A STUDY OF THE EFFECTS OF INTERVAL TRAINING AND LONG SLOW DISTANCE TRAINING ON CARDIOVASCULAR ENDURANCE OF SECOND FORMERS AT ALLIANCE HIGH SCHOOL.

BY:

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A Research Thesis Submitted to the Department of Physical Education and Games at Kenyatta University in Partial Fulfillment of the Requirements for the Degree of Master of Education

February, 1992
DECLARATION

This research thesis is my original work and has not been presented for a degree in any other university.

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This thesis is dedicated to my brother,

Geoffrey William Odhiambo
ACKNOWLEDGEMENT

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ABSTRACT

This research was conducted in Alliance High School with the sample being drawn from form two students only. The thrust of this study was to find out the superiority of either interval or long slow distance training in the enhancement of cardiovascular endurance after a six-week treatment condition. A total of 45 subjects were randomly selected and randomly assigned to each of the training groups as follows: Interval training (n=15) aged+15.5+ 1.30 years and weighing 57.9 +4.33 kg; Long slow distance training (n=15) aged 15.1 ± 1.06 years and weighing 56.0 +4.93 kg. control group (n=15) aged 15.2 ± 1.32 years and weighing 56.0 ± 4.93 kg. The study involved 6 weeks of treatment at a frequency of 3 sessions per week. The measuring instrument was the one and a half mile endurance run; a timed test that requires covering that distance as fast as possible.

The variables measured included the resting heart rate, working heart rate and time taken to perform the test. A one way analysis of variance was used to test the difference between the groups. Differences at p<.05 were considered significant. The results showed no significant differences in the ages and weights distances covered per session and resting heart rate amongst the groups. There was a significant difference in the working heart rate between the interval and long slow distance groups only during the 1st week. On
average, the interval training group was faster on the test than the two other groups. The ANOVA summary table indicated a significant difference while the Scheffe's test also indicated a significant difference between the means of the interval and control groups. However, these differences were not conclusive. Based on these results, it is concluded that neither interval nor long slow distance training appears superior in the enhancement of cardiovascular endurance. More research is however called for.
1.0 INTRODUCTION AND BACKGROUND OF THE PROBLEM

Cardiovascular endurance is also known as cardiorespiratory endurance. It is a means by which oxygen is supplied to the various tissues of the body during prolonged exercise. The oxygen is used for aerobic metabolism without which the cells within the body cannot function efficiently. Transport of oxygen throughout the body involves the co-ordinated function of four components namely the heart, the lungs, the blood vessels and the blood. The respiratory system provides a means whereby air is moved into and out of the lungs. This rhythmic to and fro movement of air is called pulmonary ventilation. Next the oxygen brought in from outside the environment through pulmonary ventilation is made available to the blood by a vast network of small blood vessels called capillaries that surround the 600 million or so tiny closed air sacs or alveoli found deep within the lungs. At the alveolar-capillary membrane oxygen moves by a physical process called diffusion from the air in the alveoli to the blood in the capillaries whereas carbon dioxide diffuses in the opposite direction. The alveolar capillary membranes therefore represent a functional union between the respiratory and circulatory systems. The next important job is the transport of the oxygen to the body tissues. The heart represents two muscle pumps each with its own circuit of blood vessels (Moore, 1975).
The right side of the heart and its vessels are primarily responsible for transporting venous blood to and arterial blood from the alveoli of the lungs. Maintaining an adequate flow of arterial blood to venous blood from the body tissues on the other hand, is the primary function of the left side of the heart and is known as systemic circulation. Skeletal muscles are richly supplied with capillary beds that come into close contact with individual muscle fibre and it is at these tissue-capillary membranes that a second exchange of gases occur whereby oxygen diffuses from the blood in the capillaries to the cells of the tissues and carbon dioxide diffuses in the opposite direction. The oxygen delivered via the cardia-respiratory system is utilized by the muscle cells for the purposes of supplying energy in the form of adenosine triphosphate (ATP). The improvement of cardiovascular endurance through training occurs because of the increased efficiency of the system described (Moore, 1975).

The main training procedures for developing cardiovascular endurance are interval training and long slow distance training. There has been considerable discussion as to the merits of long slow distance training and interval training. In fact, each of these training techniques possesses certain advantages over the other and the ideal program most likely is a combination of the two.
Nevertheless, there are more advantages with interval training for most types of conditioning programs in that more physical work is possible in the same amount of time and the same level of work can be undertaken with reduced physiological demand and with lower levels of lactic acid levels of lactic acid. As a general rule, however, since exercise intensity is greater with interval training it is not recommended at the beginning of the exercise program. Continuous training should be emphasized at the outset in order to prepare the myocardium, skeletal muscles, ligaments and tendons for more intense physical exertion. Interval training then can be implemented safely. It is therefore imperative that the most effective method be found since the prime objective of physical educators and coaches is to construct the most effective individualized training programmes for their students and athletes (Burke, 1980). During the pre-season phase (3 to 4 weeks prior to competition) training programmes should be designed to increase to a maximum the capacities of the energy systems in order to enable the participants to perform at a high level (Watson, 1983).

