CHAPTER – I

INTRODUCTION

Human beings are by nature, competitive and aspire for excellence in all athletic performance. Not only man but every nation shows their supremacy by challenging the other nations. Thus this challenge stimulates, inspires and motivates nations to sweat and strive, to run faster, jump higher, throw further and exhibit greater strength, endurance and skill in the present competitive world of sports. This is only possible by channelizing their potential energy into appropriate games and sports according to their potentialities and through scientific, systematic and planned sports training.

The non-ending creation of new records shows a continuous upward trend and improvement in the standards of sports performances. The acquisition of new standard may be attributed to better understanding of the human organism in relation to physical, mental and motor performance qualities that underline success in any sports endeavour, besides intensive research in the areas of training methods, exercise physiology, sports medicine, biomechanics, sports psychology, sports sociology and many other areas related and specific to sports (Carpenter, 1938).

Ever since the modern Olympic games, human performance has captured the attention of a wide segment of the population. In addition to the athlete, there
is a growing scientific awareness among coaches and investigators. Athletic records are followed by more and more people and data are meticulously kept by officials of various sports and by the media as well. For an athlete, achieving peak performance is one of the factors that make competition go self sustaining. The growth in size, complexity and number of research laboratories has provided an impetus for the study of the athletic performer. Data are now available in every sport, and the elite athlete has been described in a variety of scientific journals. Ultimately it will benefit the performer to have information on which to base future performance and training methods, as well as to help explain the achievement of certain competitive standards (Clarke, 1985).

1.1 TRAINING

The word ‘training’ has been a part of human language since ancient times. It denotes the process of preparation for some 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, understand 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, the training has to be based on the result of successful practice which has withstood the test of time. Sports science has still not been able to provide a scientific base for all the aspects and elements of training. Many things are still based on the results of 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).

“Sports training is a planned and controlled process in which, for achieving a goal, changes in complex sports motor performance, ability to act and behavior are made through measures of content, methods and organization” (Martin, 1979).

Williams (2000) defines “Sports training is a process of preparation of sportsman, based on scientific and pedagogical principles for higher performance.”

Training means preparing for something: 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, enchanting attitudes, developing and strengthening organs and their functions. When we train, we have something in mind; a goal, a level of competence, a performance of some kind. An aspiration is established in our mind,
which we systematically pursue. We get prepared to meet the increasing demands of some of kind with respect to our current mental or physical resources. We seek in some way to change and better our present status, 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 (Edward, 1984). Training is the total process of preparation of a sportsman, through different means and forms for better performance (Singh, 1983).

Sports Training, based on scientific knowledge, is a pedagogical process of sports perfection which through systematic effect on psycho-physical performance ability and performance readiness aims at leading the sportsman to the highest performance. Through active and conscious interaction with the given demands in sports training, the sportsman’s personality develops according to the norms and standards of socialist society (Harre, 1986).

1.1.1 CONCEPTS OF TRAINING

Training is a pedagogical process, based on scientific principles, aiming at preparing sportmen for higher performances in sports competitions. It aims at improving the performance of sports persons. The performance of a sports person primarily depends on the performance capacity which is a complex group of factors. The constitution or physique is genetically determined and hence cannot
be improved by training. The improvement and maintenance of physical fitness is the main concept of training.

Training is not mere physical activity involving physical movements or actions. Such type of physical activity is common to several types of human activities, e.g. play and dance, physical or manual work like household work, work in industries and factories. Sports training mainly aims at achieving higher performance in sports competitions. It is a process which is spread over a long period of time. It is a competition and performance oriented process.

In order to achieve high performance, sports training is done in a planned and systematic manner. A system most suitable for achieving high performance has to be first made on the basis of the planned sports training.

1.1.2 PRINCIPLES OF 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. The specific principles are applicable to a limited part or aspect of training only.
The 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. Uniformity means that 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 might 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.
There are certain principles that govern on how the body responds to the physical activity. Following principles will ensure the safety and effectiveness of the activity programme.

**Overload Principle** states that a body system (muscular, skeletal) must be exposed to physical stress beyond the ordinary in order to adapt and improve function. For example, to build stronger muscles one must work against resistance that pushes the muscles to their limits. Over a period of time, the muscles adapt to this new workload and become stronger.

**Principle of Progression** states that, to ensure safety and effectiveness, the overload must be applied in a systematic and logical fashion. If too much physical stress is applied too soon, the system will not have time to adapt properly and benefits may be delayed or injury may occur. The body may be overloaded gradually so that it has time to adjust and improve. If the muscles are sore after exercising, they are doing more than their current level of fitness allows. One should reduce the intensity of the activity and progress more gradually.

**Principle of Specificity** states that particular activities must be performed to bring about particular adaptations. For instance, if the goal is to build muscular strength, you need to undertake an activity that overloads the muscles. For example, one must do exercise that physically stress the biceps muscles of the upper arm if
strength gain in the biceps is desirable. Stressing the quadriceps muscle of the thigh will not develop strength in the biceps of the arm.

**Principle of Reversibility** tells that, any gains may get through regular physical activity will disappear, if we do not continue to be active – thus the maxim “Use it or lose it”. If we decrease our activity levels, we will experience some loss in fitness, in as little as two weeks (Coyle, 1990). Therefore, it is important to continue our activity programme for life.

**Principle of Individuality** reinforces the concept that all people have different genetic blueprints, and activity programmes must be designed with this in mind. Determine what one wishes to achieve, find activities that will bring about those results, and set out to obtain the desired outcomes.

**Principle of Recovery** reminds that the body takes time to adjust to the physical stress of being active. One must allow adequate time for adaptation to take place. It is generally recommended that one should allow 48 to 72 hours between exhaustive activity sessions, those are similar in nature. This doesn’t mean that one shouldn’t be active at all for this period of time. It does mean that one should vary the activities so that one system is allowed time to adjust before it is stressed again (Thomas, 2007).
1.1.3 AIMS OF SPORTS TRAINING

In the light of the meaning and definitions of sports training, the major aim of sports training is to improve rapidly the sports performance of a sports person particularly in sports competitions, which is mainly based on his physical, psychological, intellectual and technical capacities and capabilities. In other words, the aim of sports training in competitive sports is to prepare the sportsperson for the attainment of highest possible sports performance in competition (Ajmer Singh, 2008).

The definition of sports training gives the overall aim of training process. This is the major aim which can be subdivided into different aims, achievement of which is necessary to improve the sports performance. These aims are related to different performance factors and are described briefly in the following.

(i) Improvement of physical fitness

The sports performance depends largely on physical fitness that is strength, speed, endurance, flexibility and various coordinative abilities. Sports activity is a physical activity, which is not possible without these motor abilities. Therefore, the improvement of physical fitness or motor abilities is a principal aim of sports training. The process of improvement of motor abilities is also called conditioning. Improvement of physical fitness also includes the improvement of general health and organic functions as well as increase in the strength and
stability of the musculoskeletal system. Each sports activity demands different types and levels of motor abilities and when a sportsman possesses these, is said to have the specific physical fitness. General physical fitness is the level of various motor abilities, regardless of any sport, which the sportsman possesses. The contribution of general physical fitness towards the sports performance is indirect. But it should never be over looked that specific physical fitness depends largely on the general physical fitness.

