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Bone Density in Athletes

Bo E. Nilsson and Nils E. Westlin

Commensurate with the fact that osteoporosis may be caused by inactivity, physical exercise is used clinically for its prevention and cure. There is, however, no convincing evidence that exercise actually will increase the bone mass in pathological cases nor that physical exercise should at all influence the bone mass in man. Some circumstantial evidence may be extracted from the positive relationships between body weight and bone mass in women[2] and between weight bearing and bone density in rats.[3, 5] The objective of the present study was to evaluate the influence of physical activity on bone mass in healthy young men.

MATERIAL AND METHODS

Included in the study were 64 athletes who participated in a full-scale physical exercise program as well as in national contests. Among these were 9 with achievements on an international level (Olympic games, European cup football, etc.) In this latter group, referred to as top-rank athletes, one individual had used anabolic steroids regularly and 2 had used them occasionally.

The control group consisted of 39 healthy men of the same age distribution. When questioned, 24 of them stated that they regularly participated in some kind of exercise to maintain their physical fitness. The remaining 15 either did not exercise at all or they only exercised occasionally.

The bone density in the distal end of the femora was evaluated in all the individuals included in the study, using a photon-absorption method. The attenuation of a photon-beam from ^{241}Am was recorded in the distal end of the femur in comparison to a water phantom of the same thickness (Fig. 1). From the recordings and the width of the femur at the same level, the mineral content could be calculated in g/cc.[1]

The force of the quadriceps muscle was measured with the patient sitting and the knee in 45° of flexion (Fig. 2). The extension force from this position was recorded by means of an isometric spring balance.

The athletes were also ranked according to the load on the lower limb associated with their particular sports activities or with their training programs. All the subjects involved in this study were questioned with regard to their leg of preference; in some instances, however, a specific preference could not be established.

In addition, height and weight were recorded in all the cases.

For comparison of the measured variables, a Student *t* Test was used. Probability levels of 5 per cent or better were regarded as significant.

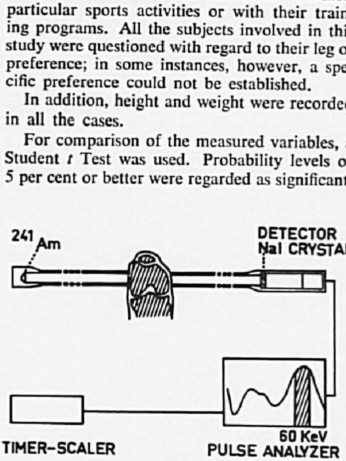

Fig. 1. Measuring device.

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Financial support for this investigation was obtained from the Swedish Medical Research Council No. B70-23X-2737-02.

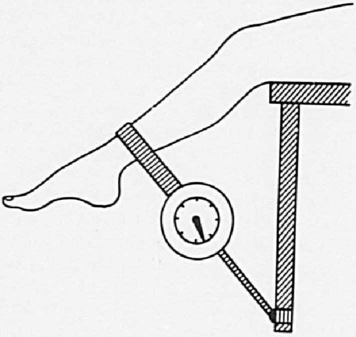

FIG. 2. Measurement of quadriceps force.

RESULTS

The athletes had significantly denser femora, compared to the non-athletes. In the control group, individuals who regularly exercised had a significantly higher density than those who did not (Table 1). If the athletes were grouped according to the load taken on the lower limb, the bone density decreased with decreasing load; thus, the group of swimmers did not significantly differ from the controls (Table 2). The top-rank athletes and the throwers contained 2 gigantic individuals who considerably increased the scatter in these groups.

High quadriceps force and high bone density values coincided in some groups (top-rank athletes, weight lifters, and throwers). However, on the whole there was no correlation between quadriceps force and bone density nor between weight or height and bone density (Table 3).

There was no preponderance for either the left or right leg with regard to bone density either in the athletes or in the controls; nor was there any preponderance for the best leg in the controls. However, in the athletes the femur bone density of the leg of preference was significantly higher (Fig. 3).

