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ATHLETE SELECTION MODEL USING SPORTS STATISTICS DATA FABRIC TECHNIQUES FOR NATIONAL SPORTS EXCELLENCE

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ABSTRACT

Physical fitness factors that significantly impact athletes' performance. This research objective is to analyze and develop a model for the successful selection of athletes based on physical fitness factors. The sample comprises data from high-potential athletes who attend sports schools affiliated with the Thailand National Sports University. The research methodology combines Multi-Layer Perceptron and Multiple Linear Regression as data analysis techniques to identify suitable models for successful competitive athletes. The results of the model evaluation indicate that the accuracy is 72.73% and the R-squared value is 0.665. The experiment shows that analyzing the athlete selection model could reveal the factors that influence the selection of athletes. These factors will be described in this article.

Keywords: *Data Mining, Neural Network, Data Fabric Technique, Aquatic Athletes, Physical Fitness*

1. INTRODUCTION

Sports science studies are conducted to develop the sports industry. Athletes are very important to their success in the sports industry. The study of sports science makes the operation of the sports industry more modern]1[–[3]. Nowadays, competition is very intense, resulting in more data usage [4]. The use of effective technology and techniques for analyzing data can help find the key to success with strength, endurance, and muscle activity, where even small improvements can affect the results [5].

Physical activity is related to body composition and physical fitness including fat mass index, body mass index, and aerobic fitness. All of this is important information [6]–[9]. The study of sports information for the development of athlete potential is very important for sporting competitions [10]. Physical fitness data obtained from exercise and sports skills practice can help athletes perform at their best in competition [11]. Therefore, it is of interest to most sports scientists and sports developers. There is an assessment of the physical fitness of athletes, which will be tested according to the objectives and compared with the standard criteria of athletes[12]. For this reason, information about an athlete's physical fitness is very important. It is used to develop the potential of athletes toward success in professional and amateur sports, promote good physical fitness and make them aware of having good health. It also indicates a person's potential to become an athlete.

Most research uses sports data analysis to predict sports competition [4], [13], assess the use of sports strategies [4], [13] and assess sports skills to predict the players' outcomes[14]. The essentials that are fundamental to athletes cannot be overlooked i.e., the physical fitness of athletes. Therefore, this research is interested in the hidden indicators of the fundamental characteristics of an athlete's physical fitness by using the process of science and data analysis. This is because it is a method based on theory and principles that provide accuracy and precision that can be proven in mathematics. This results in a model that is practical and highly reliable.

2. OBJECTIVE OF THE RESEARCH

The purpose of the study is to analyze and develop a model of successful athletes based on physical fitness factors using sports statistics data fabrication techniques.

3. METHODS AND INSTRUMENT

3.1 Data Fabric Technique

For this research, the tools that we use are data fabric techniques for sports statistical data from the concept of data science [15], and data analytics with deep neural networks)Artificial Neural Network: ANN(, namely Multi-Layer Perceptron and Multiple Linear Regression, and a combination of both methods. This technique is a modern prediction technique and is suitable for analysis, classification, and the creation of new knowledge [16]. The design concept is in the form of a data layer and the process is linked to the data structure to analyse the data. The process of the Data Fabric Technique can be described as shown in Figure 1. The neural network's ability to learn and memorize, to find and generate the best patterns was through a multi-directionally trained data analysis[10]. A deep neural network modelling approach was used as a method to help identify correlation nonlinearities [17], supplemented by the method of constructing linear equations from multiple linear regression data analysis. This is a predictive model from training and testing the dataset using ANN's deep algorithm)Multi-Layer Perceptron)MLP(algorithm(. Therefore, the Data Fabric Sports Statistical technique is a very good problem-solving method with the ability to help identify the linear and non-linearity relationship of both dependent variables and independent variables. With the dependent variable and the independent variable, it is possible to create complex correlation models with precise linear equations for the assessment and analysis of numerical data.

