Research on Functional Recovery of Skeletal Muscle after Exercise Injury Based on Association Rules

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Abstract: Skeletal Muscle Contusion and Delayed Injury Are Common Sports Injuries. Improper or Incomplete Recovery and Repeated Injuries Will Seriously Affect the Physiological Function of Skeletal Muscle, Cause the Decline of Human Body's Sports Ability and Even Affect Athletes' Sports Life. Therefore, It is of Practical Significance to Study the Influence of Extremely Low Frequency Magnetic Field on the Recovery Process of Sports Injuries. This Paper Proposes a Risk Assessment Method for Sports Injuries Based on Association Rules. the Data Preprocessing Method is Adopted to Process the Statistical Injury Data of High-Level Athletes in Different Competitive Events. Aiming At the Initial Index Set of Sports Injury Risk Assessment, Apriori Association Rule Analysis is Adopted to Realize the Analysis and Mining of Association Indexes That Have Influence on Sports Injury. Taking Football as an Example, This Paper Combines the Skeletal Muscle Injury Information of Some Athletes with the Competition Sports Data, and through Data Collection and Data Preprocessing, It Digs out Various Rules Related to Injuries, Thus Realizing the Application of the System.

1. Introduction

Among All Kinds of Sports Injuries, the Incidence of Muscle and Fascia Injuries is Relatively High, Reaching 21.01%[1]. Skeletal Muscle Sports Injury Directly Affects Normal Training and Competition, and Restricts the Maintenance and Development of Sports Skills. Serious Cases Will End Their Sports Career. the Regeneration Process Involves Degeneration and Necrosis of Skeletal Muscle, Structural Destruction of Muscle Fibers, Phagocytosis of Necrotic Cell Components, Activation of Satellite Cells, Division and Proliferation, Etc. to Form New Myotubular Cells and Further Develop into Muscle Fibers, Differentiation and Maturation of Regenerated Muscle Fibers, and Recovery of Muscle Functions, Etc. Epidemiological Investigation of Different Sports Shows That the Incidence of Skeletal Muscle Injury Has Its Own Differences, and Some Sports Can Reach More Than 30% [2]. It Can Be Seen That the Incidence of Skeletal Muscle Injury is Relatively High in Both General Population and Special Occupational Population. in This Case, the Study on How to Establish and Evaluate the Risk Factors of Sports Injury, to Avoid the Risk of Sports Injury as Much as Possible, to Put Forward Effective Coping Strategies for Athletes' Injury, and to Make Reasonable Training Plans for Athletes Have Certain Guiding Significance, and Have Very Important Practical Significance for Coaches and Athletes to Adjust Tactics [3]. Therefore, This Paper Studies the Recovery of Skeletal Muscle Function after Exercise Injury, in Order to Provide Reference for Exosomes as the Latest Clinical Treatment for Exercise Injury.

2. Recovery Mechanism of Skeletal Muscle after Exercise Injury

On the 1st and 2nd days after muscle injury, all animals had severe inflammatory reactions in the injured parts, which were manifested as hemorrhage, swelling and necrosis of muscle fibers, and a large number of inflammatory cells gathered and infiltrated in and around the necrotic muscle fibers. Skeletal muscle injury is mostly seen in endurance events of periodic exercise. It is a delayed injury of muscle fibers caused by repeated exercise. It is prone to eccentric contraction of skeletal muscle, which can destroy the integrity of muscular fibrous membrane and basement membrane, leading to the formation of extracellular calcium influx and local hematoma [4]. However, a small spindle, flat

or cubic monocyte between mature skeletal muscle fibers and basement membrane, namely skeletal muscle satellite cells, also known as muscle precursor cells, can be activated to differentiate into muscle fibers after injury. Three days after strain injury, regenerated muscle tube appeared at the injured site. After inflammatory reaction, muscle fibers regenerate: firstly, phagocytes remove necrotic muscle fibers and cell debris, leaving the substrate as a scaffold, and then satellite cells (myoblasts) are arranged on the substrate [5]. ELFMF can induce the changes of reactive oxygen species in myoblasts and myotubes, reduce mitochondrial membrane potential, activate the detoxification system of cells, change intracellular calcium and increase the spontaneous activity of myotubes, reflecting that elfm can selectively stimulate the repair of skeletal muscle injury. When muscle is stimulated by injury, satellite cells are activated, proliferated and expressed to differentiate into muscle cells. Finally, these cells fuse with the original skeletal muscle cells, or fuse with each other to form muscle tubes, which are added to the tail of muscle fibers to form new muscle fibers.

