# A COMPARISON OF THE EFFECT OF TWO INTERVAL TRAINING FREQUENCIES ON PHYSICAL WORKING CAPACITY AND RUNNING SPEED IN UNTRAINED SUBJECTS UNDER CONSTANT WEEKLY WORK LOADS



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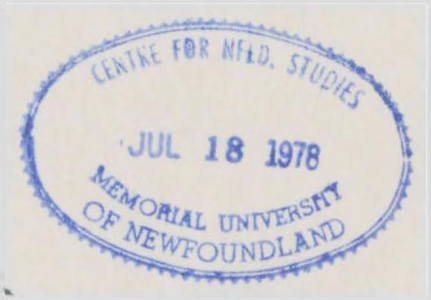
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# A COMPARISON OF THE EFFECT OF TWO INTERVAL TRAINING FREQUENCIES ON PHYSICAL WORKING CAPACITY AND RUNNING SPEED IN UNTRAINED SUBJECTS UNDER CONSTANT WEEKLY WORK LOADS

by

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# ABSTRACT

The purpose of this study was to determine the effect of two interval training frequencies, on physical working capacity and running speed, when using untrained subjects and a constant work load.

Eighteen untrained male subjects were divided into three matched groups, according to their placement in a modified Barrow zig zag run. Group one trained four times per week, group two trained two times per week and group three acted as a control group. All subjects received a pre and post test in a PWC-170 Test, a Shuttle Run and a Modified Barrow Zig Zag Run. The F-Test and Newman-Keuls Test were administered in the statistical analysis of the data.

The results indicated that there was a significant difference between group one and group three and group two and group three in all tests used in the study. There were no significant differences between the two experimental groups.

It was therefore concluded that training at a frequency of two times per week was just as effective as training four times per week in improving running speed and physical working capacity.

ACKNOWLEDGMENTS

The researcher expresses sincere appreciation to C. Higgs and D. Szvetko for their guidance and assistance in making this study possible.

The researcher would also like to express appreciation to the wardens and administrative staff of Her Majesty's Penitentiary for their assistance in carrying out this study.

The researcher will always be grateful to those inmates at Her Majesty's Penitentiary who so faithfully gave their time and efforts to this study.

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# INTRODUCTION

# CHAPTER I

## INTRODUCTION

Coaches and physical educators over the years have debated the question: How much and how often should athletes be trained? Current demands on time and the use of facilities has made the question more difficult. Coaches have often found themselves in situations where they had to decide which training program was best. For example, either, to train twice a week for two hours per session or, to train four times per week for one hour per session. With this in mind, and keeping the weekly work load constant, it is hoped that this study will shed some light on the question of frequency of training.

The process of progressively increasing exercise stress on one or more systems of the living body for a period of time is referred to as conditioning or training (19). Mathews (25) states that there are five physiological changes which may be brought about as a result of a conditioning program:

- increase in strength
- increase in muscular endurance
- increased flexibility of joints

- better neuro-muscular coordination

- increased cardiovascular or cardiorespiratory endurance.

Increases in endurance can be brought about by both continuous and by interval training. Studies by Harper (18), O'Brien (26), and Webb (32) are but a few which indicate that interval training is an effective way of conditioning. These studies have specifically shown interval training to be an effective method of increasing a subject's ability to utilize oxygen. Mathews, et al., (25) have stated that the single most important factor in physical conditioning is the ability to utilize oxygen.

Soccer players, like most other players involved in team games, use interval training of one form or another to raise and maintain a particular level of fitness for competition.

According to Fried (16), the main merit of interval training for soccer is its similarity to soccer; the player undertakes short bursts of maximum activity, alternating with recovery periods of light activity. A typical regime would comprise sprints of a few hundred meters for thirty to forty seconds, alternating with slow jogging for a similar period of time.

The training program used in this study had been

used by national, provincial and local soccer teams. It consisted of shuttle running one hundred and fifty yards in a time of thirty-five seconds, alternating with a recovery period of thirty-five seconds.

## Statement of the problem

The purpose of this study was to compare the effectiveness of training at frequencies of two times per week and four times per week on physical fitness.

A Physical Work Capacity Test (PWC-170) was used to measure the aerobic capabilities, or the amount of work each subject could do at a heart rate of one hundred and seventy beats per minute. This test indicates the efficiency of the cardiorespiratory system.

A modified Barrow zig zag run and a shuttle run were used to measure running speed and agility. Soccer players, as well as players of other team games, require running speed and agility of movement in order to be successful. These tests provided the examiner an opportunity to measure running speed while the subjects changed direction and stopped and started.

## Selection of testing procedures

The variables which were tested in this study were chosen because they each required, for success, a

particular aspect of fitness, essential to such team games as soccer.

The PWC-170 Test was used to measure the cardiorespiratory efficiency of the subject. Endurance sports such as soccer require a well developed cardiorespiratory system. The test used was similar to that which was used by Adams, et al., (1). The test consisted of two consecutive five-minute bicycle ergometer rides, in which the work loads were selected to produce heart rates of approximately one hundred and thirty-five to one hundred and fifty beats per minute. The working capacity was calculated by plotting (on graph paper) the heart rate against the work load at the end of each trial. A straight line was drawn through the two points to intersect the line of one hundred and seventy beats per minute. The estimated amount of work that corresponded to a heart rate of one hundred and seventy was then recorded as the subject's PWC-170.

The heart rate of one hundred and seventy was used because this is generally accepted as the level above which no significant increase in work load occurs (11).

A Modified Barrow Zig Zag Run was used as a measure of speed and agility. This test was administered as outlined by Barrow (4), with one exception. An obstacle was placed on each corner and in the center of a rectangle

whose dimensions were ten yards by sixteen yards. (Barrow used ten feet by sixteen feet.) This change was necessary so that the distance covered was realistic and comparable to distances that might be covered in the game of soccer.

The subjects traversed this maze of obstacles three times, in a figure of eight pattern, with the center obstacle always to his right. The subject was not permitted to grasp any of the obstacles.

The score for the test was the time required to traverse the course three times. Times were recorded to the nearest tenth of a second. If a subject fell or failed to execute the course correctly, the subject was permitted a second trial.

The Shuttle Run was also administered to measure speed and agility. This test was administered as outlined in item four of the Canada Fitness Test Manual (7), with one exception. This change in procedure was necessary, so that the technique of rising to ones feet from the prone position would be eliminated. It was felt that this technique would greatly affect the times. Furthermore, it was a technique not necessary for measurement of running speed.

Two blocks of wood were placed thirty feet from a starting line. From a standing position behind the start line, the subject, on the starting signal ran to

the blocks. He picked up one block, and returned to the starting line and placed the block behind the line. He then returned for the second block and raced back across the starting line, still holding the block. Two trials were allowed, with the fastest time being recorded.

Significance of the problem

There are a number of factors which made this study a significant one. There is a definite need in both physical education and athletics to replace subjective observations and judgement with objective measurement which is scientifically based.

Athletic coaches have an obligation to do the best possible job of conditioning those athletes with whom they work. They must ensure the welfare and safety of these athletes, and also help them reach levels which their potentials will permit. It is also essential that the amount of time necessary for the conditioning process be scientifically determined. Increased emphasis on sport and a greater effort to excel has brought about the idea that more frequent training results in better conditioning.

Finally, time is of the essence in our society today. Limited pre-season conditioning time in athletics, due to the tremendously increased time necessary to ade-

quately handle other pressures of today's society, are all further justifications for this study.

