CHAPTER I

INTRODUCTION

Physical conditioning programme provides an opportunity for the development and maintenance of physical fitness. It offers an opportunity for the facilitation of the normal growth of a child and prevents the reversal factors of the performance such as strength, endurance, flexibility, speed and skill. By undergoing a physical conditioning programme, one experiences a number of changes that better the performance and faster recovery. Through repeated muscular work, strength is gained and as a result one can produce more power as there is a faster contraction in both power and speed. Conditioning the body through regular exercise enables an individual to meet the emergencies more effectively.

Training and conditioning are the best known ways to prepare the players for efficient performance and healthful living. Efficient performance is possible only through a carefully planned programme of progressive practice, which will perfect the co-ordination, eliminate the unnecessary movements and accomplish a result at the expense of minimum energy as well as conditioning the muscle structure and the circulation to withstand without harming the intensive demands made upon them (Koubova and Guarente, 2003).

Running tracks are a basic requirement for all sports facilities. Providing the best running track surface is very important for athletes preparing for competitions, as
well as for the school children during regular physical education classes. The running track composition will have a great impact on the performance and health of the runners who use them.

Different surface properties have different effects on the dynamics and mechanics of movement (Ferris et al., 1999; Kerdok et al., 2002), and also affect the energetics of running (Kerdok et al., 2002). Metabolic rate on various surfaces is positively related to surface stiffness. Running on different surfaces will have different effects on the human body and it is important to know the benefits and downsides of each surface. The grass surface is soft, therefore, easy on impact, and this shields the joints. Similarly, wooden floors are also considered as soft surfaces. In addition, unlike indoor surfaces, outdoor surfaces are often uneven so the body gets a complete workout with its stabilizing musculature working harder, and logically burning more calories. The downside of uneven terrain is the increased possibility of injury.

Concrete and asphalt surfaces create the greatest impact on runners’ legs and can lead to a variety of overuse injuries as well as lower back strain. Patello femoral syndrome and medial tibial stress syndrome (known to most of us as runner’s knee and shin splints) are associated with harder running surfaces such as concrete and asphalt. Tracks built within this enhanced performance range (250 kN/m) at Harvard University, Yale University, and Adison square garden have been shown to increase in running speeds by 2–3% and decrease in running injuries by 50% (McMahon & Greene, 1979). Tracks tuned at 250 kN/m also optimize energy return (Stafilidis &
The studies that investigated running on different surfaces were carried out by other authors on recreational samples (Leger & Lambert, 1982; Pinnington, & Dawson, 2001; Kerdok et al., 2002) and samples consisting of athletes (Zamparo et al., 1992; Pinnington & Dawson, 2001; Tessutti 2007), and very rarely on samples including school-age participants. However, the studies which focus on gender differences appear to be lacking. Some studies investigated the effect of training on different running surfaces on the performance of athletes. To assess the effect of training on different running surfaces they used the calf and thigh circumference of athletes, and their running performance (Karve & Tiwari, 2010). The greatest physiological and performance changes were found after a 6-week sand running programme, which was expected because it is the most intense and demanding surface.

1.1 PHYSICAL EDUCATION AND SPORTS

Every human being has a fundamental right of access to physical education and sport, which are essential for the full development of his or her personality. The freedom to develop physical, intellectual and moral powers through physical education and sport must be guaranteed both within the educational system and in other aspects of social life. Everyone must have opportunities, in accordance with his or her national tradition of sport, for practicing in physical education and sport, developing physical fitness and attaining a level of achievement in sport which corresponds to his or her gifts. Physical education performances are essential
elements of lifelong education in the overall education system. Physical education and sport, as an essential dimension of education and culture, develop the abilities, will-power and self-discipline of every human being as a fully integrated member of society. The continuity of physical activity and the practice of sports must be ensured throughout life by means of a global lifelong and democratized education.

At the individual level, physical education and sport contribute to the maintenance and improvement of health by providing a wholesome leisure-time occupation and enable man to overcome the drawbacks of modern living. At the community level, they enrich social relations and develop fair play, which is essential not only to sport but also to life in society. Physical education and sport programmers must meet the individual and social needs to suit the requirements and personal characteristics of those practicing as well as the institutional, cultural, socio-economic and climatic conditions of each country. They must give priority to the requirements of disadvantaged groups in society (March and Bucher, 2007).

Physical education and sports are important for nurturing physically and mentally healthy citizens, apart from fostering friendship and camaraderie among those who participate in sports. At the personal level, sports enhance the individual’s abilities, general health and self-knowledge. At the national level, Physical education and sports can contribute to socio-economic development, improvement of public health and to encourage national identity and community spirit. This perspective is compatible with the International Charter of Physical Education and Sport, adopted
by the General Conference of the United Nations Educational, Scientific and Cultural Organization (UNESCO) at its 20th session in Paris in 1978. The charter highlights the role of physical education and sports in contributing to social, human and intellectual development by Promoting human values, fair play, ethics, well-being and healthy lifestyle, bringing together persons from different social, cultural and geographic background regardless of religion and ideology, contributing to peace and human development and by preventing violence, delinquency and use of drugs.

Physical Education and fitness have traditionally been emphasized to help the physical growth and development of students within the context of liberal education. Presently in Asia, the purpose is more focused on active living, fitness and healthy lifestyles. There is now a better integration of physical education lessons and lifestyles, making the connection clearer for the students. Traditionally, physical education consisted mainly of practical exercises, with learning through doing or moving. Spurred by the active living concept, current physical education pedagogies are also trying to transmit more knowledge-based lessons to students.

While European, American and Olympic sports are taught extensively in Asian schools, calls have been made for Asian physical activities and games to be included in the curriculum. This will help the students identify their own cultures and strengthen the development of a healthy image and self-confidence. Some efforts have been given to implement local Asian indigenous activities, especially Asian martial arts and physical health, into the curriculum (Haddad, 2008).
Quality physical education programmes should provide the student with the following benefits

- **Skill development:** To develop motor skills for safe, successful, and satisfying participation in physical activities.

- **Regular, healthful physical activity:** To provide a wide range of developmentally appropriate activities for all children and youth, and to encourage young people to be physically active and to be aware of the benefits.

- **Improved physical fitness:** To improve the health-related components of physical fitness (cardiovascular endurance, muscular strength, muscular endurance, flexibility, and body composition).

- **Support of other subject areas:** To reinforce knowledge learned in across the curriculum and to serve as a laboratory for application of content in science, maths, and social studies for communication skills and literacy.

- **Self-discipline:** To facilitate development of responsibility for personal health, safety, and fitness.

