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RESEARCH ARTICLE

Common Sports Injuries of Track and Field Athletes Using Cloud Computing and Internet of Things

Quantao He[1] · Xiongfei Li[2] · Wenjuan Li[1]

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Abstract

Cloud computing and the Internet of Things (IoT), are popular technologies on the Internet. They can connect everything with the Internet and have a huge role in promoting social development. This paper aimed to conduct an in-depth study on the common sports injuries of track and field athletes by studying the related algorithms of cloud computing and the IoT, and selected the cluster analysis method, so that it can better serve the analysis of human movement. The problem studied in this paper is to find out how to improve the efficiency of clustering algorithms, especially the ability to process high-dimensional data. A motion algorithm system that is suitable for analyzing human sports injuries. This paper gave a general introduction to the cluster analysis algorithm in cloud computing and IoT, made a detailed analysis of the common sports injuries of track and field athletes, and applied the cluster analysis method to the analysis of human sports injuries. The basic principle is to use mathematical methods to quantitatively determine the relationship between samples based on their own attributes and certain similarity or difference indicators, and cluster the samples according to the degree of this relationship. The introduction of this method greatly enhances the efficiency of clustering algorithms, especially the ability to process high-dimensional data, which is suitable for analyzing human sports injuries. Based on the experiments in this paper, it can see that this paper took 70 track and field athletes from a high school as the research object, and conducted a more detailed analysis of the nature, location and causes of their common sports injuries. The computational and Internet of Things (IoT) based research method for common athletic injuries among track and field athletes proposed in this article is higher than the multi-level model method, with a speed of about 10% faster and an accuracy of 18% higher than the multi-level model method. The experimental results in this paper showed that using cloud computing and IoT as the basic methods to study common sports injuries of track and field athletes can obtain richer experimental data and make the analysis of results more scientific and credible, which has practical significance for the study of human sports injuries.

Keywords Track and field athletes · Sports injuries · Cloud computing · Internet of Things

1 Introduction

IoT and cloud computing are Internet application technologies with a wide range of applications. With the feature that everything can be connected to the Internet, it has greatly facilitated the lives of the public. Some scholars believed that IoT was the third trend in the development of the information industry and has a profound impact on social development [1, 2].

Athletics is an indispensable sport nowadays, and it is even closely related to the daily life of the public. Athletics, as a competitive sport, has different degrees of competitive pressure in different events. However, to maintain their excellent sports status, athletes are prone to some post-exercise injuries. Therefore, predicting them is also a key research project. Athletics is a national sport, to obtain better results, there are many scholars who analyze track and field athletes. It usually studies how to obtain the best performance, and also studies the common injuries of athletes, but

✉ Xiongfei Li
xjwu_153t@luohuedu.net

Quantao He
hequantao@szu.edu.cn

Wenjuan Li
2200371014@email.szu.edu.cn

[1] Sport School of Shenzhen University, Shenzhen 518000, Guangdong, China

[2] Guangdong Justice Police Vocational College, Guangzhou 510520, Guangdong, China

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rarely combines cloud computing and IoT for further analysis [3, 4]. This paper was based on cloud computing and IoT to analyze the common sports injuries of track and field athletes, so as to further explore the development of track and field sports and sports injuries and other related aspects.

In this paper, cloud computing and IoT are used as relevant research methods for common sports injuries of track and field athletes, and relevant algorithms are used to analyze the experimental data and obtain practical conclusions. The innovation of this paper is that this paper is based on the related algorithms of cloud computing and IoT, and conducts related research on common sports injuries of track and field athletes.

2 Related Works

Track and field athletes are prone to physical injuries, so there are many studies on common sports injuries in track and field athletes. Asperti et al. [5] organized the athletes to fill out the injury monitoring system questionnaire to obtain the relevant data information of 396 athletes in the 2013 season. Through specific analysis, he can thought that the probability of an athlete being injured during the game far exceeds the probability of being injured during the practice process. During the game, the injury caused by player contact is the most, while the injury caused by non-player contact during the practice process is more. The study of Makubuya et al. [6] estimated the relative risk of sports injuries by pre-competition assessments of Ugandan athletes. He found that athletes who were measured had a lower risk of developing sports injuries than those who were not evaluated. Nunes et al. [7] conducted a survey of records of athletes treated in sports specialist physiotherapy centres. The survey involving 1090 patients showed that the most common type of injury was joint injury. Purser et al. [8] believed that cross country and track and field have high injury rates, but it was difficult to have specific criteria for predicting future injuries. Therefore, he conducted a study of 15 athletes to determine whether hip strength is associated with injury risk and functional movement screen scores. Because track and field is a national sport and an all-around sport, it can promote physical and mental health and is closely related to people's lives. Therefore, there are many scholars who have studied it, but researchers mostly conduct surveys based on the nature of questionnaires, and rarely combine with cloud computing and IoT.