DISCUSSION

Athletes, particularly top-rank athletes, may be a pre-selected group with special properties including a larger bone mass. However, it should be noted that there was an increasing bone density with increasing load taken on the lower limbs within the

TABLE 1. Comparison Between Athletes and Controls (average ± standard deviation)

	Number	*Bone Density (g/cc)*	*Quadriceps Force (kg)*	*Age (yrs)*	*Height (cm)*	*Weight (kg)*
Athletes						
Top rank	9	0.252 ±0.049	47.6 ±13.2	22.3 ±4.1	187 ±8	90.3 ±26.3
Ordinary	55	0.236 ±0.049	42.8 ±9.9	22.2 ±6.8	178 ±7	70.2 ±9.6
Controls						
Exercising	24	0.213 ±0.031	38.8 ±9.4	22.5 ±5.1	177 ±7	69.8 ±10.7
Not exercising	15	0.168 ±0.037	38.2 ±6.7	22.8 ±5.2	180 ±5	68.5 ±9.2

TABLE 2. Comparison Between Athletes Performing Different Activities (average ± standard deviation)

	Number	*Bone Density (g/cc)*	*Quadriceps Force (kg)*	*Age (yrs)*	*Height (cm)*	*Weight (kg)*
Weight-lifters	11	0.247 ±0.058	50.1 ±9.1	20.7 ±8.4	173 ±6	71.7 ±9.1
Throwers	4	0.238 ±0.061	59.1 ±7.2	23.5 ±3.0	191 ±8	106.7 ±24.7
Runners	25	0.235 ±0.052	38.6 ±8.2	22.2 ±7.1	179 ±7	66.2 ±8.1
Soccer players	15	0.233 ±0.048	41.4 ±8.7	24.9 ±5.2	179 ±3	72.2 ±6.4
Swimmers	9	0.226 ±0.041	45.2 ±11.6	17.9 ±4.5	183 ±9	75.4 ±12.8

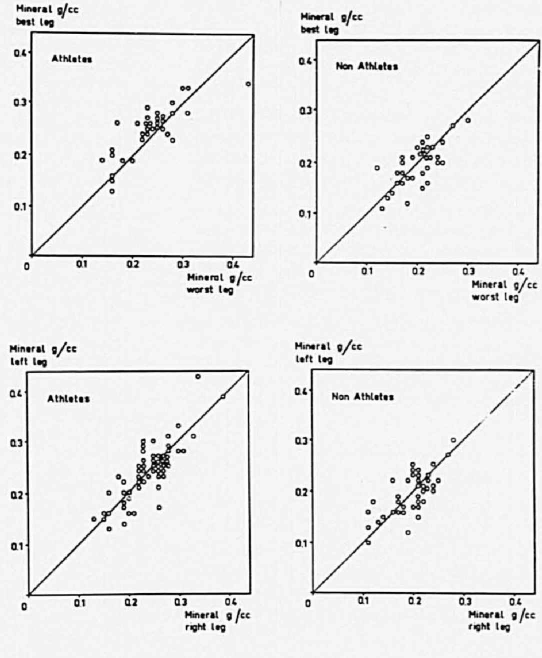

FIG. 3. Left-right and preference - nonpreference side relationships of bone density.

TABLE 3. Correlation Between Height, Weight, Femur Density and Quadriceps Force (N = 103)

Treatment	*Correl. Coeff.*	*P*
Height *vs* bone density	0.025	>0.2
Weight *vs* bone density	0.007	>0.2
Quadr. force *vs* bone density	0.079	>0.2

group of athletes. In addition, obvious physical properties such as height and weight did not relate systematically to bone density and do not provide an explanation to the differences. Saville and Whyte[4] found in growing rats that exercise increased the size and the mineral mass of the femur but not the density and that the increase was associated with an increased muscle mass. In adult man, as demonstrated in this study, variables such as body weight, muscle force and bone density are not closely related. On the other hand, it seems to be possible to increase the bone density in man to above "normal" by exercise. From the findings in the present study one must, however, not necessarily draw the conclusion that physical exercise will increase the bone mass in patients suffering from osteoporosis.

The most pronounced difference was found between the group of non-athletes who exercised and the group who did not. This finding indicates that even moderate physical activity may increase the bone mass.

SUMMARY

The bone density was evaluated in 64 male athletes and compared to 39 healthy age-matched non-athletes. The athletes had significantly denser bone in the distal end of the femur than had the non-athletes. Within the group of athletes there was evidence that sports activities, including heavy load on the lower limbs, were associated with higher bone density. Also in the athletes, the leg of preference had a denser femur. Among the controls, those who regularly exercised had a higher bone density than those who did not.

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