

Injuries in Tennis

Agrotou Stella

Abstract: Nowadays, the phenomenon of sports injuries is hitting more and more people involved in all kinds of sports activity. In particular, for the sport of Tennis, the range of ages affected by injuries caused by engagement of these people with the sport of Tennis is a lot larger, given that Tennis is a sport that is widespread all over the planet and people of all ages can engage with him, either on a professional or recreational level. The purpose of this literature review is to determine the concerns of the global sports scientific community regarding the injuries caused by the sport Tennis to professional sportsmen and women, as well as to recreational sportsmen and women. In this effort, the bibliography review identifies the issues of determining workload and training load that is legitimate for Tennis athletes to be burdened without risking the possibility of injury, if the use stretching exercises is a necessary measure for the prevention of sports injuries of injuries caused by the athletes' involvement in the sport of Tennis, as well as the issue of choosing the right one is also touched upon equipment of athletes, which will result in the reduction of sports injuries that may arise from their involvement in sport of Tennis. An interesting piece of the world review literature was the investigation of risk factors such as these have so far been defined by the scientific community sport of Tennis. More specifically, an attempt is made to determine the intrinsic and extrinsic risk factors that may contribute to a sports injury in one professional or not, tennis player. Also, reference is made to the pre-diagnostic test which, as the researchers argue, should all those interested in participating in her sport are submitted to Tennis, to establish whether their industrial situation is suitable to serve the special requirements presented by its sport Tennis. Finally, reference is made to the most frequent injuries presented in the sport of Tennis, as well as in the frequency of these injuries in proportion to the age of the athletes, as well as in proportion to the field surface on which the sport is played at that moment activity.

Keywords: Tennis, Injuries, Upper limbs

1. Introduction

In the sport of Tennis, there is a variety of injuries from which an athlete can be affected, regardless of age, level, or field surface. According to scientific literature, the most common injuries in the sport of Tennis involve joint sprains and resulting muscle injuries usually in overuse syndromes [1]. The most frequent overuse syndromes concern tendinitis in the joint knee and elbow epicondylitis syndrome and are more common appearing in older athletes. Common injuries to the sport of Tennis should also be considered the injuries of ankles, back, and neck. Also, very common injuries in the sport of Tennis are also the incidents that occur in the shoulder area, due to the repetitive nature of the service stroke and of the smash which are performed above the level of the head, as well as the injuries observed in the joint of the elbow, as mentioned earlier in the case of his epicondylitis elbow. Furthermore, according to Robert and Perkins, from pro- of use, the wrist joint also suffers, due to the large size burden received by the joint during mainly one ground impact [2]. It is also important to note that the frequency of injuries to the back, neck, and groin area is about the same as the number of injuries that occur in the upper limbs. According to studies, the total injuries that occur to the feet of an athlete, as in the area of the knee joint and ankle joint, show approximately twice the frequency of occurrence compared to the injuries that occur in the area of the upper limbs [3]. According to the study by Kibler and Safran, two mechanisms seem to be responsible for injuries to tennis athletes, mainly younger age, macro trauma, and microtrauma injuries. More in detail, macro trauma injuries (direct injuries) include acute sprains, acute joint injuries, fractures, and bruises and appear to be caused by direct boring of the area at a specific moment of the game, while they are usually observed at the lower ends of the athletes' body. Regarding microtrauma injuries (syndromes over-use), these include tendinitis, chronic sprained muscles, and instability in the joints of the body. Specific injuries are found more in the upper limbs of the body and more often it is the result of repeated strenuous training or simply engaging in sports activity, which results in relative changes in muscle tissues [3]. Regarding the physiological demands of the body in its sport Tennis, these seem to focus on the requirement for greater bone density, in demand to increase the collagen contained in tendons of the muscles, in need to increase the maximum oxygen intake from the organism, as well as the necessity of growth in anaerobic athletes' threshold for maximum performance. These requirements seem to find an answer from the athletes through their process training units, especially when these athletes are younger, and their organization can adopt the results of the training units much more easily. The specific requirements just mentioned do not appear to pose any particular risk of injury on their own. On the contrary, with the adjustments that an athlete must make about flexibility, strength, and endurance to be competitive in the sport of Tennis, there is a risk of injury during it

training process of the specific factors. This may have as a result not necessarily stopped the competitive process for one athlete, but certainly the noticeable reduction in his performance [3]. In the scientific literature, it is argued that the most common way for an athlete's injury, especially a younger one, is to practice and learn a skill of the sport with incorrect technical application or even with inappropriate equipment. Also, it is common for athletes to perform skills in which their somatometric characteristics do not they can respond. This implies wrong industrial adjustments of the young players' body and consequently the creation of trauma which can even affect his smooth somatometric development sportsman or sportswoman. Examples of such cases may consider the excessive inclination of the trunk during its execution service, the wrong use of the elbow during its execution service, and the forehand as well as the wrong movement of the wrist during the duration of the forehand stroke [4].

