CHAPTER I
CHAPTER – I

1.1. INTRODUCTION

Sports have become as competitive as other fields in the world. In ancient times, our ancestors exhibited the extraordinary talents in terms of physical activity. But now it has become completely professional. Somehow or other irrespective of age the human race is involved in different kinds of sports either for recreation or competition. In the present world, Sports have become extremely competitive. It is not mere participation or practice that makes an individual victorious. Sports life is affected by various factors like physiology, biomechanics, sports training, sports medicine, sociology and coaching, computer application and psychology and so on.

To achieve top level performance in the international arena one has to have a plan and systematic execution. To win medals, in the Olympics, there should be spotting of talent, systematic and scientific method of training, competitive exposure, etc. It is not only because of training, but also because of psychological, and physiological aspects that goals are achieved. The experts in the field of sports have put their mind into it and made tremendous efforts to find out ways and means to achieve top-level performance. During this Olympic season, one may hear from announcers, critics, commentators and even athletes that the Olympic Games are too commercial, too political, and too "professional," and that judging too is nationalistic.

It is easy to assume that the ancient Olympic Games were different, that ancient Greek athletes were pure in mind and body, and that they trained and competed for no other reason than the love of physical exercise, fair competition and to honor their gods.

In modern Olympics sports ideology has been totally changed. It is not to participate in the Olympics to honor their Gods, nor for love of physical exercise, but only to win medals that players compete. Almost all involving in
the sports think of winning medals in the international arena rather than participating in them. One cannot ignore the fact that for winning in particular sports at the international level one would have to sweat his life out for the sake of a medal. To win a medal in the Olympics, the knowledge and application of Sports Sciences are most essential. Many physical qualities and skills go into the making of a successful athlete. The craze and quest for high performance in sports have obtained new dimensions. The physical qualities required for top performance are targeted. The different training methods are invented to project the physical components and skills of sport. The experts in the field of all branches of sports take pains to achieve this goal. There are different training methods to attain the required physical fitness and skill perfection. They are resistance training, circuit training, plyometric training, interval training, and fartleg training.

Volleyball is a sport played by two teams consisting of 12 players each on a playing court, divided by a net. The object of the game is to send the ball over the net in order to ground it on the opponent’s court and to prevent the same effort by the opponent. The team has three hits or contacts to return the ball.

To play volleyball one has to be good at vertical jump, known as explosive power. A volleyball match can be played for five sets which means a match can last about 90 minutes, during which a player can perform 250-300 actions dominated by the explosive type of strength of the leg muscles. The total number of actions as jumps takes up around 50-60% high speed movements and change of direction in space about 30% and as falls about 15%. The spike and block actions are dominated by the corresponding explosive type of strength which is referred to as a player’s vertical jump which is usually the key to winning point (T.Stojanovic, Radmila Kostic 2004). Volleyball is a dynamic, fast-paced game. The purpose of strength training for volleyball is not to build big muscles, but to develop the physical attributes necessary to improve a player’s performance. So strength training is very important to volleyball and should not be developed independently of other
abilities such as agility, quickness and endurance. When watching a great volleyball player, the one word that comes to the mind is "quick". Everything the player does is short and quick. There are no long drawn out motions like sprinting in other sports. There is simply a succession of explosive bursts that keep the ball in play and control the flow of the game. The quickness that must be focused on, when training a volleyball player is not only quickness from side to side and front to back, but also quickness from up to down. Unique from other sports, volleyball players must be able to quickly change direction from the upward motion of a vertical jump to the downward motion of a point-saving dig (or vice versa). One of the most crucial phases of volleyball is how players perform at the net. To be successful, teams must be able to control play at the net both offensively and defensively. Since this is the case, two of the most valued traits in a volleyball player are height and jumping ability. Both of these traits allow players to greatly influence the game because they can more easily go where the ball is inevitably going...Up! Since there is no way to train height (yet), the focus of training falls squarely on jumping ability. Developing an athlete's jumping skills allows them to elevate quicker and higher in order to take better shots themselves and to block more of their opponent's shots. Also, since the same skills that send an athlete up also create quick first steps, improving jumping skills will also positively impact other areas of a volleyball player's performance!

Participation requires expertise in many physical skills and performance is often dependent on an individual's ability to jump and land. The incidence of injury in volleyball is similar to the rates reported for sports that are considered more physical contact sports.

