INJURIES BY FATIGUE FROM AEROBIC TRAINING IN JUMPING ATHLETES

LESÕES CAUSADAS POR FADIGA ORIUNDAS DE TREINOS AERÓBICOS EM ATLETAS DE SALTO ESPORTIVO

LESIONES CAUSADAS POR FATIGA ORIGINADA POR EL ENTRENAMIENTO AERÓBICO EN ATLETAS DE SALTO DEPORTIVO

Original Article
Artigo Original
Artículo Original

Zhendi Wen[1]
(Physical Education Professional)

1. Boda College Jilin Normal University, Physical Education College, Siping, China.

Correspondence:
ZhenDi Wen
Siping, China. 136000.
wenzhendi121577@163.com

ABSTRACT

Introduction: The increasingly tense and aggressive competition in the competitive sports field has led to a continuous increase in the athletes' exercise load. Sports injuries resulting from this increased load are also increasing. Research in this area helps prevent jumping sports injuries and guides protocols for treatment. Currently, research on sports injuries in athletics jumping events is relatively rare. Objective: This paper examines sports injuries in sport jumping athletes. Methods: This article investigates injuries in 16 vault athletes with 5 to 10 years of training. Results: Distance jumping is a significant risk factor for anterior cruciate ligament injuries. The risk of injury when landing on one foot is more significant than when landing on both feet. Especially when the body is in a state of neuromuscular fatigue, this will significantly increase the risk of anterior cruciate ligament injury. Conclusion: Excessive local exercise load, incorrect technical movements, and physical fatigue are the leading causes of sports injuries. Coaches should organize training and competitions reasonably. Athletes need to reinforce the protection of the knees, ankles, and other frequently injured parts. ***Evidence Level II; Therapeutic Studies - Investigating the result.***

Keywords: Athlete; Athletic Injuries; Sports; Endurance Training.

RESUMO

Introdução: A competição cada vez mais tensa e feroz no campo esportivo competitivo tem levado a um aumento contínuo da carga de exercícios dos atletas. As lesões esportivas resultantes desse aumento de cargas também estão aumentando. Pesquisas nessa área ajudam a prevenir lesões esportivas de saltos e guiam protocolos de tratamento. Atualmente, as pesquisas sobre lesões esportivas em provas de atletismo em salto esportivo são relativamente raras. Objetivo: Este artigo analisa as lesões esportivas dos atletas de salto esportivo. Métodos: Este artigo investiga as lesões esportivas em 16 atletas em salto esportivo com 5 a 10 anos de treino. Resultados: Salto à distância é um fator de risco significativo para lesões do ligamento cruzado anterior. O risco de lesão ao pousar em um pé é mais significativo do que ao pousar em ambos os pés. Especialmente quando o corpo está num estado de fadiga neuromuscular, isso aumentará significativamente o risco de lesão do ligamento cruzado anterior. Conclusão: Excessiva carga de exercício local, movimentos técnicos incorretos e fadiga física são as principais causas de lesões esportivas. Os treinadores devem organizar treinamentos e competições razoavelmente. Os atletas precisam reforçar a proteção dos joelhos, tornozelos e outras partes frequentemente lesionadas. ***Nível de evidência II; Estudos Terapêuticos - Investigação de Resultados.***

Descritores: *Atleta; Traumatismos em Atletas; Esportes; Treino Aeróbico.*

RESUMEN

Introducción: La competición cada vez más tensa y feroz en el ámbito deportivo competitivo ha llevado a un aumento continuo de la carga de ejercicio de los atletas. Las lesiones deportivas derivadas de este aumento de las cargas también están aumentando. Investigaciones en este ámbito ayudan a prevenir las lesiones deportivas por salto y a orientar los protocolos de tratamiento. En la actualidad, investigaciones sobre las lesiones deportivas en las pruebas de salto del atletismo son relativamente escasas. Objetivo: Este artículo examina las lesiones deportivas en atletas de salto. Métodos: Este artículo investiga las lesiones deportivas en 16 atletas de salto deportivo con 5 a 10 años de entrenamiento. Resultados: Los saltos de distancia son un factor de riesgo significativo para las lesiones del ligamento cruzado anterior. El riesgo de lesión al aterrizar sobre un pie es más importante que al aterrizar sobre los dos pies. Especialmente cuando el cuerpo se encuentra en un estado de fatiga neuromuscular, esto aumentará significativamente el riesgo de lesión del ligamento cruzado anterior. Conclusión: La excesiva carga de ejercicio local, los movimientos técnicos incorrectos y la fatiga física son las principales causas de las lesiones deportivas. Los entrenadores deben organizar los entrenamientos y las competiciones de forma razonable. Los atletas necesitan reforzar la protección de rodillas, tobillos y otras partes que se lesionan con frecuencia. ***Nivel de evidencia II; Estudios terapéuticos - Investigación de resultados.***