2. Upper Limbs

2.1 Shoulder

One of the areas of the body in general, and of the upper limbs in particular that present more frequent incidents of injuries in her sport Tennis is the shoulder joint. In the requirements of the specific of sport, the contribution of the shoulder joint is very important as contributes the most to the acceleration and deceleration of the hand, while maintaining precise control of the racket and consequently of it ball, characteristics very important for the sport of Tennis, the which in addition to very high physiological requirements, also requires a high level technical training [5]. As noted by Allan Levy and Mark Fuerst in their book *Tennis Injury Handbook*, sports which require the arm to be raised above shoulder level, such as Tennis, are also those that are the most decisive factor for the appearance of immediate boredom in the area, or more likely for the appearance overuse syndromes [5]. More specifically, for moves like the service and the smash, the high powers of rotation experienced by the shoulder during the acceleration phases and slowing down movements that are carried out above its height shoulder girdle, put the soft tissue structures at risk for minor trauma and subsequent more serious trauma [6]. In more detail, the repetitive nature of the sport of Tennis with high speed movements are mainly to blame for the appearance overuse syndromes in athletes, especially in the upper body area body [6]. As mentioned in the research of Kevin Laudner and Rob Sipes the moves up from shoulder girdle height require a high level of agility and stability of the shoulder in order to effectively participate in the sport and avoiding injuries [7]. Regarding anatomy of the shoulder joint, according to Roetert and Kovacs, three bones are visible how they contribute to the dominant movements of the shoulder joint in sport of Tennis, the humerus, the clavicle and the scapula [8]. Still, it looks like quite a large amount of muscle is involved in the movement of the shoulder joint. In more detail, the sub-shoulder, o the supraspinatus, the subspinatus and the Hellasian roundus as well as the tendons and ligaments related to these muscles are the elements of the anatomical area of the shoulder that are responsible for the appearance of inflammation in the tendinous lobe of the shoulder [9].

2.2 Tendonitis

The injury to the joint of the shoulder girdle with the most frequent appearance in Tennis athletes, regardless of competition-level inflammation in the area of the Petal Tendon is considered [10]. More specifically, the Tendonial Petal is one group of three muscles, which are responsible for performing external rotation and abduction in the shoulder joint. These muscles are the Hyperacanthios, Hypacanthios, and the Lesser Round [11]. Inflammation of the Tendonial Petal in the area of the shoulder joint usually occurs as a result of repetitive motion hitting the ball either at shoulder height or above shoulder height head [11],[12]. In more detail, the researchers found that the inflammation of the Tendinous Petal appears significantly more often in Tennis compared to other sports because of the contraction of soft tissues in the area of the shoulder girdle, the weakness of its muscles specific area and the alteration of neuromuscular coordination. Also, as can be seen from the specific study, influencing factors in the appearance of inflammation in the Tendonial Petal can also be considered bony anomalies as well as the anomalies during the posture of the body [12]. In the case of inflammation in the tendinous lobe of the shoulder are common tennis players to complain of a gradual increase in pain in the affected area, which links the specific injury to overuse syndrome rather than direct injury. More specifically, the athletes and female athletes complain of pain in a specific area during duration of arm movement above the head range. The pain increases during sports activity and in many cases remains even after its expiry [13]. In order to prevent and avoid injury to the tendon pad it is important to understand and take into account the symptoms that may to be presented by the Tennis player, as well as to be recorded time devoted to each training unit for the practice of smash, serve and volley shots [13]. Also, for her diagnosis and the severity of the injury to the tendon pad is important to examine and assess range of motion in both shoulders of the athlete in order to compare the range of motion in the healthy limb concerning the injured limb [14]. In the study by Laudner and Sipes, the researchers note that in case that an athlete is affected by a specific injury or something similar overuse syndrome is very common to follow and subsequent trauma to the specific area.

That's why it is very important early diagnosis and appropriate treatment with the aim of smooth inclusion of the athlete in the sport without risk of subsequent injury [15]. It is also important to use stretching exercises in specific area before and after the training unit or competition process as well as the strengthening of the shoulder joint in order to ensuring the normal and desired range of motion of the joint without disturbances, as well as increasing efficiency in static as well as dynamic movements required for her sport Tennis [16].

