

# IMPROVEMENT OF MOTOR COORDINATION SKILLS IN GYMNASTICS ATHLETES

APRIMORAMENTO DA CAPACIDADE DE COORDENAÇÃO MOTORA NOS ATLETAS DE GINÁSTICA

MEJORA DE LA CAPACIDAD DE COORDINACIÓN MOTORA EN ATLETAS DE GIMNASIA



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## ABSTRACT

**Introduction:** The great difficulty and the high risk are inherent marks of artistic gymnastics. It demands motor coordination of large muscle groups. **Objective:** Improve the training of body coordination control in gymnasts. **Methods:** We randomly selected 16 gymnasts as research volunteers, randomly divided into two groups of the same age distribution. After the training period, a new training protocol was implemented, and motor coordination control was analyzed after this intervention. **Results:** There was no significant difference in a one-sided comparative index ( $P>0.05$ ). There were statistically significant differences in the balance index and the speed index in the fast touch point direction in the athletes ( $P<0.01$ ). Compared with the control group, there was a significant difference in the overall test index between the experimental groups ( $P<0.01$ ). The motor coordination of the experimental group had a significant improvement. **Conclusion:** The techniques of cross-striking, fast pedaling, balance, jump rope, two-handed grip, two-handed dribbling, kicking, and seven other techniques evaluated showed a great relationship with the motor coordination of gymnastics athletes. **Level of evidence II; Therapeutic studies - investigation of treatment outcomes.**

**Keywords:** Gymnastics; Athletes; Physical Fitness; Sports.

## RESUMO

**Introdução:** A elevada dificuldade e o alto risco são marcas inerentes da ginástica artística. Ela exige a coordenação motora de grandes grupos musculares. **Objetivo:** Aprimorar o treinamento do controle da coordenação corporal dos ginastas. **Métodos:** Selecionou-se aleatoriamente 16 ginastas como voluntários de pesquisa, divididos aleatoriamente em dois grupos de mesma distribuição etária. Após o período de treinamento, implementou-se um novo protocolo de treino e analisou-se o controle da coordenação motora após essa intervenção. **Resultados:** Não houve diferença significativa em um índice comparativo unilateral ( $P>0,05$ ). Houve diferenças estatisticamente significantes no índice de equilíbrio e no índice de velocidade na direção de ponto de toque rápido nos atletas ( $P<0,01$ ). Em comparação com o grupo controle, houve uma diferença significativa no índice geral de teste entre os grupos experimental ( $P<0,01$ ). A coordenação motora do grupo experimental teve uma melhora significativa. **Conclusão:** As técnicas de batida cruzada, pedalada rápida, equilíbrio, pular corda, pegada com duas mãos, drible com duas mãos, chute e outras sete técnicas avaliadas demonstraram uma grande relação com a coordenação motora dos atletas de ginástica. **Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.**

**Descritores:** Ginástica; Atletas; Aptidão Física; Esportes.

## RESUMEN

**Introducción:** La alta dificultad y el alto riesgo son marcas inherentes a la gimnasia artística. Exige la coordinación motriz de grandes grupos musculares. **Objetivo:** Mejorar el entrenamiento del control de la coordinación corporal en gimnastas. **Métodos:** Se seleccionaron al azar 16 gimnastas como voluntarios de la investigación, divididos aleatoriamente en dos grupos con la misma distribución de edad. Tras el periodo de entrenamiento, se aplicó un nuevo protocolo de entrenamiento y se analizó el control de la coordinación motora después de esta intervención. **Resultados:** No hubo diferencias significativas en el índice comparativo unilateral ( $P>0,05$ ). Hubo diferencias estadísticamente significativas en el índice de equilibrio y en el índice de velocidad en la dirección del punto de contacto rápido en los atletas ( $P<0,01$ ). En comparación con el grupo de control, hubo una diferencia significativa en el índice de prueba global entre los grupos experimentales ( $P<0,01$ ). La coordinación motora del grupo experimental tuvo una mejora significativa. **Conclusión:** Las técnicas de golpe cruzado, pedaleo rápido, equilibrio, salto de cuerda, agarre con dos manos, regate con dos manos, patada y otras siete técnicas evaluadas mostraron una gran relación con la coordinación motora de los atletas de gimnasia. **Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.**

