THE EFFECT OF SPORTS IN PROMOTING THE ENHANCEMENT OF ADULT BONE DENSITY

EFEITO DOS ESPORTES NA PROMOÇÃO DO AUMENTO DA DENSIDADE ÓSSEA EM ADULTOS

EFECTO DE LOS DEPORTES EN LA PROMOCIÓN DEL AUMENTO DE LA DENSIDAD ÓSEA EN ADULTOS

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ABSTRACT

Introduction: Exercise is an important part of osteoporosis treatment. A moderate amount of exercise can improve bone metabolism, improve bone biomechanics and increase bone density. Objective: To study the effects of different sports on adult bone mineral density. Methods: We selected volunteers to perform different exercises and used quantitative ultrasound and bioelectrical impedance methods to test the volunteers. Results: Exercise can increase the content of lean body mass in body composition and reduce body fat percentage. The calcaneal bone mineral density of physical education students is positively correlated with low body weight. Conclusion: Exercise can promote the bone mineral density of young adults. Stronger weight-bearing exercises can better promote the increase of bone density. ***Level of evidence II; Therapeutic studies - investigation of treatment results.***

Keywords: Sports; Bone Density; Strength Training.

RESUMO

Introdução: Atividades físicas são uma parte importante do tratamento de osteoporose. Uma quantidade moderada de exercícios pode melhorar a biomecânica, o metabolismo, e a densidade ósseos. Objetivo: Estudar os efeitos de diferentes esportes na densidade mineral óssea de adultos. Métodos: Selecionou-se voluntários para realizarem diferentes atividades físicas e utilizou-se ultrassom quantitativo e bioimpedância elétrica como métodos para testar os voluntários. Resultados: A atividade física pode aumentar o conteúdo de massa magra na composição corporal e reduzir a porcentagem de gordura no corpo. A densidade mineral do calcâneo de estudantes de educação física mostrou uma relação positiva com peso baixo. Conclusão: A atividade física melhorou a densidade mineral óssea de jovens. Exercícios mais intensos de suporte de carga podem promover o aumento da densidade óssea. ***Nível de evidência II; Estudos terapêuticos – investigação de resultados de tratamento.***

Descritores: *Esportes; Densidade Óssea; Treinamento de Força.*

RESUMEN

Introducción: Actividades físicas son una parte importante del tratamiento de osteoporosis. Una cantidad moderada de ejercicios puede mejorar la biomecánica, el metabolismo y la densidad óseos. Objetivo: Estudiar los efectos de diferentes deportes en la densidad mineral ósea de adultos. Métodos: Se seleccionaron voluntarios para realizar diferentes actividades físicas y se utilizó el ultrasonido cuantitativo y la bioimpedancia eléctrica como métodos para testear a los voluntarios. Resultados: La actividad física puede aumentar el contenido de masa muscular en la composición corporal y reducir el porcentaje de grasa en el cuerpo. La densidad mineral del calcáneo de estudiantes de educación física mostró una relación positiva con peso bajo. Conclusión: La actividad física mejoró la densidad mineral ósea de jóvenes. Ejercicios más intensos de soporte de peso pueden favorecer el aumento de la densidad ósea. ***Nivel de evidencia II; Estudios terapéuticos – investigación de resultados de tratamiento.***

Descriptores: *Deportes; Densidad ósea; Entrenamiento de Fuerza.*

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INTRODUCTION

The exercise of different sports will have varying degrees of impact on the bone density of the human body. Therefore, exercises can be divided into weight-bearing exercises with greater physical stimulation and non-weight--bearing exercises with relatively less stimulation according to the degree of impact on bone load. Weight-bearing sports such as weightlifting, running, basketball, badminton, and other sports will exert gravity load stimulation on the human body's bones. Non-weight-bearing exercise has a relatively small load on the overall stimulation of the human body. Its irritation to human bones is also small[1], such as walking, cycling, swimming, etc.

However, weight-bearing exercises of different intensities have different effects on bone density. The best bone density test site for the human body should be the hip bone and the calcaneus. The bone density and bone structure are evaluated by measuring the ultrasonic conduction velocity of the calcaneus and other indicators. The measurement results are highly correlated with the measurement results of other parts of the body. In this study, basketball, volleyball, aerobics, and martial arts athletes were used to test the bone mineral density of the calcaneus.[2] We compare and analyze the effects of different weight-bearing exercises on bone density. This provides suggestions and references for people's physical exercise.