1.1 THE PROBLEM

Most of the ball games are collision sports that require the build up of stamina or endurance and skill. In this study the focus has been on cardiovascular endurance
It is assumed that lack of endurance directly affects performance. The two most popular training methods used by our coaches for developing cardiovascular endurance are interval training and long slow distance training. The training methods therefore become the independent variables. The question of the superiority of either method in developing cardiovascular endurance is the main problem in this study because of the following reasons:

- There is need to find out which of the two methods would bring about the best results in building cardiovascular endurance so that the most effective method can be recommended to the coaches.
- This research focused on the question of whether the two training methods differ markedly in their effectiveness in the development of cardiovascular endurance.

1.2 HYPOTHESES

1. There is no significant difference between the interval training group and control group as per their cardiovascular endurance.

2. There is no significant difference between the long slow distance training group and control group as per their cardiovascular endurance.

3. There is no significant difference between the interval
training group and the long slow distance training group as per their cardiovascular endurance.

The "independent" variable is the training method while the "dependent" variable is cardiovascular endurance.

1.3 ASSUMPTIONS OF THE STUDY
(a) The subjects had the same level of endurance at the beginning of the study
(b) The subjects were not suffering from any heart diseases which might have affected their cardiovascular systems.
(c) With the school being a boarding school and the students having been in the school for a month before the treatment was begun, it is assumed that no student was affected by having to run to school every morning.

1.4 LIMITATION OF THE STUDY
(a) It was difficult to ensure that the subjects did not participate in any other physical activity that could have affected their cardiovascular systems. However, since environmental conditions were similar any variance would have affected all the subjects to the same extent.
(b) Lack of laboratory equipment forced the researcher not to use accurate laboratory measures of cardiovascular endurance like the treadmill ergometer. The researcher
was therefore limited to the use of field test in which the time taken to run 1.5 miles is used to predict the cardiovascular fitness of the subject.

1.5. SIGNIFICANCE OF THE STUDY

The issue of which method to use during pre-season training for the build-up of cardiovascular endurance is becoming a major concern. Stamina plays a very big role in ball games especially the collision sports and since cardiovascular endurance forms the core fitness component for building stamina, it is imperative that it is given a major emphasis.

The study therefore attempted to investigate the effectiveness of the two training methods by:—

(a) Differentiating between interval training and long slow distance training and the effect on cardiovascular endurance of second formers at Alliance High School.

(b) Giving some recommendations which might be found useful by physical education teachers at Alliance High School for preparing pre-season training programs.

(c) Motivating and providing guidelines for more people to do research on the training programmers administered to our athletes.
1.6 DEFINITIONS OF TERMS

**Aerobic Activity**

Involves the combustion of a fuel in the muscle cell in the presence of oxygen. The fuel can come from the source within the muscle (free fatty acids, glycogen) and from sources outside the muscle (free fatty acids from adipose tissue, glucose from liver) (MacDougall et al, 1982).

It can also be defined as an activity in which the amount of oxygen being supplied is sufficient to meet the demands of the working tissues. As exercise intensity diminishes and the duration extends to 2 or 4 minutes, reliance on energy from phosphate stores decreases whereas the production of ATP becomes increasingly more important. The activity must be geared to provide a sufficient cardiovascular overload to stimulate increases in stroke volume and cardiac output (Katch and McArdle, 1986).

**Anaerobic Alactacid Activity**

Relies on energy derived from the muscle phosphate pool (ATP-CP energy system). The phosphate pool can be overloaded by engaging specific muscles in repeated maximum bursts of effort for 5 to 10 seconds. Because of the high-energy phosphates supply for intense, intermittent exercise, only small amounts of lactic acid are produced and recovery is rapid (Katch and McArdle, 1986).
Anaerobic Lactacid Activity

As the duration of all-out effort extends beyond ten seconds, dependence on anaerobic energy from the phosphates decreases while the quantity of anaerobic energy generated in glycolysis increases (Katch and McArdle, 1986). It therefore involves the breakdown of carbohydrate (mainly muscle glycogen) to lactic acid. Since oxygen is not used and lactic acid is formed, this source of energy is described as anaerobic lactacid. Although large amounts of ATP can be regenerated from this energy pathway per unit time, it is not possible to continue contraction for prolonged periods using glycolytic processes (MacDougall et al, 1982).

Cardiac Output

Is the volume of blood ejected out of the heart usually expressed as liters per minute \((Q)\). With small fluctuations, the cardiac outputs of the right and left ventricles are identical. The cardiac output divided by the estimated body surface area gives the "cardiac index" which relates the cardiac output to the body size (Astrand and Rodahl, 1986).

Can also be expressed as the output of the heart pump and can be determined by two factors:

(a) The rate of the pump's stroke or heart rate

(b) The quantity of fluid ejected with each stroke or stroke volume.
Thus, Cardiac Output = Heart Rate x Stroke Volume (Katch and McArdle, 1988).

