Practice of Artificial Intelligence Technology Based on Big Data in Football Training and Physical Education

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Abstract: *Soccer is a sport in which the feet are mainly used to control the ball. Football today generally refers to modern football, which originated in China's "Cuju". It is an official event of the Olympic Games and a national sport that the public loves more. This paper aims to research and analyze the practice of football training and physical education through the football and related information obtained by big data artificial intelligence technology, so as to obtain practical conclusions. This paper gives a general introduction to the big data artificial intelligence technology, analyzes the relevant information of athletes in football training and actual physical education, and combines big data artificial intelligence technology with practical research in football training and physical education. Based on the experiments in this paper, it can be seen that the training intensity of the coaches arranged twice a week in the X football club was 85%. The coaches who arranged 3 times a week had a moderate to high exercise intensity of 65%. For coaches who arranged 4 or more times a week, the moderate exercise intensity was 50%. The results of this paper showed that the analysis of practical research in football training and physical education based on big data artificial intelligence technology was more abundant and scientific than the data obtained using traditional analysis methods.*

Keywords: Football Training, Physical Education, Big Data, Artificial Intelligence

1. Introduction

The data age has accelerated the speed of information acquisition and analysis, and the emergence of big data artificial intelligence technology has greatly facilitated the lives of the public. Big data is a tool that can acquire and process massive amounts of information in a short period of time, which is mainly a technology that uses computers to operate. Artificial intelligence is a branch of computer. It is a new science and technology developed by simulating human thinking processing. It involves mathematics, psychology, etc., belonging to the intersection of natural science and social science.

Football is a healthy sport that is beneficial to the body and mind. It requires athletes to have certain sprint ability on the basis of maintaining strong endurance, so the physical fitness requirements of athletes are also relatively high, and the importance of football training is also derived from this. Therefore, it is very important to analyze the application in football training and physical education. There are many scholars who have studied football, but few scholars have analyzed it from the perspective of big data artificial intelligence technology. This article is to study the actual situation in football training and physical education based on big data artificial intelligence technology. It explores the situation in the training and actual teaching of the X football club, and effectively helps the football club to improve the actual teaching method. This paper uses big data and artificial intelligence technology to study football training and physical education, and expands the research methods in this direction, thus providing a reference angle for football training and physical education.

In this paper, big data and artificial intelligence technology are used as a means to study football training and the practice of football in physical education, and relevant algorithms are used to study the experimental data obtained in this paper, so as to obtain effective experimental conclusions. The innovation of this paper is to analyze football training and its practical research in physical education based on big data and artificial intelligence technology.

2. Related Work

Football is a competition between two multiplayer teams. It is a world sport and a national sport.

Therefore, there is a lot of research on football training and its teaching. Cui C proposed to use surface electromyography (EMG) signal analysis to monitor and identify the fatigue state of athletes during football training, with an effective rate of more than 95% [1]. Zavalishina S Y in Moscow investigated the impact of regular football on the physique of football players aged 12-14. It was concluded that football players with more than one year of systematic sports experience generally have better physical development than untrained players [2]. Research by Zen G has shown that the metabolic stress induced by 6 weeks of football training in the pre-match phase has a significant effect on the internal blood parameters of football players [3]. Experiments by Uebersax J assessed the structure, content, contact and intensity and incidence of headers in Swiss under-13 football training sessions [4]. Aleksieva M's research confirmed that after the game method was applied to football education, students' interest in football increased significantly [5]. Football is a national sport, so there is a lot of research into the sport and its associated training methods. However, after consulting a large number of literatures, it can be found that scholars mainly use traditional measurement methods to study the training status or physical condition of athletes, and the application of new technologies is relatively small, such as big data artificial neural network technology.

