ABSTRACT

The purpose of this study was to find out effects of different surfaces of circuit training on selected performance related variables of inter-collegiate cricketers. The investigator randomly selected eighty cricketers (20 cricketers from each college) from various colleges in Kerala namely Z. G. College, Kozhikode, School of Physical Education and Sports Sciences, Kannur, NIT Calicut, and Govt. Arts and Science College, Kozhikode and they were equally divided into 4 groups namely grass surface circuit training group, wooden surface circuit training group, synthetic surface circuit training group, and control group. Their age group were 18 to 23 years. The circuit training groups underwent training programme for twelve weeks (three days a week) whereas the control group was not given any training.

The data pertaining to the selected performance related variables such as speed, agility, leg explosive power, resting pulse rate, VO$_2$ max and aerobic capacity were collected by conducting pre-test and post-test. The collected data were statistically examined for significant difference by dependent ‘t’ test and ANCOVA. When the study was significant, the scheffe’s post-hoc test was used to find out the paired mean difference. The level of significance was chosen at 0.05 level.

It was found that all the circuit training groups had produced significant improvement on the selected performance related variables when compared to the control group. Further, the study concluded that when the improvement among the three surfaces namely grass, wooden, and synthetic were compared, no significant differences were found on the selected performance related variables.

Key words: circuit training, speed, agility, leg explosive power, resting pulse rate, VO$_2$ max and aerobic capacity
CHAPTER I

INTRODUCTION
Sports in the narrow sense can be defined as competitive activity, an active factor in physical education, which has taken shape mainly in the field of physical culture of a society, as a special sphere of identifying and comparing potentials in a unified form. Sports is a worldwide phenomenon today. It has occupied a prominent place both in physical, as well as in the moral culture of a society.

Sports training is done for improving sports performance. The sports performance, as any other type of human performance, is not the product of one single system or aspect of human personality. On the contrary, it is the product of the total personality of sports person. The personality of a person has several dimensions e.g., physical, physiological, social and psychological. In order to improve the sports performance the social and psychological capacities of the sports person also 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.

A definition of sports training has to be worked out in the light of the above discussed nature of training. A few definitions, however, as given by some experts, may well be presented as below:
“Sports training is a planned and controlled process in which, for achieving a goal, changes in complex sports motor performance, ability to act and behaviour are made through measures of content, methods and organisation” (Martin, 1979).

“The preparation of sportsman represents a multisided process of purposeful utilisation of the total complex of factors (means, methods and condition) which help in development of the sportsman and ensure a necessary level of his sports performance ability” (Matwejew, 1981).

“Sports training is a scientifically based and pedagogically organised 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” (Thiess, and Schnabel, 1986).

1.1 SPORTS TRAINING AND DIFFERENT TRAINING SURFACES

Many sports that are still extremely popular today have origins that date back to many years, when surfaces would typically have been local fields and common open spaces. More modern forms of these sports are played on specially prepared surfaces, specifically designed for the game requirements but, still have a long history; international cricket test matches began in 1944, international Davis Cup matches for tennis have been held since 1900, field hockey has been included as a modern Olympic event since 1908 and the dimensions of an association football rules pitch were laid out in 1963.

The range of surfaces used for sports participation today appears unlimited. Surfaces include grass, wood, concrete, acrylic, rubber, carpet, clay, cinder, soil,
foam, asphalt and sand (often in combination with each other). Since the original development of sports, there have been huge advances in natural surface preparations (e.g. drainage systems, soil composition, grass cultivation, cutting and rolling technology), and more recently technological leaps in the development of artificial surfaces and hybrid systems (polymer fibre carpets, sand-based and rubber based systems, grass fibre reinforcement). These changes have made huge differences to the access to, enjoyment of and even style of play, perhaps most noticeably in the field hockey. The Europeans were quick to adopt Astroturf surface for Hockey and were seen overtaking Asian counterparts. That it took decades for the Asians to catch up is history.