Cloud computing and IoT technology are the research objects that are widely discussed by many scholars. The study of Subhakala et al. [9] mainly built smart villages through the combination of IoT and artificial intelligence, and connects villages through the Internet to build smart villages. Shiny et al. [10] believed that the existing water tank control system can help reduce water waste, but the sensor cannot determine the exact change of the water level, and there are some unstable factors. Therefore, it was proposed to use IoT to monitor the water level. Nasution and Fajar [11] believes that IoT is inseparable from cloud computing. Due to the low cost and strong reliability of cloud computing, it has more advantages than traditional computing methods and can be widely used in meteorology and other fields. Therefore, a new type of IoT weather detection system has been developed. Yi [12] conducted a detailed analysis of the development of the logistics industry. Combined with the current form of economic development, IoT and cloud computing are used as the basic research methods to further optimize the intelligent logistics information management system. To build a cold chain monitoring system that can improve the cold chain logistics distribution system, Chen [13] fully integrated IoT and cloud computing in the process. IoT and cloud computing are widely used data analysis methods. Because of its wide application range and strong permeability, it is especially suitable for the transmission industry. Therefore, there are certain limitations in the research projects using it, such as less research on human motion.

3 Cloud Computing and IoT Methods for Common Sports Injuries of Track and Field Athletes

Cloud computing and the Internet of Things methods can play an important role in calculating sports injuries. It can analyze the common sports injuries of track and field athletes in detail, and apply the clustering analysis method to the analysis of human sports injuries.

3.1 Common Sports Injuries of Track and Field Athletes

Athletics is a basic sports project, and it is also the foundation of various sports, involving running, jumping, throwing, and race walking, etc., and these activities involve the daily life of the public [14, 15]. However, the lack of scientific understanding of track and field events can easily cause sports injuries and affect the training quality of athletes. It is an important factor affecting the promotion or retirement of athletes [16]. Among them, the common track and field injuries of athletes include: ligament strain, muscle injury, joint and bone injury [17, 18]. Injuries caused by racing are rare, but sprinting is more likely to cause injury than long-distance running, and it is generally more related to leg injuries. Throwing events are generally prone to injuries between the shoulders, elbows, waist, and knees [19]. Factors causing sports injuries include, but are not limited to, the strength of sports training, the conditions of the sports environment, and the mastery of sports techniques [20, 21].

3.2 Cloud Computing

Cloud computing, as a new concept of network application, is a system resource that can be accessed in a shared resource library without space limitations in the Internet. Therefore, it is usually possible to obtain higher and faster levels of information technology with less operational constraints [22, 23]. As a comprehensive distributed computing, it can better cope with the classification and processing of massive data, so as to provide users with faster computing services. Because cloud computing has virtualization technology, it can break through the limitations of time and space and complete the connection between the physical platform and the application space [24]. Cloud computing services include software as a service, platform as a service and infrastructure as a service. Users do not need very professional knowledge and skills to use cloud computing services, which reduces the maintenance effort of related aspects, thereby reducing the basic cost in the early stage [25, 26]. The resource utilization of cloud computing is very high, usually does not cause idle resources, and has high reliability with multiple redundant sites.

3.3 Internet of Things

IoT is a derivative of the Internet, which is a technical way to connect the Internet with the real world. The main function is to connect many factors with the network, so that the network can obtain relevant information. At the same time, it realizes the detection and management of objects through the network, and finally enables objects to acquire the ability of intelligent management [27]. IoT can be seen as the third development trend of the information industry, focusing on user experience and the connectivity between things, and the connection between things and things is its most significant feature. When IoT is connected, it generally uses radio frequency identification and laser scanning. According to a certain communication agreement, it communicates items with the Internet to achieve intelligent management and monitoring. Figure 1 is the basic hierarchical structure diagram of IoT.

