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**Original Article**

# Basketball Affects Bone Mineral Density Accrual in Boys More Than Swimming and Other Impact Sports: 9-mo Follow-Up

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## Abstract

The objective of this study was to analyze the effect of different sports on bone mineral density (BMD) accrual among male adolescents during a 9-mo follow-up. The sample was composed of 82 boys (control [n = 13], basketball [n = 14], karate [n = 9], soccer [n = 18], judo [n = 12], and swimming [n = 16]) who were followed up for 9 mo (from October 2013 to August 2014). BMD (gram per square centimeter) was assessed at baseline and follow-up using a dual-energy X-ray absorptiometry scanner, whereas somatic maturation was estimated through the use of the peak height velocity. Vitamin D consumption was assessed by questionnaire. After 9 mo of follow-up, all groups (including the control group) presented significant BMD accrual (overall sample: 4.5% in the whole body). On the other hand, the basketball group presented higher BMD accrual in the upper limbs (17.6%) than the control group (7.2%). A similar difference was observed in whole-body BMD (control group: 4.1% vs basketball group: 7.1%). The basketball group had significantly higher BMD gains than the control group and other sports groups.

**Key Words:** Adolescents; bone mass; impact sports; swimming.

## Introduction

Regular exercise during childhood and adolescence has been considered an important behavior for achieving higher peak bone mass *(1,2)*, which in later life protects against fractures and osteoporosis *(3,4)*.

The muscle contraction that occurs during exercise provides tension on the skeleton, which modifies structure and geometry in both cortical and trabecular bones *(5)*. The pathways by which physical exercise increases bone mass involve the recruitment of osteoblasts, osteocyte maturation, collagen release, and calcification of the bone matrix *(5,6)*. However, when considering the osteogenic effect of exercise, the best type, intensity, and duration to achieve optimal bone mineral density (BMD) are not known *(1)*.

Among adolescents, the engagement in sports is the most common manifestation of physical activity, which has been widely advocated by health professionals and organizations *(7)*. However, when targeting bone health improvement, there is still no consensus on which type of sport is more profitable. In a systematic review, Bielemann et al examined cohort studies with young adults and concluded that there is no agreement on the ideal sport for bone mass gain *(6)*. Therefore, due the large variety of sports available for children and adolescents, as well as the fact that not all sports are effective in the promotion of osteogenic effects *(5,8,9)*, the identification of sports with increased potential to improve bone health in pediatric groups is relevant.

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Thus, the purpose of the present study was to compare the effects of different sports on BMD accrual among male adolescents during a 9-mo follow-up.

## Methods

### Sample

Sample size estimation was performed using an equation based on analysis of variance, which included a minimum difference for whole-body BMD of 0.212 g/cm$^2$ between the control and sports groups *(10)*, a standard deviation of 0.120 g/cm$^2$ for each sport group, a standard deviation of 0.090 g/cm$^2$ for the control group, a power of 80%, and an alpha of 5%. The final sample size was estimated as a minimum of 5 adolescents per group. The following inclusion criteria were adopted (at baseline): (1) chronological age between 11 and 17 yr old, (2) male, (3) prior authorization of the coach and parents, (4) a minimum of 6 mo of previous sport practice (sports group) or absence of any organized sports in the last 3 mo (control group), (5) no use of medication that could affect bone metabolism, and (6) a signed consent form.

The present study was presented to the municipality administration (Department of Education and Department of Sports) and also to private sport clubs. After authorization, coaches were contacted by phone and the inclusion criteria were described. At baseline, the sample was composed of 90 boys, and after 9 mo of follow-up, 82 adolescents remained. The age range of the final sample at baseline was 11.1–14.5 yr old. The present study adopted 9-mo follow-up because there are significant modifications in bone variables after this amount of time *(10)*. The adolescents were contacted in 8 different locations (3 public and private schools [control group] and 5 sport clubs [sports groups]). The swimmers, soccer players, and karate fighters participated in competitions at national level, while other athletes (judo and basketball) were engaged in tournaments at the regional level.

The present cohort study was conducted from October 2013 to August 2014 in the city of Presidente Prudente, São Paulo, Brazil. The study was previously approved by the ethical board of the São Paulo State University, Presidente Prudente campus.

### Bone Mineral Variables and Body Composition

BMD (in gram per square centimeter), body fat (in percentage), and fat free mass (FFM, in kilogram) were assessed using a dual-energy X-ray absorptiometry scanner (Lunar DPX-NT; General Electric Healthcare, Little Chalfont, Buckinghamshire, UK) with Lunar software (version 4.7; GE Medical Systems, Madison, WI). The scanner quality was tested by a trained researcher before each day of measurement, following the manufacturer's recommendations. The participants wore light clothing, without shoes, and remained in the supine position on the machine for approximately 15 min. BMD was measured at the (1) upper limbs, (2) lower limbs, (3) spine, and (4) whole body.

### Data Related to Sport Practice

Training routines (sessions per week and minutes per day) were provided by coaches and the previous 6 mo of practice was estimated. The athletes reported the number of months they were previously involved in sports. Moreover, coaches and athletes reported routines of resistance training, which have been considered a potential confounder in multivariate models.

### Vitamin D Score Questionnaire

The adolescents reported the frequency of consumption of foods rich in vitamin D (Likert scale) during the week before evaluation (baseline and end of follow-up). The sum of the generated score was considered proxy of vitamin D intake.

### Biological Maturation

Body weight was measured using an electronic scale (Filizzola model PL 150; Filizzola Ltda, São Paulo, Brazil), and height was assessed using a wall-mounted stadiometer (Sanny model; American Medical of the Brazil Ltda, Brazil). The leg length and sitting height were measured using standardized techniques. These measurements were used to calculate the maturity offset, which denotes the time (years) from/to age at peak height velocity (APHV). The results represent time (in years) lacking (negative values) or passed (positive values) to growth peak, which is characterized as this important biological event in human maturation process. *(11)*.

### Statistical Analysis

Mean and standard deviation values were used in the descriptive statistics. Student's *t*-test for paired samples compared BMD values at baseline and at 9-mo follow-up. Analysis of variance compared baseline and follow-up values according to sports and adjusted by chronological age (baseline), resistance training, vitamin D consumption score (sum of baseline and follow-up), APHV (baseline), and FFM (baseline). Analysis of covariance verified differences in BMD accrual according to sports, adjusted by chronological age (baseline), resistance training, vitamin D consumption score (sum of baseline and follow-up), APHV (baseline), and FFM (baseline). Measurements of the effect size, responsible for checking interactions and error in an ANOVA study, were provided by eta-squared (small effect size: 0.010, medium effect size: 0.060, and large effect size: 0.140). All statistical procedures were conducted using BioEstat software, version 5.2 (BioEstat, Teffe, Amazon) and statistical significance was set at 0.05.

## Results

The sample was composed of 82 boys with a mean age of 11.9 yr (95% confidence interval: 12.5–13.3). At baseline, the mean age was similar for all sports ($p$ value = 0.127), while basketball players and swimmers were taller than the