2.3 Elbow

Another area of the upper extremities that seems to be prone to injuries, and indeed with similar injury rates of incidents with the shoulder joint, is the elbow joint. The elbow divides the arm into an upper and lower part. It is considered a flexible joint which, however, is limited to two movements: flexion and extension [17]. More serious and more frequently occurring injury to the joint of the elbow is considered elbow epicondylitis, or Tennis Elbow. As can be seen from the world scientific literature his epicondylitis Elbow (Tennis Elbow) is an injury with very high rates of appearance among male and female tennis players regardless of age, while it is considered an overuse syndrome [14-17]. Research has proven that they can suffer epicondylitis of the elbow in 45% of tennis players who are involved in the sport daily, as well as 25% of those involved in her sport Tennis 1 or 2 times a week [18]. Many researchers agree that the basic pathology for its appearance elbow epicondylitis can be considered the inflammation that is created from the denervation of the extensor carpi brevis, as well as and the extensor digitorum joint [19]. From the review of the relevant scientific literature, it appears that the Elbow epicondylitis can be caused by hitting the ground Backhand and more specifically because of the bad technique that can beginner athletes or recreational athletes apply Tennis in the specific stroke. During the stroke of this they extend their fruit more than the permissible limit, a fact that leads them to elbow epicondylitis because of it often repetitive use of this incorrect movement [20]. Important factors that can affect the appearance elbow epicondylitis are the characteristics of the athlete's racket, such as its weight and overall size [19]. Others factors that can contribute to the appearance of the specific of injury is the age as well as the frequency of its occupation athlete with the sport of Tennis [19]. It still seems as a factor that can be considered responsible to some significant extent regarding the occurrence of elbow epicondylitis is also smoking as shown by the research of Solheim and colleagues, as well and from the research carried out by De Smedt and his colleagues [19-22]. Complementary to the specific view, Tichener et al his colleagues report that after their own research in 2012, found that smoking and diabetes can be important factors in the occurrence of elbow epicondylitis [23]. Moreover, as found by the research of Kibler and Safran it is also likely to cause the particular injury from the creation of many of small fractures in the area of the elbow joint through use of incorrect technique in consecutive games, resulting in the creation of elbow epicondylitis [24]. More specifically, the researchers claim that epicondylitis of the elbow can be caused by repetitive use of movements in which the specific joint is burdened with large force loads and as a result, micro-injuries are caused which can lead later in elbow epicondylitis [25]. In addition, the researchers in a study they conducted found after a comparison, that the Tennis athletes who suffer from elbow epicondylitis burdened with significant greater force loads on the extensor muscles of the wrist joint and exhibited much shorter movement during the final phase at in relation to the athletes who had not shown the specific injury. According to the researchers, this finding can result from bad application of technique in tennis strokes as for example the hyperextension of the wrist, the open head of the racket at its moment contact of the racket with the ball or even the contact of the ball on the bottom half of the racket head strings. Also, as can be seen from the specific study, Tennis athletes who use both hands during the backhand stroke, are less likely to show this injury, as the non-dominant hand during the particular shock absorber absorbs much of the energy applied to the dominant hand and as a result the application of the force that would affect it is shared a single hand in the case of using only one hand during it backhand stroke. In addition, the sportsmen and women who use it a hand during the groundstroke backhand is much more likely to use bad technique in relation to sportsmen and women who they use both hands for the backhand ground stroke, fact which contributes to the appearance of the specific injury. With reference to the factors that influence the occurrence of epicondylitis of the elbow in Tennis athletes seems to be the characteristics of the equipment used by athletes during of the competitive process. More specifically, through the study of De Smedt and his collaborators it seems that the use of anti-vibration does not it affects both the transmission of vibrations from the racket to the athlete's hand in the phase of contact between the racket and the ball, as previously argued studies. On the contrary, they seem to play a crucial role in the transmission of vibrations role the somatometric characteristics of the athlete, from the point of view that the more trained are the athlete's muscles in the areas involved in specific movements to produce energy in a stroke in the sport of Tennis, the less vibration will be allowed to the joints that they also participate in the execution of a stroke during it game[26]. Also, the level of experience she has in her sport Tennis and of course the characteristics of the racket. More specifically, the increased racket head size as well as high capacity resonance has been shown to reduce vibrations passing through the arm of the athlete. This reduction is also observed in athletes with