The regeneration ability of muscle tissue is very weak. Whether the repair after injury is complete regeneration or scar repair mainly depends on two conditions: first, whether the blood circulation in the injured area can be restored; second, whether the sarcolemma is complete and whether the muscle nuclei attached to it are alive. So as to improve the activity of biomembrane, increase aerobic metabolism, thus reducing the generation of free radicals and the like, and being beneficial to the repair of skeletal muscle injury [6]. With the change of physical and chemical conditions, the activity of regulatory factors also changes, thus affecting regeneration. Therefore, the regulatory factors controlling skeletal muscle regeneration are still under research and development. If the scope of injury is not large and the muscular membrane is sound, most of them can be completely regenerated and healed by splitting the residual myonuclear to produce myoplasm and differentiating myofibrils. If the muscle fiber is completely broken, although there is regeneration, the two broken ends cannot be directly connected and indirectly connected with fibrous tissue to heal [7]. Infiltration of leukocytes in the process of tissue inflammation involves tissue regeneration, phagocytosis of leukocytes helps to release free radicals, which can stimulate tissue decomposition. Recently, the calcium overload mechanism of muscle cell injury has been proposed. HGF transcripts can be found in both newborn myotubes and muscle satellite cells, indicating that HGF is produced by paracrine/autocrine mechanisms. HCF regulates the activity of muscle satellite cells during muscle regeneration, and can push stationary satellite cells into the cell cycle to promote the proliferation of myogenic precursor cells and inhibit their differentiation.

3. Association Rule Mining Algorithm is Integrated into Functional Recovery Management System after Skeletal Muscle Exercise Injury

The association rule mining method provides reliable decision support for studying athletes' injury laws in competitions. The algorithm of association rules is integrated into the skeletal muscle exercise injury management system, and the association and rule between valuable attributes are mined in the skeletal muscle exercise injury data set [8]. Association rules integrate database, data mining model and knowledge mining expression. The system chooses the data in the data warehouse as the object of mining, and uses the principle and method of association rules to extract the information of topological relations, and uses the specific data model to process and mine.

3.1 Functional Modules of Skeletal Muscle Exercise Injury Management System

Skeletal muscle sports injury management system stores various injury data in a database, and the system includes basic modules such as constraint condition input, injury information input, mining algorithm input, data processing, etc. Figure 1 shows the basic system model. According to the principle of association rules, the process of image formation and the details and gray level changes before and after image degradation are analyzed, the gray level change association between the original image and the changed image is mined, the maximum posterior estimation and prior calculation are carried out on the original image, and the segmentation and parameter estimation of the image area are carried out, so that the lossless restoration of the image is finally realized. The

application server is configured with corresponding data, and the data mining client, files and description files are stored on the server, so that multiple clients can simultaneously access the Web page and trigger downloading of the data mining client related thereto. In the case of such structural changes, continued heavy load exercise may cause acute or chronic muscle injury, resulting in muscle stiffness, muscle function decline and accompanying pain of varying degrees. According to the statistical results of historical injury data and the calculation method of association rules, the weight coefficient of each individual state quantity in the athletes' injury comprehensive state quantity is determined, and the score of each individual state quantity in the athletes' injury comprehensive state quantity is calculated.
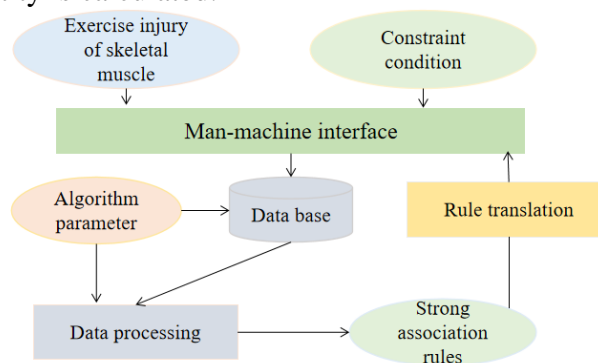
Fig.1 Skeletal Muscle Exercise Injury Management System Model

