INFLUENCE OF DOUBLE JUMP ROPES ON ATHLETES' LOWER LIMBS

INFLUÊNCIA DO SALTO DUPLO DE CORDA DE BALANÇO NOS MEMBROS INFERIORES DOS ATLETAS

INFLUENCIA DEL DOBLE SALTO DE CUERDA DE BALANCEO EN LOS MIEMBROS INFERIORES DE LOS ATLETAS

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ABSTRACT

Introduction: The double jump rope swing is a rope jumping technique that combines the technology of vertical jump and rope swing, requiring participants to jump twice in a row with the soles of their feet. Objective: Study the effect of double-balance jump rope training on athletes' muscular strength in the lower limbs. Methods: Through the experimental process, the dynamic and kinematic parameters generated during the process of vertical jump of the participants before and after the double balance rope jump exercise were tested; the effects of double balance rope jump on the biomechanical characteristics of the lower limbs and hip, knee and ankle joints of the participants were analyzed. Results: Compared to pre-training, subjects in the experimental group improved significantly ($p = 0.05$). Conclusion: After double rope jump training, the subjects obtained an increase in lower limb strength and ground reaction force at the extension stage in the vertical jump. They produced greater force in less time, suggesting that the lower limb burst strength was enhanced. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Biomechanical Phenomena; Resistance Training; Athletes.

RESUMO

Introdução: O salto duplo de corda de balanço é uma técnica de salto de corda, que combina a tecnologia de salto vertical com a de balanço de corda, sendo necessário que os participantes saltem duas vezes seguidas com a sola de seus pés. Objetivo: Estudar o efeito do treinamento de salto de corda de balanço duplo sobre a força muscular nos membros inferiores dos atletas. Métodos: Mediante o processo experimental, foram testados os parâmetros dinâmicos e cinemáticos gerados durante o processo de salto vertical dos participantes antes e depois do exercício de salto de corda de balanço duplo, foram analisados os efeitos do salto de corda de balanço duplo sobre as características biomecânicas dos membros inferiores e articulações do quadril, joelho e tornozelo dos participantes. Resultados: Em comparação ao pré-treinamento, os sujeitos do grupo experimental melhoraram significativamente ($p = 0,05$). Conclusão: Os sujeitos obtiveram um aumento da resistência dos membros inferiores e da força de reação no solo no estágio de extensão em salto vertical após o duplo treinamento de salto de corda. Verificou-se a produção de maior força em menor tempo, sugerindo que a força de explosão nos membros inferiores foi aprimorada. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

***Descritores*:** *Fenômenos Biomecânicos; Treinamento de Força; Atletas.*

RESUMEN

Introducción: El doble salto de cuerda es una técnica de salto de cuerda que combina la técnica de salto vertical con el balanceo de la cuerda, exigiendo a los participantes que salten dos veces seguidas con la planta de los pies. Objetivo: Estudiar el efecto del entrenamiento con cuerda de doble salto de balanceo sobre la fuerza muscular en los miembros inferiores de los atletas. Métodos: A través del proceso experimental, se comprobaron los parámetros dinámicos y cinemáticos generados durante el proceso de salto vertical de los participantes antes y después del ejercicio de salto con cuerda de balanceo doble, se analizaron los efectos del salto con cuerda de balanceo doble sobre las características biomecánicas de las extremidades inferiores y las articulaciones de la cadera, la rodilla y el tobillo de los participantes. Resultados: En comparación con el preentrenamiento, los sujetos del grupo experimental mejoraron significativamente ($p = 0,05$). Conclusión: Los sujetos obtuvieron un aumento de la fuerza de las extremidades inferiores y de la fuerza de reacción al suelo en la fase de extensión en el salto vertical tras el entrenamiento de salto a la cuerda doble. Se verificó la producción de mayor fuerza en menos tiempo, lo que sugiere que se mejoró la fuerza de explosión en los miembros inferiores. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

***Descriptores*:** *Fenómenos Biomecánicos; Entrenamiento de Fuerza; Atletas.*

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INTRODUCTION

Double rocking rope skipping is a kind of rope skipping exercise, which is a combination of vertical jumping and rocking rope technology, participants are required to jump through the soles of their feet twice in a row. Rope skipping includes a large number of lower limb bouncing movements, the elements of this movement are the extension and flexion of the lower limbs, both movements have the characteristics of Stretch Shortening Cycle (SSC), which can exercise the hyper-isometric contraction ability of muscles around the hip, knee and ankle joints, or as a special auxiliary exercise for some competitive sports athletes.[1] In situ vertical jumping is a common action used for lower limb dynamics in people of all ages. Therefore, this study uses double-rock skipping rope as an intervention method, and uses the research method of biomechanics, the lower limb dynamics and kinematics data of healthy college students before and after the intervention were tested and calculated, in order to prove that double rocking rope skipping can promote the lower limb muscle strength and explosive power of sedentary people and provide objective data reference.[2,3]

METHOD

Research object

A total of 40 sedentary college students (20 males and 20 females) were recruited from the school, they were randomly divided into experimental group and control group Inclusion criteria: Subjects were physically active less than 1.5METs per day, or sedentary for more than 13 hours; No flat feet, no lower extremity sports injury within 1 year; Voluntarily participate in the training designed in this study, and guarantee to complete the entire experimental process.

