Chapter-I
INTRODUCTION

“Talent wins games, but teamwork and intelligence wins championships.”
—Michael Jordan (American NBA Basketball Player)

Sports coaches and sports scientists always look for new, better or different ways to improve performance. What is now popularly known as Plyometrics was discovered and refined over the past 30 or so years. Plyometric Exercises are specialized high intensity training technique used to develop strength and speed. Plyometric movements are those 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 or hit harder, depending on desired training goal. Plyometrics in the form of dynamic depth jumps, where an individual steps off a box 20 to 80 cms in height and performs an explosive vertical jump has been reported to enhance an individual’s ability to rapidly develop force. Plyometrics was first known as “Jump training’? Fredwit, an American track and field coach first coined the term Plyometrics.

Plyometric training is also known as "shock training.” It was developed by Yuri Verkhoshansky in 1977. Plyometric training is when a person performs explosive movements which generate large amounts of force quickly. The aim of these exercises is to increase concentric power output, by lengthening the muscle prior to the contraction. This will produce greater force through the storage of elastic energy. Athletes who participate in power sports i.e. football, basketball, hockey, use this method of training to develop explosive power. Performing Plyometrics correctly can increase power output dramatically on the other hand, lack of knowledge in this subject usually leads to injury.

The practical definition of plyometrics is a quick powerful movement involving prestretching or countermovement that activates the stretch shortening cycle.l Within this powerful movement is an eccentric or force reduction phase; an amortization phase, or transition moment involving
dynamic stabilization, and a concentric phase, or force production phase.2 
Plyometric Training refers to performance of stretch-shortening cycle (SSC) 
movements that involve a high intensity eccentric contraction immediately 
after a rapid and powerful concentric contraction. Plyometrics training is when 
a person performs explosive movements which generate large amount of force 
quickly. The aim of these exercises is to increase concentric power output by 
lengthens the muscle prior to the contraction. This produces the greater force 
through the storage of elastic energy. Plyometrics also may enhance strength 
because muscles are trained under tensions greater than normal maximum 
tension due to the SSC. The effectiveness of plyometric in combination with 
resistance training at improving lower body power has been investigated. 
Baker (1996) concludes that the greatest improvements in Vertical Jump 
performance will be elicited when training both the contractile components of 
the muscle (utilized primarily by general strength exercises), as well as the SSC 
(utilized primarily by the special and specific strength exercises) rather than 
simply performing one type of training or the other.

To achieve plyometric effect, an athlete can jump of a height and bounce back 
up, with minimal absorption time, to create a greater stretch reflex. This is 
usually done from heights of 30cm and up to one meter. Advanced athletes 
may only train at maximal heights and not beginners. The reason for advance 
athletes, who have a strong base, train on tall platforms, is because they are 
professional athletes and can handle these heights. When people first hear 
about Plyometric, they try and attempt them, without putting much thought 
into it rather than that you just need to jump. The main down fall is not 
planning a training session correctly and not understanding the full effect of 
Plyometric.

Now looking back at weight training again, when a new person ever tries to 
create his own training routine besides the fact that it is usually crap, it always 
has high amounts of volume. This is because he tries to cram in as many
exercises as possible with high set and repetition. This is the exact problem with Plyometric and people usually misuse them. They add all of the lower body plyometric exercises together with an insane amount of volume. Hoping that performing by quantity not quality they will achieve the desired effect. We all know that when doing weights with the same mind set, one will achieve very little or injury. We know this because, we all did it and now people are doing the same thing to Plyometric.

Performing Plyometrics at high amounts and intensity is very dangerous. As fatigue sets in, one becomes more prone to lose form and perform the movement incorrectly. These jumps should be done sparingly and each jump should be done for quality not quantity so doing death jumps from the top of your garage roof over and over again, isn't going to help you much. This simply means performing Plyometrics is same as to lift weights. Concentrate, keep perfect form and give it all you got; jumping as high as possible. This will also maximize out one’s anaerobic system. This is because the stretch shortening cycle affects the sensory response of the muscle spindles. The muscle spindles are involved in the stretch reflex and are triggered by rapid lengthening of the muscle. 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. This just means performing Plyometric on your body is extremely taxing and should only be done for short periods of time.