**Endurance**

"Auszauer ist charakterisiert durch die Faehigkeit eine gegebene leistung uber einen moeglichst langen Zeitraum durcha iten zu koennen. Somit ist Ausdauer edentisch mit Ermuedungswiederstands fachigkeit."(is characterized by the ability to carry on a given task for over a relatively long period of time. Endurance is therefore identical with resistance to fatigue) (Hollmann & Hettinger, 1990, 138); (see also Winnick 1985, 37)

**Heart Rate**

Also referred to as pulse rate. It is the number of ventricular beats per minute as count form records of the electrocardiogram or blood pressure curve. The heart rate can easily be determined by palpitation over the heart, femoral, temporal, carotid or brachial arteries both during rest and exercise (Astrand and Rodahl, 1986).

**Interval Training**

Intermittent activities characterized by periods on intense activity interspersed with periods requiring only a moderate to low level energy expenditure (Katch and McArdle, 1988)
Long Slow Distance Training

Submaximal effort for 45 to 75 minutes. Heart rates should range from 130 to 170 beats/min with maximal rates achieved at certain lines. It involves a steady state exercise performed at either moderate or high intensity for a sustained period of time (Katch and McArdle, 1988); see also Froelicher, 1987).

Physical Fitness

A multifaceted area consisting of specific abilities or components. These include muscular strength, muscular flexibility, co-ordination and speed (Harre, 1982). It is also the ability to perform physical tasks with minimal effort (Winnick, 1985).

Practice

"die systematische Wiederholung gaxietter Bewegungsstergerung," (Is a systematic repetition of specific movement patterns aimed at improving performance without morphological changes) (Hollmann and Hettinger, 1990, 129); see also Stegemann, 1981).

Stamina

Collective physiologic body change based on the overload principle whereby body tissues are physically overworked such that by the time they recover, they set themselves to a slightly higher potential. A system of exercise that alternates overload and rest in this way takes the body to remarkable levels of strength and endurance. The most
valuable effect of overloading is believed to be on the heart. Aerobic exercise presumably forces the heart to beat faster than usual to pump the more-than-normal amount of oxygen-rich blood needed by the muscles being exercised. As the heart recuperates between exercise sessions, it becomes slightly stronger and does not have to work quite so hard the next time to satisfy the demands of the muscles (Gilmore, 1981).

Training

"die systematische Wiederholung gezielter überschwelliger muskelanspannungen mit morphologischen und funktionellen Anpassungserscheinungen zum Zwecke der Leistungssteigerung." (Training is a systematic repetition of specific muscle contractions above the threshold level with morphological and functional adaptations aimed at improving performance (Hollman and Hettinger, 1990, 124)."
CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 INTRODUCTION

Cardiovascular function and physical work capacity are best enhanced through dynamic aerobic activities. These should be continuous rhythmical movements of large muscle groups sustained for prolonged periods without exhausting the oxygen transport system. Such activities include jogging, cycling, rowing and swimming. Sudden stop and go anaerobic activities as well as heavy resistance and isometric exercises are less beneficial and are more likely to place undue oxygen demands upon the myocardium (Burke, 1980). On the recommended quantity and quality of exercise for developing and maintaining fitness -

"An optimal cardiovascular functional training programme is one which the exercise regimen is at an average intensity of 75% of maximal heart rate for a period of 20-40 minutes per sessions. With sessions repeated at least three to four times per week within 48 to 72 hour intervals". (Falls, 1980, 143)

2.2 INTERVAL TRAINING VERSUS LONG SLOW DISTANCE TRAINING

Most modes of exercise can be carried out either at a continuous steady rate or as short bursts of intense activity separated by rest or more moderate exercise. It would be expected that high intensity interval training would be a more effective method of increasing power endurance than long slow distance running but the difference has never been
clearly demonstrated. Both methods are capable of increasing the concentration of ATP in muscle. It is also difficult to know how much energy an athlete has obtained from the production of lactic acid and this makes comparisons of different training methods difficult. Long slow distance training may be just as effective as interval training provided it is of sufficient intensity. However, no direct comparisons of the two methods seems to have been made (Watson, 1983).

"At present there is insufficient evidence or a claim as to the superiority of either continuous or interval exercise training for enhancing aerobic capacity. Either training procedure will succeed; they can preferably be used interchangeably." (Katch and McArdle, 1988, 236).

"Interval training does not appear to have an advantage over continuous training in enhancing endurance capacity. On the other hand, continuous training is not better than discontinuous." (Sharkey, 1979, 39)

Long slow distance and interval training have a similar effect upon aerobic endurance. The changes in maximum oxygen uptake are the same with both types of training when the total work done by the subjects is equal. Long slow distance and interval training have also been shown to produce similar increases in leg speed (Watson, 1983).

