

Chapter-I

INTRODUCTION

The world is on wheels, moving faster day by day even though it is always regular 24 hours for a day. We do not allocate time for outdoor activities as it used to be in the olden days. Practice makes it a habit. Encouraging family members to participate in games and sports are greater ways towards a healthy life.

The word 'Training' has been a part of human language since ancient times. It denotes the process of preparation for some task. This process invariably extends to a number of days and even months and years. The term 'Training' is widely used in sports. There is, however, some disagreement among sports coaches and also among sports scientists regarding the exact meaning of this word. Some experts, especially belonging to sports medicine, understand sports training as basically doing physical exercises.

The term training refers to the acquisition of knowledge, skills, and competencies as a result of the teaching of vocational or practical skills and knowledge that relate to specific useful competencies.

Training induces physiological changes in almost every system of the body, particularly within the skeletal muscle and the cardio respiratory system. The changes resulting from training are influenced by the frequency, direction and particularly, by the intensity of the training program, and heredity. The effects of training are specific to the type of exercise performed, the muscles groups involved and to the

type of training program used. The specificity of training and exercise has two broad physiological bases – metabolic and neuromuscular. Training effects can be maintained with programs consisting of one or two days of exercise per week. Previous training does not significantly influence the magnitude or rate of gain of training effects induced by subsequent training program.

Sports' training is done for improving sports performance. The sports performance, as any other type of human performance, is not the product of any single system or aspect of human personality. On the contrary, it is the product of the total personality of the sports person. The personality of a person has several dimensions e.g., physical, physiological, social and psychic. In order to improve sports performance the social and psychic capacities of the sports person have to be improved in addition to the physical and physiological ones. In other words the total personality of a sportsman has to be improved in order to improve his performance. Sports' training, therefore, directly and indirectly aims at improving the personality of the sportsman. No wonder, therefore, sports training is an educational (i.e., pedagogical) process.

"Sports training is a scientifically based and pedagogically organized process which through planned and systematic, effect on performance ability and performance readiness aims at sports perfection and performance improvement as well as at the contest in sports competition".

"Sports training, based on scientific knowledge, is a pedagogical process of sports perfection which through systematic effect on

psycho-physical performance ability and performance readiness aims at leading the sportsman to high and the highest performance. Through active and conscious interaction with the given demands in sports training, the sportsman's personality develops according to the norms and standards of socialist society".

The ability of muscles to exert maximal force output in a minimal amount of time (also known as rate of force production) enhances performance during functional activities.

1.1 PLYOMETRIC TRAINING

The term plyometric has been derived from the Greek word pleythyein' means "to augment" or "to increase" and the shorter Greek words 'plio' means "more" and 'plyo' means "to move" and 'metrics' means "to measure" or "length" (*Radcliffe et al., 1999*).

Power output and reactive neuromuscular control represents a component of function. Power and reactive neuromuscular control are perhaps the best measures of success in activities that require rapid force production. Plyometric training, also called reactive training, makes use of the stretch shortening cycle to produce maximum force in the shortest period of time and to enhance neuromuscular control efficient, rate of force production, and reduce neuromuscular inhibition (*Chimera et al, 2004*).

Plyometrics refers to exercises that enable a muscle to reach maximal strength in as short a time as possible. Such exercise usually involves some form of jumping, but other modes of exercise exist. The elements ply and metric come from Latin roots for "increase" and

“measure”, ‘respectively; the combination thus means “measurable increase”. Plyometric exercise utilize the force of gravity (e.g., you step off a box) to store energy in the muscles (potential energy). This energy is then utilized immediately in an opposite reaction (e.g., you immediately jump up, up on landing), so the natural elastic properties of the muscle will produce kinetic energy.

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

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

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

Power is the ability to produce maximal muscular forces very rapidly, and is therefore very important in the game of rugby. Plyometric are specialist exercises that enable a muscle to reach maximal strength in a short space of time. This works by stretching a muscle and then relying on its elastic properties to produce greater forces that are normally possible in the reflex contraction which means muscle returns to its resting length.

In order to achieve this greater muscular force, the muscle must contract within the shortest possible time following lengthening. The

following drills use dynamic movements to achieve such a stretch-shortening in a muscle, thus causing a faster concentric contraction of the muscle.

Plyometric is one of the best ways to improve power. When a person performs a specific resistance movement, such as jumping, the fastest would be said to have more power. Therefore, power is not just the contraction of a muscle, but also how fast it contracts. Research has shown that a muscle will contract the fastest after it has been loaded. Research has shown that practicing plyometric will decrease the time it takes for the muscles to contract resulting in more power.

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

A plyometric exercise involves an eccentric contraction, a brief amortization phase which means no change in muscle length and a

short concentric contraction delivering maximum force in a short period of time.

Plyometric is any exercise where the muscle is stretched (loaded) before it is contracted. A good example is push-ups with a clap between each push-up. Muscles are elongated and loaded by the downward force of the body, then immediately contract the muscles to push back. For a muscle to cause movement it must shorten; this is known as a concentric contraction. There is a maximum amount of force with which a certain muscle can concentrically contract. However, if the muscle is lengthened that is while loaded eccentric contraction just prior to the contraction, it will produce greater force through, "the storage of elastic energy. This effect requires that the transition time between eccentric contraction and concentric contraction or amortization phase be very short. This energy dissipates rapidly, so the following concentric contraction must rapidly follow the eccentric stretch. The process is frequently referred to as the "stretch shortening cycle", and is one of the underlying mechanisms of plyometric training.

