

CHAPTER- I

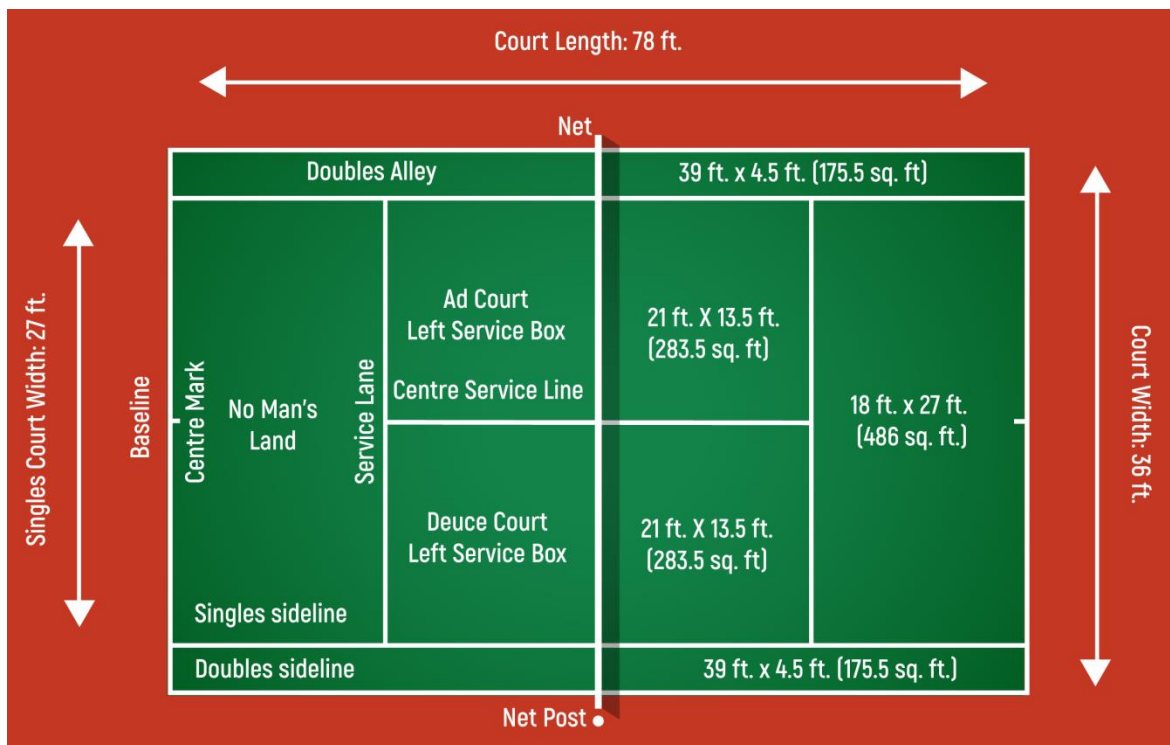
INTRODUCTION

1.1 HISTORY OF TENNIS

Tennis was originated during 12th or 13th century in France. It was played by Major Walter C. Winfield, in an hourglass shaped court in 1873 in Great Britain. In 1877, the All-England Croquet club held a tennis championship in a rectangular court with rules similar to that of modern tennis. It quickly spread to America, Britain, and later to other parts of the world. Tennis is a sport played among two players or two pairs of players competing with each other in a rectangular tennis court with fixed boundaries. The two sides of the court are separated with a net. Davis Cup, an international tennis tournament was held in 1900 to promote the game all over the world. On March 1st, 1913, International Tennis Federation ITF was established. It formulates rules guidelines, equipment used, defines court dimensions to be followed by all the players participating in competitions throughout the world (Gillmeister and Heiner, 1998). Tennis is a one of the lifelong sports and the goal is enhance the performance and staying injury free at the professional level (Paul & Mark, 2011). Tennis is one of the most popular sports, a world-class competitive sport attracting millions of players and fans worldwide (USTA, 2002).

The tennis court shall be a rectangle, 78 feet (or) 23.77 m long, for singles 27 feet (or) 8.23 m wide, for doubles the court shall be 36 feet (or) 10.97 m wide. The court shall be divided across the middle by a net suspended by a cord or metal cable shall pass over or be attached to two net posts at a height of 3 ½ feet (or) 1.07 m. The height of the net shall be 3 feet (or) 0.914 m at the centre it shall be held down tightly by a strap. The lines at the ends of the court are called baselines and the lines at the sides of the court are called sidelines. All court measurements shall be made to the outside of the lines and all lines of the court shall be of the same colour clearly contrasting with the colour of the surface (ITF, 2017).

