CHAPTER - I
INTRODUCTION
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INTRODUCTION

Basketball is one of the most popular games played all over the world. According to Eric J. Drinkwater (2006), Basketball is a sport with many complex demands that require a combination of fitness, skills, team tactics and strategies and motivational aspects. However, key areas that play an important role in a Basketball player’s success are muscular strength, muscular fitness and body size. Successful competition in international Basketball requires an appreciation of the physical demands of the sport and the capacities of the team to respond to those demands. In the development of this game with multifaceted skills, there is a need to retrospect the usual training programmes and its adaptations to the game. Among the different modalities of physical training, circuit training is comparatively a new edition that achieves all round fitness. Resistance training is another one, which increases muscular strength and endurance. The most effective resistance training programme is that which is designed to target specific training goals. Thus, the process, which utilizes variation by systematically varying volume and intensity for an effective long-term progression design, is known as periodization. Periodization is a method of planning periods or cycles in which training specificity, intensity and volume changes within an overall training program (Baechle and Earle, 2000). In order to produce substantial and continued increase in muscle strength and size, the training must be progressive in nature. Thus a training programme named “Progressive circuit type resistance training” the first of its kind is custom designed to gradually increase the given resistance against which a given muscle must work.
The General Adaptation Syndrome [GAS] developed by Hans Seyle (1998), a Canadian endocrinologist defines a three stage response to stress (Alarm, Resistance and Exhaustion) (Baechle and Earle). During the alarm phase, the body experiences a new or more intense stress (e.g. Lifting a heavier load) and homeostasis is altered as a result. The alarm phase can last several days or weeks. At this stage, the athlete may experience excessive soreness, stiffness and temporary drop in performance. The next phase is resistance phase during which the body adapts to the stimulus and returns to a more normal functioning. During this stage, the body exhibits its ability to endure stress as the muscle tissue adapts by making various biochemical, structural and mechanical adjustments that lead to increased performance. However if a specific stress persists for an extended period of time, the symptoms experienced during the alarm phase reappear and the athlete loses the ability to adapt to the stressors. These responses are known as the exhaustion phase.

While unfolding all these effects the present study was taken to ensure the development of various complex skills with the effects of Low Volume Circuit Type Resistance Training (LVCTRT Group I), Periodized High and Low Volume Circuit Type Resistance Training (PHLVCTRT Group II) on physical, physiological and skill performance variables adaptations in women college Basketball players.

1.1 NATURE OF THE GAME

Basketball has always been considered as a game of precision, timing, accuracy, continuous flow of activity and agility. However, the changing character of the game and the improved ability of the players from inter-school competition to international competition demand greater
attention to a player's preparation. Competitive Basketball appears to be more dependent on the player's anaerobic power and endurance rather than aerobic power. Although only 15% of playing time in a Basketball game is supposed to be of high intensity, these actions are likely to determine the outcome of a contest. The swift change of direction, explosive speed required to execute an open shot, the ability to jump spontaneously, the speed needed to reach loose balls and run a fast break, are examples of high intensity activities in Basketball. A Basketball player must not only have tremendous cardiovascular endurance to run up and down the court for the entire duration of the game, but also agility to execute explosive movements. Such an ability to perform explosively, regardless of extreme cardiovascular fatigue is called "strength-endurance". Basketball is a game of complex skills that refers to a wide range of playing abilities like, stance, ball holding, passing, catching, dribbling, shooting, lay-up shot, set shot, free throw, rebounding, fakes, screening, tackling, defense, offence, fast break, dodging, jumping, shifting and shuffling.

1.1.1 Fundamental skills in Basketball

The major fundamental skills such as dribbling, passing, and shooting in Basketball are considered in this study.

1.1.1.1 Dribbling

Dribbling is the only method for moving with the ball and one of the integral parts of offensive skills of Basketball. Dribble is executed using the hand farthest from the opponent, effectively without looking at the ball. It should be used only in particular situations on court. By dribbling one can advance the ball up the court and evade pressure by defenders, move the
ball out of a congested area, penetrate the defense, draw defender, set up offensive play, create own shot, improve position or angle. The basic dribbles are the control or low dribble, speed or high dribble and power dribble or cross over dribble, foot fire dribble, change-of-pace dribble, inside out dribble, reverse dribble (Joe Whelton, 1988). Dribbling is done with the finger pad that involves fingertip control, flexing the wrist and fingers to impart force to the ball. (Hal Wissel, 1939)

1.1.1.2 Passing

Passing is the most exciting aspect of basketball. It is the most effective method for moving the ball around the court. It refers to the displacement of ball during the game situation by one player to another with different type of movements. It is vital to a team because it creates high percentage shots and brings the players closer to each other. A pass should always be made crisply and firmly. It is the quickest way to advance the ball. Based on its nature, passing has been segmented into three aspects namely chest pass, bounce pass and flip pass. (Cornelius Bykerk, 1970). Depending upon the range of the pass, the force comes from legs, back, arms, elbows, wrists and fingers through the ball. Knowing how and when to pass makes good shooters into great shooters and average shooters much better.

