A SIMULATION MODEL ACCORDING TO THE MECHANICAL APPROPRIATE OF THE SKILL OF THE LOW ARC SERVING IN TENNIS

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ABSTRACT

The purpose of this paper is to design an appropriate biomechanical model of low arc serving skill according to appropriate biomechanical outcomes, and predict the values of the most important biomechanical variables in the effectiveness of low arc serving. As for the research problem, it is summarized by following up the researcher being a follower of the effectiveness of tennis and conducting some interviews with a number of effectiveness coaches. Found the lack of a mechanical model for the skill of serving the arc trampling in tennis despite the availability of many devices that help in giving numbers for the mechanical, physiological and psychological variables. The research community and sample the study sample was chosen by the intentional method, which is the first ranked player on Iraq in the tennis game, and since the number of attempts made by the player (56) attempts for the skill of serving the low arc, the sample consisted of the number of successful attempts, which numbered (56) attempts. The researchers concluded that it is possible to build a prediction model using neural network technology with a near-zero probability of error for the low arc serving classification. Under the conclusions, the researcher recommends the use model for prediction in the low arc serving level.

Keywords: simulation model, mechanical appropriate.

I. INTRODUCTION:

Given the development witnessed by different sports in general and the game of tennis in particular, whether at the level of game practitioners or by its fans, it has made an effective contribution to the development of this game in various countries of the world and has become attracting fans from all countries and different personalities, whether they are stars of other sports or Coaches, celebrities or ordinary people, because of the competition and enthusiasm that the game enjoys among the players, depending on the player’s physical, skill, tactical and psychological capabilities in an effort to win titles and achieve the achievements that the player adds to his sports career and that achieving championships requires high capabilities that the player cannot easily reach. He must be fluent in many movements, whether simple or complex, in order to be able to master a specific skill, as this game includes many skills, and that each skill performed by the player has a kinetic model, whether with international or local classifiers or among the applicants through the performance they present in this game, Where the experts and specialists in the field of the game paid great attention at a time when it was found that the low levels of players ranked at the country level became necessary. Knowing the skills of local ranked players at a high level of performance to create a model on which to base it. Among these skills is the serving skill, where the serving kick is considered one of the basic skills that has become a great and direct impact on the outcome of the match, through which points are harvested with the least effort and the fastest possible time, and the slate of matches tends to the player who reaps the most points by serving “that the serving kick is one of the important strikes in a game Tennis is one of the difficult strikes because it requires control and mastery in order for the server to be able to implement it, as its success can be scored a point” (1) despite it being a way to start the match or playing before every point “and the serve was not initially It is important other than that it is a way to start playing and the player's place of interest when performing is to be in accordance with the law of play only, that
is, he was sending in the manner of a raised kick with the aim of crossing over the net and falling into the limited serving area (2).

**Importance of the study:**
The importance of the study is in providing a mathematical model according to the results of the statistical analysis of the skill of serving the low arc in tennis in order to avoid some of the obstacles facing the novice players and providing them to coaches during the training process, by building a future vision (predicting) any achievement and simulating technical performance based on the results of the model to predict the variables Biomechanics taken from performing the skill of serving the low arc.

**Research problem:**
It is summarized by following up on the researcher being a follower of the effectiveness of tennis and conducting some interviews with a number of effective coaches. Found the lack of a mechanical model for the skill of serving the arc in tennis despite the availability of many devices that help in giving numbers to the mechanical, physiological and psychological variables.

**Research objective:**
- Identifying biomechanical variables in the skill of serving the low arc in tennis.
- Identifying the classification of biomechanical variables according to the technical performance of the skill of serving the low arc in tennis.
- Recognizing the relationship between biomechanical variables and serving skill of the low arc in tennis.
- Designing a model according to the biomechanical alignment of the low arc serving skill according to the biomechanical alignment results.
- Predicting the values of the most important biomechanical variables in the effectiveness of serving the low arch in tennis.

**II. RESEARCH METHODOLOGY AND FIELD PROCEDURES:**

**Research Methodology:**
The research community was determined by the national team player and the first ranked player in Iraq and ranked (50) globally, the advance category (Akram Mustafa Abdul Karim), and he plays with the right arm.