Descriptores: *Atleta; Traumatismos en Atletas; Deportes; Entrenamiento Aeróbico.*

DOI: http://dx.doi.org/10.1590/1517-8692202228062022_0021 Article received on 01/06/2022 accepted on 02/18/2022

INTRODUCTION

The increasingly tense and fierce competition in the arena makes the athletes' exercise load continue to increase, resulting in sports injuries are also on the rise. This has seriously hindered the normal performance and improvement of athletes' technical level and has become one of the main reasons athletes are eliminated.[1] At present, the research on the mechanism and prevention of sports injuries has become the focus of research. Jumping is an advantageous event in my country's track and field events, and it has a pivotal position in the process of China's track and field sports to the world. However, the research on sports injuries of track and field jumping events is relatively rare. The article takes 16 outstanding jumping athletes as the research objects and investigates their sports injuries to determine the cause. This will facilitate us to actively and effectively do prevention and treatment work and promote jumping athletes' sports skills.[2] This can also refer to sports injury treatment and prevention for athletes of the same level and type.

METHOD

Research object

We chose 16 jumping athletes in the jumping group. 4 are males, and 12 are females, aged 15-25.[3] The training period is 5-10 years.

Predictive modeling and simulation of severe sports injury parts

Goodness-of-fit test

We use the regression function statistics of the vulnerable body parts to predict the sample regression function to measure the fitting degree of the sample regression to the sample observation value. Equation (1) represents the sum of squared deviations of the observed values of vulnerable body parts TSS.

$$TSS = \Sigma(Y_i - \overline{Y})^2 \quad (1)$$

Equation (2) represents the regression sum of squares of the observed values of samples of vulnerable body parts

$$TSS = \Sigma(\hat{Y}_i - \overline{Y})^2 \quad (2)$$

Equation (3) represents the sum of squared residuals of the observation values of vulnerable body parts

$$TSS = \Sigma(Y_i - \hat{Y}_i)^2 \quad (3)$$

But

$$R^2 = \frac{ESS}{TSS} = 1 - \frac{RSS}{TSS} \quad (4)$$

R^2 represents the coefficient of determination. The closer this statistic is to 1, the higher the fit of the prediction model.

Significance test of the overall linearity of the equation (F test)

Under the condition that the initial hypothesis H_0 is established, we express the regression function statistics of the sample to predict vulnerable body parts as

$$F = \frac{ESS/k}{RSS/(n-k-1)} \quad (5)$$

It obeys the F distribution of the degree of freedom $(k, n - k - 1)$. TSS represents the sum of squared deviations of the observed value of the vulnerable body part sample is

$$TSS = \Sigma(Y_i - \overline{Y})^2 \quad (6)$$

The regression sum of squares of the sample observations is

$$ESS = \Sigma(\hat{Y}_i - \overline{Y})^2 \quad (7)$$

The sum of squared residuals of the sample observations is

$$RSS = \Sigma(Y_i - \hat{Y}_i)^2 \quad (8)$$

Therefore, the significance level a is set. The critical value obtained by looking up the table is $F_a\ (k, n - k - 1)$. Obtain the value of the F statistic based on the sample.[4] Reject or accept the initial hypothesis by testing $F > F_a\ (k, n - k - 1)$. From this it is determined whether the overall linear relationship of the initial equation holds.

RESULTS

Athlete injury rate

Eight out of 16 people were injured, and the prevalence rate was 50%. The injury rate of each special item is quite different.[5] The most injured are high jump and long jump, both with a probability of 75%. The triple jump and pole vault are less, with the probability of 20% and 33.3%. (Table 1)

Nature of injury

We found a total of 9 cases of 6 types of injuries. The injury of each special project is quite different.[6] There were 5 cases of knee joints, 2 cases of ankles, and 1 case of waist and abdomen. (Table 2)

Injury course and condition

The proportion of rapid and slow changes is the highest, with a probability of 50%. Among injuries, the proportion of moderate injuries is the highest.[7] The probability is 87.5% (Table 3).

Cause of injury

There are 5 reasons for sports injuries. Excessive local load causes the most damage. There are 3 cases in number. Technical errors and physical fatigue are the second places. The number is 2 cases, and the rest is 1 case. (Table 4)

Table 1. List of the distribution and injury rate of the surveyed subjects.

