CHAPTER I

INTRODUCTION

Sport training is a systematic process extending over a long period. For best result the system of training has to be based and conducted on scientific facts and lines where it is not possible to do that, the training has to be based on the results « successful practice which has withstood the test of time sport.

Physical training aims at improving the performance of sports persons. The sports performance depends on several factors. The performance of a sports primarily depends on his performance capacity, such as speed, strength and endurance. All these factors therefore are the principle aims of physical training.

Sport training is a physical, technical, moral and intellectual participation of with the help of physical exercises. It is a planned process for the participation of athlete and players to achieve top-level performance.

Training is much like constructing a multi storey building. One needs for the building such as aerobic, anaerobic running, comprehensive conditioning, flexibility, etc. several kinds of materials like training intensities and modalities should be utilized in an on going process to complete the goal of
finished buildings or competitively fit athlete. Depending on the progress in the construction plan, the relative mix of all these materials will vary. As a training season develops, compressive conditioning work for strength of endurance will gradually form a transition into an emphasis on power with a substitution of intensity of volume in determining the total load.

1.1 CONCEPT OF SPORTS TRAINING

It must be understood on a wider sense since physical exercises undoubtedly are the principle means to improving performance. But the sports performance is improved by other means also which should be included in the concept of sports training. Such means, which are most commonly used along with physical exercise, are theoretical instructions, discussions, tasks of observations, physiotherapeutic measures for recovery from fatigue, psycho regulative procedures and so on. These means and the physical exercises, actual training process are used in a complex integrated manner. In reality, we cannot separate physical exercises from other means. Hence the concept of sports training must include all the means for the improvement of performance. The sports training therefore is the total process of preparation of a sportsman, through different means and forms for better performance. Sports performance is the result and
expression of the total personality of the sportsman's physical fitness, technique and tactics. In addition to that, the sportsman must possess certain cognitive, volitional and perceptual activities, certain personality traits, habits and above all positive belief, values, attitude and interest of training and competition. Therefore, sport training also aims at better education of the sportsman. The educational aspects of sports training is unfortunately often overlooked by the coaches and physical education teachers in India. Performance improvement is stressed more at the cost of education of sportsman. The pedagogical aspect of sports training comes into sharp focus. When we consider that in performance sports, the systematic training in almost all the sports has to start from childhood. Therefore, it becomes all the more important to educate the child and youth along with improving their performance through sports training. Training involves periodic assessment of the athlete's status and progress. Training usually varies regular increase in the difficulty of task performance. Training suggests some form of gradual increase in performance output over an extended period of time. Most kind of training needs regular repeated and collected trait repetition of some of the original movements. Any invariable raining implies hard work. Training should be associated with good health.
1.2 PLYOMETRIC TRAINING

Plyometrics refers to exercises that enable a muscle to reach maximal strength in as short a time as possible. Such exercise usually involve some form of jumping, but other modes of exercise exist. The elements ply and metric come from Latin roots for ‘increase” and “measure”, respectively; the combination thus means “measurable increase”. Plyometric exercise utilize the force of gravity (e.g., you step off a box) to store energy in the muscles (potential energy). This energy is then utilized immediately in an opposite reaction (e.g., you immediately jump up, up on landing), so the natural elastic properties of the muscle will produce kinetic energy.

Elastic strength is the ability of muscle and connective tissues (muscle sheath and tensions tissues) to rapidly exert a force in order to produce maximal power in linear, vertical, lateral or combination movements. Plyometric exercises are especially useful in sport that require speed-strength. Speed strength is the ability to exert maximal force during high-speed movements. Sports that require speed-strength include track – and- field jumping, throwing and sprinting; volley ball, basketball, football, baseball, and diving (Which require maximal jumping ability); blocking and tackling in football; and rockets
sports, base ball and softball. (Which requires swinging movements). Plyometric for the upper body include medicine ball throws, catches and several type of push-ups. In depth jumps, a form of plyometric characterized by a shock, intensity level, have been shown to increase leg power and strength either on their own or in conjunction with resistance training. In depth jumping may not improve vertical jumping ability, however. In-depth jumps are performed by steeping off a box and jumping immediately upon landing. Box heights range from 0.3m to 0.9m with 0.5 being the norm for many athletes. Athletes weighing over 100kg should not perform in depth jump from over 0.5m.

