Physical activity increases bone density

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Osteoporosis is a recognized health problem associated with fractures in the elderly. It is characterized by an abnormally low bone mass (8). Severe back pain, loss of height, disfigurement, and reduced mobility are complications associated with vertebral fractures resulting from advanced osteoporosis (8, 20). Death occurs within six months in approximately 22 percent of the individuals with fractured hip bones due to the complications precipitated by the fractures (11). Loss of bone mineral is a normal consequence of aging in both men and women, but is more rapid in women. It may begin as early as age 30 in women and is accelerated at menopause, making women more susceptible to fractures (20).

Males and females reach their peak bone mass at about age 35 and then begin to lose it at a gradual rate. Since women have a smaller initial bone mass and bone loss accelerates at menopause, the bone loss may exceed 45 percent by age 80 (16). In contrast, men may lose approximately 25 percent of their bone mass by the same age (16). Those individuals who have a large bone mass when they begin menopause are less likely to develop osteoporosis and suffer from fractures (13).

Despite the severity of the problem, the loss of bone with aging is poorly understood. Suggested causes include nutritional, hormonal, and genetic factors (1, 5, 9, 14, 20, 21, 22). Recently, attention has been focused upon the role of physical activity in the prevention and treatment of the condition. Cross-sectional studies have examined the long-term effects of sport and aerobic activity upon bone mineral content (BMC) in healthy individuals (2, 4, 6, 10, 12, 18). Generally, these studies indicate that chronic physical activity is consistent with greater BMC. Weight bearing exercise, such as running, is particularly associated with greater BMC levels (6, 18). Longitudinal studies also indicate that exercise increases BMC in premenopausal women or slows the loss of bone in postmenopausal women (3, 24, 25, 27). This paper will review some of the current research about the effects of exercise and activity on bone density and the implications for the prevention of bone loss.

Individuals at Risk

Postmenopausal, sedentary light-skinned women are primarily at risk. Women who experience early menopause are more at risk than women who have a later menopause (1). Small, lightweight women are also more likely to develop osteoporosis than taller, heavier women (20). An inadequate calcium and/or vitamin D intake also affects bone mineral. Smokers and those who drink large amounts of coffee and alcohol are also at risk (1).

Genetic Factors

Genetic factors play a role in the development of osteoporosis. Whites have a much higher incidence of osteoporosis than do Blacks, which may be related to the greater bone mass in Blacks (5). Certain populations such as Eskimos have been reported to have rapid age-related mineral losses and a high incidence of osteoporosis (20).

Nutritional Factors

Nutritional factors are also important. Negative calcium balances result in calcium being withdrawn from the bones. Low calcium intakes in the elderly are associated with higher fracture rates (9). High protein intakes could facilitate bone loss by increasing urinary calcium excretion (20). There is also some evidence that bone losses are greater in individuals who drink large amounts of coffee (20). High amounts of dietary phosphorus from fast foods and snack foods such as crackers, hamburgers, and potato chips and from soft drinks, especially colas, also increase the breakdown of bone (13).

Hormonal Factors

Many hormones affect bone metabolism and could be important in age-related bone loss. These hormones include parathyroid hormone (responsible for maintenance of serum calcium concentrations by stimulating bone resorption or breakdown; (20),
vitamin D (which controls the absorption of calcium and phosphorus; 1, 14), and calcitriol (which inhibits bone resorption; 20, 21). A decrease in estrogen at menopause may be responsible for accelerated bone resorption (1, 8, 20). Other hormones including glucocorticoids and the thyroid hormones also influence BMC (20).

**Mechanical Factors**

The original suggestion that mechanical forces may cause changes in bone structure is known as Wolff's Law. According to this law, bone adapts to mechanical stress or loading by increasing mineralization in a particular region of the bone to increase the strength of the bone to withstand the stress. Exercise places a mechanical stress upon bones through muscular contraction. If the force from muscular contraction is reduced or increased, the bone mineral content is affected. The mechanical effects on bone may be studied by observing the effects of inactivity and physical activity on bone.

Inactivity results in a loss of bone mineral. Prolonged bed rest and immobilization increased mineral loss and bone volume in healthy individuals (7,17). Astronauts also demonstrate a significant bone mineral loss due to decreased gravitational and muscular forces during space flight (15).