(ii) Acquisition of motor skills

Technique is the motor procedure of tackling a sports task and when this motor procedure is learned and stabilized it is called a skill. Sports activities consist of motor movement and action, and their success depends largely on their correctness. Skills are indispensable for maximum utilization of the motor abilities and for successful execution of tactical actions. Hence, technique training forms an important component of sports training which aims at acquiring skill of the specific sport, of other sports as well as of the various physical exercises. The role of technique and the amount of technique of training defer from sport to sport. In gymnastic, team and combative sports there are a large number of techniques to be learnt and mastered. On the other hand, in track and field, weightlifting, etc., only one or two techniques have to be learnt and mastered.
(iii) Improvement of tactical efficiency

Tactics is carrying out a competition in such a way that the sportsman can fully utilize his abilities, skills and external factors while at the same time hindering the opponent to do so. The role of tactics is different in different sports. The performance in 100 meter sprint does not depend significantly upon the tactical factor, but in team and combative sport, a good performance without tactical efficiency is impossible. Therefore, the improvement of tactical efficiency is an important aim of sports training. The tactical training aims at improving the knowledge of rules and regulation of the specific sport and how this and other factors can be exploited by the sportsman, for better performance during the completion, improving the tactical abilities and at improving tactical skills. It must be noted that with the improvement of sports performance of a sportsman, the aim of improving tactical efficiency becomes more and more important.

(iv) Educational and improvement of mental capabilities

Performance in sports is a result of the total personality of the sportsman. Therefore, the educational and improvement of mental capabilities must be considered in sports training. Education, in short, means:

1. Development of positive beliefs, values, attitudes and interest towards sports training and competition.
2. Development of personality traits and quality which are important for successful training and competition, e.g., self control, regularity, honesty, quality of hard work, courage, social qualities, etc.

3. Formation of good habits, e.g., eating and sleeping habits, leisure time habits and habits of personal hygiene. The sportsman should be educated not only for the purpose of training and competition, but also to become valuable members of the society and the nation. The educational aim of the sports training must conform to the educational aim of the society.

   For successfully carrying out the training and competition activities, a sportsman must have certain mental capabilities, e.g., intelligence, ability to concentrate, thinking ability, problem-solving ability, ability to take quick and correct decisions, etc. Such mental capabilities form a part of education, and should be improved.

   The educational and improvement of mental capabilities must take place through sports training and competitions. Hence, the training process must be consciously planned according to the principles of pedagogy. Training and competitions are important means to achieve this and it is the moral, social and professional duty of each coach and physical education teacher to educate the sportsman through training and competitions.
1.1.4 TRAINING MEANS

The means and measures used for achieving the various aims of training are called training means. Like the aims of training, these are also very comprehensive. The means range from material objects like equipment, the psychological and the physiotherapeutic measures. In a wider sense the methods of improving physical fitness, technical skills and tactical efficiency are essentially training means (Bauersfeld and Schroter, 1979).

The principal means of sports training obviously are physical exercises. Without these, an effective improvement and maintenance of performance capacity cannot take place. But physical exercises alone do not guarantee the optimum improvement of performance capacity. Therefore, other means, in correct combination with physical exercise have also to be used for the optimum effect.

The various means of sports training along with their effects are mentioned below.

<table>
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<th>Training means</th>
<th>Effects</th>
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<td>Principal training means</td>
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<td>1. Physical exercise</td>
<td>- Physical fitness (condition).</td>
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<tr>
<td>3. Special exercise</td>
<td>- Techniques and tactics</td>
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Additional training means

(a) Psychological means

a. Ideo-motor training - Techniques and tactics.
c. Other psychological means - Control of activation, behaviors control, removal of fear and complexes, and psychic preparation.

(b) Medical and physiotherapeutic means:

a. Hygienic measures - Health, recovery and relaxation, prevention against infections, etc.
b. Massage - Recovery, relaxation, rehabilitation and control of activation
c. Nutrition - Health, recovery and relaxation prevention against infections, etc.
d. Hydro and electro therapy - Recovery, relaxation and rehabilitation.

(c) Natural means

a. Light, air, water - Health, resistance against infections and diseases.
b. Weather conditions - Affect training load.
c. Altitude - Health and physical fitness (Condition).
(d) Material objects

  e. Audio-visual aids - Physical fitness (Condition).
  f. Equipment, apparatus, etc. - Techniques and tactics.

1.1.5 TRAINING LOAD

Training load is the central concept in sports training as it leads to increase in sports performance. For improvement of sports performance, the training load also is to be increased. Stagnation in training load means stagnation in performance. Sports training can be compared to stimulus reaction process. By giving load, stimulus is given to the organism which reacts in the form of adaptation to that stimulus. In the sports training, the load leads to functional, biochemical and structural adaptation of the organism for higher demands.

Training load is the psychological and physiological demands put on the organism through motor stimuli (movements) resulting in the improvement or maintenance of performance capacity.

Every physical activity accompanies physiological demands. This is generally recognized and accepted. But most of the times it is overlooked that physical activity also puts psychological demands on the sportsman. A competition or trial is characterized by high psychological demands. Technical, tactical and endurance training are also accompanied by high psychological demands.
The training load must satisfy one important condition, i.e., must lead to an increase or maintenance of performance capacity.

External load

It is the work done by the sportsman. The total distance run by a distance runner is one aspect of external load. The external load can be divided into various load components which shall be discussed later.

Internal load

It is the degree and extent of psycho-physiological reaction of the sportsman to external load. The degree of internal load is judged by pulse rate, lactic acid concentration in the blood, and various biochemical changes in the tissues. The degree of internal load can also be judged by various symptoms of fatigue.

External and internal load are inter-related. External load is the cause of internal load. For biological adaptation (performance improvement) internal load is a must and should be optimum. In other words, the aim of doing exercises (i.e., giving of external load) is to produce internal load. The sports training, therefore, is internal load oriented and external load is only a means of causing internal load. Same external load may not result in the same degree of internal load in two sportsmen in different levels of training state. For top level sportsmen, higher external load is necessary to produce optimum internal load, i.e., with
improvement of training state more external load should be given to produce a certain degree of load. The principles of load can be described as follows:

**Principles of continuity and repetition of load**

The load must be given several times in order to achieve a stable increase in performance capacity. Further, the training should be continuous, otherwise the achieved adaptation or performance improvement will be lost after some days.

**Principles of optimum load**

If load given is less, very little or no super-compensation takes place. If excessive load is given, the recovery process is slowed down. Therefore, for optimum recovery and super-compensation, optimum load should be given.

**Principles of load and recovery**

Optimum load is essential to achieve good super-compensation. But super compensation will take place only if enough time for recovery is given. For super compensation, recovery is as important as load (*Jakowlev, 1977 and Schube, 1979*).

**Principles of specificity of load**

A specific type of load leads to super compensation of a particular type of substance. Therefore, after recovery, one’s performance capacity is improved for
that load only which has caused super compensation. Different types of load should be given when different performance factors need to be improved.

**Principles of progression of load**

For continuous improvement of performance, the load should be increased from time to time. A particular quantity of load leads to adaptation to tackle the load successfully. But it will not help in tackling loads, for which the adaptation takes place at a higher level. Therefore, higher load should be given so that adaptation to a higher level can take place.

**1.1.6. COMPONENTS OF LOAD**

The components of load, as important aspects or elements of training load, have been discussed by various authors (e.g. Harre, 1979; Martin, 1977; Letzelter, 1979; Berger, 1980). The components of load are various aspects of load which determine the degree of load. One cannot predict what will be the effect of physical activity done for 20 minutes unless and until one knows some other aspects of load also, e.g., the intensity, the density, etc. By properly controlling the load components, we can achieve the desired effect through physical activity.

**Intensity**

It is the rate of doing work. In other words intensity is the pace at which physical activity is done. 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.

**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. The role of density is two-fold.

**Volume**

It is the total amount of work done in a training session. When the activity is done according to continuous method, the total distance covered, or total number of repetitions or the total duration of the activity is referred as the volume. Like intensity, the volume should also be 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 (Harre, 1979). In training activity, which done with a pause in between, the volume is usually the product of duration of stimulus and frequency of stimulus.