- **Improved judgment:** To influences moral development, leadership, cooperation and to accept responsibility.
• Stress reduction: To release tension and anxiety and facilitate emotional stability and resilience (Cox, 2008).

1.2 TRAINING

The word ‘training’ has been a part of human language since ancient times. It denotes the process of preparation for a task. This process invariably extends to a number of days and even months and years. The term ‘training’ is widely used in sports. There is, however, some disagreement among coaches and also among sports scientists regarding the exact meaning of this word. Some experts, especially belonging to sports medicine, consider sports training as basically doing physical exercises.

Sports training is a systematic process extending over a long period. For best results the system of training has to be based and conducted on scientific facts and lines. Where it is not possible, it has to be based on the result of successful practices which has withstood the test of time. Many things are still based on the successful practice, which on deeper analysis is also a method of science to prove or disprove a theory. Moreover, the principal characteristic of a science is the existence of a systemized body of knowledge. The science of sports training has its own systemized body of knowledge and hence is a science in itself (Singh, 1991).

Training means preparing for an event, a season, an athletic competition, a nursing career, an operatic performance, or military combat. Much growth and change occur during training. It usually involves learning or polishing skills, enhancing
attitudes, and developing and strengthening organs and their functions. When we train, we have a goal, a level of competence or a performance in mind. An aspiration is established in our mind, which we systematically pursue. We get prepared to meet the increasing demands of some of the kind with respect to our current mental or physical resources. We seek in some way to change and better our present status and to improve our previous level of performance.

Training is a programme of exercise designed to improve the skills and increase the energy capacities of an athlete for a particular event. Training is the total process of preparation of a sportsman, through different means and forms for better performance (Singh, 1984).

Table - 1

1.3 TRAINING MEANS

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(Singh, 1984)
1.4 PRINCIPLES OF SPORTS TRAINING

Principles of training are the guide-lines for coaches, teachers and sports persons for the formulation and control of sports training. These principles are valid for all aspects and elements of training. These are formed on the basis of knowledge gained from various sports science disciplines and successful practice. The principles of training can be general or specific. General principles are valid for the process of sports training as a whole, whereas specific principles are applicable to a limited part or aspect of training only.

Training should be a continuous and regular process. Continuous and regular training leads to the improvement of performance capacity. The sportsman must be educated about the importance of continuity of training by convincing him about the negative effects of training breaks and irregular training on his performance capacity.

The training load is the principal stimulus for starting the psycho-physical processes of adaptation which eventually leads to the increase in performance capacity. A quantum of training load forces the organism to adapt to a certain level of psychic and physical demands. If the same load is repeated, it gradually loses its value as a stimulus for adaptation. Higher performance will be achieved when the organism adapts to a higher level of functioning, and this is possible only by increasing the load.

The training programme should be formulated uniformly but allowing for individual differences. Training for all should be based on the same principles and
system which have been worked out to achieve the prognostic sports performance in
stages.

According to Singh (1984) training aims at improving the fitness of a person and
promoting the acquisition of basic movement skills. To achieve this, training should
have some basic principles and the most important basic principle of training is
overload. Most Physiological systems can adapt to functional demands that exceed
these loads encountered in normal daily life. Training often systematically exposes
selected physiological systems to intensities of work or function that exceed those to
which the system is already adapted. Excessive overload has to be avoided because
physiological system cannot adapt to extreme consistency as most physiological
systems require exposure to overloading activities three times a week or more. The
required frequency of training however depends on the season, the athlete, the activity
and the specific components of fitness. There is no substitute for consistency in a
training programme. The athlete must participate in training that are highly specific to
the participation of physiological system overload, to the particular muscle group
used, and to the particular muscle fibers performing the work progression in the
successful training programme plan for a steady rate of progression over a load
period. The athlete has to improve over several years of participation; the training
programme must progress so that the appropriate physiological systems continue to
be overloaded. However, too rapid increase of the training stress may lead to
exhaustion and impaired performance.
Apart from these principles one has to give due attention to the individuality. Factors such as age, sex, maturity, current fitness level, years of training, body size, somatic type and psychological characteristics should be considered by the coach in designing each athlete’s training regimen (Thomas, 2008).

1.5 COMPONENTS OF TRAINING

1. Progressive Loading (Overload)

   Biological systems can adapt to loads that are higher than the demands of normal daily activities. Training loads must be increased gradually, however, to allow the body to adapt and to avoid injury (system failure due to overloading). Varying the type, volume, and intensity of the training load allow the body an opportunity to recover, and to over-compensate.

2. Adaptation

   Adaptations to the demands of training occur gradually, over long periods of time. Efforts to accelerate the process may lead to injury, illness, or “overtraining”. Many adaptive changes reverse when training ceases conversely, an inadequate training load.

3. Specificity

   Energy pathways, enzyme systems, muscle fiber types, and neuro-muscular responses adapt specifically to the type of training to which they are subjected. For
example, strength training has little effect on endurance. Conversely, endurance training activates aerobic pathways, with little effect on speed or strength. Even so, a well-rounded training programme should contain a variety of elements (aerobic, anaerobic, speed, strength, flexibility), and involve all of the major muscle groups in order to prevent imbalances and avoid injuries.

4. Reversibility

A regular training stimulus is required for adaptation to occur and to be maintained. Without suitable, repeated bouts of training, fitness levels remain low or regress to the pre-training levels.

5. Variation and Recovery

Muscle groups adapt to a specific training stimulus in about three weeks and then plateau. Variations in training and periods of recovery are needed to continue progressive loading, without the risks of injury and/or overtraining. Training sessions should alternate between heavy, light, and moderate in order to permit recovery. The content of training programmes must also vary in order to prevent boredom and “staleness”.

6. Individual Response

Each athlete responds differently to the same training stimulus. There are many factors that alter the training response: genetics, maturity, nutrition, prior training, environment, sleep, rest, stress, illness or injury, and motivation, to name a few.
7. Periodization of the Training Cycle

The training programme must consist of a variety of elements, including cardio respiratory (aerobic) fitness, general strength, anaerobic fitness (power), speed, neuro-muscular skills development, flexibility, and mental preparation. The emphasis placed upon each of these elements varies during the training year; Skill acquisition should not be emphasized during a high-intensity training cycle, but should be reserved for periods of lower volume and intensity.

8. Maintenance

Gains achieved during high-intensity training periods can be maintained with a moderate level of work. Thus, by means of periodization, some elements can be maintained with less work, while other elements are stressed.

1.6 COMPONENTS OF LOAD

The effect and direction of load depends upon the load components. One cannot predict the effect of physical activity done for 20 minutes unless and until one knows some others aspects of load such as intensity, density, etc. Only by properly controlling the load components we can achieve the desired effect through physical activity (Harre, 1979).

