BIOMEDICINE ON HORMONE MEDIATION OF SPORTS IN ADOLESCENT HEIGHT DEVELOPMENT

BIOMEDICINA NA MEDIAÇÃO HORMONAL DO ESPORTE PARA DESENVOLVIMENTO DA ALTURA DOS ADOLESCENTES

BIOMEDICINA EN LA MEDIACIÓN HORMONAL DEL DEPORTE PARA EL DESARROLLO DE LA ESTATURA DE LOS ADOLESCENTES

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ABSTRACT

Introduction: Physical exercise is an important factor in regulating energy balance and body composition. Exercise itself is a kind of body stress. It involves the central nervous system, cardiovascular, respiratory, endocrine, and other systems. Sports have various effects on the hormones in adolescent height development. Objective: This article analyzes the effects of different time and load exercise training on the levels of serum testosterone, free testosterone, and cortisol in young athletes. Methods: The athletes' blood samples were collected at the quiet time in the morning before each experiment, immediately after exercise, and at three time intervals the next morning. Then blood testosterone (T), free testosterone (FT), and corticosteroids (C) were measured. Results: One-time and one-day high-volume training can cause a decrease in serum testosterone and free testosterone levels and an increase in cortisol hormones in young athletes. The testosterone level of young athletes rises immediately after exercise. Conclusion: Hormonal changes after physical exercise provide a scientific basis for athlete exercise load prediction and exercise plan formulation. ***Level of evidence II; Therapeutic studies - investigation of treatment results.***

Keywords: Sports; Athlete; Hormone; Testosterone; Corticoid.

RESUMO

Introdução: O exercício físico é um fator importante na regulação do equilíbrio energético e da composição corporal. O exercício em si é um tipo de estresse corporal. Envolve os sistemas nervoso central, cardiovascular, respiratório, endócrino e outros. O esporte tem vários efeitos sobre os hormônios no desenvolvimento da altura do adolescente. Objetivo: Este artigo analisa os efeitos de diferentes tempos e cargas de treinamento sobre os níveis de testosterona sérica, testosterona livre e cortisol em jovens atletas. Métodos: Foram coletadas amostras de sangue dos atletas pela manhã antes de cada experimento, imediatamente depois de exercício e em três intervalos de tempo na manhã seguinte. Em seguida, foram medidos testosterona sérica (T), testosterona livre (FT) e corticosteroides (C). Resultados: O treinamento de alto volume uma vez por dia pode causar diminuição dos níveis de testosterona sérica e livre e aumento do cortisol em jovens atletas. O nível de testosterona de jovens atletas aumenta imediatamente depois do exercício. Conclusões: As mudanças hormonais depois de exercício físico fornecem uma base científica para a previsão da carga dos exercícios e para a formulação do plano de treinamento. ***Nível de Evidência II; Estudos terapêuticos - Investigação dos resultados do tratamento.***

Descritores: *Esportes; Atletas; Hormônios; Testosterona; Corticoide.*

RESUMEN

Introducción: El ejercicio físico es un factor importante en la regulación del equilibrio energético y la composición corporal. El propio ejercicio es un tipo de estrés corporal. Afecta a los sistemas nervioso central, cardiovascular, respiratorio y endocrino, entre otros. El deporte tiene varios efectos sobre las hormonas en el desarrollo de la estatura de los adolescentes. Objetivo: Este artículo analiza los efectos de diferentes tiempos y cargas de entrenamiento sobre los niveles de testosterona sérica, testosterona libre y cortisol en jóvenes atletas. Métodos: Se tomaron muestras de sangre de los atletas por la mañana antes de cada experimento, inmediatamente después del ejercicio, y en tres intervalos de tiempo a la mañana siguiente. Luego se midieron la testosterona sérica (T), la testosterona libre (FT) y los corticosteroides (C). Resultados: El entrenamiento de alto volumen una vez al día puede causar una disminución de los niveles de testosterona sérica y libre y un aumento del cortisol en los atletas. El nivel de testosterona de los jóvenes atletas aumenta inmediatamente después del ejercicio. Conclusión: Los cambios hormonales después del ejercicio físico proporcionan una base científica para predecir la carga de ejercicios y formular el plan de entrenamiento. ***Nivel de Evidencia II; Estudios terapéuticos - Investigación de los resultados del tratamiento.***