The sport of volleyball has continued to increase in participation since its inception over one hundred years ago. Volleyball has become one of the most widely played participant sports in the world with over 200 million players (Aagaard et al., 1997; Briner and Kacmar, 1997). The number of participants rivals the number of soccer participants (250 million) reported by the Federation Internationale de Football Association (Dvorak et al., 2000). Another indication
of the worldwide appeal of all forms of volleyball was the inclusion of beach volleyball as an Olympic sport in 1996. The potential reasons for the popularity of volleyball are that the sport requires a minimal amount of equipment and that individuals can participate throughout their lives at a variety of skill levels. Women's athletics is one segment of the sporting community that has seen particular support for volleyball.

It is important to consider that spikes and blocks are not only jumps, but jump-landing sequences. In particular, the landing phase requires dissipation of the kinetic energy generated during the jump. Newtonian mechanics dictates that increases in jump height (most prevalent in elite volleyball players) must be accompanied by a proportional increase in the kinetic energy that must be properly absorbed to avoid injury (Dufek and Zhang, 1996). These landings often result in the creation of ground reaction forces on the order of five times body weight (Adrian and Laughlin, 1983). The deleterious effects of these forces may be compounded when considering that a front-row player may jump and land many times during a regulation match.

The predominant requirement for success in a large number of athletic skills is explosive power. For the lower body, this is perhaps best exemplified by the vertical jump. During vertical jumping, the muscles about the hips, knees, and ankles act rapidly and with great force in an attempt to produce the greatest possible velocity of the body as it leaves the ground; the jump height is ultimately determined by the takeoff velocity. This article addresses the factors that contribute to vertical jumping ability and describes the training strategies that have been shown to be effective in achieving maximal jump performance.

Dynamic strength is defined as the maximal ability of a muscle to exert force or torque at a specified velocity (Knuttgen & Kraemer, 1987) and is often assessed by using a one-repetition-maximum (1 RM) test, in which strength is defined as the maximal weight an athlete can lift one time through the entire range of motion. However, tests of 1 RM strength are of limited practical value because this specific type of strength is employed in only a few athletic endeavors, such as power lifting. Most sports require the explosive application
endeavors, such as power lifting. Most sports require the explosive application of force to accelerate the body or limb, whereas 1 RM strength tests do not require rapid acceleration to produce the necessary force. In fact, 1 RM type of strength is maximized during slow muscle actions and minimized as the velocity of movement increases (Figure 1). Conversely vertical jump performance requires great power; that is, the ability to exert force rapidly through a vertical distance.

Obviously the ultimate test of vertical jumping ability is simply to measure the height of the athlete's vertical jump. However, various other tests can be used to assess different components of vertical jump performance, including the athlete's maximal leg strength, the maximal rate at which force can be developed, the ability of the athlete to increase power by employing the stretch-shortening cycle during the crouch before the jump, the ability of the athlete to generate maximal mechanical power, and the athlete's ability to coordinate the movements involved in jumping (Table 1). Using such tests on a regular basis could be important in helping the coach to determine which component is deficient so that training can be implemented to address the deficiency and to provide motivation to the athlete.

Muscular strength clearly contributes to vertical jump performance, but whether or not an athlete's jump performance will be improved by concentrating on improving absolute strength seems to depend on how strong the athlete is at the initiation of a training program. Thus, vertical jump performance improved markedly following strength training in subjects who began training with only average strength (Adams et al., 1992; Bauer et al., 1990; Clutch et al., 1983), but very little in previously strength-trained individuals (Hakkinen & Komi, 1985a).

Lower body strength in the jump movement can be assessed by 1 RM squat or leg press. For a complete analysis of rate of force development, maximal mechanical power, and ability to employ the stretch-shortening cycle, a force plate is the instrument of choice. However, some measures can be
recorded with less sophisticated equipment. For example, the height of a jump initiated by a crouch or squat performed either slowly (static crouch) or rapidly (counter movement crouch) can be measured using the jump-and-reach test or an electronic contact mat with timer attached. In addition, many aspects of jump performance can be appraised by measuring the time in contact with the ground and flight times for jumping upward immediately after dropping down from various heights (drop jumps) (Bosco et al., 1982; Schmidtbleicher et al., 1988). These variables can also be measured using a simple electronic contact mat with a timing device to record the contact and flight times (Bosco, 1992a, b). For a detailed explanation of the methods for assessing various muscle functions during a vertical jump, the interested reader is referred to Bosco (1992a,b).