Figure – 1 Tennis Court



In tennis technique, there are numerous skills but the serve is an important key to success because the fast and power flat serve is the most intimidating and fearsome weapon of a player (Sgro et al., 2013). The important key to success for a good tennis player is to be able to take the advantage of serving and keep the serve. The world's professional tennis player in front of the world rankings, most have very excellent serve skills (Elliot, 1983).

Among all tennis strokes, the tennis serve has received more attention than the other strokes, because it produces large loads on the shoulder and lower back which results in overuse injuries (Chow, 2009; Fleisig et al., 2003; Kovacs & Ellenbecker, 2011). Service is a highly complex stroke because of the multiple body segments to produce power through properly timed rotations and complex coordinated muscular activations, as well as the most important strategic standpoint to get a free point in the ace serve and hold the service game (Ryu et al., 1988; Kovacs, 2007).

The coordination of body segments in the kinetic chain, allows generation, summation, transfer, and regulation of forces from the legs to the hand (Elliott, 2006; Elliott et al., 2003). It increases serve performance muscle strength of the entire kinetic chain must be increased without affecting serve accuracy (Roetert et al., 2009).

Success in tennis depends on several physical, technical, tactical and psychological factors, and power combined with medium to high aerobic and anaerobic capacity (Fernandez et al., 2009). Success in tennis requires a mix of player talent, good coaching, appropriate equipment and an understanding of sports science pertinent to the game (Girard & Millet, 2009; Kraemer, et al., 2003).

1.2 TENNIS SERVE

The serve has been the most important skill in professional players (Johnson et al., 2006). Tennis serve is one of the most important basic technique key to success (Elliot, Marsh & Balankshy, 1986). It involves the complex co-ordination of the lower and upper body segments (Brody, 1987, Elliot & Kilderry, 1983). Tennis serve is the only closed skill a player has a full control on the trajectory path of the ball. The professional player's ability to produce high ball velocity to be the key elements of successful play, because it puts the opponent under stress and may hinder its return. In tennis, the serve is a sequence of motion referred to as a kinetic chain that begins with the lower limb action and followed by rotations of the trunk and the upper limb (Elliott et al., 2003). The serve is one of the most important shots in tennis, use power, swing, and placement to create a tennis weapon (Joey & Scott, 2012). The serve is that determines the success of a player, deciding the outcome of the match. So all level players try to develop fast and

powerful serve as most influential and fearsome weapon of their game (Sun, Lui & Zhon, 2012).

Australian Samuel Growth hit an ace recorded at 163.4 mph (263 kph) during an ATP challenger event in Bussan, South Korea (Sam, 2012).

1.2.1 TYPE OF SERVICE

Tennis serve is one of the most important and powerful weapon among all tennis skills and technique. The power service plays a very important role during a match (Elliot, 1986).

The serve had three types of technique, which are following

- Flat Service
- Slice Service
- Topspin Service

The first serve is flat serve used little spin or no spin of the ball, the second serve is slice serve used side spin of the ball, the another technique for kick or topspin serve is used topspin of the ball. Each serve has a different technique and performs a different function (Joey & Scott, 2012).

1.2.2 FLAT SERVICE

The tennis flat serve is the most commonly hit serve in both professional and club level tennis. The tennis flat serve hit a shot in besides the overhead, a minimal use of spin, and the focus on placement and power, rather than net clearance. The main keys to a successful serve are pace, spin and placement. The best servers combine all three components. A good serve has become more important in professional tennis. Statistics from the 2009 U.S Open tennis championships shows that for the men's event, 5 of the top 10 ranked players also had the highest service speed. The women's game has followed a similar trend (Optimum tennis, 2015).

1.2.2.1 FLAT SERVICE TECHNIQUE

In the flat service technique, the right stance is very important to maintain good balance and rhythm throughout the motion. There are two main stances used to hit a serve are the platform stance or foot-back and pinpoint stance or foot-up. Then the knees can help provide flexion in the beginning of the serve motion, but mainly they are used to extend and lift the body up to hit the ball. The knees flex forward to start the loading process of the legs.