**Table (1) shows Sample Measurements**

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>measurement</th>
<th>measuring unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Age</td>
<td>35</td>
<td>Years</td>
</tr>
<tr>
<td>2</td>
<td>Length</td>
<td>179</td>
<td>Cm</td>
</tr>
<tr>
<td>3</td>
<td>weight</td>
<td>79</td>
<td>Kg</td>
</tr>
<tr>
<td>4</td>
<td>Head and neck length</td>
<td>33</td>
<td>Cm</td>
</tr>
<tr>
<td>5</td>
<td>torso length</td>
<td>54</td>
<td>Cm</td>
</tr>
<tr>
<td>6</td>
<td>chest width</td>
<td>42</td>
<td>Cm</td>
</tr>
<tr>
<td>7</td>
<td>arm length</td>
<td>77</td>
<td>Cm</td>
</tr>
<tr>
<td>8</td>
<td>humerus length</td>
<td>31</td>
<td>Cm</td>
</tr>
<tr>
<td>9</td>
<td>Forearm length</td>
<td>28.5</td>
<td>Cm</td>
</tr>
<tr>
<td>10</td>
<td>palm length</td>
<td>17</td>
<td>Cm</td>
</tr>
<tr>
<td>11</td>
<td>man length</td>
<td>89</td>
<td>Cm</td>
</tr>
<tr>
<td>12</td>
<td>thigh length</td>
<td>38</td>
<td>Cm</td>
</tr>
<tr>
<td>13</td>
<td>leg length</td>
<td>45</td>
<td>Cm</td>
</tr>
<tr>
<td>14</td>
<td>foot height</td>
<td>7</td>
<td>Cm</td>
</tr>
</tbody>
</table>
Research Design

The researcher followed the descriptive approach, which is one of the common research methods that many researchers have worked with, and that the descriptive approach in the style of correlational studies is the method that reveals the relationships between two or more variables and through which the values of correlation between these variables are identified and expressed digitally. Accurately the characteristics of an individual, group or situation. Among the purposes of this research is also to determine the times of occurrence of something or association of the appearance of something with another (3). As for the nature of the study, it is applied, the adoption of variable selection technique was used, as the multiple regression method is one of the traditional methods of selecting variables, similar to factor analysis and other means.

The data was referred to after converting it to the modified standard scores, which were previously addressed so that the reference of collecting the results of individuals in all variables can be adopted. Thus, we have independent data and a single follower through which the variables that have an impact and contribute to the dependent variable can be selected. The purpose of this process is to nominate the most important the variables contributing to the overall result for the purpose of including it with neural network technology, which is one of the best and most recent methods for building optimal models.

The studied variables

Some biomechanical variables were identified with the skill of the low arc serving in tennis in the subject of his research.

Search procedures:

Tests used:

Hobby serving accuracy Test:

The tennis court is planned as shown in Figure (1).

A rope with a diameter of (1/4) inch from its two ends shall be fixed to the posts of the net from the top so that the distance between it and the net is (4) feet (121.92 centimeters), and the distance between it and the ground is (7) feet, and it is noted that it is tightly screwed and completely parallel to the net.

The numbers (6-5-4-3-2-1) are values that indicate areas of exclusion as follows:

- The number (1) refers to a rectangle 15 x 13.5 feet (457.2 x 411.48 centimeters).
- Number 2 refers to a rectangle 6 x 10.5 feet (182.88 x 320.04 centimeters).
- The numbers 6-5-4-3 refer to rectangles of 3 x 1.5 feet (91.44 x 45.72 centimeters) each.
- The same numbers indicate the scores assigned to each of the areas in which the ball falls.
- The test is explained and a model is made before it is applied to the players.
- The application of the test shall be preceded by a warm-up for a period of no less than (10) minutes on the tennis court.
- After that, the player stands behind the base and then hits (10) consecutive balls on the targets set in the opposite half of the court, provided that all the balls pass between the net and the rope, and where the player tries to get the highest score by dropping the ball in the area No. (6).
Scoring Calculation:

- Balls that touch the net or the rope are not counted as an attempt and are replayed.
- The ball that passes above the rope is considered an attempt and awarded a score of zero even if it falls into any of the goals.
- Each correct ball is calculated for its degree value in the area in which it falls, which is shown in Figure (1).
- The player's score is the sum of the points he gets from the ten attempts.

