CHAPTER 1

INTRODUCTION

Ever since the first 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 so 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 nearly every sport, and 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.¹

Whether there can be an end to human efficiency relating to his performance in sports, is an extremely difficult question to answer

though every day records in athletics are being shattered. To the casual observer, it would seem that we must indeed be reaching the point where further improvement in performance is almost impossible. But this is the reality, for the existing trends clearly show that improvement is without doubt, possible. May be that the more precise ways of measuring performance are used. Knowledge obtained from the progress of past records over the years should permit one to speculate on the future changes likely to occur.²

Training in games and sports is no longer a myth and it does not appreciate casual approach, but it provides opportunities for scientific application and verification. Training has been accepted as a high specialized science. Physical education scientists are striving to understand the various factors affecting skeletal and muscular activity during a variety of human movements with the help of electromyography and are engaged in analyzing the bio-mechanics of the performance of elite athletes by focusing their attention on the analysis of sports skills. They are consistently studying factors like strength,

limb length, mass, inertia, proportions and angular and linear velocity that influence these movements and performance.³

Speed in training theory is defined as a capacity of moving a limb or parts of the body's lever system or the whole body with greater velocity. Speed is not only necessary in sports activities where man compels to show his superiority but also in activities with which nature has blessed mankind. Speed is the rapidity with which one repeats successive movements of the same pattern. Great speed in muscle contraction is not always conducive to the greatest efficiency of movement. It seems that there is an optimum speed at which muscle contract with the greatest conservation of energy for the amount of work done.

Speed of whole body movement or of individual's joint actions is a decisive factor of successful performance in many sports. While speed is frequently the product of co-ordinated sequence of strength expression of joint actions.⁴


Strength is one of the most important components of physical fitness, which effects the performance in all activities in some form or the other. Development of strength is essential for power and speed. Strength is a complex factor which depends upon both the stimulus given by the nervous system and upon the capacity of the muscles for contraction, their size and shape. Improvement in strength is brought about by the principle of over loading through resistance exercises and also through repetition of specific movements of the muscles especially of those which are involved. Weight training is today considered as one of the principle methods of securing strength, but this requires the guidance of a coach or expert.5

The consensus opinion from a survey of nearly 200 certified personal trainers from the National Strength and Conditioning Association (N.S.C.A.) indicates that strength training is the best foundation for an effective exercise regimen. Most experts agree that 25 to 30 minutes of strength training coupled with about 25 to 30 minutes of aerobic exercise, plus 5-10 minutes of stretching, make for a well-balanced work out. The N.S.C.A. – certified personal trainers say that the formula will produce the results that most people desire if people

regularly exercise 2 or 3 times a week a growing number of people are seeking advice and motivation from personal trainers because they want to improve their physical appearance, need motivation and want effective programs designed for them to need their personal exercise goals.⁶

When weight training occurs on a regular basis and is accompanied by sensible eating choices, various system of the body change in positive ways. Muscles become stronger, better toned and show less fatigue with each additional session of training. The neuromuscular (nerve-impulse) system learns to work in better harmony. That is, the brain learns to selectively recruit specific muscles, and types of muscle fibres within them to assume the various loads used in your weight training exercises. The neuromuscular system also improve in its ability to control the speed of movement and to guide you through the correct movement patterns required in different exercises.⁷

In this connection it seems to be worth quoting:

"Muscles are meant to be used; give them extra work and they grow bigger and stronger."


This is the basic philosophy of weight training and it is certainly no new idea. Men have exercised with weights for almost two thousand years, mostly using crude dumbbells or sandbags. Now we have modern disc loading system, barbell and dumbbell and a scientific approach, but it is only comparatively recently that this system of physical training has become universally accepted. It is now recognized that a planned schedule of exercise using progressive load lead to greater strength for the athlete and a harmonious, fully developed physique for the body builders.

The ancient tradition of stone lifting evolved into the modern sport of weight lifting. It stands as established that weight plays an important role in bringing the fit and healthy people to a certain requisite standard. As the sport developed it took on different shapes in different cultures. In Europe, weight training was a form of entertainment from which the professional strongmen emerged.

The common method prevalent during those olden periods almost in all the sports was that weights were used upon hands. The other method comparatively less popularly used was the throwing of weights. They used to lift solid weights, but these were clumsy in their make. Iron globes were cast with iron and steel connecting bars while rest of the weights were cast as single globes or block with single projecting handles.
It was in the year 1903 when the first ever company was established to manufacture the weights. The Milo Barbell company was started by the first known instructor Mr. Alen Calvert. He brought out sound weights and also the Training Methods to the mass following.