1. Intensity

Intensity is the pace at which physical activity is done or it is the rate of doing work. An activity can be carried out with different intensity which will have different
effect on the organism. Hence, in practice, the total range of intensity is divided into various zones. This is important for planning, implementation and evaluation of the training. The highest intensity which can be achieved by the sportsman is taken as 100% and this is used as a reference point for the various intensity zones. In endurance training the intensity zones are made according to the heart rate.

2. Density

If the training activity is done with pauses in between, then the intensity is affected to a large extent by the density. The density characterizes the temporal relationship between load and recovery phases in a training session. Most commonly, it is referred to as the rest period between two motor stimuli. If more stimuli are given in a certain time period, then the training is denser, i.e., the density is high. The density is determined by the aim and objective of the training activity.

3. Volume

It is the total amount of work done in a training session. When the activity is done according to the continuous method, the total distance covered, the total number of repetitions or the total duration of the activity is the volume. Like intensity, volume should also be the optimum in order to have some effect on the organism, e.g., for the development of basic endurance, one should run continuously for at least 30 minutes. In training activity, which is done with a pause in between, the volume is usually the product of duration of stimulus and frequency of stimulus (Harre, 1979).
4. Duration

It is the time period for which a single motor stimulus acts on the organism. Optimum of stimulus is important to start the desired adaptation process, e.g. for the development of acceleration ability, the duration of each repetition should be at least 6 seconds. In some activities, the duration of stimulus can be so short that it may not carry any significance for the calculation of load, e.g., in jumps and throws.

5. Frequency

It is the number of time a motor stimulus (repetition) is given. In cyclic activities like swimming, running etc, there is no frequency of stimulus as there is only one long duration stimulus. In interval and repetition method, it is the number of repetition. In weight training it is the number of repetitions of an exercise. Same is the case in jumps, throws and free-hand exercises (Singh, 1984).

1.7 RUNNING

Running is a means of terrestrial locomotion allowing humans and other animals to move rapidly on foot. It is simply defined in athletic terms as a gait in which at regular points during the running cycle both feet are off the ground. This is in contrast to walking, where one foot is always in contact with the ground, the legs are kept mostly straight and the center of gravity vaults over the legs in an inverted pendulum fashion. (Biewener, 2003). A characteristic feature of a running body from the viewpoint of spring-mass mechanics is the changes in kinetic and potential energy
within a stride which occur simultaneously, with energy storage accomplished by springy tendons and passive muscle elasticity (Cavagna et al., 1964). The term running can refer to any of a variety of speeds ranging from jogging to sprinting.

Studies show that a combination of diet and exercise is the most effective way to lose weight, as it triggers loss of body fat and a proportional increase of lean tissue. Running, a rigorous cardiovascular exercise, allows a person to burn an average of 100 calories per each mile. Other popular activities, such as biking and walking, only burn a fraction of those calories in the same amount of time. While the average human being burns about 2000-2500 calories a day by simply existing, running 5 miles a day can burn an additional 500 calories, making it a legitimate way to lose weight.

Surprisingly, how fast a person runs has little effect on the number of calories he or she will burn. The most important factor is weight. For example, a 220-pound person running an eight-minute mile burns 150 calories, while a 120-pound person running at the same pace burns only 82. Every person’s body requires an excess of 3500 calories in order to gain a pound or a deficit of 3500 calories in order to lose a pound. Thus, 180-pound person who runs 5 miles each day will lose about 5 pounds a month. However, as his or her weight goes down, he or she will burn fewer calories per mile. Eventually, a runner’s weight will stabilize. It depends on how much the runner eats and how far he or she runs. Most runners lose weight effortlessly at first,
but eventually, their weight stops declining and reaches a plateau. In order to continue to lose weight, serious runners intensify their workouts, as extra weight will only slow them down.

Health benefits are another motivation for runners. For example, running helps to lower blood pressure by maintaining the elasticity of the arteries. As a person runs, his or her arteries expand and contract more than usual, keeping the arteries elastic and the blood pressure low. In fact, most serious runners have unusually low blood pressure. Running also helps to maximize the lungs’ potential, as it keeps them strong and powerful. While deep breaths force the lungs to use more tissue, the 50% of normally unused lung potential is utilized. Even smokers can sometimes recover full lung potential through running. Running strengthens the heart and helps to prevent heart attacks. The large muscle exercise it provides helps to keep the cardio system efficient and strong. In fact, the heart of an inactive person beats 36,000 more times each day than that of a runner, as running keep the arteries open and the blood flow smooth.

Runners say the intense exhilaration and euphoria that comes after a run is what motivates them most. In fact, this euphoria comes from a beta endorphin release triggered by the neurons in the nervous system. Intended to alleviate the pain after a run, it creates a feeling of extreme happiness and exhilaration. Runners become addicted to this intense high, and it can often replace other addictions to drugs, alcohol, and even food. It also helps to bring appetite, exercise and food into balance.
Today, humans living in big cities need recreation in order to regain physical and spiritual energy after an intense daily working. Sport is one of the most favorable recreational activities. If one participates in his sport longer, he will get rid of his stress quicker. The duration of exercise is inversely related to muscle performance.

1.8 CONTINUOUS RUNNING

Continuous training is when low- to mid-intensity exercises are performed for more than 20 minutes without resting intervals. Generally, this type of training is used to prepare the body for sustained workouts such as marathons and triathlons, but can also be effective for more casual athletes. It allows the body to work from its aerobic energy stores to improve overall fitness and endurance. Chief benefits of continuous training include fat burning, muscle building, and increasing maximum aerobic potential.

Almost any type of exercise can be done in a continuous way. Jogging, cycling, and swimming are often the most common, but the style of exercise is nowhere near as important as the manner in which it is accomplished. The most important part of this type of training is the amount of time spent in performing the exercise.

The main goal behind continuity training is to condition the heart for long periods of exertion. Athletes typically start at about 60% of their full capacity, which means that they are working, but not burning themselves out. A light jog or an easy
bike ride that lasts an hour or more are good examples of what this might look like. Professional athletes often use continuity techniques to improve their endurance training, but it is by no means limited to those with superior athletic ability.

Continuous training is a type of physical training that involves activity without rest intervals (Kenney and Larry, 1994). This type of training may be of high intensity, or moderate intensity with an extended duration, or fartlek training. (Wilmore and Jack, 1977)

Exercise modes noted as suitable for continuous training include indoor and outdoor cycling, jogging, running, walking, rowing, stair climbing, simulated climbing, Nordic skiing, elliptical training, aerobic riding, aerobic dancing, bench step aerobics, hiking, in-line skating, rope skipping, swimming, and water aerobics. (Heyward and Vivian, 2006).

