CHAPTER I

INTRODUCTION

Research on all aspects of the game of cricket is needed in order to understand the demands being placed on players as well as to link these to fatigue indicators and injury risk. The sport has a long way to go in terms of linking science and practice evident in othersports such as football. Until more is understood of the demands of the game, training programmes will be merely based on trial and error and not grounded in science. This means that it is probable that players are not getting adequately prepared for play and as a result, are becoming injured more frequently. This is particularly the case for injuries which are more avoidable and linked to fatigue, such as sprains and strains. Further, there is a need for more communication and co-operation between sports scientists involved in cricket research and coaches of the game to ensure mutual benefit. This chapter contends that the real source of stress for cricketers is the musculoskeletal demands and associated stressors and that research needs to consider linking appropriate eccentrically based training programmes with fatigue indicators, performance affects and injury risk reduction.

1.1 HISTORY OF CRICKET

The game of cricket has a known history spanning from the 16th century to the present day. With international matches since 1844, although the official history of international test cricket began in 1877. During this game, developed on its

origins in England into a game which is now played professionally in most of the commonwealth of nations.

1.1.1 Early Cricket Origin

No one knows when or where cricket began but there is a body of evidence, much of it circumstantial, that strongly suggests the game was devised during Saxon or Norman times by children living in the wealth, an area of dense woodlands and clearings in South-East Englandthat lies Acroeskent and Sussex it is generally believed that cricket survived as a children's game for may generations before. It was increasingly taken up by adults around the beginning of the 17th (century possible cricket was derived from bows. Assuming bows is the older sport, by the intervention of a batsman trying to stop the ball from reaching its target by hitting its ways. Playing on sheep-grazed land or in clearings the original implements may have been a matted lump of sheep's wool as the ball, a stick or a crook or another farm toot as the bat and a stool or a true stump or a gate as the wicket.

1.1.2 Derivation of the Name of Cricket

A number of words or thoughts to be possible sources too the term 'cricket' in the earliest known reference to the sport in 1598. It is called cricket. The name may have been derived from the middle. Dutch krick, meaning a stick, or the old English cricket or cryle meaning a crutch or staff. Another possible source is the middle Dutch word krickstoel,meaning a long low stool used for kneeling in church and which resembled the long low wicket with two stumps used in early cricket.

It is more likely that the terminology of cricket was based on worlds in use in South East England at the time and, given trade connections with the country of Handess. Especially in the 15th century when it belonged to the Duchy of Burgundy, many middle Dutch words found their way into Southern English dialects.

1.1.3 Cricket Moves out of England

Cricket was introduced to North America via the English colonies in the 17thcentury. Probably before it had even reached the north of England. In the 18th century it arrived in other parts of the globe. It was introduced to the West Indies by colonists and to India by British East India Company marines in the first half of the century. It arrived in Australia almost as soon as colonization began in 1788. New Zealand and South Africa followed in the early years of the 19th century.

Cricket never caught on in Canada, despite efforts by an imperial-minded elite to promote the game as a way of identifying with the British Empire, Canada, unlike Australia and the West Indies, witnessed a continual decline in the popularity of the game during 1866-1960. Linked to upper class British – Canadian elites,the game never became popular with the general public, in the summer season it had to compete with baseball. During the first world war, Canadian units stationed in British played baseball not cricket.

1.1.4 Development of the Laws

The basis rules of cricket such as bat and ball, the wicket, pitch dimensions, overs, how out, etc. have existed since time immemorial. In 1728 the Duke of Richmond and Alan Brodick drew up Articles of Agreement to determine the code

of practice in a particular game and this became a common feature, especially around payments of stake money and distributing the winnings given the importance of gambling.

In 1744, the laws of cricket were codified for the first time and then amended in 1774, when innovations such as the, middle stump and maximum bat width were added. These laws stated that the principals shall choose from amongst the gentlemen present two umpire who shall absolutely decide all disputes. The codes were drawn up by the so-called "Star and Garter Club" whose members ultimately founded MCC at Lord's in 1787, MCC immediately became the custodian of the laws and has mad periodic revisions and recodifications subsequently.

1.1.5 Growth of Test Cricket

When the imperial cricket conference was founded in 1909, only England, Australia and South Africa were members, India, West Indies and New Zealand became Test nations before the second world war and Pakistan soon afterwards. The International game grew with several "affiliate nations" getting involved and, in the closing years of the 20th century, there of those became test nations also Srilanka, Zimbabwe and Bangladesh.

Test Cricket remained the sports highest level of standard through out the 20th century but it had its Prodems, notably in the infunous 'Bodyline' series of 1932-33 when DouglasJardines England used so-called "leg theory" to try and neutralise the run-scoring brilliance of Australia's Don Bradman.

1.1.6 World Series Cricket

The money problems of top Cricketers were also the root cause of another cricketing critics that arose in 1977.Taking advantage of the low remuneration paid to players, Pakcer retaliated by signing several of the best players in the world to a privately run cricket league outside the structure of international cricket. World series cricket hired some of the banned South African players and allowed them to show off their skills in an international arena against other world class players. The schism lasted only until 1979 and the 'rebel' players were allowed back into established international cricket. Though many found that their national teams had moved on without them. Long-term results of world series cricket have included the introduction of significantly higher players' salaries and innovationssuch as coloured kit and night games.

1.1.7 Limited-Over Cricket

In the labos, England country teams began playing a version of cricket with game of only one innings each and a maximum number of overs per innings. Starting in 1963 as a knockout competition only. Limited overs grens in popularity and, in 1969, a national league was created which consequently caused a reduction in the country championship.

Although many 'traditional' cricket fans objected to the shorter form of the game, limited over cricket did have the advantage of delivering a result to spectator within a single day: it did improve cricket's appeal to younger or busier people and if did prove commercially successful.

The first limited-over international match took place at Melbourne Cricket Ground in 1971 as a time filter after a test match had been abandoned because of heavy rain on the opening days. It was tried simply as an experiment and to give the players some exercise, but turned out to be immensely popular. Limited-over international have since grown to become a massively popular form of the game. Especially, for busy people who want to be able to see a whole match. The international cricket council reacted to this development by organizing the first cricket world cup in England in 1975, with all the test playing nations taking part.

In June 2001, the ICC introduced a “Test championship table”. As indicated by ICC rankings, the various cricket formats have continued to be a major competitive sport in most former British Empire countries. Notably the Indian subcontinent, and new participants including the Netherlands. As of August 2013 the top rankings were held by South Africa (Tests), India (one-day internationals) and Srilanka (Twenty 20 champion)

The ICC expanded its development programme aiming to produce more national teams capable of competing at the various formats. Development efforts are focused on African and Asian nations, and on the United States. In 2004,the ICC intercontinental cup brought first-class cricket to 12 nations. Mostly for the first time, Cricket’s newest innovation is Twenty 20 essentially an evening entertainment. It has so far enjoyed enormous popularity and has large attendances at matches as well as good TV audience ratings. The inaugural ICC Twenty 20 World Cup tournament was held in 2007 the formation of twenty 20 leagues in India-the unofficial Indian cricket league,which started in 2007 and the official

Indian premier league. Starting in 2008-raised much speculation in the cricketing press about their effect on the future of cricket.

1.2 CRICKET IN INDIA

Cricket is the most popular sport in India. It is played many people in open spaces throughout the country. The Indian natural cricket team won the 1983 cricket world cup. The 2007 ICC world Twenty 20, and the 2011 cricket world cup the 2013 ICC champions Trophy and shared the 2002 ICC champions Trophy with Srilanka. Domestic competitions include the RanjiTrophy,the Deodhar Trophy, the Train Trophy and the NKP Salve Challenger Trophy. In addition to that BCCI conducts the Indian premier league, a twenty 20 competition.