1.1.1.3 Shooting

Shooting is one of the most fascinating offensive skills. The objective of offense is accurate shooting – to throw the ball through the basket defended by the opponent. Good shooting can often overcome weakness than the other fundamental skills. According to Walters et al.
(1990) in the sport of Basketball, the ability to shoot in Basketball is a key skill. Shooting involves synchronizing the extension of the legs, back, shoulders and shooting elbow and the flexion of the wrist and fingers. The skills in shooting differ in types. There are seven basic shots: the one-hand set shot, free throw, jump shot, three-point shot, hook shot, lay-up and runner. These shots all share some basic mechanics, including sight, balance, hand position, elbow-in alignment, shooting rhythm and follow-through. To develop the shot it is best to concentrate on only one or two mechanics at a time. (Hal Wissel, 1939)

The lay-up is one of the most frequently used ways of scoring. The lay-up is a skill in which the ball is laid up on the backboard. It requires players to jump at the time of release to bank the shot gently off the backboard. (Jill Hutchinson, D, 1945). The jump shot is an advanced skill that allows a player to jump from a two-foot take off and shoot over an opponent. It is usually combined with a run or a dribble, which contributes more momentum to the jump. The jump shot requires considerable body coordination to jump, hang in the air momentarily, and release the ball at the peak of the jump. (Bob Cousy, 1976).

1.2 PERFORMANCE RELATED SKILL VARIABLES

Performance in any sports activity depends largely on physical fitness. A player without specific fitness may not be able to maintain quality of performance beyond a certain limit. Sports performance is a unity of execution and result of sports action or a complex sequence of sports actions measured or evaluated according to agreed and socially determined norms. Peak performance in sports requires technical skill and power. Skill in most activities combines natural ability and learned specialized
proficiency in an activity. Many athletic performances usually demand varying degrees of common physical and physiological requisites.

Basketball is a game played for 40 minutes with 2 minutes break between 1st and 2nd quarter and 3rd and 4th quarter and 15 minutes between 2nd and 3rd quarter. During the game situation, when the player gets tired his skills are inaccurate. Endurance is important for ensuring good quality of the skills, accuracy and rhythm. Co-ordination and flexibility are other important fitness factors. Reaction time and movement time are of immense importance for a Basketball player whether in offensive or defensive position. An offensive player has to react quickly and execute the shooting faster to outwit the defense. But the defensive player should be quick enough to react and execute to tackle successfully. Success in execution of these skills underlies the capabilities of player’s physical and physiological attributes specifically strength, speed, explosive power, anaerobic endurance, VO₂ max and coordinative abilities.

1.2.1 Strength

Strength is the ability of the individual to exert force against an object. It is not merely a product of muscular contractions but a product of voluntary muscular contractions caused by the neuromuscular system. Strength is a consistent differentiator of ability and all top-flight athletes possess superior muscular strength. High quantity and quality of trained muscle tissue is an asset in the demonstration of body strength. Body strength is either static or dynamic, depending on whether the body is held in relatively fixed position during muscular contractions or when the body or body parts are lifted or propelled in any particular direction. Lifting a maximum weight throughout the range of motion once, such as in a barbell,
is a demonstration of dynamic strength. (B.A.F. National Coaches, 1996). Grip strength right hand and left hand, lower extremity and upper extremity strength are the other important strength variables included in this study.

1.2.2 Abdominal muscular strength and endurance

An individual possessing a high degree of abdominal strength will be able to perform any type of activity effectively such as running, jumping and throwing. Though abdominal muscular endurance or core strength relates to the ability of muscle groups to sustain activity, it can also be a limiting factor for performance. The continual performance of muscular activity also relates to the anaerobic energy system supplying energy and the build up of lactic acid that occurs with prolonged activity. The abdominal strength helps to maintain the body postures, thereby required in many activities in the field of sports and games. Lifting a load or moving an inanimate or animate object depends on the abdominal muscular strength (B.A.F. National Coaches, 1996). Developing strength and power in the abdominal region is a must for high performance. It also provides the body stability and balance, which enhances a player’s ability to tolerate the day-to-day pounding that comes with participating in the game of Basketball. Counteracting this wear and tear with additional core strength will go a long way towards preventing body breakdown.

1.2.3 Explosive power

Power represents the amount of work which a muscle or muscle group can produce per unit of time. Until recent years, power related sports performance has only been the subject of limited research, but in the last
decade or so researchers realized the importance of training for power in a wide variety of sporting activities (Clutch et al., 1983).

In sports the successful sporting performance at elite levels of competition often depends heavily on the leg explosive power of the athletes. Explosive power, one of the most important components of performance related factors, helps the player to move fast, jump high, and beat out the man in front of him. It is an intensive skill demanding incredible levels of fitness from the player. With the mastery on explosive power a player can have a higher degree of body strength and stamina, as well as increasing ability to hold position under the basket, rebound, increase speed and agility. Many team sports such as Basketball, Volleyball, Netball, Rugby and Football require high levels of explosive power.

Vertical and horizontal jumping, in its many different forms, require high levels of explosive muscular power. Basketball players typically jump from one leg to perform a lay up, and from two legs to rebound jump, again both are 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 the training for one type of jumping technique will not necessarily improve performance in another style of jumping (Young, 1995).
1.2.4 Speed

Speed is an important motor ability that moves the body or a part of the body as rapidly as possible from one point to another. It is a major factor determining the overall outcome of the sport. Like how running speed and leg speed is important in short distance track events and soccer kicking respectively, arm and body speed (acceleration) is highly essential in Basketball. In fact, all skill-related components contribute to speed. It requires the expenditure of a large amount of energy in a short period.