Descriptores: *Deportes; Atletas; Hormonas; Testosterona; Corticoide.*

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INTRODUCTION

The growth and development of adolescents are very important. Young people's low self-esteem due to poor physical development can easily lead to young people not adapting well to social life. Proper physical function training is very important for young people.[1] Through years of follow-up and observation, we can understand the influence of different times, loads, exercise forms, and methods on the androgen level of young athletes. To strengthen the monitoring of the growth and development of young athletes in sports training, we explore the methods of scientific training for young athletes.

METHOD

Research object

The number of young athletes in excellent sports teams is 50. Among them, 12 were in track and field, eight were in synchronized swimming, 22 were in bicycle, and eight were in wrestling. The age range is 14-18 years old.

Experimental method

Athlete's blood sample collection: The athlete's blood sample was collected at the quiet time in the morning before each experiment and immediately after the exercise, at the quiet time the next morning. Blood testosterone (T), free testosterone (FT), and corticosteroids (C) are all measured by radioimmunoassay. The hemoglobin was measured by the cyanmethemoglobin method and measured on the 721 spectrophotometers.[2] The age of the athletes shall be following the bone age standards checked when the athlete participates in the competition. The bone age was determined by the CHN method.

Modeling the effect of aerobic exercise on the regulation of height hormones

In the process of aerobic exercise for the association modeling of the height development of adolescents, we first collect the various factors that form the height of adolescents. Calculate the weight coefficient of the harm caused by various factors to young people's health.[3] At the same time, we establish a model of the relationship constraint of aerobic exercise on the height development of adolescents and give the constraint conditions of the relationship of aerobic exercise on the height development of adolescents.

Q_s represents the main factor causing the lack of height. x_i, ω_i represents the psychological and physical harm caused by insufficient height to adolescents. Then use the following formula to calculate the weight coefficient of each hazard factor of insufficient height to the health of adolescents

$$q_h = \frac{(Q_s \bullet \lambda)}{\chi_i \bullet \omega_i} \times \varepsilon(Q \bullet \beta) \quad (1)$$

ε represents the number of nutrients in the body and Q represents the period of height increase. β represents the calorie intake of food for a tall youth. Establish a restraint model of the relationship between aerobic exercise and the height development of adolescents and use the following formula to express

$$Q_{rij}(t+n) = \frac{(1-\rho) \bullet Q_{rij}(t)}{q_h} \quad (2)$$

ρ represents the changes in adolescents' body shape and composition before and after exercise and $Q_{rij}(t)$ represents the comprehensive risk factors for cardiovascular and other pathological changes in height youth.[4] The constraint condition of aerobic exercise on the height development of adolescents is given by $\tau_{ij}(t+1)$. TP represents the height of adolescents. Then use the following formula to calculate the objective function of the relationship between aerobic exercise and the height development of adolescents

$$Q^* = Q_{rij}(t+n) * \frac{FN}{TP} \bullet FP\tau_{ij}(t+1) \quad (3)$$

FP represents the blood pressure changes of adolescents before and after exercise. FN represents the height increase rate of adolescents after exercise.

RESULTS

The impact of a heavy-load training session on the testosterone value of young athletes

We choose cyclists to take a blood test on the morning of the heavy exercise training day and blood tests immediately after training and the next morning.[5] Seven male athletes rode continuously for 80km at once, and nine female athletes rode for 60km. The heart rate immediately after exercise averaged 194.9±6.3 beats/min. The test results of serum testosterone value are shown in Table 1.