Big data artificial intelligence technology is very important in the current Internet era, and there are many scholars who study it. Chen K's research was based on artificial intelligence and big data technology to provide professional users with reading behavior analysis and intelligent recommendation services, which can provide bilingual reading services [6]. Bhat N A's research mainly discussed the impact of the arrival of the era of big data on contemporary society, and put forward relevant views on how to deal with the technological revolution [7]. Zsyw A believed that the information processing capability of the existing data collection system is very strong, which can better cope with the massive data obtained from public health surveillance [8]. By demonstrating a golf-assist training system, Li C wanted to demonstrate to the public that the use of artificial intelligence and big data methods can transform from experience-based sports training methods to human motion analysis methods [9]. Zhang Z's research analyzed the application of support vector machine (SVM) method in multi-classification problem, and creatively designed a one-to-one SVM multi-classification method [10]. Big data and artificial intelligence are the most used means of information technology analysis today. Therefore, there are many scholars who use it as a research object or research method. However, it can be clearly found that researchers mainly use it as a research method to study objects with a large amount of data, but seldom study part of the training information of the human body, such as football training.

3. Practical Methods Based on Big Data Artificial Intelligence Technology in Football Training and Physical Education

3.1 Football Training and Physical Education

Football is one of the most popular national sports in the world. It originated from the "Cuju" sport in China and is deeply loved by people all over the world [11]. With the deepening of football research in various countries, more and more people have noticed the importance of football training and teaching to football players. Therefore, it is very important to improve the physical fitness of athletes and master the basic knowledge of football. Playing football consumes a lot of physical energy. It needs to be able to complete high-intensity running, master football skills such as passing, catching, and shooting, as well as tactics that can be flexibly played in actual combat [12]. Figure 1 shows a typical football training program:

Figure 1: Typical football training program

Football has a high degree of national participation. It is a sport that has a positive effect on the body and mind of the individual, and can represent the school, city, and country to fight for honor. Therefore, there is a great demand for teaching football [13]. But because football requires a close

combination of physical fitness, skills and tactics, it is very important to have a professional coach and field [14]. Physical training in football includes aspects such as speed, strength, endurance and flexibility. Skill training is to simulate training athletes to upload catching, shooting, header and other sports on the field. Tactical training involves professional football knowledge, including filling positions and scrambles [15]. Figure 2 shows a simulation of basic football teaching:
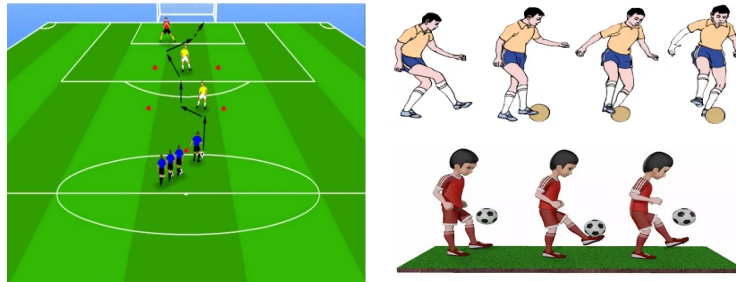

Figure 2: Simulation diagram of basic football teaching

3.2 Big Data Artificial Intelligence Technology

Big data artificial intelligence technology is the most widely used data processing method in the information age. It can process huge amounts of data, and has the characteristics of fast transmission speed and low value density [16]. The difference from the traditional information processing method is that it has the function of analog signal and can transform a variety of data formats. Big data artificial intelligence technology has a great impact on the fields of economy, natural science and society, and can be widely used in machine translation, huge information processing and other tasks [17]. Based on the rich content of big data artificial intelligence technology, this paper selects the BP artificial neural network as the main analysis method in this paper.

BP artificial neural network is a new hotspot in the field of big data artificial intelligence that emerged in the 1980s. It is a process of abstractly simulating the human brain and establishing a model. It is composed of a large number of neurons, belongs to the multi-layer perceptron, contains multi-layer network layers, and has a complex structure, so it can be used to solve more complex information problems [18]. As a multi-layer perceptron, the BP artificial neural network has very good derivative performance and has a fast convergence speed, thereby improving the actual learning efficiency. It can also improve the connectivity of the network to a certain extent, which is an efficient learning algorithm [19]. It can be seen from the research of related literature that the essence of the BP algorithm is to obtain the minimum value of the energy function, so that the weights in the neural network are adjusted in the direction of the decreasing error function. The BP artificial neural network algorithm has a very powerful adaptive learning ability, which can promote the development of ANN. It mainly includes two aspects: forward propagation and back propagation.

