour.[10]

Analysis of Data

The analysis of variance was performed on Group A, B, and C to determine if there was a significant difference at the 10 per cent confidence level between initial and final mile sprint times.

Mean scores were recorded for all first and final fitness test, and t-ratio's were calculated to see if a significant difference existed between initial and final test means.

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[10] *Cycling Speed Tables* (London, 1966), p. 92.

CHAPTER IV

RESULTS

This study attempted to determine which of three training programs would develop an individual to the maximum of his ability for riding a one mile sprint. A secondary purpose was to determine the effects, if any, these bicycle training programs had on specific fitness components. The data in the following tables reflect the answers as found in this study.

TABLE I

GROUP MEAN MILE SPRINT TIMES CALCULATED IN MINUTES AND SECONDS

Groups	Initial	Final	Difference
A	1.48	1.39	.9
B	1.47	1.41	.6
C	1.48	1.40	.8

TABLE II

ANALYSIS OF VARIANCE AT 10 PER CENT LEVEL FOR MILE SPRINT TIMES

Source	d.f.	Sum of Squares	Mean Square	f
Total	23	2813.6		
Among Groups	2	-71.7	35.85	cal. = .275
Within Groups	21	2741.9	130.6	f.90 = 2.57

Table I shows the mean improvement in mile sprint time to be 9 seconds for Group A (speed).

In Group B (speed and endurance) the mean improvement in mile sprint time was 6 seconds.

In Group C (endurance) the mean improvement in mile sprint times was 8 seconds.

Table II, the results of the analysis of variance, showed that the f-ratio was not larger than the 2.57 which the f table gives as the expected ratio for a difference at the 10 per cent level of significance. However, while noting that no statistical significance existed the writer tends to believe that Group A's improvement was more significant than that of Group B or C calculated in terms of distance traveled at 40 m.p.h. Also the fact that the actual training program lasted only six weeks was probably a contributing factor to the small improvement and close final differences.

As much as a shortcut or a secret way to training success is desirable, there seems to be no substitute for vigorous, prolonged work. All factors being equal, the best training would seem to be doing the greatest amount of work with the greatest energy expenditure.

TABLE III

GROUP MEAN 50 YARD DASH
IN SECONDS

Groups	Initial	Final	Difference	t
A	6.825	6.725	.100	1.62
B	7.025	6.762	.263	2.18
C	6.825	6.612	.213	2.33

t-ratio of significance at the 10% level - 1.77

Table III demonstrates the average increase in 50 yard dash time to be .100 for Group A.

In Group B, the average increase in 50 yard dash time was .263 seconds.

In Group C, the average increase in 50 yard dash time was .213 seconds.

The average improvement for Group A, B, and C combined was .192 seconds.

The analysis of the experimental data showed that there was a significant difference between the initial and final 50 yard dash times of Group B and C. The required t-ratio for significance at the 10 per cent level of confidence was 1.77 for 7 degrees of freedom. The obtained t-ratio of Group B and C are respectively 2.18 and 2.33 while Group A fell to 1.62.

Since all subjects were basically unfit at the initial test and showed a mean improvement it can be stated that bicycle riding improves ones speed, when centered around a training program of speed and endurance.

TABLE IV

MEAN LEG STRENGTH IN UNCORRECTED POUNDS

Groups	Initial	Final	Difference	t
A	220.63	225.13	4.50	1.01
B	210.13	212.88	2.75	1.14
C	211.25	217.13	5.88	1.17
t-ratio for significance at 10% level			-	1.77

Table IV shows the mean improvement in leg strength was 4.50 pounds for Group A.

In Group B, the mean improvement in leg strength was 2.75 pounds.

In Group C, the mean improvement in leg strength was 5.88 pounds.

The required t-ratio for significance at the 10 per cent level of confidence is 1.77 for 7 degrees of freedom.

The obtained t-ratio for Groups A, B, and C are respectively 1.01, 1.14 and 1.17 which indicates no statistically significant difference in any group. However, since improvement from all training groups occurred it can be stated that bicycle riding appears to improve leg strength to a certain degree.