It is intuitively obvious that the ability to generate force rapidly is a major contributor to vertical jump performance. As an extreme example, a very strong individual who tries to smoothly execute the vertical jump movements slowly over a period of 10 s will never leave the ground. To examine the maximal rate of force development, scientists determine the maximal slope of the early portion of the force: time curve during maximal strength tests; it is at this portion of the curve that the rate of force production is maximal, and the resulting value is termed the maximal rate of force development (mRFD).

In support of the notion that the maximal rate of force development is important to vertical jump performance, many investigations have shown that (mRFD) is a very significant factor in explosive performance (Behm & Sale, 1993b; Hakkinen & Komi, 1985 a, b; Schmidtbleicher, 1992). Surprisingly, however, a recent study on the rate of force development in isometrically contracting muscles reported a poor relationship between mRFD and vertical jump performance (Young & Bilby, 1993). Thus, one is faced with the dilemma of which joint angle to test when attempting to predict dynamic performance through an entire range of the movement, as in a vertical jump. Therefore, it may be more appropriate to use dynamic RFD tests in which a constant load (isoinertial) rather than an isometric load is used.
It is not surprising that training-induced improvements in maximal force during slow movements do not usually produce great improvements in mRFD or in vertical jump ability. In fact, such training might even reduce the ability of the muscles to develop force rapidly (Hakkinen, 1989). On the other hand, vertical jump training with light loads increases an athlete’s ability to rapidly develop force (Hakkinen et al., 1981). Although heavy resistance training increases maximal strength (and thus the highest point on the force: time curve), this type of training does not improve vertical jump performance appreciably, especially in athletes who have already been strength trained for more than 6 mo. This is because the time during which the feet are in contact with the ground or floor while executing a vertical jump is typically less than 350 ms, and most of the training-induced increases in force-producing potential cannot be realized over such a short time.

A heavier athlete obviously must generate a greater power output to jump a given height when compared to a lighter athlete. It is a common belief that strength training should be minimized when training for vertical jump improvement because additional body weight should be avoided, even if that extra weight consists largely of increased muscle mass. However, an increase in muscle cross-sectional area is always accompanied by an improvement of relative strength and, therefore, an improved power-to-weight ratio (Schmidtbleicher, 1992). This is evident in the exceptional vertical jumping ability and 30 m sprinting performances of many heavy athletes such as American football players, weight throwers, and weightlifters (Hatfield, 1989; Schmidtbleicher, 1992). Thus, strength training cannot be justifiably excluded from a vertical jumping training program for the reason that an athlete might gain muscle mass.

1.2. SPORTS PERFORMANCE

One of the greatest pleasures in the sports is exposure to performance at its highest level. There is something almost artistic about an athletic that is well beyond the normal and demonstrates exceptional grace speed, and control
while performing a skill. Getting to the highest level requires skill attainment, mental toughness, years of purposeful practice and dedication.

Successful sports performance at the highest levels of competition often depends heavily on explosive leg power of the athletes involved. In many individual sports such as track and field events, gymnastics and diving ability to use high levels of strength as quickly and as explosively as possible is essential to perform at a elite level. Many team sports also require high levels of explosive power, such as basketball, volleyball and football for achieving success at elite levels of competition.

The ultimate aim of sports training is to achieve top level performance and win medals in the Olympics. Serious athletes' do not need reminding of the importance of sports conditioning. They know it is not enough nowadays simply to put in hundreds of hours of basic training - be it on the bike, on the track, in the pool or on the court.

One's best gains in performance will be achieved when key parts of one's training closely mimic what one does when one competes. The more specific one's training, the greater will be the impact on one's performance.

In many individual sports such as Track and Field events, Gymnastics and Diving the ability to use high levels of strength as quickly and as explosively as possible is essential to perform at elite levels. Many team sports also require high levels of explosive power, such as Basketball, Volleyball, Netball and the Rugby and Football codes for success at elite levels of competition.). Until recent years, powers as it relates to sports performances has been the subject of limited research, but in the last decade or so researchers have realized the importance of training for power in a wide variety of sporting activities.