Wherever we look 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. The soviets were strong users of plyometrics and their early success in the jump events was credited in large part to this type of training. Plyometrics exercises are based on the understanding that a concentric (shortening) muscular

contraction is much stronger if it immediately follows an eccentric (lengthening) contraction in 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 recoil / stretch / reflex capacity in a muscle. With regular exposure to this training stimulus, muscle fibers 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 where weight training can play a crucial role.

Thus plyometric training is the key to develop maximal explosive power and speed of movement, which in turn is the key element involved in sports. By doing various plyometric exercises, one can increase the performance level greatly.

The secret to unlocking dormant speed and power within athletes is very simple. The key is to develop their overall athletic ability by developing all the elements required for success in any sport by using ideal training modalities.

Maximal power training and plyometric training have become very popular in developing explosive power. Explosive power is seen in quick movement when body weight is propelled either upward or forward, it is characterized by one short burst of energy and is seen in such tests as the standing long jump and vertical jump. It has been

known for a long time that the amount of energy transformed in muscular exercise is proportional to the oxygen consumption.

1.1.1 BENEFITS OF PLYOMETRIC TRAINING

The benefits of plyometrics are the simple but elusive athletic needs of more speed, more stamina and more power, be it in running, jumping, throwing, swimming or another sport-specific movement. It's about the efficient use and manipulation of muscles to produce consistent peak performance, not about building bulkier muscles.

These benefits come with practice, training and care. These exercises take competitive athletes who want a permanent, physical edge to the next level of competition by teaching their bodies to do what they want them to do. While sometimes used to build muscle back as part of rehabilitation or physical therapy, plyometrics are still primarily for use by athletes who are in training and are already strong, fit and flexible. Flexibility prevents injury, while also ensuring that the plyometrics are used to their peak efficiency. It also helps to be strong and currently engaged in a strength-building routine.

1.2 ANAEROBIC TRAINING

Anaerobic exercise is any exercise intense enough to trigger lactic acid formation. It is used by athletes in non-endurance sports to promote strength, speed, and power and by body builders to build muscle mass. Muscle energy systems trained using anaerobic exercise develop differently compared to aerobic exercise, leading to

greater performance in short duration, high intensity activities, which last from mere seconds to up to about 2 minutes. Any activity lasting longer than about two minutes has a large aerobic metabolic component.

Anaerobic exercise comprises brief, strength-based activities, such as sprinting or bodybuilding, whereas aerobic exercise is centered on endurance activities, such as marathon running or long-distance cycling. However, the early stage of all exercise is anaerobic. Examples of anaerobic exercise include weight lifting, sprinting, and jumping; any exercise that consists of short exertion, high-intensity movement, is an anaerobic exercise.

Anaerobic Power

Anaerobic power is the power produced without the requirement for oxygen to be present. Sprinting, mainly at the end of a race, is predominately an anaerobic activity. Anaerobic literally means without oxygen. It relates to short-term high-energy production where the predominant fuels are produced without the necessity of oxygen.

Anaerobic power or capacity is an expression used for the maximal exercise up to a maximum of two minutes and the energy used during the workload is provided in large measure without necessitating oxygen, since the stored phosphagens and glycogen in the muscles would be enough up to two minutes. At the onset of the exercise, since ready energy materials are used, lactate is not formed.

Anaerobic capacity is the ability to keep violent muscle contraction that depends genuinely on anaerobic mechanism in

providing energy (Radhwan, 1998). The oxygen debt, defined as the recovery oxygen uptake above resting metabolic rates, has been discredited as a valid and reliable measure of the anaerobic capacity power as it is generally acknowledged that mechanisms other than the metabolism of lactate also contribute to the post-exercise oxygen uptake (Medbo and Tabata, 1989).

1.2.1 TYPES OF ANAEROBIC TRAINING

There are different types of exercise mechanisms, based on the intake of oxygen during working out. While aerobic is based on taking in a lot of oxygen, anaerobic involves less or little oxygen to exercise. This is nothing to do with breathing in and out but rather how one's tissue deals with the oxygen content present. Anaerobic exercises mean intense and pushing to the maximum exertion, in a limited or short duration of time. Such an exercise mechanism allows the body to make normally impossible heavy or tasking movements but they cannot be kept up for a long time. Examples of anaerobic exercise include: resistance training, all types of sprints (running, etc.) interval training, isometrics, or any rapid burst of hard exercise.

Below are the variants of anaerobic exercises with a brief description of the activity involved.

Resistance Training

Resistance training is a common type of anaerobic training for developing the strength and size of skeletal muscles. It uses the

weight force of gravity (in the form of weighted bars, dumbbells or weight stacks) to oppose the force generated by muscle through concentric or eccentric contraction. Weight training uses a variety of specialized equipment to target specific muscle groups and types of movement.