(1) Forward propagation: The input information is first transmitted through the neurons of the input source in order, and after the nonlinear processing of each layer of nodes, the output neurons produce the final signal. In this process, the input information of each layer of neurons only contains the output information of the previous layer of neurons. The neurons in the same layer do not interfere with each other, and the intermediate weights do not change [20].

(2) Back propagation: When there is a large difference between the actual output information and the ideal output information during the training process, the error information between the two is generally selected as the input information, and is propagated from the final output layer of the network forward layer by layer. Backpropagation will correct the weights of the system in the direction of decreasing error function until the error is controlled within a certain range [21].

Figure 3 shows a BP artificial neural network with hidden layers. The input layer contains t input nodes. The hidden layer contains k neurons. The q neurons make up the output layer of the network. In the i-th iteration, the input of the neurons in the hidden layer is set to $U_k(i)$. The output of the hidden layer neuron is set to $V_k(i)$. The ideal response value is set to $d_n(i)$. The actual output of this neural network is set to $t_k(i)$. Among them, the activation functions of the nodes in the hidden layer and the output layer all use the sigmoid function, as shown in Figure 3. Then Formulas 1 and 2 can be obtained.
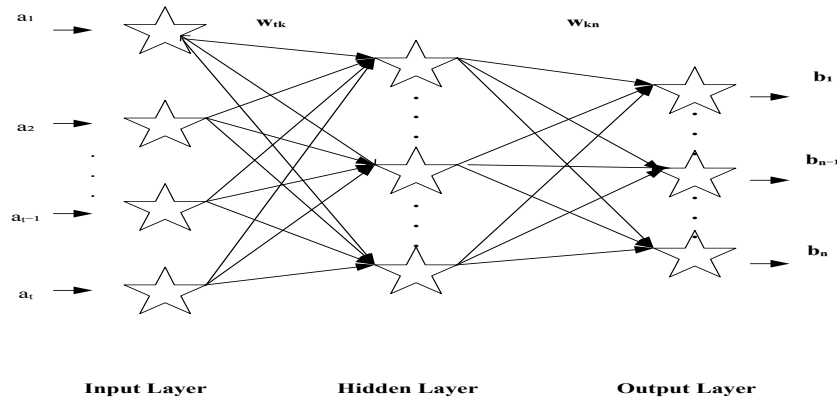
Figure 3: Simple BP artificial neural network structure diagram

$$U_k(i) = \sum_t w_{ak}(i) \cdot a_t(i)$$

(1)

$$V_k(i) = f(U_k(i)) = \frac{1}{1 + e^{-U_k(i)}}$$

(2)

The input of the n-th output neuron is as Formula 3:

$$U_n(i) = \sum_k w_{kn}(i) \cdot V_k(i)$$

(3)

The output of the n-th output neuron is as Formula 4:

$$b_n(i) = f(U_k(i)) = \frac{1}{1 + e^{-U_n(i)}}$$

(4)

The output error of the n-th output neuron is as Formula 5:

$$e_n(i) = d_n(i) - b_n(i)$$

(5)

When the trivial error of the output neuron n is 1, the sum of the obtained error energies of all output neurons is as Formula 6:

$$E(i) = \frac{1}{2} \sum_n e_n(i)^2$$

(6)

The weights between neurons and output nodes in the hidden layer are adjusted. In the BP algorithm, the adjusted weight is proportional to the differential time of the weight affected by the energy function. Local gradient is set to $\delta_n(i) = f'(U_n(i))e_n(i)$. For function $f(a) = \frac{1}{1 + e^{-a}}, f'(a) = f(a) \cdot (1 - f(a)) = b_n(i) \cdot (1 - b_n(i))$, Formulas 7-13 can be obtained:

$$\delta_n(i) = b_n(i) \cdot (1 - b_n(i)) \cdot e_n(i)$$

(7)

$$\frac{\partial E(i)}{\partial w_{kn}(i)} = \frac{\partial E(i)}{\partial e_n(i)} \times \frac{\partial e_n(i)}{\partial b_n(i)} \times \frac{\partial b_n(i)}{\partial U_n(i)} \times \frac{\partial U_n(i)}{\partial w_{kn}(i)}$$

