REFLECTIONS OF FUNCTIONAL TRAINING ON SHOOTERS' GRIP STABILITY

REFLEXOS DO TREINAMENTO FUNCIONAL SOBRE A ESTABILIDADE DA EMPUNHADURA DOS ATIRADORES

REFLEJOS DEL ENTRENAMIENTO FUNCIONAL EN LA ESTABILIDAD DE AGARRE DE LOS TIRADORES

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ABSTRACT

Introduction: Shooting is a technical sport demanding much control and accuracy from the athletes. Physical fitness is a critical factor for the sport's skill level, and it is believed that functional training can effectively improve the shooter's technical level, ensuring greater athlete stability. Objective: Analyze the results of functional abdominal core physical training on the grip stability of sport shooters. Methods: Random sampling was used to select 26 volunteer shooters as research pairs. An intervention trial was conducted for eight weeks of functional physical training with these athletes. The subjective perception scale of RPE and the exercise intensity comparison table were used for analysis. Muscle contraction data were measured at 3 s before target shooting. SPSS 19.0 software was used to statistically conduct a t-test on the data collected before and after the experiment. Results: There were significant differences in muscle stability and tolerance before and after physical training (P<0.01). The shooter's flexion stability before the test was not as good as during relaxation. The reduced sustained distance before and after physical training significantly improved the tolerance and stability of the abdominal core muscles. The average amplitude of the biceps electromyography was statistically significant compared to before the test (P<0.05). Conclusion: After eight weeks of functional physical training, the shooting stability of pistol shooters was significantly improved. The lack of physical training, especially in the core abdominal muscles, negatively affects the shooters' stability, limiting the quality of the sport. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: *Physical Conditioning, Human; Physical Functional Performance; Abdominal Core; Athletes.*

RESUMO

Introdução: O tiro esportivo é um esporte técnico, exigindo dos atletas muito controle e precisão. A aptidão física é um fator crítico para o nível de habilidade esportivo e acredita-se que o treinamento funcional possa efetivamente melhorar o nível técnico do atirador, garantindo maior estabilidade do atleta. Objetivo: Analisar os resultados do treinamento físico funcional do centro abdominal sobre a estabilidade da empunhadura dos atiradores esportistas. Métodos: Utilizou-se uma amostragem aleatória para selecionar 26 atiradores voluntários como pares de pesquisa. Um ensaio de intervenção com esses atletas foi conduzido por oito semanas de treinamento físico funcional. A escala de percepção subjetiva da RPE e a tabela de comparação de intensidade do exercício foram utilizadas para análise. Os dados de contração muscular foram aferidos em 3 s antes de atirar com mira. O software SPSS 19.0, foi usado para conduzir estatisticamente um teste-t nos dados coletados antes e depois do experimento. Resultados: Houveram diferenças significativas na estabilidade e na tolerância dos músculos antes e depois do treinamento físico (P<0,01). A estabilidade de flexão do atirador antes do teste não foi tão boa quanto no relaxamento. A distância sustentada antes e depois do treinamento físico foi reduzida, a tolerância e estabilidade dos músculos do centro abdominal foram significativamente aperfeiçoadas. A amplitude média da eletromiografia do bíceps foi estatisticamente significativa em comparação com antes do teste (P<0,05). Conclusão: Após oito semanas de treinamento físico funcional, a estabilidade de tiro dos atiradores com pistolas foi significativamente melhorada. A falta de treinamento físico, principalmente na musculatura do centro abdominal, afeta negativamente a estabilidade dos atiradores, limitando a qualidade do resultado esportivo. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

Descritores: *Condicionamento Físico Humano; Desempenho Físico Funcional; Centro Abdominal; Atletas.*

RESUMEN

Introducción: El tiro es un deporte técnico, que exige mucho control y precisión a los deportistas. La aptitud física es un factor crítico para el nivel de habilidad deportiva y se cree que el entrenamiento funcional puede mejorar eficazmente el nivel técnico del tirador, garantizando una mayor estabilidad del atleta. Objetivo: Analizar los resultados del entrenamiento físico del núcleo abdominal funcional sobre la estabilidad de agarre de los tiradores deportivos. Métodos: Se utilizó un muestreo aleatorio para seleccionar a 26 tiradores voluntarios como parejas de investigación.