1.9 GOOD RUNNING TECHNIQUE

Upright posture and a slight forward lean

Leaning forward places a runner's center of mass on the front part of the foot, which avoids landing on the heel and facilitates the use of spring mechanism of the foot. It also makes it easier for the runner to avoid landing the foot in front of the center of mass and the resultant braking effect. While upright posture is essential, a runner should maintain a relaxed frame and use his/her core to keep posture upright.
and stable. This helps to prevent injury as long as the body is neither rigid nor tense. The most common running mistakes are tilting the chin up and scrunching shoulders. (Yessis, 2000).

**Stride rate and types**

Exercise physiologists have found that the stride rates are extremely consistent across professional runners, between 185 and 200 steps per minute. The main difference between long- and short-distance runners is the length of stride rather than the rate of stride. (Hoffman, 1971).

During running, the speed at which the runner moves may be calculated by multiplying the cadence (steps per second) by the stride length. Running is often measured in terms of pace (Rompottie, 1972) in minutes per mile or kilometer. Fast stride rates coincide with the rate one pumps one's arms. The faster one's arms move up and down, parallel with the body, the faster the rate of stride. Different types of stride are necessary for different types of running. When sprinting, runners stay on their toes bringing their legs up, using shorter and faster strides. Long distance runners tend to have more relaxed strides that vary.

**1.10 BENEFITS OF RUNNING**

The benefits include potential weight loss, improved cardiovascular and respiratory health (reducing the risk of cardiovascular and respiratory diseases),
improved cardiovascular fitness, reduced total blood cholesterol, strengthening of bones (and potentially increased bone density), possible strengthening of the immune system and an improved self esteem and emotional state. (Reynolds, 2009) Running, like all forms of regular exercise, can effectively slow (Stein, 2008) or reverse the effects of aging.

Running assists people in losing weight, staying in shape and improving body composition. Running increases the metabolism. Different speeds and distances are appropriate for different individual health and fitness levels.

Running can also have psychological benefits, as many participants in the sport report feeling an elated, euphoric state, often referred to as a “runner’s high”. (Boecker et al., 2008) Running is frequently recommended as therapy for people with clinical depression and people coping with addiction. A possible benefit may be the enjoyment of nature and scenery, which also improves psychological well-being (Barton and Pretty, 2010).

In animal models, running has been shown to increase the number of newly born neurons within the brain. (Praag et al., 1999) This finding could have significant implications in aging as well as learning and memory.

1.11 ADVANTAGES OF RUNNING OR JOGGING

Many people might prefer playing basketball, football, or racquetball to running three or four miles around a track. It would not be accurate to say that
running is the best exercise or that everyone should run, but there are some major advantages to participating in this activity. First, several scientific research studies have shown that endurance-type exercise (as compared to sprinting-type, high intensity exercise) is primarily responsible for improvements in cardiovascular functioning and decreasing body fat (Astrand, Guharay, & Wahran, 1968; Holloszy, 1973).

1.12 THE POPULARITY OF RUNNING

In 1975, a National Health Interview survey estimated that there were four million white male runners in the United States between the age of 20 and 59 years. It is the estimated that the number of women runners has been increasing rapidly over the last several years but men runners still outnumber women runners two to one. Another survey (1984) conducted at the Disease Control Center in Atlanta estimated that there are presently about 12 million Americans who list running as a major activity. Nearly 40 percent of the surveyed runners ran three to five times per week, and 44 percent ran 20 to 39 minutes per session. Organized road races and marathons have also been on the increase.

Records for long distance running events appear to be broken every few months. Most people who become involved in distance running are interested in comparing their times to the record for that events or distance. However, for the recreational runner, records should be kept only as a source of motivation.
1.13 BIOCHEMISTRY OF MUSCLES CONTRACTION IN RUNNING

The fuel that the muscle cells require for contraction is called ATP (adenosine triphosphate), a high-energy substrate found in all cells in very small amounts. The amount of ATP stored in muscle cells is relatively small which means that other sources of energy must be converted to this substance. The process, involving complex biomechanical pathways, is cellular energetic. It is somewhat similar in concept to the process of refining crude oil from the ground into the more readily usable gasoline.

1.14 FORMATION OF ATP-GLYCOLYSIS

The categories of foods that the cells can break down to ATP are carbohydrates, fats, proteins. Under most circumstances, protein is rarely used as a fuel but it is extremely important for normal tissue resynthesis. When carbohydrates are used for fuel, they enter the process called glycolysis where glucose (simple sugar) is acted on by ten different enzymes and is converted into pyruvate. During this process, two ATPs have been formed. Another name for glycolysis is the anaerobic cycle. The term anaerobic literally means without oxygen. Lactic acid, which is believed to be responsible for muscle fatigue, is a byproduct of glycolysis, especially during high-intensity exercise such as sprinting.
1.15 IMPORTANCE OF OXYGEN

During exercise, it is desirable to obtain the energy for muscle contraction from aerobic processes. There is much greater efficiency and fat can also be utilized as a fuel. For aerobic energy production to occur, oxygen must be supplied to the muscle cell and this is, in turn, carried out by the blood in the vascular system. Oxygen supply can be increased by increasing the rate at which blood is flowing through the vascular system or by increasing the carrying capacity of the blood. In addition, there have to be enough capillaries perfusing the muscle tissue in order for the blood to deliver. The key to all this is that, for aerobic metabolism to produce energy, oxygen must be supplied and utilized effectively, otherwise glycolysis tends to predominate with the concomitant production of lactic acid. (Girandola, 1988)

1.16 HEART RATE

In general, running at less than 70 percent of your maximum capacity ensures that the majority of energy is supplied by the aerobic system. For most individuals running above 70 percent of their maximum involves a substantial anaerobic component. The simplest method used to determine running intensity is to monitor the heart rate during exercise. Maximal heart rate (HR) is usually taken as 220 minus age. Thus a 20 year-old has a maximal HR of approximately 200 beats per minute. If he or she jogs for three miles and the measured HR during the run is 120 beats per minute it could be assumed that this individual was exercising at 60 percent of his or her maximal.
1.17 MUSCLE FIBER CHARACTERISTICS

Muscle fibers are commonly differentiated by mechanical properties, such as being fast twitch (FT) or slow twitch (ST). Fast twitch fibers have greater anaerobic capabilities, contract very rapidly, exert a great deal of tension or force, but fatigue rapidly. Slow twitch fibers, on the other hand, contract slowly, do not exert much tension, but are highly fatigue resistant. Biochemically, these fibers have many mitochondria, which are the structure that contain the enzymes for aerobic energy production. It is certainly obvious that ST muscle fibers are better suited for endurance work, that is sustained contractions at low tension levels, and FT muscle fibers are more suited for speed, strength and power activities. (Girandola, 1988)