The ability to rapidly apply force (reactive force) is the major goal of plyometric training. Plyometrics are used to apply an overload to the muscles with speed-strength as goal. Plyometrics should not be considered an end in themselves, but part of an overall program (Stretching, running, strength training, nutrition, etc....). After the athlete has begun a proper strength and conditioning program, plyometrics are used to develop speed strength. Chu. D (1984).

Speed and strength are integral components of fitness found in varying degrees in virtually all athletic movements. Simply put, the combination of speed and strength is power. For many
years coaches and athletes have sought to improve power in order to enhance performance. Throughout this century and no doubt long before, jumping, bounding, and hopping exercises have been used in various ways to enhance athletic performance. In recent years, this distinct method of training for power or explosiveness has been termed plyometric.

Power is the ability to produce maximal muscular forces very rapidly, and is therefore very important in the game of rugby. Plyometric are specialist exercises that enable a muscle to reach maximal strength in a short space of time. This works by stretching a muscle and then relying on its elastic properties to produce greater forces that are normally possible in the reflex contraction which means muscle returns to it's resting length. In order to achieve this greater muscular force, the muscle must contract within the shortest possible time following lengthening. The following drills use dynamic movements to achieve such a stretch-shortening in a muscle, thus causing a faster concentric contraction of the muscle.

You need to ensure that your body is suitably developed and well trained before attempting such exercises. Technique is very important. If possible, try to spend some time with a coach who is experienced in such techniques as you begin to use them.
Individuals with a history of stress-induced injuries to the feet, ankle, shin, knees, hips or lower back should not perform plyometric activities without consulting a chartered physiotherapist.

Plyometric is one of the best ways to improve power. When a person performs a specific resistance movement, such as jumping, the fastest would be said to have more power. Therefore, power is not just the contraction of a muscle, but also how fast it contracts. Research has shown that a muscle will contract the fastest after it has been loaded. This is why you should be able to jump higher if you crouch down and then immediately jump up than if you have started from the crouch. Research has shown that practicing plyometric will decrease the time it takes for the muscles to contract resulting in more power.

Muscular power is determined by how long it takes for strength to be converted into speed. The ability to convert strength to speed in a very short time allows for athletic movements beyond what raw strength will allow. Thus an athlete who has strong legs and can perform the free weight squat with extremely heavy weights over a long duration may get less distance on a standing long jump or height on a vertical leap than a weaker athlete who is able to generate a smaller amount of force but in a
shorter amount of time. The plyometrically trained athlete may have a lower maximal force output, and thus may not squat as much, but his training allows him to shorten the amount of time required to reach his maximum force output, leading to more power from each contraction.

A plyometric exercise involves an eccentric contraction, a brief amortization phase which means no change in muscle length and a short concentric contraction delivering maximum force in a short period of time.

Plyometric is any exercise where the muscle is stretched (loaded) before it is contracted. A good example is push-ups with a clap between each push-up. Your muscles are elongated and loaded by the downward force of your body, then immediately you must contract the muscles to push yourself back up.

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 that is while loaded eccentric contraction just prior to the contraction, it will produce greater force through, "the storage of elastic energy. This effect requires that the transition time between eccentric contraction and concentric contraction or amortization phase be very short. This
energy dissipates rapidly, so the following concentric contraction must rapidly follow the eccentric stretch. The process is frequently referred to as the "stretch shortening cycle", and is one of the underlying mechanisms of plyometric training.