Se realizó un ensayo de intervención con estos atletas durante ocho semanas de entrenamiento físico funcional. Para el análisis se utilizó la escala de percepción subjetiva del RPE y la tabla de comparación de la intensidad del ejercicio. Los datos de la contracción muscular se midieron 3 s antes del tiro al blanco. Se utilizó el programa informático SPSS 19.0 para realizar una prueba t sobre los datos recogidos antes y después del experimento. Resultados: Hubo diferencias significativas en la estabilidad y tolerancia muscular antes y después del entrenamiento físico (P<0,01). La estabilidad de la flexión del tirador antes de la prueba no era tan buena como en la relajación. La distancia sostenida antes y después del entrenamiento físico se redujo, la tolerancia y la estabilidad de los músculos del núcleo abdominal mejoraron significativamente. La amplitud media del electromiograma del bíceps fue estadísticamente significativa en comparación con antes de la prueba (P<0,05). Conclusión: Tras ocho semanas de entrenamiento físico funcional, la estabilidad de tiro de los tiradores de pistola mejoró significativamente. La falta de entrenamiento físico, principalmente en los músculos del núcleo abdominal, afecta negativamente a la estabilidad de los tiradores, limitando la calidad del resultado deportivo. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Acondicionamiento Físico Humano; Rendimiento Físico Funcional; Núcleo Abdominal; Atletas.*

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INTRODUCTION

Shooting is the sport with the most technical content in competitive sports. This sport requires high precision in the movements of the athletes. Body balance is the key to improving shooting accuracy. Only when the shooter's body maintains enough stability can the athlete better grasp the shooting opportunity. The stability of the body when holding the gun is directly related to the stability of the gun. Special exercises for body stabilization during pistol shooting help improve the stability of the firearm.[1] In previous studies, people often used Foots can balanee7.6 human type balancer to observe the swing of the body's center of gravity. The academics measured the electromyography of the arm. Determination of the stability of shooters holding gun barrels with a laser measuring instrument. This paper explores the correlation between gun holding stability and motor performance. In this paper, the stability of the gun-holding power of shooters is indirectly improved through functional physical training.[2] The research results of this paper have particular guiding significance for the physical fitness training of gun shooting players.

METHOD

Research objects

This paper investigated a sample of 26 shooting athletes from the Shooting Sports Administration.[3] The primary data of 13 men and 13 women are shown in Table 1.

Investigation method

This article uses an 8-week functional fitness training interventional trial.[4] Experiments were conducted from March to April 2020. This paper used the RPE subjective sensory scale and the Meto-exercise strength comparison table to monitor the training effect.

The evaluation index includes 5. The body movement evaluation indicators include FMS functional movement screening, OSW lower back and leg pain function abnormality survey, and DASH upper limb function assessment scale.

One item of stability evaluation index in the core area. Specifically, McGill's kernel stability test. This paper uses the frequency domain analysis method to make statistics on the data measured within 3 seconds before aiming. This paper uses the frequency domain method to obtain each parameter's coefficient of variation CV (%).[5] This paper evaluates the changes in data stability observed before and after the experiment. Trials were conducted before and after physical training.

Sensor Simulation of Gun Data Capture

α, β, γ is the roll, pitch, and yaw angles. The torque of the roll angle is

$$U_x = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\alpha\sin\alpha & \sin\alpha \\ 0 & -\cos\alpha\sin\alpha & \cos\alpha \end{bmatrix} \quad (1)$$

The pitch angle rotation torque is

$$U_y = \begin{bmatrix} \cos\beta\sin\beta & 0 & -\sin\beta \\ 0 & 1 & 0 \\ \sin\beta & 0 & \cos\beta\sin\beta \end{bmatrix} \quad (2)$$

The yaw angle rotation matrix is

$$U_z = \begin{bmatrix} \cos\gamma & \sin\gamma\cos\gamma & 0 \\ -\sin\gamma\cos\gamma & \cos\gamma & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad (3)$$

In this paper, the unit axial force of the gun is set as $e = (x, y, z)$. α is the roll angle. The quaternion number is $g = \begin{bmatrix} v_0 \\ v_1 \\ v_2 \\ v_3 \end{bmatrix}$ represented as

Table 1. Subject profiles.