(8)

$$\frac{\partial E(i)}{\partial w_{kn}(i)} = e_k(i)$$

(9)

$$\frac{\partial e_n(i)}{\partial b_n(i)} = -1 \tag{10}$$

$$\frac{\partial b_n(i)}{\partial U_n(i)} = f'(U_k(i)) \tag{11}$$

$$\frac{\partial U_n(i)}{\partial w_{kn}(i)} = V_k(i) \tag{12}$$

$$\frac{\partial E(i)}{\partial w_{kn}(i)} = -e_k(i) \times f'(U_n(i)) \times V_k(i) \tag{13}$$

The weight adjustment value between the hidden layer and the output layer is as Formula 14:

$$\Delta w_{kn}(i) = -\eta \frac{\partial E(i)}{\partial w_{kn}(i)} = \eta \delta(i) \cdot V_k(i) \tag{14}$$

After iteration, the weight between the neurons in the hidden layer and the output nodes is as Formula 15:

$$w_{kn}(n+1) = w_{kn}(i) + \Delta w_{kn}(i) \tag{15}$$

The weight correction process between the source node of the input layer and the neurons of the hidden layer is similar to the above method, as shown in Formulas 16 and 17.

$$\frac{\partial E(i)}{\partial w_{tk}(i)} = \frac{\partial E(i)}{\partial e_n(i)} \times \frac{\partial e_n(i)}{\partial b_n(i)} \times \frac{\partial b_n(i)}{\partial U_n(i)} \times \frac{\partial U_n(i)}{\partial w_{tk}(i)} \tag{16}$$

$$\frac{\partial U_n(i)}{\partial w_{tk}(i)} = f'(U_k(i)) \sum_k w_{kn}(i) \cdot a_t(i) \tag{17}$$

From Formulas 7, 8 and 17, Formula 18 can be known.

$$\frac{\partial E(i)}{\partial w_{tk}(i)} = f'(U_n(i)) \sum_k \delta_n(i) \cdot w_{kn}(i) \cdot a_t(i) \tag{18}$$

It is assumed that there are Formulas 19 and 20:

$$\delta_k(i) = f'(U_k(U)) \sum_k w_{kn}(i) \cdot \delta_n(i) \tag{19}$$

$$f'(U_k(i)) = V_k(i) \cdot (1 - V_k(i)) \tag{20}$$

Then the weight adjustment from the neurons in the input layer to the neurons in the hidden layer can be expressed as Formula 21:

$$\Delta w_{tk}(i) = \eta \frac{\partial E(i)}{\partial w_{tk}(i)} = \eta \delta_k(i) \cdot a_t(i) \tag{21}$$

After iteration, the weight between them is as Formula 22:

$$w_{tk}(n+1) = w_{tk}(i) + \Delta w_{tk}(i) \tag{22}$$

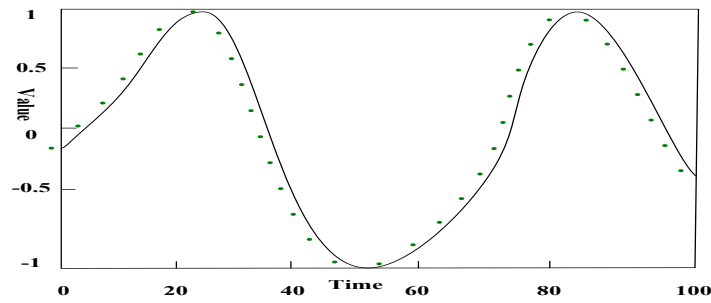Figure 4 is the simulation result of approximating the sine function after 2000 times of training using Figure 3.