In contrast, exercise stimulates bone growth producing a greater mineral content and thicker bones. Early investigations of the effects of exercise upon BMC focused upon tennis because the non-playing arm could serve as a control. The humerus of the playing arm of nationally ranked male tennis players was 35 percent thicker than the non-playing arm and 28 percent thicker in female tennis players (12). Huddleston, et al. (10) reported that BMC of the dominant arm of active male tennis players of national caliber (age range 70 to 84 years) was 13 percent greater than in the non-playing arm compared to a 7 percent difference in non-athletes. The results of these investigations indicate that playing tennis during a lifetime may produce a localized increase in bone mineralization that is greater than that found in non-athletes.

Weight bearing exercise is particularly associated with greater bone density levels. Nilsson and Westlin (18) reported that femoral BMC in 64 male athletes was significantly greater than that in a control group of age-matched non-athletes. In the group of athletes, bone density was positively correlated with the increasing load taken on the lower limb. The greatest bone density was found in weight lifters, followed in order by throwers, runners, soccer players, and finally, swimmers, whose bone density was similar to that of the control group. In the control group, individuals who exercised regularly had a higher BMC than those who did not. Another study reported that both male and female professional ballet dancers and male weight lifters had significantly greater BMC of the lower leg bones compared with age-matched healthy controls. The BMC of the radius and ulna of the weight lifters was also greater than that of the controls (19).

Running also increases BMC. Bone mineral content was 20 percent greater in middle-aged male cross-country runners than that in a control group of similar age and body build (6). In another study, total body calcium was 11 percent greater in male marathon runners than in a control group (2).

Regular exercise has also been shown to produce greater bone mass than inconsistent exercise programs. Participants who ran more than 16 km in each month of a nine-month study significantly increased their BMC compared to a control group and to participants who ran less than 16 km during at least one of the nine months (28). These results suggest that consistent running, in which distance is increased gradually and maintained, is effective in increasing the mineral content of bone, while running that is sporadic and variable has a minimal influence on BMC.

**Prevention**

The literature demonstrates that regular physical activity of a moderate to vigorous nature increases bone mass in healthy subjects. A large initial bone mass may help slow bone loss associated with aging (5). Individuals who have developed a larger bone mass by the fourth decade tend to have greater bone mass later in life. Thus, vigorous physical activity in young individuals, especially girls and young women, might significantly alter the severity of bone loss and eliminate or reduce the incidence of fractures with aging.

Bones which are most likely to be fractured in osteoporotic individuals are located in three areas—the lumbar and thoracic vertebrae, the neck of the femur, and the distal forearm (13). Since BMC is increased in bones stressed by the physical activity, specific exercises or activities should be designed to stimulate the bones of the arms and the legs as well as the vertebrae. However, there are no comparative studies which have identified the frequency, duration, and intensity of exercise which are needed to increase bone density.

Although the role of physical activity in the prevention of osteoporosis has not been fully identified, some conservative recommendations can be made. In addition to its beneficial effects upon strength, weight training is recommended for the mechanical loading and stress placed upon the muscles and bones. Since stimulation of growth is specific to the particular bones involved in the activity, it is important to use upper body exercises as well as those for the lower body. Light wrist weights may be used during activities which do not involve the arms to a great extent to provide a full-body workout. Doing sit-ups while holding weights will add additional stress to the vertebrae.

A regular aerobic exercise program of moderate to vigorous intensity (70 to 80 percent of maximum heart rate or 220 minus age) at least three times a week for a minimum of 20 minutes is also recommended to improve cardio-
respiratory fitness as well as to increase mechanical loading of the skeleton. Brisk walking (especially in heavier individuals), jogging, and aerobic dancing are the preferred modes of exercise. Stretching before and after the 20-minute exercise session should be included to avoid injury. Trunk rotation and side-bending exercises can also be used with the stretching exercises to stress the vertebrae. Twisting to either side during sit-ups is another way to stress the vertebrae.

Implications

Physical educators and coaches are in a unique position to influence the present health status and the future well-being of athletes, and the female athlete in particular. Weight training, properly utilized, has both short-term and long-term effects. The short-term effects include increases in strength, prevention of injuries, and enhanced athletic performance. The long-term effect is an increase in bone mass which may help to prevent osteoporosis long after the athlete’s competitive days are over. Since females are at greater risk of developing osteoporotic fractures, the long-term effects of weight training are especially important for the female athlete. Research studies indicate that women with strong, dense bones lose bone minerals more slowly as they age than women with less dense bones (5). Weight training exercises which stress the vertebrae should be added to those exercises which have been chosen to enhance athletic performance to stimulate increases in bone mass in the entire skeletal system. An increase in bone mass in the young athlete provides a strong foundation for continued growth and maintenance of strong, dense bones through participation in physical activity throughout the lifespan.

References

New Products

Lifecycle Training

From Bally Fitness Products Corporation, manufacturers of the Lifecycle exercise bicycle, comes the new Lifecycle 7000 Racer.

The computerized, stationary model 7000 Racer, which simulates the appearance and feel of an actual racing bicycle, will be of great interest to many of the nation's 78 million runners and 18 million serious cyclists, according to Executive Vice President Augie Nieto.

"Cyclists, triathletes, track and marathon runners have been searching for an advanced indoor training program that provides the highest level of cardiovascular conditioning," Nieto said. "Now these competitive athletes can work out inside their own home or office without having to contend with inclement weather."

The Lifecycle 7000 Racer features these improvements:
• A new configuration which places the user in a horizontal position identical to the proper racing form and which is more beneficial to the back than the standard upright posture. It also permits a more intensive workout with less perceived effort.
• Drop handlebars which aid in positioning the rider for maximum benefit.
• A narrow-profile seat which can be raised and tilted to meet individual riding needs.
• Anatomically designed racing pedals which are equipped with toe clips and straps to allow maximum pedal stroke development. By pulling up with the feet as well as pushing down on the pedals, the rider achieves a more efficient stroke and exercises more muscle groups.
• Visual feedback console which provides important data during the ride as well as allowing each user to monitor his/her progress.
• Moisture-resistant sealant which coats the console to reduce wear and to guard against damage to the microprocessor inside.

The Lifecycle 7000 Racer simulates riding up and down imaginary hills with light pedal resistance for beginning programs and significantly increased resistance for advanced rides.

For information contact Bally Fitness Products (800) 543-2925 or in California, (714) 859-1011. A free booklet, The Complete Lifecycle Workout, is available by sending a self-addressed envelope to Bally Fitness Products Corporation, Consumer Division, 10 Thomas Road, Irvine, CA 92714.

The Brutus Triad

Excel's new exercise weight bench, the Brutus Triad, is a versatile exercise bench that converts from a standard weight configuration to olympic specifications, and includes a squat station, dip stand and sliding adjustable seat. The Brutus Triad

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boasts a leg developer, butterfly and shoulder station for the most complete free weight system available on today's market. Two-inch square steel, 12-gauge premium grade cotton-backed vinyl, high density 2-inch and 4-inch foam padding and oil-impregnated bearings make the Brutus Triad state-of-the-art in every way.

For more information: Excel, 9935 Beverly Blvd., Pico Rivera, CA 90660, (213) 699-0311.

**Pullover Machine By Paramount**

Paramount introduces the Pullover Machine, a single station machine that will provide effective workouts for the muscles of the upper back (latissimus dorsi and teres major). The variable resistance cam is used to stress the muscles uniformly through the entire range of motion. An adjustable seat allows for proper shoulder alignment. The entry/exit bar is a significant feature of this new machine, allowing convenient operation. Two inch tubular steel construction will ensure years of heavy use, and a satin chrome finish creates an attractive appearance. The unit comes with a standard weight stack of 220 pounds. The desired weight load can be selected from a seated position. Weight stacks are available in chrome or black finish. The unit is 57 inches wide, 57 inches long and stands 79 inches high.

For further information, contact: Sales Department, Paramount Fitness Equipment Corp., 6450 E. Bandini Blvd., Los Angeles, CA 90040, (213) 721-2121, (800) 421-6242.

**Monark Pro Cycle #867**

Monark "Pro" Cycles have been updated with sporty new graphics on the double chain guards, an infinite tension setting mechanism with fingertip control, and comfort conscious, full-rotation handlebars with quick-release lever for adjustment of angle and height. These new features can easily be added to older models to create the high-tech look of the '80s at a very economical cost.

For more information, please contact:
In the east: Universal Fitness, 50 Commerical Street, Plainview, NY 11803, (516) 349-8600, (800) 654-7554.
In the west: Monark West Inc., 15305 N.E. 40th Street, Redmond, WA 98052, (206) 881-7618.

![The updated Monark Pro Cycle](image)

**711 Turbo Gym Combines Free Weights and Hydraulics**

Rocky Mountain Gym Equipment Company, Inc., has introduced the 711 Turbo Gym that combines free weights and hydraulics for a total body conditioning. The patented design is compact, but offers more than 60 different exercises. The hydraulic device has 16 settings, and the free weights capacity is unlimited. An optional power rower is available for cardiovascular workout.

For more information: Rocky Mountain Gym Equipment Co. Inc., 5745 Monaco Street, Commerce City, CO 80022, (303) 287-8095.

![More than 60 exercises are available through the 711 Turbo Gym](image)