Gender	n	Age	Height/cm	Weight/kg	Years of training/year
Male	13	13.8 ± 0.74	173.93 ± 8.96	71.79 ± 16.68	2.93 ± 1.85
Female	13	15.00 ± 1.68	168.54 ± 3.76	56.75 ± 6.77	4.38 ± 3.24

$$g = \begin{bmatrix} v_0 \\ v_1 \\ v_2 \\ v_3 \end{bmatrix} = \begin{bmatrix} v_0 \\ v \end{bmatrix} = \begin{bmatrix} \cos(\alpha/2) \\ e\sin(\alpha/2) \end{bmatrix} \quad (4)$$

Formula (4) $v_0^2 + v_1^2 + v_2^2 + v_3^2 = 1$. In this paper, a matrix of a set of postures can be obtained through the law of quaternion multiplication:

$$U = \begin{bmatrix} v_0^2 + v_1^2 - v_2^2 - v_3^2 & 2(v_1v_2 + v_0v_3) & 2(v_1v_3 - v_0v_2) \\ 2(v_1v_2 - v_0v_3) & v_0^2 - v_1^2 + v_2^2 - v_3^2 & 2(v_2v_3 - v_0v_1) \\ 2(v_1v_3 + v_0v_2) & 2(v_2v_3 - v_0v_1) & v_0^2 - v_1^2 - v_2^2 + v_3^2 \end{bmatrix} \quad (5)$$

Data Analysis

This paper uses the electromyography analysis system of DelsysEMG4.0 to measure the muscle data of athletes.[6] This article imports the data document into Excel 2010. This paper, SPSS19.0 is used to conduct a t-test on the data collected before and after the test.

ETHICAL COMPLIANCE

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

RESULTS

Functional Movement Screening Results

All indexes of FMS were improved after the test.[7] The scores for straight bow archery before and after the test were statistically significant (P<0.05). The shoulder flexibility test, push-up stability test, and FMS scores were all statistically significant (P<0.01). The rotational stability score did not change after the test. (Table 2)

Table 2. FMS Screening Scores Before and Before the Trial.

Project	Before experiment	After the experiment	P
Lift squat	2.6 ± 0.64	2.76 ± 0.51	>0.05
Hurdle step up	2.55 ± 0.64	2.66 ± 0.53	>0.05
Straight lunge squats	2.34 ± 0.57	2.55 ± 0.53	<0.05
Shoulder flexibility	2.71 ± 0.52	2.92 ± 0.43	<0.05
Active straight leg lift	2.45 ± 0.61	2.55 ± 0.53	>0.05
Stability push-ups	2.03 ± 0.93	2.5 ± 0.78	<0.01
Rotational stability	2.08 ± 0	2.08 ± 0	-
Overall rating	16.77 ± 2.24	18.07 ± 1.66	<0.001

Functional test scores

The scores of OSW and DASH questionnaires decreased significantly after the test (P<0.0.5). Low back and leg pain OSW scores decreased by an average of 23.15%, while DASH scores decreased by 34.14%. (Table 3)

Core Stability Test Results

There were significant differences in muscle tolerance and stability after functional physical training (P<0.01). The flexion stability of the body after training was worse than the body extension stability, while the stability of the right bridge was better than that of the left bridge. (Table 4)

Skin EMG measurements before and after the test

The rate of change of the EMG signal at different positions showed a decreasing characteristic.[8] The EMG amplitudes of the upper muscle, the anterior deltoid, the middle deltoid, and the biceps were statistically significant before and after the test (P<0.05). This indicates improved gun stability for the designer athletes. (Table 5)

Table 3. Functional Assessment Scale Scores.

