THE SCIENTIFIC SYSTEM OF HUMAN CORE BALANCE IN SPORTS

O SISTEMA CIENTÍFICO DO EQUILÍBRIO DO CORE HUMANO NOS ESPORTES

EL SISTEMA CIENTÍFICO DEL EQUILIBRIO DEL CORE HUMANO EN LOS DEPORTES

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Huan Dong[1]
(Physical Education Professional)
Kai Kong[2]
(Physical Education Professional)
Qianli Ma[3]
(Physical Education Professional)

1. Department of Sports, Zaozhuang University, Zaozhuang, China.
2. College of Business Administration, Yong In University, Gyeonggi do, Korea.
3. Department of Sports, Zaozhuang University, Zaozhuang, China

Correspondence:
Kai Kong
Gyeonggi do, Korea. 17092.
4101983@163.com

ABSTRACT

Introduction: The human brain controls the body's balance, actinh on the muscle tissues of the body and thus controlling the balance of its center of gravity. Objective: To analyze 6 indicators that affect the brain's ability to control the body's balance and to verify the important muscle areas of the human body and prove that strength training can help improve the body's balance ability. Methods: This article selected young university students with the same physical fitness as sample and analyzed the factors that affect the body's strength and balance using statistical models. Results: Strength training can effectively improve the body›s balance when standing. Conclusion: Training the brain to control the body is mainly to exercise strength, stability, balance, and other abilities of human muscle tissue. Using this kind of exercise method can effectively improve the stability of the human body. Targeted training can also enhance the brain's ability to control the balance of the body. ***Level of evidence II; Therapeutic studies - investigation of treatment results.***

Keywords: Resistance training; Sports; Evaluation methodology.

RESUMO

Introdução: O cérebro humano controla o equilíbrio do corpo, agindo sobre seus tecidos musculares e, assim, controlando o equilíbrio de seu centro de gravidade. Objetivo: Analisar seis indicadores que afetam a capacidade do cérebro de controlar o equilíbrio do corpo, avaliar áreas musculares relevantes do corpo humano, e provar que atividade física voltada à força pode melhorar o equilíbrio do corpo. Métodos: Esse artigo selecionou como amostra jovens estudantes universitários com preparo físico similar, e analisou quais fatores afetam de maneira relevante a força e o equilíbrio do corpo por meio de modelos estatísticos. Resultados: Treinamentos de força podem efetivamente melhorar o equilíbrio do corpo quando de pé. Conclusão: Treinar o cérebro para controlar o corpo significa, principalmente, treinar a força, a estabilidade, o equilíbrio, e outras capacidades dos tecidos musculares humanos. O uso dessa metodologia de atividade física pode efetivamente aprimorar a estabilidade do corpo humano. O treinamento direcionado também pode melhorar a capacidade do cérebro de controlar o equilíbrio do corpo. ***Nível de evidência II; Estudos terapêuticos – investigação do resultado de tratamentos.***

Descritores: *Treinamento de força; Esportes; Metodologia de Avaliação.*

RESUMEN

Introducción: El cerebro humano controla el equilibrio del cuerpo, actuando sobre sus tejidos musculares y, así, controlando el equilibrio de su centro de gravedad. Objetivo: Analizar seis indicadores que afectan la capacidad del cerebro de controlar el equilibrio del cuerpo, evaluar áreas musculares relevantes del cuerpo humano y probar qué actividad física centrada en la fuerza puede mejorar el equilibrio del cuerpo. Métodos: Este artículo seleccionó como muestra jóvenes estudiantes universitarios con preparación física similar y analizó cuáles factores afectan de manera relevante la fuerza y el equilibrio del cuerpo por medio de modelos estadísticos. Resultados: Entrenamientos de fuerza pueden efectivamente mejorar el equilibrio del cuerpo al estar de pie. Conclusión: Entrenar el cerebro para controlar el cuerpo significa, principalmente, entrenar la fuerza, la estabilidad, el equilibrio y otras capacidades de los tejidos musculares humanos. El uso de esta metodología de actividad física puede, efectivamente, mejorar la estabilidad del cuerpo humano. El entrenamiento dirigido también puede optimizar la capacidad del cerebro de controlar el equilibrio del cuerpo. ***Nivel de evidencia II; Estudios terapéuticos – investigación del resultado de tratamientos.***

Descriptores: *Entrenamiento de fuerza; Deportes; Metodología de Evaluación.*

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INTRODUCTION

Skill-dominant difficulty item groups value the selection of balance ability. Diving and gymnastics in China have already taken it as one of the qualification indicators for selection. A quantitative evaluation system was established in the 1990s. The selection of static balance ability in martial arts is still in the stage of experience selection.[1] Therefore, it is urgent to quantitatively evaluate the static balance ability and establish an evaluation system for martial arts athletes' static balance ability selection.