**Duration of stimulus**

It is the time period for which single motor stimulus acts on the organism. Optimum duration 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 activity 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. In cyclic movements, the time period of a series of motor stimuli is taken as the duration of stimulus, e.g., in endurance training, the duration of stimulus is the total volume of load itself. The duration of stimulus together with other load components, determines the effect and direction of load. For the development of isometric strength, the muscle contraction should last for at least 20 – 30% of total time for which the contraction can be held. In speed training, the duration of each repetition should only be that much for which the maximum intensity can be maintained. Same is the case in technique training.

**Frequency of stimulus**

It is the number of times a motor stimulus (repetition) is given. In cyclic activities like swimming, running, etc., there is no frequency of stimulus as there
is only a long duration stimulus. In interval and repetition methods, it is the number of repetitions. In weight training, it is the number of repetitions of an exercise. Same is the case in jumps, throws and free-hand exercises. In activities where duration of stimulus may not be considered for the calculation of load volume, the frequency of stimulus is taken as the volume of load. Frequency of stimulus and intensity are interdependent. The higher the intensity, the lower will be the frequency and vice versa.

**Judgment of load**

It is very important for the coach to know how much load is given to the sportsman during a training session. The external load can be measured and controlled, and it should be only that much, it results in optimum internal load on the sportsman. Unlike external load, the internal load is not easy to determine, because the coach must find out at what level the organs and systems of the body are working, and what is the degree of fatigue.

**1.2. PLYOMETRIC TRAINING**

Plyometrics (also known as "plyos") is a type of exercise training designed to produce fast, powerful movements, and improve the functions of the nervous system, generally for the purpose of improving performance in sports. Plyometric movements, in which a muscle is loaded and then contracted in rapid sequence, use the strength, elasticity and innervations of muscle and surrounding tissues to
jump higher, run faster, throw further, or hit harder, depending on the desired training goal. Plyometrics is used to increase the speed or force of muscular contractions, providing explosiveness for a variety of sport-specific activities. Plyometrics has been shown across the literature to be beneficial to a variety of athletes. Benefits range from injury prevention, power development and sprint performance amongst others.

Plyometric exercise refers to those activities that enable a muscle to reach maximal force in the shortest possible time. “Plyometric” is a combination of Greek words that literally means to increase measurement (plio = more; metric = measure). Practically defined, plyometric exercise is a quick, powerful movement using a pre-stretch or counter movement, which involves the stretch-shortening cycle (SSC). The purpose of plyometric exercise is to increase the power of subsequent movements by using both the natural elastic components of muscle and tendon, and the stretch reflex. To effectively use plyometrics as part of a training programme, it is important to understand: (1) the mechanics and physiology of plyometric exercise, (2) principles of plyometric programme design, and (3) methods of safely and effectively performing specific plyometric exercises. (Baechle et al. 2008).

For a muscle to cause movement it must shorten; this is known as a concentric contraction. There is a maximum amount of force with which a certain muscle can concentrically contract. However, if the muscle is lengthened
while loaded (eccentric contraction) just prior to the contraction, it will produce greater force through the storage of elastic energy. The quick transition from the eccentric to the concentric phase is known as the stretch shortening cycle (SSC), and is one of the underlying mechanisms of plyometric training. The force created by the muscle-tendon during the SSC is determined by the muscle's length and compliance. To increase power through plyometrics, two integral controlling aspects are required. These aspects include “a more rapid initial stretch, which generates more power in the muscle group moving in the opposite direction in the second phase of the action; and a shorter time between eccentric and concentric contractions (SSC)”.

The muscle spindles are involved in the stretch reflex and are triggered by rapid lengthening of the muscle as well as absolute length. At the end of the rapid eccentric contraction, the muscle has reached a great length at a high velocity. This may cause the muscle spindle to enact a powerful stretch reflex, further enhancing the power of the following concentric contraction. The muscle spindle's sensitivity to velocity is another reason why the amortization phase must be brief for a plyometric effect (Brooks, 1996).

A longer term neurological component involves training the muscles to contract more quickly and powerfully by altering the timing and firing rates of the motor units. During a normal contraction, motor units peak in a de-synchronized fashion until tetany is reached. Plyometric training conditions the
neurons to contract with a single powerful surge rather than several disorganized contractions. The result is a stronger, faster contraction allowing a heavy load (such as the body) to be moved quickly and forcefully.

Repeated use of plyometric exercises will gradually increase the efficiency of neuromuscular connections between brain and muscle. However, a fine balance must be used, if one wishes to build strength and power through plyometrics. It is often recommended that plyometric repetitions be no higher than 75-100 repetitions. Also, training with plyometric exercises more than three or four times per week can cause muscular degeneration, if proper nutrition and rest are not taken into account.

Plyometrics have been shown to have benefits for reducing lower-extremity injuries in team sports while combined with other neuromuscular training (i.e. strength training, balance training and stretching). Plyometric exercises involve an increased risk of injury due to the large forces generated during the training and performance, and should only be performed by well-conditioned individuals who are under supervision. Good levels of physical strength, flexibility, and proprioception should be achieved before the commencement of plyometric training.

The specified minimum strength requirement varies depending on where the information is sourced and the intensity of the plyometrics to be performed. **Chu (1998)** recommends that a participant should be able to perform 5 repetitions
of the squat exercise at 60% of his bodyweight before doing plyometrics. Core body (trunk) strength is also important.

1.2.1. PLYOMETRIC AND INTENSITY

Intensity is the effort involved in performing a given task. In plyometrics, intensity is controlled by the type of exercise performed. Plyometrics ranges from simple tasks to highly complex and stressful exercises. An activity can be carried out with different intensities, which will have different effect on the organism. Thus, the exercise load must have some minimum intensity in order to get the same effect on the organism. With the improvement in training state, the effective zone of intensity shifts to higher level. The intensity of plyometric exercises can be increased by raising the platform height for depth jumps, or simply by aiming at covering a greater distance in longitudinal jumps. Thus, the intensity of the exercise which is performed without any equipment is automatically related to one’s own body weight. These types of exercises, if properly planned, are of more effective for improving the motor fitness components.

Examples of lower body plyometric exercises with intensity level: standing based jumps performed on the spot (low intensity) such as tuck jumps and split jumps. Jumps from standing (low-medium intensity) such as standing long jump, standing hop and standing jump for height. Multiple jumps from standing (medium intensity) like bounds, bunny hops, double footed over low hurdle and double footed jumps up steps. Multiple jumps with run in (high intensity) like 11
stride run + 2 hops and a jump into sandpit and 2 stride run in + bounds. Depth jumping (high-very high intensity) variations of jumps down and up off box (40 to 100 cm), bounding up hill and Eccentric drop and hold drills like hop and hold, bound/hop over 30 meters (athletes stop and hold on each landing before springing into the next move), drop and hold from a height greater than one meter.

1.2.2. PLYOMETRIC FREQUENCY

Frequency is the number of times an exercise is performed (repetitions) as well as the number of times an exercise session takes place during a training cycle. Recovery is a key variable in determining whether plyometrics will succeed in developing power or muscular endurance.

Shaver (1982) stated that Physical training with frequency of three to five days per week is an optimal number of workouts for developing fitness levels. 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 three to five days per week. It is important, however not only to initially start out training every day of the week since chances are good that the individual after a couple of weeks, will become completely exhausted (mentally and physically), and will more than likely quit the programme. Since one of the major goals of an exercise programme is to make it not only intense enough to see some positive
results, but also to make it enjoyable enough to become it as a part of an individual’s routine life.