**Descriptorios:** Gimnasia; Atletas; Aptitud Física; Deportes.



## INTRODUCTION

Coordination is the movement of the body and limbs concerning surrounding objects and forms of activity. Coordinated movement is the proper use of multiple joints and muscles at the right time to produce fluid, efficient, and precise movement. Coordination factors of multiple muscle groups are sequential, time-sensitive, and hierarchical. The relevant kinds of literature on motor coordination at home and abroad have different interpretations of the definition of motor coordination as follows. American psychologist James proposed the concept of motor coordination when talking about motor skills and coordination.<sup>1</sup> Motor coordination includes the speed of movement, stability, the accuracy of aiming, and coordination of various body parts. B. H. Putov believed that coordination should be the ability of people to do their work quickly, reasonably, effortlessly, and flexibly. Chinese experts believe that movement coordination refers to coordinating various parts of an athlete during exercise. Coordination ability refers to the ability of each part of the athlete's body to complete various actions reasonably and effectively within a specific time and space. Coordination is the comprehensive ability of agility, rhythm, balance, and orientation. The emphasis is on the in-depth discussion of the expression of action. Harrow put forward the concept of "action coordination" from the process of action behavior.<sup>2</sup> At the same time, it also points out that the degree of coordination between the action and the surrounding environment is explicit coordination. The author believes that the essence of action coordination lies in the coordination between the three stages.

## METHOD

### Subjects

This paper takes 16 gymnasts as the research object. We randomly divided the subjects into two groups.<sup>3</sup> There were no significant differences in subjects' age, training time, and physical fitness.

### Test comparison

The trial lasted eight months.<sup>4</sup> Before the experiment, the experimental and control groups' age distribution was the same. This paper compares seven test items and conducts a comparative homogeneity test. (Table 1)

From Table 1, we can see the T-test results for 7 test items. This indicated that the indexes of the two samples had no significant difference ( $P > 0.05$ ). At the same time, it shows that the indicators of the two groups are the same before the test. It fully meets the experimental needs of this project.

### Collision dynamics of rigid models in motion landing motion

In this paper, the sagittal joint angles of the hip, knee, and ankle sagittal planes are simulated based on the simulation results of the five models. This paper performs the root mean square difference operation

**Table 1.** The completeness test table of each test index of the experimental group and the control group.

Project	Test group		Control group		P
	X	S	X	S	
Cross slap	14.883	7.403	14.916	7.458	>0.05
Quick tap	26.818	3.905	27.544	6.479	>0.05
Directional balance	12.089	1.76	12.166	1.991	>0.05
Jump rope	27.038	8.327	27.049	8.184	>0.05
Catch the ball with both hands	12.65	2.651	12.617	3.256	>0.05
Two-handed dribble	50.545	21.153	51.095	19.976	>0.05
Kick	24.574	6.204	24.915	6.16	>0.05

on the two methods.<sup>5</sup> The average M, the lower the M value, and the higher the accuracy of the simulation model.

$$\Delta \varepsilon = \sqrt{\frac{\sum_{i=1}^n (\alpha x_1 - \phi x_2)^2}{n}} \quad (1)$$

Where  $\alpha x_1$  and  $\phi x_2$  represent the actual kinematics and simulated motion data.  $n$  represents the number of data on each curve.  $\Delta \varepsilon$  represents the mean root difference between them.

$$M = \frac{1}{m} \sum_{i=1}^m \Delta \varepsilon \quad (2)$$

The six angle curves of the sagittal plane joints of the hip, knee, and ankle's left and right lower limbs.  $\Delta \varepsilon$  is the mean square root value of the joint angle of the sagittal plane of the hip, knee, and ankle of the lower limb.

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

## RESULTS

### Calibration of metrological evaluation indicators

According to the structure and type of motor coordination ability, this paper initially set up 15 test items. There are more than 2 of the same indicators of various types.<sup>6</sup> In the qualitative calibration, this thesis conducts statistical processing on the results of expert correspondence. In this paper, the reliability is determined according to the percentage of the standard value selected by the experts. Nine indicators were identified for the first time out of 15 indicators.

This paper carried out nine pre-tests according to the existing measurement methods. In this paper, five gymnastics professionals were asked to empirically evaluate the coordination ability of 18 athletes in the pre-test project. The results show that except for the two test indicators of "two-footed hitting" and "kick-tossing accuracy," the other seven correlations with the empirical evaluation of coordination ability and gymnastics performance are all moderately high. (Table 2)

The paper quantifies the correlation of markers across nine tests. The remaining seven targets were also selected after excluding two factors related to low degrees. In addition to the low correlation, the other two indicators have the lowest scores in the expert interview.<sup>7</sup> These two indicators are also characteristic of balls.