## Hypotheses

### Hypothesis one

1. There is no difference in physical work capacity when training two times per week as compared to training four times per week, with untrained subjects, when the weekly work load is the same.

### Hypothesis two

2. There is no difference in running speed as measured by a shuttle run when training two times per week as compared to training four times per week, with untrained subjects, when the weekly work load is the same.

### Hypothesis three

3. There is no difference in running speed as measured by a modified Barrow zig zag run when training two times per week as compared to training four times per week, with untrained subjects, when the weekly work load is the same.

### Statistical hypotheses

| | | |
|---|---|---|
| $Ho_{WC}$ | $U_1 = U_2$ | Where $U_1$ represents training two times per week, and $U_2$ represents training four times per week. |
| $Ho_{SR}$ | $U_1 = U_2$ | |
| $Ho_{ZZ}$ | $U_1 = U_2$ | |

Hypotheses will be tested at the 0.05 level.

Limitations of the study

The subjects at Her Majesty's Penitentiary, in St. John's, Newfoundland, received a one hour recreation period in the gymnasium per week. The amount and type of activity during this one hour weekly period could not be controlled. Those who were involved in the study were asked not to run through the training exercise, or any other similar exercise during this recreation period.

Definition of terms

Untrained: Any person who has not been involved in a regular training program within three months prior to the study.

Shuttle Running: Running to and from selected distances from a given starting point.

Running Speed: The time taken to traverse a set distance while changing direction or stopping and starting.

Interval Training: Regular, though relatively short, periods of stress, interspersed with adequate periods of recovery.

Max. $O_2$ Uptake: The point at which no further increase in oxygen uptake occurs despite an increase in the rate of work.

$\dot{V}O_2$ Max.: The number of liters/min. of oxygen utilized by the body during exercise.

# CHAPTER II

# SURVEY OF RELATED LITERATURE

# CHAPTER II

## SURVEY OF RELATED LITERATURE

Research by Bartels, et al., (5) is of special significance to this study. Using interval training programs of running two times per week and four times per week over periods of seven and thirteen weeks, and using the variables of maximum oxygen consumption, heart rate during and after exercise, the Harvard Step Text Index, and 220-yard and 880-yard running times on a random sampling of college students, the researchers concluded that:

- A program of interval training (running) applied at least twice weekly produced highly significant improvement in maximum oxygen consumption, maximum ventilation, rate of recovery of heart rate following maximum work, and running times over short and longer distances after either seven or thirteen weeks of training.
- It appears to make virtually no difference whether such an interval training program is applied two times weekly or four times weekly; the degree of improvement is the same.
- There is suggestive but not conclusive evidence that training in this manner for thirteen weeks produces more improvement than training for seven weeks.

- The time expended in this method of physical conditioning need not be more than about one hour per training session, or two hours weekly.

- This method of training also produces significant improvement in the heart rates associated with heavy, but submaximal work.

Pollock, et al., (27) randomly assigned nineteen volunteer men, between twenty-eight and thirty-nine years of age, to one of two experimental groups. Group I exercised two days per week, and Group II exercised four days per week for a period of twenty weeks. The exercise sessions were thirty minutes in duration and consisted of continuous walking, jogging or running.

Both groups were tested at the beginning, middle and end of the program. Maximum oxygen intake capacity, body composition, heart rate response to a standard treadmill run, and a two mile running time were determined on all subjects.

As a result of this research, it was concluded that:

- Adult men participating in endurance training of two or four days per week improve significantly in working capacity and cardiovascular fitness.

- Endurance training two days per week does not appear to be sufficient to alter body composition, while endurance training for four days per week significantly decreased body fatness.

- Changes resulting from endurance training are manifested in proportion to the frequency of participation. Four days of training per week elicit a more significant improvement in working capacity, cardiovascular fitness, and body composition than two days per week.

- A larger percentage of between group training effects occurred during the latter portion of the training program; thus, optimal training effects occur after many weeks.

Stanley (30), using thirty-six subjects, compared the effectiveness of interval training programs of running at frequencies of two times per week and four times per week. A statistical analysis of the data reveals that since no significant differences were found between the groups on any of the variables either before or after training, and since no significant differences were found on the mean improvements between groups after training on any variables, training two times per week is just as effective as training four times per week, in a seven week interval training program of running.

Thompson and Stull (31) studied the effects of various training programs on speed of swimming. Six matched training groups were developed with eighty-one subjects. A thirty yard "all-out" swim was used as the criterion. Each group participated in a different training program for six weeks.

Two of the groups trained using exactly the same work out plan. The only difference in the training of the two groups was that Group I trained three times per week, while Group II trained six times per week.

Statistical analysis by the "t" method showed that both groups significantly improved their times in the thirty yard swim (beyond the 0.01 level of significance).

Using thirty-two subjects, Zimkin (36) exercised four different muscle groups in order to study the importance of the size of the load, rate of performance, duration of exercise and of the intervals between sessions relative to effective muscular training.

It was found that when loads and tempo were held constant and the interval between training sessions varied from one to two days, the two day interval showed more improvement in strength. The training with the longer interval between sessions proved much more effective in every case.

Egolinskii (13), using eighty subjects, collected data relative to endurance training. The endurance test consisted of flexing the middle finger of the right hand on a hand ergograph at a rate of sixty times per minute to exhaustion using a two kilogram weight.

The following results were obtained:

- All exercise bouts on one day at half hour intervals increased endurance five times.
- Five exercises a day at half hour intervals for three consecutive days increased endurance eight times.
- Two exercises per day for seven days increased endurance twelve times.
- One exercise per day for fifteen days increased endurance eight times.
- One exercise a day performed every other day (30 days) increased endurance seven times.

Using twenty young male volunteers, Jackson, et al., (21) randomly assigned each volunteer to one of four training groups or a control group in a study of the effect of various training frequencies on cardiorespiratory endurance.

They concluded that considering the initial fitness level of the subjects in the study, it seems that training two or three times a week may have been as beneficial as the five day program. The five day program, while not excessive when compared with typical track work outs, seemed to be too intense to allow for optimal adaptation in these subjects.

Fox, et al., (15) using sixty-nine young healthy college males, studied the effects of seven and thirteen

week interval training programs with frequencies of two days per week and four days per week, on improvement in maximal aerobic power.

The results indicated that:

- Maximal stroke volume and/or maximal $a\bar{v}O_2$ difference, principle determinants of $\dot{V}O_2$ max., are not dependent on training frequency nor training duration.
- One benefit of more frequent and longer duration interval training is less circulatory stress as evidenced by decreased heart rate, during submaximal exercise.

Davies, et al., (10) and Knuttgen, et al., (24) have shown no relationship between training frequency and $\dot{V}O_2$ max., while Shephard (29) has shown a direct relationship between training frequency and gains in $\dot{V}O_2$ max.

O'Brien (26), using twenty-four subjects, studied the effect of frequency of training on cardiorespiratory conditioning.

Since no significant differences were found between the groups before or after training for any of the variables, it was concluded that within the limits of this study, training twice a week is just as beneficial as four times per week for cardiorespiratory conditioning over a seven week period.

Using thirty-three male college subjects, Churdar (8) divided subjects into five groups to determine the

effect of four different frequencies of a specific exercise program on an attained level of physical fitness. Group I engaged in the exercise program once each week; Group II two days each week; Group III three days each week; Group IV six days each week. Group V served as a control group.

