Review of Related Literature
CHAPTER - II

REVIEW OF RELATED LITERATURE

A study of relevant literature is essential step to get a picture of what has been done with regard to the problem under study. Such a review brings out a deep and clear perspective of the overall field.

The relevant literature pertaining to the present study has been abstracted in this chapter to provide the background material to evaluate the significance of this study as well as to interpret its findings. Literature plays a crucial part in the planning of the study. It contributes to the scholarship of the investigator and it provides a background for the development of the present reader up to date.

The literature in any field forms the foundation upon which all future work will be built. The collection of relevant literature provides the basic understandings of the problem and its depths such a review brings about a deep insight and clear perspective of the overall field. Only when a large and extensive study is made on the released problems or only when one has come across old problem, method of finding and solution for such problems can be easily achieved with confidence.
STUDIES ON SPEED

Dasgupta conducted a study on effects of various intensities and frequencies of bench step training on selected motor ability components physiological and performance variables of college “sprinters”. To facilitate the study 63 male students in the age group were selected as subjects. In the first factorial analysis homogeneity of variance of all the pre test scores were tested. In the second factorial analysis the significant difference between the post hoc test was used to find at the paired mean difference. Four days of frequencies of training improved the speed, anaerobic power and pulse rate greater than three and two days frequencies.

Dintinman (1964) Studied the effects of various training programme on running speed which were the components of physical fitness. The purpose of the study was to determine whether a flexibility training programme and the combination of the both would effect on running programme to the conventional method of training programme to where as both weight training and flexibility training used as supplements to sprint training increased running speed significantly.

Miura (1995) studied to determine the aerobic training intensity from the maximal and sub maximal running exercise in 21 untrained adult men. To accomplish this he evaluated the relationship between physiological (oxygen intake and heart rate) and physical parameters (running speed) of training intensity, and determined the training intensity at the sub maximal exercise.
Oxygen intake and heart rate were measured by a treadmill test. The maximal oxygen intake (VO₂ max), and the aerobic threshold (AerT) and anaerobic threshold (AT) were measured to determine respiratory gas exchange. Running capacity was measure by a 12-min running and treadmill test. For the maximal exercise, there was a significant correlation (r=0.088, P<0.01) between VO₂ max and 12 min running distance (Speed). In addition, the oxygen intake and heart rate at AerT and AT is this sub maximal exercise were linearly correlated with running speed. Three levels of training intensity of sub maximal exercise were termed light, moderate and heavy, since AerT was the lower limit intensity and AT was the upper limit. He took the middle of their values as the moderate intensity. The end point for the determination of the training intensity at the sub maximal exercise was estimated to be 85% VO₂ max and 180 beats min⁻¹.

Clarke and Henry conducted a study on neuromotor specificity and increased speed from strength development. The experiments group was given weight training. Arm strength effective arm mass and speed in lateral addictive arm movement were measured in sixty two college men and remeasured three weeks later. They came to the conclusion that conditioning exercise of progressive resistance type causes increased mean arm Arm Strength and increased Speed of Test movements.

Lamelbawn devised a pre-season circuit programme that would help to develop all areas of conditioning including strength,
endurance, speed and agility. The team was divided into three groups and the total practice time should be around two hours of which forty five minutes should be devoted to the circuit (1) strength Station (2) Endurance Station (3) Speed and Agility station each group rotates approximately twelve minutes.

Leshkevitch and others studied the influence of sequence of exercise in training undertake in the development of physical foundation of speed in young sportsman. Three groups of boys 12-14 years of age were given training for four times a week for three months to determine the effect of sequence of exercise. The observed changes were noted in speed.

Human performance can be correlated to various aspects like strength, speed and agility. It is believed that the agility is somewhat closely related to performance, this type of study was conducted by Hilsendager, D.K.Strow M.H. and Ackerman K.J. was to determine whether exercise designed specifically to develop agility, the group particularly in exercise demonstrated statistically significant superiority in exercise over one or more of the other groups on four of the seven agility tests, heading to the conclusion that agility can be developed in programme designed specifically for the purpose consequently that unique factor of agility does exist.
STUDIES ON ENDURANCE

Evan (1988) conducted a study on the effects of progressive weight training upon running speed and endurance. The dependent variables on running speed and endurance were measured before and after twelve week training programme including fifty yards dash for speed and 300 yards for endurance. The experimental group participated only is running. It was conducted that the programme of weight training and running was more different than running in developing running speed and endurance.

STUDIES ON RESTING PULSE RATE

Thirumalaisamy (1994) conducted a study on “Comparative effect of varied intensities of interval training on selected physiological and haematological variables among university sportsmen”. In this study forty five university sprinters were selected and divided into three equal groups. ANCOVA statistical technique was employed. The study showed that 60 percent intensities of interval training had reduced the resting pulse rate and increased R.B.C. haemoglobin content and cardio respiratory endurance than 50 percent and 70 percent of interval training.

Wilmore, Royce, Gurandola, Katch and Katch (1970) conducted a study, fifty five men between the age of 17 and 59 years participated voluntarily in the lower programme of jogging. The group was randomly divided into two subgroups, one training 12 minutes per day, 3 days a week and the other 24 minutes for the
same number of days. Both groups demonstrated significant increases in vital capacity Vo2 and O2 pulse and decreases in resting systolic blood pressure, resting heart rate and maximal heart rate.

Ragg (1972) studied the effects of two selected recovery periods during interval training on metabolic energy sources. He studied two groups of six untrained subjects who participated in an interval training regime conditions of nineteen 30 seconds run per work out on a treadmill. Group A recovered to a pulse rate of 140 beats per minute before beginning the next work out while group B recovered to a pulse rate of 120 beats per minute. Programme was followed thrice a week. He concluded that,

An eight weeks high intensity interval training programme did not cause significant heart rate indications of 140 beats or 120 beats per minute; Resting heart rate could be reduced significantly regardless of the length of recovery period used; Maximum heart rate could not be reduced significantly after training though rates do not show similar alterations; the maximum recovery period indicator (that is) heart rate 140 beats per minute and Physical work capacity showed substantial improvements as a result of an eight week of interval training.

Ratna Raj (1994) conducted a study on “Effect of varied frequencies of bench step exercise on selected physical and physiological variables,” To facilitate the study ninety boys students were selected at random and divided into three groups.
To find out the significant difference between the groups, the analysis of covariance techniques were applied. The frequencies of bench step exercise brought out significant improvement in explosive power, breath holding time, resting pulse rate and mean arterial blood pressure. It was also found that the bench step exercise did not bring any significant improvement on speed and agility.

Indirani (1993) conducted a study on “Effects of aerobic exercise on selected physical and physiological variables among school boys,” In this study subjects drawn randomly from one hundred and fifty subjects. Their age was ranging from twelve to fourteen years. Analysis of covariance was used as a statistical difference among treatment groups. The result showed that the aerobic exercise had significantly improved speed, maximum inspiratory breath holding capacity and resting pulse rate.

Gentry and Roy (1973) conducted a study on “The effect of nine weeks aerobic jogging programme on selected cardiovascular functions of young male college students through a time course evaluation process.” Fifteen male students of college ranging in age from eighteen to twenty years were selected as subjects. For this purpose analysis of covariance was used as statistical technique. The results indicated significant decrease in resting diastolic blood pressure and steady state heart rate, while no change occurred in exercise, cardiac output resting and exercise cardiac index and resting heart rate.
Colemen (1974) and others conducted a research on "Anaerobic and aerobic responses of male college freshmen during the season of basketball." Pre-test and Post-test were conducted on Variables, the resting and recovery heart rate performance on treadmill, maximum oxygen intake and the source of Margaria's anaerobic capacity test. Analysis of data yielded non significant decreases in recovery heart rate, treadmill performance time and Vo2 max and a non significant increases on resting heart rate and anaerobic power and a significant increase in vertical velocity from pre to post tests. The result of these investigation suggest than the training session in basketball was of sufficient intensity to maintain cardio respiratory function and improve anaerobic performance.