1.2.1 History of Cricket in India to 1918

The entire history of cricket in India and the sub-continent as a whole is based on the existence and development of the British Raj via the East India Company. In 1721 the first definite reference to cricket being played a game at Cambay, near Baroda. The Calcutta cricket and football club is known to exist by 1792, but was possibly founded more than a decade earlier. In 1799, another club was formed at Sirangapama in South India after the successful British and the defeat of TipuSultan. In 1864, a Madras Calcutta match was arguably the start of first class cricket in India.

1.2.2 Cricket in India from 1918-19 to 1945

India became a member of the ‘elite club’ joining England, South Africa, New Zealand and the West Indies in June 1932. India’s first match in Lords against

England attracted a massive crowd of 24,000 people as well as the king of England, who was also the Emperor of India.

1945 to 1960

The major and defining event in the history of Indian cricket during this period was the partition of India following full independence from the British Raj in 1947.

An early casualty of change was the Bombay quadrangular tournament, which has been a focal point of Indian Cricket for over 50 years. The new India had no place for teams based on ethnic origin. As a result, the Ranji Trophy came into its brown as the national championship. The last over Bombay pentangular, as it had become, was non by the Hindus in 1945-46.

India also recorded its first Test victory in 1952 beating England by an innings in Madras.

1970 -1985

India enjoyed two international high lists in 1971, they won a test series in England for the first time ever, surprisingly, defeating Ray Illingworth's Ashes winners, in 1983, again in England, Indians were surprise winners of the 1983 world cup under the captainship of Kapil Dev.

1985 to 2010

Several team names and spellings were altered during the 1990 when traditional Indian names were introduced to replace those that were associated with

the British Raj. Most notably, Bombay became Mumbai and the famous venue of Madras became Chennai.

India's victory in the cricket world cup in 1983 the team performed poorly in the test arena including 28 consecutive test matches without a victory. HoweverIndia won the Asia Cup in 1984 and won the world championship of Cricket in Australia in 1985.In the 1987 Cricket World Cup was held in India.

In September 2007,India won the first ever Twenty 20 World Cup held in South Africa, beating Pakistan by 5 runs in a thrilling final.

India won the Cricket World Cup in 2011 under the captainship of Mahindra singles Dhoni the first time since 1983 – they beat Srilanka in the final held in Mumbai.

1.3 CRICKET

Cricket is a team sport played using a bat and ball on an oval-shaped outdoor arena. During the course of a cricket game we experience long rest intervals with short bursts of high intensity. As a result, specific components of fitness are essential for a high-level of cricket performance.

Cricket is a sport that generates a broad range of reaction from sports fans. Among those who are a part of more action-packed athletic traditions, cricket is variously seen as a boring, tedious game. To its hundreds of millions of fans united in an intense global following, cricket is a truly international sport, one of the immeasurable subtlety, sportsmanship, and athletic skills. The international contests generate a passion that is only approached by Soccer's World Cup. To play cricket

as a representative of one's country is to achieve celebrity status in countries such as India, Pakistan, the various West Indies, and South Africa.

Cricket was a product of the English countryside, an ancient game that was played in a formalized fashion at least as early as the 1500s. The rules of the game were first codified in 1744; the format of cricket has been only modified, as opposed to being subjected to wholesale reconstruction, since that time. As with American baseball, the fundamental distinction between cricket and virtually all other sports is the fact that traditionally there was no time limit imposed on play; the length of the game was determined by how long it took one team to retire the other side in their turn at bat, known as their "innings." The game was an exclusively English pursuit until it was locally adopted into the various English colonies around the world in the nineteenth century. Ironically, the first international cricket match was played between two countries with a more limited current cricket tradition, when Canada played with the United States in 1844.

Cricket is a predominately, but not exclusively, male sport. Women's cricket enjoys a following in various countries where cricket is widely played, but the women's game has not enjoyed the attention nor the professional organization of men's cricket.

The rules of cricket are not complicated, but there are subtleties to the game that are best appreciated through actual participation, as opposed to observation. The rules of the game include:

The game is played on a field (usually a natural grass surface) that is oval shaped, measuring between 290 ft and 480 ft (90 m to 150 m) across.

Within the oval is a "pitch," with two marked creases in which the two batsmen will stand awaiting the delivery of a ball from the opposing team's bowler. One batsman faces the bowler at a time, measured by the delivery of six balls, known as an "over." The batsman uses his bat to protect the wicket from being struck by a bowled ball. The wicket is composed of three upright posts, known as stumps, upon which are set two bails, square blocks that rest on notches cut into the stumps.

The batting team, or side, begins the game with one batsman at each crease. The defensive team takes their positions, one player as the bowler, the remaining 10 players placed in the field positioned to either catch or stop the ball if it is hit toward them. One of the 10 fielders is a wicketkeeper, designated to catch the bowled balls that are not hit by the batsman when bowled.

The primary object of the game is to score more runs than the opposing team. When the ball is bowled, the batsman generates a run by both hitting the ball in the field, and then running to the opposite crease while his teammate exchanges positions. One run counts when each batsman has reached the other crease; any part of the batsman body or bat that touches inside the crease prior to the arrival of the ball will score the run.

The bowler delivers the ball with an overhand, straight arm motion (the throwing arm may not be bent at the elbow on delivery), thrown after a run up. The ball is usually delivered with a bounce in front of the batsman, and the ball is not permitted to bounce higher than the waist of the batsman to constitute a legal ball. There are generally two types of bowlers, the spin bowler, who delivers balls that

tend to curve or break as they approach the batsman, and the fast bowler, whose ball is thrown with greater emphasis on speed than movement. An elite international fast bowler can deliver a ball at speeds in excess of 120 mi (180 km) per hour.

The bowler delivers six balls, which comprise an over. At the conclusion of the over, the bowler changes sides and delivers the next six balls from the opposite end of the pitch. The cricket ball is a hard-surfaced, cork, string, and leather object, with a single raised stitch seam. The ball must be 8.81 in to 9.0 in (224 mm to 229 mm) in circumference, with a prescribed weight of 5.5 oz to 5.75 oz (160 g). Unlike the sport of baseball, a cricket bowler is permitted to scuff the ball, which is typically done to make the ball spin the air.

The batsman uses a bat constructed a willow wood with a flat side, a maximum of 4.25 in (108 rmm) width, and 38 in length (965 mm). Given the speed that the ball can be delivered by the bowler, the batsman wears gloves, a helmet and face protection, and leg pads.

The position of the batsman permits them to react quickly to both the line and bounce of the ball, while protecting the wicket behind them, wicketkeeper, who is permitted gloves and protective gear, no other fielder has any special equipment.

The batsman has a number of different strategies available to him. In some circumstances, the batsman may choose to take a defensive posture toward a ball bowled, where the batsman protects the wicket from being struck by the ball by using the bat as a blocker. In other instances, the batsman may direct the ball in any direction; he is not obligated to run.

When the ball is batted, and the two batsmen on the field successfully exchange positions, crease to crease, one run will be scored. If the ball is hit far enough to permit the batsmen to run between the creases twice, two runs will score. When the batsman strikes the ball and hits along the ground over the boundary of the oval, four runs score and the batsmen are not required to run between the creases. When the ball is hit in the air and it crosses the boundary to the oval in the air, six runs score.

Consistent with the nature of a game that developed with no time limits, a batsman may remain at bat indefinitely, subject to any tactical decisions made about the conduct of the team's innings, or the special rules associated with different formats such as one-day cricket.

As with baseball, which owes some of its structure to cricket, the batsmen on a cricket side have different specialties and defined roles within the match. Some batsmen are required to occupy the bowler, especially if partnered with an adapt batsman. These players typically take a defensive stance, protecting the wicket and running when their batting partner is facing the bowler and makes contact with the ball. Early in an inning, often the role of the batsman, known as the opener, will be to wear down the opposition by being on the receiving end of the fastest opposition. In games where a new cricket ball is being used in play, the new ball will often be faster. The batsmen in the middle of the team's order will be the best, most free-swinging batsmen of the side. The last batsmen tend to be the weaker members of the side, often the team bowlers. A player who is both an adapt batsman and a bowler is referred to as an "all rounder."