Figure 4: Approximation of sine function by simple three-layer BP neural network

4. Experiment of Football Training and Physical Education

4.1 Scheme Design of Football Training and Physical Education Teaching

The training content of football is mainly physical training, skill training and tactical training, among which physical training includes the training of speed, endurance, sensitivity and flexibility. This is also the most basic training item in football training. Figure 5 shows the proportions of physical fitness, skill and tactical training during the preparation period, competition period and recovery period:
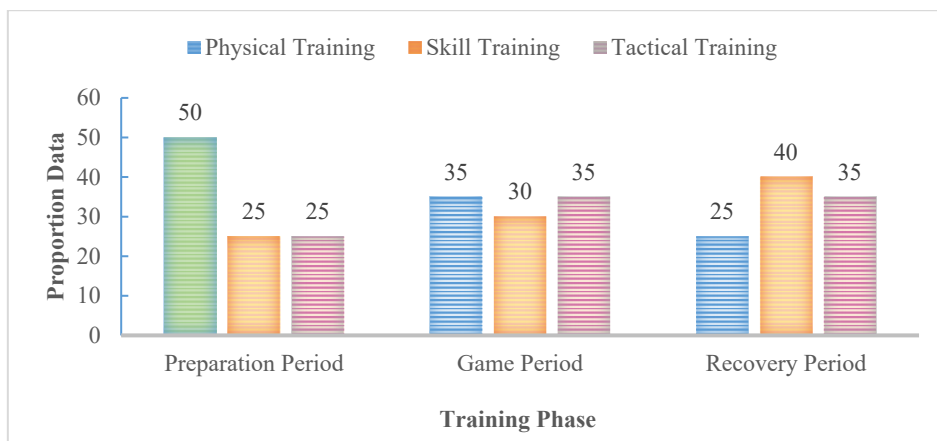

Figure 5: Proportion of physical fitness, skills, and tactics training in each stage of training

It can be seen from Figure 5 that football players mainly focused on physical training during the preparation period, while skill training and tactical training accounted for a small proportion. During the competition period, the proportion of various training contents was basically the same, with more emphasis on physical fitness and tactics. During the post-match recovery period, more emphasis was placed on the review of skills and tactics.

Since skill training and tactical training were generally based on physical training, supplemented by oral form or after improving the basic physical training content, the design scheme of this experiment was mainly designed around the physical training status of football players. The data of this experimental program were obtained by means of a questionnaire survey. Before conducting the questionnaire survey, the source of the football team in H region can be leaned through some channels, and the X football club with the best average strength in the past three years was selected for research.

Since football training and teaching are inseparable from the rational planning of the coaches, the participation of the players and a good venue, the specific contents of the questionnaire are as the followings: (a) basic information of the club coach (age, years of coaching, educational status and work background); (b) basic information of football players in the club (age and training content). 200 questionnaires related to football clubs were distributed, 180 of which were completed, and the completion rate was 90%. Among them, 24 coaches participated in the questionnaire survey, and 20 valid questionnaires were actually recovered. There were 151 athletes who participated in the questionnaire survey, and 133 copies were actually recovered. There were 25 relevant staff who participated in the questionnaire survey, and 21 copies were actually recovered. The questionnaires

were completed independently by athletes and coaches. Since most of the arrangements of football training are organized by coaches, the specific experimental data in this paper were based on coaches, training content and training equipment. The age composition of the coaches is shown in Table 1:

Table 1: Age composition of coaches

Age Composition	N=20	Percentage(%)
under 25	2	10
25-34 years old	8	40
35-44 years old	6	30
15-54 years old	3	15
55 years old and above	1	5

It can be seen from Table 1 that the coaches were generally younger, and the main age group was between 25-44 years old.

Table 1 shows the age composition of the coaches. In addition to the coach's age, which can reflect part of the status of the X football club, the coaching years of the coach are also very important, as shown in Table 2:

Table 2: Coaching years of coaches

Teaching Years	N=20	Percentage(%)
under 5	12	60
5-10years	4	20
10-20 years	2	10
20-30 years	1	5
30+ years	1	5

Table 2 shows the coaching years of coaches, corresponding to age. Because the coaches are generally younger, relatively speaking, the coaching years will not be particularly long. In addition to age, it is also affected by the coaches' own learning and work background. The details are shown in Table 3:

Table 3: Coaches' study and work background

Study and work background	N=20	Percentage(%)
Graduation in physical education	12	60
Professional athlete experience, late entry to college for further study	4	20
Professional athlete retired	4	20

Table 3 shows the professional level of these 20 coaches, most of which were sports professionals or professional retired athletes with experience in sports events. This provides great strength support for the professionalism of football clubs training athletes. Professional coaches will make the training content of athletes more scientific and reasonable, but they are also inseparable from the corresponding physical training of athletes. Figure 6 is a survey of the importance of each indicator in football physical training by selecting 20 male football players and 20 female football players:
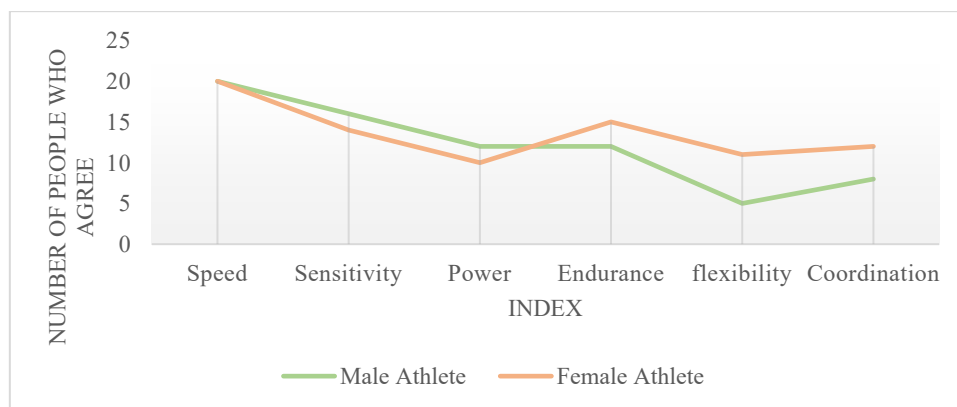

Figure 6: Statistics on the recognition degree of athletes to each index of physical training

Figure 6 shows the degree to which 20 male athletes and 20 female athletes in club X agree with each indicator in physical training. As can be seen from the data in the figure, athletes all believe that

speed is a very important indicator in physical training, and the number of people who agree is 100%, which is very related to the nature of football.

When physical training is carried out, various quality indicators cannot be carried out independently, but there will be a situation where certain indicators account for a large proportion. Table 4 is the number of physical training weeks designed by the 20 coaches in this experiment according to the physical fitness of the athletes and the training goals to be achieved. Since the design content of each coach was different, the statistical results of weekly training times were also inconsistent. The specific results are shown in Table 4:

Table 4: Physical training week times

Frequency	N=20	Training Intensity(%)
2 time	3	85%
3 times	10	65%
4 times or more	7	50%

Table 4 shows that most coaches believeed that training 3 times a week was enough. There were also a lot of coaches who thought that they should have 4 or more times. A small number of coaches believed that training twice a week was enough. This is more relevant to the training object of the X club. Table 5 is the time for each session of physical training:

Table 5: Physical training session duration

Frequency	N=20	Percentage(%)
within 30 minutes	6	30%
30-60 minutes	11	55%
more than 60 minutes	3	15%

