PHYSICAL TRAINING INTERVENTION ON THE FUNCTIONAL STATUS OF TAEKWONDO ATHLETES

INTERVENÇÃO DE TREINAMENTO FÍSICO NO STATUS FUNCIONAL DOS ATLETAS DE TAEKWONDO

INTERVENCIÓN DEL ENTRENAMIENTO FÍSICO EN EL ESTADO FUNCIONAL DE LOS ATLETAS DE TAEKWONDO

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HaiFeng Lin[1]
(Physical Education Education)
ZhenLiang Ding[1]
(Physical Education Education)

1. Wuhan Institute of Physical Education School of Sport Science & Technology, Wuhan, Hubei, China.

Correspondence:
HaiFeng Lin
Wuhan, Hubei, China. 430205.
linhaifeng0318@163.com

ABSTRACT

Introduction: Taekwondo is a fighting and confrontational game that requires exceptionally high physical and psychological qualities from athletes. It has higher requirements on the athlete's explosive power, coordination ability, spatial perception, and psychosocial quality. Any slight body changes in an athlete can destabilize the nervous system and cause changes in the immune system. These changes can increase the risk factor during training and competition. Objective: Monitor the physical function of taekwondo athletes. Methods: This paper discusses the essential role of biochemical indicators in taekwondo training. At the same time, it explores the relationship between physical function and the training effect of taekwondo athletes. Taekwondo athletes underwent a one-year training program. The program monitored and recorded the athletes' biochemical parameters during training. The relationship between the training program formulation and the biochemical indicators of taekwondo athletes was analyzed. Results: The overall average level of nitrogen and urea in the blood was significantly higher than that of the setting phase after a large amount of exercise ($P<0.05$). Changes in blood urea after the routine were relatively stable ($P>0.05$). Most participants demonstrated hemoglobin in the normal range and reached its upper limit after winter training. Conclusion: The quality of the biochemical indicators of the athlete directly affects his performance. Sanguine nitrogen and hemoglobin are the main biochemical indicators for monitoring Taekwondo athletes. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Tae Kwon Do; Athletes; Biochemical Markers; Physical Exercise.

RESUMO

Introdução: O Taekwondo é um jogo de luta e confronto que requer qualidades físicas e psicológicas excepcionalmente elevadas dos atletas. Ele tem requisitos mais altos sobre o poder explosivo do atleta, capacidade de coordenação, percepção espacial e qualidade psicossocial. Qualquer leve alteração corporal de um atleta pode desestabilizar o sistema nervoso e causar alterações no sistema imunológico. Estas mudanças podem aumentar o fator de risco durante o treinamento e a competição. Objetivo: Monitorar a função física dos atletas de taekwondo. Métodos: Este documento discute o papel essencial dos indicadores bioquímicos no treinamento de taekwondo. Ao mesmo tempo, explora a relação entre a função física e o efeito do treinamento dos atletas de taekwondo. Atletas de taekwondo foram submetidos a um programa de treinamento de um ano. O programa monitorou e registrou os parâmetros bioquímicos dos atletas durante o treinamento. Analisou-se a relação entre a formulação dos programas de treinamento e os indicadores bioquímicos dos atletas de taekwondo. Resultados: O nível médio geral de nitrogênio e ureia no sangue foi significativamente maior do que o da fase de ajuste após uma grande quantidade de exercício ($P<0,05$). As variações na ureia sanguínea após a rotina foram relativamente estáveis ($P>0,05$). A maioria dos participantes demonstrou hemoglobina na faixa normal e atingiu o seu limite superior após o treinamento de inverno. Conclusão: A qualidade dos indicadores bioquímicos do atleta afeta diretamente o seu desempenho. O nitrogênio e a hemoglobina sanguíneos podem ser usados como os principais indicadores bioquímicos para monitorar os atletas de Taekwondo. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