The results indicated significant improvement in physical fitness in the groups that engaged in the exercise program two days, three days and six days per week, in addition to going all out every three weeks in the testing procedure. The control group had a slight decline in physical fitness but was almost able to maintain its beginning level by going all out each testing period. Participating in the exercising program six days per week was significantly better than participating one day per week. The six-day-per-week group and the three-day-per-week group had significant differences when compared with the control group. None of the other combinations of groups had a significant difference as a result of the experimental period.

Hanson (17) undertook a study comparing the effects of a five day versus a three day physical education program on achievement scores of sixth grade children. Scores were collected from thirteen hundred children from

twenty Minneapolis public schools. The five day program was more effective than the three day program for both sexes in developing physical fitness as measured by sit-ups, shuttle run, broad jump, dash, and six hundred yard run-walk.

It was concluded that the five day program developed a higher degree of physical fitness than the three day program for each sex, in five out of seven test items, and that boys were superior to girls in all physical fitness test items when an equal amount of time was provided in the program.

Alost (2) and Johnson (22) also found the five day program superior to lesser frequencies in the development of cardiovascular fitness.

Keough (23) studied the effects of daily and two day per week physical education programs upon motor fitness of children. The conclusion was that the two day program was as effective in fitness development as the five day program according to the Iowa Test of Motor Fitness.

Hlavac (20) studied the frequency of physical education instruction as a factor influencing changes in strength and motor proficiency of secondary school boys. He conducted a twelve week program with 126 high school

boys from grades nine to twelve. It was concluded that there was a slight but not significant difference in favor of the five day group in both strength and motor proficiency.

Sidney, et al., (28) studied the effects of training four times, two times and once per week upon measures of physical work capacity and cardiorespiratory fitness, both after four weeks of training, and after a period of training during which all exercise groups completed equal amounts of work on the bicycle ergometer.

The results of the experiment did not indicate whether Group 4X (four times per week) was superior to Group 2X (two times per week), but rather that there appears to be an optimal frequency for training greater than once a week.

Costill (9) summarizing the Ohio State University research on interval training, reports that the cardiovascular fitness of young men can be improved by a seven week interval training program with as few as two workbouts per week. The two day a week group improved as significantly as the four day a week group. Identical results were obtained in a subsequent study lasting thirteen weeks.

Zeigler (35) studied the effects of maximum performance bouts, once a week, twice a week and three

times a week respectively, upon the development of endurance on a bicycle ergometer. He found that the endurance of all three groups improved but the group riding twice a week showed the greatest increase. Increasing the frequency beyond two days a week seemed to cause an increase in individual differences among subjects.

Witten and Witten (34), using twelve female physical education majors, studied the effects of frequency of interval training upon cardiovascular fitness. They concluded that three days a week of interval training improved cardiovascular endurance as significantly as five days a week training in female subjects, who had not had previous experience in interval training or any other type of training for distance running.

Brynteson and Sinning (6) studied the effects of different weekly exposures to exercise on the retention of cardiovascular fitness following a physical conditioning program. Specifically, the effects of training one, two, three or four times per week following a training program in which subjects exercised five times per week were studied.

They concluded that a five week physical conditioning program on a bicycle ergometer at an exercise intensity which stimulates the heart rate to eighty per cent of the maximum value is sufficient to improve cardio-

vascular fitness. The fitness gained through such a program can be retained for at least a five week period by participating in an exercise program of the same intensity at least three times a week. Improvements in pulmonary function due to training are more readily retained than cardiovascular fitness.

Summary of literature

It has been assumed that the amount of time spent and the frequency of the training sessions are directly proportional to the training effects. In other words, coaches and physical educators have assumed that the athlete must train as often as possible if he or she is to achieve the optimum conditioning necessary for the best performance. The limited amount of research now available does not substantiate such an assumption. In fact, previous studies concerning training frequency are equivocal.

For example, most studies [Pollock (27), Fox (15), Davies (10), Knuttgen (24), Shephard (29), O'Brien (26), Bartels (5)] reviewed failed to eliminate differences in the total quantity of work performed. Yet, the findings of Fox (15), Davies (10), Knuttgen (24), O'Brien (26), and Bartels (5) had shown no relationship, while Pollock (27) and Shephard (29) had shown a direct relationship between

training frequency and gains in maximal aerobic power. Sidney (28) using equal workload also found no relationship between frequency and maximal aerobic power.

Studying the effects of physical education programs, Keough (23) and Hlavac (20) found that the higher the frequency the better the results on motor fitness and strength tests. Hanson (17) reported that a five day physical education program was more effective when measuring running and performance parameters.

The findings of Thompson and Stull (31) and Bartels (5) indicated no relationship between running or swim speed when comparing frequencies of two and four and three and six times per week.

In conclusion, the results of the research presented above points most assuredly to the need for further research and study before any decisive conclusions can be made.

# CHAPTER III

# METHODS AND PROCEDURES

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The subjects for this study were eighteen inmates at Her Majesty's Penitentiary in St. John's, Newfoundland. All the subjects for the study had been in dentention for at least three months prior to the experiment. The reason these subjects were chosen, was to ensure that the subjects used in the experiment were as close to untrained as possible. The subjects were divided into three groups, a control group (blue), a twice a week training group (white) and a four times a week training group (red). Table I contains the vital statistics of each group.

TABLE I

Vital Data of Groups

| Group | No. | Age | | Height (cm) | | Weight (kg) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Before | | After | |
| | | Mean | S.D. | Mean | S.D. | Mean | S.D. | Mean | S.D. |
| Red | 6 | 22.16 | 3.20 | 170.50 | 7.40 | 70.70 | 10.66 | 69.18 | 9.82 |
| White | 6 | 20.16 | 3.20 | 170.33 | 3.00 | 74.03 | 9.96 | 72.55 | 9.38 |
| Blue | 6 | 21.00 | 3.00 | 172.33 | 1.79 | 71.63 | 7.43 | 72.23 | 7.50 |

Location and facilities

The study was performed at Her Majesty's Penitentiary in St. John's, Newfoundland. The facility used in the study was the gymnasium at the penitentiary.

Equating the Groups

Eighteen subjects were used in this study. Each subject was pre-tested on three test items: a PWC-170 test, a zig zag run and a shuttle run. A comparison of the means on each of the tests indicated that each test was not significant at the 0.05 level of significance. (Results of pre-test are found in Appendix B.) The subjects were placed in groups which were equated on the basis of the best time recorded by each in the zig zag run. The mean and standard deviation was computed for each group to ensure that the groups were as equally matched as possible.

Group one participated in training four days per week for a period of seven weeks. These training sessions were held on Tuesday through Friday of each week. Hereafter, this group will be known as the Red group.

The second group participated in training two days per week for a period of seven weeks. These training sessions were held on Tuesday and Friday of each week. Hereafter, this group will be known as the White group.

The third group acted as the control for the experiment. The only training they received was a one hour recreation period each week. Hereafter, this group will be known as the Blue group.

The training program

The Red and White groups participated in a pre-established program of interval training for a period of seven weeks. This program consisted of shuttle running, one hundred and fifty yards in thirty-five seconds. The rest period also consisted of thirty-five seconds. While the subjects rested, they were asked to keep walking or moving about. Before and after each training session the subjects jogged around the gymnasium for a period of four minutes. Figure I indicates the method of training.

