

Retraction

Retracted: A Novel Artificial Neural Network-Based Biomechanical Research on Elbow Injury of Tennis Serve

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This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] J. Zhu and M. Zhang, "A Novel Artificial Neural Network-Based Biomechanical Research on Elbow Injury of Tennis Serve," *Security and Communication Networks*, vol. 2022, Article ID 2725900, 8 pages, 2022.

Research Article

A Novel Artificial Neural Network-Based Biomechanical Research on Elbow Injury of Tennis Serve

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Tennis is a sport with a large age span. Its technology is complex. Factors such as tennis racket and service position will affect the effect of players holding the ball, but often the service posture and strength will affect the players' elbow tendon. Once the service posture is wrong or the strength is too strong, it will cause irreversible damage to players. Therefore, the study of artificial neural network training on tennis elbow injury is of great significance. Based on artificial neural network, this paper studies the biomechanics of elbow injury in tennis service. Firstly, this paper expounds the concept and characteristics of tennis service technology and studies the injury of tennis players' elbow. Then this paper studies the artificial neural network technology and uses the experimental comparison method to test the force generated by the two groups of tennis players from different angles. The results show that, in the professional group, the forearm is in the internal rotation state before and after hitting the ball, while the beginner group is generally in the external rotation state. It can be inferred that, under the constant collision force, the reversal force absorbed by the beginner group in the swing process is greater than that of the professional group, which will increase the load of the supinator muscle on the antipronation, which will damage the supinator muscle, which is also one of the causes of the "tennis elbow" disease.

1. Introduction

Tennis is a very important sport in the game. Serving technology has high requirements for athletes [1, 2]. Tennis ball, size, weight, and other parameters are likely to change; serving the players elbow has different degrees of influence, but also for tennis players elbow injuries, the incidence rate is very high, and it is difficult to treat [3, 4]. A computing mode divides a computing task into several subtasks and then sends the subtasks to the distributed computing network for synchronous processing. It is often used in large-scale operation with time-consuming serial calculation. In parallel computing, each node communicates through the network. Most neural computing is considered as distributed parallel processing.

Many scholars have done relevant research on artificial neural network. In recent ten years, the research of artificial neural network has made great progress. It has good fault tolerance, so it has wide application and great development

potential. Some scholars studied the influencing factors of basketball injury in physical education teaching based on artificial neural network. They used the method of sports factor analysis to analyze the causes of knee injury in basketball training in colleges and universities. 35 key factors were determined through data investigation. Kmo value and Bach Wright test: $kmo = 0.868$, Bach Wright test $X = 186.128$, $P \leq 0.001$, and the test results were significant. Other researchers focus on two widely used artificial neural networks (ANN), perceptron back propagation and Hopfield Boltzmann machine model. They discussed in detail the characteristics of a simple feedforward neural network model [5, 6]. They introduced the Hopfield Boltzmann machine neural network model. Artificial neural networks represent a fundamentally different calculation method. They are explicitly designed to mimic the basic organizational characteristics of biological nervous systems, parallel and distributed processing. Artificial neural networks are also known as "parallel distributed processing," "connection

theory,” and “neuromorphological system” [7, 8]. The above research is based on artificial neural network, which is helpful to the research of elbow injury in tennis service. A neural network is usually composed of multiple neurons connected widely. The overall behavior of a system depends not only on the characteristics of a single neuron, but also on the interaction and interconnection between units, simulating the nonlimitation of the brain through a large number of connections between units.

Through the biomechanical analysis of elbow injury in tennis service, it is concluded that the player and shoulder joint, the front, middle, and cross racket of the net are affected. The experimental research is carried out by using neural network, and the hitting angle will be different under different types of hitting. This paper mainly uses the single factor cross bar method to analyze the damage of steel straight shoulder and ball small angle stage and then uses BP artificial neural network technology to analyze the damage. Single factor experiment is to experiment on only one factor and fix other factors. This approach must first assume that there is no interaction between the factors. If there is interaction between various factors, using this method will often draw wrong conclusions.