It is now the latest fashion between young people, to perform these routines, which have been poorly constructed. It is something along the lines of 4×20 depth jumps, 4×15 box jumps, 4×20 lunge leaps and to finish this disaster off with hurdles, miles and miles of hurdles. This isn't the greatest of routines but this scenario is made worse by performing this, three times a week, in
combination with lengthy lower body training routines and long distance running. This isn't wise because you don't have enough time to recover for the next session to be productive.

People also want to be conditioned at the same time. This is because most people that attempt plyometric are sport participating athletes therefore, they require a certain level of conditioning. By doing this, the athletes are reversing what they have achieved as a result of muscle fiber mechanics. The result, lack of improvement in power, is because when you perform plyometric and heavy weight lifting you harness the growth of fast twitch fibers. Fast twitch muscle fibers are responsible for short explosive movements despite; this condition can harness the growth of slow twitch fibers. Slow twitch muscle fibers are responsible for movements which are repeated without fatigue setting in. The human body will react negatively from a bombardment of both types of training. This is because you are converting the fast twitch muscle fibers back to slow twitch resulting in no gain in power and masses of lactic acid. Not too clever as you will be too sore and too tired to do anything. To clear things up so far, plyometric will result in growth in fast twitch and pro-longed activities will result in slow twitch muscle fiber growth. Two main sporting comparisons of this would be a football player, a line backer preferably, who has large amounts of fast twitch muscle fibers. This results in extreme speed on the pitch, powerful tackles and for most a 30 plus vertical jump. Now in contrast a cross country runner would have large amounts of slow twitch muscle fibers: responsible for the athlete being able to run 20 miles tireless.

"Guess who has more explosive muscle fibers", looking back on the vertical leap comment, if you are looking to increase vertically, you are probably doing this so that you could dunk in basketball. A sure fire tip that always ads inches in seconds to most of the athletes is practicing the movement correctly as many times as possible. Try to break up the movement and concentrate on the correct foot placement needed in the take off. You will be amused by how
much your leaping will improve from this simple hint as many people do this wrong. The correct technique allows far greater transfer of power from your legs to gain maximum height in your jump.

Another mistake that beginners practice in their Plyometric training is the over use of them. Plyometric work should only be done once or twice in a year. Yes, it should be done to shock your system and it works the best that way. You will receive most boosts in your power when shock training is introduced for short periods of time, no more than eight weeks in one go, so that your body wouldn't adapt to this tactic. Pro longed training will not be as effective as introducing short periods of 3-5 week blocks preferably once or twice a year, no more. This rule is the most effective and what has worked for many athletes.

Doing this yearly will cause joint problems in the knee and flexibility problems in the ankle as your Achilles tendon will be thrashed. It is also recommended that an athlete take at least three to four weeks in between Plyometric training gaps. Many strength coaches recommend that you should not perform more than 2-3 blocks yearly. Plyometric training isn't the greatest thing for your knee that's why proper footwear and surface areas need to be used to reduce the friction shock to the joints.

Plyometric exercises should only be performed when an athlete is sufficiently warmed up. For example a light jog and some dynamic movements to stretch, don't overdo the warm up it isn't necessary. Absorbing the shock when landing for too long is another mistake people make. The aim is to spend the least amount on the ground because your muscles are relying on stretch reflex to explode up as fast as possible. For example if you jump of a 30 inch box and you spend three seconds on the ground absorbing the shock of the impact and then leaping up 15 inches in the air that will do you no good. To fix this you need to lower the height of the platform. A height at which you perform at your optimum, you need to keep your absorption time less than a third of a
second, when on the ground. Doing this is way more beneficial than jumping of a great height but absorbing for too long. Make each jump count because quality of jumping is far more important than quantity, this means stop doing thousand leaps and cut down to a select few and make each one count. To perform Plyometric jumps you have to be 100% and not fatigued because that can cause many injuries so don't jump when tired or directly after a leg training sessions with weights.

