SIN-CHN SCIENTIFIC PRESS PTE.LTD.

Molecular & Cellular Biomechanics 2024, 21, 142.
https://doi.org/10.62617/mcb.v21.142

Article

Athlete muscle strength control training based on network security and multi-source information fusion

Zhongxing Zhang[1], **Jun Cai**[2,*]

[1] College of Humanities and Medicine, Anhui Medical University, Hefei 230032, China
[2] School of Physical Education and Health, Anhui University of Traditional Chinese Medicine, Hefei 230032, China
*** Corresponding author:** Jun Cai, zzx204@163.com

CITATION

Zhang Z, Cai J. Athlete muscle strength control training based on network security and multi-source information fusion. Molecular & Cellular Biomechanics. 2024. 21: 142.
https://doi.org/10.62617/mcb.v21.142

ARTICLE INFO

Received: 14 May 2024
Accepted: 25 May 2024
Available online: 21 June 2024

COPYRIGHT

Copyright © 2024 by author(s). *Molecular & Cellular Biomechanics* is published by Sin-Chn Scientific Press Pte. Ltd. This work is licensed under the Creative Commons Attribution (CC BY) license.
https://creativecommons.org/licenses/by/4.0/

Abstract: With the booming development of competitive sports worldwide, athletic training is receiving increasing interest in the world. Major sports organizations and universities around the world have established their own athlete training centers to support sports training and scientific research activities in recent years. Data from strength training is crucial for controlling muscle strength. However, this key factor is often attacked by the network. As NS threats escalate, artificial intelligence-driven strength training systems encounter information security risks. Therefore, this paper proposed a new strength training method based on NS and Multi-Source Information Fusion (MSIF). This method evaluates athletes' sports skills, speed quality and strength quality through data fusion algorithm to effectively monitor the activities related to muscle strength control training. The research results showed that under the same conditions, the *P* value of the indexes of sports skills, speed quality and strength quality of male and female athletes in Group X before and after the experiment was greater than 0.05, and there was no significant difference; the *P* value of Group Y was less than 0.05, showing a significant difference, and indicating that the relationship between NS and MSIF and athletes' muscle strength control training was positive.

Keywords: athlete muscle strength control training; multi-source information fusion; network security; sports skills; speed quality; strength quality

1. Introduction

In recent years, due to the increase of information security risks, the strength training system based on artificial intelligence has received more and more attention. With the continuous development and progress of sports training technology, the strength training system based on artificial intelligence has been widely used. It provides more personalized and intelligent services for athletes and greatly improves the performance of athletes in fierce competitions.

However, at the same time, people should also see that the threat of NS is becoming more and more. At present, athletes' strength training faces two major risks: data security and personal privacy disclosure, which seriously hinders the application of NS and big data analysis. In order to ensure that the training process and results of athletes' muscle strength control are not affected by NS risks, it is necessary to establish a complete, executable and complete NS evaluation system. The key step is to use advanced and reliable detection technology to identify and evaluate NS risks. However, at present, there is no comprehensive, feasible and enforceable standard for the identification and assessment of risks at different levels involved in the above process.

This article presents a novel method of muscle strength control training for athletes based on network security and multi-source information fusion, and uses data fusion algorithms to analyze the test data of the three indicators of motor skills, speed quality and strength quality for male and female athletes. According to the independent T test, the method proposed in this paper has significant differences before and after the experiment.

2. Related work

Strength training of athletes is an important means to improve sports performance and performance. For the research of athletes, there have been many research results. Because many studies in the past 35 years have reported that the symptoms of upper respiratory tract infection of athletes have increased during high-intensity training and competition, Walsh NP has provided new insights and evidence-based suggestions for coping with various challenges faced by athletes in immune health, including strenuous exercise, life pressure, sleep interruption, extreme environment and malnutrition [1]. The purpose of Foskett RL's research was to investigate the prevalence of anxiety or depression and depressive symptoms among British elite athletes and determine the variables related to anxiety or depression and depressive symptoms in the same sample. The results showed that the screening of professional dissatisfaction among elite athletes may help to detect the signs of anxiety, depression or distress as soon as possible [2]. Carnevale Pellino Vittoria's research aimed to evaluate the impact of COVID-19 blockade on the mental health of elite athletes, and found that COVID-19 has an impact on the mental health of elite athletes, and is related to pressure, anxiety and psychological distress. The size of its impact is related to the emotional state, personality and recovery ability of athletes. The blockade period also affects the mental health and training habits of elite athletes, and increases anxiety. However, due to adequate emotional regulation and coping strategies, the impact is smaller than that of the general population [3]. However, the above studies are all based on the analysis of athletes' own situation, and do not involve the study of their muscle strength control training.

In view of the above problems, the integration of MSIF into the training of athletes' muscle strength control has become the focus of more and more scholars, and has carried out research in relevant fields. Among them, in order to improve the scientific level of track and field training methods and develop China's sports industry, Li Ling designed a track and field training information collection and feedback system based on multi-sensor information fusion. The research found that the data collection and feedback system using multi-sensor information fusion can be applied to track and field training more accurately and differently, and can find the problems of athletes, so as to remedy the situation [4]. Because there is little information about how endurance athletes perceive the sodium intake related to training and competition, McCubbin Alan J's research evaluated the beliefs, information sources and expected practices of sodium intake related to training and competition through online questionnaires [5]. The above research shows the importance of information to athletes' performance and lays a solid foundation for combining it with NS to analyze the effect of athletes' muscle strength control training.