1.2.5 Anaerobic fitness

The term anaerobic means without oxygen and is used to describe exercise, which is intense, such as sprinting, or weight training. It is inefficient when compared to aerobic activity, and it requires the athlete to work his heart very hard. Anaerobic activities cannot be sustained for long periods. Anaerobic fitness builds the muscle mass and positively affects resting metabolic rate, enhances bone density, and may contribute to long term weight control.

1.2.6 Maximal oxygen uptake

Maximum oxygen uptake (VO$_2$ max) refers to the highest rate at which oxygen can be taken up and consumed by the body during intense exercises (Bassett and Howley 2000). Traditionally, the magnitude of an individual’s VO$_2$max has been viewed as one of the most important predictors of endurance. The ability of the cardio respiratory system to transport oxygen to the exercising muscles refers to the central component of VO$_2$max (Roberts and Robergs 1997). The role of the central component is to transport oxygen from the atmosphere and deliver it to the muscles.
where it is utilized during mitochondrial respiration to produce ATP. The major limitations to oxygen delivery are pulmonary diffusion, cardiac output, blood volume and flow (Bassett and Howley 2000). In aerobic work, oxygen is obtained from the air and is transferred from the lungs to the blood and then to the muscles via the circulatory system. Maximal oxygen uptake or maximal aerobic power (VO$_2$ max) is the indicator of aerobic fitness. As VO$_2$ max increases, the level of aerobic fitness also increases which refers to individual aerobic capacity. An individual who is fit will have a cardio-respiratory system that is capable of meeting the demands of the tissues under conditions of intense exercise.

1.3 RESISTANCE TRAINING

Resistance training, also known as weight training or strength training, is for everyone. The dictionary definition for resistance training is: training designed to increase the power, muscular endurance and body's muscular strength, through resistance exercise. Muscular strength has been recognized in both the scientific and medical communities as a fundamental physical trait necessary for health, functional ability, and an enhanced quality of life. For developing musculoskeletal strength, resistance training has been shown to be the most effective method, particularly when incorporated into a comprehensive fitness programme, improves dynamic stability and preserves functional capacity and muscular strength. Resistance training does improve tone of the body but it is now known to be more than just a specialized exercise activity (Lynne and Cupertino, 2005).
1.3.1 Basic principles

A repetition is the act of lifting and lowering a weight once in a controlled manner. A set consists of several repetitions performed one after another with no break between them. The number of repetitions per set depends upon the aims of the individual performing the exercise. Sets with fewer repetitions are generally performed using more weight. Repetition tempo is also an important factor. According to popular theory, sets of one to five repetitions primarily develop strength, with less impact on muscle size and none on endurance., sets of six to twelve repetitions develop a balance of strength, muscle size and endurance., sets of thirteen to twenty repetitions develop endurance, with some increases to muscle size and limited impact on strength., sets of more than twenty repetitions are considered to be an aerobic exercise. Specific combinations of repetitions, exercises, sets and break duration depend on the goals of the individual programme. The duration of the breaks determine which energy system the body utilizes. It has been shown that for beginner’s multiple-set training offers minimal benefits over single set training with respect to either strength gain or muscle mass increase, but for the experienced athlete multiple-set systems are required for optimal progress.

Progressive overload

In one common method weight training uses the principle of progressive overload, in which the muscles are overloaded by attempting to lift at least as much weight as they are capable of. They respond by growing large and stronger. The procedure is repeated with progressively heavier weights as the practitioners gain strength and endurance. However performing exercises at the absolute limit of one’s strength (so called “one
repetition maximum") is considered too risky for all but the most experienced practitioners. Moreover, most individuals wish to develop a combination of strength, endurance and muscle size. One repetition sets are not well suited to these aims. Practitioners therefore lift lighter (sub-maximal) weights with more repetitions to fatigue the muscle – and all fibers within that muscle – as required by the progressive overload principle. Commonly each exercise is continued to momentary muscular failure. Weight training can be a very effective form of strength training because exercises can be chosen and weights adjusted to safely exhaust each individual muscle group after the specific numbers of sets and repetitions that have been found most effective for the individual.

Recovery

Weight training causes micro trauma to the muscles. Muscles grow during the rest period following workout by repairs to the areas of muscle, making them stronger than before (the exercise depletes/damages the muscles and the body’s response is to heal the damage and increase the strength of the muscle, ligaments and tendons beyond the pre-workout level). Weight training programmes should therefore allow the muscles time to repair and grow, otherwise overtraining can occur. Therefore the individual should exercise caution in increasing the level of exertion. Muscle growth is normally completed within 36 to 96 hours depending on the intensity of the workout. More advanced practitioners may exercise specific muscle groups only every three and four days – since they are capable of producing maximum force output from the muscle, their workouts have the potential to damage the muscle to a greater extent and require longer periods to repair and replete to a greater strength
Intensity, volume and frequency

Three important principles of weight training are intensity, volume and frequency. Intensity refers to the amount of force required to achieve the activity. Volume refers to how much one can do in a particular session, and includes the number of sets, repetition and exercises whereas frequency refers to how many sessions per week. These principles are important because they are all mutually conflicting, as only the muscle has so much strength and endurance, and takes time to recover due to micro trauma. Increasing one by any significant amount necessitates the decrease of the other two, e.g. increasing weight means one cannot do as many repetitions and it will cause more damage, requiring more recovery time and therefore the high-medium-low formula should be used with either intensity, volume or frequency being high, one of other factors being high, one of the other factors being medium, and other being low.