The basic effect of weight lifting is the increase in muscle mass and physical strength of a person. This is done by a person using weights to cause himself or herself physical pain and minor damage to his or her muscles. When the muscle is repaired by his or her body, it is made slightly stronger than it was prior to the injury. The process is then repeated to create stronger and stronger muscle. This process makes sense, from a physiological stance; the body of someone straining his or her muscles to survive a dangerous situation repairs itself to make him or her more likely to survive a similar situation later (www.wisegeek.com).

1.2.2 BENEFITS OF ANAEROBIC TRAINING

Anaerobic capacities play an important role in influencing the sports performance, particularly in activities which involve working with maximum intensity for a short period of time, such as sprinting, weightlifting, explosive jumping etc. Under anaerobic conditions a sports person has to work incurring oxygen debt. Such type of activities cannot be prolonged for long duration. It is quite evident that when a sportsperson undertakes an anaerobic task, he normally works with medium intensity. Therefore, the body would be able to

supply the required amount of oxygen to enable a person to continue activity for relatively longer duration.

For the purposes of this research, the investigator selected only weight training.

1.3 CROSS TRAINING

Cross-training refers to an athlete training in sports other than the one that the athlete competes in, with a goal of improving overall performance. It takes advantage of the particular effectiveness of each training method, while at the same time attempting to negate the shortcomings of that method by combining it with other methods that address its weaknesses.

Cross-training in sports and fitness refers to the combining the exercises to work on various parts of the body. Often one particular activity works certain muscle groups, but not others: cross-training aims to eliminate this. The term cross training refers to training routine that involves several different forms of exercise. While it is necessary for an athlete to train specifically for their sport if they want to excel, for most exercises cross training is a beneficial training method for maintaining a high level of overall fitness. Cross training limits the stress that occurs on a specific muscle group because different activities use muscles in slightly different ways (*Quinn, 2008*).

While professional athletic trainers once believed it was most important to work on those muscles directly related to a particular sport or activity, experts now say cross training is a much better

approach. All sorts of professional athletes, from ball players to golfers, tennis players to swimmers, make cross training part of their regimes.

Cross training is also making its way into the average person's fitness routine, with more and more "weekend workout warriors" discovering its benefits.

In the pursuit of strength gains, improved performance and a chiseled midsection, it's important to utilize every method at your disposal. Too many guys get stuck on a single technique or school of thought and dig themselves into a rut that's hard to escape. We all experience plateaus, and to surpass them they need to be approached constructively for a single, comprehensive training session.

1.3.1 TYPES OF CROSS TRAINING

Cross-training exercises can be virtually any exercises that one doesn't do as part of a regular exercise. Cross-training exercises would help to develop skills that might be used in the sport. This might include running, swimming, weight lifting, stretching, or any other exercises that help to work various muscle groups.

Cross-training exercises really only exist in relation to other exercises. If an individual frequently gets all of his or her exercise from going for a jog every day, then the muscles will become conditioned to these exercises. In order to work the rest of the muscles in the body, different exercises may be added such as stretching or strength

training, which would then be considered a type of cross training. This is a simplified example of cross-training exercises.

For people who simply exercise to maintain a healthy weight, boost cardiovascular endurance, and get in shape, mixing up the exercise routine and adding some cross-training exercises is essential. This is because it provides more of a challenge to the body, and can help one to get past an exercise or weight loss plateau. In addition, it can help to alleviate the boredom that can come from doing the same exercise every day, as well as prevent injury from repetitive motion on one muscle group without also working a corresponding yet opposite muscle group.

Athletes often use cross-training exercises as a way to improve their speed and agility. They might do exercises to target specific muscle groups that are used in the particular sport that they play, in order to help them develop skills that will be beneficial during a competition or game. Circuit training, for example, where an individual will move rapidly from one aerobic or strength exercise to the next without taking much rest in between, is a common type of cross training. Runners will often participate in stretching or yoga classes on the side, as well as weight lifting, to prevent muscle tightness or weakness in other areas of the body that can easily lead to injury.

1.3.2 BENEFITS OF CROSS TRAINING

Conditioning or cross training refers to working out in several ways so as to enhance overall performance. This kind of training is meant to be used for supplementing other training methods and not replacing your primary workout. However, cross training still offers innumerable benefits.

Increases motivation

Constant repetition usually leads to boredom, thus making the workout routine bothersome and stale. Cross training focuses on alternating different kinds of training. This injects excitement into the workout and may enhance endurance. Moreover, through adding the factor of frequently changing the exercises, the alternate workouts keep the body fresh and ready for more workouts.

Prevents injuries

Player can prevent injuries through engaging in cross training. It provides the major muscles an opportunity to recuperate and rest. For instance, running mostly uses the calf and hamstring muscles. Most runners who get injuries normally get them because of over-training. However, when you perform an alternate exercise, the primary muscles are given time to rebuild and heal and the supporting muscles become stronger. While this happens, you still get an effective cardio workout for strengthening the lungs and heart.

