

# IMPACTS OF RUNNING ON JOINTS

IMPACTOS DA CORRIDA NAS ARTICULAÇÕES

IMPACTOS DE LA CARRERA EN LAS ARTICULACIONES



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Luhua Nong<sup>1</sup>   
(Physical Education Professional)

1. Guangxi University of Science and Technology, School of Physical Education, Liuzhou, Guangxi, China.

## Correspondence:

Luhua Nong  
Liuzhou, Guangxi, China. 545006.  
Nong2688375@126.com

## ABSTRACT

**Introduction:** Running is a competitive sports activity based on speed. Its training methods aim to improve performance and physique but may lead to sports joint injuries. It is important to clarify the relationship between training methods and sports rehabilitation, including the influence of training methods on the quality of life, such as joint health. **Objective:** Explore the relationship between the influence of running training methods on joints and their sports rehabilitation. **Methods:** 44 running athletes were randomly divided into two groups. The joint and rehabilitation indices of the hip, knee, and ankle joints were recorded and statistically analyzed. **Results:** The range of flexion and extension in the sagittal plane, the range of internal and external rotation in the horizontal plane, and the running performance of the knee joints of the athletes who received the variable speed running training were improved, indicating that the running training mode improves the joint performance and sports rehabilitation level of the athletes. **Conclusion:** The appropriate running training method has a beneficial effect on the state of the joints in its athletes, including in the rehabilitation process. This effect is reflected in the physical parameters and the athlete's competitive ability. **Level of evidence II; Therapeutic studies - investigation of treatment outcomes.**

**Keywords:** Running; Physical Education and Training; Exercise Therapy.

## RESUMO

**Introdução:** A corrida é uma atividade esportiva competitiva baseada na velocidade. Os seus métodos de treinamento têm como objetivo melhorar o desempenho e o físico, mas talvez possa ocasionar lesões articulares esportivas. É de grande importância esclarecer a relação entre métodos de treinamento e reabilitação esportiva, incluindo a influência dos métodos de treinamento na qualidade de vida, como a saúde das articulações. **Objetivo:** Explorar a relação entre a influência dos métodos de treinamento de corrida sobre as articulações e a sua reabilitação esportiva. **Métodos:** 44 esportistas em corrida foram divididos aleatoriamente em dois grupos. Os índices articulares e os índices de reabilitação das articulações do quadril, joelho e tornozelo foram registrados e analisados estatisticamente. **Resultados:** A faixa de flexão e extensão no plano sagital, a faixa de rotação interna e externa no plano horizontal e o desempenho em corrida das articulações do joelho dos atletas que receberam o treinamento de corrida de velocidade variável foram melhorados, indicando que o modo de treinamento em corrida melhora o desempenho articular e o nível de reabilitação esportiva dos atletas. **Conclusão:** O método adequado de treinamento de corrida tem um efeito benéfico no estado das articulações em seus esportistas, incluindo no processo de reabilitação. Este efeito não se reflete apenas nos parâmetros físicos, mas também na capacidade competitiva do atleta. **Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.**

**Descritores:** Corrida; Educação Física e Treinamento; Terapia por Exercício.

## RESUMEN

**Introducción:** La carrera es una actividad deportiva de competición basada en la velocidad. Sus métodos de entrenamiento pretenden mejorar el rendimiento y el físico, pero pueden provocar lesiones articulares deportivas. Es de gran importancia aclarar la relación entre los métodos de entrenamiento y la rehabilitación deportiva, incluida la influencia de los métodos de entrenamiento en la calidad de vida, como la salud articular. **Objetivo:** Explorar la relación entre la influencia de los métodos de entrenamiento de carrera en las articulaciones y su rehabilitación deportiva. **Métodos:** 44 atletas corredores fueron divididos aleatoriamente en dos grupos. Se registraron y analizaron estadísticamente los índices articulares y de rehabilitación de las articulaciones de la cadera, la rodilla y el tobillo. **Resultados:** El rango de flexión y extensión en el plano sagital, el rango de rotación interna y externa en el plano horizontal y el rendimiento en carrera de las articulaciones de la rodilla de los atletas que recibieron el entrenamiento de carrera de velocidad variable mejoraron, lo que indica que el modo de entrenamiento de carrera mejora el rendimiento de las articulaciones y el nivel de rehabilitación deportiva de los atletas. **Conclusión:** El método de entrenamiento adecuado para correr tiene un efecto beneficioso en el estado de las articulaciones de sus atletas, incluso en el proceso de rehabilitación. Este efecto no sólo se refleja en los parámetros físicos, sino también en la capacidad competitiva del atleta. **Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.**