The frequency of the exercise sessions depends partly on the health and fitness level of the individual. Normal, sedentary individuals should exercise a minimum of three times a week to produce significant changes. As the fitness level increases, however, the frequency should be increased to five times a week for continued improvement. It may be maintained by exercising two to four days a week, providing the intensity and duration of workouts are similar to that used to achieve the current fitness level.

1.2.3. CONCEPTS OF PLYOMETRIC TRAINING

Plyometrics are training techniques used by athletes and players in all types of sports to increase strength and explosiveness. Plyometrics consists of a rapid stretching of a muscle in eccentric action immediately followed by a concentric or shortening action of the same muscle and connective tissues. The stored elastic energy within the muscle is used to produce more force that can be provided by a concentric action alone. Researchers have shown that plyometric training can contribute to the improvement in vertical jump performance, acceleration, leg strength, muscular power, increased joint awareness and overall proprioception. Plyometric drills usually involve stopping, starting and changing direction in an explosive manner. These movements are components that can assist in developing
agility. Agility is the ability to maintain or control body position which quickly changes the direction during a series of movements. Agility training is thought to be a re-enforcement of motor programming through neuromuscular conditioning and neural adaptation of muscle spindles, Golgi-tendon organs and joint proprioceptors. By enhancing balance and control of the body positions during movement, agility theoretically should improve.

Since the year 1960, coaches and scientists around the world have been searching for training means and measures to improve the storage and reuse of elastic energy in skeletal muscle during stretch shortening cycle (SSC). The so called plyometric exercises can do that. They are defined as exercises that activate the stretch shortening cycle of skeletal muscles, including the elastic, reflex and mechanical potentiating. Several factors interfere with this potentiating, changing the capacity to generate positive work during SSC. Among them, the most important are the amplitude and speed of the eccentric phase, as well as the coupling time between the eccentric and concentric phases. The most favorable situation in track and field combines small amplitude with high speed in the eccentric phase and a short coupling time.

Plyometric exercises train the muscles to carry out effectively the SSC, which is a pattern of muscle contraction, involving in a stretch of the muscle followed immediately by an explosive contraction. Plyometric training is a method of developing explosive power, and ultimately improving athletic performance.
Plyometric exercises include jumps, hops, skips, bounds and throws. Although plyometric have long been practiced in athletic training and conditioning, the term did not appear in the literature until 1960’s. Research has shown that the plyometric training in varied intensities can elicit greater performance and can improve maximal strength in athletes who have not previously participated in plyometric training.

Two considerations regarding training level are important when structuring a plyometric training programme: the intensity level of the exercise and the experience of the players. Plyometric training should be a progression of exercises and skilled movements that are considered to be elementary, intermediate and advanced in scope. Plyometric training is used for the lower body, upper body and core to enhance speed of movement in more specific skills. Plyometric training helps athletes learn greater balance, co-ordination, quickness, agility, speed and power.

Plyometric training can take many forms, including jump training for the lower extremities and medicine ball exercises for the upper extremities. Each jump training exercises were classified according to the relative demands they placed on the athlete. All the exercises are progressive in nature, with a range of low to high intensity in each type of exercise.

The classifications of exercises are jumps in place; standing jumps; multiple hops and jumps, bounding, box drills and depth jumps. Age, experience and
athletic maturity are all important criteria in establishing and modifying plyometric training. Plyometric training can be adapted to virtually every sport, and athletes should do exercises that help to enhance the movements they perform. By mimicking certain movements in plyometric training, athletes can decrease movement time and become more powerful.

Plyometric training should be considered in the context of the athlete’s age, skills levels, injury history, and a myriad of other variables that comprise his or her athletic development. In this way through applied research, practitioners can learn to establish realistic expectations.

1.2.4. TYPES OF PLYOMETRIC EXERCISES

A systematic and progressive plyometric training programme is a vital component of any integrated training programme. As plyometric training is one of the more advanced training tools, the athlete needs proper levels of flexibility, core strength, and balance before progressing into plyometric training. Sports Performance Professionals must follow very specific program guideline, proper exercise selection criteria, and detailed program variables for the best outcome and lowest risk of injury.

As with all training programs, overload will need to be considered with plyometrics. Increasing the stretch load increases intensity. This can be accomplished by using body weight over a greater jump distance or drop height.
Progressing from two-legged to one-legged jumps also increases intensity. As the athlete progresses, the duration of the amortization phase should be as brief as possible. The number of foot contacts monitors training volume; the more contacts, the greater the training volume. As always, training volume is inversely related to training intensity. Potach and Chu (2000) offer the following suggestions for a single training session: low-intensity training – 400 foot contacts; medium-intensity training – 350 foot contacts; high-intensity training – 300 foot contacts; very-high-intensity training – 200 foot contacts. Experience should also be considered when prescribing plyometrics. Athletes with minimal experience using plyometrics should keep the ground contacts to less than 100 maximal efforts per session, whereas those with considerable experience could have as many as 120–140 maximal effort ground contacts per session.

The Optimum Performance Training model provides a systematic, progressive and integrated plyometric training programme to safely and effectively progress an athlete through this portion of their programme.

1.2.5. PLYOMETRIC STABILIZATION EXERCISES

Plyometric exercises are designed to establish optimum landing mechanics, postural alignment and reactive neuromuscular efficiency. Exercises in the stabilization level of plyometric training involve little joint motion. Upon landing,
the athlete should hold the landing position (or stabilize) for 3–5 seconds before repeating.

1.2.6. PLYOMETRIC STRENGTH EXERCISES

Plyometric exercises are designed to improve dynamic joint stabilization, eccentric strength, rate of force production and neuromuscular efficiency of the entire human movement system. These exercises are performed in a more repetitive fashion by spending a shorter amount of time on the ground.

In the strength level of plyometric training, exercises are more dynamic, requiring eccentric and concentric movement throughout the full range of motion. The specificity, speed and neural demands are also progressed within this level. Exercises in this level can also be performed in all three planes of motion.

1.2.7. PLYOMETRIC POWER EXERCISES

Plyometric exercises are performed as fast and as explosively as possible. In the power level of plyometric training, exercises involve the entire spectrum of muscle actions and contraction velocities important for integrated, functional movement. These exercises are designed to improve the rate of force production, eccentric strength, reactive strength, reactive joint stabilization, dynamic neuromuscular efficiency, and optimum force production.
1.2.8. UPPER BODY PLYOMETRIC EXERCISES

When one hears the word plyometrics, the first thought that comes to mind is some type of jumping movements: for example, on hand off boxes of various heights. Plyometric exercises take advantages of a phenomenon known as the stretch-shortening cycle (SSC).

In brief, when a muscle is stretched very rapidly in an eccentric fashion, immediately prior to a concentric shortening (rebounds), stored elastic energy and neural mechanisms cause the resultant concentric contraction, to be more forceful than, if the rapid stretching of the muscle not occur. The SSC phenomenon can be seen in a vertical jump test. A person performing a vertical jump test will always achieve a higher jump with a preceding counter movement.

Plyometrics are often performed as a shock method to increase power and explosiveness. For example, jumpers in track and field often employ lower body plyometric exercise in order to increase their power capabilities which are crucial to success in jumping. However, plyometric exercises for the upper body receive less attention. Certainly, the performance of many athletes would benefit from implementing upper body plyometric training into their routine (Joseph et al. 2007). Press ups and hand clap: Press-ups with a hand clap in between is a particularly vigorous way to condition the arms and chest. The pre-stretch takes place as the hands arrive back on the ground and the chest sinks and this is followed quickly by the explosive upward action. Once again, to get the best
training effect, the time should be kept in contact with the ground to a maximum.