3.2 Multi-Layer Perceptron (MLP)

Multi-Layer Perceptron)MLP(is an Artificial Neural Network)ANN(algorithm for classification and prediction by discovering patterns from datasets or variables as a pattern recognition method. It simulates the behaviors of complex interconnected human neurons that work together to solve problems [18]. The process of MLP is organized into layers. However, the stack of layers makes it as complex as the operation of a neuron. The MLP equations begin from the input layer to the hidden layer. The MLP function as equation (3) consists of the summation function as equation (1) and the summation transforms with the ReLU activation function as equation (2), weight and bias that bring the output to the lowest error point[19]–[21], which is a high-accuracy in-depth model creation method [17] and is evaluated by confusion matrix: accuracy, precision, recall, and f1-score[22].

$$f(x) = x_0 w_0 + x_1 w_2 + x_3 w_3 + \dots + x_n w_n \quad (1)$$

Where $f(x)$ is value of dependent variable, x is value of independent variable, w is coefficient of each independent variable.

$$f(x) = \begin{cases} 0 & for\ x \le 0 \\ x & for\ x > 0 \end{cases} \quad)2($$

Where $f(x)$ is value of dependent variable, x is value of independent variable, w is coefficient of each independent variable.

$$f(x) = f[(b + \sum_{i=1}^{n}(x_i w_i)) - T] \quad)3($$

Where $f(x)$ is value of dependent variable, x is value of independent variable, w is coefficient of each independent variable, b is bias, T is activation function

3.3 Multiple Linear Regression *(*MLR*)*

Creating a model from multiple linear regression equations to analyse the influence of factors on the dependent variable as equation (4) is

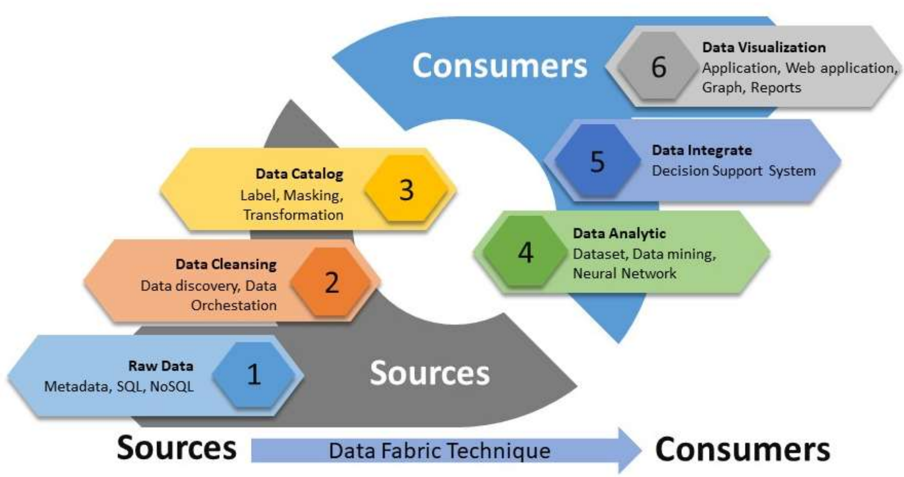

Figure 1: Process of Data Fabric Technique

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an indicator of the efficiency of the regression model from the R square value. Therefore, evaluating the MLR model with R square as a measure of the fit of the model gives the percentage of variance w

here the model explains the significance of the results, as shown in equation (4) [23], [24].

$$f(x) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p + e \quad)4($$

Where $f(x)$ is value of dependent variable, x is value of independent variable, β_0 is the constant of regression equation, β is regression coefficient of each independent variable, e is the error value

From the model analysis using the MLP method from equations)1(,)2(,)3(and the MLR method from equation)4(, the values from the data analysis were used to create the equations used to predict the opportunity to win, with athlete's medals and athlete's potential as equations)5(,)6(and)7(respectively.

$$f(x_{medal}) = \begin{cases} f(x_{gold}) & = f[(c + \sum_{i=1}^{n}(x_i w_i))] \\ f(x_{silver}) & = f[(c + \sum_{i=1}^{n}(x_i w_i))] \\ f(x_{bronze}) & = f[(c + \sum_{i=1}^{n}(x_i w_i))] \end{cases} \quad)5($$

Where $f(x_{medal})$ is prediction of medal result, $f(x_{gold})$ is a gold medalist class, $f(x_{silver})$ is a silver medal class, $f(x_{bronze})$ is a bronze medal class, x is the value of input factor i = 1 to n, w is coefficient of each input factor calculated from prototype model, c is a constant

$$f(x_{Potential}) = c + (b_1 x_1 + b_2 x_2 + b_3 x_3 + \cdots + b_n x_n) = (c + \sum_{i=1}^{n}(b_i x_i)) \quad)6($$

Where $f(x_{Potential})$ is the result of prediction potential of athletes, x is the value of input factors 1 to n, b is regression coefficient, c is constant of the regression equation.

From equation)5(and)6(, get the function of Data Fabric Sports Statistical technique as equation)7(.

