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Original Research Article

Injury Profile of Professional Indian Tennis Players

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ABSTRACT

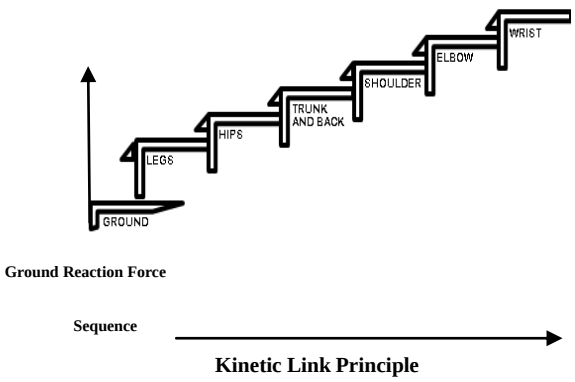
Tennis is characterized by repeated, explosive motions and involvement of several muscle groups during different strokes, which fluctuates randomly from brief periods of maximal or near maximal work to longer periods of moderate and low intensity activity. The volume of play combined with the physical demands of the sport imposes a high load of strain resulting in a number of inter-related intrinsic and extrinsic factors which predispose the subjects to injuries. Hence this research brings out a Comprehensive Injury Profile of Professional Indian Tennis Players with due weightage to the pattern and prevalence of injuries. A cross sectional survey using self-drafted pre validated questionnaire based on with a convenience sample of 100 professional Indian tennis players with mean age of 18.08 ± 5.19, from various national tennis sport complexes were recruited in this study.
Result: 21% players reported of injury at wrist and ankle respectively; 13% in shoulder; 12% in knee; 10% in back; 7% in elbow; 4% in neck; 3% in hand and hip respectively.
Conclusion: Descending order of prevalence of injury is Wrist/Ankle> Shoulder > Knee > Back > Elbow > Neck > Hand/Hip > Head.

Keywords: Lawn tennis, tennis injury profile, professional Indian players, prevalence, intrinsic factors, extrinsic factors

INTRODUCTION

Over the years, the game of tennis has evolved from the wooden-racquet era of long, crafty points based on style and finesse, to the current fast paced explosive sport, based on power, strength and speed. [1] Today, tennis places acute physical demands on players, given the repetition and intensity of quick starts and stops, changes in direction, running and shuffling side-to-side that are required in tennis, while maintaining sufficient balance, control and upper body strength to hit the ball effectively. [2]

Biomechanical analyses of stroke production indicates that the kinetic chain links upper extremity, lower extremity, and core muscle segments by transmitting coordinated activation and motion; in this regard, any faulty stroke mechanics that disturbs the groin, hip, and abdominal musculature can further result in an increased risk of injury to the shoulder and upper extremity. [3]



Preadolescent and adolescent players have open growth plates and a reduced muscle power, lower level of coordination and smaller stature compared with adult players. This creates adaptations, which alter the biomechanics of the tennis strokes and place unique demands on the developing athletes, thus creating increased injury risk. [4] The work-to-rest ratios of competitive tennis athletes range between 1: 3 and 1: 5, and fatigue has been shown to greatly reduce the hitting accuracy. [1]

The repetitive demands placed upon the human body from countless hours of training and competition can gradually lead to muscle and/or tendon breakdown, therefore many of the injuries in elite tennis players is usually classified as 'overuse' injuries. As an example, serves and forehands make up 75% of all strokes during a typical match. Couple this with the fact that players hit with incredible power from virtually anywhere on the court and it is easy to see how players could develop muscular imbalances and experience forces that could ultimately lead to injury. There are a number of factors that can increase a player's risk of injury, including overtraining, inadequate muscular strength and/or endurance, inflexibility, improper equipment and poor aerobic fitness level. [5] Different court surfaces also tend to revise the demands that are placed on the tennis player and hence play a role in injury rates and patterns. [6]

The interplay of above mentioned intrinsic & extrinsic factors thus increases predilection for various types of musculoskeletal injuries in tennis players. However there are not many studies with a comprehensive Injury Profile in Professional Indian Tennis players. The game of tennis is unique in its biomechanics and physical demands which along with the evolution in equipment and play surfaces make it very different from other racquet and throwing sports thus deserving its own separate Injury Profile. [7]

Hence the purpose of this research is to draft a Comprehensive Injury Profile of Professional Indian Tennis Players with due weightage to the pattern, prevalence of injuries by comparing their age, gender, BMI, tennis experience, technique of play, posture assessment, foot posture index, fluid intake, duration and type of equipment used, type of fitness training in these players.