In interval training, a large number of variables can be manipulated in order to produce different types of program. The work interval should be selected first. This can be done either in terms of distance - the training distance - or time
- the work interval. In the case of the track athlete, it may be best to begin with a training distance close to that run in competition. When training for a game the distance should be selected to produce a work interval corresponding to the most common duration of intense activity. For most sports short intensity is ensured by adjusting the training time so that the training distance is covered at a suitable pace. The subjects' heart rate at the end of the work interval is often used as a guide. One hundred and eighty beats per minute is often recommended for subjects under 30 years of age. The next variable that needs to be considered is the duration of the relief interval. This must be long enough to allow regeneration of the ATP/CP stores - 20 to 30 seconds is about the minimum time required. If the relief interval is too long the aerobic effects of the training will be reduced. Once again heart rate is a good guide. It should drop to about 150 beats per minute by the end of the relief interval. The relief interval can consist of either complete rest or work of a lower intensity. If the training is for an activity where speed is of at least as much importance as endurance, then short, fast intervals should be used with relatively long relief intervals of complete rest. In longer intervals of 0.5 - 2 minutes duration a significant proportion of energy is derived from the production of lactic acid. It has been shown that lactic acid is removed more rapidly during moderate work than during complete rest. The other variables in
interval training are; the number of intervals per session, the organization of intervals into sets and the training frequency. The optimum training frequency would appear to be three times per week. A higher frequency is not all that likely to result in significantly greater gains but improvements will be slower if training occurs less often. Useful gains in aerobic endurance can be made in 6-8 weeks (Watson, 1983).

There are three types of interval training namely short term, medium term and long term. In short term interval training, the training distance (work interval) is between 50 and 100 meters and there is usually a rest relief period. It is reputed to develop speed and short term endurance. Medium term interval training consists of a training distance between 200 and 400 meters and the relief period is made up of exercises at half speed or whatever speed feels comfortable. It tends to develop lactate endurance (tolerance to lactic acid and increase in the rate at which it is removed) and aerobic endurance. Finally, long term interval training consists of a training distance between 800 and 1200 meters. The relief period can either be a resting one or work while it is reputed to develop aerobic endurance exclusively (Watson, 1983).
There are various advantages of interval training. Interval training is attractive particularly since the technique can be applied in rigidly graduated doses and can be modified easily to incorporate a variety of activities designed to enhance total fitness including upper and lower extremities. This offers a great advantage when attempting to create interesting and diverse exercise sessions. (Burke, 1980). Then the correct spacing of work and rest periods enables someone to accomplish a tremendous amount of exercise over a considerable period of time with minimal fatigue (Stegemann, 1981). Interval training also permits high intensity training for long periods of actual exercise at a given intensity. For example, running continuously at a "4 minute mile" pace would exhaust most people within 1 or 2 minutes. However, running at this speed for only 15 seconds followed by a 30 second rest period alternately would enable many people to run 4 minutes at this near record pace (Stegemann, 1981). Another advantage claimed for interval training is its effect on lactic endurance. Some studies have shown that short periods of such training do increase this capacity and this is very useful for middle distance sprinting like 800 meters. Interval training is more highly structured so that is easier to control the training dosage, the combination of intensity and the duration that produces the training effect. It seems to have advantages in the preparation of intermittent activities like most team games.
It is closer to the situation that actually occurs in most of the team games. (Watson, 1983).

In long slow distance training the effects on the improvement of aerobic capacity are to mainly increase the general load tolerance and to improve recovery after strenuous exercise (Harre, 1982). Such a program may be required by the sedentary adult who wishes to improve his general physical condition. Any type of exercise can be used as long as it involves large muscle groups and produces a heart rate in the range of 120 - 150 beats per minute. Gains in aerobic fitness have been reported using programmes of walking, running, skipping, cycling and swimming. Training should occur about three times per week since a higher frequency may increase the risk of injury (Watson, 1983).

The advantages of long slow distance training include the fact that it is only necessary to exercise at least 20 minutes at a or above threshold heart rate, can be done with activities such as swimming, cycling and rope skipping and is submaximum. It can also be engaged in for a considerable time in relative comfort and is suitable for people just beginning an exercise program. (Stegemann, 1981) Long slow distance training is very likely to be the best type of training for very long events. An increasing proportion of fats are oxidized as the duration of activity increases thus sparing
the muscle glycogen reserves. The concentration of enzymes involved in fatty acid oxidation is increased by this type of training and the body must also adapt to cope effectively with the dissipation of heat. It is sometimes said that slow, long duration exercise achieves greater capillarisation of muscle. There appears to be no studies which show that long duration training is superior to other types in this respect (Watson, 1983).

2.3. RESEARCH DONE BY OTHERS

"A series of studies have shown that maximal oxygen uptake (and cardiac output) may be attained in connection with repeated periods of exercise of very high intensity of as short duration as 10–15 seconds provided the rest periods between each burst of activity are very short (of equal or shorter duration than the exercise periods." (Astrand and Rodahl, 1986, 427).

One subject was made to accomplish a certain amount of work (635 kj) in the course of 1 hr. This could be done either by uninterrupted exercise with a load of 175 watts or by intermittent exercise with a heavier load interrupted by rest periods at regular intervals. The double work rate (350 watts) was chosen, thus the required amount of work (635 kj) could be accomplished by 30 minutes of exercise within the span of 1 hour. Exercising continuously without any rest periods, the subject tolerated this high work rate for only 9 minutes at the end of which he was completely exhausted. IF instead he exercised for 30s, rested for 30s, exercised for
30s and so on, he could complete the work with moderate exertion. The longer the activity periods, the more exhausting the exercise appeared even though the rest periods were correspondingly increased (Astrand and Rodahl, 1986).