***Descritores*:** *Tae Kwon Do; Atletas; Marcadores Bioquímicos; Treinamento Físico.*

RESUMEN

Introducción: El taekwondo es un juego de lucha y enfrentamiento que exige a los deportistas unas cualidades físicas y psicológicas excepcionalmente altas. Tiene mayores exigencias en cuanto a la potencia explosiva, la capacidad de coordinación, la percepción espacial y la calidad psicosocial del atleta. Cualquier pequeño cambio corporal en un deportista puede desestabilizar el sistema nervioso y provocar cambios en el sistema inmunitario. Estos cambios pueden aumentar el factor de riesgo durante el entrenamiento y la competición. Objetivo: controlar la función física de los atletas de taekwondo. Métodos: Este artículo analiza el papel esencial de los indicadores bioquímicos en el entrenamiento de taekwondo. Al mismo tiempo, explora la relación entre la función física y el efecto del entrenamiento de los atletas de taekwondo. Los atletas de taekwondo se sometieron a un programa de entrenamiento de un año. El programa controló y registró los parámetros bioquímicos de los atletas durante el entrenamiento. Se analizó la relación entre la formulación de los programas de entrenamiento y los indicadores bioquímicos de los atletas de taekwondo. Resultados: El nivel medio global de nitrógeno y urea en sangre fue significativamente mayor que el de

la fase de ajuste después de una gran cantidad de ejercicio (P<0,05). Los cambios en la urea en sangre después de la rutina fueron relativamente estables (P>0,05). La mayoría de los participantes mostraron una hemoglobina en el rango normal y alcanzaron su límite superior después del entrenamiento invernal. Conclusión: La calidad de los indicadores bioquímicos del deportista afecta directamente a su rendimiento. El nitrógeno sanguíneo y la hemoglobina pueden utilizarse como principales indicadores bioquímicos para el seguimiento de los atletas de taekwondo.
Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.

Descriptores: *Tae Kwon Do; Atletas; Marcadores Bioquímicos; Entrenamiento Físico.*

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INTRODUCTION

Competitive taekwondo is a highly technical confrontational sport. It has higher requirements on the athlete's explosive power, coordination ability, sense of space, and psychological quality. The danger is always present in training and competition. Any slight change in an athlete's body can affect the performance of the motor function. It also increases the risk factor during training and competition.[1] Because the competition is very intense for the nervous system, fatigue in athletes after exercise is also manifested in the nervous system. In addition, any small changes in the athlete's body will make the nervous system highly tense and cause changes in the immune system. This will reduce the body's resistance and affect the exercise of motor function. This will also increase the risk factor during training and competition. When physical strength declines, athletes are susceptible to diseases that affect movement.

We can monitor the athlete's physical condition in time by watching it through some biological indicators. This scientific organization of training and competition can reduce injury and danger to a minimum. This is the primary purpose of the physical function assessment of athletes, and it is also an urgent problem for athletes and coaches to solve. Mastering the laws of functional changes in athletes can help to organize and arrange training and competition scientifically. In this way, the blindness of exercise can be reduced as much as possible, the competition performance can be improved, and athletes' injuries can be minimized.[2] This paper researches the related issues of functional evaluation of taekwondo athletes. The results of this paper can provide a reference for the majority of taekwondo coaches and teachers engaged in taekwondo teaching.

METHOD

Research objects

This article selects 16 high-level taekwondo athletes. The average age of 6 female team members was (17.67±2.10) years old. The average number of years of the exercise was (7.86±2.44) years. The average age of the ten male players was (18.54±1.62) years old. The average number of years of practice was (8.56±2.12) years.

Instruments and methods

Resting heart rate (HR) was determined by palpation. Resting blood pressure (BP) was measured with a mercury sphygmomanometer.[3] Hemoglobin (Hb) was tested with a BC-2000 semi-automatic blood analyzer. Urine protein was determined by Coomassie brilliant blue method.

