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Section V: Bone Patho-Physiology

Enhanced Bone Mass and Physical Fitness in Prepubescent Basketball Players

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Abstract

The aim of this study was to examine the effect of basketball practice on bone acquisition in the prepubertal age. In total, 48 prepubescent male basketball players aged 11.1 ± 0.8 yr, Tanner stage 1, were compared with 50 controls matched for age and pubertal stage. Areal bone mineral density, bone mineral content (BMC), and bone area (BA) in deferent sites associated with anthropometric parameters were measured by dual-energy X-ray absorptiometry. Running and jumping tests were performed. Analysis of Student's impaired *t*-test revealed that basketball players attained better results in all physical fitness tests ($p < 0.05$). They also exhibited significantly greater BMC and BA in whole body, upper and lower extremities, trochanter, total hip, and whole right and left radius ($p < 0.001$) compared with the controls. No significant differences were observed between groups in right and left ultradistal and third distal radius and spinal regions, BMC, and BA, whereas a significant positive correlation was reported between lean mass, BMC, and BA of lower limbs. In summary, basketball practice in prepubertal age is associated with improved physical fitness and enhanced lean and bone mass in loaded sites.

Key Words: BMC; bone area; prepubescent; regular training.

Introduction

Physical activity has been described as a strategy to optimize skeletal development and widely recommended as one of the key preventative strategies to reduce the risk of osteoporosis, falls, and fractures *(1)*.

In adults, exercise produces modest increases in bone mineral density (BMD) of only 1–3% per year *(2)*. By contrast, physical activities undertaken in childhood, particularly activities that apply large forces quickly, convey optimal benefits to bone mass, size, and structure *(3)*. The pre- and early pubertal years seem to be the period with the greatest responsiveness *(4–6)*. The average gain in bone mineral content (BMC) and BMD in controlled trials is in the order of 2–5% per year *(2)*. Kannus et al *(4)* reported a 2.5 times greater benefit from racquet sports in the premenarchal years compared with the same activity begun after menarche. In addition, the bone mass acquisition in childhood persists for 7 months *(7)* to 3 years after exercise cessation *(8)*.

Studies in children showed the increase of the accrual of BMD from weight bearing physical activities practice particularly in weight-loaded skeletal regions *(9,10)*. In gymnasts, the higher values of BMD in the whole body *(11)*, spine, and lower extremities *(9)* compared with nonactive counterparts are due to the higher ground reaction forces, which are close to 10 times body mass in young gymnast *(12)*. Soccer participation is associated with enhanced trochanteric BMC and increased femoral and lumbar spine BMD in prepubertal boys *(13)* and enhanced whole body, lumbar spine, femoral neck, pelvis, and lower limbs BMD and BMC *(14)*. There is increasing evidence that weight-bearing sporting activities involving rapid directional changes, starts, stops, and

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great reaction forces enhance bone mineral accrual in prepubertal age *(13,14)*.

Basketball, a weight-bearing intermittent sport, is played worldwide by more than 450 million people *(15)*. During the match, players cover about 4500−5000 m with a variety of multidirectional movements such as running, starts, stops, shuffling and dribbling at variable velocities, and jumping *(16)*. Upper extremities are also solicited in many actions such as dribbling, throwing, and blocking the ball. These actions generate strain and compressive forces and stimulate bone remodeling process *(17)*. Therefore, basketball may be considered as an excellent osteogenic sport for adults and adolescents *(18)*.

It has been reported that adolescent basketball players displayed greater bone mass in most of the measured sites compared with swimmers and nonathletes *(18)*. Participation of male adolescents in a range of high-impact activities such as basketball for 1 h or more a day is associated with greater bone size and mineral content, especially at the hip *(19)*. However, to the best of our knowledge, the effects of practicing basketball, osteogenic sport for adults and adolescents, on bone mass and their effects in prepubertal age have not been studied.

The purpose of this study was to determine whether prepubescent boys practicing basketball for 3 h/wk for at least 1 yr have additional osteogenic effects compared with those obtained from the compulsory school education session. We hypothesized that prepubescent children practicing basketball would have greater enhancement in bone mass than control subjects matched for age and pubertal stage.

Materials and Methods

Subjects

Ninety-eight healthy boys aged 10−12 yr belonging to Tanner stage 1 participated in this cross-sectional study. They were divided into 2 groups depending on their physical patterns. Forty-eight were assigned to the basketball group (BG) as, in addition to a weekly physical education session at school, they practiced basketball in a primary training center for 3 h/wk for at least 1 yr (1.4 ± 0.1 yr). The other 50, participated only in the compulsory physical education curriculum at school (1 weekly session of 50 min), were assigned to the control group (CG).

This study was approved by the Independent Ethics Committee of Farhat Hached Tunisian Hospital and had been led according to the World Health Organization's recommendation elaborated at Helsinki. All children's parents were asked to read and sign an informed consent document before participation.

Anthropometric Measurements

Standard calibrated scale and stadiometer were used to determine height and body mass in stockinged feet and underwear to the nearest 5 mm and 100 g, respectively. Body mass index (BMI) was then calculated (body mass/height^2).

The Calcium Intake

The amount of calcium consumed per day (mg/d) was measured by using the Bilnut SCDA Nutrisoft (Cerelles, France) program.

Bone Measurements

Areal BMD (aBMD, g/cm^2), BMC (g), and bone area (BA, cm^2) for the whole body; lumbar spine (L2−L4); femoral neck of the dominant leg, right, and left radius; lean mass (kg); and fat mass (kg) were measured by dual-energy X-ray absorptiometry (DXA) using Lunar Prodigy (model DXAP 2004, software version 3.6; GE Healthcare, Madison, WI).

The coefficients of variation of aBMD, BMC, and BA were less than 1% in lumbar spine, femoral neck, and whole body and 2.5% in upper and lower limbs.

Physical Fitness

Aerobic Maximal Power $VO_{2\ max}$

The maximum oxygen uptake ($VO_{2\ max}$) was estimated by the multistage 20-m shuttle-test *(20)*.

Anaerobic Capacity

Anaerobic capacity was estimated by using 300-m running test.

Running Speed Test

Photoelectric cell (Cell Kit Speed Brower, USA) was used to measure the time needed to run 30 m.

Jump Tests

Squat jump and countermovement jump were performed using an Opto Jump (Microgate, Bolzano, Italy) and horizontal jump and 5-jump test *(21)* using a dual Dkm.

Basal Physical Activity Level

Basal activity level was calculated by using the Bratteby's questionnaire, which estimates the level of daily physical activities during a typical day without basketball training *(22)*.

Pubertal Status

Tanner pubertal status was determined by serum rates of follicle-stimulating hormone, luteinizing hormone, and testosterone *(23)* and confirmed by a clinical method of recognized validity and reliability *(24)*.

Statistical Analysis

Means (±standard deviation) are given as descriptive statistics. Differences between groups were established using Student's unpaired *t*-test. The analyses of covariance entering height and lean mass as covariates were performed to evaluate differences in BMC and BA between the 2 groups. Bivariate correlation and linear stepwise multiple regression was applied to identify the relationship between lean mass and bone variables. Statistical significance was set at $p < 0.05$.