The next part of the chain is the motion of the hips. The racket head is either stationary, slightly swaying, the hips make a slight rocking motion forward and gain momentum before rotating backward to put

weight on the back leg. As the hips rotate backward and the toss arm makes the V to begin the carry, the trunk naturally begins to rotate backward. The shoulder to make half turn because the toss arm is carrying the ball up, the front shoulder is higher than the back shoulder and elbow. The elbow rotates backward position past the center if the back at about the same height as the rib cage on that side.

The toss arm moves toward the thigh of the front leg, and the serve arm moves down and backward, reaching back with the palm down to a comfortable position. The racket head then reaches up and back toward the shoulders, creating a set position of the elbow. The serve arm bends to make an L shape 90 degree angles, but the front shoulder is tilted upward this position is as the trophy position.

The goal of elbow extension is for the player to be able to hit the ball as high as possible and near the height of the tossed ball. The elbow sets slightly lower than shoulder level and at 90 degree angle. On the take back of the arm, the wrist is slightly hyper extended as the hand bends back at the wrist. As the wrist accelerates toward striking the ball, the wrist straightens and then continues to flex as part of the follow-through.

The completion of the serve begins with the weight transfer from one leg to the other and then the racket moving through the contact point. After the ball has been struck, the arm begins to decelerate and the body begins to recover and prepare for the return (Joey & Scott, 2012).

1.3 IMPORTANCE SERVICE IN TENNIS

Match statistics - Roland- Garros, Paris 2018
Men's singles

RAFAEL NADAL (SPAIN)	STATISTICS	DOMINIC THIEM (AUSTRIA)
0	Aces	8
3	Double Faults	5
56/82 (68 %)	1st Serve in	59/102 (57%)
46/56(82%)	1st Serve points won	40/59(67%)
12/26(46%)	2nd Serve points won	15/43(34%)
192 KMH	Fastest serve	224 KMH
170 KMH	1st serve average speed	183 KMH
145 KMH	2nd serve average speed	153 KMH
16/18 (88 %)	Net points won	8/15(53 %)
5/17(29 %)	Converted	1/3(33%)
47/102(47 %)	Return points	24/82(30%)
26	Winners	34
24	Unforced errors	42
105	Total points won	79

The French Open is officially called Roland-Garros is a major tennis tournament held over two weeks BETWEEN LATE MAY and early June at the Stade Roland-Garros in Paris, France. The French Open is the only Grand Slam event held on clay court. The seven rounds needed for a championship, the slow-playing surface and the best-of-five-set

men's singles matches without a tiebreak in the final set, the event is widely considered to be the most physically demanding tennis tournament in the world.

Based on this match statistics Rafael Nadal had more consistency for 1st serve and 2nd service, only three double faults in the match to compare Dominic Thiem had five double faults. Nadal had twenty-four unforced errors but Thiem had forty-two unforced errors in a match. Nadal won one hundred five points but Thiem won only seventy-nine points. The service helped to Nadal to win 11th Roland Garros title in 2018, and he won 17th Grand slam title.

1.4 IMPORTANCE OF ANTHROPOMETRIC VARIABLES IN TENNIS

The anthropometric variable is very useful for physical educationists, coaches and trainers are to measure different parts and components of human body. The scientific terminology to anthropometric is a word synthesized from two Greek words anthropos means man metre in means to measure the measurement of human body (Devinder, 2008). Anthropometry identifies the body composition of the players of different sport, because the specific physical characteristics essential in many sports that indicate whether the player would be suitable to compete the highest level in specific sports (Reilly et al. 2001). The common perception of many athletes competes in sports appearance, attainment of an ideal body composition becomes a central theme of

training in any sports to achieve an optimal body composition, there may also be safety reasons (Ackland et al. 2003). During past two decades great changes have taken place in tennis with respect to technique and tactic, even more with respect to physical performance of the players. Taller players had an advantage in playing ability over their peers in tennis (Yixiong et al. 2019). Height of the players associated with better ranking (Kumar, 2017).

1.5 IMPORTANCE OF SKILL RELATED FITNESS IN TENNIS SERVE

The sport of tennis requires strength, flexibility, power, endurance and speed. Tennis matches can last several hours require aerobic fitness, but the short sprints, explosive movements, and directional changes are clearly anaerobic. Tennis players need both the cardio respiratory and muscular systems should be trained (Roetert & Kovacs, 2011). A total tennis fitness program must therefore include tennis serve exercises that promote the development of muscular power. The service motion in tennis involves almost all the major muscle groups from the ground up. Coordination is vital for tennis players in learning and mastering tennis skills (Zeotu et al. 2012). Strength not being the only factor involved in producing ball speed during the tennis serve (Pugh et al. 2003).