Gentry and Roy (1973) studied the effects of a nine weeks aerobic jogging programme on selected cardio vascular functions of the fifteen colleges male students ranging in age from eighteen to twenty two years the training programme consider of running or gogging or walking as specified distance 800 metres 1500 metres five times per week. The result indicated significant decrease in resting diastolic blood pressure and steady state heart rate while no change occurred in exercise cardio output resting and exercise cardio index and resting heart rate.

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Shaver (1982) writes that endurance training tends to lower the resting heart rate (bradycardia). For instance, resting heart rates in highly trained athletes may be as low or lower than 40 to 45 beats per minute. On the other hand in healthy but untrained subjects, resting heart rates may be as high as 90 to 100 beats per minute. Thus, the trained subject is generally characterised as having a low resting heart rate and the untrained as a high resting heart rate.

Uptan and Sagar (1983) conducted a study to compare the physiological profiles on highly trained middle age women distance runner with sedentary middle aged women. Thirty eight women who had run at least one marathon and were currently training for another comprised the training group and thirty five women who had not participated in the aerobic exercise programme with the last five years comprised the control group. Body composition included height, weight and percentage of body fat, forced vital capacity, forced expiatory volume for one second and maximum voluntary ventilation with the subjects in the standing position were measured using spirometer and blood pressure was measured by the sphygmomanometer. All subjects were not similar in weight and height but untrained subjects were
in total body weight. The women runners had significantly greater maximum aerobic power. The trained women had significantly lower resting pulse rate.

STUDIES ON CARDIO RESPIRATORY ENDURANCE

Uppal (1980) conducted a study to determine the effects of interval training and two continuous load methods on cardio respiratory and selected physiological parameters. One group was given interval training, the second fartlek and third group was given slow continuous running for a period of ten weeks. Five days in a week. The load was increased progressively after every two weeks. He found that (I) all the three groups had equal training effects on maximal oxygen uptake, vital capacity, leg strength, positive breath holding, negative breath holding time, (II) slow continuous and Fartlek methods results significantly higher improvement in cardio respiratory endurance when compared to interval training and (III) slow continuous running and interval training were superior to Fartlek in reducing the resting pulse rate.

Sajwan (1986) compared the effects on cardio respiratory endurance and related physiological variables caused by jogging and rope skipping. 45 male students aged 14 to 16 years have been analysed on the basis of their pre and post test results on cooper’s 12 minutes run/walk, Basal blood pressure, vital capacity, conventional pulse rate and positive breath holding time. The subjects were assigned to one of the three groups. Group I jogging for 25-40 minutes and group III acted as control group. After
analyzation it was revealed that both the training groups improved significantly on cardio respiratory endurance and other selected physiological variables and the jogging groups are better than rope skipping groups in all manner.

Santo selected 76 college men to study the effects of physical conditioning programmes on cardiorepiratory endurance. The subjects were divided into four groups, three of which participated in different physical conditioning programmes and one remained as control group. Three conditioning programmes and on remained as control group. Three conditioning programmes were (i) cooper’s aerobic programmes (ii) internal training and (iii) regular physical education programme. Cardiorespiratory endurance was measured by Harward step test, 12 minutes run/walk test, a three minutes shuttle run and one minute lateral jump. It was conducted that interval training, aerobic conditioning and regular physical education programme groups improve significantly in cardiorespiratory endurance in comparison of controlled group.

Jackson and Shaktey (1963) conducted a study of various frequencies on cardio respiratory endurance. Training consisted of treadmill running at a rate of seven miles per hour for ten minutes period. As each subject completed a ten minute run, the grade was increased one percent for the next training period. The subjects trained for one or two five days per week for five weeks. It was concluded that training two or three times a week was beneficial as five days programme.
Kibbor (1974), in his study of the comparison of three weeks load of varying intensities and distance an cardio respiratory endurance divided the subject into three groups. Group one trained at a heart rate of 150 beats per minute for fifteen minutes. Group II trained at a rate ranging from 120 to 180 beats per minute for fifteen minutes. Group III trained at the rate of 150 beats per minute even a distance run by group II.

The subjects were training five days a week. It was concluded that running for fifteen minutes a day at a heart rate of 150 beats per minute for seven weeks significantly increased cardio respiratory endurance.

Glinski (1968) studied the effects of fartlek, sprint and interval training on cardiorespiratory endurance. The subjects were seventy seven freshmen. The co-variance statistical technique was used in analyzing the data. Harvard step test and 800 yard run measured cardio respiratory endurance. It was concluded that fartlek and interval training methods were more effective than sprints method of training in developing cardio respiratory endurance.

Uppal and Tunidan (1984) studied the comparative effect of different frequencies of endurance training on cardiorespiratory endurance. According to their findings the cardiorespiratory endurance of secondary school students could be effectively improved by administering a progressive programme of interval running. To being about significant improvement in cardio
respiratory endurance varied frequencies of training namely twice, thrice and five days a week was employed. Endurance training workouts using interval running method administered three and five days a week were more effective in developing cardio respiratory endurance as compared to workouts of twice a week.

Wilten 1973 in his study tools twelve female volunteers physical education majors and placed them in three matched groups for training using the treadmill test as a measure of cardio respiratory endurance. The first group underwent interval training programme consisting of 3 sets of 3 x 200 yard run 3 x 220 yard jogging with an one to two work ratio. The total distance was two miles 220 yards daily 10 miles and 110 yards per week for six weeks. Group II performed the same programme three days a week for total distance of 6 miles. Five second after the cardio artery. Information obtained from heart rates from between 172 to 184 beats per minute. Group III the control group had no training. The results showed that there was a significant difference among three groups at the .05 level of confidence.

Glinski studied the effects of fartlek sprint and interval training on cardio respiratory endurance. The subjects were seventy seven fresh men. The co-variance statistical technique was used in analyzing the data. Harvard step test and 880 yard run measured cardio respiratory endurance. It was concluded that fartlek and interval training methods were more effective than sprints method of training in developing cardio respiratory endurance.
Thirumalaisamy (1995) conducted a study on the effect of varied intensities and frequencies of treadmill training on selected motor ability, physiological and performance variables. Sixty intercollegiate male long distance runners were selected as subjects at random and their age was between 18 to 25 years. Two different intensities and frequencies were selected for this study: 10 km/hour and 15 km/hour, and training was done two days per week respectively. Initial test was conducted for selected motor ability compounds such as speed, leg explosive power, and agility. Physiological variables such as pulse rate, anaerobic power, and cardiorespiratory endurance were also measured, along with a 1500 meters running performance. The post-test was conducted after six weeks of treatment in the above variables. A (2x2) factorial design was used to analyze the results. The findings of the study show that 15 km/hour intensities of treadmill training were better for the improvement of the above said variables. Also, three days frequency is better for the improvement of above variables than two days frequency. Three days training showed that the above variables were improved significantly due to the influence of varied intensity and frequencies of training.