According to the requirements of sports experts, the key data items of skeletal muscle sports injuries, their data formats, optional ranges and other information are defined. The input data of this module is submitted to the database through the man-machine interface. The data management and human-computer interaction module of biochemical indexes of sports training based on association rules is the core module of the whole system. ArcSDE is used to complete the information extraction of data mining, and the components in the module are used to mine the original data. Each athlete's data is collected according to the constraint conditions. Since the mined object database contains all the objects of concern, the database also needs to collect the data of healthy athletes. The athlete data of this module is stored in the database through the man-machine interface. Such as fibroblast growth factor and platelet-derived growth factor, play an important role in muscle cell generation and muscle development. Exosomes control stem cells to tend to muscle cells through the transfer of different myogenic factors, thus promoting muscle regeneration. Apriori association rule analysis is used to analyze and mine the association indexes that have influence on sports injuries, classify and sort out the main risk state quantities of sports injuries, and construct the comprehensive state quantities of athletes' injury risks. The association rule mining algorithm is implemented by code as an independent function of association rule mining in the system.

3.2 Implementation of Mining Algorithm

The user inputs the injury name F related to the rule to be mined, the minimum support minsup and the minimum confidence mincon of the association rule from the terminal. The system preprocesses and calls up all records in the injury information database. Among them, the server of application layer Web is responsible for receiving the requests sent by coaches, training centers and decision makers of sports bureaus through browsers, and then transmitting them back to browsers according to the data acquired by the database server, thus realizing the design of the system framework. Registered in a two-dimensional array in memory, Apriori algorithm is used to generate frequent k- itemsets with support greater than minsup, and all itemsets containing F are extracted and included in these k- itemsets. Targeted delivery occurs during the humoral regulation of motor reflex. Studies have shown that exosomes derived from brain cells and neural stem cells can play an effective role in repairing neurological diseases. According to the statistical results of historical injury data and the calculation method of association rules, the weight coefficient of each individual state quantity in the athletes' injury comprehensive state quantity is determined, and the score of

each individual state quantity in the athletes' injury comprehensive state quantity is calculated. Principal component analysis can reduce the dimension of such indexes, express the original indexes through comprehensive indexes, and simplify complex indexes into simple comprehensive indexes.

Since the association rules cannot distinguish the continuous numerical data of historical sports injuries, the statistical historical sports injury data need to be discretized, and the statistical sports injury data are classified by the normalization processing method, namely:

$$y = (x - H_{min})/(H_{max} - H_{min}) \tag{1}$$

Where: x and y are respectively used to describe the judgment threshold of injury grade of athletes after normalization; Hmin and Hmax respectively represent the lowest and highest values of the sports injury judgment level.

Furthermore, the correlation between frequent itemsets of sports injury risk factors is analyzed, and important association rules are obtained by introducing interest degree model. Considering the association rules of multiple factors that analyze athletes' injury and injury data, there are:

$$I(A \Rightarrow B) = \frac{P(B \mid A)}{P(B)} = \frac{S(A \cup B)}{S(A)S(B)} \tag{2}$$

Where: S(A)= P(A) represents the probability that the athlete injury risk factor a appears in the injury risk factor transaction set t; S(B)= P(B) is used to describe the probability of occurrence of injury risk factor b in injury risk factor transaction set t; P(B| A) is used to describe the probability of occurrence of b under the condition of occurrence of injury risk factor a; S (ab) represents the probability of simultaneous occurrence in frequent itemsets containing injury risk factors a, b.
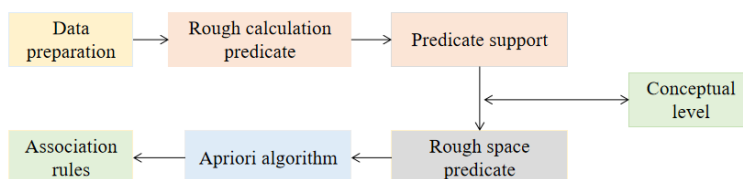

Fig.2 The Concrete Flow of Association Rule Data Mining Algorithm.