1.2.1 Neurological component

In addition to the elastic-recoil of the musculotendinous system there is a neurological component. The stretch shortening cycle affects the sensory response of the muscle spindles and Golgi tendon organs (GTO). It is believed that during plyometric exercise, the excitatory threshold of the GTO's is increased, making them less likely to send signals to limit force production when the muscle has increased tension. This facilitates greater contraction force than normal strength or power exercise, and thus greater training ability.

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.
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. **Chu D., (1998)**

1.3 MECHANICS OF PLYOMETRIC EXERCISE

To continue with the example mentioned earlier, if you were to stand on a box, step off, and, upon landing (with the knees flexing), immediately jump as high as possible, you would have performed a plyometric exercise (specifically, an in-depth jump). As soon as the balls of the feet touch the floor, the knees are quickly flexed, resulting in a rapid eccentric action of the quadriceps and hip extensors. A rapid deceleration (eccentric action) of a mass followed by a rapid acceleration (concentric contraction) of the mass in another direction is the basis of plyometric training. The rapid eccentric movement evokes the stretch reflex, or stretch-shortening cycle, which results in greater concentric contraction of the same muscles.
The main mechanism of the stretch reflex is the muscle spindle. Muscle spindles are sensory mechanisms located within intrafusal muscles that run parallel with extrafusal muscle fibers. Muscle spindles are sensitive to the rate and magnitude of a stretch. A sensory neuron from the muscle spindle innervates with a motor neuron in the spinal column. The motor neuron then causes a contraction in the muscle (extrafusal fibers) that was previously stretched. This process protects the muscle from excessive rapid stretching and injury.

The rate of the stretch is vital to plyometric training. A high stretch rate results in greater muscle tension and concentric contraction. Training movements that incorporate rapid eccentric movement (during sprinting, bounding, in-depth jumps, or lateral hops, for example), produce greater eccentric and concentric actions while one performs the exercise during a sport activity. The importance of the stretch rate may be illustrated by different vertical jump tests: a static squat jump, a countermovement with no steps, and an approach jump with several steps. A countermovement "rapid eccentric response followed immediately by a rapid concentric contraction. As the rate of stretch performance in these tests improves. The static squat jump will the shortest jump and the approach jump the highest.
The static squat jump does not utilize a counter movement (the countermovement involves the rapid eccentric response during the flexion of the ankles, knees, and hips) and the approach the utilizes a more forceful counter-movement only. Because plyometrics are active drills that produce high muscle tension (eccentric), the stretch reflex will produce a greater force than a concentric contraction from a static position not preceded by a stretch. During the stretch-shortening cycle (the result of the stimulation of the stretch reflex), the muscles and tendons elongate. It is during the elongation that the elastic tendencies of the muscle develops stored energy. If the eccentric response is followed immediately by a concentric contraction, the force produced by the concentric contraction will be increased. Speed-strength is thus increased.

The three main components of a plyometric drill are the eccentric phase, the amortization phase, and the concentric contraction. The amortization phase is the period of time from the initiation of the eccentric phase (touching the surface) to the initiation of the concentric contraction (start of the upward motion of the jump). As a result, the muscles in the leg become like a rapidly stretched rubber band. The "stretched rubber band" will result in a greater ability to develop power. In other words, the muscles are being trained to become more explosive.
To take advantage of the stretch reflex, keep the amortization phase as brief as possible (11). Remember, the rate of stretch is more important than the magnitude. Greater power is produced when the depth of the countermovement is short and rapid rather than large and slow.

Besides in-depth jumps, there are other types of plyometric drills with various intensity levels and directions, movements; these will be explained later. Jumping, hopping, skipping, and even running involve some degree of a stretch-shortening movement, in that all of them utilize a countermovement of varying degree. Examples of the countermovement in sports are a basketball player's preparing to jump up for a rebound, a volleyball player preparing to jump up for a spike, a high jumper preparing to jump over the bar, and a wrestler preparing for the drop step.