METHOD

Research objects

There was a random sample of 140 8-year-old boys from 32 classes in 16 primary schools in 4 regions and 8 counties (cities). The subject did not engage in systematic sports training, had no myopia, and had a normal body shape. Test 11 8-year-old male athletes who have been engaged in martial arts training for 2 years. The subject has been engaged in systematic martial arts training for 2 years. Participate in training 5 times a week and uninterrupted winter and summer vacations.

Research methods

Interview method

Visit senior martial arts experts and experienced grassroots martial arts coaches. We consult on test methods.[2] Visit experts in physiology, biomechanics, training science, material selection, statistics, and other disciplines. We consult on the selection of indicators and the advancement, accuracy, and comprehensiveness of test indicators.

Experimental method

The experiment used the 6 indicators of the experimental equipment to evaluate the static balance ability. Each subject was tested in 6 postures, including the "Crane Legislation" in the selection of martial arts.[3] The test is conducted indoors. Subjects warmed up for 10 minutes and took off their shoes to participate in the test. The test environment is kept quiet.

Mathematical Statistics

(1) The original data is input in the format of Microsoft. Excel. The SPSS11.0 software package processes data statistics. (2) Use conventional statistical methods and non-parametric tests to test the discriminativeness of the indicators. (3) We use hierarchical cluster analysis to classify the indicators. We use factor analysis to establish a comprehensive test index for static balance ability. The experiment uses the standard percentage scoring method to score and evaluate the individual indicators of balance ability.

Simulation and verification of human balance dynamics

The law of movement of the upper body during the balance of the human body is determined.[4] Always use the hip joint to keep it perpendicular to the ground. Because when we control the balance, only the ankle joint drives the human body to swing left and right, so the dynamic analysis of the center of gravity of the human body is carried out.

$$F = Ml_G\ddot{\theta} - Mg\sin\theta \quad (1)$$

$$\tau = Fl_G \quad (2)$$

In the case where the center of gravity offset angle θ is very small, the center of gravity of the model is approximately

$$\sin\theta \approx \theta \quad (3)$$

Then we can get

$$\tau = Ml_G^2\ddot{\theta} - Mgl_G\theta \quad (4)$$

In this study, the human body balance controller adopts a PD controller with delay in the ankle joint.[5] The delay only affects the proportional control, which can effectively reflect the state of unconscious dumping of the human body in the initial stage of imbalance. The output torque of PD controller with delay

$$\tau(t) = K_P\theta(t-t_d) + K_D\frac{d\theta(t)}{dt} \quad (5)$$

From (4) and (5)

$$Ml_G^2\ddot{\theta} - Mgl_G\theta = K_P\theta(t-t_d) + K_D\frac{d\theta(t)}{dt} \quad (6)$$

The angle that the human body deviates from the equilibrium position is measured by connecting the two ankles with the detection module.[6] After the balance controller adjusts the deviation, the actuation module converts the torque to act on the two ankles to adjust the whole body to return to a balanced position.

RESULTS

Establishment of comprehensive evaluation index for static balance ability

We merge the indicators of the same content on the left and right legs and average them to represent the static balance ability when standing on one leg. The posture has been changed from the original 6 types to 4 types. The indicators for each subject have also changed from 36 items to 24 items.

Screening of cluster analysis indicators

We perform hierarchical cluster analysis on the 6 indicators of each posture. The clustering method selects the connection method between groups. Select the square of the Euclidean distance as the distance measure.[7] We select one of the most representative indicators from each of the categories gathered as a typical indicator of the category. Calculate the average value of the sum of squares of correlation coefficients of the i-th index to other indexes in the class.

$$R_i^2 = \frac{\sum r^2}{K-1} \quad (7)$$

Where K is the number of variables (indicators) within the class. We choose the variable with the largest R_i^2 as the type variable. According to this method, the indicators have been changed from 24 items to 17 items.

Synthesis of factor analysis indicators

The static balance ability of the human body is a comprehensive ability, which should include the balance of the human body in different postures. Therefore, we should consider these four postures to analyze the comprehensive balance ability of the human body in these four different postures.[8] We perform factor analysis on 17 indicators after cluster analysis. We perform the maximum variance orthogonal rotation on the factor loading matrix and select the eigenvalue $\lambda_i>1$. Factors with a cumulative contribution rate greater than 75%. (Table 1)

Seven factors or principal components are summarized through classification (Table 2). Choose an index from the high-load index included

Table 1. Principal component eigenvalues after rotation.

Main ingredient	Eigenvalues (λ_i)	Contribution rate (%)	Cumulative contribution rate (%)
1	2.676	15.74	15.74
2	2.028	11.927	27.667
3	1.93	11.355	39.021
4	1.922	11.304	50.325
5	1.816	10.682	61.007
6	1.769	10.408	71.416
7	1.134	6.672	78.087

in each principal component factor as the representative index of the factor. The selected series of indicators represent these factors and represent the information of all indicators. These indicators can make a more comprehensive evaluation of the static balance ability. The basis for selecting indicators is as follows: the factor load is large, and the calculated indicators are concentrated.[9] According to these conditions and methods, 7 are selected as comprehensive evaluation indicators for evaluating static balance ability. We also call it the dominant factor of static balance ability. The index selection results are shown in the representative index column in Table 2.