METHODOLOGY

This retrospective study was conducted on 100 elite Indian Tennis players, both male and female in 10-30 years of age group, playing tennis at District Level and above. Players playing tennis below District Level were not included. Written informed consent from all the adult subjects and consent from parents and assent from study subjects under 18 were taken before enrolling in the study.

For the survey, a questionnaire was drafted following with due deliberations of the relevant literature and thereby validated by an expert in the field. Revisions were made based on comments regarding the language, format, and context issues of the questions after a pilot study conducted on 10 subjects. The survey Questionnaire contained information on four broad domains:

1 . Demographic Details
2. General Tennis-specific details
3. Training and Fitness details
4. Injury Profile

Anthropometric measurements of height and weight were noted with the help of a stadiometer and weighing scale. BMI values of the individuals were calculated. Khadilkar's Revised IAP Growth Charts for Height, Weight and Body Mass Index for 5 to 18 year old Indian Children was used to categorize overweight/obesity in for players up to 18 years of age. [8]

Grip Measurement and Racquet Circumference were measured with a measuring tape.

Foot Posture was observed using the Foot Posture Index – 6. [9]

Ethical approval

Permission for the study was obtained by making a petition prior to collecting data. This was achieved by contacting and receiving approval from the Research committee, D.Y. Patil University. This study was conducted in accordance with the ethical standards of institutional review boards and with the Helsinki Declaration.

OBSERVATIONS AND DATA ANALYSIS

The data was processed using Descriptive statistics - for demographic data (age & BMI) and percentages were used to depict proportions. Tables were made using Microsoft word and figures were plotted using Microsoft Office Excel 2013.

A total of 100 players participated in the research.

Gender & Age Distribution: Sample included 38 females with mean age of 17.93±5.20 years; and 62 males with mean age 18.05±5.21 years. Players were found to have started playing tennis at a mean age of 8.50±3.18

Table 1. Demographic Data

Age			
	Girls	Boys	Total
Early Adolescent (10-13)	21.05%	25.81%	24 %
Mid Adolescent (14-16)	21.05%	12.90%	16 %
Late Adolescent (17-19)	13.16%	20.97%	18 %
Adult >19	44.74%	40.32%	42 %
Body Mass Index			
	Girls	Boys	Total
Obese	7.89%	11.29%	10%
Overweight	5.26%	37.09%	25%
Normal	78.95%	51.61%	62%
Underweight	7.89%	NIL	3%

Table 2: Injury Profile

Groups	Total Number	No of Injured	No of Injuries	Prevalence
Total	100	58	133	1.33
Gender				
Female	62	21	50	0.50
Male	38	37	83	0.83
Age				
Early Adolescent (10-13)	24	9	12	0.12
Mid Adolescent (14-16)	16	9	14	0.14
Late Adolescent (17-19)	18	9	21	0.21
Adult >19	42	31	86	0.86
Weight				
Obese	10	5	10	0.10
Over weight	25	15	42	0.25
Normal	59	37	73	0.59
Under weight	5	2	8	0.05
Level				
District	18	8	17	
State	17	7	7	
National	60	43	109	
Surface				
Hard	74	40	85	
Clay	25	18	48	
Grass	1	-	-	
Postural deformity	31	20	41	

Site of Injury: Analysis of data revealed 21% players reported of injury at the wrist and ankle respectively; 13% in the shoulder; 12% in the knee; 10% in the back; 7% in the elbow; 4% in the neck and other parts; 3% in the hand and hip respectively; 2% in the head.

Status of Re-Injury: Data analysis revealed 10% players reported of repeated injuries in the ankle; 7% in the wrist; 4% in the back; 3% in the shoulder and knee respectively;

Treatment sought for Injuries incurred: When asked, 33% of the injured players were found to visit General Physicians; 29% visited Orthopedics and Physiotherapists respectively; 6% visited others. Injury specific rehabilitation protocol was not followed by 71% players whereas 29% players followed it.