The total weekly work load for each group was the same throughout the experiment. Each group began with a weekly work load of eight workbouts. The work load increased by two workbouts each week for seven weeks until the weekly work load reached a total of twenty workbouts. (For a complete listing of the training programs for each group, see Appendix B.)

Training times

The training time for each group was 3:30 p.m.

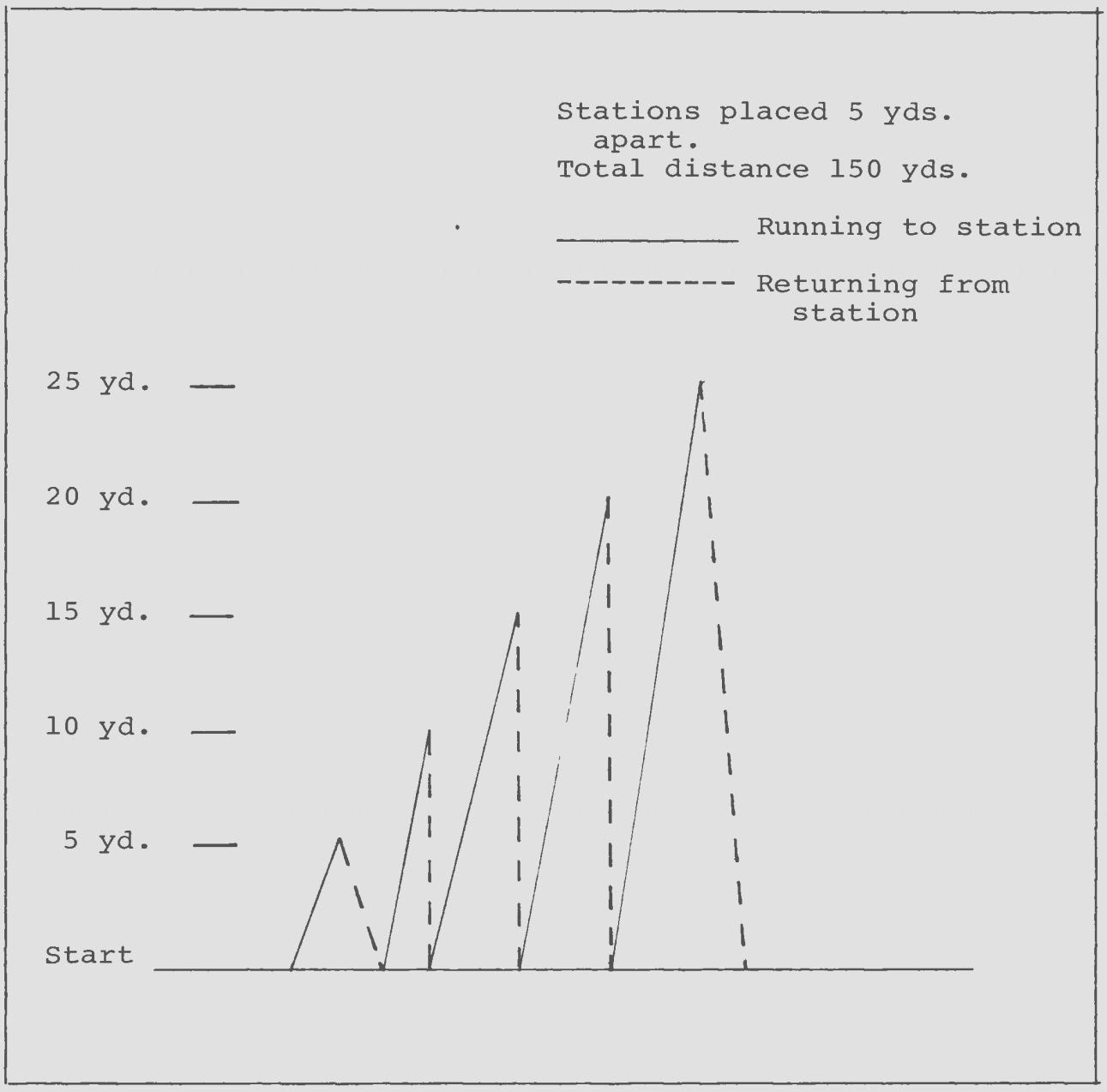


Figure I - Training Course

Those who could not attend that training session, trained at 6:00 p.m. The training session was established at the above mentioned times for the convenience of the subjects and penitentiary personnel.

Test used in the study

The following tests were administered to all subjects before the study began, and again after the training sessions were completed. (Figures II and III indicate the zig zag run and the shuttle run respectively.)

- Modified Barrow Zig Zag Run
- Thirty-foot Shuttle Run
- Physical Working Capacity (PWC-170) Test

The Zig Zag Run: The subjects traversed a five obstacle course ten yards by sixteen yards in a figure of eight pattern. Times were recorded to the nearest one-tenth of a second after the subjects had completed three repetitions of the course. Before each testing session, the examiner walked through the course explaining the procedure. The subject was also given the opportunity to walk through the course. Any subject who fell, or failed to execute the course correctly, was retested after a five minute rest period.