Plyometric training is similar to progressive resistance training in that both incorporate overload principles. Drills should progress gradually from basic difficult, and from low to high intensity. Form and technique should be emphasized at all stages of the program. Fleck, S., and W.Karaemer (1987)
1.4 PROGRAM DESIGN

EQUIPMENT AND FACILITIES

The following guidelines to select appropriate equipment and facilities for plyometric training will enhance effectiveness and safety. Gamvetta, V., (1988)

1.4.1 Proper footwear

Footwear with good ankle and arch support, good lateral stability, and a wide, nonslip sole is required. A crosstraining shoe is ideal because it helps to prevent ankle rollover. Shoes with a narrow sole and poor upper support (such as running shoes) may create ankle problems, especially with lateral movements.

1.4.2 Resilient surface

To prevent injuries, the landing surface must possess good shock-absorbing properties. The best surface is a good grass field; the next-best surfaces are well-padded artificial turf and wrestling mats. Such surfaces as concrete, tile, and hardwood are not recommended, because they lack shock-absorbing properties. Excessively thick (>15 cm) exercise mats may extend the amortization phase, thus not allowing efficient use of the stretch reflex.
Minitrampolines are not effective for plyometric training because of the extended amortization phase while the athlete is in contact with the elastic surface.

1.4.3 Proper sturdy equipment

Boxes used for box jumps and in-depth jumps must be sturdy and should have a non-slip top.

1.4.4 Sufficient training area

The amount of space needed depends on the drill. Long-response drills may require a straightaway of 100 m. For most of the bounding and running drills, at least 30 m of straightaway are required. For some of the vertical and in-depth jumps, only a minimum surface area is needed, but adequate height (3 to 4 m) is required.

1.4.5 Procedures

As with any training program, begin exercise sessions with a warm-up period that includes general warm-up, stretching, and specific warm-up. It is the easiest to think of a training program in 1-week units of time. The three basic features of a program, which determine the overall overload of the weekly training period, are frequency, volume, and intensity. (Overload refers to a greater than normal stress placed upon a muscle.) Alterations in any one of these may require adjustment
to one or both of the others. Additional factors to consider are progression, recovery periods, and direction of motion.

1.4.6 Frequency:

Frequency is simply the number of plyometric workouts per week. The usual range is one to three sessions, with two being the norm for most off-season sports, including football, and two to three for track and field athletes. In season, one session/week is appropriate for football players and two or three for track-and-field athletes. The intensity of the daily workouts (practice, strength training, running, and plyometrics) may affect the number of workouts needed each week. Football players may not perform plyometrics in season because of the overall volume and intensity of practices. Three days of low-intensity drills may result in lower overall weekly training effect than 2 days of high-intensity drills. In any case, do not perform drills for the same body area 2 days in succession.

1.4.7 Volume

Volume is normally expressed as the number of foot contacts (each time a foot, or feet together, contact the surface) per workout. Volume should be 80 to 100 foot contacts/session for beginners, 100 to 120 contacts/session for intermediate-level athletes, and 120 to 140 contacts/session for advanced athletes.
If intensity is high, volume should be low or medium. Volume may also be expressed as distance (i.e., 600 m).

1.4.8 Intensity

Intensity refers to the amount of stress placed upon muscles, connective tissue, and joints. Skipping places low stress on the muscles and joints whereas in-depth jumps place high stress on the muscles and joints. Generally speaking, as intensity increases, volume should decrease. In the early phases of training, both intensity and volume may increase, but once high-intensity drills form the base of the program, volume should decrease. The intensity of plyometric drills is related to a number of factors:

a) Whether one or two feet make contact with the surface.
   Alternate leg bounds, which may emphasize a greater vertical than horizontal component, result in a large force when the athlete lands.

b) The direction of the jump (vertical or horizontal).

c) Horizontal speed.

d) How high the center of gravity of the body is raised above the ground. The higher the center of gravity, the greater the force will be upon landing.
e) Whether, and how much, external weight (in the form of weight vests, ankle weights, and wrist weights) is added to the body. Only experienced athletes should use such weights.