Athlete risk optimization assessment model

Hypothesis S represents the overall athlete risk under high-intensity exercise being assessed. The different types of athlete risk factors are represented by S_1, S_2, S_n. R_i represents the value at risk for each risk factor. We use formula (1) to calculate the risk value of S.

$$R=\sum_{i=1}^{n}\{p_i\times\frac{S}{(S_1,S_2,S_3)}(R_i+\sum_{j=1}E_n^{\wedge})\} \quad (1)$$

$V^k_{ij}=(L^k_{ij}, M^k_{ij}, U^k_{ij})$ represents the triangular fuzzy number evaluation of the risk factor for the i athlete by the k rater. We take a comprehensive average of the different ambiguous judgments V^k_{ij} of q raters.[4] We bring the R calculated by the formula (1) into the calculation of the complete fuzzy evaluation value of the i athlete's risk factor

$$V_{ij}=(1/q)\times\frac{V^k_{ij}}{(\upsilon^1_{ij}+\upsilon^2_{ij}+\cdots\upsilon^q_{ij})}\frac{(L^k_{ij},M^k_{ij},U^k_{ij})}{R\times i} \quad (2)$$

$(\upsilon^1_{ij}, \upsilon^2_{ij}, \upsilon^q_{ij})$ stands for different athlete risk factor assessment values. $fS\rightarrow F(A)$ represents experts to evaluate each risk factor, and use formula (3) to describe the expert's estimation of risk factors for different athletes

$$R_j=\begin{bmatrix} r_{l1} & r_{1u} \\ r_{\upsilon 1} & r_{\upsilon u}\end{bmatrix}\times\frac{fS\rightarrow F(A)}{V_{ij}} \quad (3)$$

(r_{l1}, r_{1u}) represents the entropy weighting factor for athlete risk factors. $(r_{\upsilon 1}, r_{\upsilon u})$ stands for assessing the severity of risk factors in athletes. We use Equation (4) to describe the controllability, predictability, and identifiability of risk factors for all athletes

$$t'=1-\prod_{i=1}^{u}(1-t_i)*R_j/R \quad (4)$$

t_i represents a vector that measures risk factors for athletes. We use formula (5) to calculate the probability function of each athlete's risk factor value

$$f(X)=t'\begin{cases}\lambda_1\geq(0,1)\\ \lambda_2\leq(0,1)\\ \lambda_3\neq(0,1)\end{cases} \quad (5)$$

$(\lambda_1, \lambda_2, \lambda_3)$ represents the probability function for the value of risk factors for different athletes. We can determine the risk factor level of athletes under high-intensity exercise by calculating the probability function of each athlete's risk factor value according to the above formula. Condition $\lambda_1\geq(0,1)$, the athlete's risk factor is high risk.[5] For conditions $\lambda_2\leq(0,1)$, the athlete's risk factor is low risk. The athlete's risk factor is a moderate risk for infection $\lambda_3\neq(0,1)$. Based on the optimal modeling principle of athlete risk assessment under high-intensity exercise, we effectively established an optimization model of athlete's risk assessment under high-intensity practice.

Data processing

The data is calculated, organized, and counted on the computer using Excel spreadsheets.

RESULTS

Cardiovascular system test indicators

Heart Rate (HR)

During the winter training, the resting heart rate of the players was generally stable. There are inevitable fluctuations of individual players in a specific period, and this fluctuation is related to the athletes' technical difficulty, intensity, and psychological state during training.[6] Individual players have morning pulse fluctuations during athlete training and actual combat (the fluctuation range is more significant than eight times/min).

Blood pressure (BP)

Attention should be paid to athletes whose resting systolic blood pressure is more significant than 130 mmHg and diastolic blood pressure is greater than 90 mmHg. If the resting blood pressure rises by about 20% more than usual and lasts for two days, it can be regarded as the performance of a decreased function or excessive fatigue.[7] Athletes' resting blood pressure was relatively stable during winter training. The average was maintained between (96.56±7.88) (/60.14±6.81) mmHg.

Oxygen transport system and anemia test indicators

Hemoglobin (Hb)

Hb can comprehensively reflect the ability of athletes to carry oxygen in their blood during exercise. In the athlete's nutritional assessment, we know the athlete's nutritional status and whether the body is in an anemia state by measuring Hb. It is generally believed that the index of Hb should be at the middle or above the average level for athletes.[8] It is best to reach the upper limit of this indicator before the game. It will be beneficial for the athlete to perform at the athletic level. The average Hb of female players before and after winter training was 13.5g/dl and 14.9g/dl, respectively. The average Hb of male players was 14.2g/dl and 16.1g/dl, respectively. The test results show that most athletes' Hb is within the normal range and reaches the upper limit after winter training.