1.18 CARDIOVASCULAR RESPONSE TO EXERCISE

The cardiovascular system is comprised of the heart (pump), vessels (arteries, veins and capillaries) and blood (red and white cells and plasma). The function of this system is to supply blood (with oxygen) to the various tissues of the body and also to help in temperature regulation. There are approximately 5 liters (quarts) of blood in the capsular system and under normal resting conditions, that volume makes one complete circuit in one minute. In other words, normal resting cardiac output (Blood flow) is about 5 liters per minute. When one begin to exercise, that value increases substantially. The average unconditioned male may achieve a cardiac output of about 16 liters per minute during maximal exercise.
It is apparent that there is a major cardiovascular adjustment to exercise. Although there is still some argument about this in the scientific community, it is believed that the cardiovascular system is the major limiting factor to endurance performance. This means that an individual who has a very large cardiac output should be able to outperform an individual who has an average cardiac output, in terms of distance-type activities. It has been shown that endurance trained runners have stronger and more functional hearts. More specifically, it was found that the thickness of the walls was greater, they had large ventricular muscle mass, higher diastolic (filling) volume, and improved ventricular function. It should be comforting to note that when you run for distance (at least a mile and preferably longer) you are helping to develop your cardiovascular system. (Girandola, 1988)

1.19 PSYCHOLOGICAL BENEFITS

Earlier studies attempted to identify personality differences between runners and non-runners. In general, it was revealed that runners had a tendency to be more creative and imaginative, more trusting and accepting, and less anxious or depressed. A high degree of mature or “adult” characteristics were found to prevail among many of the tested runners. Greater emotional stability, persistence, and conscientiousness were among the common traits observed.

Running provides an attractive exercise modality for the middle-aged and older adult, women, and even children. Marathon running has long been associated
with individual success in the late twenties. Whereas most track and field records are often set by teenagers and those in their early twenties, long distance running records are often set by those in their early thirties. Many men and women in their sixth and seventh decade of life participate on a regular basis in long-distance running. These individuals (aside from the psychological benefits) benefit from their ability to train for and compete in rigorous physical challenges. To a certain degree, the training may act as a “psychological rejuvenation” for them.

There is some scientific evidence to indicate that runners display better emotional traits, when compared to sedentary control subjects. Whether these personality traits were developed as a result of a running programme or the individuals processed these traits before they began running, is not known. It would appear that there may be some psychological benefits that an individual would obtain from exercising on a regular basis, running begin an excellent example. They in general obtain great personality benefits. It is suggested that running be carried out under pleasant condition and surroundings to infer great pleasure. Allowing the running to become an all-consuming obsession is not advisable since there may be unwanted psychological as well as physiological repercussion. (Girandola, 1988)

1.20 RUNNING ON DIFFERENT SURFACES

There are different kinds of surfaces on which the subjects play sports, e.g. natural grass, asphalt and wooden parquet. Besides, synthetic surfaces for sport and
recreational usages have been manufactured. One of the important aspects in the construction of sport surfaces is to improve athletic performance [Baroud et al., (1999); Daren J.S. and Nigg (2003); McMahon et al., (1987)]. It has been suggested that the main feature of a sport surface that can affect the athletic performance is the storage and return of energy [Baroud et al., (1999); Daren and Nigg (2003)] have argued that if some of the energy that an athlete requires for each step, stride, jump, landing, etc. can be reused, through energy return from the surface, the athlete can perform the same movement more efficiently. In other words, one can achieve a given physical activity by using less energy and can continue his activity for a longer period.

Several studies have revealed a relationship between the compliance of the sport surface and performance. The analytic model of McMahon and Greene (1979) has predicted a slight speed enhancement on tracks of intermediate compliance compared to running on a hard surface. Kerdok et al. (2002) have postulated that an increased energy rebound from the compliant surfaces contributes to the enhanced running economy. It has been also reported that the reuse of elastic energy increases the muscular work efficiency in jumping (Bosco, 1997).

If there is a relationship, whether it is positive or negative, between surface compliance and sport performance, the same relationship is expected to exist between surface compliance and muscle performance. The effect of a given training programme on muscle performance will be different on surfaces having distinct compliance.
1.21 SAND RUNNING

Nowadays many athletics run on sand as an alternative to road running to enhance their endurance or even to supplement normal training however the effect of sand running remains incomplete.

Sand running has a more dramatic effect during a short term training programme typical of many preseason programmes. When running on a hard surface, the overall push of the active muscular are applied upward and forward and as a consequences kinetic energy potential energy increases and decreases simultaneously.

On the other hand, kinetic energy changes at each stride are not affected; the changes of potential energy at each stride become larger on sand. So the energy cost of running on sand is greater than on a firm surface. These findings indicate that running on sand is strongly related with strength of leg muscles and muscular endurance in order to meet the high energy demands.

Trainers and coaches have increasingly begun to understand the importance of aerobic endurance and thus have applied many training methods to develop this biomotor ability. Treadmill running, water running and sand running are popular forms of aerobic endurance training.

Sand dune running is a common training method used by both sprinters and endurance athletes. The Australian athlete Herb Elliott and his coach Percy Cerutti are often credited with popularizing the use of sand dune running as an effective training method. While much anecdotal evidence exists on the training benefits of running on
sand, there is very little scientific literature that explains the role that sand running may play in training for sprint or power events. From an endurance perspective, the current published literature highlights that running on flat soft sand is 1.4 times more energy demanding than running on other flat surfaces such as grass (Pinnington and Dawson, 2001).

Sand sprinting is another common training method used to develop sprint speed (Oviatt, 1991). The sand moves underfoot during the ground contact phase of the stride and so the athlete receives a greater training stimulus through the extra work that is performed on the sand. However, it is currently not known whether the athlete’s movement patterns during sand sprinting are the same as those during sprinting on an athletic track. Among sprint coaches there is a concern that sprinting on an unstable sand surface may induce detrimental changes in technique that will transfer to competition performances (Jakalski, 1998). In particular, coaches are concerned that sand sprinting may induce ‘sitting’, where the athlete has lower hips during the ground contact phase of the stride and an excessive forward lean in the trunk. Such detrimental changes in technique are seen in sled-towing exercises when the load on the sled is too high (Letzelter, 1995) and it is feared that similar changes may also be evident in sand sprinting.