Because drills can vary so much in intensity, owing to these factors and other aspects of the drills themselves, careful consideration must be given to choosing optimal drills during a training cycle. *(Allerheiligen, B. 1992).*
<table>
<thead>
<tr>
<th>TABLE: I</th>
<th>PLYOMETRIC DRILLS, CLASSIFIED BY VARIED INTENSITY LEVEL</th>
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<tbody>
<tr>
<td><strong>Low intensity</strong></td>
<td><strong>Medium intensity</strong></td>
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| **In-place jumps** | • Squat jump  
• Split squat jump  
• Cycled split squat jump (Also: ankle bounce, ice skater, lateral cone jump) | • Pike jump  
• Double leg tuck jump  
(Also: Jump-up, lateral hop) | • Double leg vertical power jump  
• Single leg vertical power jump  
• Single leg tuck jump |
| **Standing jumps** | • Standing triple jump (Also: Standing long jump) | | |
| **Short-response hops** | • Double and single leg zigzag hop and double leg hop | • Single leg hop and double and single leg speed hop | |
| **Long-response hops** | • Double leg hop | • Single leg hop and double and single leg speed hop | |
| **Short-response bounds** | • Alternate leg bound  
• Combination bound | | |
| **Long-response bounds** | • Alternate leg bound  
Combination bound | | |
| **Shocks** | | | • In-depth jump  
• Box jump |
| **Upper body plyometrics** | • Medicine ball sit-up  
• Plyometric sit-up (Also: two-hand overhead forward throw clap push-ups) | • Medicine ball push-up (Also: overhead backward throw, underhand forward throw, Russian twist) | • Drop-and-catch push-up |

_Thomas R. Baechle, (1994)_

- **First Package**  
  Low Intensity
- **Second Package**  
  Medium Intensity
- **Third Package**  
  High Intensity
1.5 PROGRESSION IN A PLYOMETRIC TRAINING PROGRAM

A program should be initiated with low-intensity drills and low volume (up to 80 foot contacts). Begin training neuromuscular reactivity with low- and medium-intensity jumps in place. These emphasize the vertical component. The single leg tuck jump, a high-intensity jump, is also permitted at this stage. Jumps over cones may also be done.

Progress from jumps in place to standing jumps. These latter emphasize both linear and vertical components. Although standing jumps are (1RM) efforts, they should be performed in sets of 5 to 10 repetitions. In addition to the standing triple jump, the standing long jump and jumps over cones and barriers may be performed.

Progress to multiple jumps and hops. These patterns involve repeated movements. Multiple jumps may be viewed as a combination of jumps in place and standing jumps. One possible multiple jump is repeat triple jumps (this will turn into combination bounding as soon as a long response is used). Bounding involves movements with greater linear speed, compared to other drills, of preestablished distances or preestablished repetitions for maximal distance.
Bounding drills are normally greater than 30 m and may include single and double leg bounds in addition to the ones. The next type of drills to be added, shocks, comprise in-depth jumps and box jumps. These make greater use of gravity than other plyometric drills because the body is elevated to a higher level, which increases the response of the stretch reflex. The height of the box depends on the size of the athlete, the landing surface, and the goals of the program during that phase of training. In-depth jumps may involve one or both legs, box drills may involve one, both, or alternating legs, as well as straddle jumps.

Upper body plyometric drills are the other part of a plyometric program. Upper body plyometrics are similar to lower body plyometrics because they both (a) use the stretch reflex, (b) should follow proper progression, and (c) will increase power in a specific area of the body.