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intensities and frequencies 18 to 25 years. Two different intensities and frequencies selected for this study were 10 k.m/hour and 15 k.m/hours and also 2 days per week training and 3 days per week training respectively initial test was conducted for selected motor ability components such as speed, leg explosive power and agility physiological variables such as pulse rate anaerobic power and cardio respiratory endurance and also 1500 metres running performance. The post tests were conducted after six weeks of treatment in the above variables (2x2) factorial design was used to analyze the result. The findings of the study shows that 15 km/hour intensities of treadmill training is better for the improvement of the above said variables. Also the three days frequency is better for the improvement of above variables than two days frequency 3 days training showed that the above variables were improved significantly due to the influence of varied intensity and frequencies of training.

Robert Alexander (2002) conducted a study on “circadian changes in selected motor ability, physiological and performance variables of college men athletes. In this study, fifteen athletes each in sprints, jump and 800 metre run event were selected at random and their age was between 19 and 22 years. The entire test were administered to each subject at different times of the day. Measurements were made in a counter balanced sequence for each subject at 2:00, 6:00, 10:00, 14:00, 18:00, 20:00 hours. He selected speed, agility and explosive power as the motor ability components and resting pulse rate; skin temperature and
anaerobic power as the physiological components and 200 metre sprinters, high jumpers, discus throwers and 400 metre and 800 metre runners were selected as one of the categorical variables for this study. The study found the following conclusions. Speed, agility, explosive power, resting pulse rate, skin temperature, anaerobic power and cardiac respiratory endurance showed significant difference among the college men sprinters, jumpers, throwers and middle distance (400 mt, 800 mt) runners. There was significant changes in leg explosive power, skin temperature and cardio respiratory endurance among sprinters, jumpers, throwers and middle distance runners at six different times of the day such as 2:00, 6:00, 10:00, 14:00, 18:00, 20:00 hours.

Shaver (1982) suggests that a sufficient amount of cardio respiratory endurance can be accomplished by training at somewhere between 60 and 90 percent of maximum heart rate. Improvements in cardio respiratory endurance about 15 to 20% can be noticed with high—intensity (heart rates around 85 to 90% of maximum) work lasting for only 5 to 10 minutes per day. Continuous training at low intensity (heart rates around 65 to 75% of maximum) level for a duration between 30 and 60 minutes per day will result in significantly greater improvements than training at low intensity for shorter periods of time.

Writing on frequency, Shaver (1982) puts in that in order to develop one’s cardio respiratory endurance capacity, daily exercise and training is not necessary. In fact, studies show that 3 to 5 days per week is an optimal number of workouts for developing cardio
respiratory fitness. Once a regular exercise routine has been established and the workouts have become enjoyable, then the frequency of workouts may be extended to more than 3 to 5 days per week.

**STUDIES ON RESPIRATORY RATE**

Moore (1987) *et al.*, conducted a study to find out the effect of training and detraining on sub maximal exercise response in humans. For this they selected trained and untrained subject placed into two groups, for seven weeks of intense endurance training followed by three weeks of in activity (detraining). Training produced $923.9 + 7.2\%$ increase in maximal aerobic power (Vo2 max). In previously trained subjects, the training and detraining program did not affect Vo2 max. Respiratory exchange ratios for untrained during sub maximal exercise after detraining for trained was not affected by training but increased after detraining.

Vaithianathan (1988) conducted a study to determine the effects of circuit training and detraining on muscular strength, muscular endurance, circulorespiratory endurance, vital capacity, blood pressure (systolic and diastolic) and respiratory rate. The practice of circuit training after twelve weeks had significant effect on selected variables. After cessation of training efficiency in strength came down quickly when compared to the muscles and circulorespiratory endurance as their efficiency stand through the cessation period. In physiological variables systolic blood pressure
and vital capacity existed for a longer duration after cessation and diastolic blood pressure showed an irregular behaviour.

Clocking (1965) studied the effect of two training programmes on selected cardiorespiratory variables on college women. The physiological reaction measured were pulse rate, respiration rate and oxygen consumption. The respiratory variables were recorded simultaneously by a spirometer. The cardiovascular reaction was measured by counting the pulse rate. All variables improved during the four weeks of the training programme prescribed. Both training programmes were of sufficient duration and intensity to effect changes in post exercise scores.

Rundell (1996) studied the compromised uptake in speed skaters during treadmill in-line skating seven to PUS male subjects performed incremental tests on a motor driven treadmill to volitional exhaustion running (TR) m-line skating in an upright position, and m-line skating in the low skating position (LS). The treadmill used in this study had a skating surface of 2.44X3.05m. Tests were performed on separate days, and order of tests and subjects was randomized. Oxygen uptake (Vo2) ventilation (VE) and respiratory exchange ratio (R) were determined continuously during each test using open circuit spirometry (sensor medics 2900). Calibration was performed using standard gases (26% O2 balance N2, and 16% O2 4% CO2 balance N2 ) and verified before each test. Heart rate (HR) was continuously monitored using polar
vantage XL heart rate monitors. Steady rate KR was recorded during the last minute of each stage.

Uptan and Sagar (1983) conducted a study to compare the physiological profiles on highly trained middle age women distance runner with sedentary middle aged women. Thirty eight women who had run at least one marathon and were currently training for another comprised the training group and thirty five women who had not participated in the aerobic exercise programme with the past five years comprised the control group. Body composition included height, weight and percentage of body fat, forced vital capacity, forced expiatory volume for one second and maximum voluntary ventilation with the subjects in the standing position were measured using spirometer and blood pressure was measured by the sphygmomanometer. All subjects were not similar in weight and height but untrained subjects were in total body weight. The women runners had significantly greater maximum aerobic power. The trained women had significantly lower resting pulse rate.

STUDIES ON PERFORMANCE VARIABLE

Gregory (1979) conducted a research on : The development of aerobic capacities, a comparison of continuous and interval training”. Untrained college males who were randomly assigned to one of the two experimental group and a control group were selected as subjects. He took four, seven subjects in the control interval running and continuous running groups respectively.
Training consisted of jogging (or) running on a quarter mile track for a distance of two miles, five days a week and for the period of six weeks. The intensity of run was controlled by keeping the pulse count at 162 beats and 174 beats per minute, for continuous and interval groups respectively. He was concluded that continuous and interval training method were equally effective in developing aerobic capacity when the same total work is performed.

Shaver (1975) conducted a study on maximum anaerobic power and aerobic work capacity prediction from various running performance on untrained collegemen. A group of thirty untrained college males aged 18 to 20 years volunteered for test on 100, 200, 400 and 800 yards runs as well as 1,2,3 miles runs. No practice sessions were given for the track running. In addition the subjects were tested for maximum aerobic capacity on a treadmill and aerobic work capacity as measured by method of margaria. It was concluded that distance beyond half mile are significantly related to aerobic work capacity and distance upto and including quarter mile are significantly related to anaerobic work capacity.

Krahenbuhi (1979) et.al, conducted a research on “The aerobic responses of young boys to sub maximal running”. Two groups of eight year old boys were studied. The aerobic responses of these subjects were determined for sub maximal treadmill running at speed of 134, 151 and 174m min. Maximal aerobic power and maximal running speed also measured. The estimation
of aerobic demand of a 9 min run suggested that 18 years old males are better distances runners.

Overend Peterson and Cunningham (1992) investigate change the parameters of aerobic function resulting from continuous training (CT) and interval training of both lower power (LPO-IT) and high power output (HPO-IT) untrained makes (n=17, 25-1 years) were trained ten weeks cycle rump function tests at zero and ten weeks were used to determine the four aerobic parameters, Vo2 max ventilation threshold (V&T) effective time constant for O2 uptake kinetics (MRT) and work efficiency (ETA) Vo2 max increased significantly (3.30 to 3.661 min-1) absolute VT increased significantly (2.17 to 2.451 mm-1) but there was no change in the relative threshold (Ve T/ Vo2 max) MRT decreased significantly from 38.8 to 33.1 seconds and there was no change in the ETA. There was no difference between group thus neither low power output nor high power output interval training offers and advantage over continuous training of the some average power output on alternating the aerobic parameters.