One of the many intricacies of cricket is found in the fact that there are 10 different ways in which a batsman may be called out on a bowled ball. The most common ways to get a batsman out are to be bowled out by the bowler (the ball strikes the wickets and dislodges the bails), caught out when the batted ball is caught by a fielder without the ball first hitting the ground, run out, if the batsman hits the ball but fails to reach the opposite crease, or "leg before wicket" (LBW), when the batsman swings and misses at a bowled ball, and part of leg or pad block the ball from striking the wicket.

Games can have a variety of lengths and structures. The traditional cricket game consisted of one inning per side, and such a match could take hours or more than one day to complete. The English game was famous for the break for the teams to take tea and other refreshment. In international test competitions, the countries involved will set rules for how long the matches will take; test matches usually run for a number of days. In recent years, the one-day cricket concept has evolved to a relatively fixed series of rules, where each team gets a specified number of overs, the typical number being 50 overs. While there is no time limit as to how long each over may take, the overs limit greatly shortens the traditional cricket match. Kerry Packer of Australia (1937–2005), a cricket fan and television impresario, spearheaded the formation of the World Series of Cricket and the one-day, television-friendly cricket match in the 1970s.

While cricket has enjoyed a growth in professional competition in a number of countries throughout the world, including Australia and England, cricket supremacy is measured on a world scale through the test matches. Countries are certified as being worthy of participating in test matches by the International Cricket

Council, the supreme governing body of world cricket. Ascendancy to test status is the supreme indication of the cricketing status of a nation. The current test membership includes Australia, Bangladesh, England, India, New Zealand, Pakistan, South Africa, Sri Lanka, the West Indies, and Zimbabwe.

The longest held and best-known international competition is that of the theAshes, which originated in the defeat of the English team by Australia in 1882, an event referred to as "the death of English cricket." When England travelled to Australia to resume the rivalry in 1883, the English captain was presented with an urn, purporting to carry the Ashes of dead English cricket. The urn and the ashes have been the prize contested between those countries since that date.

1.4 FITNESS FOR CRICKET

Cricket is a sport in which fitness is traditionally not thought of as very important. However, the success in the 1990s and 2000s of the world beating Australian team has been attributed to their professionalism, and in part to the way they addressed their fitness. The other test playing nations have rightfully put more emphasis on fitness recently and are reaping the benefits.

With the introduction of one day Cricket and more recently Twenty20, the game has gone through major changes and the physical demands made on a cricketer's body has also increased dramatically.

Depending on the version of the game being played and the role of the player in the team, the importance of fitness will vary: the fitness requirements of a fast

bowler will be greater and also different than that of an opening batsman, and one-day cricket will be more demanding than a test match.

1.5 CRICKET BATTING

Cricket, like baseball, is a team game that at its essence is a confrontation between two players; in cricket, it is between the bowler and the batsman, while in baseball, which is a sporting cousin of cricket, it is between the pitcher and the batter. The degree of the engagement in the game of the other 10 players in the field in support of the bowler, and the corresponding involvement of the batsman's partner in the opposite crease, depends entirely on the outcome of each ball bowled at the batsman's wicket.

The bowler and the batsman face one another on the pitch, the portion of the cricket playing surface that contains the wickets. The distance between the two cricket wickets is 66 ft (20.1 m). As the batsman facing a bowler has a distance of 4 ft (1.2 m) from the wickets to the edge of the crease, a bowler will deliver a ball, at the end of the run up, from a point approximately 62 ft (19 m) from the batsman. As the ball may be delivered by an elite-level fast bowler at speeds approaching 120 mph (180 km/h), a competent batsman must possess both quick reflexes and considerable nerve to make quick and accurate decisions about each ball that he faces.

The batting technique employed by a batsman will be dictated by the nature of both the bowler and each ball faced; it is difficult for the batsman to impose his will on a particular circumstance, by way of attempting to strike the ball in a particular direction or manner, if the ball bowled is unsuitable. Generally, a batsman

will be adopting either a defensive or an offensive attacking approach; when a Game of cricket in progress, particular ball is not capable of being played as the batsman would like, it will generally be defended.

Cricket batting is also a partnership between two batsmen. The batsman facing the bowler is the striker, the second batsman is the non-striker. The chief responsibility of the non-striker is to be prepared to run to the opposite crease on a struck ball, and to call to the striker as to whether they may run without being out. Often in a batting partnership, one batsman is the designated defensive player, whose role is to stand in, to occupy the bowler, to create possible arm fatigue, and place the other batsman in a position where he has a greater chance of success.

Whether the batsman is seeking to drive the ball and create runs, or whether he is adopting a defensive posture, the physical stance of the batsman will have common features. The batsman will face the bowler in an athletic stance, the slightly crouched position similar to that of a defensive player in basketball, a baseball fielder, or a boxer. The batsman stands with his knees slightly bent, his weight balanced on the balls of the feet, and his head level, aligned directly above the bat that is gripped so that the top of the bat is touching the ground at the batsman's feet. This position permits the batsman to react quickly to both the line and the bounce of the ball, while protecting the wicket behind him. The bent knees allow for explosive power to be developed, both in a forward position and in a turning position, as the batsman may drive the ball in any direction once it is bowled.

Cricket has a variety of terms to describe the different types of batting strokes employed by a batsman. The primary defensive, or blocking, strokes are

closely tied to the foot position in relation to how the ball is bowled. When the batsman is facing a very fast bowler, the rear foot, that closest to the defended wickets, will be the foot on which the batsman's weight will be placed when the bat is swung, as the movement of the batsman to his rear foot creates a slightly longer reaction time as regards the flight of the ball. A defensive shot has the dual purpose of both protecting the wicket and being driven directly into the ground, to prevent it from being caught in the air by a fielder and rendering the batsman out.

A variety of more aggressive strokes are employed by a batsman to put the ball into play and to create the potential for runs to be scored. Drive shots, where the swing of the bat is extended through the line of the ball's path, are used when the batsman is seeking to hit the ball with force into a particular place in the field. The square cut is a shot to direct the ball in a perpendicular direction from that at which it was bowled. The pull stroke is a ball struck by the batsman driving the ball hard to the side of the cricket field aligned with his body. The sweep stroke is a motion in which the bat is drawn across the body in a wide arc. The lofted shot is a motion to drive the ball into the air, often aiming for the boundary.

The rules of cricket (formally referred to as the "Laws of the Game") provide for 10 different ways in which a batter may be ruled out by the umpire. The four best known outs include:

Bowled out is when the ball strikes the defended wicket, causing the bails positioned on the top of the wicket stumps to be dislodged.

Caught out is when the ball, when struck by the batsman, is caught in the air by any one of the 11 fielding players.

Run out is when one of the two batsmen, in exchanging positions after a ball is hit into the field, does not reach the opposite crease before the ball is thrown to the wicket and used to knock it down.

"Leg before wicket" is when a batsman swings at and misses a bowled ball, and his leg prevents the ball from otherwise striking the wicket. This determination is a judgment call for the umpire.

No matter what changes are made to the format of cricket matches, the successful batsman makes his reputation on how many times in his career he has batted for 100 runs or more in a single match. This feat, known as the "century," requires both batting skill and stamina, as the batsman may be on the field for several hours. Sir Garfield Sobers, of the successful West Indies Test teams of the 1960s, and Sachin Tendulkar, India standout in the twenty-first century, are two examples of batsmen who achieved legendary status for their ability to deliver centuries for their countries in international competition.

Batsman aims to stay at the crease for as long as possible, sometimes for periods of over 4 hours. In order to occupy this position, a good batsman most be able to stay focused, have good ball / eye skills, and have the strengths and fitness to make each shot played count.

The power will come from having a strong core, abdominal mid-section and the ability to generate explosive upper body actions, however with that said, using the kinetic energy of the ball as it speeds towards you, only requires a slight change

in direction in order to score 4 runs - unfortunately this skill has only be given to a few class batsman.