A desire to provide consistent surface to improve elite sports performance, together with the development of strategies to increase sports participation, has led to the development and increased usage of artificial sports surfaces. Synthetic running tracks and artificial turf provide two examples. Running tracks have been developed to allow optimal performance by minimising the influence of weather conditions on the interaction with the surface – hence the term ‘all weather’ track. Early tracks were cinder, clay or grass, meaning that weather had a significant influence on their performance. The first artificial running surface is thought to have been a warm up track constructed for the 1956 Summer Olympics in Melbourne, Australia, made from a mix of asphalt and rubber. Polymethane ‘Tartan’ track surfaces were developed in the 1960s by the company 3M. The 1968 Summer Olympics in Mexico saw the first synthetic track being used for an Olympics.
Synthetic turf surfaces have been adopted widely with the main motivation being to provide a surface that allows repeated use in all weathers with limited maintenance, for safe performance at an optimum level thus improving the availability of the playing surface to a greater and wider population. History demonstrates that the initial application of synthetic materials in sports surface development were not always successful in achieving these aims. For example, the early use of artificial pitches in American football was associated with injuries such as abrasions and ‘turf toe’, while the initial use of these surfaces in soccer was also associated with marked changes in performance requirements as a result of both shoe-surface and ball-surface interactions (Dixon, et al. 1999).

More recently, sports surface research and technological advances have led to the development of artificial surfaces that are more acceptable to sports participants either because they are considered to adequately reproduce the playing conditions of natural turf (e.g. soccer), or the changes as a result of using the surface are considered to enhance the sport (e.g. track and field athletics, field hockey). This acceptance has led to a large increase in the availability of artificial surfaces for recreational sports participation.

Individuals are able to adapt their play to the different surfaces, both in terms of the player-surface interaction and the movement of the ball on the surface. While this requirement for adaptation does influence the game, this level of freedom can add to the variety and enjoyment. Tennis is a modern example of the need for player adaptation, with high-profile international tournaments being played on three very different surfaces: ‘hard courts’ (a relatively stiff surface utilising a top surface of
acrylic paint mixed with silica particles) used at the Australian and US Open; ‘clay’ (an unbound surface with a top layer of particles free to move, that requires sweeping and watering for preparation) used at the French Open; and ‘grass’ (a natural surface that requires professional preparation and can be affected by the elements, as well as being worn over the duration of a tournament) used at the Wimbledon. In recent years, there have also been trends for elite tennis players to change their style of movement, for instance an increasing tendency to slide on hard courts, in a similar style to that typical on clay. An improved understanding of player response to different surface and the factors that govern this response can be used to inform the development of safe surfaces for optimal performance.

Despite the described rise in the use of artificial sports surfaces, natural turf surfaces remain an important feature of many sports, both at the elite level and in the recreational community sport. Huge advances have been made in recent times in the provision of high-quality natural surfaces, which will remain the elite standard for many sports, and will always have a role in sports, particularly those that utilise large playing area. International Cricket is always played on natural turf pitches surrounded by natural grass outfield. Hence, elite cricketers always perform their fitness training as well as skill training on natural grass surface itself. They train indoors only for gymnasium training and when the weather conditions are unsuitable.

When sports training is done on natural grass surface, it offers a shock absorbing effect to the athletes. Hence, the athletes are prone very less to injuries but the natural grass offers less rebounding height and it is found to be moderately
fatiguing surface for the training athletes. Wooden surfaces are mainly used for sports disciplines played in indoor stadiums especially for games like basketball, volleyball, handball, shuttle badminton etc. It is found that wooden surfaces are more compliant and less fatiguing surface for the athletes training on it. Moreover, it has got good rebounding ability. Synthetic surfaces are mainly used in outdoor stadiums especially for track and field athletics. It is found that synthetic surfaces, that offer high rebounding ability, are compliant in nature and are less fatiguing surface for the players training on it.

