Chapter II

REVIEW OF RELATED LITERATURE

Since the scope of the problem selected for the study was very broad it was not possible to cover all the pertinent sources of information and literature. The review of literature related to the study was mainly confined to the libraries of Lakshmi Bai National College of Physical Education, Gwalior, Y.M.C.A. College of Physical Education, Madras, Department of Physical Education and Sports Sciences, Annamalai University, Annamalainagar, Madras Medical College, Madras and Sri Sarada College of Physical Education for Women, Salem. In this chapter, a brief abstract of the related literature reviewed has been presented.

Three work loads of varying intensity and distance on cardiovascular endurance were compared by McKibben. The subjects were grouped into three for training, one at heart rate of 150 beats per minute for 15 minutes, the second at a rate of 120 to 180 beats per minute for 15 minutes and the third at a rate of 150 beats per minute over the distance run by group II. The subjects had training five days a week for seven weeks on the treadmill. An analysis of

variance on the pre and post test and Tukey’s Range test were used for the analysis of the results. It was found that running for 15 minutes a day at a heart rate of 150 beats per minute for seven weeks improved the cardiovascular efficiency and that when expending equal amounts of energy during a given time there was no difference in continuous running and interval training in the development of cardiovascular endurance.

Parks² studied the effects of a 10 week physical fitness programme on selected physiological and psychological variables of elderly people of 65 to 82 years. The subjects were 15 females. By the state-trait anxiety inventory, the pre and post measurements were obtained for psychological variables. The physiological variables measured were body composition, flexibility, heart rate and blood pressure. All subjects participated in the fitness programme, half an hour in the mornings, three days a week for 10 weeks. Each exercise began with 10 minutes of warming up followed by 15 minutes of exercise of moderate intensity. The last five minutes were used as cooling off period. To determine if a significant difference existed between pre and post test measures on the related physiological and psychological

variables, the 't' test of correlated samples was used. The results showed the following significant changes:

1. There was a decrease in percentage of body fat
2. Increase in flexibility and
3. A decrease in heart rate.

However in systolic and diastolic blood pressure and anxiety levels of the subjects, there was no significant changes.

Withers\(^3\) studied the effects of anaerobic work at submaximal workloads in subjects of high and medium fitness. Eight subjects of higher fitness and eight subjects of medium fitness acted as the subjects. The subjects worked for six minutes on a bicycle ergometer at workloads which elicited 70, 80 and 90 per cent of their individual optimum oxygen uptake. During the last 30 seconds of each workload the heart rates were recorded. For the purpose of lactic acid determination, blood samples were taken three and a half minutes after exercise. The results showed that when compared to the medium fitness group the subjects of high fitness exhibited significantly less blood lactic acid over all post exercise. There was a significant increase in blood lactic acid with an increase in workload. When working at submaximal relative workloads, though the high fitness group exhibited lower

heart rates than the medium fitness group, there was no overall significant difference statistically between the two fitness levels. When compared to the subjects of medium fitness the high fitness group attained their maximum oxygen uptake at a significantly lower mean heart rate.

Delsanto\textsuperscript{4} conducted a study to determine the effects of physical conditioning programmes, on selected physiological components, and cardiovascular fitness. Seventy six college men were related as subjects and they were divided into four groups. Group I participated in Cooper's aerobic programme and group II was given interval conditioning programme. Group III had regular physical education programme and for group IV no special programme was given and they acted as the control group. The results of the study revealed that though the control group did not improve in its cardiovascular fitness, the other three groups, Cooper's aerobic programme group, interval conditioning programme group and the regular physical education programme group exhibited a significant improvement in cardiovascular fitness.

White\textsuperscript{5} studied the changes by aerobic dance and six month walking programme on the skeletal and cardiovascular


\textsuperscript{5} Mary K. White, "The Effects of Walking and Aerobic Dancing on the Skeletal and Cardiovascular Fitness Three Systems of post Menopausal Females" Dissertation Abstracts
systems of post menopausal females. The subjects of this study were ninety-six women, whose ages were from 49 to 62 years. To assess the skeletal changes the bone mineral content and bone width were used. The changes in cardiovascular fitness was assessed by administering the Balke Treadmill Test. The results showed that a six month exercise programme for post menopausal women resulted in favourable changes in bone status, muscular strength and cardiovascular fitness.