1.3.2 Varied forms of resistance training

Resistance training has been found to be the most effective means for developing musculoskeletal strength, principally when included into a comprehensive fitness programme. However, the way to implicate resistance training differs in its nature of application. As far as the method of application of resistance training in extracting its internal benefits in the field of sports is concerned, the mostly used are progressive nature, volume based and periodization. The detailed nature of these modules is briefly described as follows.
1.3.2.1 Progressive resistance training

The common theme of most resistance training studies is that the training programme must be "progressive" in order to produce substantial and continued increases in muscle strength and size. Progression is defined as "the act of moving forward or advancing toward a specific goal". In resistance training, progression entails the continued improvement in a desired variable over time until the target goal has been achieved. Although it is impossible to continually improve at the same rate with long-term training, the proper manipulation of programme variables (choice of resistance, exercise selection and order, number of sets and repetitions, rest period length) can limit natural training plateaus (that point in time where no further improvements takes place) and consequently enable achievement of higher levels of muscular fitness.

According to Evans (1996) progressive resistance exercise can produce substantial increases in strength and muscle size, even in the oldest old. For many older patients, resistance training represents the safest, least expensive means to lose body fat, decrease blood pressure, improve glucose tolerance, and maintain long-term independence.

1.3.2.2 Super slow resistance training

Super slow resistance training is one of the methods of resistance training. This form of training has been presented as a safe and effective means of building strength in both beginning and advanced weight training (Westcott, 1999). Super slow training, originated in 1982 by Ken Hutchins, was developed in an osteoporosis study with older women because of the need to utilize a safer speed for subjects to perform the resistance exercises.
The result was the beginning of a new resistance training technique, which became to be known as super slow strength training. One possible advantage of super slow training is that it involves less momentum, resulting in a more evenly applied muscle force throughout the range of motion. A potential disadvantage of this training is that it is characterized as tedious and tough.

1.3.2.3 Circuit weight training

Circuit weight training is a form of exercise that uses a number of weight training exercise sets separated by short intervals. The cardiovascular effort to recover from each set serves a function similar to an aerobic exercise, but this is not the same as saying that a weight training set is itself an aerobic process.

Starting at a low level, appertaining from the standard of the class or individual, intensity should be gradually increased, with a progressive load being placed on the cardiovascular system. Circuit training can be used in different ways with a bit of ingenuity. It is an interval training technique that minimizes rest between sets and exercises. It can consist of only weight training or alternating intervals of weight training and brief high intensity cardiovascular exercise. In a circuit type of weight-training programme, each exercise is done in succession with minimal rest between exercises in a row. Instead of resting between sets of an exercise, it can be done in a row then return to the first exercise to begin again. This allows maximizing the exercise time by minimizing the rest time. In an interval circuit, after each set of a weight-training exercise a brief cardio interval is completed. The cardio segments are usually exercises like step-ups, jumping rope, cycling, jumping jacks or sprints. The interval circuit allows
incorporating a cardiovascular workout into a weight-training workout. Both are great ways to build muscular endurance. Depending upon the fitness level and goals circuit training can be divided into three categories. Whole body circuit training consists of selecting 6-10 strength exercises, utilizing every major muscle group. Split circuit training splits the routine into different body parts on different days. The most typical division involves two splits: upper body and lower body. Sports specific circuit training is used by athletes to enhance their abilities and endurance. The circuits involve strength and cardio exercises that are specific to the sports. According to Verill et al (1992) circuit weight training has been recommended and has been reported to improve strength, lean body mass, self-efficacy, and may decrease risk factors for coronary artery disease. There appears to be considerable benefit and minimal risk of resistive exercise training for patients with cardiovascular impairment. This mode of exercise may allow patients to perform daily strength tasks safely, more efficiently, and with greater self confidence.” Studies have concluded that, depending on the structure and balance of the session, one can dramatically improve fitness level by taking part in circuit training exercises. One can significantly improve cardiovascular fitness level by exercising in short bursts of approximately 60 seconds each. If one individual follows an aerobic work-station with a high repetition and strength station, individual will sustain a raised heart rate and therefore get the best possible results. It saves time, develops the physical qualities namely strength, endurance by work with upper body and lower body. The benefits of taking part in circuit training can be summed up in a few words: “Maximum results in the minimum time”. It is probably one of the best methods of exercising as it provides excellent all round fitness, tone and strength.
1.4 Periodization