1.2 CIRCUIT TRAINING

Circuit training entails a series of activities performed one after the other. At the end of last activity, one starts from the beginning again and carries on until the entire series has been repeated several times. By a preliminary test, in which many of the activities are performed at maximal exertion, the number of repetitions of each activity is determined. The advantage with the circuit training is that every individual undergoes a programme adjusted to his or her level of fitness and that it may be accomplished in a limited space. The disadvantage is that an untrained individual is exposed to tests requiring maximal exertion. Persons may follow their own improvement by recording the time required for the series of repetitions and endeavoring to shorten the time required. At the end of a few weeks of training, a new test is performed on the number of repetitions of each activity the individual can manage (e.g. Push ups). This type of training produces a high degree of motivation. It has been found that a correctly planned programme varying the involvement of large and small muscle groups and mixing static and dynamic
exercise does not produce maximal oxygen uptake measured on the cycle ergometer but rather produces only about eighty percentage of the maximal oxygen uptake (Hedman, 1960). Despite this, the heart rate is almost maximal, the lactic acid concentration in the blood is very high, and the degree of exertion is considerable. Circuit training can be included in a training programme, not only for athletes but also for school children for the sake of variation and for experience. It can also be applied very effectively in a strength-training programme.

Circuit training was first proposed by Morgan and Adamson (1959) of Leeds University as a method for developing general fitness. Their initial circuit training routine consisted of several stations arranged in a circle (hence the name circuit training) so as to work muscle groups alternately from station to station. As circuit training grew in popularity, other authors began to provide additional information. Perhaps the best book on the market is Circuit Training for All Sports (Scholich, 1992).

A wide variety of exercises and devices can be used in a circuit training routine, such as body weight, surgical tubing, medicine balls, light implements, dumbbells, barbells, and any strength training machines. A circuit may be of short (6 to 9 exercises), medium (9 to 12 exercises), or long (12 to 15 exercises) duration and may be repeated several times depending on the number of exercises involved. In deciding the number of circuits, the number of reps per station, and the load, coaches must consider the athlete’s work tolerance and fitness level.

Total workload during the anatomical adaptation phases should not be so high as to cause the athlete pain or high discomfort. Athletes should help determine
the amount of work they can perform. Circuit training is a useful, although not magic method for developing the foundation of strength during the anatomical adaptation phase. Any other training method in which the muscle groups can be alternated can be equally beneficial. The key to any training method used during this phases is the number of exercises, number of repetitions and sets, and the rest interval. The training methodology used for the anatomical adaptation phase has to be adapted to the physiological profile of the sport (e.g., speed or power vs. a sport in which endurance has a certain role) and the needs of the athlete. It must also develop most muscles used in that sport. In line with the overall purpose of the preparatory phase, and particularly the goal of anatomical adaptation, exercises should be selected to develop the core area of the body as well as the prime movers.

Circuit training exercises alternate muscle groups, which facilitates recovery. The rest interval between stations can be anywhere from 30 to 90 seconds, with one to three minutes between circuits. A wide variety of circuits can be created because most gyms have many different apparatuses, work stations, and strength training machines. This variety constantly challenges the athlete’s skills and, at the same time, keeps them interested. Circuit training should not be used as a testing device or to compare athletes. Athlete differences are mainly due to anthropometric differences. Because the speed of performance and the degree of flexion and extension can vary greatly, comparing athletes is unfair. On the contrary, achievements should only be compared with the individual athlete’s past performance (Bompa, 2005).
1.3 BENEFITS OF CIRCUIT TRAINING

Circuit training is a great, diverse way to improve the overall fitness level, even if you are already doing normal fitness training programmes. Following are the benefits of circuit training.

1.3.1 People of all fitness levels can work together through circuit training

If you have a partner to exercise with, but your fitness levels are not similar, circuit training allows you to work together. The great thing is that you can work according to your own pace and fitness level at each activity. Circuit training can be an excellent way to improve your fitness alongside your partner.

1.3.2 Basic strength and body tone can be developed through circuit training

In a circuit training programme you can do more repetitions with lower weight. In addition, circuit training exercises generally tend to use more than one muscle group at a time. These exercises can give you quicker whole body benefits than spending more time on one piece of gymnasium equipment focusing on one set of muscles.