Enhances Flexibility

Cross training encourages the addition of exercises like yoga and martial arts for enhancing overall flexibility. Actually, the sports persons who used cross training workouts had improved performances since they had enhanced their stability and balance. They were more agile and eluded more tackles during sports. Cross training works by creating a good balance in the various muscle groups, thereby boosting flexibility.

Enjoy other sports

The good lungs and strong heart that is for running may also serve you well in bicycling, swimming and skating among other sports. Cross training offers an excellent chance to try out new things while conditioning the body in the process.

Although cross training is beneficial, its main shortcoming is that it may not provide effective muscle growth since the user is supposed to switch exercises quickly.

1.4 VOLLEYBALL

On February 9, 1895, in Holyoke, Massachusetts (USA), William G. Morgan, a YMCA physical education director, created a new game called Mintonette as a pastime to be played (preferably) indoors and by any number of players. Volleyball is a team sport in which two teams of six players are separated by a net. Each team tries to score points by grounding a ball on the other team's court under organized rules ("Volleyball "International Olympic Committee). It has been a

part of the official program of the Summer Olympic Games since 1964.

The complete rules are extensive. But simply, play proceeds as follows: a player on one of the teams begins a 'rally' by serving the ball (tossing or releasing it and then hitting it with a hand or arm), from behind the back boundary line of the court, over the net, and into the receiving team's court. The receiving team must not let the ball be grounded within their court. The team may touch the ball up to 3 times but individual players may not touch the ball twice consecutively. Typically, the first two touches are used to set up for an attack, an attempt to direct the ball back over the net in such a way that the serving team is unable to prevent it from being grounded in their court.

The rally continues, with each team allowed as many as three consecutive touches, until either (1): a team makes a *kill*, grounding the ball on the opponent's court and winning the rally; or (2): a team commits a fault and loses the rally. The team that wins the rally is awarded a point, and serves the ball to start the next rally (www.wikipedia.org/wiki/Volleyball).

Development of Volleyball in India

The game of Volleyball was brought to India more than 70 years ago when some Physical Education teachers who had been abroad, were trained in different games including Volleyball. Y.M.C.A., College of Physical Education, Madras took this game seriously and started

training of Volleyball. In The students trained here took the sport to other parts of the country. The formation of V.F.I. has been one of the main factors in the development and popularization of the game of Volleyball in India.

The Volleyball Federation of India was formed in the year 1951. Prior to the formation of the Volleyball Federation of India (VFI), the game was controlled by the Indian Olympic Association (IOA) and at that time the Inter-state Volleyball Championship was held every two years from 1936 to 1950 for men only. The first Championship was held in the year 1936 at Lahore (now in Pakistan). In 1951, Volleyball Federation of India was formed and its first meeting was held in Ludhiana (Punjab).

Since the formation of the V.F.I. the Indian team started to participate in World Championships, Asian Games, Asian Championship, Commonwealth Championship and many other International Tournaments held in India and abroad. India won the Gold medal at the Invitation Asian Meet at Japan in 1955. In the third and fourth Asian Games held at Tokyo in 1958 and Djakarta in 1962, India won the bronze and silver medal respectively. India got a major setback when no player was honored with the Arjuna Award from 1963 to 1971.

India also did not take part in any class of competition from 1964 to 1973. In the year 1974 when India participated in the Asian Games at Tehran it got 5th place and it was felt that India had lagged behind. In the year 1980 in the first Commonwealth Games for Men,

India got 3rd place in the Championships. Moreover the Indian team won many matches against visiting teams in India and also out of India in International meets.

The Indian volleyball team, who finished second in the World U-19 Volleyball championship in Thailand, arrives at IGI airport, New Delhi.

The Volleyball Federation of India has quickly fallen in line with the World body's desire to popularize the game by promoting club volleyball. India is among half a dozen Asian countries putting this variety of league in place. The preliminary phase of the National Volleyball League Club Championship was spread across different centres culminating in a Final League. This new platform has given Club volleyball a fresh lease of life. For these clubs there is now this national pride to play for, greater exposure and recognition coming in its wake. Some of the top clubs in the country jumped into the bandwagon.

In India, the game is played both indoors and outdoors. The volleyball courts in India are generally 18 meters long and 9m wide. It is split into 2 halves, each 9m in length. The net is 2.43 and 2.24 m above ground level for men and women respectively. There is an attack line 3m from and parallel to the net. This is for the teams to split their formations into a front and back row sub-teams. Each team has 6 players, and the sport in India adheres to all international standards.

The popularity of the game in India shot to better heights when India won the gold medal at the SAF (South Asian Federation) games in 1987 at Calcutta. IN the 1989 version of the game, India lost the finals to arch rivals Pakistan. The Indian team clinched the gold medal again in 1991 at Colombo. After this, the women's game started gaining popularity. Though they put up a good show in the 1993 SAF games at Dhaka, the women's team is yet to make an impact as big as the men's team.

1.4.1 BASIC FITNESS NEEDED FOR VOLLEYBALL

Volleyball is a team sport that requires great skill and can be very rewarding when played properly. Certainly considered to be both a competitive and leisurely activity.

Normally, each team in an indoor volleyball match consists of six players. However, the health benefits of playing with fewer people on each team increases with the larger area for which each player is responsible; as in outdoor beach volleyball.