A comparative study on the relative effects of high intensity, low duration and low intensity high duration training on cardiorespiratory responses of young adult males was done. The conclusion was that neither high intensity low duration nor low intensity high duration training appears superior for the purpose of significantly enhancing cardiovascular fitness and reducing total body fat (Alexander, 1982).

Subjects performed 3 different test protocols which consisted of a series of repeated all-out sprints in a study of a physiological evaluation of high intensity intermittent exercise. Heart rate was continually monitored and oxygen uptake and blood lactate concentration were measured pre and post test during parts of the recovery periods. The occurrence of fatigue, defined as decrease in performance during repeated sprints appeared to be dependent on both the sprint distance and the duration recovery period. The results suggested that during repeated all out sprints there appears to be a critical exercise time where the lactacid energy production system is stimulated. (Balsom et al, 1991).
A study in which there was phased training in rugby league concluded that the training program must be organized to:

(i) Balance the factors of speed, strength, suppleness, skill and stamina.

(ii) "Peak" the participant for every week.

(iii) Arrive at the play-off time with high degrees of physical and emotional energy.

Each week an emphasis of either stamina, power, or speed. The intensity of each week varies according to choice with stamina conducted at low/medium intensity, power at medium, high intensity and speed at close maximum intensity. Utilizing this method of periodization allows for controlled overload throughout the 22 weeks of the season and has resulted in the players arriving at play-off time with high values in critical areas (Giles, 1991).

In a study of the physiological characterization of physical fitness on the basis of physiologic values during a five-month training session including an interval like loading test in the form of a 15 x 30 meters, a running exercise done twice in field conditions was applied. The results indicate that the athletes running speed increased, the blood lactate level decreased and the aerobic threshold shifted to the direction of a higher speed. A significant co-relation was detectable between aerobic power and the efficiency of the
anaerobic effort. It was concluded that during the five-
month training session the sportsmen’s physical fitness
improved proven by the increase of aerobic power (Maloasoky,
CHAPTER THREE

3.0 METHODOLOGY

3.1 TARGET POPULATION

The purpose of the study was to compare interval training and long slow distance training as per their effect on cardiovascular endurance of second formers at Alliance High School and to find out which method was most effective. Second form at Alliance High School is made up of three streams and each stream has a total number of 120 students. Second formers of Alliance High School were chosen because:-

(a) The school is a fairly representative school of students in Kenya since it is a national school and all parts of Kenya are represented in the annual enrolment of students.

(b) An experiment on cardiovascular fitness of second formers is easier to control than other grades. This is because second formers are mature enough to understand that they should not get involved in any physical activity during the treatment period. They are also not very prominent in their regular school teams and their absence therefore during the treatment period does not affect the extramurals involving the school.

3.2 SAMPLE SIZE

The sample that was used in the study was selected by simple random sampling (secret ballot in which the first 20
students from each stream were picked) from all the second form students except for two invalid cases and one case of a subject exempted from physical activity for medical reasons. The subjects were then randomly assigned in equal numbers to the two different treatment conditions and the control group. (See Table 1)

Table 1 : Means and Standard Deviation of Anthropometric Data

<table>
<thead>
<tr>
<th>GROUP</th>
<th>AGE (YEARS) (X ± SD)</th>
<th>WEIGHT (KG) (X ± SD)</th>
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<tr>
<td>INTERVAL TRAINING</td>
<td>15.5 ± 1.30</td>
<td>57.9 ± 4.33</td>
</tr>
<tr>
<td>LONG SLOW DISTANCE TRAINING</td>
<td>15.1 ± 1.06</td>
<td>55.5 ± 4.36</td>
</tr>
<tr>
<td>CONTROL GROUP</td>
<td>15.2 ± 1.32</td>
<td>56 ± 4.93</td>
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</tbody>
</table>

3.3 RESEARCH DESIGN

The experimental design used in the study is a randomized group design known as the post test only control group design. This is the design that contains as many groups in the experimental treatments plus a control or comparison group. Subjects are measured only after the experimental treatments have been applied. Pre-testing of the subjects was not necessary since it was assumed that due to random sampling
from the population and random assignment to the treatment groups all the three group means were equal. This is because the randomization process gave every possible group of forty-five subjects selected from the population an equal probability of being assigned to any of the three groups.