Establishment of quantitative scoring standards for static balance ability

Scoring of individual indicators

Each index in the dominant factor (factor) of static balance ability represents a factor. The scoring evaluation of each indicator is the scoring evaluation of the factors represented by the indicator. We use the standard percentage scoring method to score individual indicators. We formulate the individual index scoring table as follows: (1) Find each index's average and standard deviation. (2) Within the scoring range of X±3S. The calculation formula is T=50-(X-X) S*16.67.

Scoring of comprehensive indicators

We use the unique scoring formula to find the score of each indicator. Calculate the weight coefficient of each index according to the characteristic value of each principal component of static balance ability. The weight coefficient is $V_i = \lambda_i \Sigma \lambda_i, (i = 1 to 7)$. Then all these indicators and their weight coefficients constitute the scoring structure of static balance ability. (Table 3)

Establishment of scoring standards

We substitute the actual measured values of each index in the comprehensive evaluation index of static balance ability into the individual scoring formula to obtain the score of each index. Then according to the weight coefficient of each index in Table 4, the individual scores are weighted to obtain the total score. The total score is the total score of static balance ability. We do frequency analysis on the overall score. We divide the total scores of all testers into 5 levels according to the same percentage. Make each level accounted for 20% of the total number of subjects. The scores from high to low are determined as high, medium and high, medium, medium and low, and inferior. Each level has a corresponding scoring range. (Table 4)

Table 2. Factor analysis results and comprehensive evaluation index table.

Main ingredient	High load index	Factor loading	Representative index
1	MYSC4	0.863	MYSC4
	MYSO3	0.853	
	YDO1	0.739	
	YDC2	0.724	
2	MLNGSO3	0.924	MLNGSO3
	MACSO3	0.895	
3	LNGDO1	0.851	LNGDO1
	ACDO1	0.769	
4	MXSO3	0.839	MXSO3
	MXSC4	0.762	
5	ACDC2	0.734	ACDC2
	LNGDC2	0.680	
6	MACSC4	0.905	MACSC4
	MLNGSC4	0.877	
7	XDC2	0.886	XDC2

Table 3. Rating structure of static balance ability.

Index number	Index	Weight coefficient
1	MYSC4	0.202
2	MLNGSO3	0.153
3	LNGDO1	0.145
4	MXSO3	0.145
5	ACDC2	0.137
6	MACSC4	0.133
7	XDC2	0.085

DISCUSSION

We selected 11 8-year-old male athletes from the martial arts amateur training team. They are all trained in martial arts after selecting talents through the experience of static balance ability. Its static balance ability meets the requirements of experience selection. We test them in the same condition. Use this scoring standard to perform a quantitative evaluation to compare the similarities and differences between traditional experience selection and quantitative evaluation.

We respectively put their measured values into the scoring formula to find their total score. Use the evaluation criteria of this age to classify and evaluate them. It turns out that after the quantitative evaluation of this evaluation standard, their static balance ability has 5 people in the top class and 4 people in the middle and top class. The proportion of these two items is 69%. There are 3 people in the middle, accounting for 23%. There is 1 inferior, accounting for 8%. (Table 5)

After evaluating the evaluation system, the number of people with the same evaluation results reached 69%. This shows that the evaluation system has high consistency with the traditional empirical selection method. This quantitative evaluation system of static balance ability will more accurately reflect the static balance ability of 8-year-old children. But there are 23% different and 8% contradictory. This shows that the traditional empirical selection method has larger errors than these quantitative evaluation systems. The success rate of selection is still relatively low because it is difficult to see the speed, range, and direction of the center of gravity when the human body is standing still with the naked eye alone.

CONCLUSION

Based on analyzing the static balance ability of 6 postures, we used cluster analysis and factor analysis to reduce the evaluation index of static balance ability into 7 factors. The culture selects the representative

Table 4. Evaluation Criteria for Static Balance Ability.

Evaluation index	Evaluation standard
First-class	Score>59.31
Upper middle class	54.84 <score≤59.31
medium	50.72 <score≤54.84
Inferior	45.71 <score≤50.72
Inferior	Score ≤45.71

Table 5. Wushu athletes' static balance ability score and grade evaluation.

Gender	Age	overall ratings	At the level
Male	8	58.99	Upper middle class
		59.38	First class
		65.21	First class
		63.97	First class
		51.83	medium
		41.35	inferior
		58.88	medium
		63.15	First class
		53.91	medium
		58.5	Upper middle class
		58	Upper middle class

index of each factor and determines the evaluation index system of static balance ability. We bring the measured values of 8-year-old male athletes selected based on the experience selection method into the evaluation system for scoring. We conclude that the evaluation system has a high consistency with the traditional experience selection method. This quantitative evaluation system will more accurately reflect the static balance ability of 8-year-old children and has certain applicability.

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