Red blood cells (RBC)

Whether an athlete has anemia is inferred by indicators such as red blood cell count. Female players' average red blood cell counts before and after winter training were 4.5×10^{12}/L and 4.9×10^{12}/L, respectively.[9] The male players' average red blood cell counts were 4.7×10^{12}/L and 5.2×10^{12}/L, respectively. Both male and female players' red blood cell counts increased after training. (Table 1)

Test index table of material energy metabolism system

From Table 2, we can see that the overall average blood urea nitrogen level is significantly higher than that in the adjustment stage after large-scale exercise. Overall levels were largely back to normal the following day. However, it is still slightly higher than the adjusted test value.[10] This shows that the index has a more pronounced response to taekwondo's training volume and training intensity. According to the evaluation of the exercise volume and exercise intensity of other projects using this index, we can draw lessons from it and think that the training volume and intensity are more reasonable in the overall arrangement. However, it cannot be ruled out that individual athletes have fatigue in the test and show that the urea nitrogen value is continuously high.

Blood Urea (BUN)

Blood urea can be an essential indicator to reflect the body's degree of fatigue and evaluate the functional state. The less the body adapts to the load, the more urea is produced by exercise. When the urea exceeds 8mmol/L the following day after a training session, the amount of exercise is too much, so pay attention to adjusting the amount of activity.[11] The test results showed that the changes in blood urea of the female players after routine were relatively stable, with an average value of 6.41mmol/L. Most team members did not exceed the threshold for fatigue of 8mmol/L. The blood urea of individual team members exceeded or was close to 8mmol/L. Refer to other indicators to comprehensively assess the functional state of the player's body relative to the fatigue state.

Urine protein

During the entire winter training period, we monitored the urinary protein of the athletes after training and the following day.[12] The monitoring results showed little change in urine protein, and the specific training was generally less than 10mg/dl. (Table 3)

DISCUSSION

Table 3 shows the changes in blood urea nitrogen and hemoglobin detected periodically within one year. The hemoglobin level varies regularly with the different overall levels of the exercise cycle. About half a month after the game, hemoglobin gradually turned to a low point. Hemoglobin fluctuated with the onset of recovery training and the gradual increase in training intensity. About half a month before the game, the hemoglobin was close to my high value. The change of blood urea nitrogen value each time shows that the overall level is closely related to the amount of training, but there are also significant individual differences. This indicates that the application of this indicator to training varies from person to person.

Athlete A's hemoglobin was 15.2 g/dl, and his blood and urine nitrogen was 6.81 mmol/L. The athlete's performance indicators are satisfactory. Therefore, its performance expectations are higher. The athlete finished second in the competition. Athlete B's hemoglobin was 14.1 g/dl, and blood and urine nitrogen was 6.91 mmol/L. Biochemical indicators are ideal. Its game is typically played (1st place).

Table 1. Average value of blood urea nitrogen at rest in the morning during the adjustment phase.

Time	Blood urea nitrogen	Amount of exercise
20.10-20.12	14.3±1.7	50%-60%
21.1-21.3	13.1±1.9	50%-60%
21.4-21.6	13.7±1.6	60%-70%
21.7-21.9	11.6±1.8	60%-70%

Table 2. Changes in blood urea nitrogen values before and after the last major exercise.

Time	Morning quiet value	After a large amount of exercise	Next morning quiet
20.10.23	14.6±2.2	21.6±3.2	15.1±2.1
21.1.18	13.2±1.8	22.4±3.1	14.8±2.3
21.5.15	12.2±2.1	20.2±2.8	13.7±2.7
21.9.14	11.8±1.9	21.7±3.1	13.1±2.2

Table 3. The change rule of the average hemoglobin value of athletes in one year.