Vertical and horizontal jumping, in its many different forms, requires high levels of explosive muscular power. The double legged volleyball spike jumps and block jumps are very different in technique, but fundamentally they are similar Basketball players typically jump from one leg to perform a lay up, and
from two legs to rebound jump. Again both are very different styles of jumping which are fundamentally similar in their movement patterns. Different jumping styles also involve very different approaches and run-ups which increase or decrease the velocity of the movement performed, depending on the type of jump. It has been suggested that different styles of jumping require different strength properties and that training for one type of jumping technique will not necessarily improve performance in another style of jumping.

There have been many research studies that have investigated leg power as it relates to vertical jump and about how to develop leg power through various weight training and plyometric training techniques. Data has been produced for many elite individual and team sport athletes for physical and physiological characteristics, including standing vertical jump scores, related to specific sports performance. There is limited research available however, comparing athletes of different sporting disciplines in vertical jump ability, in an attempt to explain why athletes in some sports perform better at vertical jump than athletes in other sports.

To compete at one's very best; one needs to build the appropriate strength, power and speed elements into one's conditioning regime. That is what gives one the extra edge one needs, to excel at one's sport. Players all want more of it, whether they are 100m sprinters or marathon runners. After all, is it any more frustrating to lose a track event in the last two meters, or a marathon in the last two hundred yards?

However, it is often assumed that those blessed with great speed or strength are born with a higher percentage of fast-twitch muscle fibers, and that no amount of speed work (or neuronal stimulation) will turn a cart-horse into a race horse.

But, in fact, fast-twitch fibers are fairly evenly distributed between the muscles of sedentary people, with most possessing 45-55% of both fast- and slow-twitch varieties. That means few of us are inherently destined for any
particular type of sports activity, and how we develop will depend mostly on two factors:

1.3. SPORTS TRAINING

Sport training is a physical, technical, moral and intellectual participation of an athlete 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 materials 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.

1.4. PURPOSE OF SPORTS TRAINING:

The purpose of the training programme is to produce metabolic, physiological and psychological adaptation that allows the sportsperson to achieve top level performance. When the training increases the demand for aerobic energy, the number of size of muscle mitochondria will increase so that in these chemical factories where aerobic metabolism takes place becomes larger and more numerous. These will help athletes to provide more energy from aerobic metabolism. There are three steps of adaptation; the first involves creating the need for more aerobic energy. Training must be sufficient in both duration and intensity to accomplish. The second step is to provide nutrients to build and repair mitochondrial tissues. Third is that the athlete must be given enough rest to regain the energy as super compensation. There are different
types of training by which one can attain the required development. Each training has its own effect.

1.5. PLYOMETRICS

Plyometrics by definition is, a type of exercise using explosive movements to develop muscular power, esp. bounding, hopping and jumping. This is a somewhat narrow interpretation. Plyometrics or 'Shock method training' is the term now applied to exercises that have their roots in Russia, where it was first known simply as jump training drills. The actual term "Plyometrics" was first coined in 1975 by FRED WILT, one of American’s more forward-thinking track and field coaches. Based in Latin origins ploy + metrics means "measurable increases".

Plyometric is a term that describes exercises that help bridge the gap between strength and speed. It refers to human movement that involves an eccentric muscle contraction immediately and rapidly followed by concentric contraction. The main objective in plyometric training is to improve quickness through strength. The fast twitch or white fiber is responsible for explosive type of muscular contraction. Dr. Chu (1996) states "Plyometric has undergone a considerable metamorphosis over the past few years. New ideas and techniques will lead the reader into the second generation of plyometric training. The coach or trainer who understands the options and opportunities available through plyometric will find new ways to train athletes".

