# BOXING SPEED AND MUSCLE SCIENTIFIC TRAINING

*VELOCIDADE NO BOXE E TREINO MUSCULAR BASEADO EM EVIDÊNCIAS*

*VELOCIDAD EN EL BOXEO Y ENTRENAMIENTO MUSCULAR BASADO EN EVIDENCIAS*

**Original Article**
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## ABSTRACT

Introduction: Boxing is a sport that requires a lot of explosive power, that is, it demands from its practitioners not only to use their strength, but to do so very rapidly. Objective: To analyze the influence of muscle training on the explosive power of boxers, providing a theoretical reference for the training of their core strength. Methods: This article makes a statistical analysis of boxing explosive power and analyzes the factors relevant to punch speed. Results: The key factors that affect the maximum speed of the straight punch in boxing are the maximum elbow joint flexion and extension, angular velocity, and the maximum trunk angular velocity. Conclusion: In daily training, attention should be paid to upper limb strength and core strength training, which is the only way for boxers to have a correct body posture and ensure a reliable center of gravity when punching. ***Level of evidence II; Therapeutic studies - investigation of treatment results.***

**Keywords:** Boxing; Strength training; Muscle strength; Response speed.

## *RESUMO*

*Introdução: O boxe é um esporte que exige muita força explosiva, isto é, requer que seus praticantes não apenas usem sua força, mas que o façam muito rapidamente. Objetivo: Analisar a influência do treino muscular na força explosiva de boxeadores, fornecendo uma referência teórica para seu treino de força do core. Métodos: Esse artigo analisa estatisticamente a força explosiva no boxe e os fatores relevantes para a velocidade do soco. Resultados: Os fatores-chave, que afetam a velocidade máxima do soco direto no boxe, são a flexão e a extensão máxima da articulação do cotovelo, sua velocidade angular, e a velocidade angular máxima do tronco. Conclusão: No treinamento diário, deve-se considerar com atenção a força dos membros superiores e o treino da força do core. Só assim boxeadores podem conseguir uma postura correta e um centro de gravidade confiável para seus socos.* ***Nível de evidência II; Estudos terapêuticos – investigação de resultados de tratamento.***

***Descritores:*** *Boxe; Treinamento de Força; Tempo de reação.*

## *RESUMEN*

*Introducción: El boxeo es un deporte que exige mucha fuerza explosiva, es decir, requiere que sus practicantes no solo usen su fuerza, sino que lo hagan muy rápidamente. Objetivo: Analizar la influencia del entrenamiento muscular en la fuerza explosiva de boxeadores, proporcionando una referencia teórica para su entrenamiento de fuerza del core. Métodos: Este artículo analiza estadísticamente la fuerza explosiva en el boxeo y los factores relevantes para la velocidad del golpe. Resultados: Los factores clave, que afectan la velocidad máxima del golpe directo en el boxeo, son la flexión y extensión máxima de la articulación del codo, su velocidad angular y la velocidad angular máxima del tronco. Conclusión: En el entrenamiento cotidiano, se debe considerar con atención la fuerza de los miembros superiores y el entrenamiento de la fuerza del core. Solo así los boxeadores pueden conseguir una postura correcta y un centro de gravedad confiable para sus golpes.* ***Nivel de evidencia II; Estudios terapéuticos – investigación de resultados de tratamiento.***

***Descriptores:*** *Boxeo; Entrenamiento de Fuerza; Tiempo de reacción.*



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## INTRODUCTION

After introducing the new boxing rules in 2009, the training concept of "improving the clarity and strength of strikes on a fast basis" reached a broad consensus in the boxing community.[1] Emphasizing that quick punching is the core content and a guarantee for maintaining the superiority of Chinese boxing sport.

In this study, two three-dimensional force plates and the VICON-MX infrared high-speed photography system were used to collect parameters such as the athlete's front hand straight fist hitting the engineer's active kicking force stage and the lower limbs' rapid kicking force, and the punching speed.[2] The article analyzes the correlation between the maximum force peak force/weight of the front and back feet, the time to reach the peak force, the rapid force index/weight, and the punching speed. At the same time, we select the parameters with significant correlation and the punching speed for curve estimation. In this way, it explores the relationship between the rapid force exertion of the lower limbs and the speed of punching. It provides practical support and guidance for the special strength training of the lower limbs of boxing.

## METHOD

### Research object

We take the relationship between the lower limbs' rapid force and the punch's speed before boxing as the research object, and the test objects are 16 outstanding male boxers from competitive sports schools.

### Experimental program

Two Swiss KISTLER three-dimensional force plates with built-in signal amplifiers.[3] Synchronization is achieved by connecting the digital-to-analog converter with the VICONMX infrared high-speed photography system.[4] According to the principle of bionics, the Chinese Kung Fu test engineer has a deformation coefficient of the skin and internal filling similar to that of the human body. As a fixed target in this study.

The subject wore boxing shoes and boxing gloves. The volunteers warmed up for 15 minutes and then practiced hitting the boxer target for 3 minutes. Strike the engineer's sternum at the fastest speed with a straight punch with the front hand. Technical actions require completeness and coherence. Collect 3 successful hits, with an interval of 1 min between each hit.