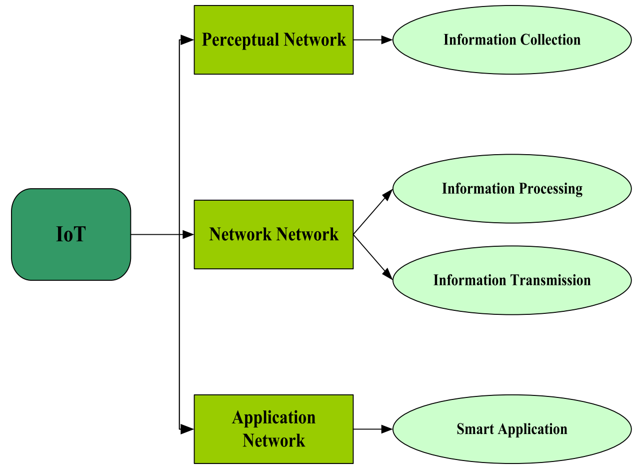


Fig. 1 Basic hierarchy diagram of IoT

Since this paper discusses common sports injuries of track and field athletes, based on the perspective of cloud computing and IoT, the method of cluster analysis is used to analyze the experimental data in this article. Computation is the premise of cluster analysis, which can divide data into several categories according to data characteristics, involving many fields. The clustering process is a process in which the components in the same group are constantly increasing due to the similarity, and the members in different groups are constantly decreasing due to the similarity, which belongs to an unsupervised learning process. The clustering process is different from the classification process and is similar to the data pre-processing process. The characteristics to be based on can be clearly identified before the classification is carried out, which can be used as a preliminary step in data processing. Generally speaking, cluster analysis includes: hierarchical method, partition method and grid method. According to the similarity of the defined data, the distance range between the sample points can be described. The following are the more commonly used distance metrics:

Standard Euclidean distance: It is a more commonly used way to measure distance. For example, the formula for the distance between $o = (o_1, \cdots, o_k)$ and $p = (p_1, \cdots, p_k)$ is:

$$d(o,p) = \sqrt{(o_1 - p_1)^2 + (o_2 - p_2)^2 + \cdots (o_k - p_k)^2} \tag{1}$$

Then in a two-dimensional plane, the Euclidean distance between two points is:

$$d_{12} = \sqrt{(o_1 - o_2)^2 + (p_1 - p_2)^2} \tag{2}$$

In three-dimensional space, the Euclidean distance between two points is:

$$d_{12} = \sqrt{(o_1 - o_2)^2 + (p_1 - p_2)^2 + (q_1 - q_2)^2} \tag{3}$$

If it finds the Euclidean distance between two vectors, it should be:

$$d_{12} = \sqrt{\sum_{i=1}^{k} (o_{1i} - o_{2i})^2} \tag{4}$$

Manhattan distance: It mainly refers to L1 distance or city block distance. The measurement content generally refers to the sum of the lengths of the line between two points in the plane rectangular coordinate system projected to the two-dimensional plane. Assuming that there are two points $(o_1, p_1), (o_2, p_2)$ in a plane rectangular coordinate system, the Manhattan distance is:

$$|o_1 - o_2| + |p_1 - p_2| \tag{5}$$

However, the Manhattan distance between the two vectors is:

$$d_{12} = \sum_{i=1}^{k} |o_{1i} - o_{2i}| \tag{6}$$

Minkowski distance: Its essence is not a distance measure, but simply a distance definition. Therefore, assuming that there are two k-dimensional variables, the Min's distance between $a(o_{11}, o_{12}, \dots o_{1k}), (o_{21}, o_{22}, \dots o_{2k})$ is:

$$d_{12} = \sqrt[y]{\sum_{i=1}^{k} |o_{1i} - o_{2i}|^y} \tag{7}$$

Among them, when $y = 1$, it is the Manhattan distance; when $y = 2$, it is the Euclidean distance; when $y = 3$, it is the Chebyshev distance.

Normalized Euclidean distance: The simple Euclidean distance is improved to form a standardized Euclidean distance, which can reduce the deviation of the measurement distance and make the standardization to mean = 0 and variance = 1:

Among them, the mathematical expectation of sample O is s, and the standard deviation is m, then the standardized variable of O − "O*" can be expressed as:

$$O *= \frac{O - s}{m} \tag{8}$$

Therefore, the normalized Euclidean distance of these two k-dimensional vectors $a(o_{11}, o_{12}, \dots, o_{1k}), b(o_{21}, o_{22}, \dots, o_{2k})$ is:

$$d_{12} = \sqrt{\sum_{i=1}^{k} (\frac{o_{1i} - o_{2i}}{m_i})^2} \tag{9}$$

Angle cosine: It is mainly used to measure the difference in the direction of two vectors, usually used in machine learning to measure the difference between two samples.

Assuming that there are vectors $e(o_1, p_1)$ and $f(o_2, p_2)$ in the plane rectangular coordinates, the formula for the cosine of the included angle is:

$$\cos\theta = \frac{o_1 o_2 + p_1 p_2}{\sqrt{o_1^2 + p_1^2}\sqrt{o_2^2 + p_2^2}} \tag{10}$$

Then the cosine of the included angle of the two k-dimensional samples $e(o_{11}, o_{12}, \dots, o_{1k}), f(o_{21}, o_{22}, \dots, o_{2k})$ is:

$$\cos(\theta) = \frac{e \cdot f}{|e||f|} \tag{11}$$

Then the degree of similarity can be expressed by the cosine angle as:

$$\cos(\theta) = \frac{\sum_{i=1}^{k} o_{1i} o_{2i}}{\sqrt{\sum_{i=1}^{k} o_{1i}^2}\sqrt{\sum_{i=1}^{k} o_{2i}^2}} \tag{12}$$

When the value range of the angle cosine is [− 1, 1], the smaller the value, the larger the angle between the vectors. When the value is 1, the two vector directions are exactly the same, and when the value is -1, the directions are opposite.