3. Construction of athlete muscle strength control training system

3.1. NS and MSIF

1) NS framework

As an important training facility in the field of competitive sports, the muscle strength training system for athletes has an essential function in the whole sports system role in the overall sports regime [6]. With the improvement of the level of competitive sports, the NS of athletes has also been paid more and more attention. Sports NS refers to various security threats generated or existing between the athletes and the whole sports system. This paper proposes a new NS framework and establishes a relevant theoretical framework to guide the NS risk assessment in the muscle strength control training of athletes. A model detection, prediction and protection mechanism is established between the athletes and the whole sports system to ensure the safety, stability, reliability and integrity of the athletes' training system and provide reference for the follow-up athletes' strength control training [7,8]. Its applicable fields are shown in **Figure 1**:

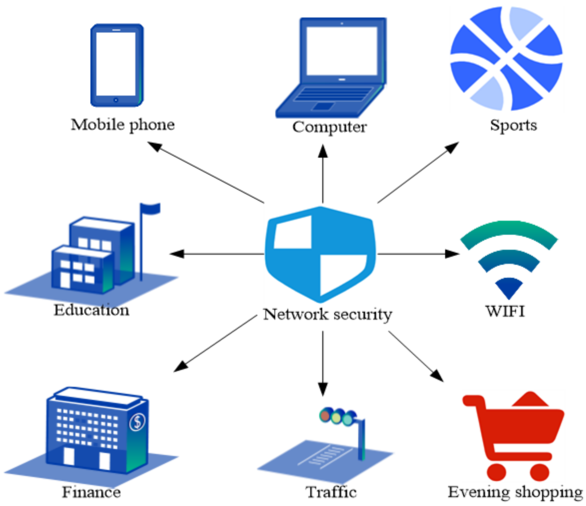


Figure 1. Applicable fields of NS.

2) Establishment of MSIF technology

MSIF technology is to process the sensor or equipment data collected by the sensor or equipment, convert it into eigenvalues that can reflect multiple attributes of the detected system (such as measurement data, status information and feature information), and finally achieve the goal of improving the motion control ability by making multi-attribute decisions and judgments on the eigenvalues. The process is shown in **Figure 2**. The athlete muscle strength control training system adheres to the principles of human biomechanics, with a training model that accounts for characteristics such as force, speed, and acceleration during muscle movement. Based on the principles of human biomechanics, combined with the characteristics of athletes' training actions, the motion parameters and characteristic indicators of various muscle groups of the human body are determined, and the MSIF technology is used to establish the multi-group athletes' motion data model [9,10].

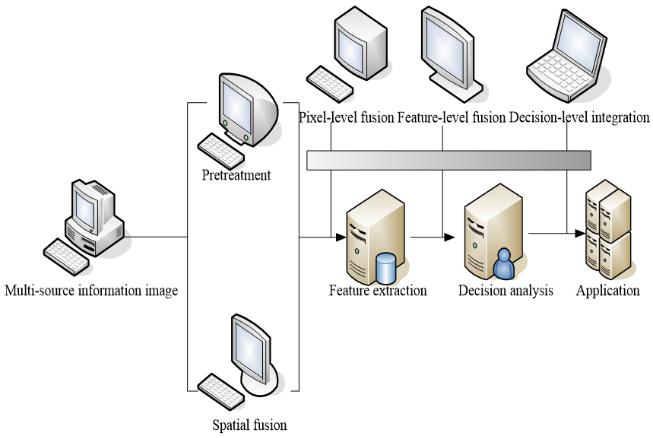


Figure 2. Process of MSIF.

3) The training plan and implementation of athletes' muscle strength control

The athlete muscle strength control training program consists of two parts, namely, the athlete data collection system and the athlete MSIF model [11]. The athlete data collection system is composed of training database and athlete multi-sensor data collection platform. The training database consists of three parts: training database, motion sensor module and data transmission system. The MSIF model module is used to obtain the athletes' motion parameters, biomechanical characteristic parameters and multi-source information in the training database. The data transmission system is used to transmit the collected relevant data to the training database [12,13].

The athletes' muscle strength control training program studied in this paper includes three main parts, which are as follows: firstly, the corresponding model is established according to the key data involved in muscle strength training to provide a model basis for subsequent research; secondly, the MSIF technology is used to predict the characteristic indicators, establish a variety of detection indicators and identify them to find potential safety hazards; finally, the identified characteristic indicators and prediction results are comprehensively analyzed to find potential risks and timely carry out safety prevention and control.

The multi-sensor data acquisition platform for athletes consists of three parts: an image acquisition module based on motion sensing and MSIF technology, a biomechanical detection and analysis module based on big data processing and deep learning framework, and a NS detection and analysis module based on big data computing processing. The image acquisition part mainly includes three subsystems: image acquisition system, motion sensor detection and recognition module, and MSIF model and algorithm. The motion sensor detection and recognition module mainly includes human motion parameter perception module, human feature recognition and classification module. This module is mainly realized through sensor array, which can provide relevant information for motion sensors to improve the accuracy and speed of multi-source information recognition.

3.2. Data fusion algorithm based on neural network

In order to verify the relationship between NS and MSIF and athlete muscle strength control training, this paper needs to carry out comprehensive data monitoring during the athlete experiment. This results in extremely high repeatability of the information collected by adjacent sensor nodes in the same time, forming a large amount of redundant data [14,15].

To tackle this issue, we introduce a data fusion algorithm that leverages NS and MSIF to enhance data quality through data consolidation, forecasting, and advanced technical methods.

In order to solve this problem, this paper proposes a data fusion algorithm based on NS and MSIF, which means to improve the data quality by combining similar data, forecasting unknown data and other technical means, so as to make the data have real and reliable data characteristics.

The algorithm is mainly divided into two parts. The first level neural network is mainly to preprocess the information collected in the cluster, and take the preprocessed data as the input of the second level neural network. The second level of neural network is to process the monitoring data.

1) The first stage of the neural network is to directly transmit the information obtained by the sensing nodes in the input layer to the first hidden layer

The first hidden layer neuron model would set a threshold to filter out the original data with time similarity. If the difference between the data is less than $\varDelta a_o$, it indicates that there is continuous data before and after the time, and then the last data would be output, which can better filter out the error information collected from the network.

$$b = g[a_o(o)(u), \varDelta a_o(o)(u)] = \begin{cases} -a_o(u-1), \varDelta a_o(o) < \vartheta \\ a_o, others \end{cases} \tag{1}$$

$$\varDelta a_o(u) = |a_o(t) - a_o(u-1)| \tag{2}$$

Among them, $a_o(u-1)$ is the test data of neuron o at $u-1$; $a_o(u)$ is the test data of neuron o at u; $\varDelta a_o(u)$ is the change between the input value and output value of neuron o at the adjacent time.