A workout involving volleyball is an effective way to burn calories. Approximately 20 minutes of volleyball consumes up to 126 calories. Over a twelve month period given 20 minutes of volleyball per day, that would add up to a total of 45,990 calories (or thirteen pounds of body fat) burned per year. Volleyball also develops key upper body muscles (especially the arms), improves sprint speed and agility due to the quick changes of pace and direction, and improves overall flexibility.

Volleyball places a large number of demands on the technical and physical skills of a player. During the course of play, players are required to serve, pass, set, attack, block and dig the ball. Playing volleyball requires flexibility, good balance, upper and lower body strength and speed in order to be played effectively.

Successful participation in volleyball sport requires expertise in many physical skills and performance is often dependent on an individual's ability to propel themselves into the air during both offensive and defensive manoeuvres. These movements include the jump serve, spike, and block. During the carrying out of a jump serve or a spike, the player jumps high into the air and strikes the ball at the highest point of their jump in an effort to propel the ball rapidly down towards the opposing side of the net.

Defensively, front row players defend against spikes by jumping into the air with their hands raised in an effort to impede the offensive attack. Unlike offensive jumps, defensive jumps are not maximal vertical jump efforts.

A well-structured volleyball training program can increase explosive power, vertical jump height, stamina and speed and agility around the court. Skill training alone, such as practicing spikes, won't develop the physical traits necessary to play to the athlete's full potential (*Gabbet et al, 2006*).

Volleyball players have exceptional lower body power and perform well in the vertical jump test (*Fleck et al, 1985*). Power in the

legs is needed to jump explosively off the ground in order to spike, block, set and dive.

The repetitive nature of jumping movements makes power endurance an important outcome of training and the length of games and sets places a significant demand on strength endurance (*Bompa 1999*). Power and strength endurance are more important than aerobic endurance, although at elite levels, volleyball players have moderate to high values for aerobic power (*Fleck et al, 1985*).

1.5 MOTOR FITNESS VARIABLES CHOSEN FOR THE STUDY

The Motor fitness variables chosen for the study are:

1. Agility
2. Speed
3. Explosive Power
4. Flexibility
5. Co-ordination

Agility

Agility in volleyball requires quick and sometimes awkward movements of the body position to adjust the ball during play. Volleyball is a sport that involves extreme lateral movement and the ability to move with fast feet during volleyball matches. Volleyball players need to be able to move from side to side and at a variety of angles effectively and quickly in order to be successful. These

movements are often the difference in a volleyball team winning or losing.

Speed

Speed in forward, backward, and lateral positions is important in many sports. Speed refers to the point at which athletes can accelerate no more and have reached their maximum rate of movement. In most sports, what is referred to as speed is really acceleration because athletes rarely reach maximum speed during competition.

The type of foot speed needed in volleyball is characterized by the athlete being able to quickly get from point A to point B. This rarely entails taking more than three or four steps in any one direction, so long-distance sprint-speed training is not very functional for the volleyball players.

Explosive Power

Power may be the most important factor in sports performance. For most sports, maximal strength is always a training goal but speed of movement is crucial as well.

Successful sporting performance at elite levels of competition often depends heavily on the explosive leg power of the athletes involved. 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. Team sports like volleyball require high level of explosive power. For success at elite levels of competition. Explosive power comes from the development of speed strength and pure strength. Power represents the amount of work a muscle or muscle group can produce per unit of time (Adams et al, 1992).

Vertical and horizontal jumping, in its many different forms, requires high levels of explosive muscular power. The double legged volleyball spike jump and block jumps are very different in technique, but fundamentally they are similar (Samsan, & Roy, 1976).

Flexibility

Flexibility is an often ignored part of volleyball fitness; however, it is essential to perform the highest quality movements. This is because flexibility increases coordination skills. It is also an important part of speed and strength, because, if muscles are tight, they cannot complete their full range of movement. This can result in a loss of player power and speed.

Flexibility refers to the absolute range of movement in a joint or series of joints, and length in muscles that cross the joints. Flexibility is variable between individuals, particularly in terms of differences in muscle length of multi-joint muscles. Flexibility in some joints can be increased to a certain degree by exercise, with stretching a common exercise component to maintain or improve flexibility.

Co-ordination

Volleyball is a team game which is often based on the players arm - eye - leg Co-ordination. Only when these co-ordination of arm-eye - leg combine, the execution of the skills in volleyball support high level performance which also support a good understanding and harmonization among team members to be successful team as a whole. Even when a player is individually competent, he should work with the rest of his team players for better result of the game.

1.6 PHYSIOLOGICAL VARIABLES NEEDED FOR VOLLEYBALL PLAYERS

Besides physical variables, the importance of physiological parameters cannot be underestimated when judging the performance of players in Volleyball. Cardiovascular endurance plays a vital role in this game as there is no fixed duration of Volleyball match. It has been reported that the duration of the volleyball match between Russia and Czechoslovakia lasted for 3 hours and 2 minutes during the Olympic Games in October 1964. The game requires the functioning of the cardiovascular system to its maximum efficiency in order to supply fuel to the working muscles as well as to carry away waste products (*Nicholas 1978*).