1.6 CRICKET: THE PHYSICS OF HOW THE BALL IS BOWLED

As with most confrontations that can sometimes take on epic stature, the tools of the conflict between a cricket bowler and the batsman are very simple. The batsman strides into the crease, prepared to defend a three-posted wooden wicket with a flat-sided willow bat, equipped with modest protective equipment and his reflexes. The opposing bowler has a single weapon, a hard-wound, leather-skinned ball, bound with a single raised seam, that is delivered by the bowler with a variety of spins and speeds.

The manner in which a cricket ball may be delivered is well defined by the rules of the game. The bowler is not permitted to flex the elbow of the arm used to deliver the ball, in the manner of a baseball pitcher. The arm of the bowler must generally be straight, with the elbow extended. At the conclusion of the delivery, as the bowler approaches the limit of the crease, the bowler will often incorporate a dynamic leap to bring greater force to the ball as it is released from his hand. The ball is not required to be bounced in front of the batsman, but is done so invariably to assist in the deception as to the ball's movement as it is thrown toward the wicket.

The pitch on which the bowler delivers the ball is 66 ft long (19 m); the ball must be delivered within an 8 ft (2.6 m) wide crease. There are two general methods for the delivery of a cricket ball, and two corresponding types of bowlers, representing terms as well as strategies: fast bowling and spin bowling. The type of

bowling to be used will depend on both the nature of the opponent and the conditions of the pitch.

A fast bowler is one who delivers the ball at a high rate of speed; a typical international caliber fast bowler will reach speeds of between 85 mph and 90 mph (140 km/hour and 150 km/hour). While the ball is delivered to achieve a measure of spin and resulting break when it bounces off the surface of the pitch in front of the batsman, the velocity of the ball is its primary feature.

By contrast, a spin bowler uses a variety of techniques to induce the ball to spin sideways after contact with the pitch, to fool the batsman as to the ball's trajectory. A typical spin bowler delivers the ball at speeds ranging from 45 mph to 60 mph (70 km/hour to 100 km/hour).

By rule, an innings of a cricket match will commence with the use of a new, unmarked cricket ball. A new ball, and its tendency to bounce harder and faster from the surface of the pitch, makes it a desirable ball to be thrown by the fast bowlers. As the match goes on and the ball is marked by the effects of play, as well as the permitted scuffing of its surface by the bowlers, a ball is created that is preferred by the spin bowlers.

There are distinct physical principles underlying each of the fast bowling and the spin bowling techniques. Fast bowling is further subdivided into two categories: the seam bowling method and the swing bowling method. Seam bowling involves a delivery where the seam of the ball is vertical to the ground, and the rotation imparted to the ball on delivery is horizontal. When this ball strikes the surface of

the pitch, it tends to move unpredictably and therefore is difficult for the batsman to hit.

Swing bowling is a delivery intended to make the ball move in flight, through a combination of three different physical factors. These factors include:

- the speed of the ball at delivery
- the imperfections of the surface of the ball induced by the rubbing of the surface by the bowler, the application of sweat or saliva by the bowler, and the effects of prior play
- the use of the seam

As the ball leaves the bowler's hand, the surface of the ball is exposed to two different types of airflow; the laminar flow is that of the air moving on the smooth, polished portion of the ball surface, and the turbulent flow is that directed to the roughened side of the ball. The combination of these effects is a net increase of forces directed to the turbulent side of the ball, which causes it to move in the air, or "break," in that direction. There are further variants of swing bowling effect achieved through the imparting of different spins on delivery, which will result in the ball breaking in one direction in the air, and moving in the opposite direction after contact with the pitch.

Spin bowling relies more on the technique of the bowler on delivery than it does on the velocity of the ball. There are a number of different mechanisms for the imparting of spin by the bowler; each involves the application of the same physical principles. Using either the action of the wrist or the fingers being drawn along the

surface of the ball, the ball is delivered with a sideways spin. This spin is intended to induce "drift," the expression describing the deviation of the ball from a straight trajectory. Spin bowling allows for the generation of the "Magnus effect," whereby the spin of the ball creates different velocities on each side of its surface, causing the path of the ball to be deflected. The Magnus effect, coupled with the different imperfections on the pitch when the ball strikes it, can create a very unpredictable ball for the batsman to contend with as it approaches. The rougher the ball surface, the better the ball may adhere at the point of impact, causing an even greater potential for erratic movement on the bounce.

1.7 FIELDING

Fielders need the ability to sustain a concentrated effort for a 6 hour plus period without fatigue, in sometimes very warm conditions. Their bodies must be capable of explosive bursts at any given time - such as racing for a ball, jumping for a catch.

Aim to keep your body moving whilst on the pitch, walking and stretching the muscles whenever possible. Keep your mind busy by visualizing exactly what you will do when the ball comes towards you.

Bowlers require both explosive strength and speed, combined with good muscular endurance, in order to be able to maintain a high number of over's. Poor fitness and muscular strength will result in inaccurate bowling, and greater risk of injury, especially for high speed bowlers.

1.7.1 Strength

Strength is our ability to apply force using a single muscle or combination of muscle groups. In cricket our strength plays an important role in preventing chronic and acute injuries and in increasing our performance. Building our strength can be achieved with traditional weight lifting and exercises such as squats, lunges, presses and Olympic lifts.

1.7.2 Stamina and Endurance

Cricket involves continuous changes from high intensity to rest. During the periods of high intensity, it's critical that you use energy quickly for maximum speed, strength and power output. Stamina refers to your body's ability to process, deliver, store and utilize energy, which is an essential fitness component of cricket. Matches can last anywhere from one hour to several hours. As a result, endurance is a fitness component that can improve your performance. Endurance involves the ability of your cardiovascular and respiratory systems to gather, process and deliver oxygen to working tissues and muscles.

1.7.3 Speed

Speed is the ability to repeat movements in a short time frame, and cricket players use speed while running on offense and defense. They can build and improve their speed using plyometric exercises, shuttle sprints or speed workouts.

1.7.4 Coordination and Agility

The ability to field, throw and hit requires a high-level of coordination and agility. Coordination in cricket refers to their ability to combine several complex

movement patterns into one smooth movement. They can improve their coordination through repeated practice sessions reinforcing proper mechanics. Agility refers to the ability to minimize the transition time between movements. In cricket they use agility while playing defense and running the bases to score a run.

1.7.5 Accuracy and Power

The fitness component of accuracy refers to the ability to control movements in a specific direction or specific intensity. Similar to coordination, they can improve their accuracy through repeated practice. Power is your ability to apply a maximum amount of force in a minimum amount of time. Improving their power can be achieved by improving their strength with strength training, Olympic lifts, plyometrics and speed training. In cricket your accuracy and power are essential fitness components for bowling and batting.

1.7.6 Flexibility

Flexibility is a common fitness component and refers to their ability to maximize the range of motion of your joints and muscles. With improved flexibility they can also improve their speed, agility and other fitness components. Flexibility can be improved with stretching after your practice sessions or strength and conditioning workouts.

Like any athlete, cricket players also need to follow a strength and conditioning programme that aims towards them peaking at certain stages of the year. Why not use our FREE cricket training programme by concentrating on a combination of strength training and CV workouts throughout the winter / off season

will enable them to perform with greater ability and reduce risk of injury during the summer season.

The members area of the site, has a number of strength programmes that will be suitably for improving all-round strength, especially in vital areas such as the abdominal oblique's, and also shoulder girdle.

To prevent, injury, and to enable a full season to hopefully be completed, its essential that a correct warm up and stretching routine be implemented prior to the start of each match, along with dynamic movements to enable bowlers and bats man to stay in optimum performance during long matches. There is dedicated section on stretching within our members area, designed purely for cricket players.

Along with building a good base of strength and fitness, the skills of the game should be worked on, ideally as a team in order to produce a higher level of combined skills, as cricket is a sport that is played in two forms, batting and fielding.