**Descriptor:** Carrera; Educación y Entrenamiento Físico; Terapia por Ejercicio.



## INTRODUCTION

As one of the sports with a long history of development, sprint sports have certain unique characteristics. It mainly takes the hip joint as the axis, and coordinates the knee joint, ankle joint and related muscles for high-speed sports.<sup>1,2</sup> The core of sprint sports is to improve the coordination and high-speed between joints, so as to obtain faster speed.<sup>3</sup> Among them, the knee joint is the key part connecting the hip joint and ankle joint in the lower limbs, and its functional strength directly affects the performance of athletes.<sup>4</sup> Whether the training mode, as a prerequisite factor to determine the athletes' Sprint status, will also affect the performance of human joints is also a question worth considering at present.<sup>5</sup> Therefore, in order to explore the relationship between the impact of sprint training methods on human joints and sports rehabilitation, this paper refers to many articles and tries to reveal the relationship between sprint training methods and human joints and sports rehabilitation, so as to provide data support for athletes' sports injury rehabilitation and performance improvement.<sup>6</sup>

## METHOD

In this paper, 44 male and Female Sprinters were selected for the experiment, and they were randomly divided into control group and experimental group, with 11 men and 11 women in each group. The study and all the participants were reviewed and approved by Ethics Committee of Guangxi University of Science and Technology (NO.2020GXUST28). Before the experiment, the joint characteristic parameters and related rehabilitation indexes of the athletes were measured. Through statistical analysis, it was found that there was no significant difference ( $P > 0.05$ ) in the above parameters of the two groups before the experiment. The specific parameter values are shown in Table 1.

Forty-four healthy sprinters were randomly divided into the experimental group and the control group, with 22 men and women in each group. The sprinters in the experimental group were trained in speed change running for 1H each time, i.e. fast sprint running, then uniform running, and finally relaxed running, while the control group was only trained in uniform running for the same length of time. The hip joint, knee joint and ankle joint of the lower limbs of the athletes are positioned and captured by the high-speed camera to ensure the accuracy and authenticity of the joint measurement angle, and the joint indexes of the two groups of athletes after the experiment, i.e. the relevant angle parameters of the hip joint, knee joint and ankle joint, as well as the sports rehabilitation indexes, i.e. the knee joint related parameters, 30m run, 100m run and standing long jump results, This paper discusses the relationship between the influence of sprint training method on knee joint and sports rehabilitation. The experiment lasted 3 months and was conducted 4 times a week.

In this study, Excel and SPSS 19.0 were used to process and analyze the data, and t-test was used to evaluate the significance of the data difference. When  $p > 0.05$ , the data was not statistically significant, and vice versa.

**Table 1.** Comparison of joint and rehabilitation indexes of two groups of athletes ( $\bar{x} \pm s$ ,  $n = 44$ ).

Category	Average hip angle (°)	Average knee angle (°)	Average ankle angle (°)	30m	100m	Standing long jump
Test group	167.26±5.4	149.08±2.1	127.97±3.8	4.55±1.3	12.35±0.1	2.71±0.1
Control group	166.35±4.2	148.27±1.9	127.16±4.1	4.65±1.6	12.56±0.2	2.62±0.2
t	0.3	0.5	1.1	0.4	0.1	1.2
p	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05

## RESULTS

### Impact of sprint training methods on human joints

As shown in Table 2, by analyzing the hip joint parameters of the athletes in the experimental group and the control group, it can be seen that the hip joint landing angle of the athletes in the experimental group after the variable speed running training is significantly increased, and the difference between the groups is not significant ( $P > 0.05$ ), but the hip flexion range is significantly increased, but there is a very significant difference between the groups ( $P < 0.01$ ), which indicates that the legs of the sprinters in the experimental group can more effectively drive the center of gravity forward when the lower limbs are off the ground, Improve body flexibility and reduce the risk of joint injury. In addition, compared with the hip flexion angle speed of the control group ( $471.67 \pm 33.3$ ) ° / s, the average hip flexion angle speed of the athletes in the experimental group was ( $559.54 \pm 51.6$ ) ° / s, indicating that the variable-speed running training increased the traction of the hip joint flexor and extensor muscles, made the leg swing faster, and reduced the off ground inclination.