Anbunath (1995) conducted a study on “Effects of varied intensities and frequencies of bench step training selected motor ability components physiological land performance variables of school sprinters”. To facilitate the study sixty three male students in the age group of twelve to thirteen years were selected as subjects. In the first factorial analysis homogeneity of variance of all the pre test scores were tested. In the second factorial analysis the significant difference between the post hoc test was used to
find at the paired mean difference. Four days of frequencies of bench step training improved the speed, anaerobic power and pulse rate greater than three days and two days frequencies.

The body type, general structure of training planning, long term training development of the components of physical fitness for the concerned event determine one’s performance.

Fast middle distance runners need to pay attention to the development of general endurance beside specific endurance. Middle distance runners require more strength than long distance runners. To achieve top level performance, all world class middle distance and long distance runners have employed running under difficult conditions to develop the strength and endurance of leg, shoulder and trunk muscles.

Hardayal Singh (1984) views that endurance is a very important ability for good performance in sports. Short endurance is needed to resist fatigue in activities lasting up to 2 minutes. Thus endurance depends upon the anaerobic metabolic processes, strength and speed endurance. The endurance needed for 800m run is typical example of short time endurance. He points out that 45% of aerobic and 55% of aerobic energy production are needed for performing 800M run.

Deason et. al (1991) at the Louisiana State University examined relationship between selected physiological and body
composition characteristics and performance in an 800 metre run. Measurement of body composition. VO₂ max, running economy, and performance times for 100 and 800 metre running were obtained on 11 male track athletes. The data offer additional support for the notion that much of the intramuscular ATP produce and utilized during an 800 metre run comes from anaerobic metabolic pathway.

Brandon (1995) state that the middle distance running depends on a number of physiological factors. The physiological characteristics of successful runners are different from those of sprinters and long distance runners. Maximal oxygen uptake (VO₂ Max), running economy and the anaerobic threshold are variables that have been shown to limit performance during long distance running, and rapid velocity and anaerobic variables have been shown to limit performance during sprinting. Success with middle distance running is dependent on an integrative contribution from aerobic and anaerobic variables which allows a runner to maintain a rapid velocity during a race. The relative contribution of the two energy systems are functions of distance intensity and the physiological abilities of the runner. Middle distance runners can be successful with physiological profiles that include a variety of aerobic and anaerobic capabilities and this characteristics separates them from long distance runners.
STUDIES ON INDEPENDENT VARIABLES

Gardner, J. B. and Purty, G. J. Repetition Running differs from interval training in terms of the length of each run and the degree of recovery following each effort. It involves repetitions of comparatively longer distances with relatively complete recovery (usually walking) after each effort, during which time the heart rate reduces to below 120 beats per minute. Repetition running is concerned with repetitions of distances from one-half mile to two miles. Conversely, interval training usually includes repetitions of shorter distances (110 to 880 yards) with less complete recovery after each effort.

Uppal and Tunidon (1984) studies the comparative effect of different frequencies of endurance training on cardio respiratory endurance. According to their findings the cardio respiratory endurance of secondary school students could be effectively improved by administrating a progressive programme of training. To bring about significant improvement in cardio respiratory endurance, varied frequencies of training namely, twice, thrice and five days a week were employed. Endurance training work out using interval running method administrated three and five days a week were more effective in developing cardio respiratory endurance when compared to work outs twice a week.

Gutin et. al, conducted a study on “Effect of exercise intensity on cardio vascular fitness, total body composition, and visceral adiposity of obese adolescents” states that to determine
the effects of physical training intensity on the cardio vascular fitness percouloge body fat and visceral adipose tissue of obese adolescents, Design, obese 13-16- if olds (n=80) were assigned to weekly life style education (LSE), LSE + moderate intensity physical training or LSE + high intensity physical training. The intervention lasted 8 month physical training was offered 5d/wk and the target energy expenditure for all subjects in physical training groups was 1947 K.J (250 Kcal) session cardiovascular fitness was measured with a multi-stage treadmill test. The test will be increased in cardio vascular fitness in the intensity physical training was more effective than the moderate intensity physical training in enhancing body composition. Conclusion is cardiovascular fitness of abese adolescents was significantly improved by physical training, especially high intensity physical training. The physical training also reduced both visural and total body adiposity but there was clear effect of the intensity of physical training.

Dasgupta, Mukhopadhyay, and Dey conducted a study on ‘cardio-pulmonary efficiency in different categories of runners they selected shot distance runners, Middle distance runners and long distance runners were subjected to graded exercises on a treadmill. The maximum aerobic power (Vo2 Max) and other indices related to oxygen transports system viz. heart rate, ventilation volume, breathing reserve, dyspnoeic index, O2 pulse and RQ were recorded at respective VO2 Max than the short distance runners when VO2 max was expressed per unit of body
weight. Among the endurance runners had a significantly lower resting pulse rate as well as the maximum heart rate during work than the middle distance runners.

According to the American college of sports Medicine, cardiovascular endurance may improved by the use of an exercise programme that includes at least three 20 to 30min. Weekly sessions of sufficient strenuousness to burn about 240-360 kcal. This may be achieved, for example, by an included who weights 170/lbs and swims fast crawl for 20-30 min, or by some one who weight, 145/lbs and runs cross country at an 8min/mile pace for 16-24 min (Thus covering a distance of 2-3 miles) As the level of aerobic capacity increase so does the level aerobic capacity increase so does the level of the threshold intensity for training improvement. There fore, for further building of soccer endurance both pace and distance of training would have to be increased.

Rohal et. al. conducted a research on effectiveness of the birth right Nasal strip in collegiate Middle and long distance runners. This study examined the effect of the breathe right while at aerobic and anaerobic steadily states to see if it would increase V\textsubscript{1} and or reduce RPE. Eleven male and four female- experiment Middle and long distance collegiate runner saved as subjects. A treadmill V\textsubscript{O2}, V\textsubscript{CO2}, Vc RQ and HR date an RQ>I was used to assure maximal test for all subjects. This suggests that wearing the breath right TM nasal delator will not increase axy genation, at
either sub-maximal aerobic on anaerobic work in healthy endurance athletes.

Custer and Chaloupka intended to investigate to determine the relationship between predicated maximal oxygen consumption and running performance for six nine and twelve minute duration in college men between the age 18 and 21 years old (N=40). Maximal oxygen consumption (ml/kg/min) was predicated by the Astrand bicycle ergometer test. It was found that a significant (P<0.05 relationship Pearsonr) existed between maximal predicted oxygen consumption and performance in all three runs. Since the magnitude of the difference between correlation of the six minutes (r=0.45) and twelve minutes (r = 0.49) run was not significant, it was concluded that the six minute run could be used instead of the twelve min runs, which is customarily used as a measure of cardio-repertoire fitness.

Accoutering of Regem the human heart contracts on an average of 60-80 per minute the frequency is longer in children about 140 times per minute at birth and decreases with advancing age. Cardio vascular fitness in one health benefit of exercise includes a more efficient level of cardio-vascular function a stronger heart muscle, a lower heart rate, reduce blood pressure increase oxygen carrying capacity of the blood and improved coronary and peripheral circulation.
“A person’s maximum heart rate 200 beats per minute”. By reading the heart rate, it is possible to find out the working condition of heart muscle and the blood pressure the stroke volume the cardiac output and the cardiovascular endurance.