Intrinsic Factors contributing to Injuries: The daily fluid intake of players was established to be <= 2 litres for 25% players; 2-3 litres for 37% players; >= 3

litres for 38% players. It was also found that 29% never took supplemental electrolytes while 48% sometimes supplemented electrolytes.

A concurrent finding was that 17% players reported that they occasionally fainted on court.

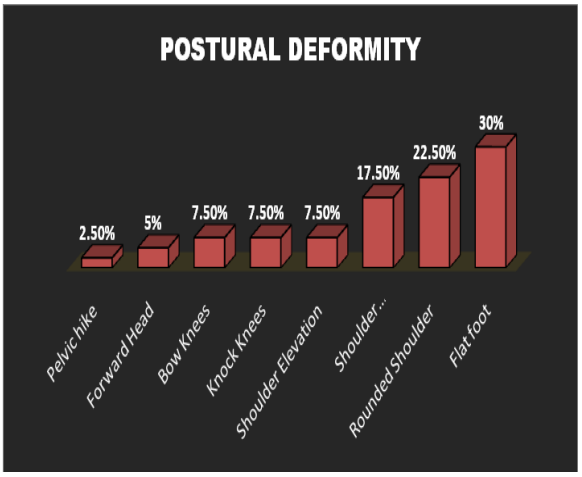


Figure 1. Postural Deviations

According to figure 1, the common postural deformities in tennis players were Flat foot 30%;

Rounded shoulder 22.50%; Shoulder depression 17.50%; Shoulder elevation 7.50%; Genu valgum 7.50%; Genu valgus 7.50%; Forward head 5%; Pelvic hike 2.50%.

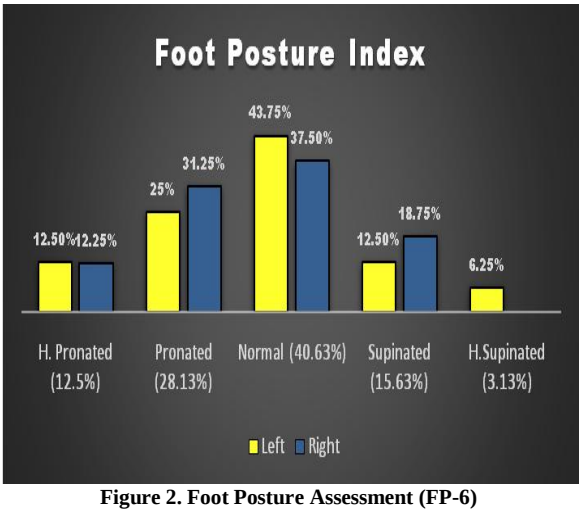


Figure 2. Foot Posture Assessment (FP-6)

According to figure 2, 40.63% players had normal foot posture; whereas players with foot deformity were found to have 28.13% (9) pronated feet; 15.63% (5) supinated feet; 12.5% (4) highly pronated; 3.13% (1) highly supinated feet.

Extrinsic Factors

It was found that 32% players are playing tennis for >= 2years; 18% are playing tennis for 2-5 years; 50% are playing professional tennis for > 5years. A significant difference was observed, with injured players having a mean of 1025.21 hours of play in a year as compared to 508.24 hours for non-injured players. Also, 58% players had undergone a gradual training program whereas 42% did not go for any such program.

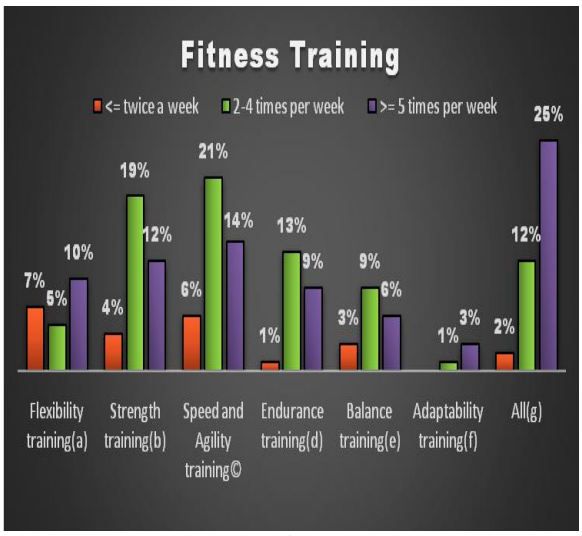


Figure 3. Level of Fitness Training

According to figure 3, there were 39% players that involved all fitness regime in their training; the most commonly performed training regime was speed and agility training > strength training > endurance training > flexibility training > balance training > adaptability training.This study also highlights the fact that warm up and cool down was done by 73% players; 21% players did only warm up before playing; 1% players did only cool down after playing; 5% players did not do either warm up or cool down.