1.8 THE PHYSICAL DEMANDS OF PROFESSIONAL CRICKET

In the current county game there is such a wide range of different forms of cricket that it is hard to break fitness down.In Twenty20 there is the fast and furious side of fitness needs for 3 hours. In the 50 over one-day game there are aspects of the Twenty20 game but also the game lasts for around 6 hours so it can be exhausting. Then there is the purist game, the County Championship. This game can be as tough as any,player can field for around 250 overs in the game and also be relied up on to bat for days at a time.

To get the power and speed in the muscles cricketer must include circuits, power lifting and hill sprints. Cricket is mainly based around short, fast movements based over a long period of time, so hill sprints is an excellent session to do to help that. Recovery is also a key part of a cricketer's role in managing their own bodies. Ice baths are constantly used after games.

1.9 CRICKET STRENGTH TRAINING AND EXERCISES

Cricket is a game that would appear to require little muscular strength. Viewed from a distance, cricket is such a seemingly gentle pursuit that the notion of strength training and exercises would seem to have a limited application. However, as with many sports that involve relatively lengthy periods of low activity punctuated by intervals of extreme muscular focus, cricket is deceptively difficult and it also presents significant physical training challenges for the athlete, especially at an elite level.

For batsmen, bowlers, and fielders, the primary energy system utilized during competition is the anaerobic lactic and alactic processes. In the acts of bowling, batting, and fielding, the intervals of activity requiring energy generation to power the athletes' muscles will almost certainly be fewer than 40 seconds. As all players in cricket are at some stage of a match called on to bat and field, much basic fitness training will be common to all players.

Cricket training is not exclusively an anaerobic focus. Players are often either stationed in the field or at bat for a number of hours at a time. Cricket, as both a traditional English summer sport as well as a competition played year round in warm, humid regions such as India, Australia, and the West Indies, places the

demands of the environment on the players. Enhanced aerobic fitness and a strong cardiovascular system assist the players in dealing with the fatigue and impact on their attentiveness in the course of a long match.

1.9.1 Bowler

The nature of the position requires that a bowler has the ability to move explosively in the run up to delivery, as a speedy run up will physically translate into a faster delivery of the ball; the arm, shoulder, and core body strength and stamina are essential to deliver the ball repeatedly.

1.9.2 Fielder

The fielder must be prepared to react to the ball when hit, and to get to a ball, field, and throw, all as a part of a game that may last six hours or more at one time. Speed of movement and agility are critical to this position.

1.9.3 Batsman

Brute muscular power is not a liability to this position, but reaction time, batting technique, and balance in the crease are of primary importance. A batsman may be required to maintain his position for a number of hours. The cricket batting stroke relies upon core strength, particularly in the abdominal and oblique muscle groups, the gluteal muscles, and the upper arms and shoulders.

A cricket strength and training programme will be of necessity to have anaerobic, aerobic, and weight training, and reaction time/coordination agility drills. The aerobic training necessary to assist the player in maintaining strength and to battle fatigue during a long match need not be intense. In the course of a weekly

trainingprogramme, two 45-minute to one-hour sessions of moderately paced running, cycling, or other activity, at approximately 50-60% of the athlete's maximum heart rate will be a strong base. The goal is improved stamina and recovery times in the course of the primarily anaerobic requirements of cricket competition.

The anaerobic qualities of cricket are evident in the requirements of all positions. Plyometrics drills that stress jumping repeats and similar explosive movements are a useful drill for the cricketer. In a similar fashion, interval running exercises that mimic the conditions of the cricket fielder, by requiring short explosive runs of between 32.8 ft and 164 ft (10-50 m) at a segment, will tend to assist in developing the sprinting abilities of the fielder in tracking down a ball to be retrieved and thrown back to the wickets. These drills can be performed with the athlete beginning from a standing start, a running start, and a prone start, as if the fielder had dived for and missed a ball, so as to emulate the types of starts that the fielder would encounter in a game situation.

Variations of interval training that develop the lateral speed of the fielder, to react to a batted ball, include foot speed drills, where the athlete must negotiate his way through a series of squares, moving sideways as quickly as possible.

There is no physical size or weight limit placed on cricketers; the nature of the sport and its "all round" characteristics tend to encourage athletes with a measure of agility, at the expense of muscle. Muscle development is however an essential component of proper cricket training programmes. High-repetition, low-weight regimes are commonly seen as the best way to balance the contrast between

muscular size and agility. The key muscle structures that should be developed for improved cricket performance are the triceps (important to both throwing and batting), the upper chest muscles (batting and bowling), and the abdominal and oblique muscles of the torso (stability in all aspects of the game).

1.9.4 Cricket Fitness

Fitness is a very important aspect of cricket performance with physically prepared cricketers proven to perform better, more consistently and with fewer injuries. The physical attributes of strength, speed and endurance enable a cricketer to bat with power over long periods of time, bowl faster and with greater accuracy, and to field athletically. Every cricketer has a different role, position, action or technique and fitness training should recognize these differences and be programmed accordingly. A well-structured training programme for a cricketer must consider the individuals training history, injury history, training age, positional requirements, technical execution and training objectives.

1.9.5 Physical Demands of Cricket

- Multi-day matches require a high number of kilometres to be covered running and sprinting spread out over a long period of time. There is a requirement to bowl a large number of overs and bat for an extended period of time.
- One day cricket requires a fast bowler to cover on average 16 km per game while performing 66 sprints. Quality movement in the field and quick running between the wickets are essential components for success.

- During a Twenty20 match fielders cover 6.4 - 8.5 km during 80 mins of fielding, while fast bowlers cover 8.5km and sprint 42 times. This format of the game moves quickly and there are increased demands in intensity and explosive ability with the bat and ball.

1.9.6 Demands of Fast Bowlers

- A fast bowler can reach up to 95% of their maximum running speed during their run-up. This may determine how fast to bowl.
- A fast bowler potentially has to absorb 5-7 times their bodyweight when their front and back foot impacts with the ground.
- Leg strength is an important determinant of fast bowling speed and the ability to absorb forces. Leg strength is therefore important for the performance and injury prevention.

1.9.7 Demands for Batsmen

- Fatigue impacts upon decision making in batting.
- Functional strength and movement affects the ability to execute cricketing shots. This means that batsmen need to work from a stable and balanced base.
- Running speed and endurance relates to how effectively over long periods of time the batsman can run between wickets.

1.9.8 Demands for Spin Bowlers

- Functional strength and movement affects the ability to execute spin bowling deliveries with consistency.
- Acceleration and explosive lateral movement are important contributors to fielding off during bowling.

1.9.9 Demands of Wicket Keeping

- A wicketkeeper is required to perform anywhere from 120 – 600 squats per day.
- Explosive movement both laterally and above are important to be able to take every chance.
- Acceleration is important when running to the wicket to receive a ball or to the field close to the batsmen.
- Good foot movement is a key component of effective wicketkeeping.

1.9.10 Physical Fitness and Cricket

Cricket is a sport in which fitness is traditionally not thought of as very important. However, the success in the 1990s and 2000s of the world beating Australian team has been attributed to their professionalism, and in part to the way they address their fitness. The other test playing nations have rightfully put more emphasis on fitness recently and are reaping the benefits.

With the introduction of one day Cricket and more recently Twenty20, the game has gone through major changes and the physical demands made on a

Cricketer's body have also increased dramatically.Depending on the version of the game being played and the role of the player in the team, the importance of fitness will vary: the fitness requirements of a fast bowler will be greater and also different than that of an opening batsman, and one-day Cricket will be more demanding than a test match.

