EVIDENCE-BASED SPORTS MEDICINE TO PREVENT KNEE JOINT INJURY IN TRIPLE JUMP

MEDICINA ESPORTIVA BASEADO EM EVIDÊNCIAS PARA PREVENIR FERIMENTOS NA ARTICULAÇÃO DO JOELHO NO SALTO TRIPLO

MEDICINA DEPORTIVA BASADA EN EVIDENCIAS PARA PREVENIR LESIONES EN LA ARTICULACIÓN DE LA RODILLA EN EL TRIPLE SALTO

Original Article
Artigo Original
Artículo Original

Shaowei Wang[1]
(Physical Education Professional)
Buwei Lyu[2]
(Physical Education Professional)

1. College of Physical Education, Hebei Normal University, Hebei, China.
2. Department of Public Physical Education, Hebei Normal University, Hebei, China.

Correspondence:
Buwei Lyu
Hebei, China. 050024.
lyubuwei@163.com

ABSTRACT

Introduction: Triple jump has high technical requirements. However, in recent years, the frequent knee injuries during the training of triple jump athletes have seriously impacted their training and competition levels. Objective: This article proposes a method for modeling knee joint injury caused by triple jump athletes overtraining based on an improved principal component analysis algorithm. It also studied the relationship between movement amplitude and sports injury. Methods: We obtained the optimal hyperplane showing data on the relationship between sports injury and joint motion range through the triple jump in the decision table. Then, the relationship model between the two was established. The article estimated the principal components of triple jump athletes' knee joint injuries and established an accurate model relating the overtraining of these athletes and their knee joint injuries. Results: The accuracy of improved algorithm modeling is closer to that of physical examination outpatient records than to that of traditional algorithm modeling. Conclusion: The relationship model between triple jump injury and joint motion range was established using the improved algorithm. This model can greatly improve the accuracy of the relationship between the two and can effectively prevent triple jump injuries. ***Level of evidence II; Therapeutic studies - investigation of treatment results.***

Keywords: Sports; Range of Motion, Articular; Sports Injuries.

RESUMO

Introdução: As exigências técnicas do salto triplo são significativas. Contudo, nos últimos anos, ferimentos no joelho de atletas durante o treino de salto triplo tem impactado na sua preparação e seu nível competitivo. Objetivo: Esse artigo propõe um método para modelagem do ferimento na articulação do joelho causado pelo sobretreinamento de atletas de salto triplo, com base num algoritmo aprimorado para análise de componente principal. Métodos: Obtivemos, na tabela decisória, um hiperplano otimizado, mostrando dados sobre a relação entre o ferimento esportivo e a amplitude do movimento articular ao longo do salto triplo. Em seguida, foi estabelecido um modelo relacional entre esses elementos. Estimou-se os principais componentes das feridas na articulação do joelho de atletas de salto triplo e estabeleceu-se um modelo preciso, relacionando o sobretreinamento desses atletas e tais feridas articulares. Resultados: A precisão do algoritmo de modelagem aprimorado se mostrou mais próxima dos resultados do exame físico ambulatorial que dos resultados da modelagem por algoritmo tradicional. Conclusão: Um modelo de relação entre o ferimento no salto triplo e a amplitude do movimento da articulação foi estabelecido usando-se o algoritmo aprimorado. Esse modelo pode aumentar consideravelmente a precisão das relações entre esses elementos e efetivamente prevenir contra ferimentos no salto triplo. **Nível de evidência II; Estudos terapêuticos – investigação de resultados de tratamento.**