METHOD

Research object

We choose ten students for aerobics, martial arts, basketball, and volleyball in the Physical Education Institute. The volunteers are all male. They are sophomores with very similar levels and years of exercise.[3] The average age is 20.13±2.24. They were all volunteers who were asked to participate in the experiment and had no injuries.

Experimental design

The experiment lasted for four weeks. On the first day of the experiment, the bone density of all subjects was measured. The raw data were recorded. After training, test the bone density of the subjects again and record the data.[4] The exercise time and exercise frequency of the subjects in the 4-week experimental period were equal. The subjects were required not to engage in other sports with high exercise volume and high intensity during the experiment period.

Experimental instrument

The experiment was carried out with the Korean SONOST3000 bone density tester. We tested the subjects' T, Z, BQI, SOS and BUA, where T is the standard deviation between the actual data of the test subject and the average bone density of healthy people of the same age. The smaller the difference between T, the better the bone density. And Z represents the standard deviation between the actual data tested by the subject and the average bone density of healthy people of the same age. The smaller the difference between Z, the better the quality of the bones. BQI is the bone mass index. It is the most important indicator of bone quality.[5] The larger the value, the higher the bone density. The SOS value is ultrasonic sound waves. The larger the value, the higher the bone density. BUA is ultrasonic frequency attenuation. The larger the value, the higher the bone density.

The predictive modeling of sports on bone mineral density

R^0 represents the promotion effect of exercise on bone length, girth, and cortical bone thickness parameters. E represents the difference in the size of the medullary cavity of the athletes. φ represents the athletic estrus cycle of long-distance running. X_{ξ} represents the historical sample data set of the feature space E. Then use formula (1) to get the probability distribution of long-distance running on the athlete's bone biomechanical characteristics

$$K_{\lambda} = \frac{R^0}{E \times \varphi} X_{\xi} \xi \quad (1)$$

$\lambda_{(i)}$ represents the load of the athlete's bones. $\Re$ represents the influence of biomechanical characteristics on the effect of movement speed training. H represents the eigenvector corresponding to the eigenvalue of the effect of motion on the bone microstructure. l stands for muscle contraction to increase the load on bones. $l\ (i,\ t)$ stands for the characteristics of both bone biomechanics.[6] Then use equations (2) and (3) to obtain the self-information and mutual information between the characteristics of the athlete's bone biomechanics by long-distance running

$$\varpi_{(i,t)} = \frac{\lambda_{(i)} \times \Re}{l(i,t)} \times \frac{H \times \varphi(i,t)}{Q(i,t) * u(\omega)} \times K_{\lambda} \quad (2)$$

$$\vartheta_{(i,t)} = \frac{\lambda_{(i)} \times \Re}{l(i,t)} \times \frac{H \times \phi(i,t)}{Q(i,t) * u(\omega)} \times \varpi_{(i,t)} \quad (3)$$

$\varphi\ (i,\ t)$ represents the changes in bone biomechanical indicators (maximum load, elastic load, maximum stress, elastic stress, stiffness coefficient, elastic modulus, and energy absorption) caused by different exercise stages. $Q\ (i,\ t)$ represents that there is a difference in the response of the athlete's different bones to the mechanical load of long-distance running. $u\ (\omega)$ represents the degree of influence of exercise load on bone density. $\Delta\ |\ \rho\ |$ represents the mechanism of bone accumulation caused by exercise. Then use formula (4) to establish a mechanical prediction model of long-distance running on bone mineral density

$$\zeta_{(p)} = \frac{\Delta\ |\ \rho\ |}{\varpi_{(i,t)} \times \vartheta_{(i,t)}} \quad (4)$$

Data processing

We enter the collected data in excel 2007. The article uses the SPSS17.0 software package for mathematical statistics processing. We performed a paired t-test on the data before and after the experiment.[7] The experimental data are expressed as mean±standard deviation. The significance level is $p<0.05$. The very significant level is $p<0.01$.

RESULTS

The experimental results of the influence of aerobics on bone density are shown in Table 1. The experimental results of the influence of martial arts on bone mineral density are shown in Table 2. The experimental results of the influence of volleyball on bone mineral density are shown in Table 3. The experimental results of the influence of basketball on bone density are shown in Table 4.

DISCUSSION

The impact of aerobics on bone density

After four weeks of special aerobics training, the subjects' BQI, SOS, BUA, T, and Z changed significantly. From the BQI, SOS, and BUA3 items, the values have increased significantly. On T and Z, the difference between the subjects after four weeks of training has become smaller. Studies have shown that after a period of aerobics exercise, testing the calcaneus of female college students found that their bone density and mass have increased to varying degrees.[8] In addition, the test also

Table 1. Numerical test results of bone mineral density before and after the experiment of aerobics.

