# IMPROVING SPEED AND STRENGTH IN LONG-DISTANCE RUNNING TRAINING

*APERFEIÇOAMENTO DE VELOCIDADE E FORÇA NO TREINAMENTO DE CORRIDA DE LONGA DISTÂNCIA*

*PERFECCIONAMIENTO DE LA VELOCIDAD Y DE LA FUERZA EN EL ENTRENAMIENTO DE CARRERAS DE LARGA DISTANCIA*

**Original Article**
***Artigo Original***
***Artículo Original***

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## ABSTRACT

Introduction: Long-distance running is a typical physical endurance sport. The athletes' fitness level plays a dominant and central role in the components of their competitive ability. Whether long-distance runners can win in fierce competition depends mainly on the endurance of their physical fitness. Objective: To analyze the physical training methods of long-distance runners and discuss the improvement of speed and strength of long-distance runners through physical training. Methods: This paper uses literature materials, expert interviews, and experimental methods to research the training practice of middle and long-distance runners in colleges and universities. The data collected comprised an experimental protocol performed on volunteer long-distance runners. The above research determined the effect of physical training on speed and strength in long-distance runners. Results: After the 12-week experimental intervention, the overall strength, flexibility, and flexibility of the long-distance runners were improved, and the data were statistically significant (P<0.05). The aerobic workability and anaerobic capacity of the athletes were improved through the experiment. Conclusion: Physical training can improve the speed and strength of long-distance runners. Athletes can increase physical training with this protocol in their daily training. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

**Keywords:** Physical Conditioning, Human; Running; Sports; Athletes; Aerobic Exercise.

## *RESUMO*

*Introdução: A corrida de longa distância é um esporte típico de resistência física. O nível de aptidão física dos atletas desempenha um papel dominante e central nos componentes de sua capacidade competitiva. Se os corredores de longa distância podem vencer em competições acirradas depende principalmente da resistência de sua aptidão física. Objetivo: Analisar os métodos de treinamento físico dos corredores de longa distância e discutir o aperfeiçoamento da velocidade e da força dos corredores de longa distância através do treinamento físico. Métodos: Este artigo utiliza materiais de literatura, entrevistas com especialistas e métodos experimentais para conduzir pesquisas aplicadas na prática de treinamento de corredores de média e longa distância em faculdades e universidades. Os dados coletados compuseram um protocolo experimental executado em atletas de longa distância voluntários. A pesquisa acima determinou o efeito do treinamento físico sobre a velocidade e a força dos corredores de longa distância. Resultados: Após as 12 semanas de intervenção experimental, a força geral, flexibilidade e flexibilidade dos corredores de longa distância foram aprimoradas e os dados foram estatisticamente significativos (P<0,05). A trabalhabilidade aeróbica e a capacidade anaeróbica dos atletas foram melhoradas através do experimento. Conclusão: O treinamento físico pode melhorar a velocidade e a força dos corredores de longa distância. Os atletas podem incrementar o treinamento físico com este protocolo em seu treinamento diário.* ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

***Descritores:*** *Condicionamento Físico Humano; Corrida; Esportes; Atletas; Exercício aeróbico.*

## *RESUMEN*

*Introducción: La carrera de larga distancia es un deporte típico de resistencia física. El nivel de forma física de los deportistas desempeña un papel dominante y central en los componentes de su capacidad competitiva. La posibilidad de que los corredores de larga distancia puedan ganar en competiciones feroces depende principalmente de la resistencia de su estado físico. Objetivo: Analizar los métodos de entrenamiento físico de los corredores de larga distancia y discutir la mejora de la velocidad y la fuerza de los corredores de fondo mediante el entrenamiento físico. Métodos: Este trabajo utiliza materiales bibliográficos, entrevistas a expertos y métodos experimentales para llevar a cabo una investigación aplicada a la práctica del entrenamiento de corredores de media y larga distancia en colegios y universidades. Los datos recogidos comprendían un protocolo experimental realizado en atletas voluntarios de larga distancia. La investigación anterior determinó el efecto del entrenamiento físico sobre la velocidad y la fuerza en corredores de larga distancia. Resultados: Tras la intervención experimental de 12 semanas, la fuerza, la flexibilidad y la flexibilidad generales de los corredores de fondo mejoraron y los datos fueron estadísticamente significativos (P<0,05). La capacidad de trabajo aeróbico y la capacidad anaeróbica*