1.6 IMPORTANCE OF BIOMECHANICS IN TENNIS SERVE

Biomechanics is a key area in player development because all the strokes have a fundamental mechanical structure and sports injuries primarily have a mechanical cause (Elliott, 2006). Biomechanics is the science that examines the internal and external forces acting on a human body and the effects produced by these forces (Hay, 1993). Sports biomechanics is necessary to have a good understanding of the application of physics to sport, as physical principles such as motion, resistance, momentum and friction play a part in most sporting events. The technique analysis refers to the way in skills are performed from both a kinetic and kinematic stand points (Lees, 2002; O' Donoghue, 2010). Kinematics is branch of biomechanics concerned with describing the motion of bodies, it deals with such things as how far body moves, how fast it moves, and how consistently it moves. The latter aspect of motion is the preserve of kinetics a complementary branch of biomechanics (Hay, 1993). The ideal motion makes use of a kinetic chain that is series of motion starting from the feet up to the legs, hips, trunk, shoulders, arms, forearm, wrist and finally the racket, which is considered an extension of the hand (Optimum tennis, 2015). Ability to generate increased serve speed is multifactorial the combination of skill, height, hip motion, and upper and lower extremity power may determine serve speed (Palmer and Morgan, 2018). Players don't use the same toss

for each type of serve (Carboch et al. 2018). Racquet lowest point contributes for tennis serve speed (Martin et al. 2013).

1.7 JUSTIFICATION FOR SELECTION OF THE PRESENT PROBLEM

In India, Tennis is a popular sport, played by men and women almost in all states. Performance analysis and identifying performance characteristics associated with success are of great importance to players and coaches in any sport (Fitzpatrick et al. 2018). The tennis serve is a crucial stroke in tennis as it is the only stroke that players have full control over, and if executed well, can allow the serving player to win points with immediate effect. First serve points won as the performance characteristics most strongly associated with match outcome (Fitzpatrick et al. 2018). The combination of specific agility and quickness along with height had a strong association with better ranking of players in tennis. Coordination is vital for tennis players in learning and mastering tennis skills (Zeotu et al. 2012). Pugh et al. (2003) ascertained that strength not being the only factor involved in producing ball speed during the tennis serve. The accuracy in serving in tennis is considered as a very critical factor in winning the highest number of points since it is considered to be one of the effectual offensive skills, where many researchers in tennis pointed to the fact that the power of aiming depends on accuracy. Conduct of future studies in biomechanics of in tennis would pave the way to enhance the performance of tennis players (Ali, 2015). Vaverka and Cernosek (2013) confirmed that body height of the both men and

women tennis players is an important factor influencing the serve speed and the taller players possibly having a significant biomechanical advantage of the tennis serve. The investigator is a player, coach and official in tennis and he explored the research gap and found that there is a need for a prediction of flat service performance in tennis based on selected anthropometric variables, skill related fitness variables, biomechanical variables. Moreover, very little research had been done on prediction of flat service in tennis, which motivated the investigator to take up the present study.

1.8 STATEMENT OF THE PROBLEM

The purpose of the study was to find out the relationship between selected anthropometric, skill related fitness and biomechanical variables with flat serve performance (speed and accuracy) and also to predict flat serve performance based on the selected anthropometric, skill related fitness and biomechanical variables among tennis players.

1.9 OBJECTIVES OF THE STUDY

1. To measure the flat service speed and accuracy among elite tennis players.
2. To measure the selected anthropometric variables such as height, weight, arm length and leg length among elite tennis players.

3. To measure the selected skill related fitness variables such as grip strength, dynamic balance, co-ordination, arm power and leg power among elite tennis players.
4. To measure the selected biomechanical variables such as ball release height, ball toss peak height, racket lowest point and relative height of contact among elite tennis players.
5. To find out the relationship between flat service performance and selected anthropometric, skill related fitness and biomechanical variables among elite tennis players.
6. To predict the flat service performance among elite tennis players based on selected anthropometric, skill related fitness and biomechanical variables.

1.10 SIGNIFICANCE OF THE STUDY

1. The results of the study would help the tennis coaches to predict flat service performance and identify the potential talent.
2. The results of the study would be useful to the coaches to identify the strength and weakness in flat serve performance.
3. The results of the study would help the tennis coaches to design suitable training program to improve the tennis flat service performance.
4. The present research study would be helpful to coaches to select the potential tennis players.

