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Original Article

Volleyball and Basketball Enhanced Bone Mass in Prepubescent Boys

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Abstract

The aim of this study was to examine the effect of volleyball and basketball practice on bone acquisition and to determine which of these 2 high-impact sports is more osteogenic in prepubertal period. We investigated 170 boys (aged 10−12 yr, Tanner stage I): 50 volleyball players (VB), 50 basketball players (BB), and 70 controls. Bone mineral content (BMC, g) and bone area (BA, cm^2) were measured by dual-energy X-ray absorptiometry at different sites. We found that, both VB and BB have a higher BMC at whole body and most weight-bearing and nonweight-bearing sites than controls, except the BMC in head which was lower in VB and BB than controls. Moreover, only VB exhibited greater BMC in right and left ultra-distal radius than controls. No significant differences were observed between the 3 groups in lumbar spine, femoral neck, and left third D radius BMC. Athletes also exhibited a higher BA in whole body, limbs, lumbar spine, and femoral region than controls. In addition, they have a similar BA in head and left third D radius with controls. The VB exhibited a greater BA in most radius region than controls and a greater femoral neck BA than BB. A significant positive correlation was reported between total lean mass and both BMC and BA in whole body, lumbar spine, total hip, and right whole radius among VB and BB. In summary, we suggest that volleyball and basketball have an osteogenic effect BMC and BA in loaded sites in prepubescent boys. The increased bone mass induced by both volleyball and basketball training in the stressed sites was associated to a decreased skull BMC. Moreover, volleyball practice produces a more sensitive mechanical stress in loaded bones than basketball. This effect seems translated by femoral neck expansion.

Key Words: Basket-ball; bone mass; boys; prepubescent; volley ball.

Introduction

The acquisition of higher peak bone mass in children ensures increased skeletal strength during adulthood and thus possibly decreased risk of osteoporotic fracture later in life *(1)*. Physical exercise and impact sports practiced in prepubertal period are as important as nutrition for the acquisition of higher peak bone mass *(2)* and might contribute to bone consolidation after the end of linear growth *(3)*. According to many studies in literature, physical activities with impacts promoted greater bone mineralization in children than in adults *(3−5)*, especially when sports participation is initiated before pubertal onset *(5)*. This is related to the bone deformations due to the vibrations and strain induced by both ground impacts and muscle traction at their bony attachments. Type, intensity, and duration of

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exercise, able to influence bone mineral content (BMC) or bone mineral density (BMD), are mostly documented in adults and adolescents *(6−8)*, although the exact loading regimen has not yet clearly been defined, especially in children. High-impact and odd-impact activities have been associated with higher bone strength than low-impact or nonimpact activities. This suggests that ground-reaction forces and muscle forces resulting from dynamic movement directions enhance the osteogenic response and alter the bone mass *(6,9−11)*. Moreover, Zouch et al *(12)* found that soccer, a high-impact sport, increases bone gain at whole body level, including weight-bearing and nonweight-bearing bones in a more efficient way in pubescent than in prepubescent boys.

Volleyball and basketball are recognized as high-impact loading sports in adults and adolescents and they were associated with higher bone mass resulting from high ground-reaction forces, especially in loaded bone sites *(6,9,13,14)*. Indeed, volleyball practice is characterized by short intensive and explosive actions such as lateral movements, jumping, serving, passing, setting, blocking, digging, diving, and spiking *(15)*. Basketball practice is also characterized by explosive actions like running with direction changes, starts, stops, shuffling, and dribbling at variable velocities, throwing, and blocking the ball *(16)*. In this context, Calbet et al *(13)* have shown a higher BMC in the axial skeleton and a higher BMD in lumbar spine and femoral region, in adult volleyball players (VB) than in controls. Alfredson et al *(14)* reported that adolescent VB had a higher bone mass in the proximal humerus compared with controls. Focusing on basketball practices, several cross-sectional studies demonstrated that this activity was associated with a greater bone mass in most solicited sites in adolescents and adults *(8,9,17)*. Indeed, adolescent basketball players (BB) displayed a greater BMC and BA in total body, lumbar spine, upper and lower limbs than swimmers and nonathletes *(9)*. Furthermore, the intensive basketball training in adolescent females increase bone mass in the lumbar spine and skeletal-loaded sites in comparison with controls *(17)*. To our knowledge, few studies have investigated the effect of volleyball and basketball training on the growing skeleton in boys. In highly trained prepubescent VB, Chaari et al *(18,19)* have shown enhanced bone formation markers and BMC in whole body, lumbar spine, total hip, and radius, accompanied by a BA expansion in radius and weight-bearing sites in comparison with controls. In prepubescent BB, Zribi et al *(20)* have shown a greater BMC and BA in whole body, upper and lower limbs, total hip, and whole radius than controls. Therefore, our study was conducted first; to verify whether prepubescent boys practicing volleyball or basketball have additional osteogenic effects compared with those obtained from the compulsory school education session; and second to determine which of these 2 high-impact sports is the most osteogenic in prepubertal period.

Methods

Subjects

One hundred prepubescent male athletes (10- to 12-year-old) and 70 control referents (C), were volunteers, recruited from sport schools and clubs of Tunisian Sahel region participated in this cross-sectional study. The athletes were 50 VB and 50 BB, they have been playing volleyball and basketball for at least 1 yr in addition to physical education at school and they completed 2−5 h of training plus 1 competition game per week. The control group participated only in the compulsory physical education curriculum at school (1 weekly session of 50 min).

In general, training volleyball and basketball sessions lasted 1 h 30 min, including about 15−20 min of warm up, low-intensity games, and stretching exercises, 15−25 min of technical volleyball (passing actions, attacking, blocking, and running with fast accelerations) and basketball (passing and dribbling at variable velocities, offensive and defensive actions, throwing and blocking the ball) exercises, 20−30 min of match practice, and 10 min of active recovery.

All subjects were clinically healthy, none had receiving medication known to affect bone metabolism.

The protocol study was approved by the independent ethical committee for clinical investigation of Farhat Hached Tunisian Hospital. A written informed consent was obtained from the participants and their parents before participation.

Anthropometric Parameters

The height (±0.1 kg) and the weight (±0.1 cm) of each subject were respectively measured by a controlled portable stadiometer (Seca Model 225, Hanover, MD) and digital scale (Tanita, Tokyo, Japan). The body mass index (BMI) was calculated by the formula: BMI = weight/(height [m])^2. The lean mass (kg) was measured by dual-energy X-ray absorptiometry whole body densitometry.

Calcium Intake

Daily calcium intake (mg/d) was calculated from all food and drink items for last 3 consecutive days by using the Bilnut 2.01 software package (SCDDA Nutrisoft, Cerelles, France).

Densitometric Measurements

BMC (g) and BA (cm^2) were measured by dual-energy X-ray absorptiometry (Lunar Prodigy, model DXAP 2004, Madison, WI, USA, software version 3.6) in the lumbar spine (L2−L4), whole body, dominant proximal femur, and bilateral forearm (with Committee d'Actions Concertes (COMAC) calibration setting in forearm). All analyses were done by the same technician.

Pubescent Status

The pubescent status of children was determined by the serum rates of follicle stimulating hormone, luteinizing