CARDIO VASCULAR ENDURANCE:

According to Dorland’s Medical Dictionary cardiovascular endurance to simply a level of aerobic fitness which one pursues by sustained activity. “Distance sports” such as running, cycling, swimming and hiking, mountain biking, and cross-country and skating.

Maffatone considers cardiovascular endurance to be “a steady state level of activity where one can develop and sustains relatively high speeds at a sub maximum effort over time; the ability to develop high speed which remaining predominately aerobic; increasing the percent fat burning and decreasing the dependency of carbohydrate utilization with training.

Fox (1984) stated that sports training is done for improving sports performance. The sports performance as any other type of human performance is not product of one single system or aspect of human personality. The personality of a person has several dimension, example physical, physiological, social and psychological.
Berg and Pargmen (1986) states that sports training is not merely physical activity involving physical movements or action such type of physical activity is common and several types of human activities.

FOX (1984) stated that training efficiency is body adaptability which enhances bodies adjustments while performing an activity requiring maximum or near maximal perform over a considerable period of time. A sound training program causes functional bio chemical and morphological changes in the body resulting in adaptation in training load.

Fox stated that the sports training in a process of preparation of sports man based on scientific and pedagogical principle for higher performance.

William and Spenryn (1976) stated that training is a programme of exercise designed to improve the skill and increase the energy capacities of an athlete for a particular event.

Sprint training brings about a lot of changes in the body such as physiological consideration, biochemical consideration and anthropometric consideration.

Jordon and spencer (1968) stated that “Great sprinters are not born nor they made they have the inherent qualities of speed but they must be refined”.
According to Johnson (1977) sprinting can be defined as running at top speed. Everyone can sprint but some do it better than others. Most champions are born sprinters. They have a natural ability to move their limbs more quickly, powerfully and efficiently than others and have sharpened this ability through hours of diligent practice.

Kring (1968) stated that the best way to improve the speed is by constant work or relaxation and the use of short dashes in training. Many repetitions of twenty-thirty-forty and fifty yards dash should be used daily to help the prospects sprinters learn to improve his reaction time and leg speed.

Yokolov has reported that training by short, fast exercises of maximal and sub maximal intensities led to varied adaptation increasing the potential range of both anaerobic and aerobic provisions of energy for work that alternatively work recovery periods of interval training provided optimum stimulant for development of the heart. During the recovery period the heart continued to eject a maximal stroke volume of blood but when the skeletal muscle recovered from the effect it was approximately 70 percent.

Witten (1973) in his study tool, twelve female volunteers physical education majors and placed them in three matched groups for training using the treadmill test as a measure of cardio respiratory endurance. The first group underwent interval training...
programme consisting of three sets of $3 \times 200$ yards run, $3 \times 200$ yards Jogging with an 1 to 2 work ratio. The total distance was two miles and zero yards daily 10 miles and 110 yards per week for six week. Group II performed the same programme three days a week for total distance of six miles.

Uma (2000) conducted the study on varied intensities frequencies and densities of hallow sprints on the performance of 100 metre sprint.

Gobber (1977) stated that the improvement at speed will not only increase their performance but will tend to cause less strain running. In other words to use speed effectively, speed must be practiced regardless of what event that the athlete is training for speed or sprint work should be used to obtain the best results.

Kratheites and Brath (1987) assessed the results and of their experiments with three thousand subjects and concluded that by asking the athlete to run a specific distance at a fast pace and allowing a set recovery interval before the athlete repeated the run as efficient and controller system of performance improvement could be devised. The optima speed distance of the run was that which pushed the runners pulse rate up to 180 beats per minute and the optimum recovery period was that which allowed the pulse to drip 120 beats a minute before the run repeated.
According to Cretzmeyer et al. (1969) the pulse rate a trained athlete is as much as 15% less than as the untrained individual.

Morehouse and Miller (1986) stated that there is said to be tendency for the heart rate to be lower in subjects who are in good physical condition than in non athletes.

According to Torin (1979) it is known that sprinting ability (central nervous system distribution of muscle fibre, neuromuscular coordination, tolerance of oxygen etc., depends for more on genetic factors than training methods. It is also known that of all physical performance component speed is the hardest to develop.

According to Kunng and Darid Kaufman (1979), it is a well known fact that the two biomechanical factors that determine running speed on stride length and stride frequency. World class sprinters were found to have both longer stride length and fastes stricle frequency than other athletes.

Kerry Edwin Regg, studied the effect of selected recovery periods during interval training on metabolic energy source. Two groups of size untrained subjects each participated in an interval training programme of a maximum of nineteen thirty seconds runs per work out on a treadmill. Group ‘A’ recovered to pulse rate of 140 beats per minute while group ‘B’ to a pulse rate of 120 beats.
per minute programme followed thrice a week. He concluded that
an eight week high intensity interval training did not cause
significant heart rate indicate of 140 on 120 (indication) beats per
minute, resting heart rate could be reduce significantly regardless
of the length of the recovery interval maximum heart rate could be
reduced after training. The maximum recovery period is 150 beats
per minute seem more effective inducing changes than the
maximum suggested rate of 120 beats per minute and physical
work capacity showed substantial improvements as a result of
eight week period of training.

Donna Rae conducted a study to determine the effect of two
interval running programme on college women, when performed
for duration of eight weeks. The effects were measured by running
times on field test of fifty yards, 440 yards and 1.5miles. Forty eight
subjects were randomly assigned in to four equal groups. The four
experimental conditions were training programme R-1 for five
weeks, training programme R-1 for eight weeks, training
programme R-2 for five weeks and training programme R-2 for
eight weeks R1 training programme was made up to 55, 110 and
220 yards to emphasize development of anaerobic efficiency and
R2 training programme involved distance of 110, 220,660,880 and
1320 yards. This programme was designed to develop the
anaerobic and aerobic energy systems. Subjects participated three
times a week and intensity of work outs was regulated by heart
rates obtained after work intervals, during recovery interval and
after completed work outs. Two way analysis of covariance were
the statistical methods used on the 50 yard and 1.5 mile run date from the 440 yard test run did not satisfy ANACOVA assumption for homogeneity of regression 440 yard test was analyzed through a two way ANACOVA on the different values between pre and post test performance. The 1.5 mile test run resulted in a significant difference in fewer of eight week training programme. Over the five week duration.

Results revealed no significant differences on the fifty yard dash in regard to training method or duration of training. The same findings were evident from analysis performance on the 440 yard run.

James Harmon Johnson conducted a study to compare the effectiveness of slow continuous running, interval running and pace training methods on improving running performance one hundred and twenty college men were tested initially for maximum performance on three tests.

1) a maximum time run on a motor drive treadmill running at a speed of ten miles per hour at zero percent incline.

2) a maximum time run on a motor drive treadmill at eight and a half mile per hour and zero percent incline.

3) and a mile run. They were place into one of the three training groups. Group I the slow continuous running group. started by running twenty minutes and progressed to thirty minutes. Group II started by utilizing both fast and slow interval training on alternative days by
intermittently running a distance of either sixty or 220 yard
dashes and 440 or 880 yard dashes respectively Group III
the pace group trained at predetermined steady pace for a
mile run the subjects were trained once a day three time a
week for eight weeks.

It was concluded with in the limitation of the study 1. slow
continuous interval and pace training methods are highly effective
in improving the running performance.

Ardle (1991) stated that brief bouts of repeated exercise as
well as continuous long duration work enhance aerobic capacity,
provided the exercise is sufficiently intense to overload the
aerobic system. Interval training, continuous training and Fart
lek training are three common methods to improve aerobic
fitness.