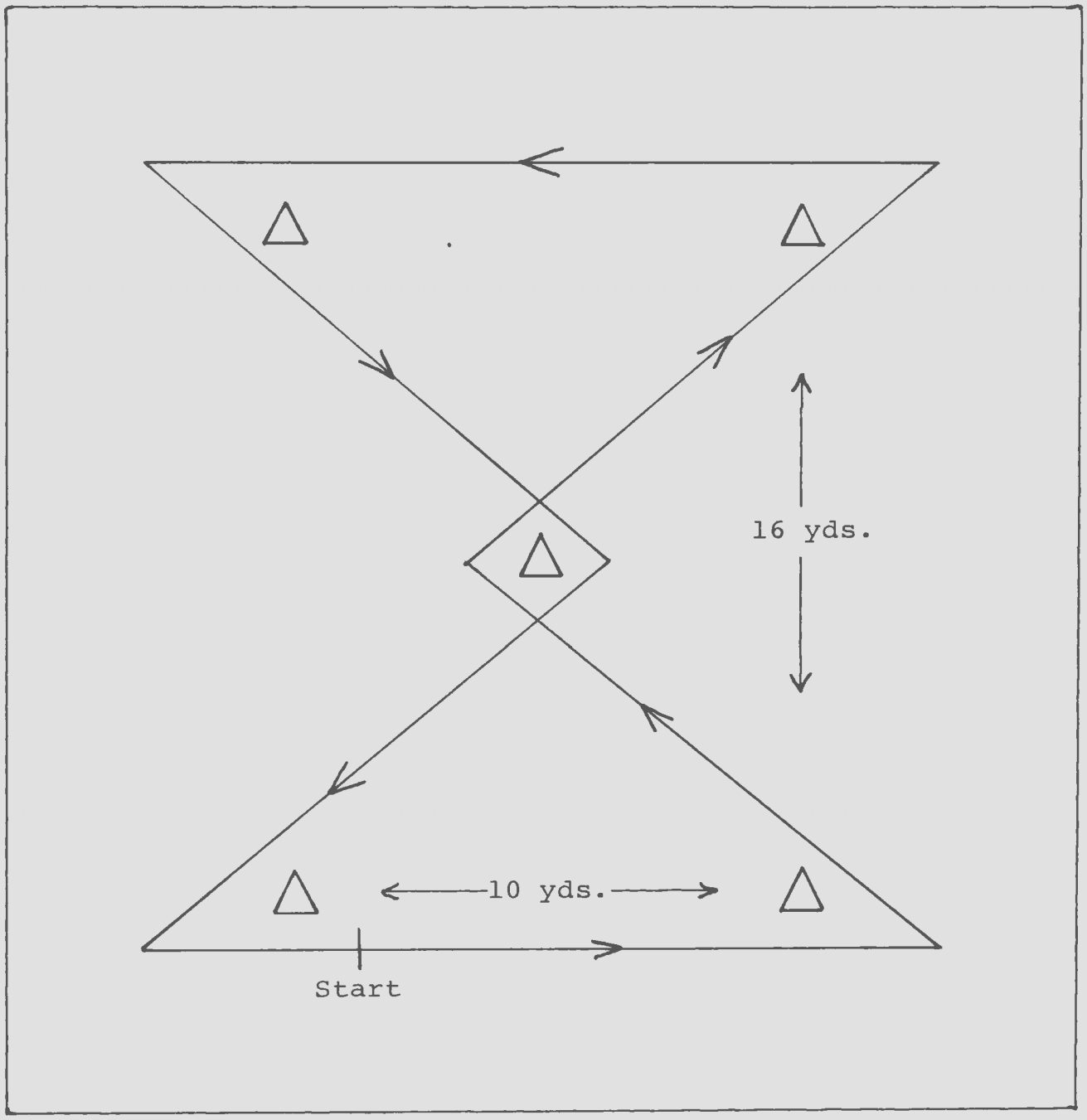


Figure II - Modified Barrow Zig Zag Run

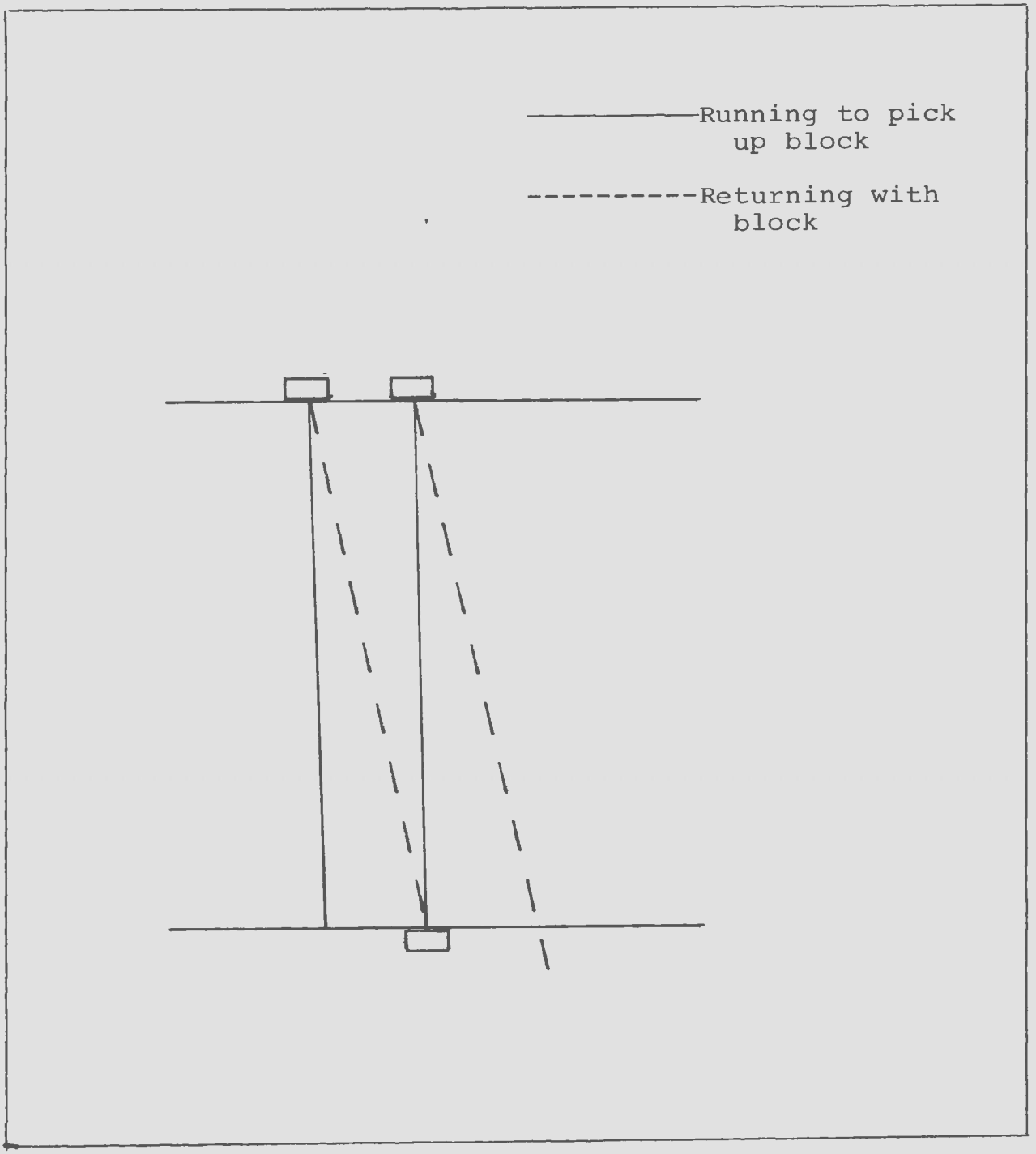


Figure III - 30 Ft. Shuttle Run

The Shuttle Run: The subjects were asked to retrieve two small blocks one after another from a position thirty feet from the start. The first block had to be placed at the start line before returning for the second block. Upon picking up the second block, the subject had to race back across the start line. Times were recorded to the nearest one-tenth of a second after the subject had crossed the start line with the second block. Each subject had two tries with the fastest time being recorded.

Physical Working Capacity (PWC-170) Test: Each subject pedalled a Monarch bicycle ergometer at sixty rpm in time with a tightly wound metronome. The work load was three hundred and sixty kilogram meters for the first five minutes of work. This load was increased to seven hundred and twenty kilogram meters for the second five minutes. The heart rate was recorded with the use of a Hewlett Packard cardiac telometer unit. Electrodes were placed on the subject's chest between the fifth and sixth intercostal space below the nipple. One ground electrode was placed on the deltoid. Heart rate was determined by length of time taken to count thirty R-wave spikes. This time was converted to heart rate by the use of Åstrand's tables (3). The heart rate count was taken during the last thirty

seconds of each work load.

Motivation of the subjects

All the subjects who were involved in the training program were constantly encouraged to do their very best throughout the study.

While the subjects ran through the workbout, the examiner shouted encouragement and the time at five second intervals. This was done so that the subjects would complete the workbout in the required time of thirty-five seconds. Failure to shout the time at five second intervals, resulted in some of the subjects taking more than the thirty-five seconds allotted to complete the workbout.

# CHAPTER IV

# RESULTS AND DISCUSSIONS

# CHAPTER IV

## RESULTS AND DISCUSSIONS

### Results

The purpose of this study was to compare the effectiveness of training at frequencies of two times per week and four times per week, as reflected by the ability of each program to produce changes in physical working capacity and running speed. The variables measured were:

- physical working capacity (PWC-170) test
- thirty foot shuttle run
- modified Barrow zig zag run.

The statistics used were: (1) the F-test, to determine if there was a significant difference among the groups; and (2) Newman-Keuls Test, to determine where the significance lay. Appendix A contains the raw data for each subject on each of the variables.