2. Discussion on Biomechanics of Elbow Injury in Tennis Service Based on Artificial Neural Network

2.1. Tennis Serving Technique. Tennis competition is the main form of tennis directly displayed to the public. The roar of fighting and many unconventional random balls on the field also make tennis highly appreciated [9, 10]. In a game, one side takes the lead in serving and the other is ready to receive. If serving is the most important and critical technical link on the tennis court, the counterattack may come in second. In tennis confrontation, receiving the opponent’s serve will lead to tension and psychological fear. It subconsciously creates more attack opportunities for the opponent and directly improves the opponent’s ability to defeat himself. On the contrary, excellent service receiving technology will not only destroy the opponent’s attack and become a powerful weapon tactically and psychologically, but also help to obtain more points, create favorable attack conditions, and finally win the game. Therefore, as the first step from defense to attack, receiving and serving technology plays an important role in tennis competition, and its importance is self-evident. In the case of a very threatening heavy blow, if the flight direction of the tennis ball can be correctly predicted, half of the successful impact will be achieved [11, 12]. According to different needs, the front and rear positions of the ball in the air relative to the body are also different. Generally speaking, the first serve emphasizes the speed and attack of the ball. The hitting point is closer to the front, so the ball is also thrown closer to the front. Second, the service is more conservative. On the premise of ensuring the success rate, it emphasizes the rotation of the ball and controlling the landing point of the ball, and the hitting point will move

back accordingly. Therefore, the ball should naturally be thrown back.

With the continuous progress of science and technology, major changes have taken place in tennis courts, tennis balls, tennis rackets, ropes, and other devices that affect the service speed. In addition, tennis training methods are more scientific and appropriate, the strength quality of players has also been greatly improved, and the level of tennis competition has been continuously improved. The service speed of professional men’s tennis players exceeded 200 km/h. In the game, the serve is often scored directly. In the game, the service is the fastest. The rotation, angle, and impact point vary greatly. The speed of the first engine is higher, and the powerful rotation of the second engine increases the range. The first task of an athlete is to keep his serve, try his best to break the other player’s serve, and strive for more chances of winning. The best tennis players in the world use fast and variable serve to use the game to keep their serve. To increase the points, rounds, and sets to win the whole game, the receiver should not only go all out to keep the service but also record the service rotation, placement, and service line, provide good service, weaken the opponent’s service advantage, and create more service break opportunities. In the different techniques of tennis, serving represents the beginning of each point of both players, so serving and serving technology are very important. In the training process, the service and service technology are the most easily ignored. Most tennis players focus on improving the return technology, and their attention and investment in service technology are relatively low. There is no doubt that high-quality service can increase tennis players’ control of the game [13, 14]. Based on the preparation posture, turn to the side holding the clapper, guide the racket close to the body, and swing the racket behind the body like a pendulum (it is not necessary to swing the straight arm back, but the palm must face the body). One throw, the position of the ball is forward; the second serve throws the ball, and the position of the ball is relatively backward.

2.2. Tennis Elbow Injury

2.2.1. Current Situation. “Tennis elbow” first appeared in German medical records in 1873. It was called “writer’s arm” at that time. It appeared in the name of “Lawn Tennis arm” and “laundry elbow” in the late nineteenth century. In 1883, “tennis elbow” was first described as an injury symptom of professional tennis players. Then, the research and intervention on the subject of “tennis elbow” are carried out from different angles. The researchers speculated on various possible causes and risk factors, including excessive repetitive training, incorrect exercise skills, exercise disorders and lack of flexibility, aging of athletes, poor blood circulation, insufficient intensity exercise and uneven muscle strength, and even psychological factors. The number of tennis fans is increasing year by year, but due to the lack of professional advice or people’s failure to prevent possible sports injuries, more and more tennis fans are troubled by injuries. As the most common chronic injury in tennis, tennis elbow should

be paid more attention [1, 15]. There are basically three kinds of service: flat serve, cutting serve, and topspin serve. Each kind of serve has its own characteristics and uses. A good serve has considerable attack power and makes the ball change in speed, power, rotation, and landing point.