The Apriori association rule analysis method is adopted. In the first stage, the frequent itemsets of all items in the observed athlete injury data set are searched iteratively layer by layer. In the second stage, strong association rules satisfying the lowest confidence level are mined from the frequent concentration of injury risk factors. When mining association rules data, it is necessary to combine data characteristics and adopt data mining algorithm. the specific process is shown in fig. 2. Rehabilitation exercise after injury can maintain the exercise adaptability of cardiovascular function and metabolism, prevent various diseases caused by stopping training, and prevent disuse muscular atrophy and bone and joint changes. Exercise therapy can cause changes in actin in troponin and improve muscle strength. In order to find out the correlation between the injury data with the given minimum support and confidence threshold, the frequent item data sets of injury risk factors are mined from the injury risk factor data sets of athletes. The increase of intracellular calcium can cause cell damage and death, and the imbalance of calcium can cause the generation of free radicals, which can also cause muscle damage to muscle cell membrane. Association rules with confidence greater than mincon are strong association rules, which are finally communicated to users through the rule translation module. The system updates the records in the injury information database in real time to ensure that the system can dig out the latest and most accurate rules.

4. Application Example

4.1 Data Collection

Take football as an example. As a competitive sport, football is relatively easy for athletes to get injured. Injury information includes the following basic data items: gender, age, cumulative playing

time, cumulative running distance, cumulative fouls, cumulative tackles, injury type.

4.2 Association Rule Mining

The minimum support degree and the minimum confidence degree are set at 0.1 and 0.6 respectively 0.6,Apriori algorithm mines the rules of muscle strain, ankle fracture and meniscus injury respectively, as shown in Table 1. Over-training of athletes leads to a significant decline in their physical strength and coordination ability. Under normal circumstances, more skilled athletes are also likely to make mistakes in technical movements and cause injuries. Inflammatory cell infiltration foci were occasionally seen in the exhaustive centrifugal exercise group immediately after exercise. Inflammatory cell infiltration increased one day after exercise, muscle fibers were unclear in light and shade, muscle fiber necrosis occurred two days after exercise, and blood stasis of small vessels was obvious.

Table 1 Association Rules For Muscle Strain.

Rules	Cumulative running distance	Cumulative fouls	Support (%)	Credibility (%)
1	C1	D1	15	100
2	C6	D5	10	100
3	C3	D7	10	85

We can give some inferences based on the above association rules table, for example, through rules inference: athletes with a history of muscle strain are prone to relapse of old injuries even if they do not have long cumulative running distance and more cumulative fouls; Many coaches and athletes believe that during the training process, insufficient stretching preparation activities lead to poor muscle strength and body coordination, which is easy to cause injuries, while excessive preparation activities in the early stage also easily cause body fatigue, which causes athletes to cause injuries during the training and competition. In the normal training group, apoptosis and necrosis cells increased. At the end of one week, the apoptotic and necrotic cells increased significantly, and at the later stage, the apoptotic and necrotic cells decreased somewhat. At the same time, the author found by electron microscopy that in the control group, the sarcomere structure of skeletal muscle tissue was normal, the myofilaments were orderly arranged, and paired bright zone mitochondria were visible. After appropriate functional recovery, not only the possibility of muscle injury relapse is reduced, but also the physical strength can be further enhanced. However, the timing of recovery training is relatively complicated, which should be comprehensively considered according to the recovery of basic functions of injured limbs, the severity of injury and the relationship between injury and sports events.

5. Conclusions

In this paper, association rule mining is applied to the study of skeletal muscle sports injuries. Through the analysis of the injuries of a football team, the internal relations between various injuries and sports data are mined, so that the competition time of athletes can be adjusted accordingly, but the final mining result is not a sufficient and necessary condition. The mechanism and mechanism of the repair effect of damaged cells should be the focus of research. At the same time, attention should be paid to whether the body's participation in exercise causes changes in the secretion quantity and contents of exosomes, and how exosomes participate in the repair and regeneration of damaged cells after exercise injury. Skeletal muscle injury and healing is a complicated process, and the focus in the future will be to study the relationship between growth factor dosage and healing quality, the synergistic effect of various factors, inhibition of muscle fibrosis, microenvironment for regulating growth factor action, auxin gene combined with stem cell therapy, etc. It is believed that with the deepening of exosomes research, its application prospect in clinical treatment of sports injuries will be even wider.

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