### Changes and analysis of each index in the control group before and after the experiment

This paper uses the T-type distribution theory to compare the sampling statistics of the T-value test and draw the following conclusions.

**Table 2.** Influencing factors of comprehensive quality test and comprehensive quality evaluation and gymnastics performance.

Project	r	Relativity
Cross slap	0.605	Middle
Quickly step on	-0.55	middle
Directional balance	-0.528	Middle
Jump rope	0.55	Middle
Catch the ball with Both hands	0.638	Middle
Two-handed dribble	0.671	Middle and high
Knock the ball with both feet	0.231	Low
Kick	0.682	Middle and high
Kick and throw	0.264	Low

The other six indexes ( $P < 0.01$ ) had no statistical significance except cross-beating. The results showed no significant difference in the overall test scores of the control group. The improvement in motor coordination was not significant. (Table 3)

### Changes and analysis of each index in the experimental group before and after the test

The statistics in Table 4 show that the growth rate of each experimental group is greater than that of the control group. The results showed a significant improvement in the evaluation index of the experimental group in the overall test.<sup>9</sup> This paper further validates the global motor coordination assessment. (Table 4)

### Comparison of each index after the test with the control group

In this study, various teaching experiments were carried out with athletes' motor coordination ability as the research object. The experimental group using gymnastics training in this study scored higher than the control group in all aspects after the experiment.<sup>9</sup> There were significant differences in the three items of dribbling with both hands, skipping rope, and catching with both hands, but there was no statistical significance in the T-test ( $P > 0.05$ ). There was a statistically significant difference between the T-test values of kicking and fast stepping ( $P < 0.05$ ). The T-test showed significant differences between the experimental and the control groups in the two indicators ( $P < 0.01$ ). (Table 5)

**Table 3.** T-test of 7 indicators before and after the test.

Project	Before experiment		After the experiment		P
	X	S	X	S	
Cross slap	14.916	7.458	18.139	6.787	<0.01
Quickly step on	27.544	6.479	26.466	3.971	>0.05
Item balance	12.166	1.991	12.067	1.727	>0.05
Jump rope	27.06	8.184	28.237	8.008	>0.05
Both hands	12.617	3.256	12.837	3.311	>0.05
Two-handed dribble	51.095	20.471	51.447	18.04	>0.05
Kick	24.915	6.16	25.553	6.094	>0.05

**Table 4.** T-check of the seven indicators before and after the experiment in the experimental group.

Project	Before experiment		After the experiment		P
	X	S	X	S	
Cross slap	14.883	7.403	21.164	6.369	<0.01
Quickly step on	26.818	3.905	25.234	3.74	<0.01
Item balance	12.089	1.76	11.264	1.595	<0.01
Jump rope	27.027	8.327	29.975	9.075	<0.05
Both hands	12.65	4.851	13.651	3.212	<0.05
Two-handed dribble	50.545	21.153	54.296	21.23	<0.05
Kick	24.574	6.204	27.566	6.523	<0.01

**Table 5.** After the test, the 7-indicator T-test of the experimental group and the control group.

Project	Before experiment		After the experiment		P
	X	S	X	S	
Cross slap	21.164	6.369	18.139	6.787	<0.01
Quickly step on	25.234	3.74	26.466	3.971	<0.05
Item balance	11.264	1.595	12.067	1.727	<0.01
Jump rope	29.975	9.075	28.237	8.008	>0.05
Both hands	13.651	3.212	12.837	3.311	>0.05
Two-handed dribble	54.296	21.23	51.447	18.04	>0.05
Kick	27.566	6.523	25.553	6.094	>0.05

## DISCUSSION

Coordination is the free movement of the body through its adjustment to achieve smooth, precise, and controlled movement. Coordination skills play a pivotal role in daily physical activity. At the same time, it is also an important indicator of motor control. A straightforward exercise involves many muscles. They act as agonists, synergists, antagonists, and fixators during all movement phases.<sup>10</sup> They have to coordinate the contraction and relaxation of muscle groups. Coordinated movement is the proper use of multiple joints and muscles at the right time to produce fluid, efficient, and precise movement. Therefore, the coordination factors are the order, timeliness, and gradation of multiple groups of muscle movements. Abnormal functional activity is mainly manifested in muscles' spatial and temporal contraction. Poor resolution means that the range of motion is not large enough. Movement breakdown is the time in coordination between the various muscle groups.