Table 1 shows that the testosterone value of cyclists increased immediately after 2 hours of continuous long-distance training.[6] But the testosterone values of male and female athletes the next morning were significantly lower than the quiet value before training the day before.

The impact of a day's heavy training on hormones

The situation of synchronized swimmers

The subjects of the study are eight young athletes from outstanding synchronized swimming teams. Five of them performed heavy load training. The specific arrangement is 2.5h special training on water in the morning and 1.5h on land and field cross-country running in the afternoon.[7] Three people only arrange a morning special training on the water. We took blood samples for testing the morning before the experiment and the morning after the experiment. The detailed results are shown in Table 2.

It can be seen from Table 2 that the serum testosterone and free testosterone values of the five athletes after a heavy-load full-day training decreased significantly (P<0.05), and the cortisol values increased significantly. However, the serum testosterone levels of the three athletes who trained for half a day increased, but cortisol did not change significantly.[8] The results suggest that athletes who train all day have a greater impact on hormone levels in the body than athletes who train for half a day.

Situation of wrestlers

Eight young male athletes have strength training in the morning, with an intensity of over 90%. Practical training in the afternoon. We use heart rate to monitor training intensity. When completing the main training content, the heart rate will reach more than 180 beats/min, and the maximum heart rate will reach 198 beats/min.[9] This is significantly different from the quiet time before training (P<0.01).

Table 1. T situation of young cyclists before and after a long-distance training session (unit: ng/dl).

	Morning of training	Immediately after training	The next morning	P
7 males	556.06±123.27	614.03±138.41	483.83±137.80	<0.05
9 females	32.08±12.51	42.64±11.89	26.0±10.82	<0.05

The influence of winter training with a large amount of exercise

The situation of short-span athletes

The subjects of the study are eight young female athletes in the short-span group of excellent sports teams. The coach plans the entire winter training for heavy exercise. The amount of running increased by 25%, and the daily training time increased by 1 hour. The test results are shown in Table 3.

Table 3 shows that the serum testosterone values of 8 female adolescent sprint athletes have significantly decreased after winter training.

The situation of race-walking athletes

Four outstanding young race-walking athletes' winter training exercise volume exceeded 30% of last year's winter training exercise volume. The average training time per day is 5 hours, the walking distance is 30km, and the heart rate at the end is more than 180 beats/min. The observation time is before, during, and after winter training. Observe the index blood testosterone and hemoglobin (Table 4).

It can be seen from Table 4 that the testosterone and hemoglobin values of 4 young race-walking athletes after three months of heavy exercise winter training have significantly decreased. Among them, three athletes are in a state of exercise anemia and feel relatively tired.

Female cyclists

Five female cyclists have adopted long-distance training in winter training for two consecutive years. The training is mainly road training, and the whole winter training time is three months.[10] Athletes ride more than 150km a day. We followed up and tested it for two consecutive years (Table 5). After two years of winter training, there was no significant change in the maximum oxygen uptake, but both hemoglobin and serum testosterone decreased. Therefore, we think the effect of winter training in these two years is worth considering.

DISCUSSION

Androgens promote protein synthesis, and the cortisol hormone has a strong effect on promoting protein breakdown. In the study, the testosterone values of cyclists and wrestlers increased significantly immediately after heavy exercise. This shows that the secretion of androgen is increased during the intense exercise of athletes. We believe that the increase in secretion may respond to exercise stress and counteract the increase in corticolimbic hormones. The serum testosterone value of the athletes in bicycle, flower tour, and wrestling decreased the next morning significantly after heavy training, and the full-day training was more obvious than the half-day training. This may be caused by excessive consumption of surrounding tissues, which temporarily disrupts the balance of hormone levels in the body. When this state accumulates to a certain extent, there will be a series of over-fatigue reactions that decrease physical fitness. For this reason, we believe that half-day training is more conducive to the growth and development of young athletes and more conducive to physical recovery than full-day training.