2.2.2. Consequences of Tennis Elbow Injury. “Tennis elbow” will not only cause elbow pain, but also interfere with normal life and sports. Repeated exercise can aggravate the pain and become persistent. In severe cases, it interferes with sleep, and in more severe cases, it may lose muscle strength. Among professional tennis players, the heavy “tennis elbow” will distort their sports skills, resulting in aggravation of muscle injury and decline of muscle function. They will have to terminate their career in advance [16].

Although tennis elbow is a medical disease; its clinical manifestations can be found and diagnosed in time. The symptoms of tennis elbow are pain on the lateral side of elbow joint and lateral epicondyle of humerus, and the pain radiates to the distribution area of extensor muscle. The specific signs are that there is no redness and swelling on the outside of the elbow joint during physical examination, and the elbow joint is normal, but there is a tenderness area of about 2 mm on the lateral epicondyle of the humerus. In the early stages of the disease, the patient’s condition is relatively mild, with only slight pain, which occurs only when the wrist is extended vigorously and the forearm is rotated. With the progress of the disease, the pain will aggravate and continue to radiate outward to the forearm and hand, which can be accompanied by numbness of fingers and even inability to grasp objects and dangerous grasping objects. Pain is usually mild during the day and aggravated at night. Elbow activities such as hitting a ball, clenching a fist, twisting an object, and holding a heavy object will aggravate the pain. The non-surgical treatment of tennis elbow mainly includes rest, ice compress, medication, protective equipment, hyperthermia, traction therapy, and strength exercise. Traction therapy means that when the acute pain disappears, gently pull the elbow and wrist according to the doctor’s advice, do not produce pain, keep the traction state for 10 seconds, and repeat for 6 times. Strength exercise means strengthening the wrist extensor muscle according to the doctor’s advice.

2.3. Artificial Neural Network

2.3.1. Concept. Artificial neural network (ANN) is a system that simulates information processing in biological brain. The system only needs to be physically activated through the combination of appropriate functions. It not only has the numerical arithmetic function similar to the computer, but also has the ability to deal with knowledge, thinking, association, learning, and memory in a way similar to the human brain. Neural network appeared as early as 1940s. Until 1980s, neural network technology developed rapidly. It is a method similar to black box theory, which finds the mapping relationship (nonlinear relationship) between input and output vectors through learning and memory. In supervised learning, the data of training samples are added

to the network input, and the corresponding expected output is compared with the network output to obtain the error signal, so as to control the adjustment of weight connection strength and converge to a certain weight after multiple training. In unsupervised learning, without giving standard samples in advance, the network is directly placed in the environment, and the learning stage and working stage become one. At this time, the change of learning law obeys the evolution equation of connection weight.

2.3.2. Neuron Model. In most artificial neural network models, their structure is usually composed of three basic devices, which are as follows:

- (1) Connection: the strength of each group of connections is calibrated by the weight, and the positive and negative values represent the current activation state of the weight. If the weight value is negative, it means locked; if the weight value is positive, it means active.
- (2) Adder: it calculates the weighted sum of input signals to each neuron synapse. Neural network has self-learning function and associative storage function. This association can be realized by using the feedback network of artificial neural network. At the same time, it has the ability to find the optimal solution at high speed. Finding the optimal solution of a complex problem often requires a lot of calculation. Using a feedback artificial neural network designed for a problem and giving full play to the high-speed computing ability of the computer, the optimal solution may be found soon.
- (3) Activation function: it used to limit the output amplitude of neurons from the network and make them enter the calibration range. The input signal processing of neuron k includes two steps: first, the input signal is weighted and summed, and then the threshold variable BP is subtracted to obtain the net input value uk of neuron k . Secondly, according to the net input value ue of merge, the real output value yk of neuron k is obtained. In addition, a threshold br can be used to constrain the neuron model. Its function is to increase or decrease the input speed of the activation function network according to the positive or negative value. Artificial neuron K is expressed as follows:

$$uk = \sum_{i=1}^m w_i k_i, \quad (1)$$

$$yk = f(uk + bk),$$

where m represents the input signal; w_i represents synaptic weight; uk represents the output value of the linear combiner; bk represents the threshold value of neurons, that is, the minimum activation value of biological neurons; $f()$ represents activation function, also known as output function and excitation function; yk represents the output

signal of neuron k . Pattern recognition is a process of processing and analyzing various forms of information representing things or phenomena to describe, identify, classify, and explain things or phenomena. This technology is based on Bayesian probability theory and Shennong's information theory. The process of information processing is closer to the logical thinking process of human brain. Artificial neural network is a common method in pattern recognition. The pattern recognition method of artificial neural network developed in recent years gradually replaces the traditional pattern recognition method. A typical model of artificial neurons is shown in Figure 1.

3. Experiment

3.1. Investigation Purpose. This paper investigates the biomechanics of tennis serving elbow injury, mainly the current situation of tennis serving elbow injury, so as to provide a basis for the biomechanical research of tennis serving elbow injury based on artificial neural network.

3.2. Investigation Process

3.2.1. Determination of Respondents. In this paper, the biomechanical development of elbow injury in tennis service based on artificial neural network is studied. Therefore, the subjects are all male, including 15 athletes with tennis major level 2 or above, from the tennis professional team of competitive sports school, and 5 tennis beginners with tennis training experience of about half a year. The subjects were on the right side, had no history of elbow injury, and had no recent disease. Table 1 is the information of respondents.

3.2.2. Experimental Method. The beginner group will use the new tennis rackets and the professional athlete group will use their own tennis rackets. Tennis balls are evenly supplied, weighing 0.056–0.058 kg. When they are ready to practice, the subjects connect landmarks and EMG electrodes to their bodies. After some adaptive attitudes, the formal test begins. The player must be in the designated area when hitting the ball, and the ball falls into the designated area after hitting the ball. During the test, a group of three balls were assigned to the players, and the balls were continuously sent to the subject's activity area, about one step away from the person. Record the complete three strokes (racket swing, hit, after swing). After hitting the ball, according to the research basis, the elbow flexion resistance test was carried out; that is, the subject's arm was placed flat on the bench, the elbow was bent sharply, and an athlete applied resistance on the wrist for about 5 seconds. In order to obtain the maximum value, the signal in the process of elbow autonomous bending was measured three times.

4. Discussion

4.1. Analysis of Joint Angle Change of Tennis Players during Swing. In the process of tennis players' swing, the angle is an important index to describe the form of action, which

reflects the relative position relationship between different limbs. In this study, each tennis player is selected to standardize the second half of each action, the whole swing stage, and the second half of the second half, as well as the average value of the standardized angle.

As shown in Figure 2 and 3, the rotation angle of the shoulder of the professional group changed more in the regression stage than that of the beginner group. In the beginner group, the rotation angle of the shoulder changed little during rebound, and the angle remained stable in the swing stage. The rotation angle of the shoulders of the two groups continued to increase at the beginning of the subsequent swing. In the swing stage, it is necessary to prevent the shoulder from rotating too early and open the body only at the moment of hitting the ball, which is more conducive to the rotation effect of the body when hitting the ball, so that the rotation potential energy can be transmitted to the tennis ball through the racket. During the swing of the professional group, the rotation angle of the shoulder first increases and then decreases, indicating that, in the swing process, the professional group first rotates the waist and shoulder at the same time, and the rotation speed of the waist is faster than that of the ordinary group. In the bounce and swing stages, the shoulder rotation angle of the beginner group remained low. This shows that professional teams can make better use of the rotation of the waist and trunk to convert the rotating potential energy into the acceleration effect of the racket, which is helpful to increase the hitting effect of the ball.