"Throughout the 1980's coaches in sports such as volleyball, football and weight lifting began to use plyometric exercises and drills to enhance their training programme. If there was any draw back to this enthusiasm it lay with the lack of expertise that American coaches and athletic had in administrating plyometrics and the faulty belief that more must be better", as commented by Dr.Chu(1996).
Plyometrics can best be described as a reflexive form of power training. This type of training involves powerful muscular contractions in response to a rapid stretching of the involved musculature. These powerful contractions are not a pure muscular event. In fact they primarily involve and augment the nervous system. It is the combination of involuntary reflex (Myotatic "stretch-reflex") which is then followed by a fast muscular contraction. This is the basic idea behind the question of the ability of plyometric training to improve athletic performance, particularly sprints and jumps, which continues to be debated. Many researchers have searched, and continue to search, to answer whether plyometrics can be the link between strength training and power development. Based on scientific discoveries, it is our position that, with proper preparation, instruction, and progressions, plyometric training can be an effective method of training athletes explosively while also preventing injury.

In 1966, Yuri Verkhoshanski, a Soviet jumping coach, discussed the importance of finding new methods to improve athletic performances because traditional training protocols, which included high volumes of jump training plus weight training, were becoming less effective. Verkhoshanski observed that the athletes, who spent the least amount of time on the ground, or in the amortization phase, displayed the greatest jumping performances. Based on this observation, he reasoned that the athletes’ muscles must also be strong eccentrically in order to withstand the high mechanical forces placed on the body during the amortization phase. Training the muscles eccentrically, he believed, would enable them to overcome the eccentric loading quickly to concentrically contract immediately, propelling the body in the desired direction. This allows the athlete to exploit the energy stored in the muscle during the eccentric stretch phase. Therefore, by increasing the amount of tension the athlete can generate during the eccentric contraction and by improving the reactive ability of the muscles in switching from eccentric to concentric work, improvements in jump performance can be made (Verkhoshanski 1966). Verkhoshanski realized early on, however, that in order for improvements to be made, proper progressions must exist.
Fred Wilt (1975) wrote of plyometrics as a training technique used by European coaches as a means to bridge the gap between sheer strength and speed. Wilt even suggested that Valery Borzov's surprising wins in the 100 and 200 meter sprints at the 1972 Olympics were due in large part to his plyometric training. This article led to the widespread implementation of plyometrics into American training, but also sparked the ongoing debate on the effectiveness of plyometric training for improving athletic performances. This type of training was made famous by Eastern European athletes, who were continually beating North American athletes at most strength and speed events. Through the late 70's and 80's plyometrics became an integral part of any sports conditioning program.

Wherever one looks in the world of top-class sport, power counts; and one of the best ways of developing this most precious commodity is through plyometric training.

This literature review has attempted to offer a comprehensive look at the history, development, and effectiveness of plyometric exercises. It has also attempted to provide a clear understanding of how to safely implement a successful plyometric training program. Although originally developed by NASA and then by the Soviets for sport, plyometrics has become a mainstream training method for athletes. Numerous studies have shown both the effectiveness in producing athletic improvements and also as a rehabilitative device, especially when combined with strength training. Many misconceptions and critics of plyometrics still exist, however Critics suggest that plyometrics are a dangerous training method and cause injury, but no studies confirm these beliefs when plyometrics are taught and progressed properly. Progressions are an essential part of any plyometric routine to minimize the risk of injury to an athlete. Athletes must progress through the exercises individually, constantly monitoring posture, balance, stability, and flexibility. When these reach satisfactory levels, only then will the athlete progress to more complex, higher intensity drills. When taught and progressed properly, plyometrics can be an
extremely effective method of developing athletic power, increasing maximal strength, and preventing injury.

Plyometric exercises are based on the understanding that a concentric (shortening) muscular contraction is much stronger and it immediately follows an eccentric (lengthening) contraction of the same muscle. It is a bit like stretching out a coiled spring to its fullest extent and then letting it go: immense levels of energy are released in a split second as the spring recoils. Plyometric exercises develop this recoil or, more technically, the stretch/reflex capacity in a muscle. With regular exposure to this training stimulus, muscle fiber should be able to store more elastic energy and transfer more quickly and powerfully from the eccentric to the concentric phase. However, to get the best out of plyometrics one needs adequate preconditioning. And that is where weight training can play a crucial role. Moreover, when it comes to selecting the right plyometric moves, the coach or athlete needs to consider the specifics of their sport, the athlete's maturity, his level of pre-conditioning and his ability to pick up what can be a complex skill.

Plyometric training is now a common element of elite sports training programmers, and is increasingly used by other athletes and their coaches. But while its beneficial effects on the lower body are well documented, there are some lingering doubts over how useful it is for upper body force development.