Descritores: *Esportes; Amplitude de Movimento Articular; Lesões do Esporte.*

RESUMEN

Introducción: Las exigencias técnicas del triple salto son significativas. Sin embargo, en los últimos años, lesiones en las rodillas de atletas durante el entrenamiento del triple salto han impactado en su preparación y en su nivel competitivo. Objetivo: Este artículo propone un método para modelar la lesión en la articulación de la rodilla causada por el sobreentrenamiento de atletas de triple salto, con base en un algoritmo mejorado para análisis de componente principal. Métodos: Obtuvimos, en la tabla decisiva, un hiperplano optimizado, mostrando datos sobre la relación entre la lesión deportiva y el rango del movimiento articular a lo largo del triple salto. Seguidamente, fue establecido un modelo relacional entre estos elementos. Se estimaron los principales componentes de las lesiones en la articulación de la rodilla de atletas de triple salto y se estableció un modelo preciso, relacionando el sobreentrenamiento de estos atletas y tales lesiones articulares. Resultados: La precisión del algoritmo de modelo mejorado se mostró más cercana a los resultados del examen físico ambulatoria que de los resultados del modelo por algoritmo tradicional. Conclusión: Un modelo de relación entre la lesión en el *triple salto y el rango del movimiento de la articulación fue establecido usándose el algoritmo mejorado. Este modelo puede aumentar considerablemente la precisión de las relaciones entre estos elementos y efectivamente prevenir contra lesiones en el triple salto.* ***Nivel de evidencia II; Estudios terapéuticos – investigación de resultados de tratamiento.***

Descriptores: *Deportes; Rango del Movimiento Articular; Traumatismos en Atletas.*

DOI: http://dx.doi.org/10.1590/1517-8692202228032021_0481 Article received on 11/03/2021 accepted on 11/23/2021

INTRODUCTION

Reducing the occurrence of sports injuries during exercise has become a hot issue that needs to be studied in the field of sports. In the study of reducing sports injury, the joint motion range is closely related to sports injury. Therefore, obtaining the relationship between joint motion range and sports injury has become a hot issue that needs to be studied in sports. This has received extensive attention from many experts and scholars.[1] At this stage, the main models of the relationship between joint motion amplitude and sports injury include the ant colony algorithm, grey neural network algorithm, an unscented Kalman filter algorithm. The most important is the relationship model between joint motion amplitude and sports injury based on the unscented Kalman filter algorithm. Because the model of the relationship between joint motion range and sports injury has a good development space in sports, it has received the attention of many experts. This has become a hot issue for everyone to study, and it has a huge potential for development.

There is a very high random state in the inherent relationship between sports injury and joint motion amplitude.[2] Many factors change the injury, including the different angles of the exercise, the environment in which the exercise is located, etc. The so-called modeling method in the traditional sense only uses previous data and information. A way to complete statistics without considering other constraints. This leads to inaccurate modeling effects.

Based on this, we propose a rough set decision-making algorithm that reflects the relationship between sports injury and joint motion amplitude to prevent the problems of traditional statistical methods. The so-called rough set related theoretical content is the simple and detailed processing of all the data information of sports injury and the data information of joint motion amplitude. In this way, the corresponding decision table can be obtained.[3] The optimal hyperplane showing the relationship between sports injury and joint motion amplitude can be obtained through the motion data in the decision table. In this way, the constraint conditions that the optimal hyperplane meets can be obtained, and the relationship model can be established. After experiments, we have concluded that establishing a model of the relationship between sports injuries and joint motion amplitudes through improved algorithms can greatly improve the accuracy of the relationship between the two, and it can effectively prevent sports injuries.

METHOD

The correct expression of the relationship between sports injury and joint motion amplitude and the establishment of a relationship model can provide data support for preventing sports injuries in the field of sports. We need to choose a suitable relationship model to estimate the relationship between sports injury and joint motion amplitude.[4] The relationship model between the two is a strongly nonlinear system. The general form of the equation of state is expressed as:

$$x_{k+1} = f(x_k, u_k) + \omega_k \tag{1}$$

$$y_k = g(x_k, u_k) + \upsilon_k \tag{2}$$

The motion state vector is denoted as x, the input variable is denoted as u, and the observable output variable is denoted as y. The process error and observation error of the relational model are denoted as ω and υ. The motion ability of the joint is embodied by the motion state of the joint, which is defined as:

$$SoC_t = S_0C_0 - \frac{1}{C_a}\int_0^t \eta_i I_{L,\tau} dt \tag{3}$$

The initial value of the joint motion state is $S_0 C_0$, and the instantaneous joint motion capability is I_L. We discretize it as follows:

$$SoC_k = S_0C_{k-1} - \frac{\eta_i I_{L,\tau}\Delta t}{C_a} \tag{4}$$

Select different types of sports injury combination models can be expressed as:

$$y_k = K_0 + K_1 SoC_k + K_2 / SoC_k + K_3 \ln(SoC_k) + K_4 \ln(1 - SoC_k) - R_0 I_L \tag{5}$$