4.2. Impact Analysis of Tennis Impact Force on Opponent's Elbow. It can be seen from Table 2 that the maximum impact force of the professional group is significantly higher than that of the beginner group. The peak collision force of the professional group is greater, suggesting that it is more difficult to hit the ball. In order to give the ball more acceleration, a larger impact pulse has the same effect. However, this study assumes that the impact force at this stage should be as large as possible to hit the ball within the range that tennis players can bear, so as to achieve greater acceleration of the ball. For competitive tennis, the faster the ball changes, the easier it is to win. However, when hitting the ball, the angle between the racket and the arm is less than 180° . The collision force between the ball and the racket is transmitted to the forearm and wrist. In the professional group, the forearm is in internal rotation before and after hitting the ball, while the beginner group is generally in external rotation. It can be inferred that, under the constant collision force, the reversal force absorbed by the beginner group in the swing process is greater than that of the professional group, which will increase the load of the supinator against pronation, which will damage the supinator, which is also one of the causes of the "tennis elbow."

4.3. Comparison of Upper Body Characteristics of Tennis Players When Serving. The serving action of tennis is a whip action, so the most reasonable action and beat must

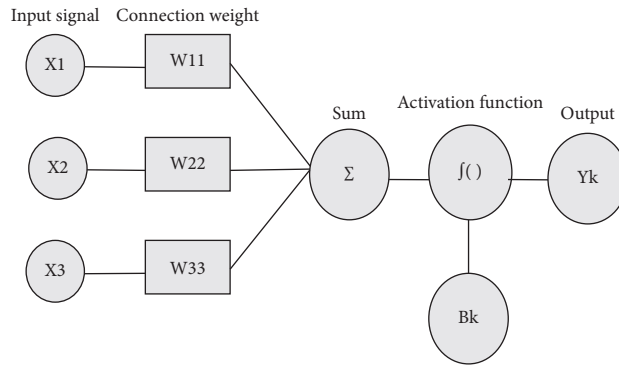


FIGURE 1: A model of artificial neurons.

TABLE 1: Basic information of tennis players.

Experimental subject	Age	Height	Weight	Training time
All of the tennis players ($n = 20$)	23 ± 5	1.84 ± 0.46	74 ± 1.36	3 ± 2
Professional athletes ($n = 15$)	23 ± 4	1.82 ± 0.3	73.6 ± 1.25	3 ± 1.53
Abecedarian ($n = 5$)	21 ± 3	1.81 ± 0.9	71 ± 2.36	1 ± 0.3

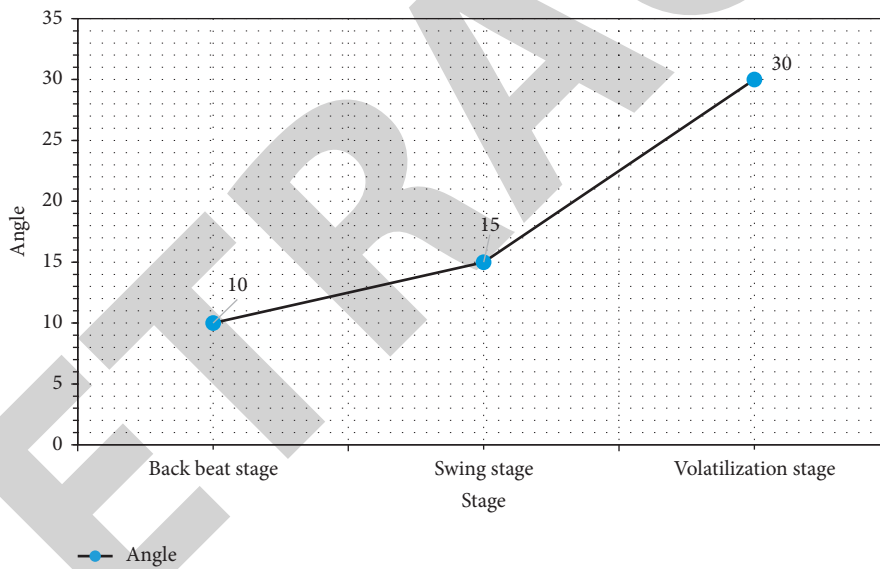


FIGURE 2: Elbow movement angle change in the beginner group.