	BQI	T	Z	SOS	BUA
Before	119.15±12.80	0.20±0.99	0.31±0.77	1601.93±12.27	84.30±6.62
After	124.34±10.85	0.49±0.57	0.63±0.66	1607.55±10.62	85.52±5.99

Table 2. Numerical test results of bone mineral density before and after the martial arts event experiment.

	BQI	T	Z	SOS	BUA
Before	113.24±17.89	–0.1±0.95	-0.05±1.03	1597.25±17.01	80.71±8.34
After	116.51±18.58	0.08±0.98	0.13±1.08	1600.35±17.22	82.03±10.1

Table 3. Numerical test results of bone mineral density before and after the volleyball project experiment.

	BQI	T	Z	SOS	BUA
Before	112.14±17.28	–0.17±0.93	0.14±0.97	1589.47±28.97	81.18±7.25
After	121.08±18.56	0.31±1.01	0.42±1.12	1606.27±19.32	83.71±6.21

Table 4. Bone mineral density test results before and after the basketball project experiment.

	BQI	T	Z	SOS	BUA
Before	116.93±10.62	0.08±0.58	0.17±0.63	1599.43±10.81	83.98±3.76
After	121.38±13.26	0.32±0.72	0.40±0.74	1603.22±13.86	86.37±5.15

found that after aerobics exercise also increased their blood estradiol (E2) levels. Our analysis believes that because E2 has a soothing effect on bone metabolism, it indirectly enhances the bone density of the calcaneus. There are significant differences in the bone density values of the aerobics subjects before and after the training. The reason is that most of the technical movements of modern aerobics are done under a certain exercise intensity. Aerobics requires athletes to use the joints of the whole body to complete many continuous jumping, flying, turning, and kicking movements. Therefore, we believe that aerobics can promote bone density.

The impact of martial arts events on bone mineral density

After four weeks of special martial arts training, the subjects' BQI, SOS, BUA, T, and Z also changed, but the changes were not very obvious. A large part of the slower increase in bone mineral density in martial arts is that the subjects are not enthusiastic about the sport and the training is not diligent enough. At the same time, during the experiment period, the subjects performed Tai Chi exercises. Tai Chi exercise itself does not require a certain intensity of exercise. Many technical movements are completed in a relatively slow exercise time, mainly for self-cultivation.[9] At the same time, martial art is a long-term exercise that can show the effect. The training volume of 4 weeks is relatively short, so it isn't easy to reflect the training effect. This leads to an insignificant increase in bone density.

The impact of volleyball on bone density

After four weeks of special volleyball training, the subjects have obvious changes in BQI, SOS, BUA, T, and Z. From the perspective of BQI, SOS, and BUA3 items, the value has increased significantly. Through the changes in T and Z, it was found that the difference between the subjects after four weeks of training was significantly smaller. Volleyball is a sport with a certain intensity and training volume. Athletes should use running, jumping, swinging, and turning on the sports field. Many movements are fast-paced, and large muscle groups are involved in contraction, stimulating the transformation of bone formation.[10] This exercise has a greater load on the bones of the lower limbs and the lumbar spine. This intensity of exercise is positively correlated with bone density. It helps to achieve the desired peak bone mass. Volleyball has a particularly significant effect on bone density.

The impact of basketball on bone density

From Table 4, it can be seen Table 4 that after four weeks of special basketball training for basketball students, the subjects have obvious changes in BQI, SOS, BUA, T, and Z. From the BQI, SOS, and BUA3 items, the values have increased significantly. From the perspective of T and Z, the difference between subjects after four weeks of training becomes smaller. Studies have shown that through the study of the elderly who are engaged in basketball and Tai Chi, it is found that the bone mineral density of the elderly who often engage in basketball and Tai Chi is very stable. These exercises can improve their bone metabolism and significantly reduce the loss of bone minerals. This exercise can adjust the dynamic balance between bone calcium and blood calcium, keeping the bone density of the elderly in a relatively stable state. Compared with Tai Chi, basketball has a more significant effect on maintaining bone mineral and bone density. Basketball itself is dominated by jumping and running and requires various joints of the whole body to complete technical movements.

CONCLUSION

From the 4-week experiment, it was found that exercise has a significant effect on improving bone density. Bone density will increase after exercise. Different weight-bearing exercises have different effects on bone density, and weight-bearing exercises with greater intensity can better promote bone density. In the regular physical exercises, it is recommended to participate in more intense exercises. Content such as basketball, volleyball, etc. These exercises can better promote bone growth and prevent bone loss.

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