Table 5 shows these coaches' views and arrangements for each training session. It can be seen from Table 5 that most coaches agreed that the training time should be 30 minutes or more, and only some coaches thought that each training time should be within 30 minutes. Physical training is inseparable from the use of equipment according to the previous questionnaire survey of athletes. Figure 7 shows the use of equipment by athletes during physical training:
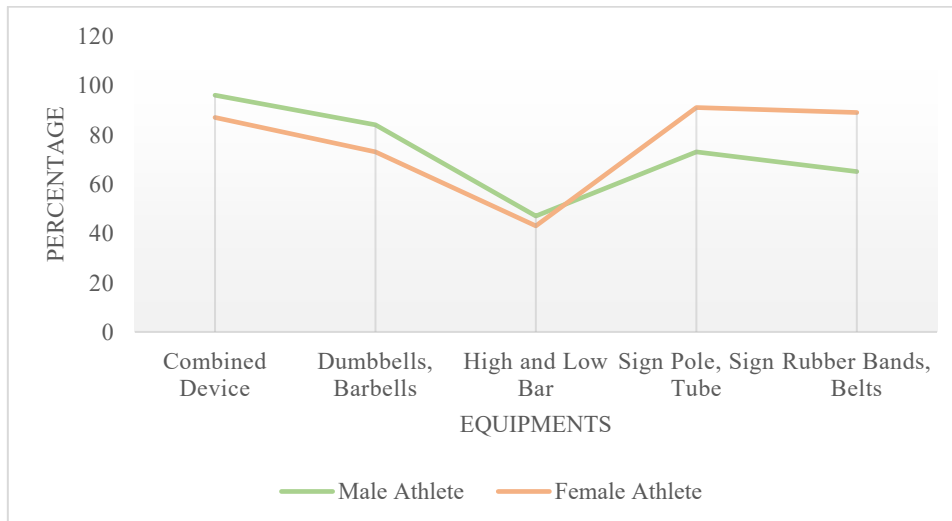

Figure 7: Equipment used in physical training

Figure 7 shows the differences in the equipment used by male and female athletes for physical training. The overall trend was the same, focusing more on strength and coordination training, corresponding to the use of joint equipment, dumbbells, barbells and sign bars and other machinery, and the use of high and low hurdles is relatively low.

4.2 Results of Football Training and Physical Education

Football is an activity that requires professional athletic knowledge and scientific physical training arrangements. In the past two decades of international competitions, the popularity of football has gradually increased. The composition of football players includes parents who want their children to

learn football, children who are interested in learning football, and the talents. Therefore, football players have a great demand for professional football teaching content, equipment, venues and coaches [22]. X football club, as the best club in H-land for three years, in addition to professional venues and facilities, the most popular are the coaches in the club. The coaches in the club tend to be younger, which makes it easy to get along with the football players in the club and communicate with them. The content of football training will be closer to a scientific and reasonable direction.

The length of the coach's coaching has a certain influence on the learning status of the athletes. Coaches who have been coaching for a long time will have more teaching experience. When teaching, it is easier for them to know whether the training posture and strength of the students are correct, and the length of the training session with the students will be shortened, but they are easily influenced by experience, not easy to accept more scientific training knowledge. There may be inappropriate training methods. Although coaches with short teaching years do not have more teaching experience and lack practical experience, who will spend more time with students when teaching, they are often just retired as athletes or just graduated from colleges, and have more knowledge about the latest and most scientific training content and methods [23]. The reason why the overall teaching years of coaches in the X club is not long is because the age of the coaches is younger.

The coaches of the X club are mainly students who have graduated from college sports-related majors, or retired athletes who have had professional sports experience. These coaches have considerable football experience and scientific training knowledge, which has brought great help to the improvement of the players in the club.

Soccer is a competitive sport that requires speed, skill and strength. Therefore, both male and female athletes agree that speed is a very important indicator in physical training. The number of people who agreed with other indicators such as agility, strength, endurance, flexibility and coordination was inconsistent. This is influenced by gender differences in athletes and individual fitness. Among the statistical data, the indicator with the largest difference in the identification of athletes with physical training indicators was flexibility. Only 5 of the male and 11 of the female athletes agreed. It showed that gender differences and physical quality will affect athletes' preferences and judgments on some items of physical training. Figure 8 is a schematic diagram of the content of flexibility training.
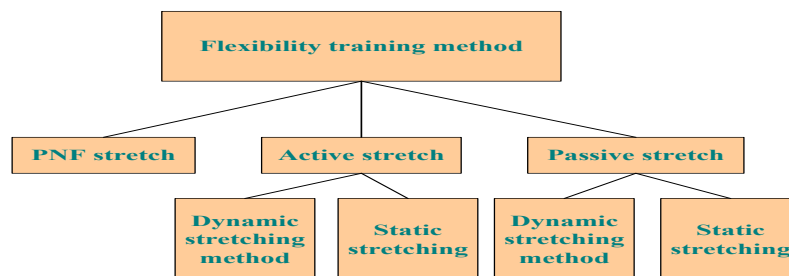

Figure 8: Schematic diagram of flexibility training content

In the related consultation of these 20 coaches, most of the coaches agreed with training multiple times a week, and some coaches agreed with a small number of training times a week. The reason for this conclusion is related to the training time arranged by each coach, the training intensity and the available training time of the athletes. Coaches who arranged twice a week had a longer training time and a stronger exercise intensity, with a training intensity of 85%. Coaches who arranged 3 times a week had a moderate training time and a moderate exercise intensity of 65%. Coaches who arranged 4 times a week or more had shorter training times and moderate exercise intensity.