In the study the subjects were exposed to the two treatment conditions for period of 6 weeks except for the control group which do not take part in any of physical activity during the six-week period. The treatment conditions were interval training and long slow distance training. A frequency of 3 days per week for a duration of one hour was found to be optimal for maximal results. For purposes of maintaining constant environmental conditions, the three programmes were conducted simultaneously on Mondays, Wednesdays and Fridays. During the first two weeks the students' response to the training was negative since most of them were not fit but as they got fitter, most of them began to appreciate the value of physical fitness and in the next four weeks training was accomplished with a lot of enthusiasm. The presence of three assistants enabled the researcher to control the treatment conditions better as it was possible to supervise all the three groups at the same time. The control group was present at all times but did not participate in any form of physical activity.
At the end of every week the heart rates were measured before and immediately after the exercise using the pulse rate count on the radial artery. The method used was the ten-second rule whereby the pulse is counted for ten seconds only then extrapolated so as to read for one minute. This was to ensure that the students exercised within the required target heart rate zone. Maximum heart rate is age-related and is calculated by subtracting the age of the subject from 220. (Falls, 1980).

On the last day of the 6-week treatment period, the 1.5 mile endurance run was administered after the subjects rested for thirty minutes. The timing was done using stop watches by the researcher and his three assistants.

The interval training group used the medium term type of training whereby the training distance was between 100 and 400 meters during the six weeks (see Appendix 1). The distances covered per session of training were as follows:– Wk.1: 1000 meters, Wk.2: 1200 meters, Wk.3: 1400 meters, Wk.4: 1600 meters, Wk.5: 1800 meters and Wk.6: 2100 meters. The long slow distance training group covered distances per session as follows:– Wk.1: 1000 meters, Wk.2: 1200 meters, Wk.3: 1400 meters, Wk.4: 1600 meters, Wk.5: 1800 meters and Wk.6: 2000 meters (See Appendix 1).
3.4. **THE MEASURING INSTRUMENT**

The one-and-a-half mile endurance run is a timed test that requires covering a distance of one and a half miles (running, jogging, walking) as quickly as possible. The procedure included:-

(a) Warming up for five minutes

(b) Running the one and a half miles round a track. One and a half miles was found to be equivalent to two thousand four hundred meters which turned out to be exactly 6 laps round a 400 meter-track.

(c) The researcher used one stop watch to read out the times. The three assistants cross-checked his time with two other watches.

3.5 **STATISTICAL TOOL**

Since the experiment design consisted of analysing two treatment conditions and control group and the objective was to test the significance of the observed difference between the means of the groups, a one way analysis of variances was used to study the data. The analysis of variance (ANOVA) is an inferential statistics procedure by which the researcher tests the null hypothesis that two or more population means are equal ($H_0: M_1 = M_2 = \ldots = M_i$). Usually it is not used for only two means because a t-test for the difference between two means can be used. The sample means one corresponding to each population mean are computed and tested
simultaneously for any statistical significant difference between them while keeping $\alpha$ at the stated level of significance. ($\alpha = 0.05$) The null hypothesis in ANOVA is tested by comparing two estimates of variance. These are put into a ratio form, called the F-ratio or F-value. The underlying distribution for this ratio is the F-distribution which is a family of distributions that are not symmetrical. It requires two degrees of freedom, one for each of the variance estimates in the ratio, to determine the correct distribution. The value of the computed F-ratio is checked against the critical value in the table for the stated significance level. If the computed F-ratio exceeds the critical value, the statistical test is statistically significant and the null hypothesis is not accepted. The researcher would then conclude that the population means are not all equal while if the computed F-ratio is less than the critical value, the test is not statistically significant and the null hypothesis is not rejected. When the null hypothesis is rejected, the only conclusion that can be arrived at is that at least two of the means differ significantly. To find out the difference between the specific means after F-test has been performed, a further statistical analysis is necessary (Morehouse and Stull, 1975).

In the study, the null hypothesis was: $H_0 : \mu_1 = \mu_2 = \mu_3$. This means that the population means of the subjects under
the two training methods and control group were assumed to be equal.

A level of significance of $p < .05$ was chosen. This level was found to be optimal because it was necessary to minimize the probability to making errors such as rejecting a true null hypothesis or accepting a false null hypothesis.

3.6 **POST HOC TEST**

There are various post hoc tests that could have been used for further analysis. Methods in common used have been developed by Newman (1939), Turkey (1949), Keul (1952), Scheffe (1953) and Duncan (1955, 1957) as stated by Ferguson (1976).

"... the Turkey test is more sensitive when comparisons involve two groups and the Scheffe test is more sensitive when comparisons involve more than two groups." (Keppel, 1973, 147)

In terms of per comparison of type 1 error, the Scheffe method in any experiment leads to the smallest number of significant differences whereas the Duncan method will lead to the largest number (Ferguson, 1976).

It is on the basis that Scheffe's method was used to test for the difference between the specific means.
3.7 **SCHEFFE’S TEST**

"... Scheffe's method allows us to test for the possible differences between pairs and between sets of means in such a way that the overall level of significance for all tests combined does not exceed .05." (Kohout, 1974, 378)

From the F-test the researcher needed to determine the following directional research hypothesis.

\[ \mu_1 > \mu_2 > \mu_3 \]

The S-Statistic which was used as a standard to judge the difference between the means is defined by:

\[ S = (J-I) \, F_{\text{crit}} \, MS_{\text{within}} \]

\[ \frac{(CJ)^2}{nj} \]

Where:

(a) \( J \) is the number of category means involved in the overall F-test

(b) \( F_{\text{crit}} \) is the tabled value for \((J-1)\) and \((N-J)\), degrees of freedom at a given level of significance.