Periodization refers to specific methods of manipulating training variables to provide variation in volume and intensity. It permits balanced progression by ensuring the appropriate mix put together in a unified plan. Periodized training programs are shown to be more effective in eliciting strength and body mass improvements than non periodized resistance training programmes (Kraemer, et.al, 2002) Periodization is an approach to resistance training programme that includes systematic alternating cycles of weight lifted (intensity) with total repetitions or volume (repetitions x sets) (Fleck, 1999). Through literatures, periodized resistance training module was observed as easily adaptable and proven method to avoid risk factors such as injury, fatigue, soreness and some bone fractures etc. The roots of this exercise programme design dates back to the 1950’s and early 1960’s where European coaches, trainers, and sports scientists were coaching some of the greatest athletes of that period. The coaches and trainers determined that no matter how fit the athletes were, they just could not continue to train harder and harder. So the trainers did something quite revolutionary with their athletes’ training schedules. They methodically had the sportspersons complete resistance training phases that included high-volume, low-intensity resistance workouts, and then alternated these cycles with low-volume, high-intensity training phases. Eventually this scheme of resistance training filtered to the United States in the 1970’s, where it had its rudimentary beginning. Over the last 10 years, different forms of periodization have attained notable popularity in the U.S. (Marx et al, 2001). But the theoretical roots of periodization come from the Canadian scientist, Dr. Hans Selye, who first presented the General Adaptation Syndrome (G.A.S.) theory (Kraemer, 1998). This theory suggests that the
body adapts to training in three different phases: the alarm stage, resistance stage and "exhaustion" or fatigue stage, caused by training too hard or too long without sufficient recovery. Overtraining is a practical occurrence of what might be occurring in the third phase of the G.A.S. To avoid the exhaustion phase of the G.A.S., there must be some type of orderly change in the stimulus, the Physiology of Periodization. The principle of progressive overload is another physiological concept important to comprehension of the basis of periodization.

Most individuals have approximately 50% of slow-twitch and fast-twitch muscle fiber types, although this varies comparatively between people, and within a person's body (McArdle, Katch and Katch, 1996). The physiological and metabolic characteristics of slow-twitch endurance fibers and fast-twitch explosive strength muscle fibers are thoroughly discussed in nearly all the current exercise physiology texts. On the contrary, the physiological explanations why periodization programmes work so effectively are just beginning to be understood by exercise scientists. One accepted explanation is that the systematic training approach of periodized programmes provides a satisfactory overload to specific muscle fiber types while other fibers are getting necessary recovery (Kraemer, Fleck and Evans, 1996). Thus, the recovery is inbuilt in periodization training design. The bottom line is that without proper recovery the body will not achieve all the potential benefits from training. The alternating cycles of high-volume with low-intensity and low-volume with high-intensity provides a satisfactory stimulus/recovery for the different types of muscle fibers, minimizing the possibility of experiencing the exhaustion phase of the G.A.S.
The research has focused primarily on the variation in training volume (total repetitions per workout or total repetitions x mass lifted) and exercise intensity (%1RM). While the underlying mechanisms that explain the differences between periodized and non-periodized programmes remains to be fully investigated and explained (Fleck 1999), the effects on neural adaptations, and the avoidance of overtraining are suggested as possible factors (Fleck 1999, Stone 1999 a and b). Most comparative studies have demonstrated the superiority of periodized over non-periodized in terms of greater changes in strength, body composition, and motor performance (Fleck 1999). When summarized these studies demonstrate that even over a relatively short period of time (the length of a mesocycle), significantly greater improvements can be realized using systematic variation in training volume and intensity compared to linear using constant sets and reps (i.e., 3 sets of 10 repetitions). In two separate studies, groups using a one-set-to-failure programme were compared to other groups using periodized training principals. Both methods resulted in improvements in strength and power measures over the training period. However, the periodized groups demonstrated significantly greater increases than did subjects in the single set groups (Fleck 1999). An obvious concern in the interpretation of these results is the greater amount of training volume (reps x sets x total mass lifted) in the periodized programmes, which may account for the differences in performance gains between the groups. However, these findings may furnish evidence for the use of periodized multiple set programmes over single set programmes.

To address the influence of overall training volume, multiple set linear programmes (constant reps and sets) have been compared to periodized programmes (decreased volume-increased intensity with time).
In the majority of cases, periodization based programmes still provided significantly greater improvements in performance measures (Fleck 1999, Stone 1999a, Stone 1999b). Therefore, there is evidence to support the idea that appropriate manipulation of volume and intensity over and above just increases in total training volume alone is an important factor in optimizing strength-training effects.

There are various types of periodized programmes due to the numerous configurations of the programme variables such as a number of sets or reps, type of exercises performed, the length of rest periods between sets, the amount or type of resistance used, type of contractions performed, and the training frequency (Fleck, 1999; Fleck and Kraemer, 1997; Rhea et al). The predominant types of periodized strength training and conditioning models are briefly described below:

**Linear periodization**

Volume and intensity are systematically manipulated. Training cycle begins with a high-volume, low intensity profile then progresses to low volume, high intensity over time.

**Undulating periodization**

Training volume and intensity increase and decrease on a regular basis but they do not follow the traditional pattern of increasing intensity and decreasing volume as the mesocycle progresses (Fleck and Kraemer, 1997).
Daily undulating periodization

Training volume and intensity increase and decrease on a daily basis (Rhea et al, 2002)

Stepwise

Like the traditional model, intensity increases and volume decreases during the training period. Volume is decreased during the training period in a stepwise fashion. Repetitions are reduced from eight to five, five to three and so forth, at specific time intervals.