It can be seen from Table 3 that the landing knee angle and the landing knee angle of the athletes in the variable speed running training experimental group are reduced by 9.21 ° and 7.26 ° respectively compared with the control group, and there are significant differences between the groups ( $P < 0.05$ ). The horizontal velocity of the knee point of the experimental group and the control group changed slightly, but there was a significant difference ( $P < 0.01$ ), and the horizontal velocity of the knee point increased by about 1.72m/s. The smaller landing and landing knee angle and knee flexion range enable the athletes to maintain higher stability during the movement, thus reducing the joint rotation amplitude and impulse. In addition, through variable speed running, the knee angle of the athletes becomes smaller, which makes the leg forward swing faster, which is also the main reason for the improvement of the horizontal speed of the knee point, and the difference between the experimental group and the control group is significant ( $P < 0.01$ ).

This study showed that the landing ankle angle and the average ankle angle of the legs of the athletes in the experimental group decreased by 5.86 ° and 5.65 ° after the variable speed running training, and there was a significant difference between the experimental group and the control group ( $P < 0.05$ ). However, the off ground ankle angle and total flexion and extension increased by 12.32 ° and 15.45 ° respectively, and the difference between the experimental group and the control group was very significant ( $P < 0.05$ ). The decrease of the landing ankle angle in the experimental group is more conducive to the buffering of the landing and the weakening of the joint impulse, while the increase of the landing ankle angle indicates that the athletes' pedaling and stretching are more efficient. Specific data are shown in Table 4.

**Table 2.** Comparison of hip joint parameters of athletes ( $\bar{x} \pm s$ ,  $n = 44$ ).

Category	Ground hip angle (°)	Ground hip angle (°)	Hip flexion (°)	Hip flexion angle speed (°/s)
Control group	168.17±6.4	137.36±5.5	31.61±8.3	471.67±33.3
Test group	169.58±7.2	118.17±5.2	48.68±7.4	559.54±51.6
t	-0.7	7.6	-6.7	-5.8
p	P>0.05	P<0.01	P<0.01	P<0.01

**Table 3.** Comparison of knee joint parameters of athletes ( $\bar{x} \pm s$ ,  $n = 44$ ).

Category	Ground knee angle (°)	Leave ground knee angle (°)	Knee flexion (°)	Horizontal speed (m/s)
Control group	62.13±10.1	88.87±7.7	20.3±6.5	11.31±0.1
test group	52.92±6.1	81.61±10.5	20.81±9.3	13.03±0.6
t	2.8	2.6	0.2	-5.3
p	P<0.05	P<0.05	P>0.05	P<0.01

**Table 4.** Comparison of ankle joint parameters of athletes ( $x \pm s$ ,  $n = 44$ ).

Category	Landing ankle angle (°)	Ankle angle off the ground (°)	Total flexion and extension amplitude (°)	Average ankle angle (°)
Control group	128.37±5.4	123.42±6.5	48.99±10.4	140.59±4.2
test group	122.51±8.5	135.74±5.9	64.44±9.7	134.94±7.1
t	2.6	-6.8	-3.4	2.2
p	P<0.05	P<0.01	P<0.01	P<0.05

### Relationship between sprint training methods and sports rehabilitation

The influence of different sprint training methods on sports rehabilitation is different. According to table 5, compared with the athletes in the control group, the range of knee joint flexion and extension in the sagittal plane and the range of horizontal rotation of the athletes in the variable speed running training are increased. The control group is only (68.48 ± 4.5) ° and (24.64 ± 6.1) °, while the experimental group is (70.8 ± 4.2) ° and (25.76 ± 7.1) °, and there is a significant difference between groups ( $P < 0.01$ ). However, different from the above results, the range of knee joint retraction in the coronal plane of the athletes in the experimental group decreased, and there was no significant difference between the groups ( $P > 0.05$ ), which indicates that the effect of sprint training on knee joint rehabilitation in the coronal plane is small. See Table 5 for details.