5. The results of the present study would help to design innovative training methods to improve flat service performance.

1.11 HYPOTHESES

1. It was hypothesized that there would be a significant relationship between tennis flat service performance and selected anthropometric variables namely, height, weight, arm length and leg length.
2. It was hypothesized that there would be a significant relationship between tennis flat service performance and selected skill related fitness variables namely, grip strength, dynamic balance, coordination, arm power and leg power.
3. It was hypothesized that there would be a significant relationship between tennis flat service performance and selected biomechanical variables namely, ball release height, ball toss peak height, racket lowest point and relative height of contact.
4. It was hypothesized that the selected anthropometric variables namely, height, weight, arm length and leg length, skill related fitness variables namely, grip strength, dynamic balance, coordination, arm power and leg power, biomechanical variables namely, ball release height, ball toss peak height, racket lowest point and relative height of contact would predict flat service performance among elite tennis players.

1.12 DELIMITATIONS

1. The study was delimited to 30 elite male tennis players from various clubs, academies, institution who represented the state and Interuniversity competitions in Chennai.
2. The age group of the subjects ranged from 18 to 25 years.
3. The study was delimited to only right-hand players.
4. The study was restricted to 2D analysis.
5. The flat serve performance (speed and accuracy) was assessed by Hewitt's tennis skill test.
6. The training age of the subjects ranged from 5 to 10 years.
7. The dependent variable of the study was flat service performance (speed and accuracy).
8. The independent variables of the study were as follow:

Anthropometric Variables

- i. Height
- ii. Weight
- iii. Arm length
- iv. Leg length

Skill related Fitness Variables

- i. Grip Strength
- ii. Dynamic Balance

- iii. Co-ordination
- iv. Arm Power
- v. Leg Power

Biomechanical Variables

- i. Ball release height
- ii. Ball toss peak height
- iii. Racket lowest point
- iv. Relative height of contact

1.13 LIMITATIONS

The study was limited in the following aspects.

1. The subject's living condition, life style, diet, personal habits, heredity, motivation factors were not taken into consideration.
2. The subject's social, economical and cultural backgrounds were not taken into consideration.
3. The subject's routine work was not controlled and its possible influence on this result of the study was noted as limitation.
4. The previous fitness level of the subjects was not considered.

1.14 DEFINITION OF TERMS

1.14.1 Kinanthropometry

Kinanthropometry is the study of human body size, shape and form and how those characteristics relate to human movement and sporting performance (Eston and Reilly, 2009).

1.14.2 Height

The vertical distance from the vertex (the crown of the head) and to floor or standing surface (Pheasant, 2014).

1.14.3 Weight

Mass is the quantity of matter in the body. Mass is calculated through the measurement of weight (Pheasant, 2014).

1.14.4 Arm Length

The vertical distance between the acromion (bony tip of the shoulder) and tip of the middle finger (Pheasant, 2014).

1.14.5 Leg Length

The vertical distance from the greater trochanter (lateral side of the hip) to the standing surface (Pheasant, 2014).

1.14.6 Skill Related Fitness

The skill related fitness variables used to measure the motor ability, motor fitness and sports skill (Yobu, 2010).

1.14.7 Grip strength

Grip strength is the force applied by the hand to pull on or suspend from objects (Koley, 2009).

1.14.8 Dynamic Balance

Dynamic balance is refers ability to execute movements and maintain balance while in motion (Bloomfield, Elliott and Auckland, 2009).

1.14.9 Co-Ordination

Co-ordination is defined as the ability of the performer to integrate types of body movements into specific patterns (Devindar, 2008).

1.14.10 Arm power

Arm power is the ability to generate force with speed to propel the ball for greater distance (Kenney, 2012).

1.14.11 Sports Biomechanics

Sports biomechanics is the study and analysis of human movement pattern in sports (Bartlett, 2007).

1.14.12 Ball release height

The distance between the ground and the point of toss is termed as ball release height (Martin et al., 2013).

1.14.13 Ball toss peak height

The maximum height reached by the ball after the toss and before impact in tennis serve (Martin et al., 2013).

1.14.14 Racket lowest point

The distance between ground/floor and tip of the racket head at cocking phase is termed as racket lowest point (Martin et al., 2013).

1.14.15 Relative height of contact

The ratio between height of contact and standing height of players is termed as relative height of contact (Martin et al., 2013).

1.14.16 Flat service performance

The flat service performance is the ability of tennis player to serve the ball with maximum speed with better accuracy (Devindar, 2008).