Overreaching

Volume or intensity is increased for a short period of time (one or two weeks) followed by a return to normal training. This method is used primarily with advanced strength trained athletes.

1.4.1 Periodized circuit type resistance training

According to Blievernicht, (1998) the development of a powerful upper body is important for basketball players. The need for leg training typically has been obvious with all the running and jumping in this sport. But today’s game, no longer a “non-contact” sport, also requires a strong upper torso. Following are some principles from his experiences in training elite level basketball players like former National Basketball Association three point champ Jim Les and current Boston Celtic’s Antonie Walker. Developing upper body strength and power should be an integrated part of a complete training program, as it is important to remember the body functions as a whole on the basketball court. The upper body, core and legs all work together to perform total-body movements. Likewise, strength and
power are not expressed independent of coordination, balance, flexibility, etc. The body is an interdependent unit.

Before loading complex dynamic movements, first analyze the player for balance of the musculo-skeletal system. According to literature reviews, basketball typically does not develop major imbalances of the upper body. However, basketball players are subject to the common upper body imbalance of round-shouldered syndrome, especially in taller players. This syndrome is due in part to weak muscles, including the rhomboids, middle/lower trapezius, posterior deltoid, external shoulder rotators and the serratus anterior. Exercises to strengthen these muscles include resisted forms of scapular-thoracic retraction, protraction and shoulder flexion, horizontal abduction and external rotation. An ideal tool to train these movements is Life Fitness’ Dual Adjustable Pulley- or any other adjustable selectorized pulley system. Protraction is also effectively worked from the pushup position on unstable apparatus such as a foam roller. In addition, include training to improve postural movement awareness, lengthen tight muscles and correct other identified imbalances.

As upper body balance is developed, more traditional pressing and pulling movements can be performed. Typical pressing movements include dips, bench presses, inclines and overhead presses. Common pulling movements include pulldowns, seated rows and upright rowing. Be sure to balance all seated pressing and pulling movements with similar movements in a standing position while using cables, dumbbells and other equipment that requires standing such as hammer strength ground base. This way of training focuses more on total-body coordination and the development of greater stability.
In addition, isolation-type exercises to develop shoulder strength should be performed. At the elite level, hand checking, holding a defender at bay and boxing out require a great deal of upper body strength. Variations of shoulder raises to the front back, side, etc., are performed in different standing positions. Cables are often used with slow contractions through limited range to develop strength specific to the action on the court. In this phase, athletes also can perform a few sets of isolated arm work for biceps and triceps. Isolated movements of the shoulder must become more integrated with the core, hip and total body. Medicine ball work can be added to lightly resist specific basketball movements. Use of isolated movements is minimized, being used only as needed to strengthen persistent weak links.

Upper body strength and power training are important for today’s basketball players and are most effective when exercises are integrated into a comprehensive training plan. Correction of musculo-skeletal imbalances should be emphasized at the beginning of the training programme. A variety of movements should be performed utilizing machines, cables, free weights or other resistance devices. Movements used in training should be chosen with basketball function in mind. Progress the program to dynamic, ground based, total body actions.

Here, resistance training should be total-body, feet-on-the-ground, basketball-specific actions. Pushing and pulling movements should now be performed with one hand at a variety of angles. Different functional stances should be used to emphasize total-body action and rotational power in the transverse plane.
The periodized resistance exercises involved in circuits encourages muscle mass development and is important for a sound overall exercise programme. The variety of strength training exercises executed in a quick paced rotation through several settings, minimum rest period within the sport of specialization is labeled as circuit training method. Periodized resistance workouts that is circuit based ideally optimizes strength, speed and endurance, which is required at a decent level to meet the demands of the various skills in Basketball and to claim that the player, is in great condition.

1.5 Adaptations to resistance training

The effects of resistance training on muscular strength, muscular hypertrophy, muscle fiber, muscular power, muscular endurance, heart rate, and body composition are briefly described in the following aspects.

1.5.1 Muscular strength

The increases in muscular strength during the initial periods of a resistance-training programme are not associated with changes in cross-sectional area of the muscle (Sale, 1988). Changes in strength evidenced in the first few weeks of resistance training are more associated with neural adaptations (Moritani and deVries, 1979), which encompass the development of more efficient neural pathways along the route to the muscle. Long-term changes in strength are more likely to be attributable to hypertrophy of the muscle fibers or muscle group (Sale, 1988). The range of increase of strength is quite variable to the individual and may range from 7% to 45% (Kraemer, 1994). It should be noted that strength results appear to be velocity specific. Velocity specificity best characterizes the
probability that the greatest increases in strength occur at or near the velocity of the training exercise (Behm and Sale, 1993). Adaptations with resistance training enable greater force generation and include enhanced neural function (e.g., greater recruitment, rate of discharge) (Leong et al., 1999), increased muscle CSA (Alway et al., 1989), changes in muscle architecture, and possibly a role of metabolites for increased strength. The magnitude of strength enhancement is dependent on the muscle actions used, intensity, volume, exercise selection and order, rest periods between sets and frequency.