	High jump	long jump	Triple jump	Pole vault
Male		2		
Female	3	1	1	1
Injury rate ratio/%	75	75	20	33.3

Table 2. List of injured parts and types of survey subjects.

	High jump	long jump	Triple jump	Pole vault	Number of cases	Proportion/%
Ankle sprain	1		1		2	22.2
Psoas muscle strain	1				1	11.1
Knee Fasciitis	1				1	11.1
Knee patella osteochondrosis		3			3	33.3
Knee meniscus injury			1		1	11.1
External oblique muscle strain				1	1	11.1
Total	3	3	2	1	9	100

Treatment methods and efficacy

Athletes use 5 kinds of treatment methods, 2.6 kinds per capita. The content includes manipulation, acupuncture, sealing, electroacupuncture, and ultrasound. Manipulation and acupuncture have the most treatment methods, with a probability of 38.1% and 33.3%. The closed method is the second, and electroacupuncture and ultrasonic are the least.[8] In the curative effect, the probability of good is 50%, and the probability of general and bad is 25% (Table 5).

Table 3. List of the course and condition of the investigation subjects' injuries.

	Course of disease			Injury		
	acute	Fast turn slow	Chronic	Minor injuries	Moderate injury	Seriously injured
n	2	4	2	0	7	1
Proportion (%)	25	50	25	0	87.5	12.5

Table 4. List of statistical results of the causes of injuries of the survey respondents.

	Number of injuries (n)	Injury ratio/%
Partial load is too large	3	33.3
Technical error	2	22.2
Physical fatigue	2	22.2
Inadequate preparation	1	11.1
Not focused	1	11.1
Total	9	100

Table 5. Survey results of treatment methods and efficacy statistics.

Method	n	Proportion/%
Technique	8	
Acupuncture	7	
Closed	4	
Electroacupuncture	1	
Ultrasound	1	
Curative effect	n	Proportion/%
good	4	50
generally	2	25
Difference	2	25

DISCUSSION

Etiological investigations show that sports injuries mainly come from training and competition. The main reasons are continuous training with a large amount of exercise, undifferentiated treatment in training, and excessive local load and physical fatigue during training with illness and injury.[9] For example, high jumpers are most prone to strains of the posterior thigh muscles. Often due to the athlete's effort in the final take-off. The main prevention measures are to scientifically formulate training plans and effectively organize and control training activities. Secondly, early detection of early fatigue of athletes. If athletes are found to be lack energy, dysfunction, aversion to training, etc., they should be correctly diagnosed and dealt with in time. Adjust the training plan appropriately and reduce the amount of exercise. It can be corrected by changing the content and methods of training and ensuring adequate rest.

The incorrect jumping technique causes waist injury when the waist is not well-cushioned when landing. In the triple jump, the ankle is used as a landing buffer, and it is easy to cause ankle sprain during the jump.[10] From the mechanism analysis, lumbar contusions, ankle sprains, meniscus injuries, and external oblique muscle strains are mostly caused by incorrect techniques. Biomechanical analysis is the most commonly used method for sports technical diagnosis. Improving and perfecting athletes' skills through technical analysis is an effective way to prevent injuries. Therefore, coaches should strengthen the technical training of athletes, especially the mastery of key techniques.

Acute and acute-to-chronic injuries accounted for 75% of the total number of sports injuries in the 8 athletes under investigation. The correct treatment of acute injury depends on understanding the pathological process of the injury.[11] Athletes need to master the basic principles of the treatment process and deal with different pathological processes to achieve a good treatment effect. In the treatment of chronic injuries, treatment and adjustment training should be reasonably coordinated. The athletes under investigation were moderately injured and severely injured. The injuries were serious, and it wasn't easy to heal.

Tuina and acupuncture are the most commonly used treatment methods. These are all-natural therapies of traditional Chinese medicine, which are economical, convenient, and practical. The use of sealing, electroacupuncture, ultrasound, etc., also has certain effects. Modern scientific and technological methods for treatment and recovery are changing with each passing day, and there are many reports on the treatment of athletes' injuries. There are more applications of Chinese and Western medicine external applications, magic lamps, magnetic therapy, cupping, dressing, infrared, etc.

The main task of injured athletes is to recover to return to the training ground as soon as possible. Insisting on rehabilitation is an important part of sports injury recovery. Failure to cooperate with the doctor or failure to follow the doctor's prescription is the main reason that the injury cannot be recovered as soon as possible. During the investigation, it was found that some athletes showed negative emotions due to unsuccessful things such as college promotion and employment after retirement. Foreign scholars have researched the life stress events of athletes. They believe that it is related to the occurrence of sports injuries. Athletes under stress are more likely to be injured than athletes under normal conditions, and the percentages of injuries are 68% and 38.5%, respectively. Educating and persuading athletes who are emotionally unstable in time and trying to solve their worries can avoid sports injuries caused by life stress events.