For the original data, the second hidden layer neuron model would be averaged.

$$q_{ave} = \frac{1}{m}\sum_{l=1}^{m} e_{2l} q_l \tag{3}$$

In Equation (3), $e_{2l} = 1$ and represents the weight coefficient.

The output layer neuron model is mainly the fusion processing of the test data of various indicators of the athletes' muscle strength control training.

$$a = \sum_{k=1}^{q} e_{2k} q_{ave,k} \tag{4}$$

In Equation (4), $e_{2k} = 1$ and represents the weight between the second hidden layer and the output layer.

2) The output layer of the first level neural network would become the composition of the input layer of the second level neural network

It is to extract features from the data a pretreated at the previous level:

$$i_k = \sum_{o=1}^{n} (e_{ok} a_o - \vartheta_k) \tag{5}$$

$$p_k = g(i_k) = \frac{1}{1 - r^{-i_k}} \tag{6}$$

Among them, i_k, ϑ_k and p_k are the input value, threshold value and output value of the fourth neuron, and e_{ok} is the weight value between the input layer neuron o and the hidden layer neuron k.

The input value of the hidden layer is taken as the input value of the output layer:

$$c = \sum_{l=1}^{1} (e_{3l} p_k - \vartheta) \tag{7}$$

$$b = g(c) = \frac{1}{1 - r^{-c}} \tag{8}$$

In Equation (8), ϑ and c are the output layer neuron threshold and input value, and e_{3l} is the weight value of the connection between the hidden layer and the output layer. The data of athletes' muscle strength control training is processed in two levels, which greatly improves the accuracy of training data collection.

The technological implementation connection of athlete muscle strength regulation training based on network security is extremely important, as it is based on the integration of information from several sources. The detailed technical implementation procedures, together with particular data fusion techniques and algorithm parameter settings, are listed below. The primary data collection methods used by the data acquisition layer include motion capture, EMG signals, and weight variations for various human body types. The secret to making sure the data gathered by the sensor is correct and up to date is making sure it is accurate and up to date. Encryption technologies like TLS/SSL are employed at the data transfer layer to guarantee secure data delivery. Based on this, a compression method is applied to enhance transmission quality and minimize the amount of data transferred efficiency. Following the completion of the data's purification, preprocessing, and feature extraction, the data processing section applies the proper filtering techniques to denoize the signal and machine learning techniques to extract the EMG signal's features. Based on this, a multisensor-based comprehensive evaluation technique is developed. The information fusion is achieved by the use of deep neural networks, weighted average methods, and Kalman filtering methods.

The size of the filter window must be established before beginning the median filtering procedure. The sampling rate and noise properties should be taken into consideration while adjusting the window's size. The primary focus throughout the feature extraction and classification phase is on choosing the best learning algorithm and establishing the necessary parameters. Setting the kernel function type, penalty factor C, etc. is necessary before implementing SVM. Appropriate fusion techniques are chosen for various data kinds based on this. A thorough evaluation result is produced by averaging and weighing the data gathered by several sensors. The sensor's importance, precision, or credibility can all be used as weights. To accurately estimate the state of the system, an iterative process is employed to determine the sum of the weights of the actual value and the forecast value. To guarantee data secrecy, transmitted data is protected using encryption methods like AES. To limit access to data, implement stringent access control procedures. Relevant information can only be accessed and modified by authorized individuals. Keep track of how the system is doing, keep an eye on things, and promptly alert users to any unusual situations. This will enable us to quickly identify and address any security threats.

4. Experimental evaluation of the impact of NS and MSIF on athletes' muscle strength control training

In order to ensure the reproducibility and consistency of athletes' muscle strength control training methods based on network security and multi-source information fusion, we need to develop detailed plans and best practice guidelines for training methods. The following are some suggested detailed plans and guidelines:

- Detailed training plan
    - Training goal setting: Clarify the specific goals of athletes' muscle strength control training, such as improving explosive power, enhancing endurance, or improving coordination. Set measurable training indicators in order to quantitatively evaluate the training effect.
    - Implementation of multi-source information fusion technology: list the types of data sources that need to be collected, such as motion sensors, biomechanical analysis systems, and monitoring equipment for athletes' physiological indicators. Formulate data acquisition standards, including sampling frequency, data accuracy and synchronization requirements. Describe data preprocessing and fusion methods, including denoising, feature extraction, and algorithm selection.
    - Implementation of network security measures: design security protocols for data transmission and storage to ensure the confidentiality and integrity of data. Implement access control policies to restrict access to data. Regularly update and check the security system to deal with potential cyber threats.
    - Personalized training plan formulation: according to the athlete's physical fitness, training goals and multi-source information fusion results, formulate a personalized training plan. Including the selection of training content, the adjustment of training intensity, and the setting of training cycle.
    - Monitoring and adjustment of the training process: collect and analyze the data of athletes in real time during the training process, find problems in time and make adjustments. Regularly evaluate the training effect and optimize the training plan based on the evaluation results.
- Best practice guidelines
    - Standardized operation process: Formulate a detailed operation process manual, including standard steps in all aspects of equipment operation, data collection, data processing and analysis. Ensure that researchers and practitioners can perform standardized operations in accordance with the manual.
    - Data quality control: emphasize the accuracy and reliability of data, and formulate data quality inspection standards. Regularly calibrate and verify data acquisition equipment and processing algorithms.
    - Privacy protection and compliance: Strictly abide by privacy protection regulations to ensure that athletes' personal privacy is not leaked. When using athlete data for research or training, the express consent of the athlete is required.

4.1. Evaluation object, content and method

1) Research object and content

This article took the athlete's muscle strength control training as the research object. Its main content is the influence of muscle strength control training on athletes' performance, strength index and speed index.

2) Research methods

- Literature method

This paper used the method of literature retrieval, collection and collation. During the research, a large number of athletes' muscle strength control training information has been collected by using the provincial library and its university library, reference room, and online document resource sharing platforms such as CNKI, Wanfang database, Longyuan journal network, Vip database, Baidu Wenku, etc. People had a comprehensive understanding and grasp of the current situation and development trend of athletes' muscle strength control training, which laid a solid theoretical foundation for the follow-up research work [16,17].