Training method

The teaching and practice of double-shake rope skipping are completed by specialized coaches. The recruited healthy college students with low physical activity were administered a continuous double-rocking rope skipping exercise for 8 weeks. Three weeks before the formal training, he was taught the correct technical movements of double-swing rope skipping, after that, he performed 4 times a week, 6 groups each time, and each group of 40 uninterrupted and continuous double-swing rope skipping training.[4] The subjects in the two groups did not change the original daily schedule, and the subjects in the control group did not engage in any form of physical exercise except for daily activities.

Test Process

Before and after the 8-week double-rocking rope skipping training, the dynamics and kinematics data of the lower limbs of the subjects during the vertical jump in situ were tested, and the ground reaction force, the explosive force of the lower limbs, and the stiffness of the lower limbs generated during the vertical jumping in situ were analyzed. During the formal test, each subject warmed up on the treadmill at a speed of 2 to 3 m/s for 5 minutes and performed static stretching for 2 minutes. In order to avoid the deviation of experimental data caused by different sports equipment, subjects were required to change the experimental special Clothing (tights, sneakers, socks).

Data Statistics

Two-way repeated measures ANOVA was used to analyze the effect of the independent variable (a group variable and the intervention time) on the variable against force, explosiveness) using SPSS24.0 statistical software. strength and air height) obtained experimental results. Impact.[5] Differences in baseline data were not significantly different between subjects compared by the independent sample T test, and statistical results were expressed as mean ± standard deviation (M ± SD) with a significance level of 0.05.

Ethical Compliance

Research experiments conducted in this article with animals or humans were approved by the Ethical Committee and responsible authorities of Tangshan Normal University following all guidelines, regulations, legal, and ethical standards as required for humans or animals.

RESULTS

Figure 1 shows the vertical jump ground reaction before and after running rope exercise in the experimental and control groups. After statistical analysis, there was no difference in the ground reaction between the withdrawal training group and the control group ($p = 0.061$), and there was no significant difference before the start of the study. training, during take off and during the vertical jump from the ground. Maximum ground response time during landing ($p = 0.075$). There was no difference in the maximum ground clearance of the control group after training compared to pre-training ($p = 0.064$), and the resistance to maximum ground clearance during landing was not after training. different from before training ($p = 0.000$); The maximum level of ground reaction during vertical jump in the training group was significantly different from the control group after training ($p = 0.000$).

The peak ground reaction force of vertical jump in situ before and after training in the two groups of subjects, the ground reaction force of the subjects in the training group was the largest after jumping rope training.[6] The ground reaction force (N) of vertical jumping in place before training in the control group, training group and training group after training were 2900.43±350.25, 2879.73±280, 3059.96±260.87, 5352.34±230.59, respectively. Among them, the first wave peak in the figure is the maximum ground reaction force value during the vertical jump and the extension period, and the acceleration changes from bottom to top in this stage; The second wave peak is the maximum ground reaction force value during the landing buffer period of the subject's vertical jump, at this moment, the human body's center of mass is at the lowest point of the squat, and the acceleration is downward in this stage.[7]

Figure 2 shows the change characteristics of the explosive force of the center of mass before and after training.Before training, there was no significant difference in explosive power between the control group and the training group ($p = 0.068$). After the training, the mean of the points in the training group differed from that before the training ($p = 0.033$); There was no significant difference in the fracture of the subjects in the control group before and after the training ($p=0.061$). The explosive force at the center of mass of the human body has two peaks, up and down, as shown by the vertical jump of the subject, because the explosive force at the center of the The size of the human body is the product.[8]

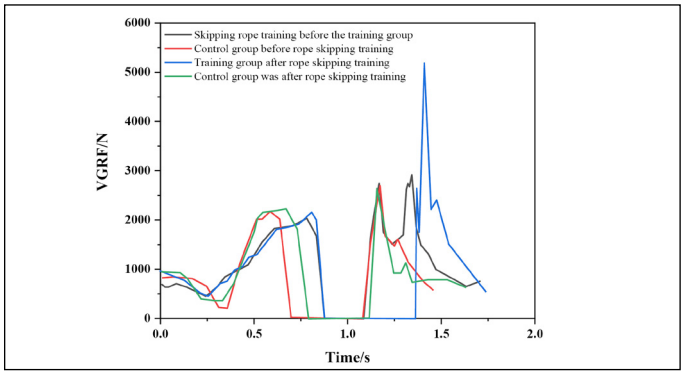

Figure 1. Changes in the ground reaction force of vertical jumping before and after the test in the training group and the control group.