TABLE V

MEAN RIGHT HAND GRIP STRENGTH IN POUNDS

Group	Initial	Final	Difference	t
A	135	138	3	
B	130	132	2	
C	128	138	10	2.19

t-ratio for significance at 10% level - 1.77

TABLE VI

MEAN LEFT HAND GRIP STRENGTH IN POUNDS

Group	Initial	Final	Difference	t
A	125	131	6	
B	121	128	7	1.21
C	129	130	1	

t-ratio for significance at 10% level - 1.77

Table V shows the mean improvement in right hand grip strength to be 3 pounds for Group A.

In Group B, the mean improvement in right hand grip strength was 2 pounds.

In Group C, the mean improvement in right hand grip strength was 10 pounds.

The mean improvement in right hand grip strength for Group A, B, and C combined was 5 pounds.

Since Group C on right hand tests showed the greatest improvement, a t-ratio was performed to determine if a significant difference existed between initial and final grip tests. The required t-ratio for significance at the 10 per cent level of confidence was 1.77 for 7 degrees of freedom. The calculated t of 2.19 showed a significant difference. No further calculations were made because of the small differences of improvement in Group A and B.

Table VI shows the mean improvement in left hand grip strength to be 6 pounds for Group A.

In Group B, the mean improvement in left hand grip strength was 7 pounds.

In Group C, the mean improvement in left hand grip strength was 1 pound.

The mean improvement in left hand grip strength for Group A, B, and C combined was 4 1/2 pounds.

Since Group B on left hand tests showed the greatest improvement, a t-ratio was performed to determine if a significant difference existed between initial and final grip tests. No significant difference existed, for the calculated t of 1.21 fell below the 10% significance level of 1.77.

Theoretically Group A should improve the most since one's grip is used more during sprint training. No explanation can be found for the greatest improvement of Group C the right hand, and Group B of the left hand. However, since all groups showed some improvement it can be stated that bicycle riding appears to improve grip strength to a small degree.

TABLE VII

MEAN GROUP VITAL CAPACITY
IN CUBIC INCHES

Groups	Initial	Final	Difference	t
A	291	303	12	1.64*
B	294	312	18	1.44*
C	294	307	13	1.42*
A-B-C	293	307	14	1.47**

*t-ratio for significance at 10% level - 1.77

**t-ratio for significance at 10% level - 1.71

Table VII shows the mean improvement in vital capacity was 12 cubic inches for Group A.

In Group B the mean improvement in vital capacity was 18 cubic inches.

In Group C the mean improvement in vital capacity was

13 cubic inches.

The required t-ratio for significance at the 10 per cent level of confidence was 1.77 for 7 degrees of freedom. The obtained t-ratio of Group A, B, and C were respectively 1.64, 1.44, and 1.42. A combined t-ratio of groups was next computed at 23 degrees of freedom (1.71) and found to be 1.47. While no statistical difference existed it can be stated that bicycle riding does appear to improve vital capacity. All groups showed a consistent improvement in vital capacity, some approaching the required level of significance.

TABLE VIII

GROUP MEAN REACTION TIME
IN SECONDS

Group	Initial	Final	Difference
A	.169	.165	.004
B	.157	.154	.003
C	.163	.158	.005

Reaction times noted in Table VIII were taken with the purpose of determining its influence on mile sprint times. Since Group A had the fastest mile sprint times and the slowest reaction times it can be stated that speed and reaction times in this study were not related.

TABLE IX

GROUP MEAN VERTICAL JUMP
IN INCHES

Groups	Initial	Final	Difference	t
A	20.63	20.13	-.50	
B	20.31	20.0	-.31	
C	20.13	20.94	+.81	1.27
t-ratio for significance at 10% level			-	1.77

Table IX shows the mean difference to be a negative .50 inches for Group A.

In Group B, the mean difference was a negative .31 inches.

In Group C, the mean difference was a positive .81 inches.

Since Group C was the only group to improve a t-ratio was performed to see if this improvement was statistically significant. A required t-ratio of 1.77 was necessary for significance at the 10 per cent level of confidence. The obtained t-ratio at 7 degrees of freedom was 1.27 which lead to a conclusion that this improvement was not statistically significant.

No explanation is apparent for Group C's improvement, except that something within its program contributed to its improvement. Future studies are needed to determine whether these observed effects on vertical jump ability are due to the training programs or merely to individual variations and chance errors in measurement.