Pseudo-code of Algorithm: data fabric function

```
Initialize Input data
set x = [age, weight, height, grip strength, sit and
        reach, standing long jump, sit-ups,
        push-ups, …, shuttle run, …. and physical
        fitness etc.]
set b = [coefficients of MLR]
set w gold = [gold coefficients of MLP]
set w silver = [silver coefficients of MLP]
set w bronze = [bronze coefficients of MLP]
set c = constant of MLR
set c gold = constant of MLP gold
set c silver = constant of MLP silver
set c bronze = constant of MLP bronze
function Fabric(x)
score1 = sum(x * b) + c
score2 = function medal(x, c gold, c silver, c bronze)
score3 = result of compare x with physical fitness
          standard
score = function standard score(score1, score2,
         score3)
return score
```

#Statement of function standard score is comparisons score1, score2, score3 and physical fitness standard of athlete

3.4 Sport Statistics and Physical Fitness

Sport Statistics and Physical Fitness is a physical fitness value that is a statistical standard for each type of sport. Abilities in physical fitness are both fundamental and specific to each sport. The classification of activities of physical fitness includes body proportion and composition, muscle, speed, respiration, metabolic rate, heart rate and coronary circulation. Most use a fitness test to measure a person's physical fitness by benchmarks according to gender and age[5], [25]–[28].

4. EXPERIMENTAL

4.1 Definition dataset *(*Features of Physical fitness*)*

The sample used in this research is the physical fitness data of young athletes who won a gold, silver or bronze medal. The characteristic of the input data is secondary data. The data is divided into two parts. The first part is used for the training set of 70 percent of the total dataset. The second part is a test set of 30 percent of the total dataset. The medaled athlete sample in this experiment was

$$S_{(x_1, x_2, x_3, \ldots, x_n)} = data\ fabric\ function(f(x_{Potential}), f(x_{medal})) \quad)7($$

Where $S_{(x_1, x_2, x_3, \ldots, x_n)}$ is the athlete's achievement score, $f(x_{medal})$ is the prediction result of medal, $f(x_{Potential})$ is the prediction result of athlete's potential

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representative of aquatic sports such as swimming and rowing.

4.2 Model development

Step 1: Data preparation)Raw data, Data cleansing(: the data were randomly divided into two parts: training data 70 percent of the dataset and testing data 30 percent of the dataset, and data cleansing was done as follows:

- Filter data with outliers, nulls or where some parts are missing and incomplete. This is done using methods including: eliminating data, input any value instead, change the processing method or data set.

- Check for incorrect data types and transform data.

- Eliminate duplicate data and irrelevant data.

- Dealing with structural errors, such as the same data but perceived meaning of different systems. Edit by determining and understanding or interpreting the meaning in corresponding data.

- Check for accuracy including the reasonableness of the questions, and appropriateness to finding the right answers for the requirements of the questions.

Table 1: Physical fitness feature

Object	**Classes**	**Feature**	**Parameter**
Sport_Group	Physical fitness	Characteristic	Age, Sex, Weight, Height, BMI (Body Mass Index), Body fat mass
		Activity Measurement	Muscle Strength, Muscle Endurance, Muscle Flexibility, Muscle Power, Speed, Agility, Anaerobic or Aerobic (VO_2max)
	Statistical sport	Medal	Gold, Silver, Bronze
	Benchmark statistics	Athlete Standard	Body composition, Muscle, Agility, Speed, Anaerobic or Aerobic, Sport Special group

Table 2: Evaluation of aquatics athlete training model with confusion matrix

Training dataset	Accuracy	Precision	Recall	F1 Score
Gold	1.00	1.00	1.00	1.00
Silver	1.00	1.00	1.00	1.00
Bronze	1.00	1.00	1.00	1.00
Summary of Training dataset Accuracy = 100.00%				

Table 3: Table 3 Evaluation of aquatics athlete testing model with confusion matrix

Testing dataset	Accuracy	Precision	Recall	F1 Score
Gold	0.68	0.20	0.20	0.20
Silver	0.82	0.67	0.86	0.75
Bronze	0.86	0.82	0.90	0.86
Summary of Testing dataset Accuracy = 72.7273%				

Step 2: Filtering, categorizing, and labelling)Data catalogue, classifier, feature selection label, masking, transformation(for factors of physical fitness.

Step 3: Data Analysis and Data Integration: the data are analysed by MLP and MLR to create and evaluate a model to find the best model for each sport. It is based on Physical Fitness Benchmark and Artificial Neural Network.