The instantaneous exercise capacity is y_k, the type of sports injury is R_0, and the five constants of the motion state are denoted as K_0, K_1, K_2, K_3, K_4. In summary, we can build a model of the relationship between sports injury and joint motion amplitude to obtain the relationship between the two.

RESULTS

This article selects the movement data of city A in the last three years as the basic data to carry out the simulation.[5] The research subjects selected nine sports items. The basic data is shown in Table 1.

Using traditional and improved algorithms to establish psoas muscle injury and various item relationship models, respectively, the results can be expressed in Table 2.

Using the improved algorithm to establish a model of the relationship between joint motion range and psoas muscle injury is much more accurate than traditional algorithm modeling.[6] Using a traditional

Table 1. Exercise data table.

Sports	2018	2019	2020
1	123	123	123
2	323	333	456
3	456	445	334
4	654	787	445
5	555	980	787
6	678	675	980
7	907	621	456
8	121	432	654
9	165	123	555

algorithm and improved algorithms to establish the relationship model of knee joint injury and various items can use Table 3 to express the results.

Using the improved algorithm to establish a relationship between the joint motion range and the knee joint injury is much more accurate than the traditional algorithm.

Table 2. Correlation degree of joint motion range and psoas muscle injury.

Sports	Number of injured	Traditional algorithm	Improve algorithm
1	11	22	11
2	32	34	32
3	44	22	44
4	15	43	15
5	22	27	22
6	34	33	34
7	23	98	23
8	12	3	12
9	10	11	10

Table 3. Comparison of the correlation between the range of joint motion and knee joint injury.

Sports	Number of injured	Traditional algorithm	Improve algorithm
1	11	22	11
2	32	34	32
3	44	22	44
4	15	43	15
5	22	27	22
6	34	33	34
7	23	98	23
8	12	3	12
9	10	11	10
1	11	22	11
2	32	34	32

DISCUSSION

Establishing exercise data decision table

The so-called rough set theory is an important basis for analyzing uncertain and incomplete information.[7] After the useful information and redundant information are determined, the spatial dimension of the input information is reasonably simplified, so that knowledge reduction can be performed without changing or increasing the classification ability. Based on the above data information, we build a sports data decision table. See the following process content for details:

Abstracting motion data as a data information system is the rough set attribute reduction method. The specific representation is as follows:

$$S = (U, A, V, f) \tag{6}$$

The collection of motion data is U. The attribute set of motion data is A. This is abbreviated as the indistinguishable relationship between $Ind\ (B)$, x_i and x_j as an equivalence relationship. Approximate space properties are not equally important in many situations.[8] There is a great correlation between some attributes, and these are redundant information. This requires larger storage space, wastes a lot of resources, and prevents people from making accurate and simple judgments. So we need to implement attribute reduction.

Modeling the relationship between joint motion amplitude and sports injury

Because SVM has a strong predictive level, SVM is used to establish a model of the relationship between joint motion amplitude and sports injury.[9] SVM forms an optimal hyperplane when the training set is linearly separable:

$$(\omega * \varphi(x)) + b = 0 \tag{7}$$

This optimal hyperplane must not only meet the following constraints:

$$y_i[\omega * \varphi(x_i) + b] \geq 1, i = 1, 2, \cdots, l \tag{8}$$

It is also necessary to obtain the minimum value of the following function:

$$\varphi(\omega) = \frac{1}{2}\|\omega\|^2 \tag{9}$$

The optimal hyperplane can be obtained by solving the optimization problem:

$$\sum_{SV} y_i a_i^0 k(x_i, x) + b_0 = 0 \tag{10}$$

The support vector is SV. The Lagrange multiplier is a_i^0. The kernel function is $k\ (x_i,x)$.