A transformation in the clumsy and roughly moulded weights took place with the beginning of the 20\textsuperscript{th} Century. By the 1920's and 30's it had become evident that weight training was the best way to produce the greatest degree of muscular development in the shortest possible time.

Because of the ease of controlling resistance and simplicity of taking measurements of results in terms of weights overcome in standard lifts, the use of barbells and weights has become a popular method of strength training.

Now modern weight equipment's i.e. multi-gym and isokinetic machines are available for the development of specific strength for specific group of muscles.

But the unique thing about training is that different programme do different things to the body. Some programme develops muscle strength, while other improves the way heart and circulatory system function. One of the best way to train for increasing muscle strength is by lifting weights.
To increase the working ability of the heart and circulation, running and cycling are good exercises. Although training programme differs depending on which organs need to be conditioned. There is something common to all of them. They all increase physical performance by applying the same principle. This principle is called the over-load principle which holds that changes take place when work is gradually increased and conditioning improves. This is the principle followed to develop muscle size and strength.

Although muscle respond in different ways depending on what "turns them on". Only certain kinds of activity lead to the development and shaping of muscles. Exercises that makes the muscle contract with relatively high force are these kind of activities.

Weight training has its best effect when the exercises are done through the longest range of motion possible. This allows to stimulate the maximum amount of muscle fibers. But it has another effect as well: when we fully contract one muscle, we are stretching its opposing muscles. Therefore weight training done correctly leads to an increase in flexibility also.

Studies have demonstrated improvements in strength and/or muscular endurance following resistance training. The classic work in this area was done by Delorme (1945) who mentioned that high resistance - low repetition exercise build powerful muscles whereas low
resistance – high repetition exercise produce the quality of endurance, suggesting a functional and specific relationship between training stimulus, and response. This contention has been supported by the work of Berger (1962), Berger and Hardage (1947), Penman (1969) and Peterson and Others (1961).\(^8\)

Maximum dynamic strength of large muscle group (shoulders, arms and legs) may be determined without the use of sophisticated measuring device by performing one repetition maximum (1-RM) in one or more weight lifting movements such as the bench press and squat. For assessing a combined level of muscular strength and endurance 5-8 RM are recommended and for muscular endurance only 12-15 RM.\(^9\)

Berger developed the use of 1-RM (the maximum load a person can raise only once) as a means for evaluating strength improvement.

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He later used the same principle for the purpose of classifying students in weight lifting classes on the basis of strength.\textsuperscript{10}

Plyometrics is an area of conditioning i.e. beginning to receive a great deal of attention in the strength training profession. Purportedly, plyometric training represents the link between strength and speed. It is yet another "secret" training technique brought back from eastern block countries. Originally, plyometrics was (and still is) quite popular among track and field coaches in the mid to late 1970's. However, it is now being used to increase jumping ability and running speed in a wide range of sports- Volleyball, basketball and football.\textsuperscript{11}

The origin of the term Plyometrics is thought to be derived from the Greek word "Pleythyein", meaning to augment or to increase, or from the Greek root words "Plio" and "Metric". Meaning more and measure respectively. Today plyometrics refers to exercises characterized by powerful muscular contractions in response to rapid, dynamic loading or stretching of the involved muscles.\textsuperscript{12}


Plyometric exercises are used to train the eccentric aspect of muscle action. This type of exercise is designed to improve the relationship between maximum strength and explosive-reactive power. Many athletes have fantastic strength, yet they cannot throw or jump far. They are unable to produce the power necessary in explosive-type activities. They fail to bridge the gap between sheer strength and power. Plyometric exercises seek to bridge this gap, since it is well known that a concentric muscular contraction immediately following an eccentric (pre-stretching) contraction is considerably stronger than if this pre-stretching of the muscle had not taken place.

The muscle is pre-stretched as it lengthens during the eccentric phase. The slack is taken up during this gathering (amortization) phase as the muscle lengthens. A body movement requiring a very high end velocity such as jumping and throwing can best be achieved by starting with a movement in the opposite direction. The golf swing and baseball batting are obvious examples. The halting (breaking) of this movement in the opposite direction develops positive acceleration power for the movement in the originally intended direction, providing this transition from the opposite direction to the intended direction is made smoothly and without delay.
The capability of producing a stronger following (subsequent) concentric muscle contraction by utilizing a previous eccentric contraction of that muscle exploits what is known as the stretch or myotatic reflex.