Plyometric drills usually involve stopping, starting, and changing directions in an explosive manner. These movements are components that can assist in developing agility (Craig, 2004; Miller et al., 2001; Parsons et al., 1998; Yap et al., 2000; Young et al., 2001). Agility is the ability to maintain or control body position while quickly changing direction during a series of movements (Twist and Benickly, 1995). 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 (Barnes and Attaway, 1996; Craig, 2004, Potteiger et al., 1999). By enhancing balance and control of body positions during movement, agility theoretically should improve.

It has been suggested that increases in power and efficiency due to plyometrics may increase agility training objectives (Stone and O'Bryant, 1984) and plyometric activities have been used in sports such as football, tennis, soccer or other sporting events that agility may be useful for their athletes (Parsons and Jones, 1998; Renfro, 1999; Robinson and Owens, 2004; Roper, 1998; Yap and Brown, 2000). Although plyometric training has been shown to increase performance variables, little scientific information is available to determine if plyometric training actually enhances agility. Marked evidence indicates that regular participation in a resistance training program or a plyometric training program can improve measures of strength and power in adults (for reviews, see Chu, 1998; Fleck and Kraemer, 2004). Studies also suggest that changes in
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Motor performance skills resulting from the performance of combined resistance training and plyometric training are greater than with either type of training alone (Adams et al., 1992; Fatouros et al., 2000; Polhemus et al., 1981). Thus, both resistance training and plyometric training are typically recommended for adults when gains in motor performance are desired.

In children and adolescents, it is well-established that training-induced gains in strength and power are indeed possible following participation in a resistance training program (Faigenbaum et al., 1996; Falk and Tenenbaum, 1996). More recent observations suggest that plyometric training may also be safe and effective for children and adolescents provided that age appropriate training guidelines are followed (Chu et al., 2006; Marginson et al., 2005). For example, Matavulj et al., 2001 found that plyometric training improved jumping performance in teenage basketball players and Kotzamanidis, 2006 reported that plyometric training enhanced jumping performance and running velocity in prepubertal boys. However, plyometric training is not intended to be a stand-alone exercise program (Bompa, 2000; Chu et al., 2006). As previously observed in adults, significantly greater gains in performance may be observed when plyometric training is combined with resistance training (Adams et al., 1992; Fatouros et al., 2000; Polhemus et al., 1981).

Plyometric refers to exercise that enables a muscle to reach maximum force in the shortest possible time. The muscle is loaded with an eccentric (lengthening) action, followed immediately by a concentric (shortening) action. This study outlines the physiology behind how and why plyometrics works. It also examines the research that demonstrates why, as a form of power training, plyometric training is very effective.

All plyometric movements involve three phases. The first phase is the pre-stretch or eccentric muscle action. Here, elastic energy is generated and stored. The second phase is the time between the end of the pre-stretch and the start of the concentric muscle action. This brief transition period from
stretching to contracting is known as the amortization phase. The shorter this phase is, the more powerful the subsequent muscle contraction will be. The third and final phase is the actual muscle contraction. In practice, this is the movement the athlete desires the powerful jump or throws. This sequence of three phases is called the stretch-shortening cycle. In fact, plyometric exercises could also be called stretch-shortening cycle exercises.