1.3.3 Cardiovascular workout can be performed through circuit training

If you practice traditional bodybuilding, then your heart rate will be lowered during the recovery period between your weight lifting exercises. If a circuit training programme is designed to focus on cardiovascular fitness then your heart rate remains elevated and sustained above the resting level throughout the workout.
Circuit training promotes cardiovascular improvements and therefore there is no need of a separate cardiovascular workout.

1.3.4 Circuit training can help fat loss

Due to the cardiovascular improvements through circuit training, it burns more fat and calorie than traditional weight lifting exercises. This benefit of circuit training means that in less time more work is performed resulting in greater caloric expenditure during the workout. In addition, you are increasing your lean body mass, which means you are improving your metabolism and burning more fat throughout the day.

1.3.5 Circuit training is an excellent off-season workout for professional athletes

The performance of a professional sportsperson depends mainly upon the fitness workouts done during the off-season. Circuit training can help you stay in shape during the off-season. Circuit training is a great way to maintain your general fitness and improve your overall strength while you prepare for the next season.

1.3.6 Circuit training helps to build muscle in conjunction with traditional bodybuilding

Since you have very few rest periods while performing circuit training, men actually increase the amount of testosterone they release, which helps in building muscle. In addition, circuit training programmes takes longer time period to complete, which means you avoid the cortisol releasing process. Cortisol release occurs when testosterone levels drop (typically during extensive cardio exercise like running a lengthy race and the cortisol can start to breakdown muscle tissues).
1.4 PRINCIPLES OF CIRCUIT TRAINING

1.4.1 Regularity

The circuit training programme should be conducted three times a week at a minimum.

1.4.2 Strength Improvement

Individuals should extend themselves at each station by working at the highest possible stress level for the 30-60 second time period.

1.4.3 Cardiovascular Improvement

Cardiovascular improvement depends on a minimum of 20-30 minutes of continuous exercise activity which may include alternating the pace between vigorous and moderate exertion. The exercise pace on this course must be conditioned with no rest or pause except when the individual may reach his limit on a particular station. Both circuit and interval portions are designed to include an alternation pace of vigorous and moderate exertion.

1.4.4 Muscular Endurance

On station exercises, the repetitions must be executed at a continuous pace with no rest or pause between repetitions.

1.4.5 Flexibility

The execution of all circuit exercise, particular by those with weight must be performed in such a manner so as to ensure full extension and contraction of the muscle groups involved.
1.5 PROGRAMME DESIGN FOR CIRCUIT TRAINING METHOD

Circuit training may be used from the first week of the anatomical adaptation phase. Athletes should follow a certain progression, depending on their classifications and training backgrounds. Younger athlete with little or no strength training background should start with exercises using their own body weights, then barbells and strength machines. Again, exercise during this phase must be selected to involve most muscle groups irrespective of the needs of the specific sport. However, the prime movers should also be targeted. After all, they are the engines behind the effective performance of sport-specific skills.

The circuits presented below (circuits A, B, and C) although far from exhausting all the possibilities available in a gym, are typical for entry–level, or junior, athletes. Athletes who are new to circuit training may want to split circuit B into two phases. As adaptation occurs, the athlete can begin adding exercise from phase II to the end of phase I until he or she can perform all eight exercises nonstop. Start with two groups of four as presented in Circuit B, and as the athlete adapts to the programme, bring the fifth exercise into phase I and so forth. This keeps the athlete motivated to reach his or her goal and keeps his or her body open to new challenges and levels of adaptation.

Entry-level athletes should individualise the number of reps and sets by working up to the point of feeling slight discomfort or discomfort. Slight discomfort can be translated as uneasiness. Discomfort, on the other hand, refers to the threshold of pain at which the athlete has to stop the exercise. Working to discomfort actually challenges the athlete. Advanced athletes may work to high
discomfort, which refers to surpassing the threshold of pain. High discomfort is suggested only for the latter part of a circuit training for advanced athletes.