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*de los atletas mejoraron con el experimento. Conclusión: El entrenamiento físico puede mejorar la velocidad y la fuerza de los corredores de larga distancia. Los atletas pueden aumentar el entrenamiento físico con este protocolo en su entrenamiento diario.* **Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.**

***Descriptores:*** *Acondicionamiento Físico Humano; Carrera; Deportes; Atletas; Ejercicio Aeróbico.*

DOI: http://dx.doi.org/10.1590/1517-8692202329012022_0298 Article received on 06/05/2022 accepted on 07/15/2022

## INTRODUCTION

Long-distance running is a physical endurance event. The physical fitness of long-distance runners is a critical factor in determining competition performance. In recent years, Chinese long-distance runners have made breakthroughs. In a series of domestic and international competitions, the training and development of long-distance running sports is a process of constantly digging out the maximum physical strength of the human body.[1] This paper explores long-distance runners' physical fitness characteristics and training methods through training experiments and applied research on sports training teams. This article provides a reference for the training practice of long-distance runners.

## METHOD

### Research objects

This paper selects 20 long-distance runners as the research object. This paper analyzes the characteristics of the training load of long-distance runners. At the same time, this paper carries out related functional physical training for long-distance runners. Before the experiment, this paper conducts 100, 400, and 800m and special endurance tests on them. In this way, we understand the initial state of the athletes and determine their specialties.[2] We then conduct a targeted training experiment for them for a and conduct regular performance tests. We compare the results obtained before and after the experiment.

### Dash model

The athlete's speed is restricted by the athlete's physical strength and resistance during the race. The resistance from the inside and outside of the race is proportional to the speed and the square.[3] From Newton's second law, the following equation holds:

$$\begin{cases} \dfrac{d\upsilon}{dt} = f(t) - a\upsilon - b\upsilon^2 \\ \upsilon(0) = 0 \end{cases} \tag{1}$$

The momentum $f(t)$ is controlled by the athlete himself. $a$, $b$ is a constant coefficient. In this paper, $f = F$ is assumed to be the athlete's most extraordinary impulse. We solve equation (1) to get:

$$\upsilon(t) = \frac{1}{2b}\left\{-a + G\tanh\left[\frac{t}{2}G + \frac{1}{2}\ln\frac{G+a}{G-a}\right]\right\} = \frac{1}{2b}\frac{(G^2-a^2)\tanh\dfrac{Gt}{2}}{G + a\tanh\dfrac{Gt}{2}} \tag{2}$$

Where $G = (4Fb + a^2)^{\frac{1}{2}}$. $E(t)$ is the oxygen-equivalent energy stored in the muscles of the body. $\sigma$ is the energy equivalent to the amount of oxygen provided per unit time. The difference between the energy $\sigma$ provided and the energy $f\upsilon$ consumed per unit time is the rate of change of the stored energy $E(t)$:

$$\begin{cases} \dfrac{dE}{dt} = \sigma - f\upsilon \\ E(0) = E_0 \end{cases} \tag{3}$$

Athletes run with maximum momentum in short distances: $f(t) = F$. We can obtain:

$$\begin{aligned} &E(t) = -0.00025t^4 + 0.00547t^3 - 0.6708t^2 + 52.0803t + \\ &\frac{F}{2b}\{at + \ln\{\tanh[0.5tG + 0.5\ln(G^2 - a^2)]^2 - 1\} - \ln\left(\frac{a^2 - G^2}{G^2}\right)\} - 2E_0 = \\ &-0.00025t^4 + 0.00547t^3 - 0.6708t^2 + 52.0803t - \\ &F\left[\frac{1}{b}\ln\frac{(G+a)e^{Gt} + (G-a)}{2G} - \frac{G+a}{2b}t\right] - 2E_0 \end{aligned} \tag{4}$$

We choose the parameter $E_0 = 2403.4J/s, a = 0.9, b = 0.01$.