First documented as an effective training method by Soviet coaches in the middle of the last century, the main purpose of ‘plyometrics’ is to increase the rate of force development, the key ingredient of power. By contrast, the main purpose of heavy weight training is to increase total force production – i.e. maximum strength.

It is logical for athletes to seek to increase the rate of force development, because most sporting movements involve fast movements, for which forces must be generated quickly. The foot-to-ground contact time in high jump, for example, is less than 100 milliseconds, yet it will take around 500 milliseconds
to generate maximum force. For elite performance, an athlete's rate of force development is often more important than the maximum force he or she is able to generate.

The other advantage of plyometric training is that it comprises jumping and throwing movement patterns that involve a stretch-shortening-cycle (SSC). The muscle and tendons are first lengthened with an eccentric load — e.g., pulling back your arm to throw a ball — which may increase the subsequent concentric force production and/or allow release of elastic energy — e.g., as the arm accelerates forwards to release the ball. Since most sporting movements involve sprinting, jumping and throwing SSC movements, plyometric training can be viewed as highly sport specific plyometrics, which if not used wastes away." Progressive resistance training dates back at least to, Ancient Greece when legend has it that the wrestler Milo of Corton trained by carrying a newborn calf on his back everyday until it was fully grown. Another Greek, the physician Galen, described strength training exercises using the halters (an early form of dumbbell) in the 2 century.

A requirement for using Plyometrics in one's training programs is an understanding of what Plyometrics is and how it works. The initial chapter in the book does a precise, clearly worded, and easy to understand explanation of a complex system. Dr. Chu's commentary, embedded throughout the book, does a good job of focusing both the science of Plyometrics with, advances in thinking regarding their use in sports specific training programs. For example, he states "Throughout the 1980's, coaches in sports such as volleyball, football, and weightlifting began to use Plyometric exercises and drills to enhance their training programs. If there was any drawback to this enthusiasm, it lay with the lack of expertise that American coaches and athletes had in administering Plyometrics and the faulty belief that more must be better".

Simply stated and starkly accurate, plyometrics defined is "exercises which enable a muscle to reach maximum strength in as short a time as possible". This speed-strength ability is known as power.
1.6. RESISTENCE TRAINING

It is a form of exercise for the development of strength and size of skeletal muscles. It is a common type of resistance training, which is one form of strength training. When one does it properly it can provide significant functional benefits and improvement in overall health and well-being. In one common training method the teaching involves lifting progressively increasing amount of weight and uses a variety of exercises as type of equipment to target specific muscle group. It is primarily an aerobic activity although some proponents have adopted it to provide the benefits of aerobic exercises.

Resistance training, also known as weight training or strength training, is for everyone. It is an important tool for achieving a complete healthy life. Resistance training is not only for athletes, but also for those who want to build or tone muscle, or those who are using resistance training to achieve a better looking body. One may also hear the terms weight training (or weight lifting) and strength training used to describe working the muscles with resistance. Resistance training is the term used to describe using weights, machines, and even one's own bodyweight to effectively work one's muscles. It is an umbrella term used to accurately describe all forms of resistance training, whether working with weights or not. Although strength training accurately describes what resistance training does, many people do not use the term because they think it only applies to those trying to become bigger and stronger when, in fact, all resistance training which is correctly done indeed increases strength, but does not necessary visibly increase size. Resistance training does improve the look and tone of the body but it is now known to be more than just a specialized exercise activity.

Resistance training environment involves numerous types of equipment to improve variety in a health-club of physical capacities - from improving daily movement to enhancing performance or changing appearance. In particular, resistance training improves the functional performance of the neuromuscular system - the system of muscles and nerve pathways that direct and control
movement. Resistance training produces increased strength, superior movement performance and general fitness, including enhanced function of the respiratory, cardiac and metabolic systems. Other improvements include an increase in muscle mass, strengthening of connective tissue and supportive tissue as well as improvements in posture and physique. Resistance training has many psychological benefits as well. It can boost self-confidence, increase motivation, enhance perseverance and produce a strong commitment to fitness. Serious athletes do not need reminding of the importance of integrating resistance training into their year-round conditioning regimes. They know there's no quicker way to significantly boost their levels of strength, speed – and even their endurance.