Pilch conducted a study to determine the cardiovascular responses on selected middle aged subjects to regular period of exercise. In this study blood pressure (systolic and diastolic) was one of the cardiovascular parameters. All subjects participated in the regular period of exercise i.e., pedalled the bicycle ergometer thirty minutes a day, four days a week for six weeks at the workload that kept the heart rate at 135 per minute. The results showed that there was a significant improvement in systolic blood pressure at the levels except at 1200 pounds/meter. Diastolic showed improvement at 300 and 750 pounds/meter. From the results it was concluded that training of one and a half month duration with the heart rate approximately 135 beats per minute was adequate for cardiovascular training stimulus for middle aged.

Cooper\(^7\) and others studied the effect of an aerobic conditioning programme on cardiovascular fitness of the school children. Twelve minute Run and Walk test was administered to assess the cardiovascular fitness. A total of 1235 students participated in the programme as subjects. The subjects were divided into an experimental group of 798 students and a control group of 437 students. Pre and post tests were administered to each student by Cooper's 12 minute Run and Walk test. The experimental group initially ran five to six minutes and then progressed to 14 minutes by the end of the term. The training was given for 15 weeks. In addition to the aerobic conditioning programme, the experimental group added jogging to their daily physical education classes, whereas the control group had their normal activities only. From the results, it was concluded that an endurance training programme significantly improved the cardiovascular fitness.

Israel\(^8\) studied the effects of aerobic, anaerobic and pulse work out exercises on selected physical fitness and physiological parameters. The subjects were 65 volunteer male


\(^8\)Richard Gay Israel, "The Effects of Aerobic, Anaerobic, and pulse Workout Exercises on Selected Physical Fitness Parameters, Plasma Cholestrol and Plasma Triglyceride Levels in College Males" Dissertation Abstracts International 37 (February 1977): 4957-A.
under graduate students. The subjects were grouped into three experimental groups and one control group. The experimental group worked four days a week for five weeks, while the control group was not allowed to participate in any exercise programme. The exercise programme consisted of aerobic treatment of 30 minutes continuous jogging session, anaerobic treatment of 15 maximal sprints 40 yards in length and the pulse workout treatment, which was of two sets of four workouts each one quarter mile in length. The pulse workout exercise programme was administered to work the subjects at their optimal work capacity (180 bpm). The pre and post test measurement were obtained by Cooper's 12 minute run and walk test, Balke treadmill test and other physiological variables. From the statistical Analysis of Variance, it was concluded that the aerobic and pulse workout exercise programmes increased the cardiovascular endurance significantly.

Mayhew\(^9\) conducted a study on the relative contributions of body compositions on selected haematological parameters and aerobic capacity to endurance running performance of male and female adolescent track athletes. For this study 24 male and 21 female track athletes from school teams were

selected as subjects. The tests administered were: all out treadmill run (a maximal oxygen intake treadmill test); anthropometrical assessment; venous blood haemoglobin and haemocrit readings and 1000 and 2000 meter run for time. The results indicated significant difference in body composition and structure, haematological parameters, aerobic capacity and endurance running performance between adolescent male and female track athletes. The circulo-respiratory, body structure and body composition variables contributed significantly to endurance running performance in both male and female track athletes.

Nagle and Irwin\textsuperscript{10} undertook a study to determine the effects of two systems of eight week weight-training on circulo-respiratory endurance and related physiological factors. The subjects (N = 20) in each group were randomly divided into three groups, two experimental and one control group were tested doing moderate and all out exercise on a bicycle ergometer. The experimental group in addition participated in archery activity. The cardio-respiratory endurance and selected physiological responses were measured. Pre and post test analysis revealed that the experimental group showed improvement in circulo-respiratory responses while there was

no significant differences among the three groups in their response to exercise.