CONCLUSION

Some jumping athletes are injured in the knees, ankles, waist, and abdomen. These multiple injuries are related to the project. A high jump is a strain of the posterior thigh muscles and an ankle sprain. The long-jump is a patella injury. The triple jump is an ankle sprain and a knee meniscus injury. Pole vault is a strain of the external oblique muscle. Excessive local exercise load, incorrect technical movements, and physical fatigue are the main causes of sports injuries. Tuina and acupuncture are the most commonly used treatment methods with good results. Therefore, coaches need to arrange training and competitions scientifically. Athletes need to strengthen the protection of knees, ankles, and other parts that are frequently injured. At the same time, pay attention to athletes' technical training and technical diagnosis to consolidate and perfect the correct jumping movements. The training center needs to improve the diagnosis and treatment of acute injuries and strengthen the summary and research of treatment methods. In this way, the optimal treatment time will not be missed, and it will turn into a chronic injury and cause a long-term cure. The training center needs to establish and improve the athlete's medical system and rehabilitation system, establish a team of experienced sports training physicians and formulate a rehabilitation plan. This supervises and guides injured athletes to carry out targeted rehabilitation training.

ACKNOWLEDGMENT

Social Science Research and Planning Project of Education Department of Jilin Province: Research on development Strategy of Sports Recreation Town under the strategy of "Raural reviatization(No. JJKH20221335SK). New Liberal Arts Research and Reform Practice Project of Boda College of Jilin Normal University: Construction and Practice of Physical Education Specialty of "Healthy China" strategic Model of Combining Body Medicine(No. 80XYK202104).

The author declare no potential conflict of interest related to this article

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. ZW: writing, data analysis and article review.

REFERENCES

1. Benjaminse A, Webster KE, Kimp A, Meijer M, Gokeler A. Revised approach to the role of fatigue in anterior cruciate ligament injury prevention: a systematic review with meta-analyses. Sports medicine. 2019;49(4):565-86.
2. Tsarbou C, Liveris NI, Tsimeas PD, Papageorgiou G, Xergia SA, Tsiokanos A. The effect of fatigue on jump height and the risk of knee injury after a volleyball training game: A pilot study. Biomedical Human Kinetics. 2021;13(1):197-204.
3. Bourne MN, Webster KE, Hewett TE. Is fatigue a risk factor for anterior cruciate ligament rupture?. Sports medicine. 2019;49(11):1629-35.
4. Abergel RE, Tuesta E, Jarvis DN. The effects of acute physical fatigue on sauté jump biomechanics in dancers. Journal of Sports Sciences. 2021;39(9):1021-9.
5. Heil J, Loffing F, Büsch D. The influence of exercise-induced fatigue on Inter-Limb asymmetries: a systematic review. Sports Medicine-Open. 2020;6(1):1-16.
6. Chen YM, Wang IL, Zhou S, Tsai TY, Chiu YS, Chiu WC. Six weeks of Jilin ginseng root supplementation attenuates drop jump-related muscle injury markers in healthy female college students. Food & Function. 2021;12(4):1458-68.
7. Dornelles MP, Fritsch CG, Sonda FC, Johnson DS, Leal-Junior ECP, Vaz MA et al. Photobiomodulation therapy as a tool to prevent hamstring strain injuries by reducing soccer-induced fatigue on hamstring muscles. Lasers in medical science. 2019;34(6):1177-84.
8. Arslan S, Ertat KA, Karamizrak S, İŞleğen Ç, Arslan, T. Soccer match induced fatigue effect on landing biomechanic and neuromuscular performance. Acta Medica Mediterr. 2019;35(1):391-7.
9. Farzami A, Sadeghi H, Fattahi A. The effect of fatigue caused by consecutive jump-landing on plantar pressure characteristics during stance phase of walking in adolescent volleyball players with and without sprain ankle injury. Studies in Sport Medicine. 2019;11(25):207-22.
10. Jarvis DN, Abergel RE. What do we know about how acute physical fatigue affects movement in dancers?: a systematic review of the literature. Medical problems of performing artists. 2019;34(3):161-8.
11. Buckthorpe M. Optimising the late-stage rehabilitation and return-to-sport training and testing process after ACL reconstruction. Sports Medicine. 2019;49(7):1043-58.