Plyometrics are training techniques used by athletes in all types of sports to increase strength and explosiveness (Chu, 1998). Plyometrics consists of a rapid stretching of a muscle (eccentric action) immediately followed by a concentric or shortening action of the same muscle and connective tissue (Baechle and Earle, 2000). The stored elastic energy within the muscle is used to produce more force than can be provided by a concentric action alone (Asmussen and Bonde-Peterson, 1974; Cavagna, 1977; Komi, 1992; Miller, et al., 2002; Pfeiffer, 1999; Wathen, 1993). Researchers have shown that plyometric training, when used with a periodized strength-training program, can contribute to improvements in vertical jump performance, acceleration, leg strength, muscular power, increased joint awareness, and overall proprioception (Adams, et al., 1992; Anderst et al., 1994; Bebi et al., 1987; Bobbert, 1990; Brown et al., 1986; Clutch et al., 1983; Harrison and Gaffney, 2001; Hennessy and Kilty, 2001; Hewett et al., 1996; Holcomb et al., 1996; Miller et al., 2002; Paasuke et al., 2001; Potteiger et al., 1999; Wilson et al., 1993). Plyometric drills usually involve stopping, starting, and changing directions in an explosive manner. These movements are components that can assist in developing agility (Craig, 2004; Miller et al., 2001; Parsons et al., 1998; Yap et al., 2000).

A combination of plyometrics and resistance training during a training cycle should be structured to allow maximal efficacy and physical improvement. To our knowledge, no randomized studies have compared the effects of combined plyometric training and prospective resistance training in children and
adolescents. In previous reports involving youth, the effects of plyometric training were compared to a ‘control’ condition which consisted of sport training or physical education class (Cosser et al., 1999; Diallo et al., 2001; Kotzamanidis, 2006; Matavulj et al., 2001) or the study did not have a control group (Brown et al., 1986). Since young athletes are often encouraged to perform static stretching prior to resistance exercise (Martens, 2004), it is intriguing as to whether plyometric training and resistance training (without pre-event static stretching) can provide combinatory effects in younger populations. Given the growing popularity of youth strength and conditioning programs, and the perception among most youth coaches that pre-event static stretching is beneficial (Shehab et al., 2006), it is important to ascertain the most efficacious method for enhancing fitness performance in children and adolescents. This information would be useful to physical educators, sport coaches and health care providers.

The comparison of plyometric exercises and weight-training protocols has produced controversial results. Plyometric protocols have been shown to be more effective (Verkhoshanski, & Tatyan, 1983), equally effective (Adams, et al. 1992; Anderst, et. al., 1994; Ioannis, et. al., 2000), or less effective (Stone, & O’Bryant, 1986; Verkhoshanski, & Tatyan, 1983) than weight training in improving the vertical jumping ability. The combination of plyometric exercises and weight training increased (Adams, et al. 1992; Baur, et. al., 1990., Behm, & Sale, 1993; Ioannis, et. al., 2000) or maintained unaffected vertical jumping performance (Stone, & O’Bryant, 1986). Adams et al. (Adams, et al. 1992) suggested that this combination may provide a more powerful training stimulus for the vertical jumping performance than either weight training or plyometric training alone. However, Clutch et al. (1983) did not reach similar conclusions and Ioannis, et al. (2000) suggested that the combination of plyometric and weight training increased muscular strength.
Basketball is a very demanding and physically challenging game. Basketball is one of the sports characterized by many of the basic and variable skills. The basketball player perfection to do such skills, defensive or offensive, needs development in the physical qualities of the basketball player, which enables him to do the required duties throughout the match. Special physical preparation in basketball is the main pillar for the players to carry out the special requirements (physical, skillful and tactical). Without these requirements, the player cannot achieve the objectives set up for the training or competition. Physical adaptation of the player to perform the sport activities is one of the practical functions of the training which improve the training of the player to reach to higher levels in the sport activities (Abdel et.al 1993). The skillful performance is relevantly associated with the special physical motor abilities as the perfection of the skillful performance depends on the range of the development of the special physical abilities to perform such requirements, such as muscular power, endurance, agility and others. The skillful performance is often measured by the level of the player to acquire physical abilities (Abdel et.al 1992).