Step 4: Visualization of data displays such as reporting model results with graphs using the Python language.

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5. RESULTS

5.1 Physical fitness data analysis experiment.

The result is a model of success for aquatic athletes. Assess scores classified by medal levels and measure the physical fitness of athletes.

Figures 2 and 3 show the independent variables of the athletes including gold, silver and bronze class. Figure 4 shows the results a model evaluation of the aquatic athletes training dataset with a confusion matrix. The evaluation results detailed in table 2 show accuracy, precision, recall and F1 score. All three classes have an accuracy of 100%. Figure 5 shows the model evaluation of the testing dataset for aquatics athlete with a confusion matrix. Details of the results are shown in table 3: accuracy, precision, recall and F1 score. All three classes had an accuracy of 72.7273%. Factors influencing aquatics athletes are gender, age, weight, height, arm muscle strength, muscle flexibility. The constants of gold, silver and bronze are -0.1534, -0.076 and -0.050 respectively. Figure 6 and 7 shows the resulting model has an R-square value of 0.665 and a constant value of 2.421. Factors influencing aquatics athletes include the power of arm and leg muscles, muscle flexibility, and oxygen utilization capacity)VO_2max(. This was used to transform the coefficient results into equations for medal prediction for high-performance aquatics athletes (7). It is detailed in table 4.