Upper body plyometrics that incorporate a pushing movement from the chest (used in football and shot put) are considered 1RM efforts and are performed in sets of 5 to 10 repetitions. The overall design of the strength and conditioning program (strength training, running, plyometrics, and time of year) will determine on what day upper body plyometrics will be
performed. Besides the pushing upper body plyometrics, some sports (baseball, discus, javelin, and tennis) may use upper body rotational plyometrics with medicine balls.

1.5.1 Progression

Assuming that the athlete has a proper strength and conditioning base, plyometric training should progress from low-intensity, in-place exercises to medium-intensity and then higher-intensity levels. Allerheiligen B., (1992)

1.5.2 Recovery

Because plyometric drills involve maximal efforts, adequate recovery between repetitions, sets and workout is required. Recovery for in-depth jumps may consist of 5 to 10 second of rest between repetitions and 2 to 3 mm between sets. Drills should not be thought of as conditioning exercises but as speed-strength training. Recovery between workouts must be adequate (2 to 4 days depending on the sport and time of year); otherwise, overtraining or injury may occur.

1.5.3 Direction of Motion

Athletes require speed and power not only in the vertical plane but also in horizontal (straight ahead), lateral and diagonal directions as well. Sports that are horizontal and/or lateral in execution include football, baseball, and sprinting. Sports that
involve horizontal movement but also emphasize vertical movement include basketball and volleyball. The long and triple jumps are a combination of horizontal and vertical movement. Some sports utilize lateral movement or change of direction and include various degrees of horizontal and vertical components. Drills for different directional movements, as well as intensities are given. Athletes involved in pushing throwing, and swinging movements of the upper body benefit from plyometric drills for the upper body.

1.5.4 Safety

Because plyometric training emphasizes technique and form, it is advisable to have strength and conditioning professional present to monitor and correct technique. Injuries occur when training procedures are violated and may be the result of an insufficient strength and conditioning base, inadequate warm-up improper progression of lead-up drills, inappropriate volume or intensity for the phase of training, poor shoes or surface, or simple lack of skill. Injuries may occur in the joints of the back, knees, hips, and ankles. Borkowski, J., (1990)
1.5.5 Individual and Sport Specificity

The strength and conditioning professional needs to monitor individual athletes carefully to help them avoid injury. For instance, large (>90-kg) athletes should avoid high-volume, high-intensity plyometric exercises. Take into account body structure—especially possible abnormalities of spinal alignment, the legs, and the feet—as well as previous injuries, when designing plyometric programs. Be aware that fatigue from high-volume training male had to poor technique and injury.

A program should also take into consideration the athlete’s sport. Large football players, (for example) may be susceptible to injury because of the nature of their sport. During practice and competition they are constantly being placed in a variety of body positions that expose them to great stress and torque on the ankles knees, and low back. This and the violent physical contact in general may require that these athletes refrain from performing high-intensity and shock drills.

1.5.6 In-Depth Jumping

There is a limit to the height at which an in-depth jump can be performed and be effective but not dangerous. A height of 1.2m would provide a great overload on the muscles, but the resistance would be too great for many athletes to overcome
while maintaining correct technique. Jumping from such a height increases the possibility of injury; furthermore, the amount of force to be overcome is so great that the amortization phase would be extended and thus the goal of the exercise lost. The recommended height for in-depth jumps ranges from 0.4 to 1.1 m, with 0.75 to 0.8 m being the norm. In-depth jumps for large (>100-kg) athletes should range from 0.5 to 0.75m. Heights greater than this may not allow for the rapid switch from eccentric to concentric activity and may produce injuries. Plyometric training has been criticized because of recommendations to perform in-depth jumps from great heights, such as 3.2 m. Such a height was part of one investigation to determine the most efficient jumping height. Stated simply, jumps from this height should not be performed. Proper landing technique is particularly important for in-depth jumps. If the center of gravity is offset from the base of support, then performance will be hindered and injury may occur. The shoulders should be over the knees during the landing, by flexion of the ankles, knees, and hip. Verkhoshanski, Y., (1973)
1.6 OBJECTIVES OF THE STUDY

Plyometric training is a very popular and effective organizational form of doing physical exercise. In plyometric training, numbers of exercises are done in the form of jumping. It can be used for the improvement of technical and tactical elements or for the improvement of conditional abilities. But it is shown that plyometric training is particularly effective for improvement of the speed, power, and endurance. VO₂ Max and Anaerobic power abilities.