There are many clustering algorithms, so there are many ways to measure the pros and cons of clustering algorithms, including the following: hierarchical method, partition method, density-based method and grid-based method. Among them, the hierarchical method refers to the clustering method obtained by hierarchical decomposition of known data, which is divided into split decomposition and composite decomposition. In this decomposition process, the measurement of data distance generally adopts the following methods:

The minimum distance is:

$$d_{\min}(r_n, r_l) = \min_{y \in r_n, y' \in r_l} |y - y'| \tag{13}$$

The maximum distance is:

$$d_{\max}(r_n, r_l) = \max_{y \in r_n, y' \in r_l} |y - y'| \tag{14}$$

The mean distance is:

$$d_{mean}(r_n, r_l) = |s_n - s_l| \tag{15}$$

The average distance is:

$$d_{avg}(r_n, r_l) = \frac{1}{k_n, k_l} \sum_{y \in r_n} \sum_{y' \in r_n} |y - y'| \tag{16}$$

The working algorithm formula of the system proposed in this paper is as follows:

$$f(x) = d/O^* + \sum_{n=1}^{\infty} \left(a_n \cos\frac{n\pi x}{L} + dy_{max} \sin\frac{n\pi x}{L} \right) \tag{17}$$

d is a standardized European distance.

Among them, s_n is the average value of r_n, and k_n is the number of data in r_n. Because the hierarchical method is clear, it is simple and easy to understand. Because there are many processes, it is easy to produce results with low clustering quality due to the behavior of some parts that do not handle the distance well.

The k-means algorithm is a more popular algorithm in the clustering algorithm, because of its fast convergence speed and simple algorithm program, it is widely used in the processing of massive data. However, since the clustering center of the algorithm is not easy to select, the number is required to be clearly specified, and it is very sensitive to noise. Therefore, when these problems exist, the k-means algorithm should not be used. The basic network model is shown in Fig. 2.

4 Experiment on Common Sports Injuries of Track and Field Athletes

4.1 Introduction to Basic Situation

Athletics involves the daily life of most of the public and is closely related to national health. With the scientific popularization of track and field in various countries and the surging fitness boom, the number of people participating in track and field sports has gradually increased. As a result, the number of professional track and field athletes and amateur track and field athletes has also gradually increased. However, the popularity of track and field has increased, and the frequency of athlete-related injuries has gradually increased, which has raised public concerns about track and field [28].

The data comes from a middle school in Beijing in the third quarter of 2020. Based on the exploration of common sports injuries of track and field athletes to achieve the purpose of prevention and rehabilitation training, this paper conducts a related survey on 70 track and field athletes in a high school. In this article, 100 athletes were randomly selected from a high school, and 70 of them met the requirements of this study after screening. Therefore, this article conducted a study on these 70 athletes. The basic situation is shown in Figs. 3 and 4 [the unit of weight: kilogram (kg); the unit of height: centimeter (cm)]:

According to the relevant data in Fig. 3, in the data survey of track and field athletes, there are 31 women and 39 men, and a total of 70 high school track and field athletes participated in the survey. Among the 70 track and field athletes, 18 were under 60 kg. Among them, 14 were female and 4