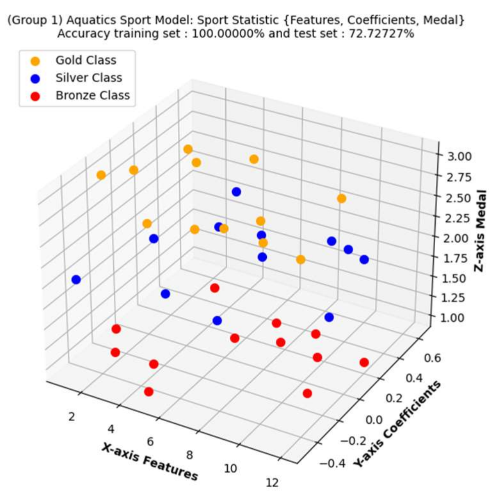

Figure 2: Features of aquatics group with MLP

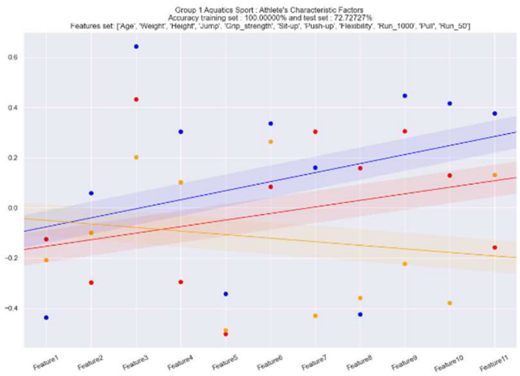

Figure 3: Evaluation of testing dataset for the aquatics athlete's model

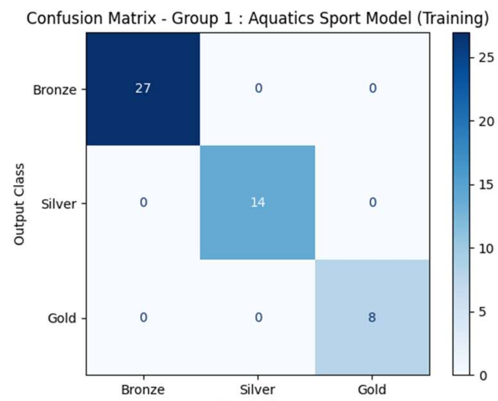

Figure 4: Evaluation of training dataset for the aquatics athlete's model

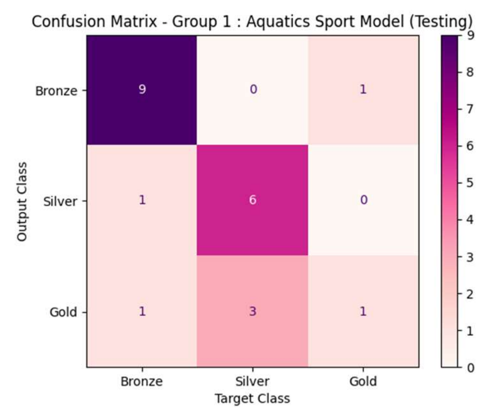

Figure 5: Evaluation of testing dataset for the aquatics athlete's model

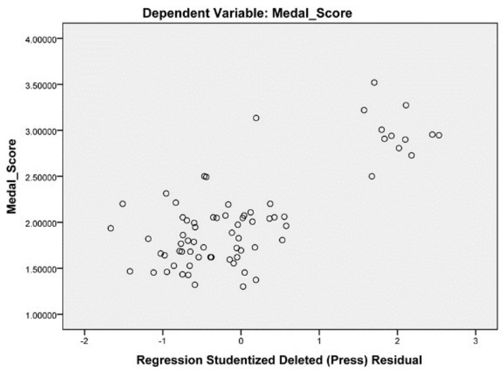

Figure 6: Features of aquatics athlete with MLR

5.2 Using data fabric techniques and sports statistical to create a model for selecting aquatic athletes.

From the experimental analysis of the physical fitness data model, with data fabric sports statistical techniques of aquatics athletes as shown in figure 2 to 6, and by using the function in equation (7) to create a model for the equation of athletes.

Consider the medal aquatics equation model. This is determined by physical fitness independent variables, i.e., muscle power of arms and legs, muscle flexibility, oxygen consumption capacity)VO_2max(, gender, age, weight, height, arm muscle strength, and muscle flexibility.

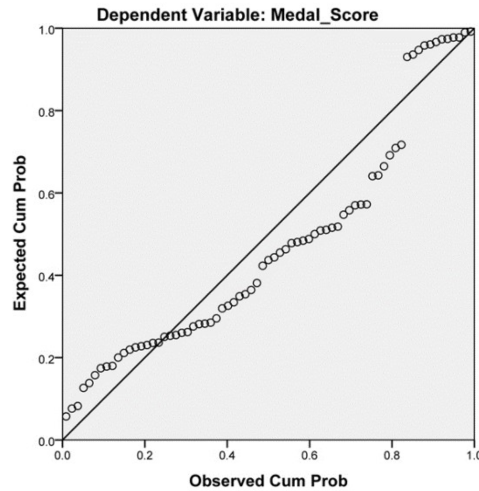

Figure 7: Equations of fit model for the aquatic athlete

The factors that are input into the data fabric function are as follows: Pl is Pull, Rn is 50-meter Sprint, Cp is Cooper Test, Ls is Leg muscle strength, Sr is Sit and Reach, Gr is Hand Grip Strength, Su is Sit-ups, Pu is Push-ups, We is Weight, He is Height, Ag is Age, Ru is Running 1000 meters, Jm is Standing Long Jump.

A function to predict the potential of aquatics athletes.

$$AquaticModel_{(x_1 x_2 x_3,\dots,x_n)} = data\ fabric\ function(f(x_{Potential}), f(x_{medal}))$$

Substitute the coefficients in the function equation as follows:

$$set\ cefs\ gold\ w_i = [-0.064, -0.078, -0.092, -0.107, -0.121, -0.135, -0.149, -0.164, -0.178, -0.192, -0.206]$$
$$set\ cefs\ silver\ w_i = [0.041, -0.004, 0.032, 0.068, 0.104, 0.140, 0.176, 0.212, 0.248, 0.284, 0.320]$$
$$set\ cefs\ bronze\ w_i = [-0.127, -0.101, -0.075, -0.049, -0.022, 0.003, 0.030, 0.0557, 0.082, 0.108, 0.134]$$
$$f(x_{Potential}) = 2.421 + 0.015Pl - 0.188Rn + 0.000001Cp - 0.464Ls + 0.268Sr$$
$$f(x_{gold}) = -0.1534 - 0.064Gr - 0.078Su - 0.092We - 0.107Ag - 0.121Ru - 0.135Jm - 0.149Rn - 0.164He - 0.178Pu - 0.192Sr - 0.206Pl$$
$$f(x_{silver}) = -0.076 + 0.041Gr - 0.004Su + 0.032We + 0.068Ag + 0.104Ru + 0.140Jm + 0.176Rn + 0.212He + 0.248Pu + 0.284Sr + 0.320Pl$$
$$f(x_{bronze}) = -0.050 - 0.127Gr - 0.101Su - 0.075We - 0.049Ag - 0.022Ru + 0.003Jm + 0.030Rn + 0.0557He + 0.082Pu + 0.108Sr + 0.134Pl$$

$$AquaticModel_{(x_1,x_2,x_3,\dots,x_n)} = fabric\left(f\left[\left(2.421 + \sum_{i=1}^{n}(b_i x_i)\right)\right], f\begin{cases} 3, & \left((-0.1534) + \sum_{i=1}^{n}(x_i w_i)\right) \\ 2, & \left((-0.076) + \sum_{i=1}^{n}(x_i w_i)\right) \\ 1, & \left((-0.050) + \sum_{i=1}^{n}(x_i w_i)\right) \end{cases} \right)$$

