Turkish Journal of Endocrinology and Metabolism, (2003) 3 : 101-105 **REVIEW**

Osteoporosis and Physical Activity

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The use of physical activity is widely accepted in preventive medicine practice. Therapeutic exercises are especially beneficial in supporting the treatment of some chronic diseases. The choice of appropriate and effective exercises in the treatment and prevention of osteoporosis is crucial. The duration, intensity, frequency, and the involved muscle mass are to be taken into account in the prescription of exercises, which are basically a combination of movement patterns.

The musculo-skeletal system is in continuous interaction with the environment. It is a very dynamic system with a high adaptive capacity. The response to stimuli depends on the biological age, health, and sports activity experience of the individual.

Weight bearing activities with different movement patterns like ball games are accepted to be more effective in the prevention of osteoporosis, especially when performed till the end of puberty. This type of activity seems to be also effective in the middle-aged. Porprioceptive and strength exercises are important in supporting postmenopausal women. In elderly people, though progressive resistance exercises are very effective, even walking and simple gymnastics can be beneficial in more sedentary cases. Less intensive exercise of shorter duration have to be performed by people with advanced stage osteoporosis with or without previous fracture complication. Strength exercises can be fulfilled isometrically in critical cases.

Particularly in older people, enhanced mobility is not only a very effective means in the therapy of osteoporosis, but also a factor in decreasing pain sensation. The increased independence of the subject provides a better life quality.

Key words: Osteoporosis, physical activity, prevention, therapeutic exercises

Introduction

Osteoporosis is a skeletal disease involving decreased density and increased fragility of the bone. The muscle system is also negatively effected in osteoporosis. Muscle mass and strength is also reported to be reduced in this disease. The main purpose in osteoporosis therapy is to prevent bone fracture and to improve life quality. To reduce the risk of fractures focus has to be given on the locomotor system as a whole. Relieving the patient from pain and enhancing mobility will help to fulfill the latter purpose. Measures to increase or at least to maintain bone density are to increase muscle strength, and to improve proprioception, which is a function of the former.

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It is thus obvious that the functional state of the locomotor system is very important. Muscles have a fast responding dynamic nature, and inactivity causes functional and structural deficits. Bone density will also decrease with immobilization or lack of gravity (1-6). Regarding the musculo-skeletal system, positive gains obtained from previous activities also regress with inactivity (7).

Bone structure is organized by means of the local forces acting on this tissue. While intrinsic factors comprise muscle contractions, extrinsic factors consist of gravity and the dynamic pressure and pull forces. Altogether, these factors can be named as 'motion'. Thus, motion is necessary to maintain the functionality of the locomotor system.

Physical activity is necessary to increase functionality. In diseases like hypertension, coronary heart disease, diabetes mellitus, obesity or depression, the general effects of therapeutic exercises are well

documented. The locomotor system benefits predominantly from the local effects of therapeutic exercises. So, one has to consider the possible local effects of various physical activities. This fact is especially obvious seen in sports where one extremity is more involved than the other (8, 9). Bone density of the weight-loaded extremity is higher than its counterpart (10-13). In complicated movement patterns, secondary positive effects ensue from the stabilization of the body (14, 15).

Physical activity in prevention and therapy of osteoporosis

At the end of puberty, bone growth is completed by 98 %. Peak bone mass is normally conserved until 40-45 years of age. Thereafter it decreases by 0.5-1.0 % each year (16).

Early prevention in osteoporosis

As peak bone mass primarily depends on physical activities performed until the end of puberty, a preventive approach should start in childhood. Kriska et al. obtained a significant correlation between bone dimensions in postmenopausal women and their physical activity level between the ages of 14 to 21 (17). Other studies similarly revealed positive correlations between physical activity during childhood or young adolescence and the radius and calcaneus bone densities measured later in life (17-19). Joakimson et al. proposed that physical activity in childhood would possibly reduce the risk of femur neck fracture later in older age (20).

Physical activities positively effect the musculoskeletal system throughout the whole childhood. In girls, the effect is greater in the beginning of puberty (21-24). Weight-bearing activities seem to be more effective. Non-weight-bearing activities, like the ones improving the aerobic capacity, are less effective when bone mineral density is considered (25,26). Turner et al. likewise determined a significant correlation between weight-bearing activities (in ball games like basketball, football or baseball) and bone mineral densities of the radius and femur in 5-14 years old children. In revenge, they failed to observe significant correlations for swimming and cycling. Furthermore, an interesting finding was that the activity level of the mothers correlated significantly with lumbar and femur bone densities of their children (27). In fact, children are looking up to their parents and they try to imitate their activity attitudes primarily.

Preventive measures are to be started in childhood, and activities which are most effective on improving bone density in children are principally weight-bearing and multidirectional activities like ball games or other intermittent activities and additional weight-training using own body-weight. Sessions of 30-50 min each for a total of 4-5 times a week are appropriate. Regular activities performed in childhood are most important to establish an exercise habit that will persist life-long.