KapilDev, former Indian Cricket team captain and one of the best all rounders in the world of cricket started training at a very young age and he firmlybelieves that it is complete physical fitness that has contributed to his overallsuccess in all aspects of the game-bowling, batting and fielding. He contends thatphysical fitness achieved during off-season periods helped him in bowling longspells over and over again without fatigue or lapse of concentration. Kapil beganhis test career in 1978. A truly remarkable accomplishment! Even as a boy, hewould go in for energetic jogging, springing and stretching exercises.Also hewould bowl at the nets for as long as possible till the point of exhaustion.

Almost all physical activities incorporate one ormore of the elements of force, quickness, duration and the range of motion.When a given exercise is required to overcome resistance, it is called a strengthexercise.When quickness and high frequency is maximized, it is referred to as aspeed exercise. If distance, duration or the number of repetitions is high, anendurance exercise is performed.On the other hand, if the range of motion ismaximized, a flexibility movement is being performed. And finally, when in agiven exercise a high degree of complexity is required, this is known as co-ordination exercise.

Four major performance skills for all elite sportsmen and women, these beingtechnical, physical, tactical and mental. The later skill is one that can make thecrucial difference for athletes performing consistently to their abilities. Sportpsychology has played a significant role in the understanding, training andultimately the use of mental skills for peak performance.

Batsmen stay at the crease for as long as possible, sometimes for periods ofover four hours. In order to occupy this position, a good batsman must be able tostay focused, have good ball / eye skills, and have the strength and fitness tomake each played shot productive. On the other hand, power comes from havinga strong core, abdominal mid-section and the ability to generate explosive upperbody actions. While on the other, the kinetic energy of the ball may be used toscore four runs by the batsman by a slight change in direction. Unfortunately thisskill has only been given to a few class batsmen. Fielders need the ability to sustain a concentrated effort for a period of six hours or more without fatigue andin sometimes very warm conditions. The body must be capable of explosive burstsat any given time- such as racing for a ball, jumping for a catch. Every cricketplayer can contribute his part to fielding unlike batting and bowling. In a tightgame, fielding performance will invariably be the decisive factor between winninga match and losing it.

Cricketers while progressing through different stages of their developmentshould find fielding enjoyable rather than a tiresome chore. Fielding drills andmechanisms thereof are taught from a very young stage. Even in internationalcricket one could observe fielders' picking up the ball with improper balance andfinding it difficult to make accurate throws to effect a run out. Learning

to pick upthe ball on either side will make the fielder confident to stop the ball and thismakes the batsman a little nervous to start for a run especially when the ball iswithin the 30 yards circle. Fielding too is an important skill of the game. In recenttimes, more attention is being paid to fielding.

The thrill that spectators get with a brilliant piece of fielding can seldom bematched by a huge six or the sight of the stumps sent flying by a quick bowler.Good fielders like Rhodes are always more popular than big hitters. Fielding is aregular part of every cricket game, big hitting may not always be seen in everymatch.

Bowlers require both explosive strength and speed, combined with goodmuscular endurance, in order to be able to maintain a high count of number ofovers. Poor fitness and muscular strength will result in inaccurate bowling and greater risk of injury, especially for high speed bowlers and also allows thebatsmen to settle down in the wicket to score more runs. All players will be at sometime in the game, bat and field. A cricket training programme shall be designedwith these as objectives in the mind.

Flexibility is very important for a fast bowler. "Flexibility is designed to give the bowler full freedom of movement whenbowling a full speed, without threatening damage to his muscle".

In Cricket, we find an excellent integration of these physical attributes indifferent actions executed by batsmen, wicket keepers and fielders. In general,strength is required when executing a powerful hit out of the ground or to bowl abouncer; speed is required to take a quick single, to stop a ball before it

crossesthe boundary line; flexibility is shown by an acrobatic fielder; a square drive, asquare cut speeding through the cordon of fielders shows a high degree of co-ordination and a pace bowler bowling through the entire session shows ampleevidence of endurance. Even a single stroke executed by a master batsman showsan excellent combination of all these characteristics, when, to a casual observerwhat was apparent was only good timing. Let us take an example of a well-executed cover drive. As a bowler runs in, the batsman has to concentrate &watch and then in a split second he lunges forward showing speed and flexibilitytimes the ball well, showing strength and co-ordination. If he sees a chance totake a quick single, he speeds off to take one, and he does this, ball after ballshowing stamina.

The game is spread over five days (in tests) and the result is oftendependent on what happens on the fifth day. An opening batsman, wicket-keeper, fast bowler and an all-rounder need ample endurance. A player who getsbreathless after taking two runs cannot have a proper co-ordination or strengthto execute a good stroke when facing the next ball. A bowler who is breathlessafter bowling three balls loses his line and length for the next three. Developingthese attributes is different for different muscle groups, as also for differentindividuals in respect of the individual requirement. Even though a trainingschedule tends to be generally uniform, it has to be individualized taking intoconsideration the need for it.

Running, jumping, throwing are referred to as the fundamentals of naturalhuman locomotion. An essential element of successful cricketperformance is

the ability to accelerate, change direction quickly and move one'sfeet quickly while at the crease. This requires development of speed and agility.

A Cricketer needs static and dynamic strength in an altogether differentway. In Cricket, one does not need such strength but proper development ofstrength is very important.

Tendulkar stressed the importance of physical fitness and mentaltoughness which has helped him to have a prolonged successful career inInternational Cricket. "Physical fitness helps you in being mentally tough,enhancing you confidence level," the 37-year-old said.

1.9.11 Ten Principles of Cricket Fitness

- **Ground Based Activities**. The theory here is that as a cricketer play cricket standing up, he should train standing up. This is because running, throwing, playing a shot and bowling are all initiated by applying force against the ground. So it makes sense to drop as many training activities that require to sit or lie down.

- **Multiple Joint Actions**. Cricket skills require a great deal of coordination. It can be trained by picking exercises that use more than one joint. For example, squats require the use of knees, hips, ankles and even shoulders and arms to hold the bar. A leg extension just requires the knees to move.

- **Three Dimensional Movements.** Cricket is played in 3D (no, really it is),this means training should reflect that by training with free weights where possible because free weight also train the cricketer on three

planes whereas machines are designed to train only in two (with the cams, seats and pulleys taking the strain from the third).

- **Train Explosively**. Speed and power come from how quickly the muscles can work. Muscles work faster if they are trained with explosive fast movements rather than slower strength based exercises. This means exercises like the clean and plyometrics are vital to cricketers.

- **Progressive Overload**. To improve fitness need to keep progressingthe workouts. More reps leads to greater muscle endurance and size, more weight leads to greater strength and power. While cricketers shouldn't ignore the former, the latter should be their ultimate goal.

- **Periodisation**. A periodised approach of yearly plan is vital to all players.

- **Split Routine**. Splitting weight training routine over several days (rather than training the whole body every time) gives time to recover that will help to train harder.

- **Hard-Easy System**. This is linked back to periodisation. The concept is simple, cricketer can't train at full effort every time or they will burn out.

- **Train Specifically**. To get the best out of us on the cricket field our training need be as close to the real thing as possible. That means exercises that train the body to be fast and powerful, not long runs.

- **Interval Training**. Leading on from specific training, work and rest should simulate the demands of cricket which means short periods of

intense activity followed by long periods of active rest, just like when batting, bowling or fielding.

1.9.12 Cricket and Speed

Cricket is a fast moving game. When a ball gets hit it will be moving close to 90mph, to catch the ball, need to be able to respond to the visual stimuli (the ball being hit) and move to the area where it is going so that can catch the ball or collect it to throw back to the wicket.

While batting you need to be quick so that a single can become a double, which also increases the intensity of the game and puts the fielding team under greater pressure.

While fielding faster, the less time is given to the batters to run, which flips the previous statement on it's head, leading to the batters being under more pressure.

While bowlingneeds speed to run up to the wicket quicker and produce more force to bowl the ball quicker.

If the fielders lack balance, speed, agility, acceleration, reaction, flexibility any shot can make them look slow and out of position.

Having the ability to make sound plays with each ball is the ultimate goal of the fielder, keeping the number of runs the opposition get down to a minimum.