1) 98% players bought specific racquets; 2% did not buy specific racquets.
2) 98% players used specific tennis shoes while playing, out of which 68% players used same shoes while playing on different surfaces.

Self-Assessment for Wear And Tear: According to data analysis, 84% players self-assessed their racquets; 64% players self-assessed tennis balls; 92% players self-assessed their shoes.

Surface and environment of injury:

It was found that injury reported during training(off season) were **55.93% (33) on hard surface**; **30.51% (18) on clay**; **13.56% (8) on grass**; whereas injury reported during tournaments (on season)were **47.06% (16) on hard surface**; **35.29% (12) on clay**; **17.65% (6) on grass**.

DISCUSSION

This study included 100 professional Indian Tennis players as subjects, with 38 females and 62 males. A total of 58 players reported a total of 133 injuries during their tennis career. The prevalence of injury in male players was 83% and in female players was 50%. No statistically significant gender difference was found in the prevalence of injury between men and women. This was consistent with various different studies. [10]

Injury prevalence in early adolescence, mid adolescence, late adolescence and adults was 12%, 14%, 21%, and 86% respectively. Average young tennis players have found to have relatively less severe injuries. However, intensely active young players are prone to deleterious maladaptation, which have been shown to increase with years of play and thus making them prone to injuries.

Upper Body Injuries

Improper and delayed timings of peak angular velocities of trunk, pelvis, and upper torso rotation results in a loss of energy, non-transferred to the serving arm. This forces the players to increase joint kinetics as compensation and consequently expose them to a greater risk of upper limb overuse joint injuries. Additionally, the backwards movement of body, as the player strikes the ball, limits the linear momentum one can generate and therefore places a greater demand on the upper body segments. [5]

As the serve progresses, player begins to further open his/her body by pulling through their abdominal muscles rather than push through the serve using their leg drive. This "arm lag" position created by the premature opening up of the body might place added stress on their abdominal muscles and shoulder as well as the inside of the right elbow joint, as these areas are forced to make up for the break in the kinetic chain that results from the lack of rotation and leg drive.

Early opening of the body and the resulting arm lag during the forehand can place excessive stress on the shoulder, particularly the rotator cuff and stabilizing structures. Failure to use the entire kinetic chain properly to generate power and assist the arm when the ball is contacted late can place additional stress on the inside of the elbow, particularly when the player compensates by using the wrist and forearm excessively. [3]

Injuries can occur on either the radial side or the ulnar side of the wrist due to extreme position and downward bending (ulnar deviation) that is often incorporated as part of the two-handed backhand technique. The repetitive use and the forces experienced at the extreme ends of the wrist's range of motion place greater stress on the tendons that cross this joint. Extreme grips also can contribute to the apparent rise in wrist injuries. Repeated positioning of the wrist in extreme extension and/or ulnar deviation stresses the triangular fibro-cartilage complex, or TFCC leading to its tear away from the end of the ulna bone. [5]

Research by Lo and Hsieh found that advanced players, regardless of open stance or square stance, have larger joint force and moment at each joint before ball impact resulting in better stroke efficiency and reduced chance of injury. [11]

Lower Body Injuries

In the open stance forehand, the repetitive loading of the dominant hip can lead to injury to the hip joint itself as well as the hip's stabilizing structures, especially when

strength imbalances and poor flexibility exist in this region.

Execution of a two-handed backhand requires a pull wide off the court, and the load is experienced by the knee. The ankle is put at high risk of sprains, mostly inversions, that tend to occur at foot strike during running or when a player is landing from a jump due to the footwork required in stroke play. Instability of the ankle joint complex may predispose a player to inversion injury. [5]

Back Injury

Serve and overhead shot combine hyperextension and rotation of the trunk causing stresses on the back. The volley, forehand and backhand groundstrokes, singly and in combination, place the back at risk of injury because they involve a marked degree of rapid axial rotations to right and left. It is the rotatory motion that increases the likelihood of disc injury and muscle strain. The quick, repetitive nature of the sport can also cause fatigue in the supporting structures of the back creating overuse injury.