### Mathematical Statistics

In this paper, SPSS16.0 statistical software was used to conduct statistics on the test data.

There is no need for a code of ethics for this type of study.

## RESULTS

Athletes showed improvements in overall strength, flexibility, and flexibility after the 12-week experimental intervention. In this paper, elastic bands and rope ladders for training have dramatically improved the athlete's interest in learning. (Table 1) Athletes can actively participate in training. The motion pattern of running has been improved-especially the posture of the arms.[4] The athlete changed from the left and right arm swing or the smaller swing arm to the front and rear swingarm. The increase in core strength corrects the side-to-side sway of the individual athlete. This makes the posture of the upper body more stable, and the effect of the gait cycle is better. The enhancement of lower body strength

**Table 1.** Exercise content for the first stage.

| Serial number | Practice movement | Load | N | Interval between sets/s |
|---|---|---|---|---|
| 1 | Swing arm back and forth while standing in place | Own weight | 2 | 90 |
| 2 | Web bridge support | Own weight | 2 | 90 |
| 3 | Back bridge support | Own weight | 2 | 90 |
| 4 | Prone straight arm lateral movement | Elastic band | 3 | 60 |
| 5 | Step forward with legs | Elastic band | 3 | 60 |
| 6 | Small step lateral movement of legs | Elastic band | 3 | 60 |
| 7 | Swing your legs straight inward | Elastic band | 3 | 60 |
| 8 | Pull forward and run-in place | Elastic band | 3 | 60 |
| 9 | One-knee kneeling single-leg back kick | Elastic band | 3 | 60 |
| 10 | Standing calf raise | Own weight | 3 | 30 |

and improved body flexibility corrected some athletes' problems such as "sitting and running," inability to lift their legs, and small strides. Athletes' aerobic work ability and anaerobic work ability are improved through practice.[5] The athlete improved the 800-meter time from 3:57 to 3:45. The athlete's 800-meter performance improved by an average of 12 seconds. The athlete's 1000m time improved from 4 minutes 11 seconds to 3 minutes 53 seconds. The athlete improved by an average of 18 seconds. (Table 2)

## DISCUSSION

### Reduce sports injuries and improve movement patterns

The economy and effectiveness of technical movements during running extensively impact performance. Improper movement and body posture can cause movement compensation, high energy consumption, and a rapid decline in physical strength.[6] The correct posture for training is conducive to optimizing the training effect. Athletes can reduce muscle imbalances and reduce joint dysfunction. Strengthening the practice of running technical movements is an effective means to reduce movement injuries. Physical motor function training emphasizes the movement mode based on the traditional physical training mode. Athletes can better recruit the muscle strength required to complete specific movements, improving the quality and efficiency of technical movements. Without a high-quality running motion pattern, the athlete will lack good stability and symmetry. In this way, compensatory actions will occur, and actions' economics will decrease.[7] Athletes cannot perform technical movements efficiently.

### Formulation and implementation of functional physical training plan

Some athletes have irregular running movements, unstable upper limbs, random arm swinging movements, poor lower limb strength, unreasonable breathing patterns, unscientific distribution of physical strength, and inconspicuous sprint running.[8] We developed a 2-stage training plan based on the class time of this semester. The first stage of the necessary strength training period is six weeks. This mainly improves the basic body movement pattern of the athlete. At the same time, the exercise at this stage can also strengthen the strength of the trunk and lower limbs and improve the coordination of the upper and lower limbs. This lays the foundation for the six weeks of speed endurance training in Phase 2.

Core strength training refers to the training of the strength, stability, balance, and other abilities of the body's core muscles and its deep small muscle groups. Good core strength can reduce the load on the limbs during exercise and reduce sports injuries. For example, the body is unstable during the backswing.[9] Weak core strength requires some muscles of the swinging leg to participate in maintaining the balance of the body. This prevents the swinging leg from being sufficiently relaxed during the backswing and increases the likelihood of straining the swinging leg during an elaborate lie on the ground. In the first stage, athletes use abdominal bridge support and hip bridge support. In the second stage, athletes use prone elbow and foot support to extend their hands and legs and supine buttocks and legs to improve core strength.