Project	Before experiment	After the experiment	P
OSW	42.41 ± 15.93	32.71 ± 17.32	<0.05
DASH	22.3 ± 18.35	14.82 ± 11.14	<0.05

Table 4. McGill stability results before and before testing.

Project	Before experiment	After the experiment	P
Trunk flexion time	83.75 ± 29.78	106.04 ± 27.74	<0.001
Trunk extension time	67.03 ± 26.69	81.04 ± 27.27	<0.001
Left side bridge time	25.16 ± 7.88	41.98 ± 6.59	<0.001
Right side bridge time	29.53 ± 7.96	44.01 ± 9.44	<0.001
Total time	205.47 ± 70.41	273.07 ± 66.03	<0.001
Stability push-ups	2.03 ± 0.93	2.5 ± 0.78	<0.01

Table 5. Comparison of the coefficient of variation of the amplitude means before and after the test.

Part	Pre-experiment amplitude mean and standard deviation	Coefficient of variation CV/%	Post-experiment amplitude mean and standard deviation	Coefficient of variation CV/%
Upper trapezius	100.84 ± 8.97	9.26	102.64 ± 9.01	9.15
Anterior deltoid	149.6 ± 21.97	15.29	152.13 ± 20.97	14.35
Middle deltoid	90.72 ± 13.17	15.11	93.24 ± 13.5	15.08
Rear deltoid	15.74 ± 1.02	6.76	16.42 ± 1.06	6.74
Biceps	15.58 ± 1.42	9.47	16.26 ± 1.3	8.34
Triceps	12.38 ± 1.05	8.85	12.1 ± 1.02	8.78
Extensor carpi radialis	59.77 ± 7.27	12.67	61.54 ± 6.48	10.96
Superficial flexor muscles	12.4 ± 1.35	11.38	14.15 ± 1.08	7.98

DISCUSSION

The stability of this paper refers to the problem of gun holding stability in shooting competitions. It refers to the swing range of the barrel in the target paper sighting area and the control of the hitting time.[9] Its stability is mainly reflected in the shaking amplitude, relative static duration, and shaking. Stability is not set in stone. There is also a slight wobble when the gun is stable. Firearms' stability depends on the human body's stability and the coordination of human senses.[10] The stability training program is one of the overall training programs developed by the coach. Its main goal is to improve the stability of the gun. It includes two aspects, physical training and the other is special training.

Functional fitness training is critical to shooting performance. Its fundamental goal is to improve athletes' physical functions through various

effective exercise methods. Functional fitness training helps athletes improve their game performance. Shooting is different from other sports.[11] There are no strenuous movements in this sport. This exercise requires very high coordination of the body. The action of raising the gun must be very stable. Functional fitness training is necessary to improve and maintain game technique and stability. There are mainly empty guns and actual combat drills in the shooting training. Stability improves the stability of the firearm when preparing for an empty gun.

The strength of the body's muscles significantly impacts stability during shooting. This requires athletes to have a high muscle tolerance. The skeletal support must be fully utilized.[12] Secondly, there must be appropriate muscle strength to maintain each joint's stability and the human body's static balance. When the bullet's center of gravity is close to the center of gravity of the body, the force between the two will be better balanced. This will make the gun more stable. Because the bullet's center of gravity is fused with the center of gravity of the body, part of the gun's weight will be offset by the bowstring around the waist. At this time, the muscles in the lower back will be stressed. Athletes must have a fixed position to maintain body stability. The center of gravity of the body is to ensure the stability of the knee and ankle joints through the force of the legs.[13] Stability support plays a crucial role in correct shooting movement. Stable support in the excellent state of the human body is achieved by regulating the body's nervous, skeletal, and muscular systems. Movement posture and muscle sensation are closely related to stability. This paper argues that the stability of holding a gun depends on the player's skeletal stability, lumbar stability, and muscle stability.

