Journal of Clinical Densitometry: Assessment & Management of Musculoskeletal Health, vol. ■, no. ■, 1–6, 2013

1094-6950/■:1–6/$36.00
http://dx.doi.org/10.1016/j.jocd.2013.09.012

Original Article

Combat Sports Practice Favors Bone Mineral Density Among Adolescent Male Athletes

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Abstract

The aim of this study was to determine the impact of combat sports practice on bone mineral density (BMD) and to analyze the relationship between bone parameters and anthropometric measurements, bone markers, and activity index (AI). In other words, to detect the most important determinant of BMD in the adolescent period among combat sports athletes. Fifty athletes engaged in combat sports, mean age 17.1 ± 0.2 yr, were compared with 30 sedentary subjects who were matched for age, height, and pubertal stage. For all subjects, the whole-body BMD, lumbar spine BMD (L2–L4), and BMD in the pelvis, arms, and legs was measured by dual-energy X-ray absorptiometry, and anthropometric measurements were evaluated. Daily calcium intake, bone resorption, and formation markers were measured. BMD measurements were greater in the combat sports athletes than in the sedentary group ($p < 0.01$). Weight, body mass index, and lean body mass were significantly correlated with BMD in different sites. Daily calcium consumption lower than daily calcium intake recommended in both athletes and sedentary group. AI was strongly correlated with all BMD measurements particularly with the whole body, legs, and arms. Negative correlations were observed between bone markers and BMD in different sites. The common major predictor of BMD measurements was AI ($p < 0.0001$). AI associated to lean body mass determined whole-body BMD until 74%. AI explained both BMD in arms and L2–L4 at 25%. AI associated to height can account for 63% of the variance in BMD legs. These observations suggested that the best model predicting BMD in different sites among adolescent combat sports athletes was the AI. Children and adolescents should be encouraged to participate in combat sports to maximize their bone accrual.

Key Words: Activity index; adolescent; bone markers; calcium intake; combat sports.

Introduction

Bone mineralization is a complex process that requires adequate nutrition, protein for osteoid formation, calcium and phosphorous for calcification, weight-bearing and muscle use, and modulation by thyroid, parathyroid, gonadal, and steroid hormone, along with other growth factors *(1)*.

Other factors may play a crucial role in bone mineral acquisition, especially during adolescence. Mechanical loading has been considered as having the predominant influence on bone mineral acquisition throughout life. The nonmechanical agents, such as hormones and nutritional and life style factors, are thought to modulate the bone response to mechanical loading *(2)*. Currently, it is commonly accepted that physical activity that leads to a load on the body and generates a strong ground impact, such as gymnastics or weight lifting, has a greater osteogenic effect than the so-called "active" components that have a predominant energy, such as swimming or cycling *(3)*. Many authors have studied the effect of sports

Received 05/30/13; Revised 08/08/13; Accepted 09/11/13.
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on bone parameters and biochemical markers for bone turnover in young athletes, especially in young women. Also, few studies had investigated the effect of sports practice in Tunisian boys. To our knowledge, no data are available that demonstrate changes in bone mineral density (BMD) among adolescent combat sports athletes. Therefore, the aims of this study were (1) to determine the impact of combat sports practice on BMD to know whether this type of sports activity influences BMD outside the physiological effects of natural growth, and to analyze the relationship between bone parameters and anthropometric measurements, bone markers, and activity index (AI), and (2) to detect the most important determinant of BMD in the adolescent period among male athletes engaging in combat sports.

Methods and Materials

Subjects

In this cross-sectional study, we compared 50 male athletes engaging in combat sports ages 17.1 ± 0.2 yr with 30 sedentary subjects matched for sex, age, height, and pubertal stage. The group of combat sports practitioners was composed of 10 judoists (JU), 10 karatekas (KA), 10 karatekas kyokushinkai (KK), 10 practitioners of kung fu, and 10 boxers. They trained 4–5 times per week for 8–10 h week^{-1} and practiced these activities for a mean of 5.4 ± 1.2 yr. The sample study group was recruited from 3 sport schools in Sahel, Tunisia. The subjects in the sedentary group were recruited from the same region and during the same period, were from other schools, and did not participate in any kind of sports other than occasional children's games. All subjects and their parents were aware of the study design and laboratory tests. They were also asked to sign a written informed consent. All studies were approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 2008 revision of the Declaration of Helsinki.

Anthropometric Measurements and Body Composition

Height was measured with a stadiometer; and weight, total body fat mass (TBF, kg), lean body mass (LBM, kg), and body mass index (BMI, kg/m^2) were assessed during the dual-energy X- ray absorptiometry examination visit.

Bone Parameter Measurements

For all subjects, bone mineral density (BMD, g/cm^2) of the whole-body (WB BMD), whole-spine (BMD spine), lumbar spine (BMD L2–L4), and BMD of the arms and legs were measured with DXA (Lunar Prodigy; GE Healthcare Medical Systems Lunar, Diegem, Belgium) in the Rheumatology Department of Monastir Teaching Hospital.

Activity Assessment

The level of practice was evaluated by activity index defined as the number of hours per week multiplied by the number of years of practice and divided by 7 *(4)*. AI = number of hours of training per week × number of years of sporting practice/7.

Calcium Intake

Calcium intake was assessed for every subject using a validated questionnaire *(5)* and adopted by the Group for Research and Information on Osteoporosis.

Bone Marker Measurement

Fasting blood samples were taken from a forearm vein between 07:30 and 09:00 a.m. Alkaline phosphate (AP) activity was measured by a kinetic method on the automated Cobas Integra 400 plus. Propeptide N-terminal *Procollagenetype 1*(P1NP), plasma β-CrossLaps (βCTx), and osteocalcin (OCN) were measured by the use of an e*lectrochemiluminescence* immunoassay, developed on Roche Elecsys 2010immunoassay analyzers (Roche Diagnostics GmbH, Mannheim, Germany).

Statistical Analysis

Results are expressed as mean and SD. Data were analyzed with SPSS.11 (SPSS Institute, Chicago, IL). Statistical significance was set at $p < 0.05$. Post-hoc test is used to examine the difference between combat athletes group and the sedentary group. Pearson correlation coefficient was applied to identify the relationship between bone measurements and other independent variables. Stepwise multiple linear regression models were constructed by the use of BMD in different sites as dependent variables.

Results

Anthropometric Measurements and Body Composition

The descriptive characteristics of the study population were provided in Table 1. The height of combat sports subjects was matched with sedentary subjects ($p > 0.05$). A significant difference in favor of combat sports athletes in both weight and BMI ($p < 0.001$) was found. The average LBM of combat sports subjects was greater than in sedentary group (55.8 ± 6.1 kg vs 49.5 ± 6.1 kg; $p < 0.001$). No significant difference between athletes and sedentary on TBF was found.

In Table 2, the measures of BMD in combat athletes were statistically greater compared with those of sedentary for the whole body and all sites ($p < 0.001$), although the BMD values were greater in JU, KK, Kung Fu subjects than in karatekas and boxers.

Combat athletes and the sedentary group had daily calcium consumption that was lower than daily calcium intake recommended by the World Health Organization *(6)*. However, no statistical difference was found for daily calcium intake (707.6 ± 131.7 mg vs 701.7 ± 146.6 mg).

Concerning serum bone formation markers levels (AP, OCN, P1NP), a significant difference was noted between the combat athletes and the sedentary group in only AP and