Medicine Ball: Another means of increasing upper body strength popular with throwers is to lie on the ground face up. A partner then drops a medicine ball down towards the chest of the athlete, who catches the ball (pre-stretch) and immediately throws it back. This is another high-intensity exercise and should only be used after some basic conditioning.

Plyometric training enables an athlete to apply more force in a shorter time span. This increases the performance in the split instant he has to perform in an on field situation. It is one of the most effective methods of increasing power in an athlete which is extremely important in modern sport. To be most beneficial plyometric training, should follow a phase of maximal strength training. The more the maximal strength of an athlete the more it can be used for generating power in his body for his chosen sport through plyometric training.

Certain sports require upper body plyometric training like the throwing events in athletics, basketball, volleyball, football, softball, golf, baseball, tennis and badminton. These kinds of exercises generally make use of a medicine ball. There are both low and high intensity plyometric exercises. Skipping is a low intensity exercise for example and reactive drop jumps are of the high intensity variety. A programme should move from low intensity to high intensity drills especially for beginners to this variety of training. A proper warm up is necessary for all plyometric exercise programmes. This can be through jogging which may
be either straight legged or toe based. Without a proper warm up the pressure of plyometric exercise may cause damage to the body. Proper rest intervals between repetitions and depth jumps are required to ensure proper recovery of the muscles as well. Balance is also a major factor in the proper and safe performance of plyometric exercises.

1.2.9. LOWER BODY PLYOMETRIC EXERCISES

Plyometric exercises involve an increased risk of injury due to the large forces generated during training and performance, and should only be performed by well-conditioned individuals who are under supervision. Good levels of physical strength, flexibility and proprioception should be achieved before the commencement of plyometric training. The specified minimum strength requirement varies depending on where the information is sourced and the intensity of the plyometrics to be performed. Flexibility is required both for injury prevention and to enhance the effect of the stretch shortening cycle. Proprioception is an important component of balance, coordination and agility, which are also required for safe performance of plyometric exercise.

The drop jumping exercise involves the athlete dropping (not jumping) to the ground from a raised platform or box, and then immediately jumping up. The drop down gives the pre-stretch to the leg muscles and the vigorous drive upwards, the secondary concentric contraction. The exercise will be more effective, the
shorter the time the feet are in contact with the ground. The loading in this exercise is governed by the height of the drop that should be in the region of 30 to 80 cm. Drop jumping is a relatively high impact form of plyometric training and would normally be introduced after the athlete becomes accustomed to lower impact alternatives, such as two-footed jumping on the spot.

The bounding and hurdling exercises with forward motion is more effective in the name of the game. This is a form of plyometric training, where over sized strides are used in the running action and extra time spent in the air. Two-legged bounds reduce the impact to be endured, but to increase the intensity, one legged bounding, or hopping, can be used. Bounding upstairs is a useful way to work on both the vertical and horizontal aspects of the running action. Multiple jumps over a series of obstacles like hurdles are valuable drills for athletes training for sprinting or jumping events.

1.2.10. PHYSIOLOGICAL PRINCIPLES OF PLYOMETRIC TRAINING

Plyometric training utilizes the elastic and proprioceptive properties of a muscle to generate maximum force production (Wilk et al. (1993), Voight and Wieder (1991). By stimulating mechanoreceptors to facilitate an increase in muscle recruitment in a minimal amount of time. Muscle spindles and Golgi tendon organs (GTOs) provide the proprioceptive basis for plyometric training. The central nervous system then uses this sensory information to influence muscle
tone, motor execution and kinesthetic awareness (Lundin, 1985). Stimulation of
these receptors can cause facilitation, inhibition and modulation of both agonist
and antagonist muscle activity. This enhances neuromuscular efficiency and
functional strength (Astrand, 2003; Jacobson, 1670; O’Connell, Gardner, 1972;
Schmidt, 1982; Swash and Fox, 1972).

The concept of plyometrics is based on the three-component model of
muscle. Muscle is modeled with a contractile element and two elastic elements
that are named according to their relationship to the contractile element, one in
line with (the series elastic element) and one in parallel (the parallel elastic
element). When a muscle contracts, tension is not directly transmitted to the ends
of the tendon and the load is not overcome, leading to movement. This would only
happen if the connection between the contractile element and its insertion were
rigid and inelastic. In reality, the contractile element develops tension, stretching
the series elastic element; the degree of stretch is dependent on the load to be
moved. After sufficient tension has been generated the tension at the ends of the
muscle is sufficient to overcome the load and the load is moved.

When a load is applied to a joint (eccentric phase), the elastic elements
stretch and store potential energy (amortization phase) prior to the contractile
element contracting (concentric phase). An eccentric contraction immediately
preceding a concentric contraction significantly increases the force generated
concentrically as a result of the storage of elastic potential energy (Bosco et al. 1982).

During the loading of the muscle, the load is transferred to the series elastic components and stored as elastic potential energy. The elastic elements then contribute to the overall force production by converting the stored elastic potential energy to kinetic energy, which enhances the contraction (Asmussen et al. 1974). The muscle’s ability to use the stored elastic potential energy is affected by the variables of time, magnitude of stretch and velocity of stretch. Increased force generation during the concentric contraction is the most effective when the preceding eccentric contraction is of short range and is performed without delay (Wilson et al. 1991).

A simple example of the use of the energy stored in the elastic element is the basic vertical or counter movement jump. The initial squat (the counter movement) is the eccentric phase that stretches the elastic elements and stores elastic energy (amortization phase). When the jump is performed (the concentric phase), the stored energy is “added” to the tension produced, leading to a higher jump. The amount of stored energy used is inversely proportional to the time spent in the amortization phase. When doing a vertical jump, the longer one waits at the end of the countermovement before performing the jump, the lower the eventual jump height due to the inability to recover the stored elastic energy.
The improved muscular performance that occurs with the pre-stretch in a muscle is the result of the combined effects of both the storage of elastic potential energy and the proprioceptive properties of the muscle. The percentage that each component contributes is unknown at this time, but the degree of muscular performance, as stated earlier, is dependent upon the time in transition from the eccentric to the concentric contraction. Training that enhances neuromuscular efficiency decreases the time between the eccentric and concentric contraction, thereby, improving performance. This can be accomplished through integrated training.

1.3. PHYSICAL FITNESS

Fitness is the capacity of heart, blood vessels, lungs and muscles to function at optimum efficiency (Mezzeo, 1985). Physical fitness is to the human body what fine tuning is to an engine. It is a physical state of wellbeing that allows people to perform daily activities with vigor, reduce their risk of health problems related to lack of physical activity and establish a base of fitness for participation in a variety of physical activities. It enables us to perform up to our potential. Fitness can be described as a condition that helps look, feel and do best (Daniel et al. 1993). More specially, it is: “the ability to endure, to bear up, to withstand stress, to carry on in circumstances where an unfit person could not continue, and is a major basis for good health and well-being.” People can only fulfill their potential when their
bodies are healthy and fit (Robert, 1993). Unfortunately, many people in our society are not healthy and are not getting sufficient physical activity in order to become physically fit.

The sports performance depends largely on physical fitness and motor fitness. Physical fitness can be differentiated into general and specific fitness. Each sports activity demands different types and levels of motor abilities, and when a sportsman possesses these, he is said to have the specific physical fitness of various motor abilities, regardless of any sports which the sportsman possesses. The contribution of physical fitness towards sports performance is indirect. But it should never be overlooked that specific physical fitness depends largely on the general physical fitness.

The decision to carry out a physical fitness programme cannot be taken lightly. It requires a lifelong commitment of time and effort. Exercise must become an activity that one does without question, like bathing and brushing the teeth. Unless one is convinced of the benefits of fitness and the risk of unfitness, will not succeed. It has been realized that fitness adds not only years to one’s life, but life to one’s years (Ajmer Singh, 2008).