be increased in the order of the body from the lower joint to the upper joint. It can be found from Figure 4 and 5 that the greater the increment of the velocity between the nodes of each ring, the better the momentum conduction efficiency of the swing. After flexing and squatting, the bat reaches a great impact rate with the help of the rapid pedaling and stretching of the lower limbs and the sequential promotion and braking between other links. The

most serious problem is the inability to explain their reasoning process and reasoning basis. It cannot make necessary inquiries to users, and when the data is insufficient, the neural network cannot work. If we change the characteristics of all problems into numbers and all reasoning into numerical calculation, the result is bound to lose information. The theory and learning algorithm need to be further improved.

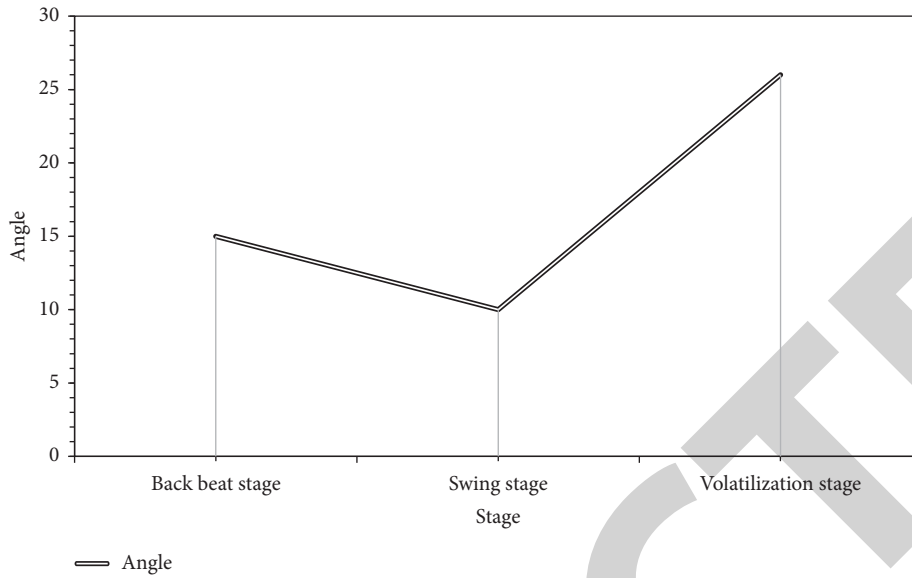


FIGURE 3: Elbow movement angle change in professional group.

TABLE 2: Striking force (N/kg).

Index	Professional group ($n = 15$)	Early study group ($n = 5$)	P
Peak collision force	472.3 ± 125.3	356 ± 58.9	0.008
Relative collision force peak	6.3 ± 2.3	4.25 ± 2.8	0.016