In 1956 the American Association for health physical
Education and Recreation established a series of tests to assent he
motor fitness of youths of 10 to 18 years old. The components
tested were believed to be important to a person’s over all motor
ability. The tests included items to measure agility, power, cardio
respiratory endurance, muscular strength, endurance and speed
the test items included a 50 yeard dash, a shuttle run, a 600 yard
run, sit-ups the standing broad Jump a soft ball throw for
distance, pull ups for boys and a flexed arm hand for girls.
Ready (1977) determined the effects of a six week motor fitness programme on selected sports skill performance and relationships between motor fitness and skill performance of seventy lower class females were randomly assigned to a control group and experimental motor fitness group for six week which included pre test and post test periods. Three way ANOVA simple effects design multiple ‘R’ and beta weights were the statistical tools employed to per hypothesis. Motor fitness elements and sports skills selected were agility flexibility lower body power, upper body power, static balance dynamic balance muscular endurance speed correlation data reported in regression equation of beta weights revealed that motor fitness variables contributing the most of prediction of sports skills were. (1) First grade agility muscular endurance and speed. (2) second grade right, left hand strength upper body power and speed and (3) Third grade (dynamic balance muscular endurance speed and lower body power.

Gentry (1973) selected fifteen male college students, run going in age from 18 to 22. years to study the effects of Jogging programme on selected cardio vascular function. The training programme consisted of Jogging on running a specified distance (800mts 1500 mts) for times per week, for nine weeks. Once training programme commenced much subject upon his level of fitness and rate of adaptation. Analysis of data showed no significant change in resting pulse rate of the subject.
Alteri (1975) selected 63 college females between 17 and 22 years of age to study the effects of endurance and interval running on selected physical parameters. Resting pulse rate was one of the physiological parameters selected. Analysis of data revealed that both treatments significantly lowered resting pulse rate.

Nichola Maffulli et al. (1991) conducted a study on anaerobic threshold to 112 endurance athletes. 33 randomly selected subjects (11 per each age group) were both laboratory and field tested for an aerobic threshold (AT) determination. The running speed (R.S) and heart rate (H.R) at which AT occurred were highly correlated in the two conditions with RS ranging from 0.82 to 0.90 with the highest correlation for the old group. All the athletes participated in a series of competition races at various distances, and the correlation between RS at AT is highly correlated with racing RS for distances from 5K.M race for the 12-18 years and 19-30 years age groups and for the one-hour race for the oldest group. Shortest distance 800mts did not show significant correlation with Rs at AT and this was particularly evident for the oldest group (R=0.30).

Deason et al. (1991) of Louisiana State University examined the relation among selected physiological and body composition characteristics and performance in an 800m race. Measurement of body composition VO2 max, running economy, and performance times for 100 and 400mtdashes were obtained.
on 11 male track athletes. The data offer additional support for the notion that much of the intra-muscular A.T.P produce and utilized during 800 meter run comes from anaerobic metabolic path way.

AnttI Mero et al (1993) conducted a study-aerobic characteristics oxygen debt and blood lactic acid were analysis in 20 male speed endurance athletic (400 mt sprinters and 800 mt runners) the results suggest that aerobic characteristics decreased during the competitive period in speed endurance athletes the anaerobic performance capacity including work time and peak blood lactic acid is a at high level in the competitive period. The specificity of the an aerobic work test should be increased according to the demands of the tested event.

Robert Alexander (2002) conducted a study on circadian changes in selected motor ability, physiological and performance variables of college men athletes. In this fifteen athletes each in sprints Jumps and 800 metre run events were selected at random and their age was between 19 and 22 years. The entire tests were administered to each subject at different times of the day. Measurements were made in a counter balanced sequence for each subject at 2.00, 6.00, 10.00, 14.00, 18.00 and 20.00 hours. He selected speed, agility and explosive power as the motor ability component, and resting pulse rate, skin temperature were and anaerobic power as the physiological components and 200 mt sprinters, high Jumpers, discus throwers and middle distance 800 mt runners were selected as one of the categorical variables for thus study. The
study found the following conclusion speed, agility, explosive power resting pulse rate, skin temperature, anaerobic power and cardio respiratory endurance showed significant difference among the college men sprinters, Jumpers, throwers and 800mt 1500 mt runners. The circadian variation was significant in speed, agility, leg explosive power, resting pulse rate skin temperature, cerotic power and arobic respiratory endurance among the college men athletes. There was significant changes in leg explosive power resting pulse rate, skin temperature and cardio respiratory endurance among sprinters, Jumpers throwers and 800metre 1500 metre runners at six different times of the day such as 2.00, 6.00,10.00, 19.00, 18.00, 22.00, hours.

Relevant literature failed to throw ample light regard to circadian rhythms selected motor ability compounds physiological variables and skill performance, the scholor thought it is appropriate to study the circadian rhythms in the selected motor ability components and physiological variables of basketball, football and volley ball players. This also has its relevancy with the performance of track and field events in Indian who are required to perform at different times of the day and show their performance at their maximum.

Alteri (1975) selected 63 college females between 17 and 22 years of age to study the effects of endurance and interval running an selected physiological parameters, resting pulse rate was one of
the physiological parameters selected. Analysis of data revealed that both treatments significantly lower pulse rate.

Brandon (1995) stated that the 800mt, 1500 mt run involve popular race distance with performance dependent on a number of physiological factors. The physiological characteristics of successful runners are different from those of sprinters and long distance runners. Maximal oxygen uptake (Vo2 max) running economy and the anaerobic threshold and variable that have been shown to limit performance during long distance running and rapid velocity and anaerobic variables have been shown to limit performance of sprinting. Success with middle distance 800 mt, 1500 mt running independent on an integrative contribution from aerobic and an-aerobic variables which allows a runner to maintain a rapid veloclity during a race. The relative contributions of the 2 energy systems are functions of distance intensity and the physiological abilities of the runner. 800mts, 1500mts runners can be successful with physiological profiles that include a variety of aerobic and an aerobic capabilities and this characteristic separates them from long distance runners.

L.G. Shaver (1975) conducted a study on maximal anaerobic power and aerobic work capacity prediction from various running performance on untrained college men. A group of thirty untrained college males aged 18 to 20 years volunteered for test on 100,200,400 and 800 yard as well as 1, 2 and 3 mile runs. No practice session was given for the track running. In addition the
subjects were tested for maximum aerobic capacity on a tread mill and anaerobic work capacity as measured by method of margaria. It was concluded that distance beyond half mile are significantly related to aerobic work capacity and distance up to and including quarts mile are significantly related to an aerobic work capacity.

Leskheritch et, al. and others studied the influence of sequence of exercise is training under taken in the development of the physiological foundation of speed, strength and endurance found in middle distance runner. Three groups of boys age 12.14 years were given physical training from times a week for three months to determine the effect of the sequence of exercises. The observed changer were noted in speed, strength and endurance.

Clarke and Clarke (1987) at purde University developed short motor fitness test batteries for high school girls. The battery found test was composed of three items, modified ups 600 yards run and standing brad Jump. The battery had a validity co-efficient of 0.755 and an estimated reliability co-efficient of 0.848.

Schever and Tipton (1977) studied that champion athletes generally have resting pulse rate 15-20 beats per minute lower than those of the general population. Although the low values for in athletes may be genetically determined. Numerous studies involving humans and animals indicate that the breadycardia is a biological adaptation resulting from chonic exercise.
Brandon (1995) stated that the 800mt, 1500mt runs involved popular race distances with performance dependent on a number of physiological factors. The physiological characteristic of successful runners are different from those of sprinters and long distance runners. Maximal oxygen up take (vo2 max) running economy and the anaerobic threshold are variables that have been shown to limit performance during long distance running and rapid velocity and anaerobic variables have been shown to limit performance during sprinting. Success with middle distance running is dependent on an integrative contribution from aerobic and anaerobic variable which allows a runner to maintain a rapid velocity during a race. The relative contribution of the 2 energy systems are functions of distance intensity and the physiological abilities of the runner. Middle distance runner (880 metres 1500 metres) can be successful with physiological profiles that include a variety of aerobic and anaerobic capabilities and this characteristic separates them from long distance runners.