Braxton\textsuperscript{11} studied the effects of calisthenics on heart rate of College women and found that sprinting and squat thrust exercises were considered anaerobic and could not be performed beyond sixty seconds. The Jumping Jack was considered as the most useful calisthenics exercise for cardiovascular benefit. It was concluded that subjects could continue performing calisthenics by maintaining the heart rate level at 150 beats per minute.

The effect of two physical conditioning programmes on cardiovascular fitness in men, were compared by Harper\textsuperscript{12} and others. Twenty five college men were selected as subjects for the study. On the basis of maximum oxygen consumption, the subjects were divided into three matched groups. Group I participated in a modified army conditioning programme of calisthenics and marching, group II participated in a programme of interval training involving running, and group III acted as control group and participated in recreational activities.

\textsuperscript{11} Wilks Barbara Lee Braxton, "Effects of Calisthenics on Heart Rate of College Women" Dissertation Abstracts International 35 (April 1975): 6500-A.

\textsuperscript{12} Donald D. Harper, Charles E. Billings and Donald K. Mathews, "Comparative Effects of Two Physical Conditioning Programme on Cardiovascular Fitness in Man" Research Quarterly 40 (May 1969): 293-298.
The groups were trained for five days a week for seven weeks. To evaluate the differences between pre and post conditioning, maximum oxygen consumption and Harward step test indices were administered. The results showed that the interval trained group had no significant improvement in maximum oxygen consumption, but there was a significant improvement in the Harward step test indices. The control group did not show any significant improvement.

Sharkey and Hollman\textsuperscript{13} studied the cardio-respiratory adaptations to training at specified intensities. Sixteen college men were selected as the subjects. The subjects were randomly divided into three training groups and one control group. The selected cardio-respiratory adaptations of six weeks of training exercises elicited either 120, 150 or 180 heart beats per minute. The training consisted of walking on the motor driven treadmill for 10 minutes a day, three days a week. The statistical analysis of the pre and post test scores revealed that the 180 heart beats per minute training group exhibited significant improvement over all other groups. The 150 group had significant difference from the 120 and the control group. From the results it was concluded that intense activity is necessary to bring about the changes associated with cardio-respiratory endurance.

\textsuperscript{13}Brain J. Sharkey and John P. Hollman, "Cardio-respiratory Adaptations to Training at Specified Intensities" Research Quarterly 38 (December 1967): 698–704.
Parr\textsuperscript{14} studied the effects of cardiovascular respiratory adaptation to manipulate cardiac acceleration. The subjects for this study were sixteen students from the general education section. The students were divided into three experimental groups. They were trained at 180 beats per minute, 160 bpm and 140 bpm, for ten minutes a day, for five days a week for six weeks. To assess the aerobic capacity and resting heart rate pre and post tests were given to each subject. From the results it was concluded that aerobic capacity can be increased by training, based on heart rate intensity. A more pronounced difference would appear within the groups if the intensity of work was greater.

Gray\textsuperscript{15} conducted a study to determine the effect of three modes of aerobic training on Cardiovascular Endurance. The three modes of aerobic training were cycling, jogging and swimming. 102 college men and women of 17 to 29 years of age were selected for the study. The subjects were divided into three groups at random. They were allowed to participate in the mode of training on their own (cycling, jogging or swimming). The three groups were further divided into

\textsuperscript{14}Richard Bruce Parr, "Cardiovascular Respiratory Adaptation to Manipulated Cardiac Acceleration" Dissertation Abstracts International 32 (April 1972): 3595-5996-A.

subgroups each as experimental and control subgroups. The experimental group exercised for 40 minutes a day for three times a week for seven consecutive weeks. From the result it was concluded that aerobic exercise programme produced a significant difference with a significant increase in cardiovascular endurance. There was no significant difference in cardiovascular endurance in the aerobic training modes of cycling, jogging and swimming.

