Bone Mineral Density in Female Junior, Senior and Former Football Players

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Abstract. The purpose of this study was to examine the bone mineral densities (BMD) of female junior and senior football (soccer) players with different training regimens and histories, female former football players, and their respective controls. Active junior (age 13-17 years, n = 62) and senior (age 18-28 years, n = 34) players, representing three teams with different levels of performance and training, were compared reciprocally and with matched controls (n = 90). Former players (age 34-84 years, n = 25) who had ended their careers on average 9.7 years previously and their matched controls (n = 57) were also studied. Body composition and total body, lumbar spine and proximal femur BMD were measured with dual-energy X-ray absorptiometry. Former players and their controls were asked in a questionnaire to specify their current level of physical activity. In a control for differences in age, weight and body mass index, football players had significantly greater BMD than controls at all sites measured. This difference appeared to be site-specific, with greater differences in BMD at the proximal femur sites (10.5-11.1%) than at the lumbar spine (4.8%) or for the total body (3.5%). Further, differences were greater for senior than for junior players. However, no BMD differences were found between teams representing different levels of performance and training. Female former football players had retained their proximal femur and total-body BMD advantage over controls. In conclusion, training in female football, which is an impact-loading activity, has a site-specific, positive effect on bone formation that is not increased over a certain level of physical activity. The BMD advantage attained appears to be preserved to some extent after the termination of the athlete’s active career, which may have a positive effect on future fracture risk.

Keywords: BMD; Bone mass measurements; DXA; Football players; Physical activity

Introduction

A number of studies of bone mineral density (BMD) in athletes have demonstrated greater BMD compared with the normal population [1-5]. The amount of load that is exerted on the skeletal tissue appears to be of importance. Grimston et al. [6] showed that children who participated in athletics classified as “impact-loading” sports (sports producing ground reaction forces greater than or equal to 3 times the body weight, such as running and gymnastics) had greater femoral neck BMD than children who participated in a non-gravitational sport such as swimming (“active-loading” sports). Similar results, as well as indications that these differences in BMD may be site-specific due to specific types of mechanical loading, were found in studies by Heinonen et al. and Fehling et al. [7,8]. It is, however, questionable whether running – a major part of football training – has positive osteogenetic effects, since runners have been shown to have lower skeletal densities than matched controls [9,10].

An interesting question is whether an advantage in BMD attained by athletes is maintained after their active careers, and consequently has an influence on their future fracture risk. There are some indications that this may be the case. Karlsson et al. [11] found that...
former weight-lifters had higher BMD levels than controls after their active careers, at least up to age 65 years, and Huddleston et al. [3] found that former tennis players, still playing but at a reduced level, had an increased BMD in the dominant forearm in old age.

To clarify further the relationship between physical activity and BMD development, we have studied junior and senior female football players with different training histories and female former football players and their respective controls.

Materials and Methods

Subjects

Female football (soccer) players, representing different levels of performance, were studied. Women's football in Sweden is highly organized, with teams playing in separate divisions according to proficiency. Members of three different teams were studied:

Team 1 (n = 34) in our study has been the best team in Sweden over recent years, and includes many players who are in the national team. Practice is conducted in a professional manner, 5 times per week, 11 months per year, mainly with regular football practice but also with weight-lifting and long-distance running.

Team 2 (n = 27) is currently playing in the second highest division. Team management and practice are not at the same high levels as in team 1. Practice is 3 or 4 times per week, 9 months per year. Weight-lifting and long-distance running are not a part of practice in the same way as in team 1.

Team 3 (n = 35) is currently playing in the third division. Practice is 2 or 3 times per week and less intense than in the two groups above.

For some calculations, players from all three teams were divided into two groups: junior (age 13–17 years) and senior players (age 18–28 years). Practice for junior players is less intense than for senior players, but differences in training intensity between the teams above are noticable already in the junior years.

Former players (n = 25, mean age 40.0 years) were also studied, recruited from files kept by the Swedish Football Association. These women had played organized football for many years, including junior years, at a level similar to teams 1 and 2 above. They ended their careers on an average 9.7 years prior to this study (range 5–20 years).

Acting as controls, were participants in a population-based study designed to obtain normative bone mass data. This study had 332 participants (age 14–42 years) living in the same region as our study population. To achieve a reasonable age-match, two control groups were formed: one for the active players (n = 90) and one for the retired players (n = 57).

Weights and heights of the subjects were recorded, and bone mass index (BMI) was calculated. A questionnaire was used to assess duration and level of training and menarcheal age. Further, former players were asked about their current level of physical activity. This part of the questionnaire has been validated in previous work by others [12]. Football players (n = 2) or control subjects (n = 1) who were amenorrheic (0–3 cycles/year), or those with a history of diseases known to affect calcium metabolism, were excluded from the study.

Bone Mineral and Body Composition Assessment

Bone mass and body composition were assessed by dual-energy X-ray absorptiometry [13]. Two separate Lunar DPX machines were used. One machine was used for teams 1 and 3, former players and controls. BMD measurements included the proximal femur (neck, trochanter, Ward’s triangle), spine (L1-4) and the whole body. Also, the body composition in terms of fat and lean body mass was calculated. The second machine was used for team 2, on which the same measurements as above were made with the exception of total body BMD and body composition. The two machines were cross-calibrated using a Lunar spine phantom, establishing that comparable bone mass values were obtained (difference <0.4%). The data were processed using software supplied by the manufacturer.

Statistical Analysis

For the statistical analysis, the Student’s t-test; analysis of covariance (ANCOVA), adjusting for age, weight and BMI; ANVOCA with interaction effects; and the Mann–Whitney U-test were used. Statistical significance was set at the 0.05 level.

Results

The descriptive characteristics and bone mass values for the active football players and their controls are summarized in Table 1. Football players 15–30 years old had significantly higher BMD values than controls at all measured sites except the lumbar spine. There was also a difference in body composition, football players having a higher lean body mass and lower fat content than controls. A covariance analysis (adjusting for age, weight and BMI) did not change the outcome significantly, except that in this calculation BMD in the lumbar spine of football players was also higher than in the controls (Table 2). These differences for mean, adjusted BMD values were greater in the hip (femoral neck +10.5%, trochanter +11.1%, Ward’s triangle +10.7%) than in the lumbar spine (+4.8%) and the total body (+3.5%). Differences in bone mass and body composition were evident for junior (13–17 years) as well as for senior players (18–28 years). Table 3 shows that these differences were generally greater for senior than for junior players (ANCOVA with interaction...