1.5.2 Muscular hypertrophy

It is well known that resistance training induces muscular hypertrophy (Jackson, et al., 1990). Muscular hypertrophy results from an accumulation of proteins, through either increased rate of synthesis, decreased degradation, or both (Booth and Thomason, 1991). The time course of muscle hypertrophy has been examined during short-term training periods in previously untrained individuals. The nervous system plays a significant role in the strength increases observed in the early stages of adaptation to training. However, by 6-7 weeks of training, muscle hypertrophy becomes evident, although changes in the quality of proteins, fiber types, and protein synthetic rates take place much earlier. From this point onwards, there appears to be interplay between neural adaptations and hypertrophy in the expression of strength. Less muscle mass is recruited during resistance training with a given intensity once adaptation has taken place. These findings indicate that progressive overloading is necessary for maximal muscle fiber recruitment and consequently muscle fiber hypertrophy.
1.5.3 Muscle fiber

The increase in size of muscle is referred to as hypertrophy, which is associated with long-term resistance training. Increases in the cross-sectional area of muscle fibers range from 20% to 45% in most training studies (Staron et al., 1991). Muscle fiber hypertrophy has been shown to require more than 16 workouts to produce significant effects (Staron et al., 1994). In addition, fast-twitch (glycolytic) muscle fiber has the potential to show greater increases in size as compared to slow-twitch (oxidative) muscle fiber (Hather, Tesch, Buchanan, and Dudley, 1991).

1.5.4 Muscular power

The expression and development of power is an important perspective from sports performance and lifestyle as well. By definition, more power is produced when the same amount of work is completed in a shorter period of time, or when a greater amount of work is performed during the same period. Neuromuscular contributions to maximal muscle power include maximal rate of force development (RFD) (Adams, 1999), muscular strength at slow and fast contraction velocities, stretch-shortening cycle (SSC) performance and coordination of movement pattern and skill.

Several studies have shown improved power performance following a traditional resistance-training programme. Yet the effectiveness of traditional resistance training methods for developing maximal power has been questioned because this type of training tends to only increase maximal strength at slow movement velocities rather than improving the other components contributing to maximal power production. Thus, alternative resistance training programmes may prove to be more effective.
A programme consisting of movements with high power output using relatively light loads has been shown to be more effective for improving vertical jump ability than traditional strength training. It appears that heavy resistance training with slow velocities of movement leads primarily to improvements in maximal strength, whereas power training (utilizing light to moderate loads at high velocities) increases force output at higher velocities and rate of force development. However, it is important to simultaneously train for strength over time to provide the basis for optimal power development. Heavy resistance training may actually decrease power output unless accompanied by explosive movements. The inherent problem with traditional weight training is that the load is decelerated for a considerable proportion (24-40%) of the concentric movement. This percentage increases to 52% when performing the lift with a lower percentage (81%) of 1 RM lifted or when attempting to move the bar rapidly in an effort to train more specifically near the movement speed of the target activity. Ballistic resistance exercise (explosive movements that enable acceleration throughout the full range of motion) has been shown to limit this problem. One such ballistic resistance exercise is the loaded jump squat. Loaded jump squats with 30% of 1 RM (Moss et al, 1997) have been shown to increase vertical jump performance more than traditional back squats and plyometrics. These results indicate the importance of minimizing the deceleration phase when maximal power is the training goal.

1.5.5 Muscular endurance

Muscular endurance has been shown to improve during resistance training (Marx et al, 2001). Traditional resistance training has been shown to increase absolute muscular endurance (the maximal number of repetitions
performed with a specific pre-training load) (Kraemer, 1997), but limited effects are observed in relative local muscular endurance (endurance assessed at a specific relative intensity, or percentage of 1 RM) (Mazzetti et al, 2000). Moderate- to low-resistance training with high repetitions has been shown to be most effective for improving absolute and relative local muscular endurance. A relationship exists between the increase in strength and local muscle endurance such that strength training alone may improve local muscular endurance to a certain extent. However, specificity of training produces the greatest improvements. Training to increase local muscular endurance implies the individual to 1) performs high repetitions (long-duration sets) and/or 2) minimize recovery between sets.

1.5.6 Heart rate

Heart rate is acutely elevated immediately following a work out and affected by the amount of resistance, the number of repetitions and the muscle mass involved in the contraction (small vs. large mass exercises) (Fleck, 1988). Interestingly, in terms of chronic adaptations, there appears to be a reduction in heart rate from resistance training, which is considered beneficial (Stone et al., 1991).

1.6 OBJECTIVES OF THE STUDY

The present study was undertaken with the following objectives:

1. To examine the effect of periodized high and low volume circuit type resistance training on selected physical, physiological and skill performance variables of women College basketball players.
2. To examine the effect of low volume circuit type resistance training on selected physical, physiological and skill performance variables of women College basketball players.

3. To compare the effect of Low Volume Circuit Type Resistance Training and Periodized High and Low Volume Circuit Type Resistance Training on selected physical, physiological and skill performance variables of Women College Basketball players.

1.7 STATEMENT OF THE PROBLEM

The purposes of the study was to find out the effect of periodized high and low volume circuit type resistance training and low volume circuit type resistance training on selected physical, physiological, and skill performance variables of women college basketball players.

1.8 HYPOTHESES

The hypotheses formulated in the present study are as follows.

1. It was hypothesized that low volume circuit type resistance training and periodized high and low volume circuit type resistance training programme would have statistically significant improvement on the selected physical, physiological and skill performance variables of women college basketball players.