Davis\textsuperscript{16} studied the effect of varied rest periods, during interval training upon aerobic and anaerobic fitness. The subjects for this study were 23 male volunteers of age 19 to 28 years. Pre and post tests were conducted for each subject on maximum oxygen consumption, oxygen debt, peak blood lactate concentration and time of ride to exhaustion on the bicycle ergometer with 350 watts of load. The training sessions consisted of 151 minutes' work periods with varying rest intervals. The rest periods were 40, 80 and 120 seconds between efforts. The intensity of work was set at 100 per cent of each individual's Max. VO\textsubscript{2} based on maximum aerobic tests before training and at the expiry of four weeks. The subjects were randomly grouped into three exercise groups and one control group. All groups were trained on the bicycle ergometer three days a week, for eight weeks. The results of the training resulted in significant

increase in maximum oxygen consumption for all groups. In the rest groups of 40 and 80 seconds, there was significant improvement in $O_2$ debt, peak blood lactate, and time of ride to exhaustion.

Massicotte\textsuperscript{17} and others studied the effects of aerobic training on men and women. Twenty three men and 11 women of age 20 to 55 years were selected as subjects for the study. All subjects participated in the aerobic training programme, one hour in the morning, three days a week, for three weeks. The pre and post tests data revealed significant increase in physical performance. Moreover from the results it was concluded that there was no significant difference in the effects of aerobic training on men and women.

Gentry\textsuperscript{18} conducted a study on the effects of a nine week aerobic jogging programme on selected cardiovascular functions of young male college students through a time course evaluation procedure. Fifteen college students of 18 to 22 years of age served as the subjects. Before training and at


the expiry of nine weeks, tests were administered to evaluate the effects of the aerobic jogging programme on selected cardiovascular parameters. Analysis of data revealed that significant changes in cardiovascular fitness occurred as a result of aerobic jogging programme.

Gibson's purpose of study was to determine the effects of three selected training intensity levels on anaerobic threshold, aerobic power and aerobic capacity on young females. Twenty nine young females were selected for the study. The maximum oxygen consumption test was administered on a treadmill using modified Balke protocol and then the anaerobic threshold (AT), aerobic capacity (Max. VO₂) and oxygen power (AP) were determined. The subjects were randomly assigned to one of the three training groups 1) forty per cent above AT, 2) AT and 3) forty per cent below AT. All subjects were trained on a treadmill at individual training heart rates of ± 5 beat per minute. The training schedule was four days a week for a total period of eight weeks. At the end of the training period the subjects were tested for maximum oxygen consumption (VO₂). The results indicated a significant difference on aerobic capacity and aerobic power. Significant difference existed between groups on anaerobic threshold with the AT+ group being different from the AT- group.

Mayfield studied the effects of aerobic dancing on the cardio-respiratory system of 40 selected females. The subjects were randomly grouped into experimental and control group. The aerobic dance programme was for ten weeks, three days a week for 45 minutes per session, as measured by the Astrand–Rhyming Bicycle ergometer test. Results of this study showed that individuals participating in the aerobic dance programme achieved significantly higher level of cardio-respiratory fitness in comparison to the control group.

Alteri conducted a study to determine the effects of interval and endurance running upon anthropometric and physiological parameters (CES). Sixty three college women of 17 to 22 years of age were selected as subjects, who were randomly grouped into four experimental groups. At the end of ten weeks of experimental conditioning the pre and post test data were collected and analysed. The results showed that subjects covered more distance on the Cooper's 12 minute run-walk test of all groups after the experimental period.


Roger Eugene Alteri, "The Effects of Interval and Endurance Running upon Anthropometric and Physiological Parameters in College Age Females" Dissertations Abstracts International 36 (December '75): 3483-A.
Knowlton and Deutsch\textsuperscript{22} conducted a study on the performance outcomes of cross country running structured in a voluntary activity class. Twenty eight college men were the subjects of the study. Their running performance and metabolic variables were evaluated during the period of a ten week cross country activity class. The three minute run was the basic criterion measure, while the treadmill tests were used to determine oxygen uptake of the speed of the field test as well as under maximal conditions. Increased running performance was not attributed to changes in maximum oxygen consumption but to a greater use of aerobic capacity. The analysis of data revealed a significant improvement in the physiological efficiency during submaximal and maximal activity as an outcome of the training programme.