1. The First objectives of the study to find out Effects of varied packages of plyometric training on selected motor ability components and physiological variables among college men students.

2. The second objectives of the study to find out superiority of the varied packages of plyometric training among college men students.

1.7 STATEMENT OF THE PROBLEM

The purpose of the study was to find out the effects of varied packages of plyometric training on selected motor ability components and physiological variables among College Men students.
1.8 SIGNIFICANCE OF THE STUDY

The result may significant in the following aspect.

1. Plyometric training develops explosive power and ultimately, improving all criterion variables performance. The variations such as three different packages of plyometric training used in the present study were a scientifically designed one. Hence it is believed that players treated with these training modules can be benefited in time with regard to the selected motor ability components and physiological variables.

2. The present study would provide a scientific base and guidance to the physical educationist and coaches, sports scientist, exercise physiologist and fitness leaders to design the different packages of plyometric training programme using the naming modules in the present study with the view to develop motor ability components and physiological variables.

3. One of the basic objectives of the study is to extract the full potentials from the students with the feasible means and methods. Having the usage of full potentials, low achievers can be easily made as high achievers.
4. Finding of this research study would give a basic knowledge to the trainers and fitness leaders to envisage and conduct further research in various raining methods, training programmes, and training intensity to enhance the performance of college students and players.

5. The result of this study would add to the quantum of knowledge in the areas of training methods, fitness and wellness, exercise, physiology and exercise science.

1.9 HYPOTHESIS

1. It was hypothesized that the varied packages (low, medium and high intensity) of plyometric training would significantly improved the selected motor ability components (speed, leg explosive power, muscular endurance) and physiological variables (resting pulse rate, VO$_2$ max, anaerobic capacity) among college men students.

2. It was hypothesized that the third packages (High intensity) of plyometric training would significantly improved the selected motor ability components (speed, leg explosive power, muscular endurance) and physiological variables (resting pulse rate, VO$_2$ max, anaerobic capacity) greater than that of second packages (medium intensity) of plyometric training.
3. It was hypothesized that the second packages (Medium intensity) of plyometric training would significantly improved the selected motor ability components (speed, leg explosive power, muscular endurance) and physiological variables (resting pulse rate, VO$_2$ max, anaerobic capacity) greater than that of first packages (low intensity) of plyometric training.

4. It was hypothesized that the first packages (Low intensity) of plyometric training would significantly improved the selected motor ability components (speed, leg explosive power, muscular endurance) and physiological variables (resting pulse rate, VO$_2$ max, anaerobic capacity) among college men students.

1.10 DELIMITATIONS

The present study delimited in the following:

1. Subjects of the present study were delimited to the college men students from MGR Arts and Science College, Hosur, Tamilnadu, who were the participants of inter-collegiate level competition.

2. The total number of subjects was delimited to one-twenty and each group was consisting of thirty subjects.

3. The period of training programme was delimited to 12 weeks.
The following variables were selected in this study.

I. DEPENDENT VARIABLES

a. Motor ability components:

1. Speed.
2. Leg Explosive power

b. Physiological variables;

1. Resting pulse rate
2. Vo$_2$ Max.
3. Anaerobic Power.

II. INDEPENDENT VARIABLES:

Experimental group A : First packages of plyometric training. (Low intensity)
Experimental group B : Second packages of plyometric training. (Medium Intensity)
Experimental group C : Third packages of plyometric training. (High Intensity)
Group D : Control group

1.11 LIMITATIONS

The study is limited to the following aspects and these limitations would be taken into consideration of the result.
1. The influence of certain factors like life style, daily routine work, diet and other factors on the results of the study were not taken into consideration.