In the field of training, there is a new technique emerged similar to the nature of performing basketball skills by developing the ability of vertical jump, which called plyometric as it includes stretching muscles (while you perform it) followed by a direct fast muscle contraction. The tension resulted from using the plyometric training is higher than the tension resulted from using other types of training, such as the static and dynamic contraction (Boatwright et.al 1994). The central muscle contraction occurred at the moment of take off becomes stronger if it is preceded by non-central muscle contraction as this kind of contraction occurs at the moment of landing the take off foot to do the next taking off while a muscle contraction by stretching occurred (non-central) (Gambetta 1989).

The main goal of plyometric training is to transform the energy that depends
on the flexibility resulted from the body and gravity throughout muscle contraction by stretching to an equivalent force in quantity and contrary in the direction throughout muscle contraction by shortening (Brown et al. 1986). Despite using the plyometric training in a lot of exercises, all of them depend on the theory of using rapid and strong resistance, which leads to muscles’ rubbery, then muscles’ shortening to overcome this resistance. This training is used for carrying out jumping, hopping, steps and different moves of trunk rotation, taking into account that the performance should be at the possible high level of speed and power. The plyometric training affects both the muscles and nervous system. It is practically and generally useful for the performance and depends on the work of sense and motive organs in muscle and tendon (Adams et al. 1986). Throughout this presentation, the author noticed that the explosive power represented in performing special basic skills using power, speed and perfection during the competition has an effective and vital role in increasing the level of all skills performed in the match in addition to the experience of the author in training the beginners’ teams and university team, the matter that makes the explosive power in the present study as the problem requiring a solution. The importance of this study lies in demonstrating an important aspect of special preparation and training for the competition as through the matches' results, we can see the failure of a number of players in passing, dribbling and shooting during the matches: the matter that enables the author to determine the problems of that study as a scientific attempt directed to study the effect of using the plyometric training on developing the special physical abilities and the skillful performance of the basketball players.

(Abdel 1999) conducted a study aimed to identify the effect of a training program of muscles fitness and power fitness on the growth rates of physical qualities and basic skills of basketball on a sample of 17 players under the age of 17 years old. The author used the experimental method where the most
important results were that the proposed training program led to the development of the muscles fitness and power fitness and improvement of the basic skills of basketball. (Tammam 2000) conducted a study aimed to identify the effect of a training program by using plyometric training on the development of muscular power and the level of performance of the shooting during basketball players jumping on a sample of 12 players under the age of 18 years old. The author used the proposed experimental method, while the main results show that the proposed training program leads to the development of maximum power and muscular power all over the body and also improves the performance of shooting through jumping (Bilal 2003) conducted a study aimed to know the effect of electro plyometric training on developing the explosive power of the two legs and its relation to the performance of the players to some basic principles in basketball. The sample included 20 players under the age of 20 years old. The author used the experimental approach which leads to the most important results for the development of the explosive power of the muscles of the legs and improving some basic skills (speed - accurate shooting through jumping and the speed of dribbling) in basketball. (Bakhit 2004) conducted a study aimed to know the effect of adapting the plyometric training with the skills of the muscular power of the legs and the skill of shooting of the basketball players on a sample of 16 players under the age of 18 years old. The author used the experimental approach which resulted in the most important results show that the plyometric exercise leads to improve the ability of the legs' muscles while adapting the plyometric exercise with the direction of shooting skills leads to the improvement of the shooting rate.