The balance of testosterone and cortisol hormone is very important for sports training. Young athletes have been in a state of stress and exhaustion for a long time and large amounts of exercise. Juvenile gonadal development is still in the growth stage, and its cells are not yet strong in secreting androgens. In addition, the lack of scientific medical monitoring during training can easily cause the serum testosterone level to decrease. The athlete feels fatigued. We think it is worth discussing whether such winter training arrangements are reasonable for young athletes. Androgens can directly promote the vitality of the hemoglobin system in the bone marrow and accelerate hemoglobin synthesis. The second is the indirect effect of stimulating red blood cell production by promoting the release of more erythropoietin from the kidneys. Therefore, androgens have a significant effect on athletes, especially female athletes. Therefore, pay attention to checking this indicator when monitoring training.

Table 2. The effect of heavy load training on hormones.

Training all-day					
	Name	**1**	**2**	**3**	**average**
T (ng/dl)	Morning	58.8	76.1	37.6	71.44±27.44
	The next morning	28.2	42.7	48.8	43.38±25.31
FT (pg/ml)	Morning	2.21	3.27	3.36	2.65±0.63
	The next morning	0.89	1.4	1.02	1.22±0.44
C (ug/dl)	Morning	15.34	20.68	17.18	19.86±4.78
	The next morning	20.27	29.48	20.87	26.27±7.04
Half-day training					
	Name	**1**	**2**	**3**	**average**
T (ng/dl)	Morning	40.88	37.3	68.3	48.83±16.95
	The next morning	56.7	45.2	67.5	56.47±11.45
FT (pg/ml)	Morning	0.85	1.29	0.69	0.94±0.31
	The next morning	0.92	1.01	0.7	0.88±0.16
C (ug/dl)	Morning	21.18	15.1	19.13	18.47±3.09
	The next morning	20.31	14.62	20.8	18.57±3.44

Table 3. T and FT values of young female short-straddles before and after winter training (ng/dl).

n=8	Before winter training	After winter training	P
T (ng/dl)	53.83±20.98	30.36±8.27	<0.01
FT (pg/mi)	3.24±1.40	2.34±0.71	<0.01

Table 4. T value and Hb value before, during, and after winter training of race-walking teenagers.

	Winter training begins		Winter training		Winter training is over	
Name	**T (ng/dl)**	**Hb (g/dl)**	**T (ng/dl)**	**Ho (g/dl)**	**T (ng/dl)**	**Hb (g/dl)**
1	30.2	13.5	18.5	11.9	25	12
2	47.2	12.3	12.6	9.1	18	7.5
3	48.2	13.2	12.5	11.1	27	11.2
4	28	12.6	11	9.5	20	10.5
Average	38.4±10.78	12.9±0.55	13.7±3.3	10.4±1.3	22.5±4.2	10.3±1.96

Table 5. Winter training of young female cyclists.

		Tng/dl	**Q2max**	**Hbg%**
2019	Winter training begins	51±12.13	14.0±0.8	3.61±0.28
	Winter training is over	43±11.36	12.6±0.7	3.64±0.25
2020	Winter training begins	47.4±5.57	13.8±0.5	3.59±0.46
	Winter training is over	37.2±3.66	12.3±0.7	3.67±0.20

CONCLUSION

One-time and one-day high-volume training will cause young athletes to reduce serum and free testosterone levels and increase cortisol hormones. Testosterone levels rise immediately after exercise. It is more beneficial for young athletes to use half-day training during the large-volume training stage than full-day training for the growth and development of the body and the recovery of physical strength. Winter training and heavy physical training all caused the decrease of serum testosterone and free testosterone in young athletes of different sports. Accompanied by a decrease in hemoglobin value and the athlete feels fatigued. We believe that attention should be paid to monitoring this indicator when training with a large amount of exercise.

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