- Expert interview method

This paper used the method of expert interview to interview the experts and scholars of the athlete training institution of the general administration of sport of a province, in order to better follow the research ideas of this paper and give scientific answers to some key problems encountered in the process of scientific research.

- Comparative experiment method

In order to understand the influence of muscle strength control training on athletes more intuitively and objectively, this paper also used the method of comparative experiment to conduct empirical research. During the experiment, 40 subjects were divided into control group (Group X) and experimental group (Group Y) by random sampling. Group X was trained by traditional muscle strength control training method, whereas Group Y underwent training utilizing a muscle strength control method that integrates NS and MSIF. while Group Y was trained by muscle strength control training method based on NS and MSIF. By observing the differences between Group X and Group Y, the effects of the two methods were analyzed and studied.

- Mathematical statistics

According to the data collected during the experiment, this paper would use SPSS (Statistical Product and Service Solutions,) social statistics software to process and analyze the data in order to provide more scientific data support and reference basis for the research.

3) Experimental design

- Place, time, object and equipment of the experiment

The experimental site is the training center of a provincial sports bureau, and the test site is the institute of sports science of the training center of the provincial sports bureau. The experimental period is 4 months, starting from March 1, 2022 and ending on June 30. The subjects of the study are 40 excellent young athletes in the province. The experimental equipment includes sponge pads, fitness equipment, balance air cushions, suspension and stopwatch.

- Experimental indicators

According to the collected literature and combined with the characteristics of athletes' muscle strength control training, the following main indicators were selected:

Sports skill indicators: when selecting the athletes' sports skill indicators, people mainly selected two kinds of dynamic test indicators and static test indicators in the core area of the athletes' body. There are four items in total, namely, A: side bending of head hugging (left); B: side bending of head hugging (right); C: back muscle tension; D: leg suspension. The purpose is to better understand the strength of athletes' core muscles and analyze the impact of muscle strength control training on athletes.

Speed quality index: when testing and analyzing the speed index of athletes, according to the characteristics of athletes, three main test methods were adopted, namely, 40 m, 50 m accelerated run, and 100 m timed run.

Strength quality indicators: when testing and analyzing the strength quality indicators of athletes, according to the specific combination degree of each strength quality indicator and sports, several indicators with good maneuverability, such as weight-bearing squat, weight-bearing squat, standing long jump, and triple jump, were mainly selected [18,19]. Because the strength that some athletes can exert in sports is far less than the strength that their muscles can exert in a stable state, although these athletes have excellent performance in the standing long jump, their performance in the triple jump is often not ideal. Therefore, this paper also included the triple jump into the experimental index system, and tested and analyzed it as an important experimental index.

- Training programme

From the principle of learning and mastering athletes' skills, people can see that in the new technology and new training, athletes must follow the cognitive development rules of athletes, which is also applicable in the muscle strength control training of athletes. Therefore, this paper plans to divide the experiment into four stages.

The training time of Group X is 4 months, but the training method used is the traditional muscle strength control training method. In the process of training, the main training methods of middle and barehanded training are leg lifting, supine hip straightening, prone "back leg" and supine right-angle sitting, etc. The training methods of muscle strength control training mainly include barbell prone pull, front and back bending of weight-bearing body, side bending of weight-bearing body, and barbell supine press. The main training instruments used are sponge pad and barbell.

The training time of Group Y is the same as that of Group X, but the training method used is the muscle strength control training method based on NS and MSIF. The training arrangement was divided into four stages, as shown in **Table 1**.

- Experimental control

The training frequency of Group X and Group Y was 20 times per month, with each training for about 30 minutes. Both groups adopted the cyclic interval training method. In order to ensure that the training effect is not affected by the training conditions, the two groups should adopt the same training intensity and load to keep the training conditions of the two groups consistent. In addition, all athletes would not participate in any training related to improving physical fitness at other times.

Table 1. Training arrangement of Group Y.

Stage	Schedule	Training content	Training method
1	March	Static exercise in stable state and no-load exercise in stable state	Static exercise in stable state and no-load exercise in stable state
2	April	Dynamic movement exercise	Lie on your back, pull the Swiss ball, turn the Swiss ball to the hip, and so on
3	May	Maintaining static posture in the core area of the body	Swiss ball supine, sitting up, leg lifting, side arm and hip straightening, etc.
4	June	Carry out dynamic exercises on suspended equipment	Suspend supine with hip lifting, single leg lifting, prone with elbow support, hip lifting and leg retraction, etc.

4.2. Results and evaluation of athletes' muscle strength control training

1) Analysis of the basic situation of the two groups of athletes

This paper made statistics on the age, height, weight, sports grade and sports performance of all the athletes participating in the experiment, and calculated the average age, height, weight and special sports performance of the two groups of athletes respectively. The specific calculation results are shown in **Table 2**:

Table 2. Comparison of basic information between the two groups.

Gender	Male			Female		
Group	**Group X**	**Group Y**	***P* value**	**Group X**	**Group Y**	***P* value**
Average age/year	21.5 ± 1.2	22.1 ± 0.8	>0.05	20.4 ± 0.3	20.5 ± 0.2	>0.05
Average height/cm	181.2 ± 0.36	181.7 ± 1.5	>0.05	168.3 ± 1.3	167.9 ± 1.5	>0.05
Average body weight/kg	73.3 ± 1.9	72.5 ± 3.6	>0.05	55.5 ± 0.9	55.1 ± 0.5	>0.05
Average score/second	10.67 ± 0.078	10.66 ± 0.08	>0.05	12.21 ± 0.11	12.2 ± 0.16	>0.05