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Table 4: Coefficients of factors for aquatic athlete model

Factors	P*	Gold	Silver	Bronze	Factors	P*	Gold	Silver	Bronze
constant	2.421	-0.153	-0.076	-0.05	run 1000 m.	0	-0.121	0.104	-0.022
pull	0.015	-0.206	0.32	0.134	grip*	0	-0.064	0.041	-0.127
50-m sprint	-0.188	-0.149	0.176	0.03	sit-ups	0	-0.078	-0.004	-0.101
cooper test	0.000001	0	0	0	push-ups	0	-0.178	0.248	0.082
leg muscle	-0.464	0	0	0	weight	0	-0.092	0.032	-0.075
sit and reach	0.268	-0.192	0.284	0.108	height	0	-0.164	0.212	0.0557
jump*	0	-0.135	0.14	0.003	age	0	-0.107	0.068	-0.049

P = Potential, jump*= standing long jump, grip* = hand grip strength*

Where $AquaticModel_{(x_1 x_2 x_3 ,\dots, x_n)}$ is prediction result of aquatics athletes' model, x is value of input factors 1 to n, b is coefficient of MLR function, w is coefficients of gold, silver and bronze for MLP function.

Therefore, from the experimental results that affect aquatics athletes include power of the arm and leg muscles, muscle flexibility, maximum oxygen consumption capacity)VO_2max(.

6. DISCUSSION

The results obtained from the experiment are constants and coefficients. It is to measure accuracy, that we use factor data analysis. This technique combines Multi-Layer Perceptron and Multiple-Linear Regression methods. These methods have complex structures, which It used together. The model for athletes' performance shows the basic factors of physical fitness. The factors that influenced the success of athletes in different sports. This experiment's results state the basic factors for athletes' success in aquatic sports.

The experiment analyzed factors that affect the success of aquatic athletes in sports schools. The results are determined by various factors that influence success. The constant values for the analytical results of the aquatic sports group are 2.421, -0.153, -0.076, and -0.050. There are several factors that can impact athletes' physical performance. These include muscle strength, flexibility, and athletes' bodies' oxygen utilization.

The factors that were considered in the study include gender, age, weight, height, and arm strength. The measurement of athletes' physical fitness through various tests. The tests consist of various skill tests, such as a 50-meter sprint, pull test, and Cooper test. It also measures abilities such as flexibility, hand grip strength, and leg muscle strength. It also includes sit and reach, sit-ups, push-ups, running 1,000 meters, and standing long jump [23], [24]. It can be concluded that the factors that most influence the success of an aquatic athlete are the power of the arm and leg muscles, muscle flexibility, and maximum oxygen consumption capacity.

A study of the fundamentals of the physical fitness of athletes from sports schools has resulted in the best model of successful athletes. The models of athletes predicted the medal and potential of athletes with a significance on the test data set of 72.73%, which is considered high. The R square is 0.665, $p < 0.05$, which is a good predictive value. The results of the model evaluation show that the neural network method using a numerical analysis experimental approach to athletes' physical fitness testing can effectively identify athletes' excellence. The analysis of physical fitness factor data showed a fit model with accuracy. It is a strong indicator of key factors influencing athletes. It has semantic significance because athletes possess specific characteristics fundamental to their physical fitness and unique abilities.

7. CONCLUSIONS

The model of successful athletes was achieved through this experiment. The experiment used artificial neural networks and the physical fitness benchmarks of the athletes. The task is to analyze the data and create models for successful athletes. The model's results are more accurate in predicting an athlete's potential and identifying those with a higher chance of success. So, the predictions made by these models are highly accurate. This study emphasizes the significance of considering the fundamental aspects of physical fitness. It is evident

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that basic baseline characteristics can significantly influence and serve as strong indicators of an athlete's performance. In the future, the process of modeling the physical fitness factor used in this research can be applied to enhance the prediction of athletes' performance in other sports. It can also assess methods for developing the physical potential of athletes.

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Conflicts of interest

Conflicts of Interest: The authors declare no conflict of interest.

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