

Influence of Extracurricular Physical Training on High School Girls' Bone Density and Bone Metabolism Index

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Abstract: objective: to discuss the influence of extracurricular exercise on high school girls' bone density and bone metabolism. **Method:** choose 60 healthy high school students as the research objects, then divide them into exercise group and control group. Employ the Japan MODULAR automatic biochemical analyzer and Enzyme-labeled meter (S200) made in America Thermo Company to test the bone metabolism index; employ the lunar prodigy dual X-ray absorptiometry to measure bone density. **Results:** among the students of exercise group, their bone density of ward triangle, trochanter and lumbar L2 are higher than that of control group ($P < 0.01$), mean density of hip femoral neck of these two groups has no statistically significant deference; the serum calcium, phosphorus concentration and BGP mean are higher than that of reference group ($P < 0.01$), ALP is also higher than that of control group ($P < 0.05$), tartrate resistant acid phosphatase mean is slightly lower than that of the reference group ($P < 0.01$). **Conclusion:** long-term extracurricular exercise can effectively improve high school girls' bone density and bone quality, and is conducive to improve their bone metabolism.

Keywords: Bone density, bone metabolism, extracurricular physical exercise, high school girls.

1. INTRODUCTION

Osteoporosis (OP) is a systemic skeletal disease, the most serious consequence of it is fracture, and it can cause the decline in life quality and other problems [1], thus, the recent studies on the prevention of OP has become a hot topic. Research shows that the youth stage before 35 is the key period to get peak bone mass. Increased bone mass will have positive impact on the increase of the peak bone. If the peak bone of female can increase 3% at this stage, their risk of postmenopausal fractures can be lowered to more than 20% [2, 3]. Thus, how to get higher peak bone mass in youth stage has become a key issue in preventing senile OP.

High school is the critical period to cultivate health habits, this period plays a vital role in shaping healthy body. If we can cultivate their good extracurricular exercise habit, it will undoubtedly have a good effect on their health condition. The purpose of this study is to analyze the influence of extracurricular physical exercise on high school girls' bone density and bone metabolism index by comparing the difference of long-term training participation students and those who don't often take extracurricular exercise, and to explore the value of exercise on teenagers' bone health, so that we can provide useful reference in improving the peak bone mass of young women.

2. MATERIAL AND METHODS

2.1. Source of Research Subjects

The test subjects are chosen from Zhoukou No.1 High School, 30 healthy students as the control group and 30 students who often take part in extracurricular training as the exercise group. The training period of exercise group is about 2.42 ± 0.56 years, at least 3 times a week; the control group can take general exercise, but never take part in systemic exercise. By homogeneity test of variance, we know there's no difference in their height and weight.

2.2. Test of Index

All tests were commissioned by the Department of Physical Examination of Zhoukou Hospital of Traditional Medicine. High protein and greasy foods should be avoided the day before haemospasia. Take venous blood for 10ml on empty stomach in the morning, then use 3000 rpm/min centrifugal separation of serum for 5 minutes, at last, pack the serum in EP tube, and store in the ice box that 80 degrees below zero for use. The test of serum calcium (Ca), phosphorus(P) and alkaline phosphatase (ALP) in the biochemical indexes of bone metabolism use the Japanese MODULAR automatic biochemical analyzer and original reagent; Bone gla protein(BGP), artrate resistant acid phosphatase 5b(TRACP5b) is tested by enzyme linked immunosorbent assay (ELISA) with the help of S200 enzyme-labelled meter made in American Thermo Company. Their bone density of left hop (femoral neck, ward triangle and trochanter) and postero-anterior limbar are tested by the lunar prodigy dual energy X-ray absorptiometry by American GE company.

Table 1. Descriptive statistics of bone density index (g/cm²).

	Group	N	Mean	Std. Deviation	Std. Error Mean
Femur neck	exercise	30	0.84	0.074	0.012
	control	30	0.80	0.064	0.011
Ward triangular	exercise	30	0.79	0.078	0.073
	control	30	0.71	0.697	0.045
Trochanter	exercise	30	0.78	0.188	0.084
	control	30	0.69	0.030	0.072
L ₂	exercise	30	1.02	0.088	0.003
	control	30	0.89	0.051	0.098

Table 2. Independent samples test.

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Femur neck	1.468	0.221	2.267	58	0.100	0.103	0.016	0.070	0.136
Ward triangular	2.494	0.000	6.129	58	0.000	0.143	0.023	0.026	0.159
Trochanter	2.160	0.000	5.800	58	0.007	0.188	0.039	0.030	0.146
L ₂	2.090	0.000	5.719	58	0.000	0.175	0.093	0.005	0.144

2.3. Statistical Analysis

Microsoft Office Excel 2003 and SPSS18.0 are used in analyzing all statistics and results.

3. RESULTS

3.1. Comparison of Female Students' Bone Density Index Between Exercise Group and Control Group

As it can be seen in Table 1, the ward triangle, trochanter and lumbar L₂ of exercise group are higher than that of control group. The test results of these two groups showed that the difference was significant between the test index among the two groups ($P < 0.01$), see Table 2, suggesting that long-term extracurriculum training can effectively improve the bone density of high school girls.

3.2. Comparison of Female Students' Bone Metabolism

It can be seen from the results (Tables 3 and 4), serum calcium and mean BGP values of students who take part in long-term extracurricular training is higher than that of the reference group ($P < 0.01$); the serum alkaline phosphatase of exercise group is higher than that of the control group, and their tartrate resistant acid phosphatase is lower than that of the control group, but the change of serum phosphorus content is not obvious. This shows that long-term extracurriculum training can not only enhance the activity of osteoblasts

and promote bone synthesis, but helps to inhibit the activity of osteoclasts and bone resorption.