When a fielder fields a routine ball that is within range it is comfortable and considered a routine play. But when the ball is hit sharply into a hole the fielder(s) must rely on reaction, starting speed, acceleration to make the play and the number

of runs the opposition get will be determined by the fielders athletic movement abilities.

1.9.13 Cricket and Strength

Another comment I hear is “Cricket athletes do not have to be strong” or “Cricketers only need to have a low level of strength”. This comment mainly seems to come from athletes, coaches and trainers from other sports.

All fast bowlers sit in a range of 3.8-9 times body weight vertical ground reaction forces that goes through their body every time that they bowl the ball. 90% of bowlers sit between 6-8 times body weight.

If we look at Tim Southee he is 91kg and is around 6 times body weight during his delivery stride. That means that he has 546kg’s of pressure going through one leg every time that he bowls the ball. If he bowls 25 overs in a Test Match day then he has to deal with 81900kg’s worth of pressure going through one leg. If you cannot tell from the numbers, this is a massive amount of weight and pressure. As an athlete to deal with this you need to be very strong through your lower body.

The only other sport that I can find that comes close to this is Gymnastics when the athletes land after a vault. They have a range of 7-18 times body weight. Look how strong those athletes are and the amount of injuries that occur. They land on a sprung floor that is padded and land either on two feet (sharing the load between legs) or with a one-two landing which is one foot followed by the other. This cuts down the pressure that they deal with through each leg by 1/4.

The distance that these guys cover coupled with the strength that they need to deal with the pressures involved makes a special athlete.

1.9.14 Cricket and Flexibility

The quest for improved Cricket performance and injury prevention is incomplete without incorporating a dedicated approach to flexibility. Failing to appreciate the importance of this quality can undo all of the benefits achieved with other types of conditioning and increase the chance of injury while reducing movement efficiency and effectiveness.

Flexibility refers to the ability to move a joint and the surrounding muscles through a full range of motion

Flexibility is critical in Cricket because of the joint stress associated with dynamic multi-joint movements like batting and bowling. Lack of range of movement can lead to injury and a reduction in speed, agility, strength and endurance potential. It can also limit individual cricket skills.

Certain approaches to stretching will dictate the outcome - if the cricketer wish to increase the range of movement on a permanent basis, he needs to include regular sessions in theprogramme. The main principle during these sessions is that he must hold each stretch for a long period of time and during a dedicated session i.e. not as a pre-workout stretch. These stretches promote temporary muscle lengthening and should be held for less time i.e. 10 seconds, so that the muscle does not become too loose before training, which is a hazard.

1.9.15 Aims of Sports Training

The major aim of sports training is to achieve high level performance. The sports performance depends largely on physical fitness and motor fitness. The physical fitness can be differentiated into general and specific fitness. Each sports activity demands different types and level of different motor abilities and when a sportsman possesses these. He is said to have the specific physical fitness of various motor abilities, regardless of any sports which the sportsman possess. The contribution of physical fitness towards sports performance indirect. Rent it should never be overlooked that specific physical fitness depends largely on the general physical fitness (Hardayalsingh (1983).

1.9.16 Weight Training

Strength training is also known as resistance Training. It is a common component of sports and physical fitness programmes for young people some adolescent and pre-adolescents may use strength training as a means to enhance muscle size and to simply improve appearance. Strength trainingprograms may include the use of these weights, weight machines, elastic tubing, or body weight stronger resistance training programmes may be under taken to improve long-term health.

Effective strength training programmes create muscle hypertrophy which is due to an increase in myofibril protein content. This hypertrophy is often associated significantly with that of the fast twitch (FT) and slow twitch (ST) fiber types. Strength training produces certain neuromuscular adaptations. These adaptive changes are associated with the co-ordination of the agonist, synergists and

antagonists. It has also been shown that mitochondrial volume density decreases as muscle mass increase. In contract to acrostic endurance training there is a decrease in capillary density with muscle from strength training which emphasizes high-load, low-repetition exercises. Strength training at moderately high load with greater repetitions may cause an increase in absolute capillarisation but increases in hypertrophy will result in a maintained or decreased capillary density. There has been some evidence from studies on animals that suggests an increase in the number of recycles which store acetylcholine in the Huron's terminal.A greater force production by the associated motor unit would result if the increase in the number vesicles also corresponds to an increase in the secretion of acetylcholine.

1.9.17 Circuit Training

Training Technique that involves moving from one exercise to another, each exercise working a different muscle group until each muscle has been worked. It can include strength training stations. Cardio stations or a mixture of the two. The purpose is to keep the heart rate cleared, although many experts feel that, with circuit training, player is actually getting the worst of both worlds since the playeris splitting the energies between cardio and strength. It can be a good work out but,like any training method, should be changed every 4-6 weeks to avoid boredom and plateaus.

Strength training conditions the muscles of the body by using weights. Circuit strength training conditions both the muscles of the body as well as the heart and wings by alternating periods of work on weight machines with short periods of rest. The term "circuit" refers to exercising on one machine and then moving quickly

to another machine with very little rest between. The amount of weight lifted at each machine can range from the lightest of weights to about 50 percent of the person's maximum strength. Anyone at any age can benefit from circuit strength training. In setting machines be used to exercise all the major muscle groups in the rotated with upper body exercises.

Twelve repetitions are performed on each machine. Beginners should start with the lightest weight on each machine. As strength improves over time, they can progress to higher weights. Advanced exercises can start at higher weights. The goal for them is to lift 50 percent of maximum strength on each machine for the 12 repetitions. After 12 repetitions have been completed on one machine, the person moves quickly on to the next machine. Completing one circuit means that all machine exercises were done and the circuit may be repeated as many times as desired for a 30 minute total work out time. Exercise heart rate should be average about 60 to 85 percent & maximum heart rate. Circuit Training needs to be continuous and rhythmical to benefit the heart and lungs as well as the muscles. When performed may lose excess body fat. Me progress is achieved the may add more weights and more machines to the circuit always keep the circuit simple. Too many exercises added fatigue greater risk for injury and giving up can result, gains do not come quickly in strength training, be patient, the body needs a day of rest between work outs to recuperate.

1.9.18 Interval Strength Training

Interval strength training also known as high intensity interval training has been used by athletes for years to build fitness. HIT means doing a number of short

bursts of intense exercise with short recovery breaks in between.Interval strength Training combines short high intensity bursts of speed, with slow recovery phases repeated during one exercise session.

1.9.19 High Intensity Interval Training / Metabolic Resistance Training

High Intensity Interval Training means that work at a high intensity (ie working HARD… as in sweating) but for short periods (intervals) of time. Then slow down, get breath, and go again. An example would be running on a treadmill (most have an 'interval training'/ programme option) at varying speeds and inclines. Run as hard as you can for say a minute, sometimes less, then take it a little easier for a minute – then go again.

Classic HIIT consists of short bursts of predominantly cardio exercise, such as running, swimming or cycling. Bursts of fast and hard exercise, followed by short rest periods, but never completely resting in between intervals.

It has been proven many times that unless you want to run very, very very long distances on a regular basis, there is no need and no benefit to running slow and steady for an hour or more at a time.

Combine the 2 – intervals training techniques of short burst of high intensity exercise – with resistance training, and we have got a workout that workson the cricketer.

1.9.20 Tabata Intervals

The great thing about many of these techinques is the time saving aspect, and Tabata Intervals are definitely time savers. Developed by Dr. Izumi Tabata for

Olympic athletes, Tabata Protocol is a form of High Intensity Interval Training (HIIT) where 20 seconds of work is coupled with 10 seconds of rest then repeated for 8 total rounds. The 20 seconds work/10 seconds rest pattern has been shown to tax both aerobic and anaerobic pathways more — and in less time — than intense exercise with longer rest periods, meaning improved overall cardiovascular fitness. This protocol can be done with running/rowing/swimming, bodyweight exercises, or weighted movements.