Physical fitness plays an important role in all sports and games. At present the concept of physical fitness can be divided into two distinct categories, the health related physical fitness and the performance related physical fitness. Health related physical fitness components are strength, muscular endurance, cardio respiratory
endurance, body composition, flexibility and free from obesity. Performance related physical fitness includes components such as speed, strength, endurance, agility, explosive power, co-ordination, balance, etc.

1.3.1. THE COMPONENTS OF PHYSICAL FITNESS

Health is a state of complete mental, physical and social well being whereas fitness is the ability to meet the demands of a physical task. Basic fitness can be classified into four main components: strength, speed, stamina and flexibility. However, exercise scientists have identified nine components that comprise the definition of fitness (Tancred, 1995).

i. **Strength** - the extent to which muscles can exert force by contracting against resistance (e.g. holding or restraining an object or person)

ii. **Power** - the ability to exert maximum muscular contraction instantly in an explosive burst of movements. The two components of power are strength and speed. (e.g. jumping or a sprint start)

iii. **Agility** - the ability to perform a series of explosive power movements in rapid succession in opposite directions (e.g. Zigzag running or cutting movements)

iv. **Balance** - the ability to control the body's position, either in stationary (e.g. a handstand) or while moving (e.g. a gymnastics stunt)
v. **Flexibility** - the ability to achieve an extended range of motion without being impeded by excess tissue, i.e. fat or muscle (e.g. executing a leg split)

vi. **Local Muscle Endurance** - a single muscle's ability to perform sustained work (e.g. rowing or cycling)

vii. **Cardiovascular Endurance** - the heart's ability to deliver blood to working muscles and their ability to use it (e.g. running long distances)

viii. **Strength Endurance** - a muscle's ability to perform a maximum contraction time after time (e.g. continuous explosive rebounding through an entire basketball game)

ix. **Co-ordination** - the ability to integrate the above listed components so that effective movements are achieved.

Of all the nine elements of fitness cardiac respiratory qualities are the most important to develop as they enhance all the other components of the conditioning equation.

**Physical Fitness**

Physical fitness refers to the capacity of an athlete to meet the varied physical demands of their sport without reducing the athlete to a fatigued state. The components of physical fitness are speed, endurance, flexibility, strength and body composition *(Davis, 2000)*.
Motor Fitness

Motor Fitness refers to the ability of an athlete to perform successfully at their sport. The components of motor fitness are agility, balance, co-ordination, power (speed and strength) and reaction time (Davis, 2000).

1.4. THE GAME SOCCER

“Soccer is a game which calls for strenuous, continuous thrilling action and therefore, appeals to the youth worldwide. The skills involved in the game are simple, natural and yet are highly stimulating and satisfying to any one who participates in the game”. Football as it is popularly called in India is a game where the foot is used much more than any part of the body. Bernard Shaw’s comment underlines this reality that “Footballers think with their feet”.

The game of soccer is very complicated in terms of skills and teamwork. Control of the soccer is perfected by the development of fundamental skills like dribbling, passing, kicking, trapping, shooting, tackling, heading etc. The unpredictability of the action sequences fosters imaginations of a kind that can be transformed instantly into physical movements.

The game soccer is both an art and science. There is a distinction, which gives a speciality to soccer compared to that of other games. It is the natural behavior of human beings to use their hands and arms for doing almost all the activities. In all other games, hands are dominantly used. But in soccer, the use of
hands has been restricted which is only used for throw in (exception is given only to the Goal Keeper-that too inside the penalty area) and all the other parts of the body are allowed to play, especially the foot. Thus, when trying to control the ball using all the parts of the body except hand in order to score a goal, it becomes a beautiful game. It involves techniques of running, dribbling, passing, kicking, trapping, shooting, tackling, blocking, heading and juggling. All these activities have to be performed at a great speed. Though these individual skills are very important, it should not be forgotten that it is a team game and the players have to work together in offence or defense. A player must therefore, develop his skill and should understand his contribution according to the situation demands in the team play. Therefore, working in a competitive situation can develop the skills, though individual practice is necessary. The game of football contains physical challenges. Though two players may be equal in their skill, because of different physical and mental response, there can be much difference in their performance. A player must be quick in assessing a situation and thus to respond rapidly. A forward has to decide between a pass and shot; a defender between marking and covering and a goalkeeper has to decide whether to advance or to be in the goal. A player may specialize for play in a particular position. It is better if he develops skills necessary for other positions. All the players should be aware of both the attacking and defensive principles of play. A player must learn from his own observations and mistakes.
The skills acquired will be of little use without fitness necessary to carry them out in a game. Soccer requires a fairly high standard of fitness along with skill. The important motor fitness components are speed, agility, flexibility, strength, endurance and power. The game of soccer demands a level of fitness that will enable the player to run strongly to move quickly off the mark in any direction, to control and pass accurately and to tackle effectively throughout the game.

All desire a system of training that will produce the most rapid increase in speed, agility, strength, endurance and co-ordination within a limited period of time. A great deal of controversy exists among coaches and athletes today as to what is the most efficient training programme for the improvement of motor skills performance. Some of the systems followed nowadays are experimentally supported, some are traditional and some are highly controversial.

There is evidence of more systematic training and selection, influencing the motor fitness components of players who compete at the highest level. Fitness is being optimized to cope with match demands while accommodating the need for specific requirements of positional roles and skill performance of soccer players (James, 1984).

All sports involve some kind of the application of skills like cognitive, intellectual, perceptual or motor. Soccer involves all the three-skill types operating simultaneously in a rapid changing environment. Soccer skills involve making correct decisions and then executing that which has been decided upon. A
technical practice involves players working in isolation on the various aspects of the game such as dribbling, passing, shooting, and ball control. The execution of a technique or soccer action such as dribbling or passing is a part of skilled performance essential but relatively valueless as lone facet. The players are judged to be truly skillful in the game of football when they can make the best decisions about where and when to play the ball and then to perform the skill accurately.

1.4.1. SOCCER TECHNIQUES

Technique can generally be termed as embracing the methods used in the execution of all the movements in the sport concerned. Each sport has its own special technique. Special technique implies not only the specific movements necessary for the sport concerned, but all the related general and complementary movement, such as running and jumping. A soccer technique covers all the methods of executing the movements that can occur when plying.

Technique in soccer is of fundamental importance. In particular it is indispensable to be familiar with all the movements carried out when in possession of the ball. It is possible for a player to continue playing reasonably while not in absolutely top condition physically, and even knowledge of tactics is not absolutely indispensable. By saying so, one cannot underestimate the significance of these important elements; to emphasize the fundamental importance of
technique, however, it is necessary to examine the relationship of all the three elements and determine the sequence of importance. One cannot intend to consider technique as the only suitable weapon to be adopted in soccer, particularly in competitive soccer, especially when players and the combative character of the game itself are becoming more closely associated with each other than ever before.

The primary characteristic of soccer technique is the fact that it can be observed directly; it is perceptible. While physical condition and the varieties of the tactics used may only be obvious to an expert, the degree of technical preparedness of a player can be judged by a layman: he can do so from the player’s control exercised over the ball, the length of a header or a kick, or from the ball-handling of the goalkeeper. Since technique is a direct experience, players are too willing to acquire and develop it. There is a great deal of pleasure in exercises with the ball than in training to develop condition and tactical sense. Therefore, the methods adopted by some coaches, using the ball in many of the tactical and conditioning exercises are completely justified. In many cases, the soccer players of today use the ball even in warming up exercises.

It is not easy to acquire an adequate level of soccer technique, perhaps because it is related to heavier limps. Naturally, this does not apply to the technique of goalkeeping which has its own characteristics. In mastering
technique, players are generally hampered by the uneven ground and the fact that, with the exception of the goalkeeper, they are usually in possession of the ball only for a few seconds at a time.