One of the common and practical means of findings out the efficiency of cardiovascular system is by means of measuring pulse rate. It is noticed that the fit player's heart has the advantage of starting at a slower rate of beating; but, on the whole, it accelerates as

many beats in response to the task as does the heart of the untrained subject (*Nicholas 1978*).

Among all the factors, the physiological variables play an important role for the attainment of high level sports performance. Physiological variables may be defined as those variables which are directly linked with various physiological systems such as heart rate, blood pressure, vital capacity, respiratory rate and hemoglobin. Physiological variables such as cardiovascular efficiency, percentage of fat, reaction time, vital capacity and other should be taken into consideration while selecting volleyball players. Cardio-respiratory endurance denoted capacity of individual to work effectively with the help of oxygen which is collected, transported and utilized by lungs, blood and muscles respectively. Any work as daily task or form of physical activity is directly related to energy supplying system which in turn is the cardio respiratory endurance. Cardio-respiratory endurance varies from individual to individual and one of the important variables for establishing top class performance in volleyball as the game involves work of long duration/endurance type.

1.7 PHYSIOLOGICAL VARIABLES CHOSEN FOR THE STUDY

The following physiological variables chosen for the study are:

1. Resting Pulse Rate
2. Respiratory Rate
3. VO_{2max}
4. Breath Holding Time

5. Anaerobic Power

Resting Pulse Rate

Resting heart rate which is the number of beats felt exactly one minute. The average rate of the pulse in a healthy adult is 72 beats in each minute. There may be variation of up to five beats per minute within the normal range. The number of beats of a pulse per minute or the number of beats of the heart. The resting heart rate varies greatly among different people and in the same person under different situations. The American Heart Rate Association accepts as normal range from 50 to 100 beats per minute. The average rate is 72 beats per minute but the rate can accelerate to 220 per minute. The lesser heart rate given good performance for all the sports and games (*Strukic, 1981*).

Respiratory Rate

Respiratory rate is also known by respiration rate, pulmonary ventilation rate, ventilation rate, or breathing frequency is the number of breaths taken within a set amount of time, typically 60 seconds. A normal respiratory rate is termed eupnea, an increased respiratory rate is termed tachypnea and lower than the normal respiratory rate is termed bradypnea.

Human respiration rate is measured when a person is at rest and involves counting the number of breaths for one minute by counting how many times the chest rises. An optical breath rate

sensor can be used for monitoring patients during a magnetic resonance imaging scan. Respiration rates may increase with fever, illness, or other medical conditions. Medical research suggests that respiratory rate is the marker of pulmonary dysfunction that gets progressively worse with the advance of a large number of chronic health conditions.

The number of breath per minute or, more formally, the numbers of movements are indicative of inspiration and expiration per unit time. In practice, the respiratory rate is usually determined by counting the number of times the chest rises or falls per minute. The aim of measuring respiratory rate is to determine whether the respirations are normal, abnormally fast (tachypnea), abnormally slow (bradypnea), or nonexistent (apnea).

VO₂ max

Aerobic fitness relies on contributions from the lungs, heart, blood and active muscles and professional players demonstrate greater aerobic capacities than the norm due to the development of these physical determinants. VO₂ max (the maximal ability to consume oxygen in strenuous exercise) which is a good indicator of aerobic fitness is found to be highest at the top levels of the game. Values between 55-70 ml.kg⁻¹ are observed for elite players.

Breath Holding Time

“The duration of time through which one can hold his or her breath without inhaling or exhaling”. Basic change in respiratory function during exercise is increase in ventilation and cardiac output. During mild exercise, rise in CO₂ tension in blood stimulates carotid sinus reflex and respiratory center causing increased pulmonary ventilation, which prevents further rise of CO₂ in alveoli. A sort of equilibrium is reached between the effect of increased CO₂ tension in arterial blood and that of increased respiratory activity in lowering CO₂ tension. Due to the impulses from the high center to respiratory center, there is increased respiratory rate even before the start of exercise. The increase in rate and amplitude of respiration is proportional to the type of exercise performed.

1. Due to increased respiratory movement the CO₂ tension in blood falls below normal.
2. Lack of Oxygen causes respiratory increase through stimulation of carotid body.
3. Liberation of adrenaline also augments pulmonary ventilation.
4. Pulmonary blood flow increases from 5 to 30 litres/minute.
5. Oxygen intake and CO₂output increase from 0.25 litres /minute to 4 litres per minute(*Rajendrakumar,2012*)

Anaerobic Power

Anaerobic power is the power produced without the requirement for oxygen to be present. Sprinting, mainly at the end of a race, is

predominately an anaerobic activity. Anaerobic literally means without oxygen. It relates to short-term high-energy production where the predominant fuels are produced without the necessity of oxygen. Tests for anaerobic performance aim to assess relatively short duration exercise bouts.

Anaerobic capacity is the ability to keep violent muscle contraction that depends genuinely on anaerobic mechanism in providing energy (*Radhwan, 1998*). The oxygen debt, defined as the recovery oxygen uptake above resting metabolic rates, has been discredited as a valid and reliable measure of the anaerobic capacity power as it is generally acknowledged that mechanisms other than the metabolism of lactate also contribute to the post-exercise oxygen uptake (*Medbo and Tabata, 1989*).