Biomechanical variables:

- Height of the right heel of the foot at the moment of hitting: The height of the heel of the right foot was measured from the end of the right ankle to the ground at the moment of hitting, and it is measured in centimeters.
- Right elbow joint angle: It is the angle between the forearm and ulna bones of the right arm at the moment of hitting the ball, and it is measured in degrees.
- Maximum ball speed.
- The angle of inclination of the torso at the moment of striking: It is the angle between the perpendicular line on the body and the line of inclination of the trunk at the moment of striking, and it is measured in degrees.
- Left knee joint angle: It is the angle between the thigh bones and the tibia of the left leg at the moment of hitting the ball, and it is measured in degrees.
- Height of the ball at the moment of hitting: It is the distance between the point of contact of the ball with the racket on one side and the ground on the other hand, and it is measured in centimeters.
- The rate of pressure on the left foot.
- Time of impact.

Kinematic analysis program (Kinovea):

It is one of the programs that are used in the field of analysis, through which it is possible to find the values of angles, speeds, times, distances, and others. Through the program (Kinovea), the video recordings of the skill of low arc serving in tennis were analyzed and the values of most of the biomechanical variables were extracted.

Exploratory experience:

The exploratory experiment is a practical training for the researcher to find out the negatives that he encounters during the testing procedures to avoid them in the future (4) or “it is a preliminary experimental study carried out
by the researcher on a small sample before carrying out his research with the aim of choosing research methods and tools" (5). The reconnaissance experiment was conducted on Friday, corresponding to 11/6/2021 at exactly two o’clock in the afternoon, on one of the International People’s Tennis Courts in Baghdad for a purpose, during which the stadium was planned and tied to the poles and rope on the network posts and according to the measurements, and it was prepared to perform the test and identify the locations of the cameras, and after Completing all the preparations for the main experiment shows that there is a decrease in the charging level of one of the cameras, so it is required to recharge it and take the necessary action.

Main experience:
The main main experiment was conducted on Friday 11/6/2021 at exactly five thirty in the afternoon and on one of the International People's Tennis Courts in Baghdad, under the supervision of the researcher and in the presence of the assistant work team.

III. RESULTS AND DISCUSSING:

Presenting the results of the variables contributing to the overall result by adopting the technique of selecting variables and discussing:

One of the most important purposes of the aforementioned classification is to arrive at predictive models that allow the beneficiary to shorten time and effort, as it is required after classifying the data into three categories to reach a model that includes the variables whose impact has been proven to be important in the classification and this is done by isolating the variables that have an important impact on the variable The dependent means that we find a way to reduce the number of variables included in the final model, which can be presented in a way that guarantees the possibility of optimum prediction at the level of each of the three categories. The traditional method of selecting variables is similar to factor analysis and other methods.

The data was returned after converting it to the modified standard scores, which were previously discussed, so that the reference of collecting the results of individuals in all variables can be adopted. Thus, we have independent data and a single follower through which the variables that have an impact and contribute to the dependent variable can be selected. The purpose of this process is to nominate the most important The variables contributing to the overall result for the purpose of including it with neural network technology, which is one of the best and most recent methods for building optimal models.

The multiple regression analysis method was adopted on steps to select the variables that contribute significantly to the final result, and through Table (2) it is clear that only (8) variables have been nominated out of (21) that have a significant effect on the dependent variable.