Durrant\textsuperscript{23} conducted a study to evaluate the effects of jogging, rope jumping and aerobic dance, on body composition and maximal oxygen uptake of 101 college women students. They were divided into three experimental groups and one control group. Group I was given jogging, group II rope


jumping and group III aerobic dance. Analysis of data showed that there was no significant differences in maximum oxygen uptake between the three treatment groups. However there was a significant difference between the treatment groups and the control group.

Dulin determined the effects of interval and continuous training on cardio-respiratory fitness of deconditioned mature males. To duplicate the time and distance parameters, the workouts were designed by using Cooper's aerobic starter programme as a framework for both the interval and the continuous running programme. The continuous running group afforded a norm group, by establishing a treadmill stimulation of the aerobics starter programme. The interval training group went through the same programme with prolonged intervals rather than in continuous running. By running faster, then slower than the continuous runners, the interval runners ran the same distance in the same time. At the end of their respective programme a comparison of cardio-respiratory fitness scores was made. The results revealed that neither exercise programme interval running nor continuous running, was significant in terms of promoting cardio-respiratory fitness of the subjects.

Parker\textsuperscript{25} studied the effect of an aerobic exercise training programme on the instantaneous power output of the quadriceps femoris muscle group. Twelve male subjects of 20 to 30 years of age were selected for the study. The subjects were divided into experimental group and control group. The aerobic exercise programme was for a period of four weeks, of three days per week and the treadmill walk was designed to maintain each subject's heart rate between 150 and 160 beats per minute for ten minutes. During the experimental treatment the control group participated in isokinetic muscle evaluation. Analysis of data revealed that the experimental group increased in aerobic capacity with concomitant increase in instantaneous power \((p = .05)\). The muscle force-velocity relation did not change as a result of aerobic training \((p = .05)\). However \('PO' changed over week \((p = .05)\) in response to the isokinetic testing.

Burris\textsuperscript{26} conducted a study to determine the effects of a six week aerobic dance and folk dance programme Vs. the effect of a six week aerobic jogging programme on the cardio-


\textsuperscript{26} Maureen Smith Burris, "The Effects of a Six Week Aerobic Dance and Folk Dance Programme Vs. the Effect of a Six Week Aerobic Jogging Programme on the Cardiovascular Efficiency and Per cent of Body Fat in Post Pubescent Girls" Dissertation Abstracts International 40 (September 1979): T344-A.
vascular efficiency and percentage of body fat in post pubescent girls. Seventy six post pubescent females were the subjects. The subjects were divided into three groups - group I dancers, group II joggers and group III as the control group. The Cooper modification of the Balke Treadmill test was used to determine cardiovascular efficiency. The percentage of body fat was determined by the skinfold Caliper method. The training programme was for six weeks, for five days a week. The subjects were tested before and at the end of the sixth week of the training programme. Results of the study indicated that 1) a six week programme of aerobic dance and folk dance increases cardiovascular efficiency and reduces per cent of body fat and 2) a six week programme of aerobic jogging increases cardiovascular efficiency and reduces per cent of body fat. The results indicated no significant difference in the effects of the two programmes.

Beaudet\textsuperscript{27} undertook a study on the comparison of selected physiological parameters in men and women of similar aerobic capacity. Physiological parameters involved in oxygen transport were compared in men and women of similar aerobic capacities as assessed by maximum oxygen uptake. The parameters of cardiac output divided by body weight, haemoglobin concentration and per cent body fat were examined to detect differences that might exist due to sex or fitness level.

\textsuperscript{27}Suzanne Michale Beaudet, "A Comparison of Selected Physiological Parameters in Men and Women of Similar Aerobic Capacity" Dissertation Abstracts International 40 (August 1979): 736-A.
The results showed that cardiac output increased with fitness level and was greater in men. Cardiac output divided by body weight increased with increase in fitness level but showed no difference due to sex. Haemoglobin concentration was greater in men but did not vary due to fitness level. Per cent body fat was greater in women and decreased with increase in fitness level.

McPeak\textsuperscript{28} conducted a study on the effect of an interval training programme on aerobic, anaerobic and anthropometric parameters on women. The Interval Training Programme of submaximal activity involved controlled running, calisthenics and weight training, on aerobic, anaerobic and anthropometric parameters on women. The subjects for this study were 31 females of 29 to 30 years of age. The training programme was submaximal in nature and continued for seven and one third weeks. The training was three days a week, each of 60 minute duration. The activities included two flexibility exercises, six weight training activities emphasising muscle endurance, three calisthenics and running. From the analysis of data it was concluded that all the parameters can be positively changed by providing a seven and one third week, of submaximal interval training programme for women from 29 to 30 years of age.

\textsuperscript{28}Clifford Thomas McPeak, "Effects of an Interval Training Programme on Aerobic, Anaerobic and Anthropometric Parameters on Women" Dissertation Abstracts International 38 (May 1978): 6602-6603-A.
Marcel undertook a study to determine the changes in psycho-physiological comparison of Cooper aerobics training programme and a running training programme. Forty one males and 31 females were selected as the subjects, who were trained two days a week for 10 weeks. The data collected were compared to the changes in physical fitness variables, attitude towards physical activity and selected personality traits after ten weeks of training following continuous work on Cooper's aerobic programme. The results showed that participation in these exercise programmes produced a more positive attitude toward physical activity, reduced level of neurotism decreased weight, decreased per cent of body fat, decreased girth, decreased systolic and diastolic blood pressure and lower resting, exercise and recovery heart rates. The programmes also increased VO₂ scores, number of sit ups and push ups flexibility and leg extension strength.

Elbel and Holures studied the relationship between exercise pulse rate and recovery following exercise on 45 male students. According to them recovery heart rate was not related to pre-exercise pulse rate.


Tuttle\(^{31}\) conducted a study to find out the efficiency of high school boys as shown by pulse ratio test. The subjects were basketball and track and field athletes, who were given stepping exercise on a 13 inch bench for a period of one minute. The high physical efficiency had a faster recovery. He also found out that normal pulse ratio of the trained individuals were materially the same as that of the untrained. He was of opinion that trained individuals had a lower initial heart rate.

Sedgwick\(^{32}\) studied the relationship between resting exercise and recovery heart rate following maximal heart rate and fitness criteria. Resting heart rate correlated high with fitness criteria.

Stephens\(^{33}\) studied the effect of isotonic and isometric exercises on selected physiological variables, haemoglobin concentration being one of them. No increase in haemoglobin


\(^{33}\)Martha Stephens, "A Study of the Effects of Isotonic and Isometric Exercise on Selected Physiological Variables" *Completed Research in Health, Physical Education and Recreation* 48 (October 1977): 606-615.
concentration was observed under exercise conditions. But isotonic conditions resulted in greater haemoglobin concentration than isometric.

Williams and Ward\textsuperscript{34} conducted a study to compare the acute and chronic effect of strenuous work task upon selected haematological components. The subjects were 24 long distance runners. Blood samples were taken one hour prior to start, ten minutes after the first mile run and approximately ten minutes after the subjects had completed the next mile. Haemo concentration occurred following the initial mile run, but haemo concentration was not significantly higher at the conclusion of the 24 hour period after the one mile run, suggesting that plasma volume was maintained during the 24 hours period.

Carder\textsuperscript{35} studied the acute and chronic effects of isometric exercise on selected haemotologic measures of which haemoglobin concentration was one of the variables. Blood samples were analysed during the fourth and sixth weeks, after the training period. No significant difference was observed between the three kinds of isometric exercise.

\textsuperscript{34}Melvin H. Williams and Anderson T. Ward, "Haematological Changes Elicited by Prolonged International Aerobic Training" \textit{Research Quarterly} 48 (October 1977): 606-615.

\textsuperscript{35}Brice W. Carder, "The Acute and Chronic Effects of Isometric Exercise on Selected Haematologic Measures" \textit{Completed Research in Health, Physical Education and Recreation} 10 (1968): 113.
Henry and Berg\textsuperscript{36} tested 24 basketball players and nine track men, before and after seasonal training. Oxygen debt and carbon dioxide production were considered to be better measures of improvement in physical condition than performance tasks. The following tests were employed: time of running 75, 150 and 300 yards, maximum time for step pack test, oxygen debt and carbon dioxide produced after four minutes step test. Of the performance test the 300 yards run was the best and the step pack test was the least effective measures. The recovery metabolism was not significantly affected by conditioning.

Pankey\textsuperscript{37} conducted a study to determine the effects of interval running and weight training on the selected measures, in which anaerobic power was one of the variables tested. The training programme was for ten weeks, five days a week. The subjects were tested on the first, fifth and tenth weeks. Analysis of data resulted in a significant increase in anaerobic power after training.


O'Brien\textsuperscript{38} studied the effects of frequency of training on cardio-respiratory conditioning. Subjects (N = 24) were employed to compare training, twice weekly verses four times weekly in running. Results of the study indicated no significant difference between the groups after training.

Waltin and Schendel\textsuperscript{39} for their study selected twenty-one middle aged (31-60 years) men. All subjects participated in a jogging programme for ten weeks, of three days a week. At the start of the training the subjects first walked and then jogged at 55-yard intervals of one and a half mile, covering a distance of 3 miles at the end of 10 weeks. Before and after the programme, they performed a six minute submaximal exercise bout on a bicycle ergometer to determine if any difference existed in heart rate and blood pressure. Differences between the means of pre and post tests of heart rate, under pre-exercise, submaximal exercise and post exercise conditions, were all significant at .01 level. Diastolic blood pressure was significantly lower than the initial mean. The difference in systolic blood pressure was not significant. The investigators concluded that the decrease in heart rate and diastolic blood pressure at rest,


\textsuperscript{39}Charles C. Waltin and Jack S. Schendel, "Physiological Changes in Middle-Aged Men Following a Ten-Week Jogging Programme" Research Digest 23 (November 1973): 3.
during submaximal exercise and during the recovery period indicate a more efficient blood transport, less strain on the cardiovascular system and functional reserves, and an increase in submaximal work capacity.

King\(^{40}\) studied the effect of two training programme on selected cardio-respiratory variables in college women. The physiological changes measured were pulse rate, respiration rate, respiration amplitude, minute volume of respiration and oxygen consumption. The respiratory variables were recorded simultaneously by a respirometer. The cardiovascular reaction was measured by counting the pulse rate. All variables improved during the four weeks training period regardless of the training programme prescribed. Both training programmes were of sufficient duration and intensity to affect changes in post exercise scores.

Standacher\(^{41}\) studied the school boys physically fit and unfit with respect to certain cardio-respiratory components

\(^{40}\) Louise Chloe King, "An Investigation of the Effects of Two Training Programmes on Selected Cardio-respiratory Variables on College Women" Completed Research in Health, Physical Education and Recreation 5 (1963): 101.

in which blood pressure was one of the components. Twenty
four subjects were selected randomly of grade twelve and
were divided into two groups according to their physical
ability. The subjects ran to exhaustion on a motor driven
treadmill with the grade and speed increased every three
minutes. Blood pressure, heart rate and oxygen consumption
were measured before, during and after the run. It was found
that there was statistically significant difference in case
of oxygen consumption.

To compare the physiological effects of training in
males and females participating in training programmes nine
males and eight females were selected for three training
sessions per week over an eight week period by Durke.\textsuperscript{42}
The training programme consisted of half mile interval runs
beginning with one mile run per session in the first week
and progressing to two and two and a half mile run in the
eight week. Analysis of co-variance revealed a significant
difference in improvement between the male experimental and
control groups in $\text{VO}_2$ maximum ($p = .001$). There was no
significant difference ($p = .05$) between the male and female
experimental groups in $\text{VO}_2$ maximum. It was concluded that
when males and females participated in training programmes,
similar relative improvement took place. From the results,

\textsuperscript{42}Edmond J. Durke, "A Comparison of the Physiological
Effects of Similar Training Programmes in Males and Females"
Research Abstracts AAHPER (1972): 82.
it was concluded that regular physical education programme groups improved significantly in cardio-respiratory fitness in comparison to control group.