1.8 SKILL PERFORMANCE

Overall Playing Ability

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 skill performance at the highest levels of competition often depends heavily on ability to use high levels of strength as quickly and as explosively. To compete

at one's very best in volleyball; one needs to build the appropriate serving, spiking and blocking, individual defensive skills, individual tactics, offensive combination and defensive combination. However, it is often assumed that those blessed are born with a higher percentage of fast-twitch muscle fibers, great speed or strength, and having trained and mastered in skills.

1.9 VOLLEYBALL SKILL PERFORMANCE VARIABLES CHOSEN FOR THE STUDY

The following Volleyball skill variables were chosen for the study they are as follows:

1. Set
2. Attack
3. Block
4. Pass
5. Service

Set

The 'set' is an overhead pass used to change the direction of the dig and put the ball in a good position for the spikier. It is usually the team's second contact. Setting is the tactical centre of volleyball. A setter must be good enough to keep the big blockers from dominating the net. The setter must feed his or her best hitters while also looking for opponent's blocking weaknesses (such as a short player in the front line or a slow centre blocker).

Attack

The attack, also known as the *spike*, is usually the third contact a team makes with the ball. The object of attacking is to handle the ball so that it lands on the opponent's court and cannot be defended. A player makes a series of steps (the "approach"), jumps, and swings at the ball.

Ideally the contact with the ball is made at the apex of the hitter's jump. At the moment of contact, the hitter's arm is fully extended above his or her head and slightly forward, making the highest possible contact while maintaining the ability to deliver a powerful hit. The hitter uses arm swing, wrist snap, and a rapid forward contraction of the entire body to drive the ball. A 'bounce' is a slang term for a very hard/loud spike that follows an almost straight trajectory steeply downward into the opponent's court and bounces very high into the air. A "kill" is the slang term for an attack that is not returned by the other team thus resulting in a point.

Block

This is the first line of defense in volleyball. The objective of the 'block' is to stop the spiked ball from crossing the net or to channel the spike to defenders. The three front-court players share blocking. The key to good blocking is penetration - the best blocker's hands reach well over the net and into the opponent's court rather than reaching straight up.

Pass

Passing is also called reception. The pass is the attempt by a team to properly handle the opponent's serve or "free ball". Proper handling includes not only preventing the ball from touching the court, but also making it reaches the position where the setter is standing quickly and precisely. The skill of passing involves fundamentally two specific techniques: underarm pass, or bump, where the ball touches the inside part of the joined forearms, at waist line; and overhand pass, where it is handled with the fingertips above the head.

Service

A serve begins each rally. A player must hit the ball with his or her hand over the net to land inside the lines of the court. Players may serve underarm or over arm. A popular serve is the 'jump' or 'spike' serve: the player jumps and serves the ball while airborne. Each player gets only one chance to serve. A new rule means the serve can now touch the net and continue into the opponent's court. Earlier, a net touch on service ended the rally and the point was awarded to the receiving team. When the serving team loses a rally, it loses the right to serve. This is called a "Side Out". The receiving team then rotates one position on the court.

1.10 OBJECTIVE OF THE STUDY

There were number of researches which have laid academic knowledge on the influence of isolated training effects of high intensity

plyometric exercises or anaerobic training or cross training on athletes and players. Objective of the study are

1. This research is proposed to be undertaken to find out the effect of high intensity plyometric training, anaerobic training and cross training on selected motor fitness variables of volleyball players.

2. This research is proposed to be undertaken to find out the effect of high intensity plyometric training, anaerobic training and cross training on selected physiological variables of volleyball players.

3. This research is proposed to be undertaken to find out the effect of high intensity plyometric training, anaerobic training and cross training on selected skill variables of volleyball players.

4. And, this is to find out which experimental training was more effective in improving the selected motor fitness, physiological and skill variables of volleyball players .

1.11 STATEMENT OF THE PROBLEM

The purpose of the study was to find out the effect of high intensity plyometric training anaerobic training and cross training on selected motor fitness physiological and skill variables of volleyball players.

1.12 HYPOTHESES

It was hypothesized that:

- 1) There would be significant improvement on selected motor fitness variables due to the effect of high intensity plyometric training anaerobic training and cross training.

- 2) There would be significant improvement on selected physiological variables due to the effect of high intensity plyometric training anaerobic training and cross training.
- 3) There would be significant improvement on selected volleyball skill variables due to the effect of high intensity plyometric training anaerobic training and cross training.
- 4) There would be significant differences on the selected motor fitness physiological and skill variables of volleyball players among the experimental groups.

1.13 SIGNIFICANCE OF THE STUDY

This study was significant in the following ways:

- 1) The study would help the coaches in determining different training schedules for College level volleyball players.
- 2) The finding of the study would be helpful in assessing the motor fitness, physiological and skill variables of volleyball players.
- 3) The result of the study would be helpful to find out the influence of high intensity plyometric training, anaerobic training and cross training packages among volleyball players.
- 4) This study would be beneficial to physical education teachers and fitness trainers to prescribe suitable high intensity plyometric training, anaerobic training and cross training for

improving motor fitness, physiological and skill variables of volleyball performance.