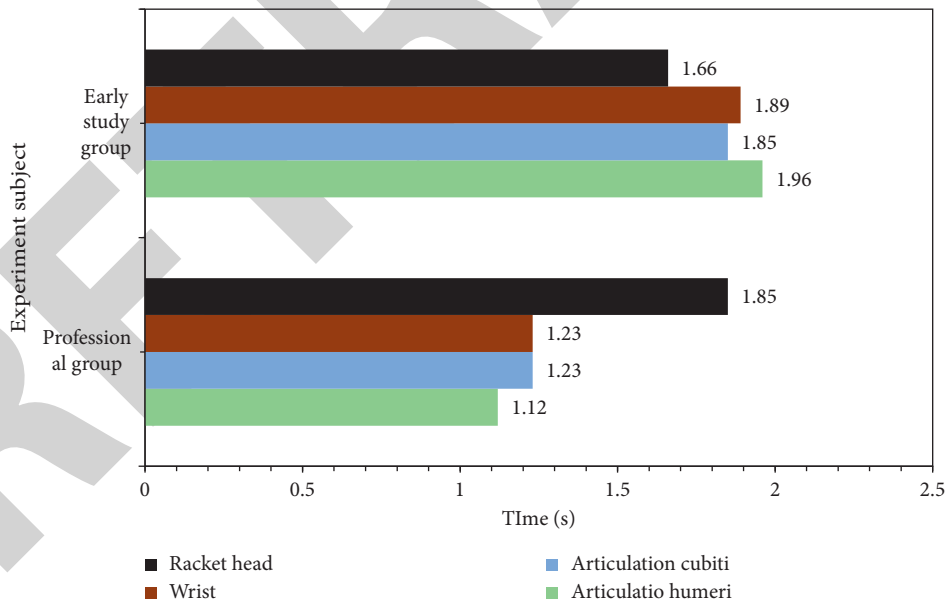


FIGURE 4: The time of a tennis player in the swing.

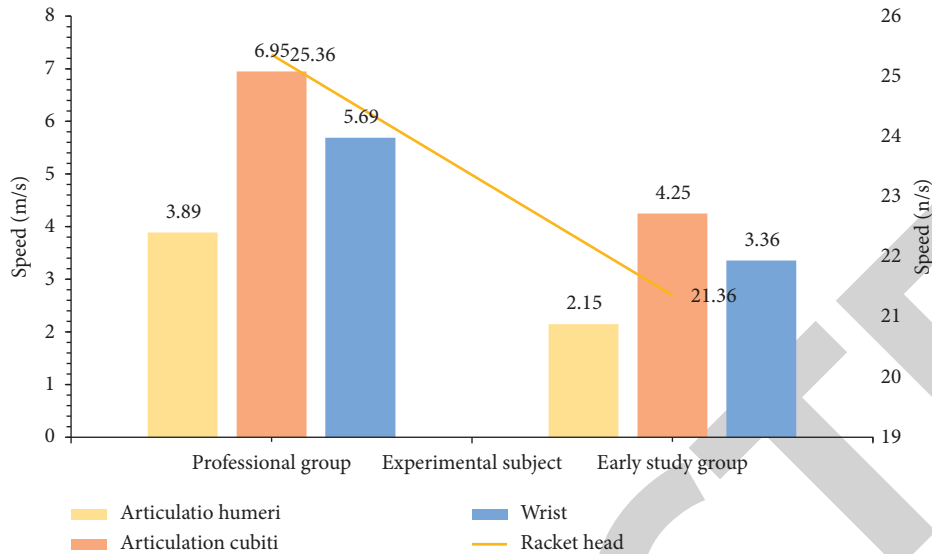


FIGURE 5: Tennis players of body speed in the swing.

5. Conclusion

After studying the literature on tennis injury, this paper uses artificial neural network to train the muscle tissue of the relevant parts of the ball elbow, and through experimental comparison and analysis, the changes of players' hitting angle and force at different positions during service are concluded. In view of this problem, this paper puts forward correspondence reasonable, effective, and suitable for the actual situation, a wide range of service technical action suggestions, and improvement measures, so as to provide reference basis and reference for improving the high-yield and high-quality tennis open in China's international arena.

Data Availability

No data were used to support this study.

Conflicts of Interest

The author declares that there are no conflicts of interest with any financial organizations regarding the material reported in this manuscript.