By doing the same exercises day after day, a technical element can become a habit; it can teach almost complete perfection after some time. Many players are capable of performing tricks with the ball which reach exhibition standard, but they fail to demonstrate the same skills in the actual game. During the game these skills disappear and the admired ball juggler is often reduced to the level of an average player. Technique, like anything else, does not exist for its own sake. When developing technique, we must always have in mind the principle of applicability. Technical knowledge should be acquired in such a way that players will automatically or naturally make use of it in the course of the game.

1.4.2. CATEGORIES OF SOCCER TECHNIQUES

Movements in soccer are rather complex. It is difficult to establish a system of movements, since partial movement and technical elements are infect processes linked together in the complex development of the play. They very rarely occur in isolation.

For the sake of comprehensibility, the essential elements of soccer technique are divided into two groups; movements without the ball and
movements with the ball. Movements without the ball are running and changing of direction, jumping, feinting without the ball (Body feint)

The eight elements that fall within group two are kicking, receiving the ball, heading, dribbling, feinting, tackling, throwing–in and technique of goalkeeping; defensive and offensive. All the movements with the ball in soccer can be classified into these eight groups.

1.5. PLYOMETRIC TRAINING AND MOTOR FITNESS

Research shows that motor fitness is essential to soccer players to improve the skill performance. For soccer players speed, agility, flexibility, strength and endurance are the most important motor fitness components. They must be strong, flexible and rigid for some time to withstand physical contact. The game of soccer involves heavy body contact with the opponents. So, the nature of the game requires unusual speed, agility, flexibility, strength, endurance and power to perform well (Conard, 1960).

Plyometrics is the term given to exercises designed to increase the power of an athlete. It is defined as the equivalent of explosive strength (Brukner and Khan, 2001) and referred to by others as “speed-strength” (Young and Bilby, 1993).

Sharkey (1986) described plyometric exercise as explosive callisthenic-like exercises which involve the conditioning of the neuromuscular system to permit
faster and more powerful changes of direction such as moving from up and down in jumping and of switching leg positions as in running.

1.6. PLYOMETRIC AND SOCCER TECHNIQUES

Creating a sport-specific programme, it requires understanding the mechanics of the sport by doing needs analysis and breaking down skill patterns into their most elementary parts. In plyometric training for soccer players 80 per cent of total foot contacts should apply to activities that closely resemble the skills necessary for success in the sport; the remaining 20 per cent can apply to general conditioning.

In other sports, such as basketball, volleyball and tennis various jump drills can be integrated with skill patterns to approximate what happens on the court or field.

Kicking is a fundamental and versatile technique used for passing, shooting and clearing. True soccer players refer to it as striking the ball because it sounds more controlled.

An important skill in the game of soccer is the ability to kick the ball forcefully and accurately. The kick with run-up produces longer and more powerful kicks than the standing kick. An important aspect of the soccer kick is the interplay between the various muscle groups active in the skill. The agonists contract to initiate the movement at each of the joints, but these muscles become the
antagonists to slow the rapid angular movements at the joints just prior to or following the release of the ball (Dufou et al. 1988).

Passing is the life of soccer. The renowned soccer players are noted for their outstanding ability to pass. To pass the ball to an apt player at right time is one of the most important qualities of a soccer player.

Soccer is performed by men, women, children and adults with different levels of expertise. One of the reasons that the soccer is so popular worldwide is that the players may not need to have an extraordinary capacity within any of the performance areas, but possess a reasonable level within all areas. As with other activities, soccer is not a science, but science may help to improve the performance of soccer. Efforts to improve soccer performance often focus on techniques and tactics at the expense of physical fitness. During a 90-minute game, elite level players run about 10 kilometers at an average intensity close to the anaerobic threshold (80-90% of maximal heart rate). Within this endurance context, numerous explosive bursts of activity are required, including jumping, kicking, tackling, turning, sprinting, and changing pace and sustaining forceful contractions to maintain balance and control of the ball against defensive pressure (Stolen et al. 2005). According to Farfel (1960), all sports disciplines may be divided into three groups, depending on the level of movement co-ordination. Soccer is one of the most difficult disciplines which require accurate and rapid movement under changing conditions. Techniques, or sports-specific technical
skills, are a central component in the development of young athletes in many sports, including soccer. Technique refers to the relationship and harmony a player demonstrates with the ball and the performance of a solitary action in isolation from the game, e.g. passing or dribbling (Bate, 1996).

Specific physical and physiological characteristics of soccer players can be used by coaches to modify the training programmes and to help players prepare for the game strategy. The modern soccer relies on the ability of all the players to attack and defend whenever necessary. Therefore, it is important that all the players achieve a high level of performance in the basic skills of dribbling, kicking, passing, trapping, tackling and heading (Tiryaki et al. 1996).

In soccer, as in most sports, physical preparation begins after the athlete can begin to profit from it. Some studies have shown that resistant training can begin before the onset of puberty; everyone agrees that the post pubertal athlete will benefit from physical training. This means that by 13 years of age, athlete on the fast track should be engaged by a structured programme of physical training. The reality is that most young athletes do not start serious physical training until they reach high school (Philips, 2000).

The competitiveness of athletics has dictated that the athletes become faster, stronger and bigger to keep up with the demands of their sport. Plyometric exercise is one such area that has been shown to increase strength and explosiveness in athletes. Various sports such as soccer, tennis, golf, volleyball,
running and basketball, as well as others use this as a tool for physical training (Shaffer, 2007).

1.7. REASON FOR SELECTING THE STUDY

Nowadays all the soccer players are facing some unique challenges to develop the required motor fitness level to execute soccer techniques while playing or in game situation. The techniques of soccer players fully depend on the important motor fitness components like speed, agility, flexibility, strength, endurance, etc.

Though there are several training methods, which are recommended for the improvement of soccer techniques, the plyometric training for soccer has not been conducted in an exhaustive manner in India. Nowadays all the soccer players are having good physique, but they differ in physiological levels. We cannot control the physiological level of an individual. Any type of problem which is faced by a soccer player may automatically disturb his physiological level and performance.

Therefore, the investigator reviewed several literatures and found that there was no study conducted on different intensities of plyometric training on soccer techniques. In order to know the effect of varied intensities of plyometric training on motor fitness components and soccer techniques, the investigator has selected this study. So, the findings of this study will definitely help to understand the
importance of plyometric training over soccer techniques of junior players, especially in Indian conditions.

1.8. STATEMENT OF THE PROBLEM

1. The primary purpose of this study was to find out the effect of plyometric training over motor fitness and soccer techniques of junior players.

2. The secondary aim of this study was to compare the effect of intensity manipulation of a 12 weeks plyometric training programme on motor fitness and soccer techniques of junior players.

1.9. OBJECTIVES OF THE STUDY

The present study was designed with the following objectives.

1. To find out the improvement due to the effect of plyometric training on motor fitness components.

2. To evaluate the improvement over soccer techniques due to plyometric training.

3. To assess the difference in improvement by varied intensities of plyometric training.

4. To find out suitable intensity of plyometric training to bring out desirable changes over motor fitness and soccer techniques of junior players.
5. To create awareness regarding the enhancement of fitness and performance due to plyometric training.

**1.10. SIGNIFICANCE OF THE STUDY**

Junior soccer players are being educated to become real soccer players. They have to learn the ingredients of the game during their junior years. A series of characteristics are important to become a soccer player, and technical level is the most important among them.

The finding of this study will be of significance in the following ways:

1. The finding of the study may add to the existing fund of knowledge with regard to the plyometric training to improve the motor fitness of junior soccer players.