The stretch reflex specifies simply that muscles involved in any particular action achieve higher (stronger) contraction values when preceded by a gathering phase involving the stretching (eccentric contraction) of such muscles. The muscle resists over-stretching. By stimulating the stretch-receptors or muscle spindles, which cause proprioceptive nerve impulses to transmit to spinal cord and return to the same muscle, a powerful contraction resist to prevent over-stretching of the muscle. This is called the stretch or myotatic reflex.  

Various exercises (e.g. bounding, hopping, in-depth jumping and box drills) have been developed in which the force of gravity (coupled with the athlete’s body weight and, in some cases, weighted vests and/or dumbbells) is used to elicit this so-called stretch (or myotatic) reflex of a muscle.

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In order to jump higher, the athlete must generate more power by increasing the strength and velocity of muscle contraction.\(^{15}\)

Explosive leg power is a key ingredient to maximizing vertical jump performance.\(^{16}\)

Verhoskauksiy emphasises the need of Depth Jumping in the training of jumpers. The reason given by him is the following: During take-off in the jump, the extensor muscle fulfills yielding work (the phase of amortization) in the beginning and later overcoming work (phase of active take-off). The older athlete has less friction of the legs in the ankle joints and more quickly extends the leg than the beginner. This muscle switch more quickly from yielding work to over coming work and more quickly develop maximum dynamic strength which is also greater than the beginners. Because of this it can be said that the reactive ability of the nerve muscle apparatus in the veteran is higher, with the understanding that his muscles have the ability to fulfill effective work of an “explosive” character immediately after significant


\(^{16}\) Fredrick Marullo, “Plyometrics -- The Link Between Speed and Strength Training”. The Coach (March 1998), pp. 18-21.
loading in the amortization phase and he likewise has the speed in
switching the muscle from yielding to over coming work.

Analysis of the work of the muscles during fulfillment of the
traditional exercises (jump type) by jumper did not reveal any means
which to a full measure would have served in developing reactive ability
of the motor apparatus of the athlete. As this appears as a leading
quality and improves mainly in the process of jump performed with full
strength and with full run, there was then needed new investigation in
order to add new effective method of specialized strength preparation to
the training arsenal of the jumper. This is how the depth jumps appeared
which proved to be useful.17

This assumption is supported by a review of results of training
studies. However, it appears that regular jumping exercises can be
helpful. The same holds for exercises with weights, provided the
subjects have no weight training history. In fact, for unskilled jumpers
who have no weight training history, the effects of training programmes
utilizing these different exercises are additive. The most effective,
efficient and safe way for a coach to improve the jumping achievement
for his athletes may well be to submit them first to a training programme

17 Yuriy Verhoskauisky. "Depths Jumping in the Training of Jump", Track Technique 51
(March 1973), pp. 1618.
for his athletes may well be to submit them first to a training programme utilizing regular jumps, then to a weight training programme and finally to a drop jump training programme.

Given the current state of knowledge, coaches seem to have no other option than to strictly copy a programme which has proved to be very effective. Obviously, there is a need for more systematic research of the relationship between design and effect of drop jump training programmes. The most important variable to be controlled is drop jumping technique. From a review of bio-mechanical studies of drop jumping, it becomes clear that jumping technique strongly affects the mechanical output of muscles. The bio-mechanics of 2 techniques are discussed. In the bounce drop jump the downward movement after the drop is reversed as soon as possible into an upward push-off, while in the counter movement drop jump this is done more gradually by increasing the amplitude of the downward movement after landing. It is speculated that the bounce drop jump might trigger improvement of the power output capacity of muscles.¹⁸

For performing plyometric exercises following guidelines may be followed.

Execution Guidelines

Warm Up/ Warm Down

Because plyometric exercises demand flexibility and agility, all drills should be preceded by an adequate period of warm-up and followed by a proper warm-down. Jogging, form running, stretching and simple calisthenics are strongly recommended before and after every workout.

High Intensity

Intensity is an important factor in plyometric training. Quickness of execution with maximal effort is essential for optimal training effects. The rate of muscle stretch is more important than the magnitude of the stretch. A greater reflex response is achieved when the muscle is loaded rapidly. Because the exercise must be performed intensely, it is important to take adequate rest between successive exercise sequences.