(Vallabhajosula et.al 2005) conducted a study aimed to identify the kinematic differences of the part during the performance of plyometric exercise by multi-weight medical balls on a sample of 59 beginners. The descriptive methods (Mechanical analysis) have been used. The most important results were that
performing the successive chest pass 10 times by medical balls leads to the improvement of throwing angle associated with an indication, despite an increase of the weight of the ball. The increase of the weight of the medical balls should be taken into consideration during performing the plyometric exercise. (Ashley et.al 2006) conducted a study aiming to identify the effect of the plyometric training, Speed training and agility training on the thigh muscles, linear speed, agility and airless capability on a sample of 43 players. The authors used the experimental methods as the results show the superiority of the plyometric training in speed and agility during the training of the skills. (Kotzamanidis 2006) conducted a study aiming to identify the effect of the plyometric training on the running speed and vertical jumping for the beginners on a sample of 30 players divided to two groups. The author used the experimental method as the results show the improvement of the experimental group in the vertical jumping and running, especially, in the 30-m distance. (Markovic et al. 2007) conducted a study aiming to identify the effect of plyometric training on the work of the muscle and sport performance on a sample of 93 players divided to three groups. The author used the experimental method as the results show the improvement of the plyometric group in the tests of broad jumping, running a speed of 20 m and shuttle running of 30 m.

The ability of today's athletes has far exceeded the limits of the game put on it by the original inventors. The skills required of today's players are incredibly different than those of yesterday. Basketball now allows for individual athletes to exhibit physical aptitude within the context of an offense or defense. The attributes of cardio-vascular endurance, acceleration speed, change of direction and muscular strength along with size of skeleton rule the game as we know it today.

The athlete should be concerned with developing coordinative ability, muscular strength and speed as well as the cardio-vascular endurance to enable
the player to sustain maximum performance for the duration of the game. Maximum performance in basketball stresses primarily anaerobic sources available within the muscles, i.e. creatinephosphate.

Plyometric training is an excellent way to train for the demands of basketball. Training programs should include repeated high intensity work, followed by periods of recovery that mimic the specific tasks associated with basketball. This type of training is known as interval training. Plyometric drills should be progressive in nature and extend through the preparatory and preseason cycles of training. In season plyometric training is often too much for players who are maintaining a full schedule of two to four games per week. One of the most important components of basketball is the ability to jump vertically. It is necessary to assess an athlete’s jumping ability and strength levels before beginning the design of the training programme.

Plyometric training is an excellent way to train for the demands of basketball. Training programs should include repeated high intensity work, followed by periods of recovery that mimic the specific tasks associated with basketball. Optimism of controlling the training process in professional sport is possible only if it is based on systematic testing of the player’s physical fitness and motor abilities. The training of player’s physical fitness should focus on developing special abilities to ensure effective competition. Basketball is a discipline dominated by high and maximum intensity efforts based on anaerobic processes. Such efforts involve fast twitch fibers with a high level of anaerobic metabolism. This type of fibers determines the level of strength, power and jumping ability of players. Jumping ability is one of the major motor abilities of Basketball players. It is a complex ability, depending on strength, speed and coordination. Its high level is a condition of quick take-off, a high speed of player’s movements on the court, the jump height and consequently high playing efficiency.

Strength and conditioning professionals must now find a way to incorporate both types of training for athletes who require muscular power. One method is complex training. Complex training alternates biomechanically comparable high-load weight training and Plyometric exercises in the same workout combining the bench press with the medicine ball power drop is an example of upper body complex training (Chu, D.A 1992). Although only one training study has examined complex training (Verkhoshansky, et.al 1973), it has gained some degree of popularity among strength and conditioning professionals.

This review examines (a) weight training as a prerequisite to plyometric training, (b) combined weight training and plyometric training, and (c) complex training. Recommendations are made within the context of accepted principles of strength and conditioning, for the purpose of assessing the usefulness of complex training in developing power for athletic performance.

To explain complex training, we can begin with a review of how weight training and plyometric training historically have been viewed as complementing each other. For example, frequently published recommendations describe weight training as a prerequisite to plyometric training. Recommendations include implementing plyometric training after a specific period of preparation, such as 4-6 weeks of weight training (Hedrick
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1994), after several weeks or months of sprint and resistance training (Allerheiligan, et.al; 1994), after developing a strength base (Bauer, et.al 1990, Chu, D.A; 1992), or after gaining experience in basic jump training and weight training (Chu, D.A; 1992).