1.5.1 Circuit A (own body weight)

1. Half squats
2. Push-ups
3. Bent-knee sit-ups
4. Two-legged low hops on spot
5. Back extensions
6. Pull-ups
7. Burpees

1.5.2. Circuit B (own body weight; combination of two mini circuits)

<table>
<thead>
<tr>
<th>Phase I</th>
<th>Phase II</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Half squats</td>
<td>5. Back extensions</td>
</tr>
<tr>
<td>4. Two-legged low hops on spot</td>
<td>8. Abdominal rainbows</td>
</tr>
</tbody>
</table>

1.5.3. Circuit C (dumbbells and medicine ball)

1. Half squats
2. Medicine ball chest throws
3. Military presses
4. Bent-knee sit-ups (medicine ball held at chest level)
5. Medicine ball forward throws (between legs)
6. Lunges
7. Back arches, ball behind the neck
8. Upright rowing
9. Toe raises
10. Trunk rotations
11. Overhead backward medicine ball throws
12. Jump squats and medicine ball throws.

Training parameters for experienced athletes are quite different from those for novices. A longer anatomical adaptation phase makes good sense for novice athletes because they need more time for adaptation and for creating a good base for the future. On the other hand, extending this phase much longer than five weeks will not result in visible gains for experienced athletes.

Similar observations can be made regarding the number of stations per circuit. Because novice athletes have to address as many muscle groups as realistically possible, they use more station and the circuits are longer. Advanced athletes, however can reduce the number of stations to focus on exercises for the prime movers, compensation, and core exercises, resulting in shorter circuits.

The total physical demand per circuit must be increased progressively and individually. Because novice athletes need longer and better adaptation, the load remains the same for two weeks. For experienced athletes, however, the load changes from cycle to cycle. The same is true regarding the load used in exercises
performed against resistance: lower loads for entry-level athletes and slightly heavier loads for advanced athletes.

A six–week cycle will give athletes time to build a stronger base, and offer the physiological benefits from longer and better adaptation. The suggested programmes should be adapted to athletes’ classifications and abilities.

Toward the end of the anatomical adaptation phase, the load reaches percentages that allow athletes to make an immediate transition to the maximum strength phase. This approach can be used for all athletes except those requiring increased muscle mass, such as throwers and American football linemen. For these athletes, a hypertrophy phase must be planned between the anatomical adaptation phase and the maximum strength phase.

The three-week anatomical adaptation programme is appropriate for athletes with a very short preparatory phase, especially those in racket and contact sports that have three or four major peaks per year. As the anatomical adaptation phase is very short, the load in training is increased very quickly to ready the athletes for the maximum strength phase. Detraining in these sports is less of an issue because the transition phase is much shorter than those in most other sports. In baseball, softball, and racket sports, certain specific exercises for trunk and hip rotation (abdominal rainbows, incline trunk rotations, and power ball side throws) are introduced as early as the anatomical adaptation phase for maximum adaptation.
1.6 OVERLOAD PRINCIPLES IN CIRCUIT TRAINING

In circuit training, overload can be produced by:

- Increasing the number of stations in the circuit
- Increasing the number of repetitions at each station.
- Increasing the number of times the circuit is completed.
- Increasing the speed at each station.

1.7 TAPERING

Tapering is defined as a short-term reduction in training load during a period leading up to a competitive event. This strategy has become very popular; it is common to incorporate a tapering period over several days before a major competition (Shepley, et al. 1992). A common misconception about tapering is that to reduce training intensity or volume immediately before a competition, may decrease exercise performance through detraining. This is clearly not the case. Coaches, trainers and athletes who make a concerted effort to taper after a period of high-intensity or high-volume training may benefit through performance enhancement in both strength and endurance events (Powers, and Howley, 2001).