Shooting movement stability depends on the law of movement. Athletes should minimize muscle contact and stress and use bone as a carrier when performing stand-up training. Athletes need to find an appropriate sports center. And as the time of holding the gun prolongs, the athlete's body will experience numbness, tremors, stiffness, and so on. Athletes must adjust their bodies to make them more flexible and more stable.

There are many closed-chain exercises in hanging upper and lower body exercises. It focuses on a fixed posture. This strength training requires the coordination of strength in many different joints. Suspension training requires multiple muscle groups to work together. For example, the straight arm pulls back of the upper body and the Y-shaped exercise. Athletes first stabilize the body's deep muscles before they can work with the muscles of the upper arm. Athletes can enhance the stability of their arms in three-dimensional space during shooting training. When doing leg exercises, athletes mainly train the strength of the trunk and lower body. The main content of functional physical training is the joints, tendons, and ligaments of the spine, multifidus, pelvic floor muscles, rotator cuff muscles, tendons, and ligaments. Increasing the stability and coordination of the muscle groups reduces the shooter's control of the shooter's arm. At the same time, this training can increase muscle strength consistency and improve shooters' balance.

CONCLUSION

After eight weeks of functional physical training, shooters proved that functional physical training has a good effect on improving the stability of gun holding. The somatosensory enhancement technology of DNS motor neurons and PNF is key to improving exercise performance, physical function, and injury reduction. Lack of athletic ability will adversely affect the shooter's gun balance and restrict the shooter's overall quality.

The authors declare that they have no competing interests.

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REFERENCES

1. Sarro KJ, Viana TDC, De Barros RML. Relationship between bow stability and postural control in recurve archery. Eur J Sport Sci. 2021;21(4):515-20.
2. Abdel-Halim MAA. The speed of the Motor Response' and its Relation to Performance Level of Receiving and Defense in Volleyball. Journal of Theories and Applications of Physical Education Sport Sciences. 2022;7(1):1-16.
3. Bondarenko V, Okhrimenko I, Tverdokhvalova I, Mannapova K, Prontenko K. Formation of the professionally significant skills and competencies of future police officers during studying at higher educational institutions. RREM. 2020;12(3):246-67.
4. Köykkä M, Laaksonen MS, Ihalainen S, Ruotsalainen K, Linnamo V. Performance-determining factors in biathlon prone shooting without physical stress. Scand J Med Sci Sports. 2022;32(2):414-23.
5. Žák M, Ondráček J. Breathing as one of the components of biathlon shooting in youth biathletes. Stud Sport. 2021;15(2):88-97.
6. Kelley MS. Feminism and Firearms: Gun Ownership, Gun Carrying, and Women's Empowerment. Sociol Perspect. 2022;65(1):77-96.
7. Günay H, Kolayiş İE. The Relatıonship Between Functional Movement and Body Stability with Service Speed on Veteran Tennis Players. TJSE. 2020;22(3):464-72.
8. Park S, Choi BG, Kang T, Park K, Kwon Y, Kim J. Efficient hardware implementation and analysis of true random-number generator based on beta source. ETRI J. 2020;42(4):518-26.
9. Olivier FM, Olivier B, Mnguni N. The core of performance in adolescent cricket pace bowlers: Trunk muscle stability, maybe, but not strength-endurance and thickness. S Afr J Sports Med. 2022;34(1):1-6.
10. Gotoh H, Nakatsuka S, Tanaka H, Yasuda N, Haketa Y, Maeda H, et al. Syntheses and Physical Properties of Cationic BN-Embedded Polycyclic Aromatic Hydrocarbons. Angew Chem. 2021;133(23):12945-50.
11. Carswell SM. Have we surrendered to gun violence in urban America? Federal neglect stymies efforts to stop the slaughter among young Black men. RAJ. 2022;12(1):126-40.
12. Warner TD. Always at the ready: fears, threats, and unsafe gun storage in households with children. Violence Vict. 2022;37(4):441-58.
13. Fisek T, Agopyan A. Effects of six weeks of stable versus unstable multi-dimensional surfaces balance training on passing skills and balance performance in young male basketball players. J Mens Health. 2021;17(4):264-77.