2. The finding of this study will add to the quantum of knowledge in the level of improvement in soccer techniques of junior players.

3. This study may help the soccer players to prepare for future competitions.

4. This study can provide guidelines for the soccer coaches and physical education teachers to understand the importance of plyometric training in order to improve the soccer techniques of the junior level soccer players.

5. The study can give information to soccer coaches to add plyometric training in the regular training programme in order to improve motor fitness components of the soccer players.
6. The contribution of this study would bring healthy fit society in India.

7. This study may help the future research scholars to select the problem relating to the study.

8. This study can give special knowledge to the fitness experts, health consultants, conditioning experts and athletes of different levels of performance and achievement with reference to plyometric training.

9. This study can also provide guidelines for the coaches of various sports and games to construct a plyometric training programme that may contribute very much to the technical and physical characteristics of their players.

1.11. HYPOTHESES

It has been widely accepted that the plyometric training helps in the promotion of motor fitness, in developing the techniques and in the enhancement of performance. Although regular plyometric training has a positive influence on motor fitness, high level systematic plyometric training has a greater impact. Based on the concept, the following hypotheses have been formulated.

1. It was hypothesized that the changes made on motor fitness components of junior soccer players from the base line to post treatment of varied intensities of plyometric training would not be a significant one.

2. It was hypothesized that the varied intensities of (low, medium, high) plyometric training would not produce significant changes over soccer techniques of junior players.
3. It was also hypothesized that varied intensities of plyometric training (low, medium, high) would not produce similar changes over motor fitness components and soccer techniques of junior players.

4. Further, it was hypothesized that the medium intensity of plyometric training would not produce significant changes over motor fitness and soccer techniques than low and high intensity of plyometric training.

1.12. DELIMITATIONS

The study was delimited to the following aspects.

1. The study was restricted to randomly selected 120 male soccer players from Government Boys Higher Secondary School, Manjeri, Hidayathul Muslimin Yatheemkhana Higher Secondary School, Manjeri, M S P Higher Secondary School, Malappuram and Govt. Higher Secondary School, Pookottur in Malappuram district of Kerala State during the academic year 2011-2012.

2. The age of the subjects ranged from 15 to 17 years and all the subjects were healthy and normal.

3. The number of experimental groups for the study was delimited to four, named as experimental group-I (low intensity plyometric training group), experimental group-II (medium intensity plyometric training group), experimental group-III (high intensity plyometric training group) and group
IV acted as control. The number of subjects in each group was confined to thirty only.

4. The study was restricted to plyometric training with three variations in intensity (low, medium and high). The duration of the training period was restricted to twelve weeks and the number of sessions per week was confined to three, which was considered adequate enough to cause changes in motor fitness components and technique performance variables of the soccer players.

5. The criterion variables chosen for the present study were confined to the motor fitness components such as speed, agility, flexibility, leg strength and cardio respiratory endurance and soccer techniques such as dribbling, passing, kicking, trapping and shooting.

1.13. LIMITATIONS

The following uncontrollable factors associated with the study were accounted as limitations of the study.

1. Meteorological factors such as atmospheric temperature, relative humidity and wind velocity may had an impact on the subjects during the training and testing periods, which could not be controlled.

2. The previous experience of the subjects in the field of sports and games, which might be influencing on the plyometric training were not considered.
3. Though all the subjects were residing in the different atmospheric conditions, no effort was made to control or assess the quality and quantity of their food intake and lifestyles.

4. The subjects’ socio-economic status, health habits and family background were not taken into consideration.

5. Though the subjects were motivated verbally, no attempt was made to differentiate the motivation level during the period of training and testing.

1.14. DEFINITION OF TECHNICAL TERMS

TRAINING

Training is a pedagogical process, based on scientific principles, aiming at preparing sportsmen for higher performance in sports competitions (Singh, 1991).

PLYOMETRICS

Plyometric exercise refers to those activities that enable a muscle to reach maximal force in the shortest possible time. “Plyometric” is a combination of Greek words that literally means to increase measurement (plio = more; metric = measure). Practically defined, plyometric exercise is a quick, powerful movement using a pre-stretch, or counter movement, that involves the stretch-shortening cycle (SSC) (Baechle et al. 2008)
PLYOMETRIC TRAINING

**Plyometrics** (also known as "plyos") is a type of exercise training designed to produce fast, powerful movements, and improve the functions of the nervous system, generally for the purpose of improving performance in sports. *(Baechle et al. 2008)*

**SOCCER**

Soccer is a game in which there are eleven players in a side and one of them shall be a goalkeeper. The ball is round and is to be kicked through the goal posts under the cross bar and no handling of the ball is allowed except by the goalkeeper.

Soccer is a game in which the ball is propelled towards the goal by skillful advancing and controlling it with feet, body and head *(Jeffery, 1970)*.

**INTENSITY**

Intensity is expressed as a percentage of load or IRM. “It is the rate of doing work. In other words, it is the pace at which physical activity is done” *(Bompa, 1999)*.

**LOW INTENSITY**

In the present study 50-65% of plyometrics exercises, performed is known as low intensity *(Piper and Erdmann 1998)*.
MEDIUM INTENSITY

In the present study 65-80% of plyometrics exercises, performed is known as medium intensity (Piper and Erdmann 1998).

HIGH INTENSITY

In the present study 80-95% of plyometrics exercises, performed is known as high intensity (Piper and Erdmann 1998).

MOTOR FITNESS

Motor fitness is ‘the ability of an athlete to perform successfully at their sport’. (Corbin and Noble, 1980).

Motor fitness may be defined as a readiness or preparedness for performance by muscle activity without fatigue. It concerns the capacity to move the body efficiently with force over a responsible length of time (Bucher and Prentice, 1985).

SPEED

Speed is defined as the capacity of the individual to perform successive movements of the same pattern at the faster rate (Johnson and Stolbery, 1976).

Gabbard (1987) and others defined speed as the ability to move from one pace to practice for technique and movement efficiency.
AGILITY

Agility is the ability to change the direction of the body in an efficient and effective manner (Prentice, 1994).

FLEXIBILITY

Flexibility is the range of motion around a joint. Good flexibility in the joint can help to prevent injuries through all stages of life. (Johnson and Nelson, 1982)

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).

Leg strength is the capacity of the lower limbs to exert muscular force (Baumgartner and Jackson, 1987).

CARDIO RESPIRATORY ENDURANCE

Cardio respiratory endurance is the ability of the lungs and heart to take in and transport adequate amounts of oxygen to working muscles which allow activities involving large muscle groups to be sustained for a long period of time (Foss et al. 1993).
It is the ability of the heart and lungs to work at optimal efficiency during continuous exercise (William, 1994).

**SKILL**

According to McGee (1989), skill is an art, craft science or similar aspects involving the hands or body.

**Dribbling**

Dribbling is nothing more than moving with the ball across the field. It is a skill used to relocate a player into desirable positions where he can shoot or pass the ball (Kugler et al. 1988).

**Passing**

Passing may be defined as “propelling the ball to a teammate in a fashion that enables the receiver to control the ball (Reilly, Lees, Davids and Murphy).

**Kicking**

Kicking is a fundamental and versatile technique used for passing, shooting and clearing. True footballers refer to it as striking the ball because it sounds more controlled (Dufour et al. 1988).
TRAPPING

Effective trapping does not end with the control of the ball. Ball control is achieved by maintaining a delicate balance on one foot while bringing the ball to a rest with the other foot (Encarta, 2007).

SHOOTING

Shooting of the goal is an attempt to send the ball directly into the opponent’s goal post, with the aim to score. It is based on individual and collective action (Isokawa and Lees, 1988).