Time	Mean hemoglobin	Mean blood urea nitrogen	Training situation
20.10.23	15.4±2.6	17.6±3.1	
20.11.18	15.0±2.8	18.5±2.7	Post-match recovery period
20.12.20	14.8±2.1	15.9±2.4	Regular training
21.1.10	14.5±1.7	14.7±2.1	Winter training period
21.2.19	14.4±1.5	14.5±1.8	Adjustment period
21.3.21	14.5±1.3	14.2±1.4	Regular training
21.4.25	14.8±1.4	13.8±1.3	Pre-match preparation period
21.5.23	15.2±1.3	15.6±1.3	Taekwondo Championship
21.6.20	13.7±1.9	14.6±2.1	Post-match recovery period
21.7.22	14.2±1.7	14.3±1.9	Regular training
21.8.25	13.6±2.3	14.8±2.1	Summer training period
21.9.23	14.6±2.1	15.6±2.3	Pre-match preparation period
21.10.5	15.1±2.5	16.8±2.9	

CONCLUSION

Through long-term tracking and monitoring, the following conclusions are drawn from the research on the evaluation indexes of athletes' functional level. The quality of athletes' biochemical indexes directly affects the quality of athletes' performance. Blood urea nitrogen and hemoglobin can be used as the leading biochemical indicators to monitor Taekwondo athletes. Pay attention to individual differences in training. The data obtained will vary from person to person. We need scientific and reasonable assessment.

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REFERENCES

1. Da Silva Santos JF, Wilson VD, Herrera-Valenzuela T, Machado FSM. Time-motion analysis and physiological responses to taekwondo combat in juvenile and adult athletes: a systematic review. Strength Cond J. 2020;42(2):103-21.
2. Fachrezzy F, Maslikah U, Safadilla E, Reginald R, Hendarto S. Physical Fitness of The Poomsae Taekwondo Athletes in Terms of Agility, Balance and Endurance. Kinestetik: Jurnal Ilmiah Pendidikan Jasmani. 2021;5(1):111-9.
3. Koshcheyev A, Dolbysheva N. Basics of planning a pre-competitive mesocycle during taekwondo training. J Phys Educ Sport. 2021;21(4):1613-21.
4. Lin Q. Effect of Taekwondo Poomsae training on weight loss of obese children. Age. 2020;11(72):11-33.
5. Akhmad I, Nugraha T, Sembiring P. Speed, Agility, and Quickness (SAQ) training of the circuit system: How does it affect kick speed and agility of junior taekwondo athletes?. J Sport Area. 2021;6(2):175-82.
6. Hailong L. Role of artificial intelligence algorithm for taekwondo teaching effect evaluation model. J Intell Fuzzy Syst. 2021;40(2):3239-50.
7. Fachrezzy F, Maslikah U, Hermawan I, Nugroho H, Jariono G, Nurulfa R. Kicking ability for the Eolgol Yoep Chagi Taekwondo Poomsae in terms of quality of physical condition, self-confidence, and comparison of leg muscle explosive power and core stability. JPES. 2021;21(4):2337-42.
8. Zulkarnain AN, Kristiyanto A, Rachma N. Effectiveness body weight strength training and plyometric in the speed and agility taekwondo athletes. Jurnal SPORTIF: Jurnal Penelitian Pembelajaran. 2021;7(2):219-31.
9. Shi J. The Application of Behavior Oriented Teaching Method in the Construction of Practical Teaching Content System of Taekwondo in Colleges and Universities. Tob Regul Sci. 2021;7(5):4193-205.
10. Khayyat HN, Sağır SG, Hataş Ö, Smolarczyk M, Akalan C. Physical, physiological and psychological profiles of elite Turkish taekwondo athletes. Biomed Hum Kinet. 2020;12(1):187-96.
11. Wahyuni S. Vo2max, Daya Ledak Otot Tungkai, Kelincahan dan Kelentukan untuk Kebutuhan Kondisi Fisik Atlet Taekwondo. Jurnal Patriot. 2020;2(2):640-53.
12. Cheon W, Hong C, Park J. Comparison of Physical Fitness Factors of High School and College Taekwondo Athletes with Anaerobic Exercise and Isokinetic Muscle Function. Int J Martial Arts. 2020;5(2):38-46.