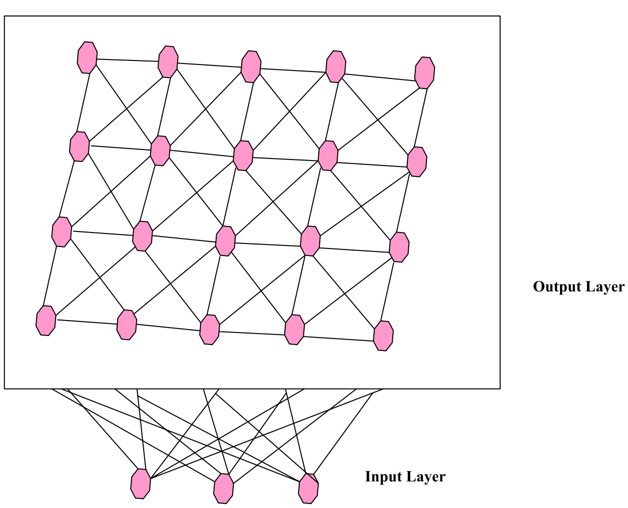


Fig. 2 The basic network model of k-means

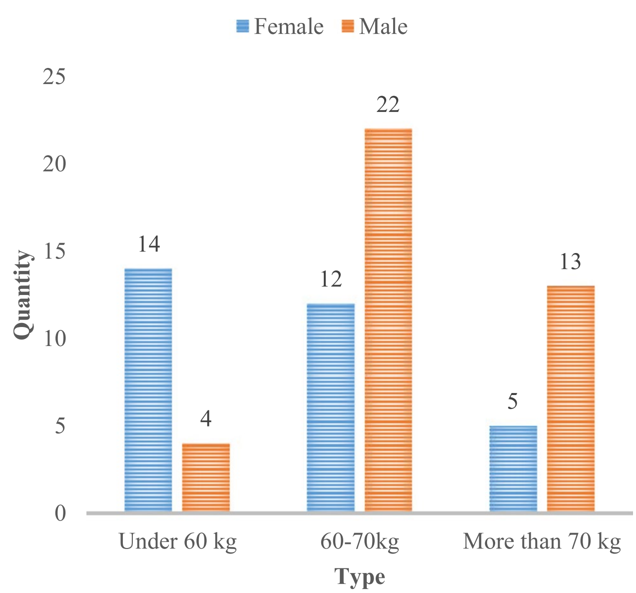


Fig. 3 Weight chart of 70 track and field athletes

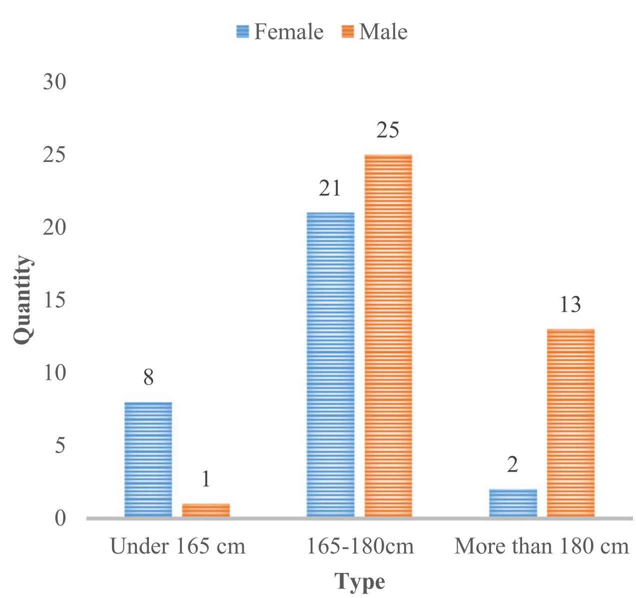


Fig. 4 The height of 70 track and field athletes

were male, accounting for 25.7% of the total; 34 were in the range of 60–70 kg. Among them, 12 were women and 22 were men, accounting for 48.6% of the total. The number of people weighing more than 70 kg was 18, including 5 women and 13 men, accounting for 25.7% of the total number. To sum up, among the 70 athletes, the weight of women is mainly below 70 kg, while the weight of men is mainly above 60 kg, which is very related to the weight of the bones and the proportion of muscles of the athletes.

According to the data in Fig. 4, the height of these 70 track and field athletes is mainly concentrated in the range of 165–180 cm. The number of people with a height below 165 cm is the least, only 9 people, accounting for 12.9% of the total number, of which the number of women is the largest, with 8 people. The number of people with a height of more than 180 cm is in the middle, there are 15 people, accounting for 21.4% of the total number, among which the number of men is the largest, with 13 people.

4.2 Experimental Design

This article examines common injuries among track and field athletes. Therefore, after a basic understanding of the relevant conditions of 70 athletes, the data of the athletes' acute injury, the basic situation of the nature of the injury, the location of the injury and the main causes of the injury were selectively counted. This paper combines cloud computing and cluster analysis to analyze.

4.2.1 Basic Situation of Acute Injury of Athletes

Athlete injury is a relatively common situation. This part of the content counts the basic situation of female athletes and male athletes when acute injuries occur within three months, as shown in Tables 1 and 2:

It can be seen from Tables 1 and 2 that the research on acute injuries in this experiment mainly involves injuries caused by professional sports, injuries caused by amateur sports and daily sudden injuries. Combining with Table 1, it can be seen that among the 31 women investigated in this experiment, acute sports injuries were mainly caused by professional sports, and there were 17 women, accounting for 54.8% of the women. The number of people who occurred in amateur sports was 12, accounting for 38.7% of the number of women; the number of sports injuries mainly caused by emergencies was 2 people, accounting for 6.5% of the number of women.