### Research on boxing force calibration method

We set the collision recovery coefficient between the hammer and the boxing surface as $K$. The recovery coefficient of collision between the gloved fist and the boxing surface is $K'$. Obviously $K' < K$. After many experiments, it can be represented by $K' = 0.8\ K$. According to the relevant definition in theoretical mechanics, we set the recovery coefficient $K$ as

$$K = \frac{|u_2 - u_1|}{\tilde{o}_1 - \ _2} \quad (1)$$

$\tilde{o}_1$ is the speed before the impact of the hammer; $\tilde{o}_2$ is the speed before the impact of the boxing face. It is equal to 0. $u_1$ is the post-impact velocity of the hammer, which can be calculated from the recovery angle $\alpha_2$. $u_2$ is the post-collision velocity of the boxing face. The impulse of boxing force is $S = \int_0^{t_0} Fdt$. The average value of the force is defined as follows:

$$F_{average} = \frac{S}{t_0} \quad (2)$$

The formula for calculating the total impulse of a boxing collision is

$$S = (1 + K')\frac{m_1 m_2}{m_1 + m_2}(\upsilon_1 - \upsilon_2) \quad (3)$$

Now $\upsilon_2 = 0$, $\upsilon_1$, K'. We substitute (3) into (2) to get the calibration formula

$$F_{average} = (1 + K')\frac{m_1 g m_2}{t_0(m_1 + m_2)}\upsilon_1 \quad (4)$$

$$F_{average} = \frac{1}{9.8t_0}(1 + K')\frac{m_1 g m_2}{(m_1 + m_2)} g\sqrt{2 \times 9.8 \times l(1 - \cos\alpha_1)} \quad (5)$$

$t_0$ takes the average value of 0.04s.

### Data processing

We use Visual3D software to calculate and smooth the experimental kinematics and dynamics data.[5] The article uses Butterworth's digital filter for low-pass filtering. After the kinetics data is processed, the data is imported into the Microsoft Excel table. Formula $V_{total} = \sqrt{x^2 + y^2 + z^2}$ is used to calculate the closing speed in the punching process. Use SPSS17.0 to perform statistical calculations on the obtained data. The results are expressed as mean ± standard deviation. P<0.01 was taken as the standard of significant difference.

## RESULTS

### Test results of the ground support reaction force of the front and back feet with a straight fist

Determine the starting point (A, A1) of the active kicking phase of the front and rear feet. Determine the endpoint (B, B1) of the active kicking force phase in the EXCLE data according to the change of the curve value and mark it in the curve. See Table 1 for the obtained test results of related fast strength parameters.

### Correlation analysis results of the rapid force exerted by the front and rear feet and the hitting effect

The fast force parameters of the front and back feet in Table 2 have been tested to be normally distributed. The average maximum speed of punching is (7.16±1.198) m/s. The correlation analysis results showed no significant correlation between the fast power parameters of the hind feet and the speed of punching (p>0.05). There is a significant correlation between the parameters of forefoot fast strength and punching speed.

### Curve fitting and regression analysis results of forefoot fast strength parameters and punching speed

The interrelationship between the three fast power parameters is not suitable for multiple regression analysis, so unary regression analysis is used for data processing. Kinematics studies have shown that the maximum speed occurs before hitting a fixed target.[6] We will estimate the maximum force peak/weight curve, the time to reach the peak, the rapid force index/weight, and the punching speed of the fast force parameters of the front and back feet during the active kicking phase. (Table 3)

Curve fitting and regression analysis results show that the linear model of maximum forefoot peak strength/weight, fast strength index/weight, and punching speed has the best fit. There is a significant positive correlation; the time to reach the maximum strength and the punching speed quadratic curve model has the highest degree of fit. There is a quadratic function curve relationship. The calculation result of the extreme value (minimum value) of the quadratic function curve is X=0.118, Y=6.11.

**Table 1.** List of quick strength parameters for both legs.

| | Forefoot | Hind feet |
|---|---|---|
| Maximum strength/weight | 1.990±0.422 | 0.68±0.16 |
| Time to reach maximum peak force (ms) | 0.084±0.018 | 0.057±0.013 |
| Fast strength index/weight | 25.72±10.87 | 12.78±6.21 |

**Table 2.** The correlation between the rapid force exerted by the front and rear feet and the impact effect.

| | Correlation coefficient r with hitting effect | P |
|---|---|---|
| The maximum peak strength of the forefoot/weight | 0.895 | <0.01 |
| Time to peak forefoot | -0.659 | <0.01 |
| Forefoot fast strength index/weight | 0.858 | <0.01 |
| Hindfoot maximum strength/weight | 0.372 | >0.05 |
| Time to reach peak | -0.247 | >0.05 |
| Hindfoot fast strength index/weight | 0.351 | >0.05 |

## DISCUSSION

### The effect of rapid force exertion of the front and back feet on the speed of punching

The results of comparative regression analysis showed a linear relationship between the maximum force/weight, rapid force index/weight, and punching speed (P<0.01). The quadratic function relationship between the time to reach the maximum force peak when pushing

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