Physical Working Capacity (PWC-170) Test - Table II contains the data for the groups after training. The F-test indicated that there was a significant difference ( $\alpha = 0.05$) among the groups.

TABLE II

F-Test PWC-170 Test

| | d.f. | SSBG | MSBG | F |
|---|---|---|---|---|
| Treatments | 2 | 146.59 | 73.30 | 4.12* |
| | | SSWG | MSWG | |
| Error | 15 | 267.18 | 17.81 | |

* $\alpha$ 0.05 F value required 3.68

A Newman-Keuls Test was then applied. Table II indicates that a significant difference was found between the Red and the Blue, and the White and the Blue groups at the 0.05 level of significance.

TABLE III

Newman-Keuls Test PWC-170 Test

| Means | $\bar{X}_B$ | $\bar{X}_W$ | $\bar{X}_R$ |
|---|---|---|---|
| $\bar{X}_B$ | - | 3.17* | 3.79* |
| $\bar{X}_W$ | - | - | 0.64 |
| $\bar{X}_R$ | - | - | - |

*Significant at 0.05 level
Critical value required 3.01

Shuttle Run - Table IV contains the data for the groups after training. The F-test indicated that there was a significant difference ( $\alpha = 0.05$) among the groups.

TABLE IV

F-Test . Shuttle Run

| | d.f. | SSBG | MSBG | F |
|---|---|---|---|---|
| Treatments | 2 | 6.02 | 3.01 | 13.08* |
| | | SSWG | MSWG | |
| Error | 15 | 3.50 | 0.23 | |

* $\alpha$ 0.05 = F value required 3.68

A Newman-Keuls Test was then applied. Table V indicates that a significant difference was found between the Red and the Blue, and the White and the Blue groups at the 0.05 level of significance.

TABLE V

Newman-Keuls Test Shuttle Run

| Means | $\bar{X}_R$ | $\bar{X}_W$ | $\bar{X}_B$ |
|---|---|---|---|
| $\bar{X}_R$ | - | 0.42 | 5.94* |
| $\bar{X}_W$ | - | - | 5.52* |
| $\bar{X}_B$ | - | - | - |

*Significant at 0.05 level
Critical value required 3.01

Zig Zag Run - Table VI contains the data for the groups after training. The F-test indicated a significant difference ( $\alpha = 0.05$) among the groups.

TABLE VI

F-Test . Zig Zag Run

| | d.f. | SSBG | MSBG | F |
|---|---|---|---|---|
| Treatments | 2 | 151.32 | 75.66 | 9.31* |
| | | SSWG | MSWG | |
| Error | 15 | 121.96 | 8.13 | |

* $\alpha$ 0.05 F value required 3.68

A Newman-Keuls Test was then applied. Table VII indicates that a significant difference was found between the Red and the Blue, and the White and the Blue groups at the 0.05 level of significance.

TABLE VII

Newman-Keuls Test Zig Zag Run

| Means | $\bar{X}_R$ | $\bar{X}_W$ | $\bar{X}_B$ |
|---|---|---|---|
| $\bar{X}_R$ | - | 0.08 | 5.11* |
| $\bar{X}_W$ | - | - | 5.02* |
| $\bar{X}_B$ | - | - | - |

*Significant at 0.05 level
Critical value required 3.01

Summary of results

The F-test indicated that there was a significant difference among the groups at the 0.05 level of significance, on all variables measured in the study.

A Newman-Keuls Test, as described by Ferguson (14), was administered to all the variables after the training period. This was used to determine where the significance lay. A significant difference was found at the 0.05 level of significance, between the Red (four times) and the Blue (control) and the White (two times) and the Blue (control) groups on all the variables after the training period.

Therefore, the hypotheses:

1. There is no difference in physical working capacity, when training two times per week as compared to training four times per week with untrained subjects, when the weekly work load is the same. Will be accepted.
2. There is no difference in running speed as measured by a shuttle run, when training two times per week as compared to training four times per week with untrained subjects, when the weekly work load is the same. Will be accepted.
3. There is no difference in running speed as measured by a zig zag run, when training two times per week as compared

to training four times per week with untrained subjects, when the weekly work load is the same. Will be accepted.

Since no significant difference occurred between the Red and White groups on either of the variables after seven weeks of training, it appears that the effects of training were similar, regardless of the training program, on any of the variables measured in the study.

Discussions

The changes in performance on the variables tested, indicated that the interval training programs of training two days per week and four days per week, provided an effective method of conditioning. Significant improvements at the 0.05 level of significance, were found for both the Red and White groups on the PWC-170 Test, the Modified Barrow Zig Zag Run and the Shuttle Run.

An analysis of the data, demonstrated that training two times per week is just as effective as training four times per week, in a seven week interval training program of running when the weekly work load is the same.

The results of the PWC-170 Test indicated that the improvement in the cardiovascular or aerobic capabilities of the subjects, was significant at the 0.05 level. To the coach and players of team games such as soccer, where cardiovascular fitness is essential, this result is very

significant.

With the great demand for training facilities, and at times the unavailability of these facilities, the coach can find himself in a somewhat precarious position. The results of this study have shown that significant improvements in cardiovascular fitness can be attained, with a somewhat limited number of training sessions per week. It is also important to mention that the results have implications in the area of off season training. That is, with a limited program such as training twice a week, a high degree of cardiovascular fitness can be maintained.

The results of the Shuttle Run and Zig Zag Run indicated that there was a significant difference at the 0.05 level of significance in running speed. However, since the training program involved running while changing direction, it is natural to believe that there may have been a learning effect. But, since the cardiovascular improvement was significant, it can be assumed that some of the improvement in running speed was a result of the training.

The primary energy source used in the Shuttle Run and Zig Zag Run was anaerobic. Both the Red and White groups improved significantly (0.05 level of significance)

on both the variables measured. It is indicated, therefore, that both groups increased their abilities to work anaerobically. It must be assumed that at least part of the improvement in running speed was due to the improvement in anaerobic abilities.

On the basis of the statistical analysis of the variables used in the study, it was indicated that an interval training program of running either two times per week or four times per week produced significant improvement at the 0.05 level of significance in physical working capacity and running speed. It also indicated that there was no significant difference at the 0.05 level of significance in the training frequencies.

From the standpoint of performance, there are a number of points which merit emphasis as a result of the above findings. Both the Red and the White groups improved in their abilities to perform all of the tests which were used to evaluate this study. Certainly, a part of the improvement in the performances must be attributed to an increase in running skill. This in itself is a great asset of the program used in the study, for it is valuable to increase running ability as a means of achieving success in a wide range of athletic activities.

It should also be emphasized that participation

in this type of a conditioning program probably will not, for example, cause an increase in the development of the specific neuromuscular skills necessary to make better games players. It may, however, equip a player with those attributes which will better enable him to develop the specific neuromuscular skills necessary for better performance in various facets of the game.

The specific skills of the game of soccer, for example, are probably best learned and perfected by playing soccer. It does seem feasible, however, to believe that the individual who is in excellent physical condition may learn and may achieve success much more readily.

# CHAPTER V

# SUMMARY AND CONCLUSIONS

# CHAPTER V

## SUMMARY AND CONCLUSIONS

The basic purpose of this study was to compare the effectiveness of training at frequencies of two times per week and four times per week with untrained subjects, while using a constant weekly work load. A statistical analysis of the data revealed that there was no significant difference at the 0.05 level of significance between the Red (twice a week) and White (four times a week) groups after training on any of the variables measured in the study. This, therefore, indicated that training two times per week, was just as effective as training four times per week, in a seven week interval training program of running.