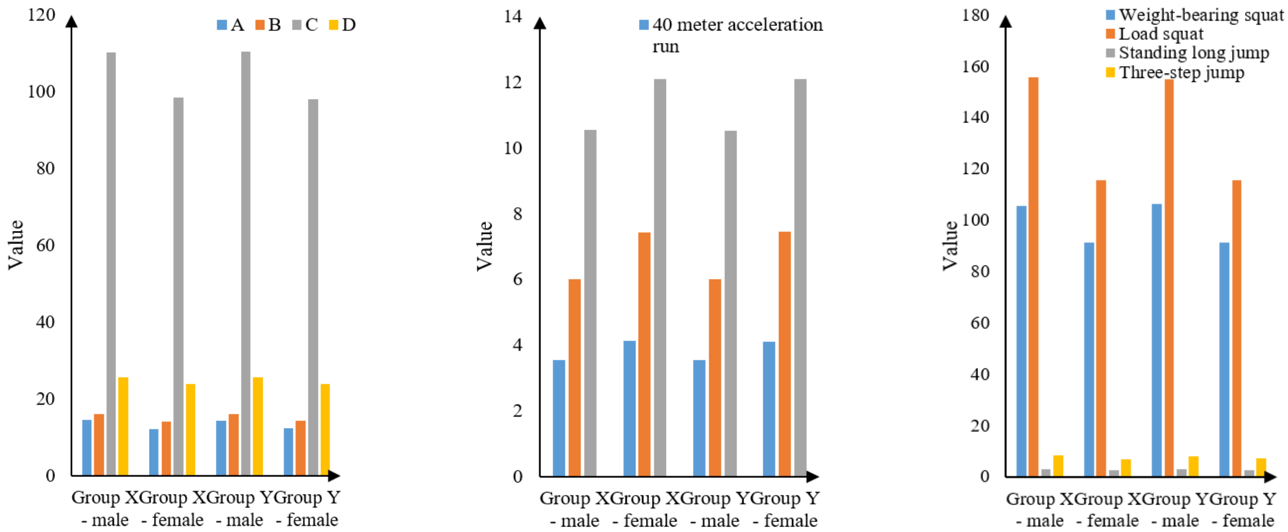
It can be seen from **Table 2** that because the *P* value was greater than 0.05, there was no significant difference between the male and female athletes in Group X and Group Y in terms of age, height, weight or sports performance, and the two groups were comparable, thus ensuring the credibility and scientificity of the results.

2) Comparison and analysis of sports performance between the two groups before and after the experiment

   • Before experiment

Before the experiment, this paper tested the sports skills, speed quality and strength quality of the two groups of athletes, and the results are shown in **Figure 3**.

From **Figure 3a**, it can be seen that the test results of the male and female athletes in Group X were 14.56, 16.05, 110.32, 25.65 and 12.26, 14.15, 98.47 and 23.99, respectively, and the results of Group Y were 14.45, 16.10, 110.47, 25.67 and 12.35, 14.25, 98.21 and 23.98, respectively. It can be seen from **Figure 3b** that the test results of the men and women athletes in Group X in the 40 m, 50 m acceleration run and 100 m time run were 3.56, 6.02, 10.55 and 4.13, 7.45 and 12.11 respectively, and the results of Group Y were 3.55, 6.01, 10.54 and 4.12, 7.47 and 12.12 respectively. It can be seen from **Figure 3c** that the test results of male and female athletes in Group X were 105.5, 155.8, 2.88, 8.15 and 91.2, 115.5, 2.43 and 6.95, respectively, and the results of Group Y were 106.2, 154.9, 2.87, 8.12 and 91.4, 115.6, 2.45 and 7.05. It can be seen from **Figure 3** that the test results of various indicators in sports skills, speed quality and strength quality of male and female athletes in Groups X and Y were similar, indicating that the two groups of athletes were on the same starting line before the experiment [20,21].



(a) (b) (c)

Figure 3. The sports skills, speed quality and strength quality of the two groups of athletes before the experiment. **(a)** motor skills; **(b)** speed quality; **(c)** strength quality.

In order to make the conclusion more convincing, this paper conducted independent T test on the test data of the above indicators, and the results are shown in **Table 3**:

Table 3. Independent *T* test of each index of male and female athletes in two groups.

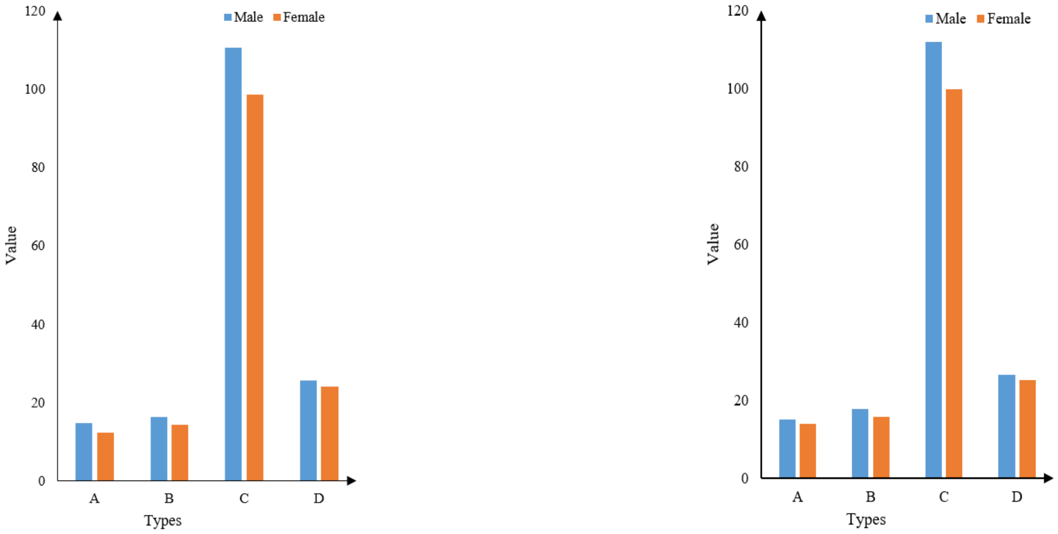
	***P* value-male**	***P* value-female**
A	>0.05	>0.05
B	>0.05	>0.05
C	>0.05	>0.05
D	>0.05	>0.05
30 m acceleration run	>0.05	>0.05
50 m acceleration run	>0.05	>0.05
100 m time run	>0.05	>0.05
Weight-bearing squat	>0.05	>0.05
Load squat	>0.05	>0.05
Standing long jump	>0.05	>0.05
Three-step jump	>0.05	>0.05

It can be seen from **Table 3** that the test data of various indicators of male and female athletes showed that the *P* value was greater than 0.05 through independent *T* test, which further showed that there was no significant difference between the two groups in sports skills, speed quality and strength quality before the start of the experiment.