An essential factor in learning control and coordination is repetition. If an action is repeated multiple times, the process is stored. This iterative process is essentially a program of programs and a memory of actions. Under the guidance of consciousness, the practitioner's brain will automatically generate an automatic memory imprint of the coordinated movement of multiple muscles.<sup>11</sup> This allows the practitioner to replicate multiple muscles coordinated, active movement freely. And the movement is faster, more precise, and more potent than pure muscle control. Any sports technique requires the coordination of multiple muscles, and the mastery of motor skills is inseparable from the precise control of muscles.

Gymnasts must maintain the axis of rotation of their bodies when performing single-leg twists, ring jumps, and handstand twists. The athlete strengthens the erector spinal muscles to ensure the precision of the movement when exercising the core strength.

Gymnasts do many complex movements, such as rolling and tossing in the air. These need to rely on the body's muscular core strength. Core strength training allows athletes to control the core muscles and thus ensures their high quality in different aerial sports. Core stability training requires multiple muscles to be involved in the movement simultaneously. This requires a single muscle to function effectively and coordinate the coordination of various muscles. Core stability training improves the body's neural stability and promotes coordination during movement. This method can improve the stability of the movement and reduce the physical requirements. In this way, the movement stability of the athlete is improved.

## CONCLUSION

Gymnastics has rich content, various movements, and complex forms of movement. This is a favorable condition for developing gymnast movement coordination. The motor coordination of the experimental group was greatly improved. In this paper, the empirical evaluation of motor coordination and the analysis of the related motor coordination and motor coordination factors. The results showed that seven indicators, such as cross-slap, fast pedaling, directional balance, skipping rope, two-handed catching, two-handed dribbling, and kicking, had a great relationship with movement coordination. Among them, four indicators, such as directional balance, cross-slap, fast stepping, and kicking, can qualitatively evaluate the movement coordination of athletes.

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## REFERENCES

1. Yilmaz S, Sicim-Sevim B. The examination of the differences in the motor proficiency skills of children practising gymnastics vs. non-sportive children. *Early Child Dev Care*. 2020;190(9):1455-62.
2. Cantergi D, Loss JF, Mochizuki L. Joint coordination in the artistic gymnastics' giant circle. *BJMB*. 2020;14(4):16-7.
3. Grigoriou C, Pricop A, Mezei M, Pelin R. Study on the Relation Between the Coordinative Capacity and the Specific Technique of Rhythmic Gymnastics in the Junior Groups. *Gymnasium*. 2021;21(2):125-39.
4. Kyzim P, Fedorov E, Batieieva N. Features of The Development of The Coordination Abilities of Fitness Athletes Aged 8-9 Years. *Slobozhanskyi Her Sci Sport*. 2021;9(5):81-91.
5. Dako N. Conditioning and Coordination a Necessity in Appropriation of Learning Program Artistic Gymnastics with Students. *J Adv Sport Phys Edu*. 2021;4(2):10-4.
6. Tarnichkova M. Example Program for Improving Coordination Skills and Spatial Orientation in Children from Primary School Age. *TJS*. 2021;19(1):582-8.
7. Vasilenko VS, Mamiev ND, Semenova YB, Karpovskaya EB. The use of whole-body cryotherapy for increasing the stress resistance of female athletes in group types of gymnastics. *Pediatrician (St. Petersburg)*. 2021;12(2):43-52.
8. Bashstovenko O, Yarchuk G, Zvekova V, Hancheva K, Silaiev V, Stanieva S. Influence of Sports Games on Coordination Abilities of Adolescents as a Component of Physical Development: Neuropsychological Features. *BRAIN*. 2021;12(4):238-49.
9. Akkari-Ghazouani H, Mkaouer B, Amara S, Chtara M. Kinetic and Kinematic Analysis of Three Different Execution Modes of Stag Leap with And Without Throw-Catch Ball in Rhythmic Gymnastics. *ScGYM*. 2020;12(3):255-434.
10. Salaxitdinovna KD. Development of Coordination Abilities Through The Perception Of Space And Time In Young Rhythmic Gymnasts. *RJAI*. 2021;2(06):73-9.
11. Yusupava L, Bodrenkova I, Moshenska T. Factor Structure of Preparedness of Young Athletes in Aerobic Gymnastics. *Slobozhanskyi Her Sci Sport*. 2021;9(6):22-32.