Developed by Dr. Izumi Tabata for Olympic speed skaters, Tabata Protocol**(Courtney Schurman and Doug Schurman, 2009)** is a form of interval strength training that's been adopted by bodybuilders, CrossFitters, and plenty of folks in-between. The 20 seconds work/10 seconds rest pattern has been shown to tax both aerobic and anaerobic pathways more— and in less time— than intense exercise with longer rest periods, meaning improved overall cardiovascular fitness. By taking rest periods only half the length of the intense bursts, the body is forced to perform without full recovery, so at some point between rounds six and eight, the athlete hits the point of maximum oxygen intake. The whole thing leaves us breathless.

While the 20/10 protocol is most readily applied to traditional cardio movements (sprint for 20 seconds, rest for 10), the regimen is also suited to all manner of resistance training, bodyweight exercises, and even explosive movements. Whether performing squats (try the challenging bottom-to-bottom version), a dumbbell press, or cha-cha-ing real smooth, the trick is to find a weight and speed that can be handled for multiple reps across multiple cycles. A good rule of thumb is to use one's 20-rep max (or a good estimate thereof).

HIT means doing a number of short bursts of intense exercise with short recovery breaks in between. The authors have already shown with young healthy college students that this produces the same physical benefits as conventional long duration endurance training despite taking much less time (and amazingly, actually doing less exercise) However, their previous work used a relatively extreme set-up that involved "all out" pedaling on a specialized laboratory bicycle. The new study used a standard stationary bicycle and a workload which was still above most people's comfort zone -about 95% of maximal heart rate -- but only about half of what can be achieved when people sprint at an all-out pace.

This less extreme HIT method may work well for people (the older, less fit, and slightly overweight among us) whose doctors might have worries about them exercising "all-out." We have known for years that repeated moderate long-term exercise tunes up fuel and oxygen delivery to muscles and aids the removal of waste products. Exercise also improves the way muscles use the oxygen to burn the fuel in mitochondria, the microscopic power station of cells.

Running or cycling for hours a week widens the network of vessels supplying muscle cells and also boosts the numbers of mitochondria in them so that a person can carry out activities of daily living more effectively and without strain, and crucially with less risk of a heart attack, stroke or diabetes.

1.9.21 Rationale of the Study

Now-a-days the sports like tennis, cricket, etc. changing from its previous decade’s characteristics as they are becoming power tennis and power cricket.Early days cricketers didn’t concentrate on their strength and power.The teams were able

to score around 220 runs. It was predicted in ancient days that if a team scored 220 runs definitely they might win the match.But, when it becomes power cricket because of the change in the playing format, the individual players also scoring around 200 runs and the team's total runs easily goes above 300.Even our team scores more than 300 runs the victory is not ours.

Very few cricket players started doing the strength and power training in their regular training schedule.Cricketers like Chris Gayle, MS Dhoni and Yusuf Pathan easily clears the ball out of the stadium.But others still concentrating more on aerobic fitness alone and saying that needs to play cricket for 100 overs in a match.But they failed to score more runs repeatedly which will end their professional career.

To maintain a peak form over a period of time and to contribute the team by scoring more runs continuously, proper strength training must be followed.So, the investigator himself as a cricketer with his lots of match experience both winning and losing motivated him to go for an innovative research topic.The research definitely will contribute the cricket players, coaches and trainers to understand the importance of strength training and to adopt the strength training in their training schedule to improve the players'physical fitness and performance.

1.9.22 Statement of the Problem

The purpose of this study was to find out the effect of varied strength training on selected physical and performance variables among cricket players.

1.9.23 Hypotheses

1. It was hypothesized that the effect of weight training would be more significant in the performance variable and physical variables than the other experimental groups.

2. It was hypothesized that the effect of circuit training would be more significant in the performance variable and physical variables than the other experimental groups.

3. It was hypothesized that the effect of interval strength training would be more significant on the physicaland performance variables than the other experimental groups.

4. It was hypothesized that the experimental groups weight training, circuit training and interval strength training would have significant difference than the control group on physical variables speed, strength, explosive power, agility and endurance.

5. It was hypothesized that there would be a significant difference on the performance variables between the experimental groups weight training, circuit training, interval strength training and control group.

1.9.24 Significance of the Study

1. The results of the study would help physical educators, trainers and coaches to understand the role of the selected physical and performance variables and their importance to the batting, bowling and fielding in cricket.

2. The study will help to identify the importance of strength training program me on the development of selected physical fitness variables of cricket players.

3. The results of the study may be helpful to physical educators, trainers and coaches in talent identification.

4. On the basis of the results, training programmes may be designed to help batsman, bowlers, wicket keepers to improve the physical fitness and performance.

5. The findings of the study may be used as a tool in screening, assessing and grouping talented players.

6. The results of the study will enlighten players and coaches about the importance of strength training program me on the improvement of batting, bowling and fielding performance in cricket.

1.9.25 Delimitations

1. For this study only 200 intercollegiate level men cricketers were randomly selected from three districts namely Theni, Dindigul and Madurai at Tamil Nadu in India.

2. The age of the players ranged from 18 to 25 years.

3. In this study, weight training, circuit training, and interval strength training were employed as experimental groups.Each group consists of 50 subjects each. (WT-50) (CT-50) (IT-50) (CG-50)

4. The following dependent and independent variables were selected for the purpose of the study,

1.9.26 Independent Variables

- Weight Training
- Circuit Training
- Interval Strength Training

1.9.27 Dependent Variables

Five physical variables and three performance variables were selected for this study.

1.9.28 Physical Variables

- Speed
- Strength
- Explosive Power
- Agility
- Endurance

1.9.29 Performance Variables

- Batting
- Bowling
- Fielding

5. The training period was delimited to eight weeks.
6. The data were collected prior and after eight weeks of training programme.

7. In performance of cricket, only batting, bowling and fielding performances were considered for this study.

1.9.30 Limitations

The study was limited to the following aspects.

1. Certain factors like food habits,life style daily routine work, climatic condition, economic status and other environmental factor were not controlled which might influence the performance and these factors were considered as limitation in the study.
2. The heredity of the subjects and its influence on the selected criterion variables were not taken into consideration.
3. Participation in the local league tournaments and local matches by the subjects could not be controlled.
4. The difference in social-economic status and educational back ground of the male cricket players were not taken into consideration.
5. The subjects' psychological impacts through watching cricket matches live and in video were not controlled.

1.9.31 Definitions and Explanation of Important Terms

The important terms used in the research study have been defined and explained,

1.9.31.1 Speed

It is the performance pre-requisite to do motor actions under given conditions (movement task external factors individual pre-requisites) in minimum of time. It is equal to the distance covered per unit of time**(Cheryl L. Hyde, 2002)**.

1.9.31.2 Strength

It is the ability to overcome resistance or to act against resistance (**Singh, 1991).**

1.9.31.3 Explosive Power

Explosive power is the power to overcome the gravitational force and rise his own body as high as possible in the air against gravitational force**(David Sandler, 2005)**.

1.9.31.4 Agility

Agility may be defined as the physical ability which enables an individual to rapidly change body position and direction in a precise manner. **(Barry L. Johnson and Jack K. Nelson, 1988)**

1.9.31.5 Endurance

It is the ability to do sports movement with the desired quality and speed, under conditions of fatigue **(Singh 1991).**

1.9.31.6 Batting

In the sport of cricket, batting is the act or skill of hitting the cricket ball with a cricket bat to score runs or prevent the loss of one's wicket**(M.A. Pervez, 2000)**.

1.9.31.7 Bowling

In the sport of cricket, bowling is the action of delivering the ball toward the wicket defended by a batsman**(M.A. Pervez, 2000)**.

1.9.31.8 Fielding

Fielding in the sport of cricket is the action of fielders in collecting the ball after it is struck by the batsman, in such a way either to limit the number of runs that the batsman scores or to get the batsman out by catching the ball in flight or running the batsman out**(M.A. Pervez, 2000)**.