Strength training using isometric exercises was popularized by Charles Atlas (1930). The 1960s saw the gradual introduction of exercise machines into the still-rare strength training gyms of the time. Weight training became increasingly popular in the 1980s, following the release of the bodybuilding movie Pumping Iron and the subsequent popularity of Arnold Schwarzenegger. Since the late 1990s increasing numbers of women have taken up weight training, influenced by programs like Body of Life. The two benefits from traditional strength work are increased neural activity and increased muscle mass (hypertrophy).

To develop the rate of force the Type IIb muscle fibres need to be targeted as these are the ones that produce force most explosively allowing for maximum power. The sorts of exercises that develop the Type IIb fibers are: Speed strength exercises, e.g. weighted squats jumps What athletes do need is reliable, unbiased and up-to-date information on resistance training Best Practice – particularly the central issue of how one increases strength and power without adding unnecessary bulk, a subject on which it is rare to find independent, evidence-based advice.

Hippocrates wrote, “That which is used develops and that which is not used wastes away” A repetition is the act of lifting and lowering a weight once in
a controlled manner; a set is lowest of several repetition performed one after another with no break between them. Weight training creates muscle growth by increasing microtrama of the muscles. Weight also provides functional benefits. Stronger muscles improve posture and provide better support for joints. Stronger muscles improve performance in a variety of sports. During the past few years, endurance athletes in a number of sports have added resistance exercises to their training programs to boost their muscle power. Scientific studies have linked resistance training with a reduced rate of injury in athletes. It fortifies leg muscles and strengthens ‘weak links’ in athletes' bodies, including the often-injured hamstrings and shin muscles, as well as abdominal and low-back muscles. Resistance work also improves tendon and ligament strength and increases bone density, which decreases the risk of injury.

It is common knowledge that all other things being equal, a weight trained muscle is not only better able to generate force; it is also more resilient and less susceptible to injury. But while the effects of different weight training regimes on muscular performance are well understood, few athletes or coaches are aware of the effect of weight training on hormone balance in the body. As John Shepherd explains, these weight training induced hormonal changes have a profound effect on musculature, body weight and subsequent performance of an athlete.

According to John, the findings in this field have demonstrated the following. The intensity of a weight training program can affect the production of natural hormones, thereby altering body mass. The age and gender of an athlete will affect how that athlete's hormonal balance responds to a weight training program. Many conventional and popular weight training programs can actually produce inappropriate hormonal responses for a particular sport! The idea is to use the combination of resistance and plyometric exercise to superbly engage the nervous system and activate more muscle fibers.
1.7. COMPLEX TRAINING

It is a highly effective form of physical training that combines both resistance strength training and plyometric explosive power training. The idea is to use the combination of resistance and plyometric exercises to superbly engage the nervous system and activate more fibres. Complex training describes a power-developing workout that combines weights and plyometric exercises. About 10 years ago, these workouts were greeted with great acclaim as research indicated that they could significantly enhance fast twitch muscle fiber power and, therefore, dynamic sports performance. According to Beachle & Earle (1994) complex training is a combination of high intensity resistance training followed by plyometrics. Ebban states that complex training alternates bio mechanically similar high load weight training exercises with plyometric exercises. An example of complex training would include performing a set of squats followed by a set of jump squats.

The logic behind this pair of exercise is that the resistance work gets the nervous system into full action so that type II b fibers are available for the explosive exercise, hence a better training benefit of complex training programme can be used in the general, specific and competitive phase of training. Ebbon (2002) in his recent literature review has stated that complex training has investigated both the acute and long term effects of this conditioning approach. Complex training describes a power-developing workout that combines weights and plyometric exercises. About 10 years ago, these workouts were greeted with great acclaim as research indicated that they could significantly enhance fast twitch muscle fiber power and, therefore, dynamic sports performance. The two benefits from traditional strength work are: increased neural activity and increased muscle mass (hypertrophy).

Many athletes include plyometric exercises in their training programs and are well aware of their benefits. However it is slightly less well known that the combination of traditional strength with power and plyometric exercises together results in greater Type IIb recruitment and consequently greater improvements.
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1.8. COMPLEX TRAINING THEORY

The proposal of the theory underpinning complex training is for training the neuro muscular system specifically for maximum power output and force development and for maximizing the involvement to the fastest muscle fibres. According to Ebbon and Watts (1998) “high load of weight increases motor neuron excitability and reflex potentiation, which may create optimum entry conditions for subsequent plyometric exercises. Also the fatigue associated with high load weight may force more motor units to be recruited during the plyometric phase for the possible enhancing of the training state.