References

- [1] S. Ge, "Research on the factors of basketball injury in physical teaching based on artificial neural network," *Revista de la Facultad de Ingenieria*, vol. 32, no. 3, pp. 415–422, 2017.
- [2] Y. Li, M. Yang, Z. Liu et al., "Detection and diagnosis of myocarditis in young patients using ECG analysis based on artificial neural networks," *Computing*, vol. 102, no. 1, pp. 1–18, 2020.
- [3] T. Varrecchia, M. C. De, M. Rinaldi et al., "Lifting activity assessment using surface electromyographic features and neural networks," *International Journal of Industrial Ergonomics*, vol. 66, pp. 1–9, 2018.
- [4] B. Hong, Y. Zhang, and Y. Zhang, "Research on the influence of attention and emotion of tea drinkers based on artificial neural network," *Mathematical Biosciences and Engineering*, vol. 18, no. 4, pp. 3423–3434, 2021.
- [5] P. S. Onishchenko, K. Y. Klyshnikov, and E. A. Ovcharenko, "Artificial neural networks in cardiology: analysis of numerical and text data," *Mathematical Biology and Bioinformatics*, vol. 15, no. 1, pp. 40–56, 2020.
- [6] W. Shirui, Z. yuelun, L. Shubin, and H. Zhu, "Performance of deep neural network based artificial intelligence method in diabetic retinopathy screening: a systematic review and method analysis of diagnostic test accuracy," *European Journal of Endocrinology*, vol. 183, no. 1, pp. 41–49, 2020.
- [7] B. Grandjean and M. A. Maier, "Emergence of gamma motor activity in an artificial neural network model of the cortico-spinal system," *Journal of Computational Neuroscience*, vol. 42, no. 1, pp. 53–70, 2017.
- [8] H. Chen and S. Ye, "Modeling and optimization of EMI filter by using artificial neural network," *IEEE Transactions on Electromagnetic Compatibility*, vol. 61, no. 99, pp. 1–9, 2019.
- [9] M. Stoffel, F. Bamer, and B. Markert, "Stability of feed forward artificial neural networks versus nonlinear structural models in high speed deformations: a critical comparison," *Archives of Mechanics*, vol. 71, no. 2, pp. 95–111, 2019.
- [10] E. I. Mohamed, R. A. Meshref, S. M. Abdel-Mageed, M. H. Moustafa, M. I. Badawi, and S. H. Darwish, "A novel morphological analysis of DXA-DICOM images by artificial neural networks for estimating bone mineral density in health and disease," *Journal of Clinical Densitometry*, vol. 22, no. 3, pp. 382–390, 2019.
- [11] W. Kuai, "Prediction method for energy consumption of high-rise buildings based on artificial neural network and big data analysis," *NeuroQuantology*, vol. 16, no. 6, pp. 524–530, 2018.
- [12] D. Mourtzis and J. Angelopoulos, "An intelligent framework for modelling and simulation of artificial neural networks (ANNs) based on augmented reality," *International Journal of Advanced Manufacturing Technology*, vol. 111, no. 5–6, 2020.
- [13] I. Payo, E. Perez-Rizo, A. Iglesias, B. Sánchez-Sánchez, M. Torres-Lacomba, and Á. Gil-Agudo, "Point-mass biomechanical model of the upper extremity during lostrand crutch-assisted gait," *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, vol. 28, no. 99, p. 1, 2020.

- [14] Y. Yamamoto, "Biomechanical study of seoi-nage in judo - influence of elbow's pain on motion," *ISBS Proceedings Archive*, vol. 37, no. 1, p. 9, 2019.
- [15] I. A. Lazarev, A. S. Strafun, and M. V. Skiban, "Biomechanical calculations of the load on the elbow structures in one-stage manual joint mobilization," *Trauma*, vol. 19, no. 5, pp. 37–46, 2018.
- [16] Y. Zhang, H. Chen, B. Yang, S. Fu, J. Yu, and Z. Wang, "Prediction of phosphate concentrate grade based on artificial neural network modeling," *Results in Physics*, vol. 11, pp. 625–628, 2018.

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