(c) \( MS_{\text{within}} \) is the within category mean square used in the overall F-test and entered in the Anova Summary Table.

(d) \( C \), is the co-efficient of a mean derived by converting the "general co-efficient formula" into the specific contrast of interest.
(e) \( n \), is the number of cases in a sample category.

For a contrast to be judged significant the difference between means must exceed the computed value of Scheffe's statistic (Kohout, 1974).
CHAPTER FOUR

4.0 DATA ANALYSIS

4.1 ANTHROPOMETRIC DATA

There was no significant difference in the ages of the subjects. (The Interval training group were the heaviest while the long slow distance training group the lightest. (see Table 1).

4.2 DISTANCE COVERED

Table 2 depicts the results of the distances covered per session per week.

<table>
<thead>
<tr>
<th>WEEK</th>
<th>INTERVAL GROUP</th>
<th>LONG SLOW DISTANCE GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>2</td>
<td>1200</td>
<td>1200</td>
</tr>
<tr>
<td>3</td>
<td>1400</td>
<td>1400</td>
</tr>
<tr>
<td>4</td>
<td>1600</td>
<td>1600</td>
</tr>
<tr>
<td>5</td>
<td>1800</td>
<td>1800</td>
</tr>
<tr>
<td>6</td>
<td>2100</td>
<td>2000</td>
</tr>
</tbody>
</table>

There was no significant difference in the distances covered per session by both groups except in the sixth week when the...
interval training group covered an extra 100 meters per session.

4.3 HEART RATE

Figures 1 and 2 depict the results for the resting heart rate and working heart respectively.

There was no significant difference in the resting heart rate (HR) amongst the groups. However, the resting heart rate decreased for all the groups during the six week treatment period.

After the first week, the mean working heart rate for interval training group was $140 \pm 7.45$ and long slow distance training group $150 \pm 8.7$. The control group was not tested. The interval training group thus depicted a significantly lower working heart rate than the long slow distance training group.

During the 2nd, 3rd, 4th, 5th and 6th weeks there was no significant difference in the working heart rate between the two groups (Week 2: INT. $147 \pm 8.28$, LSD $144 \pm 8.84$, Week 3: INT $143 \pm 8.55$ LSD $144 \pm 8.94$, Week 4: INT $145 \pm 10.15$, LSD $144 \pm 8.80$, Week 5: INT $142 \pm 8.84$, LSD $141 \pm 8.48$, LSD $146 \pm 8.58$).
Figure 1. Average Resting Heart rate of Interval (n=15), long slow distance (n=15) and control (n=15) groups in response to the six-week training programme.
Figure 2. Average Working Heart rate of Interval (n=15) and long slow distance (n=15) groups in response to the six-week training programme.
4.4 **SCHEFFE'S SUMMARY RESULTS**

Table 3 depicts the differences between means after Scheffe's test.

**Table 3: Scheff's Summary Results**

<table>
<thead>
<tr>
<th></th>
<th>$Y_1$</th>
<th>$Y_1$</th>
<th>$Y_1$</th>
<th>$Y_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(Second</td>
</tr>
<tr>
<td>$Y_1$</td>
<td></td>
<td></td>
<td></td>
<td>602.5</td>
</tr>
<tr>
<td>$Y_1$</td>
<td>44.5</td>
<td></td>
<td></td>
<td>647</td>
</tr>
<tr>
<td>$Y_1$</td>
<td>166.5</td>
<td>122</td>
<td></td>
<td>769</td>
</tr>
</tbody>
</table>

$Y_1$ Interval training group  
$Y_1$ Long slow distance training group  
$Y_1$ Control group  
$S$ Statistic + 165.2 (p<0.05)

The computed value of the Scheffe's statistic is 165.2 (p<0.05). The only contrast therefore that can be judged significant is the differences between the means of the interval training and control groups (166.5).
4.5 **TIME TAKEN DURING THE TEST**

Table 4: Time Taken to Run 1.5 Miles Endurance Test

<table>
<thead>
<tr>
<th>GROUP</th>
<th>TIME (SECONDS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERVAL TRAINING</td>
<td>602.5 ± 92</td>
</tr>
<tr>
<td>LONG SLOW DISTANCE TRAINING</td>
<td>647 ± 92</td>
</tr>
<tr>
<td>CONTROL</td>
<td>769 ± 80.1</td>
</tr>
</tbody>
</table>

There was a significant difference in the time taken to complete the test. The Interval training group were the fastest (602.5 ± 92s), followed by the long slow distance training group (647 ± 94.3s) and then the control group (749 ± 80.1s).
5.0 DISCUSSION

5.1 ANTHROPOMETRIC DATA

The findings of the study cannot be attributed to a variance of age since there was no significant difference in the ages of the subjects. Although there was a difference in the weights of the subjects it is not significant enough to affect the performance of the subjects. The anthropometric measures therefore do not appear to have affected the performance.