<table>
<thead>
<tr>
<th>No.</th>
<th>Variables</th>
<th>correlation</th>
<th>Adjusted Contribution Ratio</th>
<th>degree of freedom</th>
<th>F value</th>
<th>Level sig</th>
<th>beta coefficient</th>
<th>T value</th>
<th>Level sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Height of the right heel of the foot</td>
<td>.461</td>
<td>0.198</td>
<td>54 - 1</td>
<td>14.565</td>
<td>0.000</td>
<td>-0.983</td>
<td>-6.430</td>
<td>0.000</td>
</tr>
<tr>
<td>2</td>
<td>Right elbow joint angle</td>
<td>.599</td>
<td>0.335</td>
<td>53-2</td>
<td>14.837</td>
<td>0.000</td>
<td>1.515</td>
<td>9.319</td>
<td>0.000</td>
</tr>
<tr>
<td>3</td>
<td>Maximum ball speed</td>
<td>.657</td>
<td>0.399</td>
<td>52 - 3</td>
<td>13.167</td>
<td>0.000</td>
<td>-0.983</td>
<td>-7.562</td>
<td>0.000</td>
</tr>
<tr>
<td>4</td>
<td>The angle of inclination of the torso</td>
<td>.716</td>
<td>0.475</td>
<td>51 - 4</td>
<td>13.444</td>
<td>0.000</td>
<td>0.272</td>
<td>3.659</td>
<td>0.001</td>
</tr>
<tr>
<td>5</td>
<td>Left knee joint angle</td>
<td>.817</td>
<td>0.626</td>
<td>49 - 6</td>
<td>16.358</td>
<td>0.000</td>
<td>-0.607</td>
<td>-4.981</td>
<td>0.000</td>
</tr>
<tr>
<td>6</td>
<td>Height of the ball</td>
<td>.841</td>
<td>0.665</td>
<td>48 - 7</td>
<td>16.566</td>
<td>0.000</td>
<td>-0.286</td>
<td>-2.125</td>
<td>0.039</td>
</tr>
</tbody>
</table>
Table (2) shows the values of simple correlations, the modified contribution rate and its significance, in addition to the values of the beta coefficients, which represent the contribution of the independent variables to the dependent variable, and through the results it is clear that there are only 8 variables whose coefficients achieved a significant contribution rate, and this seems clear through the beta test. For each variable using the T-test, and therefore, all levels of significance for the variables’ coefficients were significant, and this is clear from their values, as they amounted to less than 0.05. Of great importance, and to answer this question, it must be clarified that the multiple correlation values that achieved a moral significance are the ones that naturally led to the importance of their coefficients, and since the correlation for a variable may obviate the presence of another variable similar to it in relation to the dependent variable, and thus one replaces the other, as the problem of Multiple linear correlation is one of the problems of regression analysis, and therefore it is logical to have one variable that has been compensated for others in the regression model presented.

Through the regression results, the number of variables included in the last model, which will be dealt with by the method of neural networks, which is one of the best and most recent methods in building models, has been reduced, as it is characterized by not distinguishing between the independent variable having a linear or non-linear relationship, and this by itself may overthrow other methods. Hence, we can be reassured about the problem of the absence of a linear correlation between any two variables, and neural networks, as the most important methods of artificial intelligence, provide us with the ability to train data through the back-propagation mechanism. (back propagation), which is added for the purpose of providing a mechanism for continuously modifying the coefficients of the independent variables until reaching the lowest possible residual and thus providing the lowest error rate compared to the classical methods.

**Present and discuss the importance of independent variables:**

Table (3) shows the importance and percentage of importance of the independent variables:

<table>
<thead>
<tr>
<th>No.</th>
<th>Variables</th>
<th>importance</th>
<th>percentage of importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Height of the right heel of the foot.</td>
<td>0.138</td>
<td>63.6%</td>
</tr>
<tr>
<td>2</td>
<td>Right elbow joint angle</td>
<td>0.143</td>
<td>65.7%</td>
</tr>
<tr>
<td>3</td>
<td>Maximum ball speed</td>
<td>0.098</td>
<td>44.9%</td>
</tr>
<tr>
<td>4</td>
<td>The angle of inclination of the torso.</td>
<td>0.218</td>
<td>100.0%</td>
</tr>
<tr>
<td>5</td>
<td>Left knee joint angle</td>
<td>0.096</td>
<td>44.1%</td>
</tr>
<tr>
<td>6</td>
<td>Height of the ball</td>
<td>0.139</td>
<td>63.8%</td>
</tr>
<tr>
<td>7</td>
<td>Time of impact</td>
<td>0.108</td>
<td>49.5%</td>
</tr>
<tr>
<td>8</td>
<td>The rate of pressure on the left foot.</td>
<td>0.060</td>
<td>27.7%</td>
</tr>
</tbody>
</table>
Through Table (3) and Figure (2), the importance of each of the variables that were used in the neural network in terms of its impact on the dependent variable, and these values are equivalent to the beta values of the regression coefficients, as it is possible to build a predictive equation that includes all the mentioned variables according to their proportions, as well as Table (3) shows the values of the normative importance, i.e. the ratio of each one of them to the other, as it was found that the highest independent variable in its contribution to the dependent variable was (right elbow joint angle) with a percentage (0.218), which is equivalent to (100%), i.e. a perfect ratio, followed by The variable (left knee joint angle) by (65.7%), while the least variable (pressure rate on the left foot) was (27.7%), while the rest of the variables ranged between these values.

### IV. CONCLUSIONS:

Through the presentation and discussion of the results, the researchers concluded:

- The research sample achieved through attempts the highest level in the variable right elbow joint angle among the biomechanical variables.
- It is possible to construct a prediction model to classify the low arc serving in tennis

### REFERENCES: