THE EFFECTS OF ENDURANCE EXERCISE ON THE SIZE AND STRENGTH OF ADULT AND AGED RAT FEMORA AND TIBIAE

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INTRODUCTION
As a potential treatment for osteoporosis, exercise has been shown to exert some positive effects on bone strength, but the exact nature and duration of the most effective regimen is still unknown. Many studies have examined effects of endurance or resistance exercise on bone strength in developing skeletons or in a single age group [1-7], but few have compared younger animals to aged animals [8]. The present study is unique in the fact that it compares both young adult and aged rats under the same exercise regimen to help clarify the effects of endurance exercise on the adult and aged male skeleton.

MATERIALS AND METHODS

Exercise Protocol
Adult (6 mo, n=28) and aged (24 mo, n=28) male Fisher 344 rats were used in this study. The animals were randomly divided into four groups (n=14/group) as follows: Adult Sedentary (YS), Adult Trained (YT), Aged Sedentary (OS), and Aged Trained (OT). The trained animals were conditioned to run on a treadmill with a 10% grade at 28 m/min (young) or 16 m/min (old) for 1 hr/day for 5 days/week for 12 weeks. The sedentary animals were handled and placed on a stationary treadmill twice a week to control for effects of handling stress. After 12 weeks, the animals were sacrificed and the right femur and tibia were excised and measured.

Mechanical Testing
Three different mechanical tests were performed using an MTS Mini-Bionix 385: 3-point bending of both femur and tibia, and a shear test on the femoral head. A 20 mm span equipped with carbon steel rods at the contact points and a crosshead speed of 2 mm/s was used for both the femur and tibia 3-pt bending tests. After failure, the bones were returned to saline solution. For the shear test, the proximal half of the femur was embedded in custom-made brass pots filled with a low melting point alloy. A 3 mm diameter plunger was lowered onto the superior aspect of the femoral head at a rate of 2 mm/s until failure. All force and displacement data for each test was recorded at a rate of 20 Hz.

RESULTS

Bone Physical Characteristics
Treadmill exercise produced longer and wider hind limb bones in the aged trained rats, but had little or even negative effects on the adult trained animals (Figures 1 and 2). Tukey’s pairwise comparison t-tests showed that exercise had significant effects on femoral length and tibial sagittal width (p < 0.05) in the aged trained group as compared to the aged sedentary animals, and no significant differences for exercise between the adult sedentary and adult trained groups.

Bone Mechanical Characteristics
Animal age had a significant effect in the mechanical characteristics of the femur and tibia. Ultimate load, yield load, and stiffness were all significantly increased with age for each test (p < 0.05 for all), but exercise did not significantly change the strength parameters between exercised and sedentary animals in each age group.

Figure 1: Comparison of Bone Length
(* = significant for exercise, p < 0.05)

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unexpected result was finding that 12 weeks of endurance exercise resulted in longer bones in aged animals, while not having an effect on adult animals.

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REFERENCES