HONG KONG SPORTS INSTITUTE
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RESEARCH HIGHLIGHTS

Parathyroid Hormone, Alkaline Phosphatase and Calcium Status in Athletes involved in High-impact versus Low-impact Sport

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Introduction

Physical exercise is known to induce modifications in bone mineral density (BMD) and bone turnover. A previous study showed that athletes who participate in different types of exercise have different BMD values [1]. High-impact sport that places greater mechanical stress on the bones is associated with a higher BMD, whilst low-impact sport that involves non-gravitational mechanical loading, such as cycling and swimming, is often associated with a lower BMD [2]. Dual-energy X-ray absorptiometry is the gold standard for measuring BMD. It provides only a static, rather than dynamic, picture of bones. Biochemical markers provide information about the dynamic bone remodelling response to exercise [3]. The aim of this study was to evaluate the serum concentrations of endocrine parathyroid hormone (PTH) and the bone formation markers alkaline phosphatase (ALP) and calcium (Ca) in athletes who participate in high-impact versus low-impact sport.

Methodology

Subjects and Samples

This retrospective cross-sectional study was conducted at the Hong Kong Sports Institute from January to March 2020. Forty female athletes and 79 male athletes between 9 and 20 years of age were included in this study (Table 1). The athletes were categorised into high- and low-impact sport groups according to our previous study [1]. Random venous blood samples were collected in clotted activator tubes, and the serum was separated by centrifugation and stored at −40°C until analysis.

Biochemical Markers

The serum levels of intact PTH, ALP and Ca were analysed with an Abbott Architect CI4100 machine (Abbott Diagnostics, Lake Forest, IL, USA). The PTH level was determined via a chemiluminescent microparticle immuno-assay, the ALP level was determined by the para-nitrophenyl phosphate method, and the Ca level was determined by the Arsenazo III method.

Statistical Analysis

The results are expressed as the means ± standard deviations. The differences in the three parameters between the high- and low-impact sport groups were determined separately for each sex using an indepen-dent-sample t-test, for which the significance level was set at 0.05.

Results

Fifty-seven of the 119 athletes were assigned to the high-impact sport group, and 62 were assigned to the low-impact sport group (Table 1). Each group had 20 women, and the high- and low-impact groups had 37 and 42 men, respectively. Same-sex comparisons were made between the high- and low-impact sport groups. The results showed no significant difference in any parameter of the male and female athletes between the two groups (Table 2).

Table 1. Characteristics of the participating athletes in the high- and low-impact sport groups.

Low Impact (n= 62)			High Impact (n= 57)		
	Female	Male		Female	Male
n	20	42	n	20	37
Age (mean ± SD)	15.8 ± 2.1	15.5 ± 2.2	Age (mean ± SD)	15.8 ± 2.3	15.5 ± 1.7
Sport	n	n	Sport	n	n
Archery	0	1	Athletics	3	3
Billiard Sports	0	5	Beach Volleyball	2	0
Cycling	2	5	Fencing	6	4
Equestrian	6	4	Handball	0	15
Golf	0	2	Judo	1	0
Mountaineering	2	4	Karatedo	1	2
Roller Sports	0	1	Squash	1	2
Sailing	0	1	Taekwondo	1	3
Skating	1	3	Tennis	4	6
Swimming	6	5	Wushu	1	2
Table Tennis	0	1			
Tenpin Bowling	1	2			
Windsurfing	2	8			

Table 2. Serum level of PTH, ALP and Ca in high and low impact groups (mean ± SD).

Female Athletes			
	Low	High	P-value
PTH (pg/mL)	35.77 ± 12.87	39.51 ± 12.67	0.36
ALP (U/L)	98.90 ± 63.17	105.9 ± 61.94	0.73
Ca (mg/dL)	9.47 ± 0.36	9.38 ± 0.30	0.39
Male Athletes			
	Low	High	P-value
PTH (pg/mL)	38.26 ± 19.17	39.30 ± 18.13	0.81
ALP (U/L)	153.12 ± 77.74	125.49 ± 48.68	0.07
Ca (mg/dL)	9.59 ± 0.32	9.66 ± 0.42	0.41

PTH, parathyroid hormone; ALP, alkaline phosphatase; Ca, calcium

Discussion and conclusion

The effect of PTH on bones is biphasic, as a chronic increase in the PTH level is catabolic, whilst intermittent stimulation is anabolic [4]. A cross-sectional study found that runners had a lower serum PTH level than inactive controls [5]. A randomised controlled study showed that high-impact exercise decreased the basal PTH level relative to the control group at 6 and 12 months [6]. In contrast, no difference in basal PTH levels was found between cyclists, swimmers and triathletes [7]. Our findings showed no significant difference in the PTH level of athletes between the high- and low-impact sport groups, which suggests that exercise with different levels of impact does not substantially affect Ca homeostasis. A further longitudinal study with a control group is needed to clarify the effects of high- and low-impact sports on the PTH level of athletes. The serum Ca level is mainly regulated by PTH, within a narrow physiological range [8]. No difference was found in the Ca level between the high- and low-impact groups in this study.

ALP is a product of osteoblasts that is essential for bone mineralisation. The total serum ALP level is the most frequently used biochemical marker of osteoblastic bone formation [9]. The effects of long-term exercise on this bone formation marker are controversial. Some studies have shown no effect of exercise on ALP or other bone formation markers, but others have shown higher or lower levels of bone formation markers in an exercise group relative to a control group [3]. In this study, the ALP levels showed no significant difference between high- and low-impact sport groups in both sexes. The subjects in this study were all young athletes whose ALP levels may have been affected by growth, which may have masked the effects of exercise [3]. A further longitudinal study with a more sensitive and specific bone formation marker (e.g., osteocalcin and bone-specific ALP) is needed to clarify the effects of sports with different levels of impact on bone remodelling.

In conclusion, no significant differences were found in the serum PTH, ALP and Ca levels of athletes between high- and low-impact sport groups, which concurs with the findings of some previous studies [3, 7]. The target group in this study was young athletes who had just begun elite-level training. The results may not fully reflect the effects of high-intensity and high-volume training on blood bone markers. A follow-up longitudinal study is needed to investigate the long-term effects of exercise in elite athletes.

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