4. DISCUSSION

4.1. Influence of Long-term Extracurricular Training on High School Girls' Bone Density

Bone density is an important indicator of bone quality, it has a high degree of positive correlation to bone strength and it is very important for fracture prediction index [4, 5]. The bone density in exercise group students' ward triangle, trochanter, lumbar L₂ was higher than that of control group ($P < 0.01$), which showed that long-term participation in extracurricular training can effectively improve the bone density of female students. The main reason may be that a variety of high strength training can dramatically increase muscle cell activity, oxidative capacity, blood flow and the muscular contraction force. What's more, the amount of muscle and bone mass is positively related [6, 7], muscle contraction is an important factor to increase the bone quality, which is beneficial to promote bone formation and mineral deposition. Secondly, extracurricular training is a kind of outdoor sports, thus, long exposure to sunlight can increase the synthesis of vitamin D and promote the absorption of calcium. Moreover, after exercise, the students' appetite and nutrient intake can be increased, thus it increases the nutrients, especially on calcium and phosphorus absorption. The increase

Table 3. Descriptive statistics of bone metabolism.

	Group	N	Mean	Std. Deviation	Std. Error Mean
Ca(mmol/L)	exercise	30	2.411	0.067	0.01
	control	30	2.241	0.032	0.00
P(mmol/L)	exercise	30	1.583	0.069	0.01
	control	30	1.575	0.043	0.01
ALP (U/L)	exercise	30	117.347	5.331	0.68
	control	30	114.135	8.007	1.10
BGP (µg/L)	exercise	30	8.457	0.197	0.03
	control	30	7.851	0.058	0.01
TRACP5b (µg/ml)	exercise	30	2.568	0.079	0.01
	control	30	2.582	0.096	0.01

Table 4. Independent Samples Test of Bone metabolism.

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Ca	6.492	0.012	6.954	58	0.000	0.070	0.010	0.050	0.090
P	0.720	0.398	0.780	58	0.437	0.009	0.011	-0.013	0.030
ALP	6.007	0.016	2.550	58	0.012	3.212	1.260	0.716	5.707
BGP	70.869	0.000	21.572	58	0.000	0.606	0.028	0.550	0.662
TRACP5b	5.543	0.020	-8.829	58	0.000	-0.145	0.016	-0.177	-0.112

of blood calcium content will help calcium transport and osteoclast to osteoblast transformation, reduce the inhibition of bone calcium release and bone loss, thereby increase bone density.

4.2. Effects of Long-term Extracurriculum Training on Female Students' Bone Metabolism

Calcium and phosphorus is the main composition of human bone tissue. The relative stability of serum calcium and phosphorus contents mainly depend on our absorption and excretion of calcium and phosphorus materials. The balanced capacity is mainly affected by VD3, parathyroid hormone and calcitonin, etc. Calcium and phosphorus content in human serum can indirectly reflect the bone metabolism [8, 9]. Only when the product of calcium and phosphorus concentration is greater than 40 mg²/dl², can the bone tissue metabolism be ensured (Ca: 1mmol/L=4mg/dl; P: 1mmol/L=3.5mg/dl). The calcium content, concentration of calcium and phosphorus product of exercise group is slightly higher than that of control group, the possible cause may be: for the exercise group, long-time outdoor exercise can make

their bare skin receive much more ultraviolet rays, thus can effectively promote the skin to synthesize more endogenous VD3, and D3 is beneficial to the absorption of calcium.

BGP is mainly released into the blood by osteoblasts cells, and its value will change with age and bone turnover rate [10, 11], thus, it has unique meaning in reflecting the bone turnover level of bone tissue and evaluating the bone metabolism state. The BGP value of exercise group is higher than that of control group, which showed that long-term extracurriculum exercise is helpful to improve the bone formation, bone turnover and the state of bone metabolism. ALP is an important protein involved in bone metabolism. About half ALP in our blood comes from bone tissue, and the rest comes from the liver. Clinical determination of ALP is mainly used for diagnosis of the skeletal and hepatobiliary diseases. It's generally agreed that without other hepatobiliary diseases, the increase of ALP means the increase of activity of osteoblasts and be in active state. ALP of exercise group is higher than that of the control group (P<0.05), suggesting that long-term exercise is conducive to enhancing the activity of osteoblasts and promoting the synthesis of bone.

Among bone metabolism indexes, tartrate resistant acid phosphatase (TRACP-5b) is an important index in reflecting bone absorption, it mainly releases by osteoclasts in bone absorption. Studies show that changes of TRACP-5b in blood are earlier than the changes of bone density [12]. Increase of TRACP-5b in blood indicates the increase of the activity of osteoclasts and bone absorption. The TRACP-5b of exercise group was lower than the control group, the mean difference between the two groups was significant, suggesting that long-term exercise helps to inhibit osteoclast activity. According to the research results above, we know that long-term exercise can not only enhance the activity of osteoblasts to promote the bone synthesis, but also helps to inhibit osteoclast activity and bone resorption.

To sum up, we can draw the conclusion: long-term exercise can effectively improve the students' bone density and bone quality. To students who often do extracurricular exercise, their bone density are higher than that of students do not often exercise. Their concentration product of serum calcium and phosphorus is higher than that of control group. Long-term extracurriculum exercise can not only improve their bone formation and bone turnover level, but can improve high school girls' bone metabolism ability. However, because of individual differences, we suggest that health checks should be done before doing extracurricular exercise. To students who are not suitable for high intensity exercise, we should guide them to participate in proper physical exercise to improve their physical health level.

CONFLICT OF INTEREST

The author confirms that this article content has no conflict of interest.

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