5.2 DISTANCE COVERED

Both groups covered similar distances per session during the six week treatment period except for the week when the interval training group covered an extra 100 meters per session. This difference occurred due to the fact that there are repetitions in Interval training and it is not possible to cover a distance of 2000 meters when running 7 repetitions of 300 meters each. It is difficult to interpret whether this variance could have affected the performance of the subjects.

5.3 HEART RATE

There was no significant difference in the resting heart rate amongst the groups. This seems to indicate that all the groups were at the same level as far as the efficiency of the heart was concerned. The decrease of the resting heart rate during the six weeks for the interval and long slow distance
training groups could be attributed to the treatment conditions. However, the decrease for the control group suggests that the subjects might have been participating in some form of physical activity during the normal school hours. This reflects back on the first limitation of the study.

The working heart rate for the control group was not taken since they were not taking part in any form of physical activity. The significant difference in the working heart rate during the first week is difficult to interpret since there was no significant difference for the rest of the weeks.

5.4. SCHEFFE'S RESULT

Scheffe's results depict a significant difference between the interval training group and the control group. The computed value of the Scheffe's statistic is 165.2 (p<0.05). This result is difficult to interpret in view of the fact that the contrast between the long slow distance and the control group was not significant. Neither was the contrast between the long slow distance and the interval groups significant. The only conclusion that can be drawn from these findings is that neither interval training nor long slow distance training appears superior for the purpose of enhancing cardiovascular endurance. This seems to be in line with the view expressed by Saltin (1975) as quoted by Sharkey (1979).
The result also compares favourably with the comparative study on the relative effects of high intensity low duration and low intensity high duration training on cardiorespiratory responses of young adult males Alexander (1985) and the view expressed by Katch and McArdle (1988) and that there is insufficient evidence for a claim as to the superiority of either method in enhancing aerobic capacity.

5.5 TIME TAKEN DURING THE TEST

The time taken during the 1.5 mile endurance run seems to favour the Interval training group since they appeared the fastest ($602.5 \pm 92s$) followed by the long distance training group ($647 \pm 94.3s$). It is difficult to conclude that the Interval group is superior to the long distance group from this result since this difference, although significant, might not have occurred as a result of the treatment conditions.

5.6 CONCLUSION AND RECOMMENDATIONS

From the findings of the study the only conclusion that can be drawn is that there is no sufficient evidence as to a claim of the superiority of either method in enhancing cardiovascular endurance. The researcher therefore, recommends that;

(i) More research be done using larger samples in which the test administered during the pre-season and mid-season
(ii) Since the study was only on one component of physical fitness, the other researchers should include other physical fitness components like muscular strength and muscular endurance.
BIBLIOGRAPHY


APPENDIX I: TREATMENT CONDITIONS CONDUCTED DURING THE EIGHT-WEEK TREATMENT PERIOD. INTERVAL TRAINING, CIRCUIT TRAINING AND LONG SLOW DISTANCE TRAINING.

(a) **Interval Training**

<table>
<thead>
<tr>
<th>Week</th>
<th>Distance (meters)</th>
<th>Running Speed (Seconds)</th>
<th>Break Jogging About (Seconds)</th>
<th>Repetitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>20 - 17</td>
<td>100 - 60</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>20 - 17</td>
<td>100 - 60</td>
<td>12</td>
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<tr>
<td>3</td>
<td>200</td>
<td>42 - 38</td>
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<td>8</td>
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<td>42 - 38</td>
<td>120 - 90</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>300</td>
<td>60 - 54</td>
<td>120 - 90</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>300</td>
<td>60 - 54</td>
<td>120 - 90</td>
<td>8</td>
</tr>
</tbody>
</table>

(b) **Long Slow Distance Training**

<table>
<thead>
<tr>
<th>WEEK</th>
<th>ACTIVITY (METERS)</th>
<th>TIME (MIN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1000</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>1200</td>
<td>4</td>
</tr>
<tr>
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## APPENDIX 2: ANOVA TABLES

(a) **Training Program: Treatment Groups**

<table>
<thead>
<tr>
<th>SUBJECTS</th>
<th>INTERVAL</th>
<th>SLD</th>
<th>CONTROL</th>
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<tr>
<td>1</td>
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<td>811</td>
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<td>607</td>
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<tr>
<td>15</td>
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<td>539</td>
<td>754</td>
</tr>
</tbody>
</table>
(b) Anova Summary Table

<table>
<thead>
<tr>
<th>SOURCE OF VARIATION</th>
<th>SUM OF SQUARES</th>
<th>DEGREE OF FREEDOM</th>
<th>MEAN SQUARES (MS)</th>
<th>F-RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between within Total</td>
<td>223, 387.7</td>
<td>J-1 = 2</td>
<td>11,693.8</td>
<td>14.09</td>
</tr>
<tr>
<td></td>
<td>332, 973.4</td>
<td>N-J = 42</td>
<td>7,927.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N-1 = 44</td>
<td></td>
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