- After the experiment

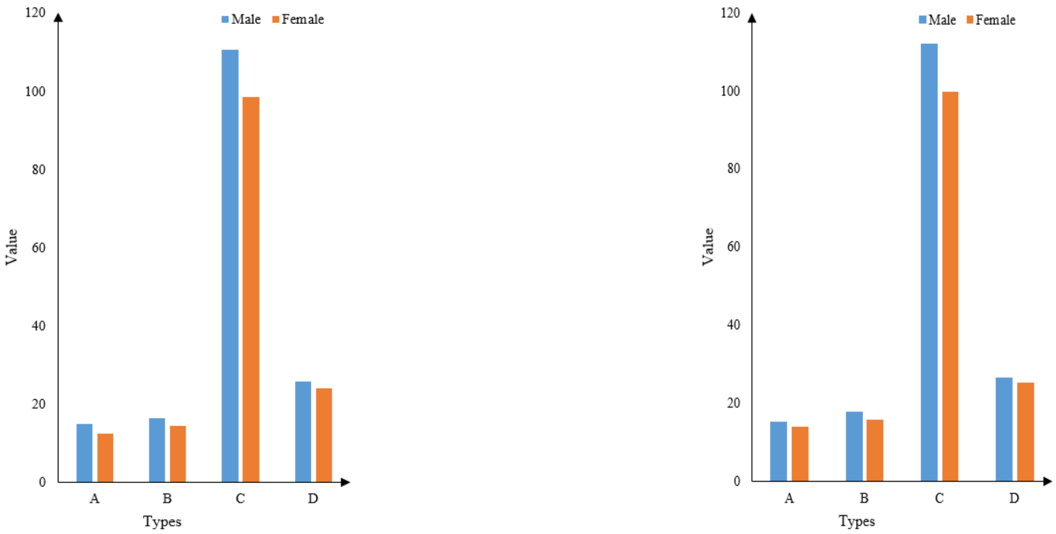
After the experiment, this paper tested the sports skills, speed quality and strength quality of the two groups of athletes, and compared the two groups of data, as shown in **Figures 4–6**.

It can be seen from **Figure 4a** that the test results of the male and female athletes in Group X were 14.77, 16.36, 110.47, 25.73 and 12.34, 14.40, 98.61 and 24.05, respectively. From **Figure 4b**, it can be seen that the test results of the male and female athletes in Group Y were 15.13, 17.86, 112.01, 26.49 and 13.87, 15.66, 99.78 and 25.08 respectively. It can be seen from **Figure 4** that the scores of various tests of sports skills of male and female athletes in Group Y were significantly better than those of Group X, which indicates that the training of athletes' muscle strength control based on NS and MSIF is conducive to the improvement of sports skills of remote mobilization.



(a) **(b)**

Figure 4. Test of sports skills of the two groups of athletes after the experiment. **(a)** group X; **(b)** group Y.

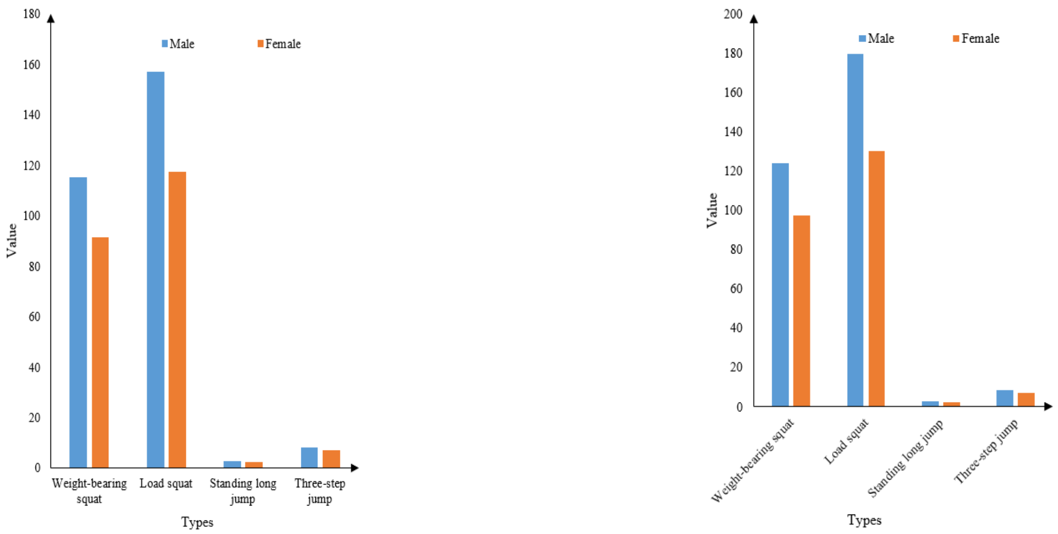


(a) **(b)**

Figure 5. Speed quality test of two groups of athletes after the experiment. **(a)** group X; **(b)** group Y.

It can be seen from **Figure 5a** that the test results of the men and women athletes in Group X in the 40 m, 50 m acceleration run and 100 m time run were 3.50, 5.97, 10.51 and 4.08, 7.41 and 12.04, respectively. From **Figure 5b**, it can be seen that the results of Group Y were 3.43, 5.78, 10.41 and 4.05, 7.35 and 11.97, respectively. It can be seen from **Figure 5** that the test scores of the speed quality of male and female athletes in Group Y were also significantly better than those in Group X, indicating that the muscle strength control training of athletes based on NS and MSIF is conducive to the improvement of speed quality.