1.22 EFFECTS OF SAND RUNNING

Sand running develops more strength in lower body. As the sand shifts beneath as one run, ankles, arches, and calves are engaged and will become stronger.
A study published in the *Journal of Strength and Conditioning Research* followed 51 young men for six weeks, comparing their physical development and performance on different surfaces. The increase in thigh circumference was similar in sand runners and road runners, but sand runners experienced a significant increase in calf circumference. In this study, sand running resulted in the most physiological and performance changes in young men.

Running on sand burns more calories. A study published in the *European Journal of Applied Physiology and Occupational Physiology* proved that people who ran or walked on sand burned between 1.2 and 1.8 times more calories per mile on each run. That’s between 20 and 80 extra calories per mile. It is thought that because runners sink into the loose sand, they use more energy when covering the same distance.

One become more coordinated and has better balance by running on sand regularly. The uneven surface of sand not only activates the muscles of lower body, it also engages upper body as subconsciously – or sometimes consciously – struggle to maintain balance. Core abdominals, back and shoulders get a workout as one move through the shifting terrain. Over time, this results in more strength and fluidity of motion, giving better control over body.

Running on sand is easier on joints. Running on a softer surface gives joints and muscles a break from the pounding they take on asphalt or pavement. If
volleyball hit the sand, it doesn’t bounce, because sand absorbs nearly 100% of the impact. Every time the foot hits the sand, the impact force is minimal, so the body is subjected to less strain.

1.23 WATER RUNNING

The stride rate will be slower during water running because of the increased resistance of moving legs through water. For steady water running sessions, effort won’t be high enough to maintain fitness. Interval sessions in the water, give brief breaks for both physical and mental.

Deep water running with a floatation vest provides an excellent training stimulus and simulates land running more closely than most other cross-training options. Running in the water is a total-body exercise that works the legs, trunk and arms and positively stresses cardiovascular system. Several studies have verified that runners can use water running to maintain aerobic fitness, lactate threshold, running economy and time-trial performance for at least 6 weeks. (Pfitzunger and douglas, 2009)

Aquatic training provides a “nonimpact medium” that produces little strain on muscle, bones, and connective tissue when compared with land activities (Politino, et al., 1995). Aquatic training also provides buoyancy that reduces weight bearing stress on the limbs; however, movement in water increases resistance (Ruoti et al., 1994, Sova et al., 1992). Weight-bearing activities on land place stress on the lower limbs, and this stress is considerably reduced in water because of its buoyancy.
Use of water as a medium for training thus reduces the impact forces and the potential trauma to the joints and connective tissue while providing resistance to movement well beyond that of air. The increased resistance to movement through the water requires additional muscle activation to overcome the resistance and produce the same movement that is more easily produced in the air.

Studies have supported the inclusion of aquatic activities in training programs to enhance muscular strength (Weinstein et al., 1986, White et al., 1999) while providing a therapeutic modality for reducing muscle soreness and pain (Woods, 1989).

Aquatic activities have been shown to be both therapeutic and an effective method of strengthening muscles while reducing muscle soreness (Weinstein et al., 1986, White et al., 1999, Woods, 1989). Woods (1989) reported that an aquatic low back rehabilitation program resulted in reduced perception of pain when compared to a land-based rehabilitation program. An aquatic setting can provide a safer environment in which impact is minimized and buoyancy supports the body. Aquatic training can provide exercise opportunities for people who need to reduce impact on their joints because of fatigue, injury, and disability, while providing improvements in performance variables.

Aquatic running is well accepted as a form of conditioning for athletes recovering from injury and for those seeking an effective mode of cross training (Reilly et al., 2003). Its popularity stems from its ability to reduce repetitive strain and stress to the lower extremity from musculoskeletal loading that is normally
associated with land-based activities (Moening et al., 1993). Therefore, substituting aquatic exercise for land running could be potentially beneficial for individuals susceptible to overuse injuries (i.e., tendonitis, plantar fascitis, stress fractures).

The most common form of aquatic running is deep-water running (DWR), where participants run in place with a tethered pulley system and a buoyant belt/vest or across the deep end of a pool (Frangolias and Rhodes, 1996). However, DWR has been shown to be quite different from land running in terms of lower extremity muscle recruitment and kinematics (Moening et al., 1993) because of the absence of a ground-support phase and the additional resistance of moving through water. Additionally, most studies have demonstrated that DWR produces lower peak oxygen consumption (VO$_2$) and heart rate (HR) compared with treadmill exercise on land (Chu et al., 2002, Dowzer et al., 1999, Frangolias and Rhodes, 1996, Glass et al., 1995, Nakanishi et al., 1996, Town and Bradley, 1991), with DWR averaging 87 and 90% of land exercise for peak VO$_2$ and HR, respectively (Reilly et al., 2003). Several factors may account for this difference, including water’s hydrostatic effect of increasing thoracic pressure, resulting in a lower HR during DWR (Arborelius et al., 1972, Christie et al., 1990, Connelly et al., 1990) the above-mentioned lack of a ground support phase (Moening et al., 1993); water temperature (Craig and Dvorak, 1966, Moening et al., 1993); self-selected stride rate and/or exercise intensity (Town and Bradley, 1991); and unfamiliarity with DWR technique (Frangolias et al., 1996).
Aquatic physical therapy is a form of physical therapy performed in a pool. Exercising in water can be helpful in improving function, fitness, balance, coordination, flexibility, and strength. Patients like exercising in water because water supports their body weight, decreasing stress on their joints and making it easier to move with less pain. Athletes can run in water as a form of cross training. Patients can run in water to reduce pain or joint stress during rehabilitation. A study published in the May 2012 issue of *JOSPT* provides new insights on water’s ability to decrease the load sustained by a runner, based on the depth of water in which the individual is running.

Stationary running in water has become a popular exercise to maintain fitness while decreasing the stress on a person’s joints. Athletes worry about quickly losing their athletic edge and fitness after injury, which can affect their seasons. So, finding ways to safely exercise while recovering from the injury is important and stationary running in water is one such option. Exercising while recovering from an injury needs to be well controlled so that it does not slow down the healing process or increase pain. The researchers in this study were able to measure the influence of depth of water and speed of running on the forces that occur during stationary running in water. Their results can help your physical therapist customize an exercise program for you. For more information on aquatic exercise, contact your physical therapist specializing in musculoskeletal disorders.
1.24 DIFFERENCE ABOUT EXERCISING IN WATER

When we exercise on land our skeletal, muscular, cardio-vascular, respiratory and other body systems are greatly affected by the forces of gravity, but when we exercise in water the effects created by the gravitational pull on the body are reduced. However, water possesses its own unique properties which affect the body in different ways and provide a totally new experience. The effectiveness of any programme will ultimately be dependent on how well these properties are understood and how well they are utilized to maximize the training benefits received.