Table 1 Basic information on acute injuries of 31 female athletes

	Quantity	Proportion
Professional sports	17	54.8%
Amateur sports	12	38.7%
Daily emergencies	2	6.5%

Table 2 Basic information on acute injuries of 39 male athletes

	Quantity	Proportion
Professional sports	23	59%
Amateur sports	12	30.8%
Daily emergencies	4	10.2%

Combining with Table 2, it can be seen that among the 39 males investigated in this experiment, acute sports injuries were mainly caused by professional sports, and there were 23 males, accounting for 59% of the male population. The number that occurred during amateur sports was 12, accounting for 30.8% of the male population. The number of sports injuries mainly caused by emergencies was 4, accounting for 10.2% of the male population. Combining Tables 1 and 2, it can be seen that the acute injury of athletes is the largest in professional sports. The second is leisure activities, which are mainly related to the relevant state of the athlete when exercising. The number of sports injuries caused by emergencies is relatively small, which is an accidental event.

4.2.2 Cause of Damage

This article explores the causes of sports injuries in 70 athletes, which is beneficial to prevent and reduce the frequency of track and field sports injuries, as shown in Table 3:

According to the injury cause table in Table 3, the reasons for the injuries of these track and field athletes include but are not limited to: insufficient preparation activities, excessive training intensity, inappropriate use of sports skills, poor physical fitness of the athletes and others. Among them, the number of athletes injured due to insufficient preparation activities is the largest, with 25 people, including 11 women and 14 men, accounting for 35.7% of the total number. The second reason is that during training activities, the overall training intensity is high, which exceeds the athlete's own ability. There are 16 people in this part, including 7 women and 9 men, accounting for 22.9% of the total number. The number of sports injuries caused by inappropriate sports

Table 3 List of causes of damage

	Female	Male
Insufficient preparation activities	11	14
Excessive training intensity	7	9
Improper sports technique	5	10
Poor physical fitness	6	5
Other	2	1

skills was 15, accounting for 21.4% of the total. Another direct cause related to sports injuries also includes the physical fitness of the athletes themselves. Athletes with poor physical fitness are more likely to increase the probability of sports injuries, in this experiment. The number of sports injuries caused by this aspect was 11, accounting for 15.7% of the total. The number of sports injuries caused by other reasons is relatively small, including but not limited to: unscientific guidance by coaches and athletes' own physical fitness.

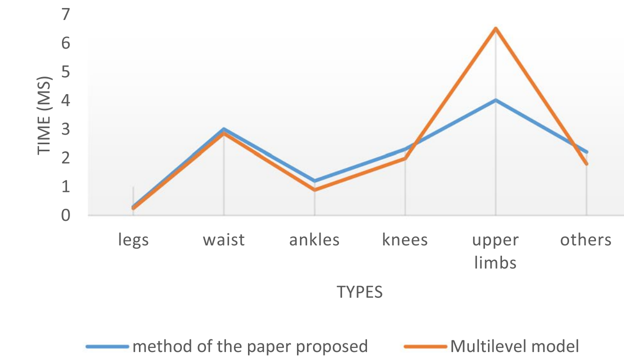
Sports injuries are extremely harmful to athletes, especially those that are prone to recurring, which are very tormenting to athletes physically and mentally. It not only affects the mentality of the athlete during the game, but also affects the athlete's performance on the field. Athletes have a high probability of injury. If the causes of sports injuries are not identified and corresponding measures are formulated, this would bring a devastating blow to the sports career of athletes.

4.3 Experimental Results

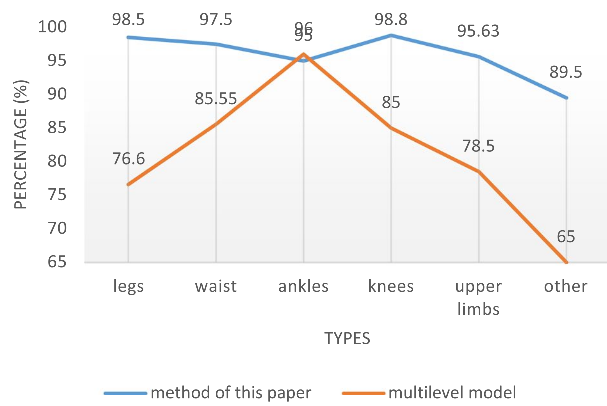
This article uses the research method of common sports injuries for track and field athletes based on cloud computing and the Internet of Things as the experimental group. The hierarchical linear model in the multi-level model is the control group of this article's experiment, while comparing the athlete's legs, waist, ankle, knee, upper limb, and other six parts for speed and accuracy comparison experiments.

As can be seen from Fig. 5, both in terms of speed and accuracy, from the overall perspective, the computational and Internet of Things (IoT) based research method for common sports injuries of track and field athletes proposed in this article is higher than the multi-level model method, with speed being about 10% faster than the multi-level model method, and accuracy being 18% higher than the multi-level model method.