- 5) The findings of this study would be helpful to the college level volleyball players in improving their motor fitness, physiological and volleyball skills.
- 6) The findings of this study would be helpful for future researchers to undertake similar studies at different levels.

1.14 DELIMITATIONS

The present study was delimited in the following aspects.

- 1) To achieve the purpose of the study, one hundred (N=100) men volleyball players who have participated in state and inter-collegiate volleyball tournament were selected as subjects from Maduari, Tamilnadu .
- 2) The age of the subjects were ranged from 19 to 23 years.
- 3) The subjects were divided at random into four groups of twenty five each (n=25). The experimental group-I underwent high intensity plyometric training, experimental group-II underwent anaerobic training (resistance training), experimental group-III underwent cross training and the group IV acted as control which was not given any special treatment, except of their routine.
- 4) The duration of the training period was restricted to twelve weeks and the number of sessions per week was confined to three.

- 5) The following variables were selected in this study.

I. Dependent Variables

a. Motor Fitness Variables

- i. Agility
- ii. Speed
- iii. Explosive Power
- iv. Flexibility
- v. Co-ordination

b. Physiological Variables

- i. Resting Pulse Rate
- ii. Respiratory Rate
- iii. VO_{2max}
- iv. Breath Holding Time
- v. Anaerobic Power

c. Volleyball Skill Variables

- i. Set
- ii. Attack
- iii. Block
- iv. Pass
- v. Serve

II. Independent Variables:

Experimental group -I : High Intensity Plyometric Training

Experimental group -II : Anaerobic Training

Experimental group -III : Cross Training

Group-IV : Control

- 6) The data were collected prior and immediately after the training period of twelve weeks.

1.15 LIMITATIONS

The following limitations were considered while interpreting the results of the study.

- 1) The environmental factor such as, climatic condition, atmospheric pressure, temperature and humidity during the training period and collection of data were taken into consideration.
- 2) The previous experience of the players in the training was not considered in this study.
- 3) Psychological factors, food habits, rest period, life style etc., could not be controlled.
- 4) Though the subjects were motivated verbally, no attempt was made to differentiate the motivation levels during the period of training and testing.
- 5) While training and testing periods, the factors like personal habits life style and other domestic involvements of the subjects which may influence the results of the study was not taken into consideration.

1.16 DEFINITION OF OPERATIONAL TERMS

Sports Training

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

Plyometric Training

Plyometric Training refers to exercises that enable a muscle to reach maximal strength in as short time as possible *(Gambetta,1988)*.

Resistance Training

A method of improving muscular strength is by gradually increasing the ability to resist force through the use of free weights, machines, or the person's own body weight. Strength training sessions are designed to impose increasingly greater resistance, which in turn stimulates development of muscle strength to meet the added demand. *(Mosby, 2009)*

Cross Training

The act or an instance of training or competing in several different sports at the same time.

Motor Fitness

Motor Fitness refers to the ability of an athlete to perform successfully at their sport*(Close, 1973)*.

Agility

Agility is to perform in a particular activity to change the direction in quick manner *(Fresh, 1971)*.

Speed

Speed is the ability to perform rapidly successive movements over a short period of time in a single direction (*Singh, 1991*).

Explosive Power

Explosive power is the capacities of the leg to release maximum muscular force in the shortest time as in executing a broad jump.

Flexibility

Flexibility is defined as the range of motion at a single joint or a series of joints (*Duncan et.al., 1983*).

Co-ordination

Harmonious adjustment of action, as of muscles in producing complex movements (*Webster's New World Dictionary, 1988*).

Resting Pulse Rate

The time from the end of one heart contraction to the end of the next contraction is a complete heart beat or pulse or cardiac cycle. The complete cardiac cycle takes less than one second (about 0.8 seconds) in a normal adult at rest and is shortened by exercise (*Eva, 1984*).

Respiratory Rate

It is the number of breaths taken in a minute or number of inspirations / expirations in a minute (*Fox and Mathews, 1981*).

VO₂max

Maximum amount of oxygen that can be consumed per minute by an individual during the physical work (*Shaver, 1982*).

Breath Holding Time

“The duration of time through which one can hold his or her breath without inhaling or exhaling”. Breath holding time has been defined as an individual’s ability to hold the breath, a voluntary forced maximal inhalation without exhalation during the period of holding the breath. Breath holding time is the time consumed to keep or without taking the breathing action as much as possible (Robson, 1972).

Anaerobic Power

Anaerobic power is the amount of work performed using primarily anaerobic energy system (*Baechle, 1994*).

Skill

Singh (1984) defined that skill is degree of automatisation of a movement which is achieved through training.

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 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.

Set

Setting is an action where a player transfers the ball for another player to make a smash (or spike)(*Vute, 2009*).

Attack

The offensive action of hitting the ball. The attempt by one team to terminate the play by hitting the ball to the floor on the opponent's side.

Block

A defensive play by one or more front row players meant to intercept a spiked ball. The combination of one, two or three players jumping in front of the opposing spiker and contacting the spiked ball with the hands pass.

Serve

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