TABLE X

MEAN HEART RATES - BEAT PER MINUTE ENDING A 5 MINUTE BICYCLE ERGOMETER RIDE

Groups	Initial	Final	Difference
A	148	130	18
B	147	130	17
C	154	143	11

TABLE XI

ANALYSIS OF VARIANCE BETWEEN GROUPS AT 10 PER CENT LEVEL FOR MEAN FINAL HEART RATES

Source	d.f.	Sum of Squares	Mean Squares	f
Total	23	3272.4		
Among Groups	2	-833.4	416.7	cal. = 3.581
Within Groups	21	2444.0	116.38	f.90 = 2.57

TABLE XII

ASTRAND BICYCLE ERGOMETER TEST PREDICTING O_2 INTAKE IN LITERS PER POUND

Group	Initial Classification	Final Classification	Difference
A	3.2-Average	4.1-Very High	.9
B	3.1-Average	3.9-High	.8
C	2.8-Somewhat Low	3.2-Average	.4

Table X and XII represent the results of a standardized work capacity test developed by Dr. Astrand to predict maximum O_2 intake. The test is performed at a set work load on a bicycle ergometer in order to determine the heart rate. Heart rates are taken every minute for 5 minutes until a steady state is reached. The most important use for the work test described is to determine objectively whether the circulatory training has been effective.

Table X shows the mean improvement in heart rates were 18 beats per minute for Group A.

In Group B, the mean improvement in heart rates was 17 beats per minute.

In Group C, the mean improvement in heart rates was 11 beats per minute.

The mean improvement for Group A, B, and C combined was 15 beats per minute.

Table XI, the results of the analysis of variance performed on mean final heart rates showed that the f-ratio was larger than the 2.57 which the f table gives as necessary for a significant difference at the 10 per cent level.

Table XII shows a conversion of heart rates into mean predicted O_2 intake for each group.[1]

Group A's initial O_2intake of 3.2 (average) improved to a very high O_2 intake of 4.1 liters per minute.

Group B's initial O_2 intake of 3.1 (average) improved to a high O_2 intake of 3.9 liters per minute.

Group C's initial O_2 intake of 2.8 (somewhat low) improved to an average O_2 intake of 3.12 liters per minute.

While noting a statistical significance existed, it can be stated that a training program centered around a great amount of work and high energy expenditure was beneficial in developing cardiovascular efficiency and work capacity as measured by the Astrand test.

Summary

To better understand the effects three different training programs had on specific fitness components the following summary is in order:

Components Which Improved Significantly.

1. Fifty yard dash - Group B and C.
2. Heart rate - All groups.
3. Maximum O_2 intake - All groups.

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[1]Per Olaf Astrand, Work Tests with the Bicycle Ergometer (Sweden), p. 29.

4. Grip Strength - Right hand, Group C.

<u>Components Which Improved Consistently but Not Significantly</u>.

1. Reaction time - All groups.
2. Fifty yard dash - Group A.
3. Vital capacity - All groups.
4. Grip strength - Right hand, Group A and B.
   - Left hand, all groups.
5. Leg Strength - All groups.

<u>Components Which Apparently Were Not Affected</u>.

1. Vertical jump - All groups.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

The primary purpose of this study was to determine which of three interval training programs would develop an individual to the maximum of his ability for riding a one mile sprint. The three interval training programs consisted of Group A (speed), Group B (speed and endurance) and Group C (endurance).

On the basis of the data collected in this study the following conclusions were made:

1. No statistical significance existed between the three training groups studied.
2. A's improvement was greater than that of Group B or Group C.
3. C's improvement was greater then B's.

A secondary purpose was to determine the effects, if any, these bicycle training programs had on specific fitness components.

On the basis of the data collected in this study the following conclusions were made:

1. A statistical significance existed in Groups B and C for improvement in the 50 yard dash. Group A showed the smallest improvement in 50 yard dash

time but was not significant.

2. A statistical significance existed in all groups for improvement in heart rates after a 5 minute bicycle ergometer test and predicted maximum O_2 intake.
3. A statistical significance existed in Group C's improvement of right hand grip strength. Improvement occurred in Groups A and B of the right hand and in all groups tested with the left hand.
4. Reaction time showed a small improvement of all groups between initial and final times.
5. Vital capacity showed a consistent improvement in all groups.
6. Leg strength showed a small improvement of all groups between initial and final tests.
7. Vertical jump showed a very small improvement in Group C while Groups A and B showed no improvement.

The author recommends that future tests be conducted with more subjects over a longer period of time, under similar conditions, using a more accurate instrument in measuring distance traveled.

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