This result agrees with the research of Fox (15), Davies (10), Knuttgen (24), O'Brien (26), Bartels (5) and Stanley (30).

The implications of the above conclusions may have a far reaching effect in today's society. This is especially true in the areas of time and the availability of facilities. For example, a coach may be able to train his team only twice a week because of the availability of facilities. The results of this study have indicated that

a significant improvement can be attained in Physical Working Capacity and running speed (measures of physical fitness) in a period of seven weeks of training. If more training time and the use of facilities were available, the coach would then have an opportunity to vary his training program by adding, for example, skills and weight training.

Recommendations

There are ways which this study can be improved upon. Some of which are dependent upon time and money, commodities which may be difficult to come by.

First, using the same training procedure and weekly work loads, the researcher might try varying various variables. For example, results could be taken at two week intervals over a period of twenty weeks. Research by Fox (15) and Pollock (27) suggest a trend for greater gains in maximal aerobic power as the duration of training increased. Consideration may also be given to varying the intensity. The researcher might try varying the intensity from fifty percent to ninety percent of the subject's maximum.

Research by Davies (10) has shown that training below fifty percent of maximum did not improve maximum

aerobic power. Other variables which could be considered are: the age, sex, number of subjects, fitness level of subjects, interval training versus continuous training and equal daily work load.

Second, the researcher might consider other parameters as measures of improvement of physical fitness. For example, maximum aerobic power, resting heart rates, lactic acid concentrations, hemoglobin and hematocrit concentrations and blood pressure. He might also consider such performance parameters as a mile run, fifty yard and two hundred and twenty yard sprints, muscle strength, power and endurance tests and finally the effect upon skills required to play a particular game or sport.

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# APPENDICES

# APPENDIX A

APPENDIX A

# A COMPARISON OF THE EFFECT OF TWO INTERVAL TRAINING FREQUENCIES ON PHYSICAL WORKING CAPACITY AND RUNNING SPEED IN UNTRAINED SUBJECTS UNDER CONSTANT WEEKLY WORK LOADS

by

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A Thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Physical Education

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# APPENDIX B

APPENDIX B

TABLE VIII

VITAL STATISTICS FOR EACH SUBJECT

RED GROUP (Four Times)

| Subjects | Age | Height (cm) | Weight (kg) | |
|---|---|---|---|---|
| | | | Before | After |
| FM | 22 | 175 | 65.0 | 64.0 |
| DG | 19 | 165 | 68.6 | 67.2 |
| HB | 27 | 173 | 76.0 | 74.6 |
| CR | 26 | 180 | 91.4 | 88.0 |
| PS | 19 | 157 | 58.2 | 57.5 |
| JW | 20 | 173 | 65.0 | 63.8 |
| Mean | 22.16 | 170.50 | 70.70 | 69.18 |
| S.D. | 3.20 | 7.40 | 10.66 | 9.82 |

WHITE GROUP (Two Times)

| Subjects | Age | Height (cm) | Weight (kg) | |
|---|---|---|---|---|
| | | | Before | After |
| TL | 19 | 168 | 61.8 | 61.0 |
| TS | 21 | 165 | 70.4 | 69.2 |
| FB | 18 | 173 | 86.0 | 84.0 |
| PD | 19 | 170 | 67.0 | 66.0 |
| HP | 23 | 173 | 70.0 | 68.6 |
| GH | 21 | 173 | 89.0 | 86.5 |
| Mean | 20.16 | 170.33 | 74.03 | 72.55 |
| S.D. | 3.20 | 3.00 | 9.96 | 9.38 |

BLUE GROUP (Control)

| Subjects | Age | Height (cm) | Weight (kg) | |
|---|---|---|---|---|
| | | | Before | After |
| CG | 17 | 170 | 65.0 | 65.8 |
| CY | 23 | 173 | 82.0 | 82.5 |
| TJ | 26 | 173 | 82.4 | 82.4 |
| SK | 18 | 173 | 70.4 | 71.4 |
| CB | 20 | 175 | 65.0 | 66.1 |
| OC | 22 | 170 | 65.0 | 65.2 |
| Mean | 21.00 | 172.33 | 71.63 | 72.23 |
| S.D. | 3.00 | 1.79 | 7.43 | 7.50 |

APPENDIX B

TABLE IX

INTERVAL TRAINING PROGRAM

| Group | Week | No. of Work Bouts Per Day | | | | No. of Work Bouts Per Week |
|---|---|---|---|---|---|---|
| | | Tues. | Wed. | Thurs. | Fri. | |
| Red | 1 | 2 | 2 | 2 | 2 | 8 |
| White | 1 | 4 | | | 4 | 8 |
| Red | 2 | 2 | 2 | 3 | 3 | 10 |
| White | 2 | 5 | | | 5 | 10 |
| Red | 3 | 3 | 3 | 3 | 3 | 12 |
| White | 3 | 6 | | | 6 | 12 |
| Red | 4 | 3 | 3 | 4 | 4 | 14 |
| White | 4 | 7 | | | 7 | 14 |
| Red | 5 | 4 | 4 | 4 | 4 | 16 |
| White | 5 | 8 | | | 8 | 16 |
| Red | 6 | 4 | 4 | 5 | 5 | 18 |
| White | 6 | 9 | | | 9 | 18 |
| Red | 7 | 5 | 5 | 5 | 5 | 20 |
| White | 7 | 10 | | | 10 | 20 |

APPENDIX B

TABLE X

RAW DATA FOR EACH SUBJECT

RED GROUP (Four Times)

| Subject | Shuttle Run | | Zig Zag Run | | PWC-170 Test (kgms/kg body-weight) | |
|---|---|---|---|---|---|---|
| | Before | After | Before | After | Before | After |
| FM | 8.5 | 8.3 | 40.0 | 37.2 | 11.53 | 13.44 |
| DG | 9.3 | 8.7 | 43.6 | 40.3 | 16.32 | 20.09 |
| HB | 8.8 | 8.3 | 41.3 | 38.5 | 23.94 | 28.15 |
| CR | 9.7 | 9.2 | 47.3 | 41.5 | 9.95 | 11.60 |
| PS | 10.7 | 9.1 | 47.3 | 41.4 | 18.90 | 21.39 |
| JW | 9.6 | 9.2 | 44.4 | 41.3 | 11.69 | 13.17 |
| Mean | 9.43 | 8.80 | 43.93 | 40.03 | 15.38 | 17.97 |
| S.D. | 0.77 | 0.39 | 2.75 | 1.63 | 4.90 | 6.13 |

WHITE GROUP (Two Times)

| Subject | Shuttle Run | | Zig Zag Run | | PWC-170 Test (kgms/kg body-weight) | |
|---|---|---|---|---|---|---|
| | Before | After | Before | After | Before | After |
| TL | 9.1 | 8.3 | 40.2 | 37.3 | 15.21 | 18.85 |
| TS | 9.0 | 8.6 | 41.8 | 39.3 | 14.34 | 17.20 |
| FB | 9.9 | 9.3 | 43.2 | 40.4 | 10.23 | 11.90 |
| PD | 10.0 | 9.6 | 46.5 | 44.0 | 18.05 | 21.20 |
| HP | 9.2 | 8.8 | 43.0 | 39.9 | 14.00 | 15.89 |
| GH | 8.9 | 8.7 | 41.9 | 38.7 | 13.14 | 16.18 |
| Mean | 9.35 | 8.80 | 42.76 | 39.93 | 14.16 | 16.87 |
| S.D. | 0.47 | 0.44 | 1.93 | 2.06 | 2.30 | 2.85 |