We use the kernel function to replace the inner product operation to map from low-dimensional to high-dimensional space.[10] Because the training parameters SVM formed by the radial basis kernel function are relatively less and easier to select, the kernel function of SVM adopts the radial basis kernel function. Through the method mentioned above, a model of the relationship between joint motion range and sports injury can be established to obtain the correlation between the two. This can prevent sports injuries.

CONCLUSION

We use the rough set decision-making algorithm to realize the relationship between joint motion amplitude and sports injury. According to the rough set theory, all the joint motion range and sports injury data are simplified and organized to obtain the corresponding decision table. Calculate the optimal hyperplane between the joint motion amplitude and the relationship between the motion injury and the motion data contained in the decision table. Obtain the constraint conditions required by the optimal hyperplane to establish its relationship model. Experiments show that using the improved algorithm to establish a model of the relationship between joint motion amplitude and sports injury can greatly increase the accuracy of the expression of the above two relationships. This can effectively prevent the occurrence of Triple jump injuries.

All authors declare no potential conflict of interest related to this article

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. Shaowei Wang: writing and performing surgeries and data analysis and performing surgeries; Buwei Lyu: article review and intellectual concept of the article.

REFERENCES

1. Allen AN, Wasserman EB, Williams RM, Simon JE, Dompier TP, Kerr ZY et al. Epidemiology of secondary school boys' and girls' basketball injuries: National Athletic Treatment, Injury and Outcomes Network. Journal of athletic training. 2019;54(11):1179-86.
2. Bond CW, Dorman JC, Odney T, Roggenbuck SJ, Young SW, Munce TA. O. Evaluation of the functional movement screen and a novel basketball mobility test as an injury prediction tool for collegiate basketball players. The Journal of Strength & Conditioning Research. 2019;33(6):1589-600.
3. Owoeye OB, Emery CA, Befus K, Palacios-Derflingher L, Pasanen K. How much, how often, how well? Adherence to a neuromuscular training warm-up injury prevention program in youth basketball. Journal of Sports Sciences. 2020;38(20):2329-37.
4. Post EG, Rosenthal MD, Root HJ, Rauh MJ. Sport specialization behaviors are associated with history of reported injury in youth basketball. Journal of Pediatric Orthopaedics. 2021;41(8):507-13.
5. Claudino JG, de Oliveira Capanema D, de Souza TV, Serrão JC, Pereira ACM, Nassis GP. Current approaches to the use of artificial intelligence for injury risk assessment and performance prediction in team sports: a systematic review. Sports medicine-open. 2019;5(1):1-12.
6. Sola M, Gregov C. Injury epidemiology in the first Croatian basketball league. Kinesiology. 2021;53(1):162-71.
7. Freitas PS, Santana TS, Manoel LS, Serenza FDS, Riberto M. A comparison of isokinetic rotator cuff performance in wheelchair basketball athletes vs. non-athletes with spinal cord injury. The journal of spinal cord medicine. 2021;44(4):557-62.
8. Piedra A, Peña J, Ciavattini V, Caparrós T. Relationship between injury risk, workload, and rate of perceived exertion in professional women's basketball. Apunts Sports Medicine. 2020;55(206):71-9.
9. Post EG, Biese KM, Schaefer DA, Watson AM, McGuine TA, Brooks MA et al. Sport-specific associations of specialization and sex with overuse injury in youth athletes. Sports Health. 2020;12(1):36-42.
10. Carrasco-Huenulef C, Moran J. Effects of a neuromuscular training program on anterior cruciate ligament injury risk factors in youth female basketball players: a pilot study. Gazzetta Medica Italiana Archivio per le Scienze Mediche. 2019;178(3):137-44.