It can be seen from **Figure 6a** that the test results of the male and female athletes in Group X were 115.5, 157.2, 2.91, 8.22 and 91.4, 117.6, 2.47 and 7.12 respectively in the squat, squat, standing long jump and triple jump. It can be seen from **Figure 6b** that the scores of Group Y were 124.2, 179.5, 2.96, 8.66 and 97.5, 130.1, 2.56 and 7.24 respectively. It can be seen from **Figure 6** that the test scores of the strength quality of the male and female athletes in Group Y were also significantly better than those in Group X, indicating that the muscle strength control training of athletes based on NS and MSIF is conducive to the high mobilization of strength quality.



(a) **(b)**

Figure 6. Strength quality test of the two groups of athletes after the experiment. **(a)** group X; **(b)** group Y.

Combined with the data in **Figures 4–6**, and the corresponding data in **Figure 3**, the test data of various indicators of male and female athletes in Group X and Group Y before and after the experiment were brought into the independent *T* test for detection, and the results are shown in **Table 4**.

It can be seen from **Table 4** that the test data of various indicators of male and female athletes in Group X were all greater than 0.05 through independent *T* test, while the *P* value of Group Y was less than 0.05. The results showed that there was no significant difference in the motor skills, speed quality and strength quality between men and women in Group X before and after the experiment, while there was a significant difference in Group Y.

Table 4. Independent *T* test of various index test data of male and female athletes in Group X and Y before and after the experiment.

	Group X		**Group Y**	
	***P* value-male**	***P* value-female**	***P* value-male**	***P* value-female**
A	>0.05	>0.05	<0.05	<0.05
B	>0.05	>0.05	<0.05	<0.05
C	>0.05	>0.05	<0.05	<0.05
D	>0.05	>0.05	<0.05	<0.05
30 m acceleration run	>0.05	>0.05	<0.05	<0.05
50 m acceleration run	>0.05	>0.05	<0.05	<0.05
100 m time run	>0.05	>0.05	<0.05	<0.05
Weight-bearing squat	>0.05	>0.05	<0.05	<0.05
Load squat	>0.05	>0.05	<0.05	<0.05
Standing long jump	>0.05	>0.05	<0.05	<0.05
Three-step jump	>0.05	>0.05	<0.05	<0.05

To sum up, after the end of the experiment, all the data of the two groups have improved, but after the independent *T* test, the *P* value of the index data of the male and female athletes in Group X before and after the experiment was greater than 0.05, that is, there was no significant difference. The *P* value of Group Y was less than 0.05, which indicates that the muscle strength control training under NS and MSIF is more conducive to the training of athletes. According to the analysis, this situation is mainly caused by the following two reasons. Although the traditional muscle strength control training can also help improve the performance of athletes' sports skills, its effect is relatively low, and it is difficult to make significant changes when its effect is relatively low.

5. Discussion

5.1. Economic feasibility

Athletes' muscle strength control training that integrates multi-source information fusion and network security faces a number of difficulties and financial expenses in the real world. An analysis of these difficulties and a financial viability assessment are provided below. First of all, technological adoption is challenging. While multi-source information fusion technology comprises several sensors and data processing systems, which is more complex to implement, network security is the foundation for guaranteeing the security of training data. Second, the cost of equipment and maintenance is high. Systems that combine information from multiple sources need a range of sensors and data processing tools. These pieces of equipment are pricey, and they need to be updated and maintained frequently. Another significant obstacle is the cost of training. A group of qualified technicians and coaches are needed to deploy this system, and the associated labor and training expenses cannot be disregarded.

Evaluation of practicality and economic viability: Economic viability: This system requires a significant initial investment, covering expenditures for system development, employee training, and equipment acquisition. In the long run, nevertheless, this investment might be financially feasible given that it can greatly increase athletes' competitive level and training effect, which will benefit athletes and associated institutions even more. Practicality: Comprehensive athlete muscle strength data can be obtained through multi-source information fusion technology, which enables coaches to create training regimens that are more precise. Network security also makes the system more functional and ensures the privacy and security of data. Solution: Technology optimization, cost reduction, and efficiency enhancement: Multi-source information fusion systems become more practical and economical as a result of reduced complexity and cost due to improved algorithms and technology. Collaboration and resource sharing: To jointly develop and market this technology, achieve resource sharing, and split costs, fortify collaboration with other organizations or businesses. Financial and policy help: To lower the cost and risk of R&D and promotion, look to the government or relevant organizations for financial and policy support.

5.2. Future research recommendations

Ignoring individual athlete variances is a significant problem in the research on network security and multi-source information fusion-based athlete muscle strength control training. Individual traits like age, gender, and training background have a big influence on how well a muscle performs and grows. Future studies must therefore evaluate these elements' effects on training outcomes in greater detail. Research ought to improve the categorization and assessment of the personal attributes of athletes, taking into account prospective variables like genetic heritage, degree of physical fitness, and psychological condition in addition to age, gender, and training history. A thorough evaluation of these variables contributes to a more accurate understanding of individual differences. Create individualized training schedules based on the athletes' individual traits. Younger athletes ought to concentrate on developing their foundational strength, whilst more experienced athletes should concentrate on developing their muscle endurance and flexibility. Training modalities and intensity may also differ depending on gender. The demands of various athletes can be better satisfied and the training effect enhanced with customized training plans.

Examine how individual traits affect the training impact: Future studies should examine in greater detail the precise ways in which individual traits affect the training effect. It is feasible to determine which characteristics are more crucial for increasing muscle strength by contrasting the changes in athletes in various characteristic groups before and after treatment. This will assist athletes and coaches in creating training regimens that work better. Boost technology optimization and research and development: In order to increase the precision and effectiveness of data processing, future research should focus on developing cutting-edge technologies like artificial intelligence and machine learning as well as network security and multi-source information fusion technology's stability, security, and integration.

6. Conclusions

Through quantitative testing of athletes' muscle ability level, this paper took sports skills, speed quality and strength quality as its index, and proposed a data fusion algorithm based on network to achieve effective monitoring of the data related to muscle strength control training. In this paper, the traditional muscle strength control training method and the muscle strength control training method based on NS and MSIF were used to carry out the training, and the data changes of various indicators in sports skills, speed quality and strength quality of male and female athletes before and after the experiment were compared. The results showed that compared with the traditional muscle strength control training method, the method proposed in this paper can effectively improve the sports skills, speed quality and strength quality of male and female athletes, which also provided a new idea for the future research direction.