Howell\textsuperscript{43} found that normal blood of an athlete contained 56,000,00 red cell and 8,800 leukocytes per cubic millimeter which is above the normal and it is true that the man under training has a large number of cells per cubic millimeter than the untrained individuals.

Moorhouse and Miller\textsuperscript{44} were of the opinion that training will decrease the haemoglobin percentage in the blood by increase plasma and decreased viscosity.

Mathews and Fox\textsuperscript{45} were of opinion that total blood volume and haemoglobin increased with training.

According to Deories\textsuperscript{46} physical conditioning can increase the total haemoglobin which would be due to the


increased blood volume, but no increase in haemoglobin concentration per unit volume will increase.

Bucher\textsuperscript{47} expressed his opinion that as the result of training the bone marrow becomes redder indicating an increased rate of blood manufacture, which result in increased red blood corpuscles in trained person.

Lathen\textsuperscript{48} conducted a study on rats to determine the effects of three types of treadmill running programme (14 weeks) on body weight, total body fat, percentage of body fat and resting heart rate. From the results he concluded that long continuous running had resulted in significantly less total body fat and percentage of body fat, than interval group. Further, the study revealed that continuous running method had the greatest change in body composition. However, no change was observed in resting heart rate.

Bradley\textsuperscript{49} selected 30 college males and divided them into two equal groups of untrained (below average fitness level) and trained (above average fitness level) distance


\textsuperscript{48}Calvin Weley Lathen, "Running Programme and their Effects on Resting Heart Rate, Body Composition and Selected Muscle Weights in Rats" Dissertation Abstracts International 36 (November 1973): 3358.

runners. An electro-cardiograph, heart sound microphone and a photo electric pulse pick-up were attached to each subject while resting. Each subject rode a bicycle ergometer for five minutes at 700 LPH at 60 cycle pedal speed. During the last 30 seconds of the exercise periods and at the end of the post exercise periods the recordings were made. Two consecutive cycles were averaged to determine selected cardiac cycle time for exercise and post exercise periods. It was found that highly trained individuals have significantly increased resting and post exercise projection periods, significantly increased resting electro-mechanical leg and iso-volumetric contraction periods and significantly increased resting, exercise and post exercise mechanical systols and total systols. Highly trained subjects had also reduction in exercise and post exercise left ventricular ejection time.

Dunn\textsuperscript{50} selected 15 women and 13 men to participate in a 10 week programme of timed Calisthenics. Assessment of aerobic capacity, strength and body composition were made at the beginning and at the conclusion of the study. Both men and women made similar improvements in all categories with the men scoring significantly higher than the women in aerobic capacity, 1.5 mile run, grip strength, jumping ability and body weight. Women showed significant improvement

\textsuperscript{50}Steven E. Dunn, "Changes in Aerobic Capacity Strength and Body Composition with Timed Calisthenics" Dissertation Abstracts International 40 (April 1980): 5363-64-A.
in 1.5 mile run. There was a remarkable increase in muscle endurance as measured by pull-ups and flexed arm-hang time respectively. No changes were found in body composition body, weight and percent body fat. There was a significant change in skinfold measurement. These data indicated that timed calisthenics is effective in increasing aerobic capacity, strength and endurance.

McCrimmon\textsuperscript{51} investigated the effects of interval and continuous training on selected cardiovascular responses in women. The subjects were grouped into three groups of five women each. All subjects participated in a twelve week training programme of four days a week. The statistical analysis indicated that in response to high intensity training, women may demonstrate similar cardiovascular adaptations to training as men.

\textsuperscript{51} Donald McCrimmon, "A Comparison of Interval and Continuous Training Effects on Selected Central and Peripheral Cardiovascular Responses to Exercise in Women" Completed Research in Health, Physical Education and Recreation \textsuperscript{79} (1977): 306.