increased physical fitness masses as well as athletes with a higher level of experience. These appear to be the factors influencing the occurrence of epicondylitis of the elbow in Tennis athletes according to De Smedt and colleagues [27]. Regarding the treatment of elbow epicondylitis, the scientific literature states that this can be combated with rest or even with surgery, depending on the extent of the damage suffered by the athlete. In more detail, Allan M. Levy and Mark L. Fuerst characteristically state that from the moment of specific injury the person's daily activities are enough to cause greater harm and therefore greater need for medical assistance. In this particular study, the researchers consider that the recreational athlete stops his occupation with the sport of Tennis for a specific period of time is not considered sufficient to fight the injury completely. The researchers report that one is necessary exercise program which will enhance their strength and flexibility muscles of the forearm and the tendons that accompany them. Just the particular one area is strong enough to withstand the pain that will be applied to it area during a technically poor groundstroke backhand, then the athlete can return to regular practice obligations [27]. Robert H. Perkins and Denise Davis in their own research report that the treatment of the specific injury can be done either with surgical methods, or without surgery. As they say, at case of the non-operative methods the success rate regarding the elimination of the symptoms that cause pain amounts to 90%. These non operative methods consist of resting the area by the athlete or the athlete, the application of cryotherapy to the injured area as well also from strengthening exercises in order to improve its functioning of the elbow joint and achieving the maximum possible flexibility in joint. Surgery, according to the analysts, is only recommended in the event that non-surgical methods have been applied were mentioned and there is no improvement in the athlete after their end 6 months [27-32].

3. Conclusions

As it appears from the review of the world scientific literature, the issue of sports injuries seems to concern to a large extent the international sports community. In the form taken by professional sports in our time, the issue is of critical importance of the health and fitness of the athletes, in order to be able to fight as much as possible during it racing year. Apart from professional athletes, however, there are also recreational athletes, who engage in some sporting activity with in order to protect their good health, to maintain it, as well and for the purpose of recreation from the many obligations faced by each person in his everyday life. In particular for the sport of Tennis a number of people who engage with him on a recreational level is huge and continues to grow rapidly over the years. This it happens because of the characteristics of its sport Tennis, which allow people of all ages to play actively with him [28]. Given the mass participation that the sport seems to attract of Tennis, is of critical importance for the scientific sports world to address the issue of sports related injuries sport of Tennis [29]. From the review of world science bibliography it seems that especially for the sport of Tennis, this is it a complex issue, because of the many different characteristics that appear in the game, either at the level of professional sports, or in level of recreational sports. This happens because of:

- The wide range of ages that are actively involved in its sport Tennis
- The many different surfaces that appear in her sport Tennis during a competitive season
- The different requirements of the organization arising from the engaging in the sport of Tennis in the different ones surfaces.

In more detail, researchers around the world deal with the prevention of sports injuries related to the sport of Tennis, trying:

1. To categorize the factors that may constitute them risk of injury to an athlete
2. To coach these factors in order to avoid possible injury.

A topic that was important to research during its preparation of a specific thesis, is the question of the frequency of sports injuries in the sport of Tennis and their type. More in detail, the review of the world scientific literature highlighted that the areas with the most frequent traumatic incidents in her sport Tennis is:

- The shoulder joint
- The elbow joint
- The knee joint
- The ankle joint

Furthermore, the researchers in the studies they carried out highlighted the importance of the following parameters:

- Learning and applying proper technical training
- Use of appropriate equipment (clothes, shoes, racket, etc.)
- Maintaining good physical condition

One more interesting fact that emerges from her review literature is that the age factor seems to affect the species and the intensity of the injury. More specifically, its young athletes Tennis players seem to be more often affected by traumatic incidents compared to adult athletes. These injuries appear to be in greater degree of overuse syndromes and appear to affect and are influenced by the athlete's musculoskeletal condition at the given moment[33-35]. Also, it is important to define a workload that will not affect the development of the athlete. In contrast to her young athletes In tennis, adult athletes show less athleticism injuries of a different kind. More specifically, adult athletes of Tennis face more immediate injuries than overuse syndromes because they are in full maturation. Regarding those factors that seem to be a possibility for a professional athlete or non-athlete to suffer a sports injury, they are divided based on the literature into intrinsic and extrinsic factors.

From the review shows that the most important intrinsic and extrinsic factors are as follows.