Dintinman (1964) studied the effect of various training programme on running speed which were the components of physical fitness. The purpose of the study was to determine weather a flexibility training programme and the combination of the both would effect on running speed when used as a supplementary training programme non the weight training programme used of supplementary training, programme nor the weight training programme used as supplement to sprint training did not improve running speed. Where both weight training and
maxibility training used as supplement to sprint training increased running speed significantly.

Wakefield Harkins Cookper (1973) the runners Jog a certain distance and than at a command sprint a specific distance. This procedure may be repeated as many time as no thought feasible.

Kring (1968) “Speed is of prime importance in all track and field events. But needless to say it is the single most importance. Pre-requisite for success in the sprinters” The best way to improve leg speed is by constant work on running and the use of short dash in training 20, 30, 40 and 50 years. Dashes should be repeated daily to help the prospective sprinters learn to improve this reaction time and leg speed.

Mortenson and Johnson Cooper (1967) “Sprinting in the type of running which the participant runs the entire distance at near maximum speed.

Peter Hildrelth (1964) “Sprinting is high powered running and the men who succeed at it are, in the muscular sense, high powered athletes Conger (1939) “Power of legs, arms and shoulders co-orderation, rhythm and speed of muscle construction are all important factors in attaining championship in running sprint.
Burnahum (1962) “Sprinters need great leg power in relation to their body weight, muscle strength, endurance and explosive power, which determine the quick action and movement in sprinting.

Reilly reported that all the world records for running distances from 1500 mts 5000 mts during the 1985 season were set between 1900 and 2300 hours prior to the Javelin throw by Fatima whitebred at the 1986 European championships the last world record in the track and field to be set in the morning was by shot-putter Charles Fonville over 30 years ago. Most at the best athletic performances at the French national championships were reported to occur in the afternoon. Heats and qualifying events frequently finals where tactics are important are usually scheduled for the evening. The environmental temperature is usually more favourable to performance in the evening besides, on hot days the midday peak in ambient temperature is best eschewed to heat & stress.

In solitary long distance events, it is argued that more than one hour of sleep can have an adverse effect on final placing and some constants wait until complete exhaustion before taking any sleep hallucinations may results in consequence. Other endeavour to take, three 2-hour or two 3-hour bouts of sleep.

The relevant literature collected after exhaustive review of the different library sources does not throw ample light with
regard to circadian rhythms, selected motor ability components, physiological variables and athletic performance since very little is reported in relation to circadian rhythms in motor abilities and physiological areas directly underlying souring underlings human performance the scholar thought at appropriate to study the circadian rhythms in the selected motor ability components and physiological variables of sprinters, jumpers, throwers and middle distance (800metre 1500metre) runners. This also has its relevancy with the performance of track and field athletes in India who are required to perform at different times of the day.

Ardle (1994) stated that brief bouts pf repeated training as well as continuous long duration work enhance aerobic capacity, provided the training is sufficiently intense to overload the aerobic system. Interval training continuous training and Fartlek training are three common methods to improve aerobic fitness.

Amusa and sohi (1985) conducted a study on college Athletes to examine the changes in muscular strength, muscular endurance power, speed, agility, cardio respiratory endurance and body composition following a twenty weeks training programme. Through analysis of covariation study was concluded that all the variables increase significantly at the end of the training period. Changes in body composition and structural measures were also observed after the athlete training programme.
EXERCISE:

"Exercises is the cheapest preventive medicine in the world" - observes Getchell and adds that after a period of training (six to eight weeks) there is a slow but consistent reduction in the resting of heart rate along with as increase in stroke volume... the slower heart rate and increased stroke volume provide a greater rest for the heart between beats.

HEART RATE:

"The pulse rate in well persons is affected by age, body size, body position, food intake, time of delay, emotions, and physical activity... Most observations have shown that the pulse rate is definitely affected by body position. The rate is lowest in lying, higher in sitting, and highest in standing. The extent of variation, however, differs with the subject."

The adage 'strongest heart beats slowest' is true and appropriate. Corder and Showalter write that the trained programmes of an aerobic or endurance nature result in a decrease in the person’s resting and activity heart rates.

Astrand and Rodhal bring out the difference between Heart Rate and Pulse Rate thus:
Heart Rate (HR) is the number of ventricular beats per minute as counted from records of the electro-cardiogram or blood pressure curves. The heart rate can also easily be determined by palpitation over the heart. Pulse Rate is the frequency of the propagated along the peripheral arteries, such as the carotid or radial arteries. In normal healthy individuals, pulse rate and heart rate are identical, but this is not necessarily so in patients with arrhythmias. In such cases, the output of blood by some beats may be too small to give rise to a detectable pulse wave.

While describing the fluctuations of the heart rate at rest and during various intensities of exercise Vitale writes:

Many factors will cause a variation in the Resting Heart Rate at any given time, such as level of prior activity, food intake, environmental conditions, smoking, emotions, illness, and even body position. It is lowest when lying, higher when sitting, and higher yet when standing. For practical purposes, the truest Resting Heart Rate can be determined by taking the pulse for one minute just after waking in the morning in the lying position.

Morehouse and Gross declare that the resting pulse rate while seated gave important information about health and fitness. Men averaged 72 to 76 beats a minute, boys 80 to 84 beats a minute, women averaged 75 to 80 beats a minute, girls 82 to 89 minute. The reason why women and girls had slightly higher pulse rates than men and boys was not understood.
Concord points out the fact that heart rate of the trained athletes is slower than untrained has much attracted much attention.

Hockey writes that the number of times the heart contracts per minute is heart rate and further says:

For an average, untrained person in a resting position, the heart beats approximately 74 times per minute. This is the heart rate, or pulse. It is caused by the impact of the blood on the arteries as the heart contracts. It can be deducted easily by placing a finger on the radial artery located on the lateral side of the wrist or at one of the carotid arteries that pass interiorly in the neck. In children this rate is much faster, whereas in the highly trained individual the heart becomes more efficient, and the resting heart rate is much lower.

Brouha and Radford stress that the heart rate alone can depict the cardio-vascular adjustment to activity and the capacity to do muscular work should be based on the speed of recovery after exercise and the subjects' actual ability to perform it.

Devries discusses the heart rate:

The heart rate at rest varies widely from individual to individual, and also within the same individual from one observation to another under similar circumstances; therefore, it is almost meaningless to speak of a normal heart rate. We may,
however, say that the average heart rate is 78 beats per minute without implying that a rate of 46 (observed in highly trained endurance athletes) or 100 is necessarily abnormal.

Falls mentions that the heart rate diminished with training and the well known sports brady Cardia may be as low as 30 beats per minute, but values around 40 beats per minute are usually observed under the basal conditions in well-trained athletes.

Hotland and Davis state that it is practically impossible to palpitate one’s heart rate while exercising, but quite simple while at rest. The pulse at the neck (carotid) or wrist (radial) may be utilized. In assessing exercise heart rate, it is important to obtain it as soon as possible after the cessation of exercise. Fifteen second heart rate later multiplied by four will provide a quick index of the work load imposed on the total physiology.