Progressive Overload

A plyometric training program must provide for resistive overload which forces the muscles to work at greater intensities. Proper overload is regulated by controlling the heights from which athletes drop, the weights used, and the distances covered. Improper overload may negate the effectiveness of the exercise or may even cause injury. Thus, using weights that exceed the resistive overload demands of certain plyometric movements may increase strength but not necessarily
explosive power. Resistive overload in most plyometric exercises takes the form of forces of momentum and gravity, using objects relatively light in weight such as medicine balls or dumbbells, or mere body weight.

Maximize force/ Minimize time

Both force and velocity of movement are important in plyometric training. In many cases the critical concern is the speed at which a particular action can be performed. For example, in Shot-putting the primary objective is to exert maximum force throughout the putting movement. The quicker the action sequence is executed, the greater the force generated and the longer the distance achieved.

Optimal No. of Repetitions

Usually the number of repetitions ranges from 8 to 10, with fewer repetitions for more exerting sequences and more repetitions for those exercises involving less overall effort. The number of sets also may vary accordingly. Various East German studies (Gambetta, 1981) suggest 6 to 10 sets for most exercises, while the Russian Literature (Veroshanski, 1966) recommends from 3 to 6 sets especially for some of the more intense jumping drills.

It is important to understand that most plyometric drills fall into one of two categories: single-response (SR) or multiple-response (MR) drills. The former represent a single, intense effort such as employed in
take-offs, initial bursts of motion, and releases. The later one also intense but they place more emphasis on stamina and overall speed by involving several efforts in succession. Actually, the same drill can be worked either way. For example, the Depth jump is basically a single drop from a box, followed by a high vertical jump. Yet by placing a row of cones in front of the box and doing a series of jumps over them, the athlete is performing a multiple-response drill. A good plyometric program utilizes both types of responses, thus working with more specific and overall action efforts.

Sometimes the number of repetitions is dictated not only by intensity of the drill but also by the athlete’s condition, the execution of each repetition, and the value of the outcome. These drills are being performed to improve nerve-muscle reactions, explosiveness, quickness and the ability to generate forces in certain directions. An athlete will only benefit from the number of repetitions done well. For example, if he or she performs a set of hops, bounds or throws correctly for eight repetitions but begins to fatigue and performs incorrectly thereafter, than eight repetitions are enough.

**Proper Rest**

A rest period of 1 to 2 minutes between sets is usually sufficient for neuromuscular systems stressed by plyometric exercises to recuperate. An adequate period of rest between plyometric training days
is also important for proper recovery of muscles, ligaments and tendons. 2 to 3 days per week of plyometric training seems to give optimal results. It is important not to precede plyometrics, especially jump drills and other leg movements with heavy weight workouts of the lower body. Previously fatigued muscles, tendons and ligaments can become overstressed by the high resistive loads placed on them during the plyometric workout.

**For Building Power Foundation**

Beginners should start with moderate drills such as jumps from ground level and hops, bounds and leaps with both legs. As strength and explosive power increase, a progression to one-legged drills, depth jumps and decline and incline work can be initiated. Strength and flexibility training of abdominal muscles and lower back muscles are recommended for several weeks prior to doing skips, swings and similar trunk exercises.

Almost every athlete can be benefited to some degree from plyometric. The principle of specificity should be applied in plyometric exercise. There are some plyometric movements designed to enhance striding power, others are used to increase jumping ability and still others may specifically work the twisting muscles of the torso. The
application of specific plyometric exercises should be determined by the athlete’s own desired performance goal.\textsuperscript{19}

The more explosive the event, the more beneficial would be the plyometric training. However, even distance runners and particularly cross country runners, can benefit from the strength gains achieved in plyometric training. The ability to run hills and the ability to sprint at the end of a race can be enhanced. The greatest benefits of plyometric training naturally would be directed towards the games involving the jumps, throws and sprints like Volleyball, Basketball, Hockey, Football, Lawn tennis, Handball, etc.

Plyometric training is the training programme for the 80’s and perhaps the 90’s and beyond. The equipment requirements are simple, the dangers are quite low and the benefits are high. Every coach should plan and include some degree of plyometric training for every athlete according to the requirement of skills of the game.

Numerous studies have been reported on strength and speed development through weight training since decades. Recently, plyometrics have also regained popularity within the athletic community for contributing towards the development of speed and explosive power.

Majority of research in weight training and plyometrics have been conducted separately. Comparatively, very few studies have been recorded combining both the methods. This has given an idea and motivation to the research scholar to study this aspect of training methods. It was felt that strength base is advantageous in plyometrics, so, weight training program should be designed to complement and supplement which has been neglected so far.