An ageing body with the demands of sport placed upon it can easily fail. Growth spurts and discomfort with a changing body image leaves the player with the risks of overload, and diminished bone strength and therefore predisposes youth to body alignment disorders. [12]

Variations in foot posture are thought to influence the function of the lower limb and may therefore play a role in predisposition to overuse injury. The ability to sense motion in the foot and make postural alterations in response is essential in preventing injury. Studies suggest highly pronated foot posture yields excessive internal rotation of the shank with excessive anterior pelvic tilt as well as altered knee movements and excessive joint stress. [13]

Flat feet have become a common phenomenon not only in athletes but also in the existing population. Initially studies suggested that Obesity was considered to be a predisposing factor but nowadays it is commonly found in anyone irrespective of their BMI. Further research is needed to understand the prevalence and incidence of flat feet in human population. Excessive height and weight have been shown to predispose to stress injuries in players due to additional stress put on their muscles, tendons and organs, therefore creating large forces even on small movements in these individuals. [14]

A high BMI in our study might not actually be reflecting high adiposity but rather an increased lean muscle mass, as it includes factor other than excess body fat i.e. bone and muscle mass and even the increased plasma volume induced by exercise training. [15]

Decreased intake of fluid and electrolytes hydration increases the effect of dehydration, hyponatremia, and overheating of the body. Without correct protein intake, an individual's soft tissue may not recover or adapt properly, and can lead to DOMS and overtraining syndrome.

Accumulation of life stress apparently predisposes to an athletic injury. It is also common for individuals to become over assertive or aggressive when competing, which can lead to them harming themselves or others. [16] In addition, for some competitive female athletes, problems such as low self-esteem, a tendency toward perfectionism, and family stress place them at risk for disordered eating. [15] Furthermore emotional well-being has been found to be affected in adolescents who form the major chunk of our study subjects. [17]

The tennis racquet is perhaps seen as the most important piece of equipment as it can be tailored to the physiology and playing style of the individual. The characteristics of a racquet do have a bearing on the power of the stroke and on the forces and loads that are transmitted to the hand, arm and shoulder of the tennis player. With repeated loading in any or all of these directions, microtrauma and overuse injuries may occur. [18]

The various playing surfaces foster different playing styles, and have been shown to

influence injury rates dramatically in tennis. [19] In most cases, injuries to the lower extremities are surface related. [6] The frictional characteristics of the tennis court–shoe interface is a major risk factor for lower extremity injuries in tennis. [20] Tennis movement patterns are relatively complex, involving forward, backward, sideways, rotational and sliding movements at a variety of speeds. Tennis is therefore demanding on footwear, and selection of the correct shoe-surface combination is crucial to strike an appropriate balance between performance enhancement and minimization of injury risk. As shoes lose around 30% of their impact attenuation properties after modest use (the equivalent of about 500 miles), they should be replaced regularly. [19]

CONCLUSION

The occurrences of injuries were common in professional Indian tennis players. Most common injuries were found as follows: Wrist/Ankle > Shoulder > Knee > Back > Elbow > Neck > Hand/Hip > Head. Players were found to injure themselves commonly on hard surface, especially while practicing. Upper limb injuries were more common than lower limb injuries but repeated injuries were more common in lower limb. Also players preferred visiting General Health Physician for treatment.

Clinical significance: Injuries can be very damaging to a player's season. An injury occurring at the wrong time can result in a loss of practice time and possible a drop in the rankings. As a result, every coach and player would want to do everything possible to minimize the risk of injury. This research has outlined intrinsic and extrinsic factors that can contribute to an injury in tennis players. Not all injuries can be eliminated, but by following a couple of basic points, their incidence can be reduced.

Clinical Implication: Data obtained from this study is an essential requirement for developing injury prevention, treatment and rehabilitation strategies. In particular, it provides data required for the development, application and assessment of injury causation. Success in tennis requires a mix of player talent, good coaching, appropriate equipment, and an understanding of those aspects of sport science pertinent to the game.

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***Conflict of Interest**:* There exists no conflict of interest in this research to the best of our knowledge

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