According to the analysis of Table 6, after the three-month variable speed running training, the 30m performance of the athletes in the experimental group increased by 0.51s, the standing long jump distance increased by 0.14m, and the 100m performance increased by 0.84s. There was a significant difference between the experimental group and the control group ( $P < 0.01$ ), and the results of the athletes in the experimental group were better than those in the control group, indicating that the appropriate sprint training method is conducive to improving the athletes' sports recovery level and competitive performance.

### DISCUSSION

From the perspective of sports physiology, the performance of each joint plays an important reference role in evaluating the competitive ability of athletes. A good joint state is the premise of exerting the competitive ability. Among them, the hip joint is the connecting point of the upper and lower limbs, and its stability and rotation range are very important for the sports process; The knee joint is a highly complex joint structure, which controls the movement of the lower limbs. The deviation of the human midline during the movement is one of the main factors causing joint injury. In addition, the knee joint pressure is closely related to the movement mode and gait, so the knee joint index is often used to measure the rehabilitation level of athletes. The importance and complexity of the knee joint can be verified not only by anatomy but also by biomechanical analysis; As the core joint of the foot, the ankle joint participates in all walking movements. Although it can buffer the external impact and stabilize the center of gravity of the human body, it also causes the ankle joint to be more vulnerable to injury. The correct training method has great reference significance for protecting joints and stabilizing joint state. Therefore, this paper takes sprint as an example to study the impact of sprint training methods on human joints. The results of this study show that the range of flexion of hip joint, knee joint and ankle joint is increased by the variable speed running training, but the increase is different. This shows that the athletes trained by the variable speed running have obtained a larger range of joint activities on the original basis, making their strides larger and their distances longer. The larger off ground ankle angle and the smaller landing knee angle

**Table 5.** Comparison of rehabilitation training indexes of athletes' knee joint ( $x \pm s$ ,  $n = 44$ ).

Category	Range of flexion and extension in sagittal plane (°)	Range of adduction and abduction in coronal plane (°)	Range of internal and external rotation in horizontal plane (°)
Control group	68.48±4.5	22.52±10.1	24.64±6.1
test group	70.8±4.2	21.41±7.7	25.76±7.1
t	14.7	1.3	7.5
p	P<0.01	P>0.05	P<0.01

**Table 6.** Comparison of sports performance of two groups of athletes ( $x \pm s$ ,  $n = 44$ ).

Category	30m acceleration run (s)	100m running (s)	Standing long jump (m)
Control group	4.65±0.3	12.67±0.2	2.79±0.1
test group	4.14±0.2	11.83±0.1	2.93±0.2
t	9.3	8.1	-3.7
p	P<0.01	P<0.01	P<0.01

make the athletes have better flexibility, reduce the inertia impulse and pressure of the joints, thereby protecting the relevant motion joints. At the same time, variable speed running can significantly increase the range of flexion and extension of ankle and hip joints, and reduce the risk of ankle joint injury. This is because compared with constant speed running training, variable speed running can provide more diversified and favorable exercise checks and balances during practice, thereby significantly improving the range of joint activity, reducing joint sliding and reducing the risk of ankle joint injury. In addition, variable speed running significantly improves the horizontal speed of the knee point, so that the athletes can get better power. While the landing angles of the hip joint and the knee joint are reduced, and the landing angles of the knee joint and the ankle joint are reduced, which improves the coordination and stability of the joint. Therefore, the coordinated movement of the knee and the ankle joint reduces the impact of the foot on the ground and avoids the collision between the foot surface and the ground. To sum up, compared with the constant speed running training, the variable speed running training has a positive impact on the lower limb joints, and improves the synergy ability of the knee, ankle and hip joints, improves the stability of the lower limb joints, and reduces the possibility of risk occurrence during the exercise.

### CONCLUSION

From the research in this paper, we can see that the sprinting training mode has a significant impact on the joint performance and sports rehabilitation level of athletes. Variable speed running training can improve the joint indexes of the landing hip angle and the landing ankle angle of the athletes, and make the knee joint swing faster, have better stability, and have stronger joint coordination ability. In addition, variable speed running training can increase the range of motion and sports performance of the athletes' knee joint, which shows that the training method of short distance running has a significant impact on the athletes' sports rehabilitation.

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