Therefore, athletes need to have corresponding injury prevention measures during daily training. First of all, coaches, as teachers who provide athletes with skills and methods, and as experienced seniors, need to help athletes as much as possible and build awareness of prevention for athletes. It is necessary to arrange the preparatory activities reasonably, with moderate intensity and warm-up preparations. People should always pay attention to the mental state of athletes and provide care. People need coaches and athletes to master the relevant knowledge of scientific rehabilitation training after sports injuries. People should pay special attention to the relationship between physical training and special training, and the ratio should be balanced. The most important thing is the need to correct the timing and method of recovery after the occurrence of cognitive impairment.



A. Speed comparison experiment



B Precision comparison experiment

Fig. 5 Experimental comparison of speed and accuracy under different research methods

5 Discussion

This paper effectively combined cloud computing, IoT, and research on common injuries in track and field athletes. This was a further expansion of the application field of cloud computing and IoT-related algorithms, and it is also a further extension of the data analysis of human sports injuries. Based on the research purpose of this paper, it is combined with the basic situation of 70 track and field athletes in a high school to conduct a specific analysis. Combined with the cluster analysis method in cloud computing, the content of the investigation is divided into damage nature, damage location, damage cause and so on. This paper conducted in-depth research on the actual situation of 70 track and field athletes, put forward relevant suggestions for athletes to prevent sports injuries, and taps the research potential of cloud computing and IoT in human sports injuries. In addition, based on the existing cloud computing and IoT algorithms, the cluster analysis algorithm is selected to further explore the causes and prevention methods of human sports injuries. Combined with 70 high school track and field athletes for in-depth analysis, the final conclusions about the common sports injuries of track and field athletes are drawn.

6 Conclusion

Combined with the analysis of this case, the following conclusions can be drawn: Cloud computing and IoT are comprehensive Internet technologies that can be applied to the study of sports injuries. Exploring common sports injuries of track and field athletes has always been a hot topic, and the combination of cloud computing and IoT on human movement is also a current research direction. Therefore, to combine cloud computing with IoT and the research on common sports injuries of track and field athletes, it is necessary to understand and enrich the knowledge of related algorithms and how to apply cloud computing and IoT technology. By applying it to related research on sports injuries, it enriches the scientific knowledge in the field of sports. Of course, there are also shortcomings in this article. First, this article takes 70 athletes as the research object, and the experimental results obtained are not scientific enough; Second, the cloud computing and IoT used in this article as the basic methods for studying common sports injuries of track and field athletes have not been compared with other existing research methods proposed by scholars, and it is difficult to see the advantages of this method.

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Author Contributions This research was mainly completed under the initiation of QH. QH played an important role in the writing and literature review of this research. XL played an important role in the proofreading of this research. WL contributed to this research. The collection and collation of research data played an important role.

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Availability of Data and Materials Data are available in this study.

Declarations

Conflict of Interest The authors declare that they have no competing interests.

Ethical Approval and Consent to Participate Not applicable.

Consent for Publication Not applicable.