Inherent risk factors:

- Physical structure of an athlete
- Physiological adaptations that he cultivates from his involvement with it sport of Tennis

Exogenous risk factors:

- Exposure to the sport of Tennis
- Sports environment
- Equipment

The critical requirement for these factors is, as mentioned, to can the coaching staffs of the athletes intervene coaching with in order to change these data for the benefit of their athletes. Finally, it seems to be of great importance to the researchers who dealt with the subject to play out the issue of the playing surface of the field. After researches carried out appeared to exist differently features appearing between hard and dirt surfaces, with the most important being the following[35-37]:

- Coefficients of friction and restoration (soil < hard)
- Net playing time (clay > hard)
- Duration of points (ground > hard)
- Number of hits during each rally (clay > hard)
- Maximum heart rate values (soil > hard)
- Blood lactic acid concentration (soil > hard)

Based on the review of the scientific literature, it seems that in future study should be done that will focus on defining one of a specific work plan that will cover the entire range of athletes who engage in the sport of Tennis and will suggest a maximum load work that each athlete can accept without risk from injury. Still, the scientific community has not yet come to a conclusion if stretching exercises can be considered as a preventive measure and prevention of injuries related to the sport of Tennis, so further research is therefore also critical in order to draw safe conclusions for the benefit of practitioners of the sport of Tennis.

4. References

- [1] Alyas, F., Connell, D., & Turner, M. (2014, July). MRI findings in the lumbar spines of asymptomatic, adolescent, elite tennis players. *Bristifh Journal of Sports Medicine*, 41, 836-841.
- [2] Asker, M., Brooke, H., Waldén, M., Tranaeus, U., Johansson, F., Skillgate, E., & Holm, L. (2018, March 26). Risk factors for, and prevention of, shoulder injuries in overhead sports: a systematic review with best evidence synthesis. *British Journal of Sports Medicine*.
- [3] Barnett, T., & Pollard, G. (2007). HOW THE TENNIS COURT SURFACE AFFECTS PLAYER PERFORMANCE AND INJURIES. *Medicine and Science in Tennis.*, 34-37.
- [4] Bylak, J., & Hutchinson, M. (1998, August). Common Sports Injuries in Young Tennis Players. *Sports Medicine*, 119-132.
- [5] Caine, D., & Maffulli, N. (2005). Epidemiology of Children's Individual Sports Injuries. *Medicine Sports Science*, 48, 1-7.
- [6] Cools, A., Johansson, F., Borms, D., & Maenhout, A. (2015). Prevention of shoulder injuries in overhead athletes: a science-based approach. *Brazilian Journal of Physical Therapy*, 331-339.
- [7] Cools, A., Palmans, T., & Johansson, F. (2014). Age-Related, Sport-Specific Adaptations of the Shoulder Girdle in Elite Adolescent Tennis Players. *Journal of Athletic Training*, 647-653.
- [8] Damm, L., Low, D., Richardson, A., Clarke, J., Carré, M., & Dixon, S. (2013). The effects of surface traction characteristics on frictional demand and kinematics in tennis. *Sports Biomechanics*, 389-402.