2. No attempt has been made to control the factors like air resistance, intensity of light atmosphere and temperature during training and testing period.

3. The difference in economic and educational back ground of the college students was not taken into consideration.

4. Since the subjects were motivated verbally during testing and training period no attempt was put to differentiate their level of motivation.

5. The psychological stress and other factors, which affect the metabolic function, were not taken into consideration.

6. The heredity of the subjects and its influence on the selected criterion variables were not taken into consideration.

1.12 OPERATIONAL DEFINITIONS OF TERMS

1.12.1 Plyometric Training

Plyometric training referees to exercise that enable a muscle to reach maximal strength in a short time as possible. (Gambetta, vern 1988)
1.12.2 Speed

Speed may be defined as the ability of an individual to perform successful movements of the same pattern at a faster rate. (Barrow, Harold M. 1979)

1.12.3 Explosive Power

Explosive power is the ability to release the maximum muscular force in an explosive manner, in the shortest possible time. (Hardayal Singh, 1991).

1.12.4 Muscular Endurance

This is the quality that enables a person to sustain localized muscular group of activities of extended period of time. (Uppal, 2004).

1.12.5 Resisting Pulse Rate

Measurement of heart rate when an organism is under physical and mental rest can be termed as resting pulse rate. (More house and Miller, 1976).

1.12.6 $\text{Vo}_2$ Max

$\text{Vo}_2$ max is the maximum capacity of an individual’s body to transport and utilize oxygen during incremental exercise, which reflects the physical fitness of the Individual.
1.12.7 Anaerobic Power

The word anaerobic means without oxygen. It is a highly intense, short term activity such as sprinting and weightlifting.

1.13 DEFINITION OF MOVEMENTS

The following are the basic types of plyometric drills. Gives specific examples classified by intensity.

1.13.1 Jump

A movement that concludes with a two-foot landing. A set may consist of 1 to 10 repetitions, but the jumps may be considered single repetitions.

1.13.2 Jump In Place

Vertical jump performed in place. Examples: tuck, pike, split squat, squat and power jumps.

1.13.3 Standing Jump

A maximal jump that may be linear, vertical, or lateral and is a 1RM (Repetition maximal) effort. Examples: standing long or lateral jumps.

1.13.4 Hop

A movement that starts and concludes with a one-foot or two-foot landing of the same foot or feet. Hops are repeated over a specific distance and/or a certain number of repetitions; they
are not maximal jumps. Hops may be performed by number of repetitions (short response, 1-10) or distance (long response, 30 m or more).

1.13.5 Short-Response Hop

Plyometrics performed with 10 it repetitions or less; a shock method may be added by adding external weights to the body. Examples: double and single leg-hop, speed hop, and lateral hop.

1.13.6 Long-Response Hop

Plyometrics performed for 30 m or more; a shock method may be added. Examples: double and single leg—hop and speed hop.

1.13.7 Bound

Series of movements in which the athlete lands successively on alternate feet. Bounds are normally measured in distance (long response, 30 m or more) but may also be performed as repetitions (short response, 10) for maximal distance.

1.13.8 Short-Response Bound

Plyometrics performed for 25 to 60 m; a shock method may be added. Examples: alternate leg, combination, or single leg.
1.13.9 Long-Response Bound

Plyometrics performed for more than 60 m; a shock method may be added. Examples: alternate leg, combination, or single leg.

1.13.10 Shock

In-depth jumps and box jumps. These are very highly intense nervous system activities that place great stress (shock) on muscle and connective tissues. The shock response is very high; few athletes (e.g., track and field, volleyball, and basketball) use this type of training. A set may consist of 1 to 10 repetitions.