References

1. Sun, Q.B., Liu, J., Li, S., Fan, C.X., Sun, J.J.: Internet of Things: summarize on concepts, architecture and key technology problem. J. Beijing Univ. Posts Telecommun. **33**(3), 1–9 (2010)
2. Zhang, Y., Chen, M., Liao, X.F.: Big data applications: a survey. J. Comput. Res. Dev. **50**(S2), 216–233 (2013)
3. Linas, R., Lina, S., Egidijus, Š: Features of sports performance related injuries of elite track and field athletes in Lithuania. Balt. J. Sport Health Sci. **4**(103), 24–31 (2016)
4. Chapon, J., Navarro, L., Edouard, P.: Relationships between performance and injury occurrence in athletics (track and field): a pilot study on 8 national-level athletes from sprints, jumps and combined events followed during at least five consecutive seasons. Front. Sports Act. Living **4**(5), 852062 (2022)
5. Asperti, A.M., Fernandes, T.L., Pedrinelli, A., Hernandez, A.J.: Sports injuries among amateur athletes at a Brazilian University. Acta Ortopedica Brasileira **25**(2), 93–98 (2017)
6. Makubuya, T., Lubega, S.K., Kalibbala, L.: Pre-participation evaluations and the relative risk of injuries in Ugandan sports: 1593 board #187 May 28 10:30 AM–12:00 PM. Med. Sci. Sports Exerc. **52**(7S), 423–424 (2020)
7. Nunes, G.S., Alessandro, H., Manuela, K., Zimermann, V.V., Santos, H.D.P.D., Bruna, W.: Sport injuries treated at a physiotherapy center specialized in sports. Fisioter Mov **30**(3), 577–583 (2017)
8. Purser, S., Brown, C., Huckaby, T., et al.: Ability of the functional movement screen (FMS) to predict injury in NCAA Division II track and field athletes and the association between the FMS, eccentric hip abduction strength, and injury risk. Int. J. Exerc. Sci. Conf. Proc. **2**(10), 16–16 (2018)
9. Subhakala, S., Muthulakshmi, S., Geetha, A., Dhanya, K., Nath, T.M.M.S.: Design of smart village using internet of things and cloud computing. Pak. J. Biotechnol. **14**(3), 511–513 (2017)
10. Shiny, A., Sarkar, A., Mishra, S., Pandita, S., Paul, A.: Smart water control with internet of things and cloud computing. J. Comput. Theor. Nanosci. **17**(4), 1696–1702 (2020)
11. Nasution, P.S., Fajar, A.N.: Weather monitoring services based on internet of things and cloud computing by using temperature, humidity and rainfall environment parameters. J. Theor. Appl. Inf. Technol. **96**(23), 7963–7972 (2018)
12. Yi, S.: Research on the development mode of intelligent logistics based on internet of things and cloud computing in big data era. Revista de la Facultad de Ingenieria **32**(16), 829–834 (2017)
13. Chen, Y.: The Ccms based on internet of things and cloud computing in the age of big data. Revista de la Facultad de Ingenieria **32**(13), 106–111 (2017)
14. Malliaropoulos, N., Bikos, G., Meke, M., Tsifountoudis, I., Pyne, D., Korakakis, V.: Mechanical low back pain in elite track and field athletes: an observational cohort study. J. Back Musculoskelet. Rehabil. **30**(4), 1–9 (2017)
15. Nikolaos, M., Georgios, B., Maria, M., et al.: Mechanical low back pain in elite track and field athletes: an observational cohort study. J. Back Musculoskelet. Rehabil. **30**(4), 681–689 (2017)
16. Rui, Y.: Application of force analysis method of human joints in track and field sports. Revista de la Facultad de Ingenieria **32**(9), 573–579 (2017)
17. Prasanna, A.: Assessing common sports injuries among sportsmen in Kerala. High Technol. Lett. **26**(6), 391–408 (2020)

18. Everard, C., Wadey, R., Howells, K.: Storying sports injury experiences of elite track athletes: a narrative analysis. Psychol. Sport Exerc. **56**(9), 102007 (2021)
19. Alizai, H., Engebretsen, L., Jarraya, M., Roemer, F.W., Guermazi, A.: Elbow injuries detected on magnetic resonance imaging in athletes participating in the Rio de Janeiro 2016 Summer Olympic Games. J. Comput. Assist. Tomogr. **43**(6), 981–985 (2019)
20. Hadizadeh, M., Azri, I., Mohafez, H., Hafiz, E.B., Azri, M.D.M.: Association between levels of sports participation and oral injuries among combat athletes. Revista Brasileira de Medicina do Esporte **27**(1), 75–79 (2021)
21. Wojciechowska-Maszkowska, B., Borzucka, D., Rogowska, A.M.: Comparison of balance skills, personality, and temperament of elite sports athletes and football players. J. Phys. Educ. Sport **20**(6), 3671–3683 (2020)
22. Christoph, F.S.: State-of-the-art, challenges, and open issues in the integration of Internet of things and cloud computing. Comput. Rev. **58**(7), 421–421 (2017)
23. Morawiec, P., Soltysik-Piorunkiewicz, A.: Cloud computing, big data, and blockchain technology adoption in ERP implementation methodology. Sustainability **14**(7), 3714 (2022)
24. Nandhini, J., Narmadha, A.S., Kalaiarasi, G.: Intelligent farming using internet of things and cloud computing. Int. J. Comput. Appl. **183**(8), 22–26 (2021)
25. Bellavista, P., Corradi, A., Zanni, A.: Integrating mobile internet of things and cloud computing towards scalability: lessons learned from existing fog computing architectures and solutions. Int. J. Cloud Comput. **6**(4), 393–406 (2017)
26. Yue, M., Wang, H.Y., Wu, Z.J., Liu, L.: A survey of DDoS attack and defense technologies in cloud computing. Chin. J. Comput. **43**(12), 2315–2336 (2020)
27. Ke, M., Gao, Z., Wu, Y., Gao, X., Wong, K.K.: Massive access in cell-free massive MIMO-based internet of things: cloud computing and edge computing paradigms. IEEE J. Sel. Areas Commun. **39**(3), 756–772 (2021)
28. McAleer, S., Macdonald, B., Lee, J., Zhu, W., Giakoumis, M., Maric, T., Kelly, S., Brown, J., Pollock, N.: Time to return to full training and recurrence of rectus femoris injuries in elite track & field athletes 2010–2019; a 9-year study using the British Athletics Muscle Injury Classification. Scand. J. Med. Sci. Sports **32**(7), 1109–1118 (2022)