BLUE GROUP (Control)

| Subject | Shuttle Run | | Zig Zag Run | | PWC-170 Test (kgms/kg body-weight) | |
|---|---|---|---|---|---|---|
| | Before | After | Before | After | Before | After |
| CG | 9.0 | 9.4 | 40.3 | 40.0 | 12.61 | 11.36 |
| CY | 9.8 | 10.2 | 45.8 | 48.5 | 11.09 | 10.04 |
| TJ | 9.9 | 10.4 | 45.0 | 48.8 | 10.92 | 9.25 |
| SK | 9.0 | 9.6 | 42.0 | 43.8 | 14.48 | 13.05 |
| CB | 9.4 | 10.0 | 43.1 | 44.8 | 15.84 | 13.65 |
| OC | 10.4 | 10.8 | 47.0 | 50.9 | 14.15 | 11.32 |
| Mean | 9.58 | 9.93 | 43.86 | 45.86 | 13.18 | 11.44 |
| S.D. | 0.40 | 0.34 | 2.29 | 3.66 | 1.88 | 1.54 |

# APPENDIX C

APPENDIX C

TABLE XI

PRE TRAINING F-TEST - PWC-170 TEST

| | $X_R$ | $X_W$ | $X_B$ |
|---|---|---|---|
| $\Sigma X$ | 92.33 | 84.97 | 79.09 |
| $\Sigma X^2$ | 1565.27 | 1236.07 | 1062.04 |
| $(\Sigma X)^2$ | 8524.82 | 7219.90 | 6255.22 |

| | d.f. | SSBG | MSBG | F |
|---|---|---|---|---|
| Treatments | 2 | 14.66 | 7.33 | |
| | d.f. | SSWG | MSWG | |
| Error | 15 | 196.73 | 13.11 | |

Not significant F Value Required 3.68

APPENDIX C

TABLE XII

PRE TRAINING F-TEST - SHUTTLE RUN

| | $X_R$ | $X_W$ | $X_B$ |
|---|---|---|---|
| $\Sigma X$ | 56.60 | 56.10 | 57.50 |
| $\Sigma X^2$ | 536.92 | 525.67 | 551.57 |
| $(\Sigma X)^2$ | 3203.56 | 3147.21 | 3306.25 |

| | d.f. | SSBG | MSBG | F |
|---|---|---|---|---|
| Treatments | 2 | 0.17 | 0.09 | 0.31 |
| | d.f. | SSWG | MSWG | |
| Error | 15 | 4.26 | 0.29 | |

Not significant F Value Required 3.68

## APPENDIX C

### TABLE XIII

### PRE TRAINING F-TEST - ZIG ZAG RUN

| | $X_R$ | $X_W$ | $X_B$ |
|---|---|---|---|
| $\Sigma X$ | 263.60 | 256.60 | 263.20 |
| $\Sigma X^2$ | 11652.59 | 10996.38 | 11577.34 |
| $(\Sigma X)^2$ | 69484.96 | 65843.56 | 69274.24 |

| | d.f. | SSBG | MSBG | F |
|---|---|---|---|---|
| Treatment | 2 | 5.16 | 2.58 | 0.31 |
| | d.f. | SSWG | MSWG | |
| Error | 15 | 125.95 | 8.39 | |

Not significant F Value Required 3.68

APPENDIX C

TABLE XIV

POST TRAINING F-TEST PWC-170 TEST

| | $X_R$ | $X_W$ | $X_B$ |
|---|---|---|---|
| $\Sigma X$ | 107.83 | 101.24 | 68.67 |
| $\Sigma x^2$ | 2142.21 | 1756.92 | 800.18 |
| $(\Sigma X)^2$ | 11627.30 | 10453.02 | 4715.57 |

| | d.f. | SSBG | MSBG | F |
|---|---|---|---|---|
| Treatments | 2 | 146.59 | 73.30 | |
| | d.f. | SSWG | MSWG | 4.12* |
| Error | 15 | 267.18 | 17.81 | |

* = 0.05 F Value Required 3.68

## APPENDIX C

### TABLE XV

POST TRAINING F-TEST SHUTTLE RUN

| | $X_R$ | $X_W$ | $X_B$ |
|---|---|---|---|
| $\Sigma X$ | 52.80 | 53.30 | 60.40 |
| $\Sigma X^2$ | 465.56 | 474.63 | 609.36 |
| $(\Sigma X)^2$ | 2787.84 | 2840.89 | 3648.16 |

| | d.f. | SSBG | MSBG | F |
|---|---|---|---|---|
| Treatments | 2 | 6.02 | 3.01 | 13.08* |
| | d.f. | SSWG | MSWG | |
| Error | 15 | 3.50 | 0.23 | |

* $\alpha = 0.05$ F Value Required 3.68

## APPENDIX C

### TABLE XVI

POST TRAINING F-TEST ZIG ZAG RUN

| | $X_R$ | $X_W$ | $X_B$ |
|---|---|---|---|
| $\Sigma X$ | 240.20 | 239.60 | 276.80 |
| $\Sigma X^2$ | 9632.08 | 9593.64 | 12849.98 |
| $(\Sigma X)^2$ | 57696.04 | 57408.16 | 76618.24 |

| | d.f. | SSBG | MSBG | F |
|---|---|---|---|---|
| Treatments | 2 | 151.32 | 75.66 | 9.31* |
| | d.f. | SSWG | MSWG | |
| Error | 15 | 121.96 | 8.13 | |

* $\alpha = 0.05$ F Value Required 3.68

APPENDIX C

TABLE XVII

POST TRAINING NEWMAN-KEULS TEST PWC-170 TEST

| Means | $\bar{X}_B$ | $\bar{X}_W$ | $\bar{X}_R$ |
|---|---|---|---|
| $\bar{X}_B$ | - | 3.17* | 3.79* |
| $\bar{X}_W$ | - | - | 0.64 |
| $\bar{X}_R$ | - | - | - |

*Significant at 0.05 level
Critical Value Required 3.01 at 2, 15 degrees of freedom

APPENDIX C

TABLE XVIII

POST TRAINING NEWMAN-KEULS TEST SHUTTLE RUN

| Means | $\bar{X}_R$ | $\bar{X}_W$ | $\bar{X}_B$ |
|---|---|---|---|
| $\bar{X}_R$ | - | 0.42 | 5.94* |
| $\bar{X}_W$ | - | - | 5.52* |
| $\bar{X}_B$ | - | - | - |

*Significant at 0.05 level
Critical Value Required 3.01 at 2, 15 degrees of freedom

APPENDIX C

TABLE XIX

POST TRAINING NEWMAN-KEULS TEST ZIG ZAG RUN

| Means | $\bar{X}_R$ | $\bar{X}_W$ | $\bar{X}_B$ |
|---|---|---|---|
| $\bar{X}_R$ | - | 0.08 | 5.11* |
| $\bar{X}_W$ | - | - | 5.02* |
| $\bar{X}_B$ | - | - | - |

*Significant at 0.05 level
Critical Value Required 3.01 at 2, 15 degrees of freedom