Although there are some restrictions, there are a lot of potential applications for the research on athlete muscular strength control training based on network security and multi-source information fusion. 1) Technical application complexity: A number of sensors and data processing devices are used in multi-source information fusion technology. High standards for synchronization and integration must be met, and data confidentiality and integrity must be guaranteed. Issues with network security cannot be disregarded. 2) Inadequate individualized training: Every athlete has different muscular strength requirements and training characteristics. It's possible that incomplete consideration of individual characteristics in current studies leads to inadequate training outcomes.

Author contributions: Conceptualization, ZZ and JC; methodology, ZZ; software, JC; validation, ZZ and JC; formal analysis, ZZ; investigation, ZZ; resources, ZZ; data curation, JC; writing—original draft preparation, ZZ; writing—review and editing, ZZ; visualization, JC; supervision, ZZ; project administration, JC; funding acquisition, ZZ. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by Key Research on Humanities and Social Sciences in Colleges and Universities in Anhui Province (SK2021A0169); Key Project on Natural Science Research in Colleges and Universities in Anhui Province (2022AH050697); Ministry of Education Industry-University Cooperation Collaborative Education Program（231007186152202）.

Ethical approval: Not applicable.

Conflict of interest: The authors declare no conflict of interest.

References

1. Walsh NP. Recommendations to maintain immune health in athletes. European Journal of Sport Science. 2018; 18(6): 820-831. doi: 10.1080/17461391.2018.1449895
2. Foskett RL, Longstaff F. The mental health of elite athletes in the United Kingdom. Journal of Science and Medicine in Sport. 2018; 21(8): 765-770. doi: 10.1016/j.jsams.2017.11.016
3. Carnevale Pellino V, Lovecchio N, Puci MV, et al. Effects of the lockdown period on the mental health of elite athletes during the COVID-19 pandemic: a narrative review. Sport Sciences for Health. 2022; 18(4): 1187-1199. doi: 10.1007/s11332-022-00964-7
4. Li L, Li C. RETRACTED ARTICLE: Design and Implementation of Track and Field Training Information Collection and Feedback System Based on Multi-sensor Information Fusion. EURASIP Journal on Advances in Signal Processing. 2021; 2021(1). doi: 10.1186/s13634-021-00773-z

5. McCubbin AJ, Cox GR, Costa RJS. Sodium Intake Beliefs, Information Sources, and Intended Practices of Endurance Athletes Before and During Exercise. International Journal of Sport Nutrition and Exercise Metabolism. 2019; 29(4): 371-381. doi: 10.1123/ijsnem.2018-0270
6. Mukhammedovich JV. Psychological Features of Competitive Motivation of Athletes. Central Asian Journal of Literature, Philosophy and Culture. 2022; 3(11): 312-314.
7. Tashpulatov FA. Student Sports as a Factor in the Preparation of Highly Qualified Athletes. European Journal of Business Startups and Open Society. 2022; 2(2): 18-23.
8. Wegierska AE, Charitos IA, Topi S, et al. The Connection Between Physical Exercise and Gut Microbiota: Implications for Competitive Sports Athletes. Sports Medicine. 2022; 52(10): 2355-2369. doi: 10.1007/s40279-022-01696-x
9. Ruuskanen O, Luoto R, Valtonen M, et al. Respiratory Viral Infections in Athletes: Many Unanswered Questions. Sports Medicine. 2022; 52(9): 2013-2021. doi: 10.1007/s40279-022-01660-9
10. Podlogar T, Wallis GA. New Horizons in Carbohydrate Research and Application for Endurance Athletes. Sports Medicine. 2022; 52(S1): 5-23. doi: 10.1007/s40279-022-01757-1
11. Campa F, Gobbo LA, Stagi S, et al. Bioelectrical impedance analysis versus reference methods in the assessment of body composition in athletes. European Journal of Applied Physiology. 2022; 122(3): 561-589. doi: 10.1007/s00421-021-04879-y
12. Hull JH, Mike L, Martin S. Respiratory health in athletes: Facing the COVID-19 challenge. The Lancet Respiratory Medicine. 2020; 8(6): 557-558.
13. Abdullaev M. Methodology of application games in the training of young athletes. American Journal of Social and Humanitarian Research. 2020; 1(4): 118-127.
14. Garthe I, Maughan RJ. Athletes and Supplements: Prevalence and Perspectives. International Journal of Sport Nutrition and Exercise Metabolism. 2018; 28(2): 126-138. doi: 10.1123/ijsnem.2017-0429
15. Sharma S, Drezner JA, Baggish A, et al. International recommendations for electrocardiographic interpretation in athletes. European Heart Journal. 2017; 39(16): 1466-1480. doi: 10.1093/eurheartj/ehw631
16. Lv Z, Qiao L, Wang Q, et al. Advanced machine-learning methods for brain-computer interfacing. IEEE/ACM Transactions on Computational Biology and Bioinformatics. 2020; 18(5).
17. Lv Z, Singh AK, Li J. Deep Learning for Security Problems in 5G Heterogeneous Networks. IEEE Network. 2021; 35(2): 67-73. doi: 10.1109/mnet.011.2000229
18. Ramu N, Pandi V, Lazarus JD, et al. A Novel Trust Model for Secure Group Communication in Distributed Computing. Journal of Organizational and End User Computing. 2020; 32(3): 1-14. doi: 10.4018/joeuc.2020070101
19. Gatenby R. A Win-win Situation between Sports and Natural Environment Protection Based on the Theory of Cooperation and Competition. Nature Environmental Protection. 2021; 2(3): 50-58. doi: 10.38007/NEP.2021.020306
20. Chen D, Wawrzynski P, Lv Z. Cyber security in smart cities: A review of deep learning-based applications and case studies. Sustainable Cities and Society. 2021; 66: 102655. doi: 10.1016/j.scs.2020.102655
21. Cvitić I, Peraković D, Periša M, et al. Novel Classification of IoT Devices Based on Traffic Flow Features. Journal of Organizational and End User Computing. 2021; 33(6): 1-20. doi: 10.4018/joeuc.20211101.oa12