1.8 EFFECTS OF CIRCUIT TRAINING

Circuit training may be designed to increase muscular strength and power, muscular endurance, flexibility and to a limited extent, cardio respiratory endurance. However the physiological effects depend to a large extent on the type of circuit that is set up. Circuit consisting only of weight resistance exercise produces substantial
gain in strength, but only minimal gains in cardio respiratory endurance. Circuit training is an effective training technique for altering muscular strength and endurance, and to a limited extent, flexibility and cardio respiratory endurance. The use of circuit training, particularly for off-season programmes, therefore may be recommended for sports that require high levels of muscular endurance, power and endurance and lower levels of cardio respiratory endurance (Fox, et al. 1993).

1.9 CIRCUIT TRAINING AND CRICKET

Unlike many other games, Cricket is a game which is played for a longer duration. Batters aim to stay at the crease for as many hours as possible with good concentration and patience. They need to have the strength and fitness to make each shot played count. They also need to have good speed and agility for running between the wickets. Bowlers aim to bowl a high number of overs with great speed and accuracy. They should be able to bowl the last ball of their spell with the same intensity and accuracy as they had bowled the first ball of their spell. Bowlers need to specifically look after their body as they are easily prone to injuries. Fielders need the ability to maintain concentration for long hours of play without undue fatigue. They should always be prepared for explosive bursts at any given time – such as racing behind a ball, jumping for a catch, diving to field a ball etc. Hence cricketers need to work on all the major physical fitness parameters namely endurance, strength, speed, agility, quickness, flexibility, and coordination. But because of the long duration of the game, special importance is given to develop strength endurance and speed endurance. For this, cricket coaches and trainers employ circuit
training method. Hence, circuit training is an integral part of cricket training programme.

1.10 JUSTIFICATION OF THE STUDY

Even though a large number of studies in sports science conducted aboard have figured circuit training and its positive effects, very few have been reported from the Indian soil. Many cricket coaches and trainers are currently doing circuit training on grass, synthetic and wooden surface without knowing whether there is any difference in the ultimate effect on doing training on different surface. Hence this unexplored domain of sports training, motivated the researcher to find out the effects of different surface of circuit training on inter-collegiate cricketers.

1.11 STATEMENT OF THE PROBLEM

The purpose of study was to find out effects of different surfaces of circuit training on selected performance related variables of inter-collegiate cricketers.

1.12 OBJECTIVES OF THE STUDY

1. To find the training effects of circuit training on grass surface on the selected performance related variables.

2. To find the training effects of circuit training on synthetic surface on the selected performance related variables.

3. To find the training effects of circuit training on wooden surface on the selected performance related variables.
4. To compare the effects of circuit training done on different surfaces on the
selected performance related variables.

1.13 HYPOTHESES

1. It was hypothesised that twelve weeks of circuit training on grass surface
would show significant improvement on selected performance related
variables such as speed, agility, leg explosive power, resting pulse rate, VO\textsubscript{2}
max, and aerobic capacity over that of the control group among inter
collegiate cricketers.

2. It was hypothesised that twelve weeks of circuit training on synthetic surface
would show significant improvement on selected performance related
variables such as speed, agility, leg explosive power, resting pulse rate, VO\textsubscript{2}
max, and aerobic capacity over that of the control group among inter
collegiate cricketers.

3. It was hypothesised that twelve weeks of circuit training on wooden surface
would show significant improvement on selected performance related
variables such as speed, agility, leg explosive power, resting pulse rate, VO\textsubscript{2}
max, and aerobic capacity over that of the control group among inter
collegiate cricketers.

4. It was hypothesised that twelve weeks of circuit training on grass surface
would show significant improvement on selected performance related
variables such as speed, agility, leg explosive power, resting pulse rate, VO\textsubscript{2}
max, and aerobic capacity over that of synthetic and wooden surface among
inter collegiate cricketers.

1.14 SIGNIFICANCE OF THE STUDY

1. The present study will be of great use to physical educators, coaches, sports
scientists and players, as they would be able to assess the effects of three
different surfaces of circuit training on selected performance related
variables.