Buoyancy theory suggests that when a body is immersed in water it will displace an amount of water equal to the mass of the body submerged. This displacement causes the water to rise and surround the body and push it upwards and out towards the water surface. Buoyancy creates the marvelous feeling of weightlessness and floatation that one experiences when submerged in water. When submerged in water to waist level the gravitational pull is reduced by 59%. This means that one is partially affected by gravity and partially affected by buoyancy.

Buoyancy pushes the body upwards and out of the water. It decreases the stress on weight bearing joints and muscles. Working with buoyancy will assist with the improvement of local muscular strength, endurance and body tone. (Lawrence, 1998)
1.25 LAND VERSUS WATER EXERCISE

People of diverse capabilities can benefit from exercising in water because water is a totally different medium to air, and exercising in the water is physiologically very different from exercising in the land. A key point is that people are virtually weightless when they are standing chest high in water. In the case of aquatic exercise, there is a basic fact that a given volume of water weighs about 750 times more than the same volume of air. This difference in relative density between water and air is responsible for water being the kinder and more flexible medium in which to exercise. (Bawn, 1998)

1.26 EFFECTS OF WATER RUNNING

Water resistance strongly affects untrained people in water-exercise. Unskilled movement may increase the energy, via anaerobic glycols, required to overcome the resistance to movement through the water (Shono et al., 2001). The physiological benefits of running are well documented and noteworthy; its overuse has contributed to a wide range of foot and leg injuries (Glass et al., 1995). In general, heart rates during deep-water exercise are approximately 17 beats per minute lower than during comparable exercise on land (McArdle et al., 1991). Aquatic running or jogging, when supported by floatation devices, offers additional benefits, most notably, the maintenance of rapid stride frequencies without the impact of landing and coordinated movements between the arms and legs (Cassady & Nielsen, 1992; Tovin, 1994).
Deep water running has been shown to compare favorably with land-based exercise. Maximum oxygen uptake values for aquatic running ranges from 83-89% when compared to the values obtained from running on land. Maximum heart rate values for aquatic running ranges from 89-95% of values measured on land (Wilder, 1993; Woolfenden, 1994). Many previous studies have reported the metabolic and cardio respiratory responses during walking and jogging in a pool (Evans et al., 1978; Whitley & Schoene, 1987; Bishop et al., 1989; Ritchie & Hopkins, 1991; Town & Bradley, 1991; Gehring et al., 1992) but it was difficult to fix the physical and physiology intensity for walking and jogging in a pool, due to water density, approximately 800 times higher than air (Di Prampero, 1986). Heart rate has been reported to decrease during head-out water immersion exercise compared with air (vellini et al., 1983; Christie et al., 1990; Connelly et al., 1990, Norsk et al., 1990).

1.27 TRAINING EFFECTS OF DEEP WATER RUNNING

One of the more compelling questions regarding DWR and injured athletes is if this type of exercise modality helps to maintain appropriate levels of fitness, specifically cardiovascular fitness, which can significantly decrease within 3 weeks. An ancillary question is if DWR can be used to supplement training programmes with similar benefits. In an effort to answer these questions, Eyestone et al., (1993) completed a study on VO2 max and 2-mile run performance over a 6-week training period. The results indicated that although there was a statistically significant
decrease in VO₂ max values ($P < 0.05$), the changes were not physiologically (practically) significant. The researchers based this statement of practical significance on the fact that all groups decreased their 2-mile run times. They concluded that an injured runner could maintain the cardiovascular fitness while running in the pool, provided the runner used the same duration, intensity, and frequency of training as he or she would normally.

Bushman et al., (1997) used 11 well-trained competitive distance runners to determine that using 4 weeks of DWR training maintained terrestrial running levels. In a comparison between pre- and post-testing, no significant differences were found between 5000-m run times; sub maximal VO₂, lactate threshold running velocity, or VO₂ max. Also, no differences were found relative to global mood state during any of the training phases (ie, pre, during, and post). These findings are corroborated by similar training studies. Hertler et al., (1992), Morrow (1996) as opposed to previous studies that found no statistically significant changes, a significant ($P < 0.01$) increase in VO₂ max values were found by Brennan et al., (1992) in an 8-week study using 8 females and 2 males. Hamer and Morton (1990) provided further evidence that an 8-week DWR program not only satisfied the principle of specificity but, as importantly, the program was successful in improving aerobic and anaerobic fitness in their 9 male subjects. To further corroborate that DWR may be used to maintain aerobic capacity, the study by Wilbur et al., (1996) concluded that with “trained runners,” DWR can maintain their aerobic performance for up to 6 weeks. Recently,
Azevedo (2010) found that with regular DWR training, there is a reduction of the differences previously reported between land-based and DWR VO₂ max values. Obviously, supporting the previously discussed need to increase the skill level of the athlete or patient participating in DWR.

Lauder and Burns (2001) offered evidence that DWR is a highly beneficial alternative for military personnel who could not engage in regular training activities due to injuries. Rudzki and Cunningham (1999) further noted that when implementing DWR after high-impact activities (eg, marches), their injury incidence rates decreased markedly. Interestingly, the military experiences an incidence rate of stress fractures of 4% to 5%, (Almeida et al., 1999) while runners have an incidence rate of 4% to 14%. Burr (1997) to the military, the use of DWR may have positive ramifications in terms of decreasing the loss of personnel hours and money (Lauder et al., 2001 and Rudzki et al., 1999).

The mechanism responsible for the lower heart rate during immersion is the distribution of blood volume from the periphery to the central region. The increased hydrostatic pressure of water, concomitant with peripheral vasoconstriction to reduce heat loss forces peripheral blood into the thorax. This result in an enhanced venous return and a decreased stroke volume while maintaining cardiac output (vellini et al., 1983). The Flow mill is able to measure various physiological responses during water walking under fixed load conditions, and various studies have been conducted.
(Onodera et al., 1992; Kanaya et al., 1993; Hotta et al., 1993; Migita et al., 1994, 1996; Takaoka et al., 1999). They found that approximately one-half to one-third of the speed is needed to walk or jog across a pool through waist-deep water at the same level of energy expenditure as treadmill-walking and jogging on land (Gleim & Nicholas, 1989). The respiratory index in the aqueous environment is similar to the one found on land in sub maximal levels and in the maximal effort (Town & Bradely, 1991; Dowzer et al., 1998; Butts et al., 1991; Gehring et al., 1992; Connelly et al., 1990). Hormonal changes have been observed with sustained periods of water immersion. Energy expenditure in water depends more on energy expended to overcome drag compared to exercise on land (Holmer, 1972). In water walking, it has also been hypothesized that differences in skills for walking through the water strongly affect energy expenditure (Shono et al., 2001).