**Table 2.** Exercise content for the second stage.

| Serial number | Practice movement | Load | N | Interval between sets/s |
|---|---|---|---|---|
| 1 | Swing arm back and forth while standing in place | Own weight | 2 | 90 |
| 2 | Prone elbow and foot support | Own weight | 2 | 90 |
| 3 | Supine Hip Raise Leg Raise | Own weight | 2 | 90 |
| 4 | In situ prone straight arm internal and external support | Rope ladder | 3 | 30-60 |
| 5 | Open and close cross jump + 20m run | Rope ladder | 3 | 30-60 |
| 6 | Small step + 20-meter run | Rope ladder | 3 | 30-60 |
| 7 | High Leg Raise + 20m Run | Rope ladder | 3 | 30-60 |
| 8 | Jumping on both feet + 20 meters running | Rope ladder | 3 | 30-60 |
| 9 | Scissor Jump + 20m Run | Rope ladder | 3 | 30-60 |
| 10 | Rear Cross Forward + 20m Run | Rope ladder | 3 | 30-60 |

### Physical function and athletic quality

Bodily functions refer to the functions of various organ systems in the body. The general functional characteristics of elite long-distance runners are large lung capacity, large stroke volume, high stroke work, and high VO2 max. Sports quality mainly includes strength, speed, endurance, flexibility, and coordination quality.[10] According to the dominant factors of the competitive ability required by the middle and long-distance running sports, we found that the 800m, 1500m, 5000m, and 10000m events are all periodic endurance events. Through the analysis of many relevant kinds of literature, it can be found that the main factors that determine the performance of middle and long-distance running are the level of speed-strength, speed, and speed endurance. Speed endurance is the foundation, speed is the core, and speed strength and strength endurance are guaranteed.

Strength quality refers to the ability of the human neuromuscular system to overcome or resist resistance at work. The training theory divides athletes' strength into three types of strength: maximum strength, speed-strength, and endurance. What mid-distance runners need is not to pursue the rapid growth of maximum strength and the infinite improvement of explosive strength but to pursue the improvement of speed strength and strength endurance level.[11] Endurance quality is an essential quality of middle and long-distance runners. It can be divided into aerobic metabolic endurance, anaerobic metabolic endurance, and aerobic and anaerobic mixed endurance. In the training process of athletes, the endurance of three different metabolic energy supplies is based on each other and interdependent as a whole.[12] Speed quality refers to the ability of the human body to move quickly, which is the basis of endurance. The speed quality of middle and long-distance runners is paramount to improve their exceptional performance—exceptionally high-speed running ability and sprint running ability. In the game, it determines the performance of the athlete.

### Training suggestions for long-distance running

Functional fitness training focuses on movement patterns. It facilitates the establishment of correct proprioception and optimization of technical movements. Athletes' interest in learning can be stimulated by rope ladder combination training and elastic band combination training methods.[13] This allows the athlete to participate in the training actively. This will promote the improvement of physical fitness. Therefore, incorporating functional physical training into daily training can help improve athletes' physical fitness and skill level. This is a safe and beneficial form of training. However, functional physical training methods cannot replace traditional training methods.

## CONCLUSION

This paper takes the 800 meters for girls and the 1000 meters for boys as the research objects. In this paper, from the perspective of functional physical training, the upper body strength, core strength, and lower body strength of athletes are trained with the help of simple equipment. After 12 weeks of teaching the experiment, the athlete's oxygen supply capacity and breathing method were improved. The correct movement pattern of the athlete is consolidated. Its strength, agility, speed, endurance, and other qualities have been improved. Long-distance runners have improved their 800m and 1000m results.

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

**AUTHORS' CONTRIBUTIONS:** Each author made significant individual contributions to this manuscript. YT and ZX: writing and performing surgeries; AC, JZ and YB: data analysis and performing surgeries, article review and intellectual concept of the article.

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