2. The study will enable researchers to find out the importance of the selected
performance related variables.

3. The study will be helpful to physical educationists and sports scientists who
are constantly in the look out to discover those factors that contribute to high
performance and apply it in the physical aspects of coaching and training.

4. The findings of the study provide an opportunity to find out the effects of
different surfaces of circuit training for the promotion of effective sports
programme.

5. The study may be helpful for the physical education professionals to adopt
circuit training as one of the training programme in their training schedule.

6. The study may stimulate the students’ interest in physical activities through
the circuit training method.
1.15 DELIMITATIONS

The study was delimited to the following aspects:

1. Eighty (N = 80) men inter-collegiate cricketers were randomly and equally selected (n = 20) from the following Colleges in Kerala:
   a) Zamorin’s Guruvayurappan College, Kozhikode – 673014.
   b) School of Physical Education and Sports Sciences, Kannur - 670567.
   c) National Institute of Technology Calicut, Kozhikode – 673601.
   d) Government Arts and Science College, Kozhikode - 673018.

2. The age of the subjects ranged between 18 to 23 years.

3. The year of participation of the subject was 2014.

4. The experimental treatment was restricted for a period of twelve weeks.

5. The selected performance related variables for the study are:
   a) Speed
   b) Agility
   c) Leg explosive power
   d) Resting pulse rate
   e) VO₂ max
   f) Aerobic capacity

6. The pre-test and post-test for all the experimental groups was administered on grass surface.

7. All the subjects had used the same brand of shoes (puma evospeed rubber sole cricket shoes) while undergoing experimental treatment and during testing phases.
8. All the subjects wore whites while undergoing experimental treatment and during testing phases.

1.16 LIMITATIONS

The following were the limitations of the present study.

1. Certain factors like rational habits, lifestyle, daily routine, diet were not taken into consideration.
2. The climatic condition was not taken into consideration.
3. The subjects belonged to different socio-economic status.
4. The subjects’ past performance in cricket was not taken into consideration.
5. The growth and development of the subjects if any, during the period of experimentation and its possible influence on the variables, could not be controlled. However the control group was employed to nullify the effects of maturation.

1.17 OPERATIONAL DEFINITIONS OF THE TERMS

The various terminologies present in the study are defined here under and explained so as to avoid misinterpretation and misapprehension.

1.17.1 Training

It is a programme of exercise designed to improve the skills and increase the energy capacity of an athlete for a particular event (Fox, 1984).
1.17.2 Circuit Training

A method of physical exercise in which activities are arranged in sets and the participants moves quickly from one activity to another with a minimum of rest between activities (Mosby’s Medical Dictionary, 9th edition. © 2009, Elsevier).

1.17.3 Speed

Speed in this study means the capacity of the individual to perform successive movement of the same pattern at a fast rate (Barrow, 1973).

1.17.4 Leg Explosive Power

It is defined as rate of force development at the outset of contraction (Hakkinen, and Komi, 1986).

1.17.5 Agility

It is the ability to move and change direction and position of the body quickly and effectively while under control (Elizabeth Quinn, 2007).

1.17.6 Resting Pulse Rate

The heart beat or heart frequency is defined as the frequency of heart beats in one minute, when a player is in resting conditions (Geddie, 1964).

1.17.7 VO$_2$ max

It is defined as the greatest oxygen uptake obtained by an individual while breathing air at sea level during the performance of physical work (Shaver, 1972).
1.17.8 Aerobic Capacity

It is the maximal amount of physiological work that an individual can do as measured by oxygen consumption. It is determined by a combination of aging, cardiovascular conditioning and is associated with the efficiency of oxygen extraction from the tissues. (Mosby's Medical Dictionary, 9th edition. © 2009, Elsevier).

1.17.9 Independent Variables

Main variable is one under consideration that is manipulated by the researcher with subjects randomly assigned to various groups or testing conditions. (Jenson, 1979).

1.17.10 Dependent Variables

A dependent variable is that condition that is observed and measured that is expected to be affected in some way as a result of the manipulation of independent variable (Morehouse, 1975).