2. It was hypothesized that there is a significant difference among the low volume circuit type resistance training and periodized high and low volume circuit type resistance training and the control group in the development of selected physical, physiological and skill performance variables of women college basketball players.
3. It was hypothesized that low volume circuit type resistance training would be statistically better than the control group in developing the selected physical, physiological and skill performance variables of women college basketball players.

4. It was hypothesized that periodized high and low volume circuit type resistance training programme would be statistically better than the low-volume circuit type resistance training and the control group in developing the selected physical, physiological and skill performance variables of women college basketball players.

1.9 SIGNIFICANCE OF THE STUDY

The present study is significant in the following aspects.

1. The findings of the study would reveal the training adaptations associated with Low Volume Circuit Type Resistance Training and Periodized High and Low-Volume Circuit Type Training with regard to the selected physical, physiological and skill performance variables of women college basketball players.

2. This study would help to provide a scientific base and guidance to the physical educationists, coaches, sports scientists, physiologists, and fitness directors to identify the best method of resistance training to develop the physical, physiological, and skill performance variables of women college Basketball players.

3. Findings of this study would give basic knowledge to the exercise physiologist and coaches to envisage and conduct further research in various training methods, training programmes, training intensity,
and training load to get necessary recovery and minimize the possibility of experiencing the exhaustion phase.

4. The results of this study would add to the quantum of knowledge in the areas of training methods, exercise physiology, sports physiology and fitness.

5. The findings of this study would provide detailed insight on periodized high and low volume circuit type resistance training that benefit to any common person who seek to enhance his or her physical fitness in a very short duration.

6. Recovery from fatigue and injury being an inbuilt factor this study would contribute to its significance and also prove to be a strategy to be implemented among our sportspersons to compete and rise to international standards.

1.10 DELIMITATIONS

The study was delimited in the following aspects:

1. The subjects of the present study was delimited to forty-five women basketball players studying in Nirmala College for Women and Bishop Appasamy College of Arts and Science, Coimbatore, Tamil Nadu.

2. The ages of the selected women college basketball players were delimited between 18 to 25 years.

3. The duration of the training programme was delimited to 12 weeks.
4. In the present study the physical variables were delimited to abdominal muscular strength and endurance, grip strength-right hand, grip strength-left hand, lower extremity strength, upper extremity strength, explosive power, speed, anaerobic capacity physiological variables were delimited to maximum oxygen consumption, resting heart rate, and skill performance variables were delimited to dribbling, passing and shooting.

1.11 LIMITATIONS

The following were the limitations of the present study:

1. Certain factors like life style, daily routine work, diet and other factors, which might have an effect on the results of the study, were not taken into consideration.

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

3. The differences in economic and social background of subjects that might have an effect on their performance were not taken into consideration.

1.12 OPERATIONAL DEFINITION OF TERMS

One Repetition Maximum (1RM):

The maximum amount of weight that can be lifted with proper technique for one repetition.
Intensity

Intensity represents the difficult of an exercise. Movements that are more rapid or have greater resistance are considered to have higher training intensity.

Load

The amount of weight assigned to an exercise set.

Repetitions

The number of times an exercise can be performed.

Set

A group of repetitions sequentially performed before the athlete stops to rest.

Volume

The function of the amount lifted multiplied by the number of repetitions multiplied by the number of sets in a given time period.

Resistance Training

Resistance training is defined as a specialized form of physical conditioning that is used to enhance the athlete’s ability to exert or resist force.
Progressive Resistance Training

Progressive resistance exercise means gradually increasing the resistance against which a given muscle must work, as the strength of the muscle improves progressively, in order to maintain a high level of tension.

Periodization

Planned variation in training methods and means on a cyclic or periodic basis.

Low Volume Circuit Type Resistance Training

Low Volume Circuit Type Resistance Training is an arrangement of known and proven exercise in a circuit form using low volume resistance (8 – 12 repetitions) performed in a single set fashion on 3 alternate days per week (Monday, Wednesday and Friday)

Periodized High and Low Volume Circuit Type Resistance Training

Periodized High And Low Volume Circuit Type Resistance Training is an arrangement of known and proven exercises in a circuit form using frequent changes in intensity and volume performed in a three set fashion on 3 alternate days per week (Monday, Wednesday and Friday). The undulating periodization method was adapted in this study. In undulating periodization programme the volume and intensity are acutely varied by workouts (daily).

Speed

Speed is an important motor ability which moves the body or a part of the body as rapidly as possible from one point to another.
Muscular strength

Muscular strength is the maximum amount of force that can be exerted by a muscle.

Muscular endurance

Muscular endurance is the ability of the muscle to exert a force repeatedly over a period of time.

Anaerobic capacity

The term anaerobic means “Without Oxygen” and is used to describe exercise, which is of high intense and short duration.

Explosive power

Explosive power is defined as the capacity of the individual to release maximum force in the shortest period of time.

Maximal oxygen consumption

The maximal oxygen uptake can be defined as the maximal amount of oxygen that can be consumed per minute during the maximal exercise and it is abbreviated as VO₂ max.

Resting heart rate

The heart rate is the number of times the heart beats per minute (Fox, 1979).