The first study that reviewed was an experiment study of 36 males, running, and looking at the effect of running economy on running performance and whether it will improve among trained distance runners. Saunders, Pyne, Telford, & Hawley, (2004) found that running at a longer duration and at a higher percentage of VO2max will increase running economy and performance of the runner, running economy increased 8% and 5 kilometer performance increased 3%. 
The next study by Bergman, B., et. al. (1999), looked at Endurance training decreases arterial lactate concentration during continuous exercise by decreasing net lactate release, appearance rates, and increasing metabolic clearance rate. Nine men between 19-33 cycled at different intensities. Bergman et.al, (1999) found MLSS training does decrease lactate production and increases clearance of lactate at absolute workload (65% pretest and 65% post-test) and at relative intensity (65% Vo2max at pretest compared with an intensity figured by, 65% of the new Vo2Max after training. Regardless if pre or post the lactate rate disappear, Post absolute workload = 71.8 ±1.5 and relative intensity = 76.0± 2.3, significant at the .05 level.

Dekerle, Baron, Dupont, Vanvelcenaher, and Pelayo, (2003) was the next study that I reviewed. They looked at the relationship between MLSS, Vo2Max, and Critical Power (CP). Eleven subjects used a cycle ergometer exercising at their chosen cadence to determine critical power. The training intensity used in this study was 65-85% of Vo2max. By running an Anova calculation, they determined that there was a significant difference between Critical Power, MLSS, and Vo2Max.

Next, Mattern et. al. (2003) examined age elated changes in skeletal muscle and enzymes, expecting power output to lower with age. This experimental study used three different age groups, younger, middle age, and older athletes, It was found that MLSS intensity goes down with age.
Heath, Hagberg, Ehsani, and Holloszy, (1981) did an experimental study on LSD training and compared two different age groups, 50-72 and 18-27 years old. Running at an intensity of 60-80% of Vo2Max did the experiment. It was determined that there was a significant difference, at the .001 level, of trained subjects using LSD training versus untrained.

In the Beneke (2003) study exams the relationship of blood lactate with different modes of exercise. Ten subjects of 17 ± 1.7 years old cycled, rowed, and speed skated. There was significant difference between rowing and cycling at the .05 level. It was also determined that there is a negative relationship between muscle mass and MLSS. As muscle mass goes up, MLSS goes down.

Lajole, Laurencelle, and Trudeau, (2000) investigated the changes in physiological variables of Heart Rate (HR), relative oxygen consumption (Vo2/Kg), minute ventilation, Respiratory Exchange Ratio (RER), Rate of Perceived Exertion (RPE) and Blood Lactate (BL), during a 60 minute cycling exercise at MLSS. The most significant difference was seen in heart rate 152 ± 4 and 170 ± 3.8, significant at the .05 level.

Another study by Slawinski, Demarle, Koralsztein, and Billat (2001) involved 6 trained runners to determine the effect of endurance training on the relationship between stride rate and aerobic energy cost would decrease by training in all-out-supra-lactate threshold run. Training was done at 50% of velocity
difference, LT and VO2max and it was done over a 8 week period. It was found that training at this intensity significantly improved Running Economy (RE) and Stride Rate variance at the .03 level.

In the Beneke, Leithauser, and Hutler (2001) research was done to determine MLSS intra-individually depends on the method of exercise. Six males 16.5 ± 1.4 years old, were used in cycling and rowing experiment. It was found that there is an inverse relationship with MLSS and the main engaged muscle mass. The more muscle mass that is engaged the lower the MLSS.

The next study by Carter, Jones, and Doust (1999) looked into the responses of VO2Max, Heart Rate, Running Speed, and Blood Lactate in response training at MLSS by V comparing trained to untrained subjects. It was found that there was a significant difference in VO2Max, Heart Rate, and running speed.

Dubouchaud, Butterfield, Wolfel, Bergman, and Brooks (2000) evaluated the effects of endurance training on the expression of monocarboxylate Transporters (MCT) comparing MCT1 & MCT4, before and after training. Nine male subjects cycled at 75% of their VO2Max over 9 weeks. The findings include improved lactate shuttle at the cellular level. More specifically, they found MCT1 and MCT4 participate in cell to cell lactate shuttle as MCTI assists intracellular lactate shuttle.
Evertsen, Medbo, Jebens, and Gjovaag (1999) looked the effect of training intensities on muscle enzymes. Twenty subjects including 11 males and 9 females crosscountry skied at 2 intensity groups, 60-70% Vo2Max and 80-90% of Vo2Max over 5 months. It was found that the High Intensity Group (HIG) improved their performance over the Moderate Intensity Group during a 20-minute test. Also, muscle enzyme activity rose 6% in HIG significant at the .02 level.

Baquet, Van Praagh, and Berthoin, (2003) analyzed the procedure to design training methods and stress the impact of aerobic training on Vo2Max in adolescents. Sixteen subjects between 11-18 years old cycled 3-4 times a week for 30 minutes to 1 hour at 80-100% of max heart rate. They found that intensities above 80% of max heart rate will lead to significant improvement.

Berg, (2003) discussed several limitations common to research concerning running. The age range of the subjects was 15-25 years old and the mode was Nordic ski, run, and cycle. Berg found intensity at LT is more beneficial training intensity and large training volumes (LSD) do not promote the development of Vo2Max. Berg also stated it was unclear whether it is better to go longer duration at sub-max and shorter duration for max Vo2 for shorter duration.

Jones and Carter (2000) examined the effect of endurance training on LT and CP. They found that training at LT should
provide the best training intensity without the accumulation of lactic acid. Additionally, they declared that MLSS is the “Gold Standard” exercise endurance capacity. Lastly, Jones and Carter found that training 65-100% of VO2Max will increase CP (MLSS) and decrease the VO2 slow component.

One study was done to investigate the glycogen depletion pattern during LSD training regime. Thirteen subjects cycled 3 different duration and intensities, 3 hour, 2 hour, and 1 hour by 30%, 60%, and 90% respectively. The finding suggest that there was a significant difference from the pre-test to the post test, 0.00 mmol/L to 3.4 ± .7 mmol/L.

Yet another study by Myburgh (2003) determined the max/submax VO2, lactate turn point, oxidation enzymes, and slow twitch fibers are not performance predictors among homogeneous groups of elite and sub-elite athletes. Myburgh stated that increasing training mileage without increasing training intensity does not enhance performance in well-trained athletes (2003). It was also suggested that the ability to race close to maximal aerobic capacity may be correlated with the training intensity sessions themselves.

Billat, Sirvent, Py, Koralztein, and Mercier (2003) looked carefully at how metabolic and protein biochemistry, exercise physiology, and sports science relate through MLSS. They found that lactate acid was removed or metabolized easier reaching
blood lactate equilibrium at higher intensities. More specifically they found that transmitters of lactate (MCT1 and MCT4) were significantly improved through MLSS training.

Donnelly, Smith, Jacobsen, Kirk, DuBose, Hyder, Bailey, and Washburn (2004) examined the concept that exercise increases energy expenditure and helps adjust the balance of weight loss and maintenance. It was their suggestion that the LSD training program improves performance and health. However, their subjects were mostly untrained allowing for just about any activity to increase performance.

STACIA BRISCENTINE

The five major cardiorespiratory changes as the result of endurance training are: change in heart size, decrease in heart rate (resting, sub-maximal, maximal), increase in stroke volume, increase in blood volume and hemoglobin and changes in skeletal muscle

Cardiorespiratory fitness reflects the ability of cardiovascular and respiratory systems to supply oxygen to the working muscles during heavy dynamic exercise (Howley 2001), and direct measurement of maximal oxygen uptake (VO2max).