1.28 REASON FOR SELECTING THE STUDY

A well designed training programme improves students’ fitness level. Physical and motor fitness is plinth of health and academic achievement of students. The fitness level of the students nowadays are getting deteriorated due to lack of physical activities. Physical fitness has a significant role in changing the students to fit worthy citizens. Physical activity increases the life span and gives better appearance to a person. Continuous running result in changes in the organisms of the body. Moreover continuous running on different terrains make different demands upon the motor fitness, physiological and athletic performance variables.
However, there was no attempt made to find out the combined effects of continuous running on different terrains among high school boys, especially in India. Hence, the researcher as an experienced physical education teacher and very much interested in students fitness and athletic performance, selected this study.

1.29 OBJECTIVES OF THE STUDY

The following objectives were made to fulfill the purpose of the study.

1. To assess the motor fitness, physiological and athletic performance status of high school boys.
2. To find out the changes in motor fitness component changes of high school boys due to the influence of continuous running on different terrains.
3. To analyze the changes in physiological status of high school boys through continuous running on different terrains.
4. To assess the influence of continuous running on different terrains over the athletic performance of high school boys.
5. To choose the best combination among the continuous running on different terrains to improve motor fitness, physiological and athletic performance variables of high school boys.
6. To analyze whether the continuous running on track, sand and water are suitable modes to get desirable results over high school boys.
1.30 SIGNIFICANCE OF THE STUDY

The findings of this study will be significant in the following ways.

1. The findings of this study may add to the existing source of knowledge with regard to the continuous running on different terrains method to improve the motor fitness, physiological and athletic performance variables.

2. It may also help the physical education teachers and coaches to know about the importance of continuous running on different terrains.

3. It may help in fixing the load for different sports men.

4. The findings of this study may also be helpful in designing the continuous running on different terrains for different age groups and different sex based on the motor fitness, physiological and athletic performance.

5. It would create awareness about fitness through continuous running on different terrains.

6. The contribution of the study would bring a healthy fit society in India.

7. The study may help the future research scholars to select the problem related to the study.

8. It may help the policy makers in physical education and youth welfare and health system of our country.
1.31 STATEMENT OF THE PROBLEM

The primary purpose of the study was to find out the effects of varied combinations of running on different terrains on motor fitness, physiological and athletic performance of high school boys.

The secondary purpose was to find out the suitable combination to bring out desirable changes over motor fitness, physiological and athletic performance variables of high school boys.

1.32 HYPOTHESES

It has been widely accepted that continuous running on track and sand has a positive influence on motor fitness components, physiological variables and performance of the athletes. Based on the concept, the following hypotheses were formulated.

1. It was hypothesized that the combination of continuous running on track and sand would produce significant changes in motor fitness, physiological variables and athletic performance of high school boys.
2. It was also hypothesized that the changes made on motor fitness, physiological variables and athletic performance of high school boys from base line to post treatment of combination of track and water running training would be a significant one.
3. Further, it was hypothesized that the combination of track, sand and water running would produce significant changes in motor fitness, physiological variables and athletic performance of high school boys.

4. It was also hypothesized that varied combinations of track and sand running, track and water running and track, sand and water running would produce similar changes in motor fitness, physiological variables and athletic performance of high school boys.

5. It was further hypothesized that the combination of track, sand and water running would produce significant changes in motor fitness, physiological variables and athletic performance of high school boys better than the other two combinations of training.

1.33 DELIMITATIONS

The study was delimited in the following aspects.

1. The study was restricted to 120 high school boys of Perunthalaivar Kamarajar Government Boys High School and Sri Aravindhar Higher secondary school, Muthialpet, Puducherry, India.

2. The age of the subjects ranged between 14 and 16 years.

3. The training period was restricted to a period of 12 weeks.

4. The following variables were selected for this study.
Independent Variables

Combination of track and sand running

Combination of track and water running (Knee level)

Combination of track, sand and water running (Knee level)

Dependent Variables

Motor fitness components

- Speed
- Explosive power
- Leg strength
- Strength endurance

Physiological variables

- Anaerobic power
- \( \text{Vo}_2 \max \)
- Resting pulse rate
- Cardio respiratory endurance

Athletic performance

- 100 meters run
- 400 meters run
- 1500 meters race
- Long Jump
1.34 LIMITATIONS

1. Certain factors such as life style, rest period, day-to-day activities and family background were not taken into consideration.

2. Socio-economic status was not taken into consideration.

3. The subject’s previous experiences in physical activities were also not taken into consideration.

4. The effect of uncontrollable factors like heredity and environment were also considered as limitation of this study.

1.35 DEFINITION OF TECHNICAL TERMS

Training

Training is a process of systematic and planned way towards given (Singh, 1991).

Sports Training

Sports training is a process of preparation of sports man, based on scientific and pedagogical principles, for higher performance (Singh, 1984).

Anaerobic power

The anaerobic power refers to the absence of oxygen. It is equated with intensity activity, yet initiates all activities. It functions in a deficit of oxygen, is the immediate precursor for all aerobic metabolism, and occurs simultaneously with it in
most strenuous that require more than 10 seconds to complete. (Stephen and Sam bell, 1984)

**Resting Pulse Rate**

The Pulse rate is a wave of increased pressure which is felt at the arteries when blood is pumped out of the heart. It is not the blood pumped by the heart into the aorta that is felt, but the pressure transmitted from the aorta which travels more rapidly than blood (Pearce, 1997).

**Cardio Respiratory Endurance**

It is the hearts and circulatory systems ability to provide adequate amounts of oxygen to the cells to meet the demands of prolonged physical activity. This is the best physiological measure of total body endurance (David et al., 1997).

**Vo$_2$max (Maximum Oxygen Consumption)**

Vo$_2$ max is the highest oxygen uptake (Vo$_2$) achieved when a person is working at maximal capacity. Classically, Vo$_2$ reaches a plateau and does not increase further, even with an increase in external workload (Evans and White, 2009).

**Speed**

Speed is defined as the capacity of the individual to perform successive movement of the same patterns at the faster rate (Johnson and Stolbery, 1971).
Explosive power

Explosive power is the ability which enables athletes to give their body, an object or a partner maximum acceleration. (Nićin, 2000)

Leg Strength

The capacity of the lower limb to exert muscular force leg strength was measured the limit of lifting resistance in lowering to and arising from sitting position (Johnson and Nelson, 1982).

Athletic performance

Performance is the psycho-socio-biological process of doing some actions of tackling some task or demands (Singh, 1987).