With this philosophy, review of the literature in this field and experts opinion has inspired the research scholar to undertake this study.

Statement of the problem

The main purpose of the study was to find out the comparative effects of weight training, plyometric training and their combination on selected motor components.

Delimitations

1. The study was confined to the male students of First and Third Semester of MBA from Prestige Institute of Management, Gwalior.

2. The period was restricted to twelve weeks.

3. The study was restrained to selected motor components i.e., speed, strength and explosive power.
4. The study was further delimited to lower extremity.

Limitations

1. The subjects selected for the study were both residential and non-residential students. Certain factors like diet, daily routine, lifestyle and habits etc., which might have an effect on the result of the study could not be controlled. Hence, no attempts were made to control these factors. But it was assumed that the random selection of the subjects has assured the nullifying effect on these factors.

2. No motivational device was used during the testing of different variables. The differences that may occur in performance due to lack of motivation was recognised as one of the limitations to the study.

3. Non-availability of sophisticated equipment was considered another limitation to the study.

Hypothesis

On the basis of the literature reviewed, research findings, discussions with senior colleagues in the field and scholar's own understanding of the problem, it was hypothesized that:
1. Different training methods may show improvement in speed, strength and explosive power of the lower extremity due to 12 weeks of training.

2. Weight training, plyometric training and combination training may have significantly different effects in improving speed, strength and explosive power.

Definition and Explanation of Terms

**Plyometrics**

Eccentric contraction followed immediately by a concentric contraction i.e., the exercise is based on the rapid lengthening of a muscle (forced stretch) just prior to a contraction. The voluntary impulse must be timed to coincide with involuntary impulse to achieve most powerful contraction to gain maximum heights of jumps (Henson, 1994)\(^{20}\).

**Concentric Contraction**

Concentric muscle action occurs when tension develops in a muscle, and the muscle shortens (Baechle and Groves, 1998)\(^{21}\).

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\(^{20}\) Phil Henson, "Plyometric Training" Track and Field Quarterly Review 4 (Winter 1994); p.53.

Eccentric Contraction

The term eccentric is used to describe muscle action in which tension is present in the muscle, but the muscle lengthens instead of shortening (Baechle and Groves, 1998)\textsuperscript{22}.

Weight Training

Weight training is concerned with improving the conditions of the body in terms of strength, power and endurance, through the use of resistive movements (or attempted movements in the case of isometric exercises) against a resisting load of some kind (Payne, 1979)\textsuperscript{23}.

Intensity

It is the weight percentage used in strength training in relation to maximum performance capacity. Absolute strength indicates 100% intensity.

Duration

It is in terms with total stimulus of the strength for a particular training session.

\textsuperscript{22} Ibid. p. 5.

\textsuperscript{23} Howard Payne, "Weight Training for All Sports" (London: Pelham Books 1979); p. 3.
Time utilized in each set may be added to find the sum.

Density

It is denoted by the recovery intervals in between the sets and also for the change of exercise.

Number of Sets

Each exercise is performed with a few numbers of sets for a thorough build up of a particular muscle group.

Speed

Speed is the quickness with which one is able to move his body from one point to another (Hockey, 1973)\(^\text{24}\).

Strength

Strength is defined as the force that a muscle group or a muscle can exert against a resistance in a single maximum contraction (Mathews, 1978)\(^\text{25}\).

Explosive Power

Explosive power is defined as the ability of a muscle or a group of muscles to release maximum force in shortest possible time in an explosive manner, projecting the body or an object (Clarke, 1976)\(^\text{26}\).


Significance of the Study

Physical educationists, coaches and sports scientists have been working over a considerable period of time to develop economical means of training so as to enable sports persons to attain high performance in various games and sports. Numerous research works have been done in the field having different training means to find out the effectiveness of various training methods to improve important motor fitness components as well as techniques. The investigator felt that the study may prove to be significant in the following ways:

1. The results of the study will be of immense help for the sports persons in almost all track and field events and for other games as well.

2. The findings of the study shall add a new dimension to the existing knowledge of sports training with special reference to different forms of plyometrics.

3. The outcomes of the study might highlight the differential effects produced by the three types of selected training methods to develop speed, strength and explosive power.

4. The physical education personnel and coaches will be able to select as to what type of training will be best suitable for their athletes.
5. It may also help to formulate training protocol for various age groups of male athletes with the combination of weight training and plyometrics.