- [9] Damm, L., Starbuck, C., Stocker, N., Clarke, J., Carré, M., & Dixon, S. (2014). Shoe-surface friction in tennis: influence on plantar pressure and implications for injury. *Footwear Science*, 155–164.
- [10] De Smedt, T., De Jong, A., Van Leemput, W., Lieven, D., & Van Glabbeek, F. (2014). Lateral epicondylitis in tennis: update on aetiology, biomechanics and treatment. *British Journal Sports Medicine*.
- [11] Fernandez-Fernandez, J., Kinner, V., & Ferrauti, A. (2010). THE PHYSIOLOGICAL DEMANDS OF HITTING AND RUNNING IN TENNIS ON DIFFERENT SURFACES. *Journal of Strength and Conditioning Research*, 3255–3264.
- [12] Ferrauti, A., Pluim, B., & Weber, K. (2001). Physiological responses in tennis and running with similar oxygen uptake. *European Journal of Applied Physiology*, 85, 27-33.
- [13] Girard, O., Eicher, F., Fourchet, F., Micallef, J., & Millet, G. (2007). Effects of the playing surface on plantar pressures and potential injuries in tennis. *British Journal of Sports Medicine*, 733-738.
- [14] Grosser, M., Starischka, S., & Zimmerman, E. (1998). *Das Neue Conditions training*. Munich, Germany: BLV Verlagsgesellschaft.
- [15] Hornery, D., Farrow, D., Mujika, I., & Young, W. (2007). Fatigue in tennis Mechanisms of fatigue and effects of performance. *Sports Medicine*, 37, 199- 212. Kibler, W., & Safran, M. (2000). MUSCULOSKELETAL INJURIES IN THE YOUNG TENNIS PLAYER (Vol. 19). Lexington: Clinics In Sports Medicine.
- [16] Kibler, B., & Safran, M. (2000). Musculoskeletal Injuries In The Young Tennis Players. CLINICS IN SPORTS MEDICINE.
- [17] Kibler, B., & Safran, M. (2005). Tennis Injuries. *Medicine Sports Science*, 48(Sports Medicine).
- [18] Kibler, B., & Safran, M. (2005). Tennis Injuries. *Medicine Sport Science*, 48, 120- 137.
- [19] Kulund, D., McCue III, F., Rockwell, D., & Gieck, J. (1979). tennis injuries: prevention and treatment. THE AMERICAN JOURNAL OF SPORTS MEDICINE, 7.
- [20] Laudner, K., & Sipes, R. (2009). The Incidence of Shoulder Injury among Collegiate Overhead Athletes. *Journal of Intercollegiate Sport*.
- [21] Levy, A., & Fuerst, M. (1999). *Tennis Injury Handbook*.
- [22] Martin, C., Thevenet, D., Zouhal, H., Mornet, Y., Deles, R., Crestel, T., Prioux, J. (2011, January). EFFECTS OF PLAYING SURFACE (HARD AND CLAY COURTS) ON HEART RATE AND BLOOD LACTATE DURING TENNIS MATCHES PLAYED BY HIGH-LEVEL PLAYERS. *Journal of Strength and Conditioning Research.*, 25, 163-170.
- [23] Oosterhoff, J., Gouttebauge, V., Moen, M., Staal, J., Kerkhoffs, G., Tol, J., & Pluim, B. (2018). Risk factors for musculoskeletal injuries in elite junior tennis players: a systematic review. *Journal of Sports Sciences*.
- [24] Perkins, R., & Davis, D. (2006). Musculoskeletal Injuries in Tennis. *Physical Medicine and Rehabilitation Clinics of North America*, 17.
- [25] Perkins, R., & Davis, D. (2006). Musculoskeletal Injuries in Tennis. 17.
- [26] Pluim, B., & Drew, M. (2016, June). It's not the destination, it's the 'road to load' that matters: a tennis injury prevention perspective. *British Journal of Sports Medicine*, 50.
- [27] Pluim, B., Staal, J., Windler, G., & Jayanthi, N. (2006). Tennis injuries: occurrence, aetiology, and prevention. *British Journal of Sports Medicine*, 40, 415-423.
- [28] Reid, M., Duffield, R., Minett, G., Sibte, N., Murphy, A., & Baker, J. (2013). Physiological, perceptual and technical responses to on-court tennis training on hard and clay courts. *Journal of Strength and Conditioning Research*, 27, 1487-1495.
- [29] Roetert, P., & Kovacs, M. (2011). *Tennis Anatomy*. Human Kinetics.
- [30] Schwellnus, M., Soligard, T., Alonso, J.-M., Bahr, R., Clarsen, B., Dijkstra, P., Engebretsen, L. (2016). How much is too much? International Olympic Committee consensus statement on load in sport and risk of illness. *British Journal of Sports Medicine*, 50, 1043-1052.
- [31] Solheim, E., Hegna, J., & Øyen, J. (2011). *Extensor tendon release in tennis elbow: results and prognosis*. Springer.
- [32] Starbuck, C., Damm, L., Clarke, J., Carré, M., Capel-Davis, J., Miller, S., . . . Dixon, S. (2015). THE INFLUENCE OF TENNIS COURT SURFACES ON PLAYER PERCEPTIONS AND BIOMECHANICAL RESPONSE. *Journal of Sports Sciences*, 1627-1636.
- [33] Titchener, A., Fakis, A., Tambe, A., Hubbard, R., Smith, C., & Clark, D. (2012). Risk factors in lateral epicondylitis (tennis elbow): a case-control study. (Vol. 38). *The Journal of Hand Surgery*.
- [34] Vinger, P., & Hoerner, E. (1986). *Sports Injuries*. PSC Publishing Company.

Author Profile



Agrotou Stella received her Bachelor degree in the School of Physical Education and Sports Science specializing in tennis from the National and Kapodistrian University of Athens in 1985. She holds a PhD from the Medicine School of Athens and has been teaching tennis at it since 1994 until today. She is also a tennis coach for high level athletes.