Functional strength is a prerequisite for plyometrics. Functional strength tests for the lower body include squatting 1-1/2 to 2-1 /2 times body weight (Allerheiligan, W.B et.al; 1994, Wathen, D.; 1993) or squatting 5 repetitions at 60% of body weight in 5 sec or less. Functional strength tests for the upper body include bench pressing body weight (for athletes weighing more than 115 kg, or approx. 250 lbs), 5 hand-clap push-ups, or bench pressing 1-1/2 times body weight. Weight training is used to prepare for plyometric training to reduce the chance of injury (Chu, D.A; 1992, Hedrick, A; 1994, Hedrick, A et.al; 1996), develop a strength base (Bauer, T et.al; 1990, Hedrick, A; 1994, Hedrick, A et.al; 1996, Wathen, D.; 1993) and prepare the musculoskeletal system for high impact forces. The literature is replete with recommendations for combining weight training and plyometric training, specifically, implementing plyometric training into an established weight training programme.

Combined Weight and Plyometric Training


According to (Young 1993), one needs to train with both heavy and light loads to develop speed strength. (Schmidtbleicher 1992) concludes that maximum

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strength and power are not distinct entities, and that power performance is influenced by training methods that maximize both strength and stretch-shorten cycle activity. More specifically, (Wilson et.al 1993) recommends that "traditional weight training," plyometric training, and "dynamic weight training" be combined to increase dynamic athletic performance. Newton and Kraemer say that mixed-method training, vs. weight training alone, trains both the force and velocity components for maximum power. According to (Yessis 1995), most athletic activity requires a combination of strength and speed.


The comparison of plyometric exercises and weight-training protocols has produced controversial results. Plyometric protocols have been shown to be more effective (Verchoshanski & Tatyan, 1983), equally effective (Adams et al., 1992; Anderst et al., 1994; Ioannis et al., 2000), or less effective (Stone &
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O'Bryant, 1986; Verkhoshanski & Tatyan, 1983) than weight training in improving the vertical jumping ability.

The combination of plyometric exercise and weight training increased (Adams et al., 1992; Baur et al., 1990; Ioannis et al., 2000) or maintained as unaffected the vertical jumping performance (Stone & O'Bryant, 1986). (Adams et.al 1992) suggested that this combination may provide a more powerful training stimulus to the vertical jumping performance than either weight training or plyometric training alone. However, (Clutch et. al 1983) did not reach similar conclusions.

It seems that researchers have not come to an agreement about the relative effectiveness of plyometric training compared with weight training or the combination of both in the development of explosive power performance.

Therefore, the purpose of the present investigation was to compare the effects of 8-week training period of plyometric, resistance and combined plyometric and resistance training with fitness and performance in youth Basketball players.

STATEMENT OF THE PROBLEM

The purpose of the study was to find out the “Effects of Plyometric, Resistance Training and Their Combination on the Fitness Level and Performance of Basketball Players”.

OBJECTIVES OF THE STUDY

The study had the following objectives:

1. To examine the effect of plyometric training on the fitness level of school national level female basketball players.

2. To draw out the effect of plyometric training on the performance of school national level female basketball players.
3. To observe the effect of resistance training on the fitness level of school national level female basketball players.

4. To find out the effect of resistance training on the performance of school national level female basketball players.

5. To examine the effect of combination of both (Plyometric & Resistance Training) on the fitness level of school national level female basketball players.

6. To examine the effect of combination of both (Plyometric & Resistance Training) on the performance of school national level female basketball players.

7. To know the comparative effect of Plyometric, Resistance and combination of both Plyometric & Resistance Training on the fitness level of school national level female basketball players.

8. To study the comparative effect of Plyometric, Resistance and combination of both Plyometric & Resistance Training on the performance of school national level female basketball players.

**HYPOTHESES OF THE STUDY**

On the basis of literature reviewed and scholar's own understanding of the problem, the following research hypotheses were prepared.