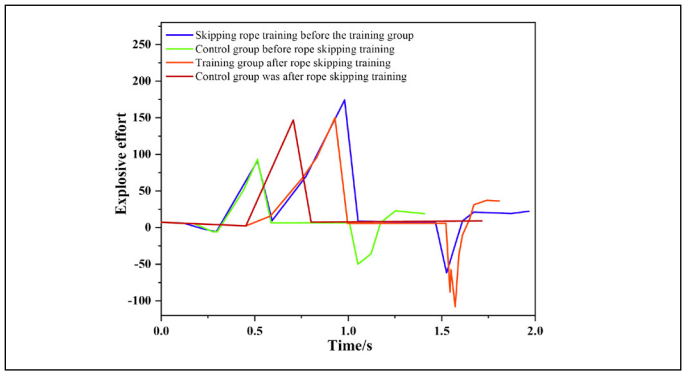

Figure 2. The explosive force of the vertical jumping center of mass before and after the test of the subjects in the training group and the control group.

Table 1 shows the non-relevant leg strength before and after two stone cross training sessions. The stiffness (N·m) of the lower limbs of the test group before and after the vertical jump were: 85.93 ± 6.56, 126.67 ± 9.75, 84.97 ± 5.34, and 82.59 ± 4.82. After statistical analysis, there was no difference in the lower level of the experimental and control groups before the two-string cross-training (p = 0.085); There was no significant difference between the vertical jump of the vertical jump after training and the control group before training (p = 0.067); The stiffness of the subjects in the experimental group was different from that before the training (p = 0.000); When comparing the lower levels of subjects in the experimental and control groups after training, the lower levels of subjects in the experimental group were higher than those in the control group (p = 0.000).

Table 2 shows that there is no difference between the two groups in hip, knee, and ankle height during vertical jump (p = 0.059, p = 0.067, p = 0.059); After training, the peak values of hip, knee, and ankle rotation in the experimental group were higher than before training, especially knee and ankle rotation increased the most (p = 0.045, p = 0.000, p = 0.000). There is no difference between knee, knee, ankle, ankle (p = 0.068, p = 0.085, p = 0.073) and hip. , knee and ankle rotation between experimental and control groups after training (p = 0.036, p = 0.000, p = 0.001).

DISCUSSION

Using double-swing rope skipping as an exercise method, by comparing the dynamic and kinematic data of the vertical jump process of the subjects in the test group before and after training, the results of various aspects suggest that the double rocking rope skipping has a certain positive effect on the lower limb strength exercises of college students.[9] The results of this study show that there is no significant difference in the ground reaction from the vertical jump between the two groups before training,after 8 weeks of rope skipping training, the ground reaction force produced by vertical jumping in the experimental group was the largest, and it was significantly increased compared with that before training. After the double-swing rope skipping training, the joint torque generated at the knee and ankle joints increased significantly when the subjects jumped vertically to the ground, indicating that, after rope skipping training, the human body can mobilize more knee extensors and ankle plantar flexors to resist the sudden ground reaction force when landing.[10]

Table 1. Effects of double-shake rope skipping exercises on the dynamic parameters of subjects during the stance period.

Group	Lower extremity stiffness (n/kg)		Stretching time (s)		Flying height (m)	
	Before training	After training	Before training	After training	Before training	After training
Control group	85.0±5.3	82.6±4.8#	3.6±0.6	3.7±0.5#	0.2±0.04	0.2±0.03#
Test group	85.9±6.6	126.7±9.7*	3.8±0.6	2.9±0.3*	0.3±0.05	0.4±0.06*

Note: * means there is a significant difference within the subject group comparison (p < 0.05); # means there is a significant difference between the subject group comparison (p < 0.05); The same as the table below.

Table 2. The effect of double-shake rope skipping exercise on the peak joint torque (N·m) of the subjects' lower limbs.

Group	Hip		Knee		Ankle	
	Before training	After training	Before training	After training	Before training	After training
control group	5.3±0.5	6.1±0.8*	2.9±0.2	6.0±0.5*	2.9±0.3	4.1±0.4*
test group	5.1±0.9	5.5±0.4#	2.9±0.3	2.9±0.3#	2.9±0.3	2.9±0.3#

CONCLUSION

Double rocking rope skipping exercise can be used as an exercise method to exercise the muscle strength around the hip, knee and ankle joints of the lower limbs of college students with low physical activity, in particular, the strength of the knee and ankle joints is mainly increased, which has a certain fitness effect. After the double-rope skipping exercise, the subject's action and extension time decreased, and the ground reaction force in the vertical jumping and extension stage increased, and a large force value could be generated in a short period of time, indicating that the subject's lower limb explosive power was improved.

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

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. Hongying Du: writing and data analysis.

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