1.9. STATEMENT OF THE PROBLEM

The purpose of this study was to analyze the effect of resistance, plyometric and complex training on the training outcomes of volleyball players.

1.10. HYPOTHESES

1. It was hypothesized that the plyometric training may improve the selected variables of anaerobic power, explosive power, muscular strength, and skill performance of volleyball players.

2. It was hypothesized that resistance training may improve the selected variables of anaerobic power, explosive power, and muscular strength.

3. It was hypothesized that the complex training (combination of plyometric and resistance training) may improve the selected variables of
anaerobic power, explosive power, muscular strength and skill performance of volleyball players.

4. It was hypothesised that the complex training (combination of plyometric and resistance training) may improve the selected variables of anaerobic power, explosive power, muscular strength, and skill performance of volleyball better than the resistance training and plyometric training.

5. It was hypothesised that the resistance training may significantly develop the selected variables of anaerobic power, muscular strength, better than the plyometric training group.

6. It was hypothesized that the plyometric training group may significantly develop the selected variables of explosive power, and skill performance better than the resistance training group.

1.11. SIGNIFICANCE OF THE STUDY

The ultimate purpose of this study is to help and guide the coaches and players of the volleyball to understand the benefit of the complex training and to develop their explosive power and skill performance.

1.12. DELIMITATIONS:

The study was restricted to the following aspects.

1. This study was conducted on Sports Development Authority of Tamilnadu sponsored Sports School volleyball players, and Vidyalaya college of arts and science volleyball players.

2. The training programme was confined to 6 weeks.

3. The study confined to 40 volleyball players who were selected at random basis.
4. They were divided into 4 groups namely Resistance training group (RT n =10), Plyometric training group (PT n=10), Complex training group (CT n=10), and control training group (CG n=10).

5. The variables were delimited to physical variables such as Explosive power, Anaerobic power and Muscular strength, and skill performance variable such as Jump service, Attack-Hit in volleyball.

1.13. LIMITATIONS

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

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

3. No attempt was taken to control the factors such as air resistance, intensity of light, atmosphere and temperature during the training period.

4. The subjects' previous experience in physical activities and playing the game volleyball were not taken into consideration.

1.14. DEFINITION OF TERMS:

1.15. TRAINING:

Training has been explained as a programme of exercises designed to improve the skills of sport and increase the energy capacities of an athlete for a particular sport.

1.16. RESISTENCE TRAINING

It is a form of exercise for the development of strength and size of skeletal muscles. It is a common type of resistance training which is one form
of strength training. It can provide significant functional benefits and improvement in overall health and well being.

1.17. PLYOMETRIC TRAINING

Plyometrics by definition is, a type of exercise using explosive movements to develop muscular power, esp. bounding, hopping and jumping. This is somewhat narrow interpretation. Plyometrics or ‘Shock method training’ is the term now applied to exercise that have their roots in Russia, where they first known simply as jump training drills. The actual term "Plometrics" was first coined in 1975 by FRED WILT, one an American's more forward thinking track and field coaches.

1.18. COMPLEX TRAINING:

It is highly effective form Physical training that combines both resistance strength training and plyometric explosive power training. Beachle & Earle, complex training is a combination of high intensity resistance training followed by phyometrics. Ebben (2002) states that complex training alternate's bio mechanically similar high load weight training exercises with plyometric exercises.

1.19. VOLLEYBALL

Volleyball is sport played by two teams consisting of 12 players each on a playing court divided by a net. The object of the game id to send the ball over the net in order to ground it on the opponent’s court, and to prevent the same effort by the opponent. The team has three hits or contacts to return the ball.

1.20. SKILL PERFORMANCE

The ability of the player to execute the various techniques of the fundamental volleyball skills, efficiently, and accurately, according to the game situation.
1.21. SERVICE

The service is the act of putting the ball into play by the back-right player, placed in the service zone.

1.22. ATTACK-HIT

All actions which direct the ball towards the opponents, with the exception of service and block, are considered as attack-hits.