Prevention of osteoporosis in middle age

Compared with the children, the situation is somewhat different in adults. The primary aim of preventive exercises in healthy adults is to keep bone density at least constant. Several studies indicate to the positive effects of general activity level on lumbar vertebral bone density (28-32). Daily total activity level (including walking distance, stair-climbing, physical activity, etc.) is suggested to effect femur fracture incidence (33).

Data gathered from female athletes performing different branches (endurance, ball-games, cycling, weight-training, ballet dancing and non-specific activities) revealed that higher lumbar vertebral bone density scores were determined in those involved in weight-training, ball-games and non-specific activities. Femur bone density scores were higher in females participating in ball games. Bone density scores in male athletes ranged from the highest to the lowest when performing ball games, weight-training, non-specific activities, endurance activities, cycling and inactive people (33).

Activities with multidirectional movement patterns (acceleration, jumping, sudden stops and direction changes) are powerful stimulators for the bone tissue. Jumping and similar movements appear to stimulate peak bone mass especially in young women (34,35). Although weight training is a very effective stimulator, activities involving multidirectional patterns like jumping and the similar (36) mostly effect the femoral neck. Weight-bearing activities with a monotype pattern such as walking and running also result in a certain positive effect on bone density, but to a lesser extent when compared with the above mentioned activities (37). To benefit from their positive effects, chronic exercises have to be performed regularly 3-4 times a week and 30-40 min/day at least.

Aerobics seems to be more effective than walking (38). Studies about the effects of walking revealed differing results (39-43). Walking close to the anaerobic threshold seems to be effective on the bone parameters (41). Platen stated that walking alone will not be enough, and added that 3-4 times/week of brisk walking or aerobics/ dancing at 60-80 % of the maximal heart rate for 45-60 min per session will yield positive effects (44). Even submaximal exercises with a monotype activity pattern are considered to be effective on femoral and vertebral bone densities when performed with this frequency and duration. For healthy people, weight-bearing activities with a multidirectional activity pattern are advised.

Prevention of osteoporosis in postmenopausal women and older age

In postmenopausal women and older people, further aspects need to be taken into account. Between 50-70 years of age, dynamic muscle strength decreases dramatically (22). This loss is also accompanied with deterioration of coordination. Falls are responsible from 90 % of hip fractures, about one third of vertebral fractures and almost all distal radius fractures (45). With increasing age and decreasing bone density, balance is also negatively affected. Thus, muscle strength training becomes very important in this period. Muscle strength scores of females with osteoporosis were measured to be lower than those with arthritis or osteopenia, especially for hip flexors, abdominal and back muscles (46).

Studies indicate that progressive resistance training (PRT) of the muscles results in strength gains even in very old people (47-51). With increasing strength, bone mineral content will be positively effected, and the balance and mobility will be enhanced (52). When performed once or twice a week, PRT results in increases in neuromuscular strength scores (53,54). Studies have documented that leg-press strength figures reveal significant correlations with bone density scores of L2-L4 vertebra and the Ward triangle (55). Grip strength is also found to be a good indicator of radius bone density (56). These studies underline the importance of strength training. A prospective, randomized and well-controlled study indicates that training the back extensors will decrease the risk of vertebral bone fracture (57). There is especially a relation between the strength of leg extensors and flexors and falling frequency.

Strength training should be individualized. People with restricted mobility have to start with isometric exercises. In the very old people, even moderate exercises stimulate the musculo-skeletal system (58,59). The very old people respond to moderate gymnastic activities, walking and isometric strength exercises. Simple balance and proprioception exercises reduce falling incidence (60,61).

The muscular stabilization of the vertebra can reduce pain sensation. When postmenopausal women with pain and at least a vertebra fracture in the last three years exercised twice a week aiming for balance and isometric body strengthening, they were able to reduce their pain (62). There is a possible additional role of exercise-induced hypoesthesia (63).

Patients with a high fracture risk should be carefully mobilized. Inappropriate exercises should be avoided (such as flexion and rotation of the body). Simple isometric strengthening exercises, simple balance and gymnastic exercises performed 2-3 times a week for 20-30 min per session are sufficient.

All the above-mentioned exercises have to follow the appropriate exercise principles. Individual exercise programs should be prescribed in the practice. The use of adequate exercise intensity is especially very important. Young people are sometimes over-motivated and tend to over-exercise. This approach can lead to overuse injuries (64,65). Physical activity in terms of prevention and therapy should never include a performance-oriented exercise program.

Overall, different exercise programs are possible in the prevention and therapy of osteoporosis for all ages, health states, physical characteristics, and motivational status. But the key factor is to apply these programs appropriately, according to the instructions. The dynamic nature of the locomotor system provides three issues: regression upon inactivity, progression upon appropriate activity, and injury upon inappropriate activity or overuse!

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