1. There would be significant effect of plyometric training on the fitness level of school national level female basketball players.

2. There would be significant effect of plyometric training on the performance of school national level female basketball players.

3. There would be significant effect of resistance training on the fitness level of school national level female basketball players.

4. There would be significant effect of resistance training on the performance of school national level female basketball players.
5. There would be significant effect of combination of both (Plyometric & Resistance Training) on the fitness level of school national level female basketball players.

6. There would be significant effect of combination of both (Plyometric & Resistance Training) on the performance of school national level female basketball players.

7. There would be significant effect of Plyometric, Resistance and combination of both Plyometric & Resistance Training on the fitness level of school national level female basketball players.

8. There would be significant effect of Plyometric, Resistance and combination of both Plyometric & Resistance Training on the performance of school national level female basketball players.

**DELIMITATIONS OF THE STUDY**

The study had the following delimitations:

1. The study was delimited to the female basketball players in the age group of 16 to 18.

2. The study was further delimited to School National level female basketball players.

3. The study was delimited to the duration of eight weeks training programme only.

**LIMITATIONS OF THE STUDY**

1. The factors such as home environment, daily routine and diet of students cannot be controlled, which were the limitations of the study.

2. No special technique was used to motivate the subjects during the administration of the tests.
DEFINITIONS AND EXPLANATION OF THE TERMS

Plyometric Training
Plyometric Exercises refers to those activities that enable a muscle to reach maximal force in shortest possible time. Plyometric is a combination of Greek words that literally means to increase measurement (plio= more; metric= to measure). A practical definition of plyometric exercise is a quick, powerful movement using a pre-stretch, or counter movement, that involves the stretch-shortening cycle (SSC).

(Thomas and Roger, 2000)

Resistance Training
Resistance Training refers to the training that increases a person’s potential to perform a sport or activity with more strength, power, control, and possibly endurance depending on training methods utilized and the particular sport or activity engaged in. Even more potential is the potential to perform these activities with a reduced risk of injury. Resistance training could possibly be the most important type of exercise one can do to prepare for any sport.

(Everett Aaberg, 1999)

Designing a resistance Training programme is a complex process that requires the recognition and manipulation of seven Program Design Variables. These are as follows: Need Analysis, Exercise selection, Training frequency, Exercise order, Training load and repetitions, volume and Rest periods.

(Thomas and Roger, 2000)

Fitness
Fitness is the ability to carry out daily tasks with vigor and alertness, without undue fatigue and with ample energy to enjoy leisure pursuits and meet unforeseen emergencies.

(Clarke, 1959)

Speed
Speed is the capacity of an individual in the rate of making successive movement of the same kind in least possible time.

(Meyer, 1974)
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**Performance**
Accomplishment of a given task measured against preset standards of accuracy, completeness, cost, and speed. It refers to the achievement of an individual that is measurable both in qualitative and quantitative terms.

**Agility**
Agility is the ability to change the direction of the body or of parts of the body rapidly. (Mc Cloy and Young, 1954)

**Strength**
Muscular strength is the force that a muscle or group of muscles can exert against resistance in one maximum effort. (Mathew and Fox, 1976)

**Flexibility**
Flexibility is usually interpreted as the range of motion of a particular joint measured in a degree. (Mathew, D.K, 1978)

**Cardiovascular Fitness**
Cardiovascular Fitness is the ability of the circulatory and respiratory systems to adjust to and recover from the effects of exercise or work. (Johnson and Nelson, 1982)

**SIGNIFICANCE OF THE STUDY**
The present study was conducted to observe the effects of plyometric, resistance training and their combination on the fitness level and performance of Basketball players and thus improves the standard of sports. The finding of the study will help the coaches and physical educationists to construct a scientific training module for Basketball players. The study will even help to improve the training plan of a team. The finding of the study may provide a source of guidance to the coaches to plan the future programme for training with relation to player's present performance.