Male athletes were more willing to use joint equipment and strength training equipment such as barbells and dumbbells, followed by coordination training equipment such as marker bars (tubes). Female athletes were more willing to use coordination training equipment such as sign bars (tubes), followed by joint training and rubber bands. The hi-lo bars were the least commonly used by athletes.

4.3 Model in Football Training and Physical Education

Through the data sorting of the questionnaires of the H X football club, and combined with the big data artificial intelligence technology to analyze the football training and physical education, the process is as follows: The purpose of football training and physical education for athletes was actually to enable them to have stronger physical fitness and acquire the professional knowledge, physical

fitness, skills and tactics that football should have in order to stand out on the field. Based on the analysis of the basic situation of the coaches of the best-developed X football club in H in the past three years and the physical training situation of some athletes, the conclusion was drawn that football training and physical education must adjust the training content in time around the actual training situation of coaches and athletes. For example, if the overall quality of the athlete is high, the intensity of physical training needs to be increased. Otherwise, the requirements for physical training should be appropriately reduced. Based on big data artificial intelligence technology, starting from a large number of research data, some suggestions related to football training and physical education teaching are put forward, but how to improve should be analyzed in combination with the actual situation of athletes and coaches.

5. Discussion

This paper is devoted to the research of big data artificial intelligence technology and its application to the practical research of football training and physical education. This is not only a further expansion of the application scope of big data artificial intelligence technology, but also a new attempt to analyze the practice of football training and physical education. By analyzing the basic information of coaches, training arrangements and players' training content of X football club in H, the club's football training and physical education practice are studied. The research potential of big data artificial intelligence technology as a scientific data analysis tool in analyzing the actual aspects of football training and physical education has been tapped. In addition, based on the existing research on big data artificial intelligence analysis technology, the algorithm is improved and combined with the research on football training and physical education to obtain the best solution. In the experimental analysis part, the final results are analyzed in a realistic sense, and it can be seen that the results are in line with reality.

Through the analysis of this case, it is shown that the actual method of studying football training and physical education based on big data artificial intelligence technology is more accurate than the traditional analysis method. The measurer can use the artificial neural network algorithm in artificial intelligence technology to further explore the relevant content of football, and optimize the algorithm to obtain the best results in the specific experimental process.

This paper analyzes some of the information of some coaches and athletes of X football club in H combined with big data artificial intelligence technology, and draws relevant measures that are beneficial to football training and physical education practice.

6. Conclusions

Through the statistics and analysis of the questionnaires, the following conclusions are drawn: The arrival of the era of big data artificial intelligence has prompted the sports industry to develop in a more scientific direction. The football industry is not a new industry, and its development in the world is relatively mature. However, there are still many deficiencies in the practice of football players' related training and physical education, such as decreased emphasis on basic physical training. Determining the player's position on the court prematurely affects the player's later performance. Failure to coordinate the relationship between the entire team and individuals makes some athletes pay more attention to personal gains and losses. The content of football training is mostly daily training, with a lack of actual combat experience, which is unable to improve athletes. Although football is a popular national sport, due to the influence of venues and funds, football has not been popularized to the masses. Based on the artificial neural network, this paper analyzes the related situation of football training and physical education of X football club in H, and discusses the sustainable development scheme of football. In response to the current football-related problems, the local government should provide more learning opportunities and platforms, and coaches and teaching institutions should improve the daily training mechanism so that players can establish a correct concept of football training. What's more important is to let athletes master scientific training methods so that they can avoid sports injuries as much as possible.

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