Introduction

Osteoporosis is a reduction of bone mass that leads to an increase in fracture incidence. It affects mainly post-menopausal women and elderly and represents a world-wide health problem. The peak of bone mass achieved before the third decade of life and factors that influence bone loss determine the amount of bone mass present at a given time in adult age (National Institutes of Health Consensus Development Conference Statement. Osteoporosis Prevention, Diagnosis, and Therapy. Bethesda, USA 2000, March 27–29; http://consensus.nih.gov). Genetic characteristics, hormonal status, and lifestyle conditions, such as dietary calcium intake and physical activity, are known to be the most important factors acting on bone.

Physical activity can reduce fracture risk by increasing bone mass during youth, by preventing bone loss and by...
improving muscular and articular fitness that decreases the risk of falling [1].

While there is general agreement in literature about effectiveness of physical activity on development of peak bone mass and on its maintenance during life, there are still uncertainties about the type, intensity, duration, and frequency of exercise [2]. A high-impact exercise program has been reported to be more effective than a low-impact one in increasing bone mass of weight-bearing skeletal sites [3–5]. Only a few works also deal with its effect on body composition [6, 7], but data are referred to a male athlete population or to pre-menarchal girls.

No single study is available about the effect of high-impact exercise on bone mass and body composition in pre-menopausal athletes. The aim of this study was to assess bone, fat and lean mass in pre-menopausal young athletes and in a sedentary control group.

Patients and methods

Healthy pre-menopausal women, aged 18–45 years, were recruited and divided into two groups: (i) sedentary women (n=39), selected among the employers of the main teaching hospital in Milan through a formal request for volunteers mailed to all the hospital departments, and (ii) physically active women (n=29), recruited through advertising in several karate clubs of the same city. The active women were competing athletes at international level and they reported strenuous exercise for about 18 hours weekly: two hours of aerobic and one hour of anaerobic exercise daily for six days. Sedentary women reported simple walking exercise for a maximum of about four hours weekly. The mean age at the start of competing activity among the athletes was 17 years (range, 15–18 years), while the sedentary women never did any competitive physical activity during their adolescence and young age. Women presenting the following characteristics were not included in the study: natural or surgical menopause; pathologies and surgery that may influence the hormonal pattern such as ovariectomy; long-term drug therapy for chronic pathologies; hormonal replacement therapy; anorexia; alcohol and drug abuse.

Every woman was asked to sign an informed consent form to fill out a self-administered questionnaire concerning her family history, habits and medical history. Dietary information was collected through a food frequency questionnaire which included pictures of the portions of the main foods. It was a modified version of the questionnaire used by Willett et al. [8], validated for suitability to the Italian population and for acceptability in a pilot study on 10 healthy women. Calcium intake was calculated by adding up the mean calcium content of each component of the diet assumed by each participant in the week previous to the interview. Mean caloric intake in the same period was also calculated in both groups.

Bone mineral density (BMD) at the lumbar spine, proximal femur of the dominant leg and whole body was measured in all the subjects by means of dual energy X-ray absorptiometry (DEXA) densitometer (Hologic QDR 4500A scanner; Hologic, Waltham, USA; software version 8.26). The BMD values were expressed as bone mineral content (grams) divided by the area of interest (square centimeters). For lumbar spine, the value of BMD of the entire region of interest was considered (measured from L2 to L4). For proximal femur, the values of BMD of the whole femur and of the following subregions were considered: neck, trochanter, intertrochanter, Ward’s triangle. We also considered the values of total BMD and leg BMD of the whole body scan.

Regarding body composition, we measured: total fat and total lean body mass; trunk fat and lean mass; limb fat and lean mass. These values were expressed in grams.

The in vivo coefficient of variation (CV) of scan-rescan DEXA measurements at our center was: for lumbar spine, 0.5%; for proximal femur, 0.7%; for whole body scan (total), 0.7%; for whole body scan (legs), 1.3%. CV for whole lean mass was 1.1% and for whole fat mass 1.9%. The individual exposure dose was less than 7 mRem.

Comparisons between means were performed by t test for unequal variances to allow for the small sample size; comparisons between proportions were performed by chi-square test.

Multivariate analysis was conducted using the SAS package version 6.12. The general linear model (GLM) was performed, using the variables of bone mineral density as dependent variables. Independent variables included age (years), BMI [weight in kg/(height in m)²], physical activity (hours per week), smoking (yes/no), dietary calcium intake (mg/day), oral contraceptive use (yes/no), and family history for osteoporosis (yes/no). The model was also run by substituting BMI with weight and height.

Results

Bone mass and body composition were investigated in 39 healthy sedentary women and in 29 healthy physically active women (Table 1). The only statistically significant difference between the two groups was the higher calcium dietary intake reported by the sedentary women (50%), besides the obvious difference in hours per week of physical activity (392%).

Values of bone mineral density of whole body and its subregions are presented in Table 2. The mean values for all the variables were higher in active women than in sedentary women, and there was a significantly higher density in total body (4.3%), total femur (5.2%), femoral neck (8.0%), intertrochanter (5.4%) and trochanter (10%).

Fat mass was significantly higher in sedentary women (total, 25.5%; trunk, 43.3%; limbs, 19.4%), while there was no significant difference in lean mass between the two groups (Table 3).

Multivariate analysis (Table 4) showed that there was an independent association of physical activity with the mineral composition of femur, femoral neck, trochanter,