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The Role of Physical Therapy in Slowing the Progression of Osteoporosis

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ABSTRACT

Osteoporosis is a progressive skeletal disorder characterized by decreased bone mass and deterioration of bone tissue, leading to increased fracture risk. [1] [2] It often remains asymptomatic until a fracture occurs. [3] The treatment can be use of pharmacological agents depending upon the cause of osteoporosis. Physical therapy plays a crucial role in managing osteoporosis by enhancing bone strength, improving balance, and reducing fall risk. [4] Specific weight-bearing exercises, resistance training, and postural correction techniques help stimulate bone remodelling and slowing down bone loss. [5] Along with physical therapy interventions focus on improving functional mobility, flexibility, and proprioception is vital to enhancing overall quality of life. Additionally, patient education on body mechanics and lifestyle modifications further supports long-term bone health. This review highlights the importance of physical therapy in osteoporosis management and underscores the need for individualized therapeutic approaches to optimize bone health.

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KEYWORDS:
osteoporosis, bone strength, fall prevention, fracture prevention

INTRODUCTION

Osteoporosis, in simpler terms is the 'porous' bone with low density or a bone with decreased mass. [6] Osteoporosis as per definition is the disease that is characterized by presence of low bone mass and deterioration of the normal bone tissue that increases the risk of fractures as per WHO. [1] It is the most prevalent metabolic bone
disorder and continues to be a growing concern. [3] Osteoporosis affects millions of individuals worldwide with increased risk with advancing age. A study estimates that there are over 200 million people with osteoporosis worldwide. [7] The disease is more prevalent in women as compared to men and is more common in white and Caucasian race as compared to any other. [8] The ratio of osteoporosis in men / women is 4 / 5.7. [9]

Osteoporosis can be 2 types: Primary osteoporosis and secondary osteoporosis. Primary osteoporosis can further be divided into subtypes – Involutional Osteoporosis Type I and Involuntional Osteoporosis Type II. Involutional Osteoporosis Type I is also called as Postmenopausal osteoporosis and is seen in women post menopause due to sudden drop in the oestrogen levels. On the other hand Involutional Osteoporosis Type II also called as senile osteoporosis is caused due to age related loss of bone mass. [9] Secondary osteoporosis is a form of osteoporosis that results from an underlying medical condition, medication use, or lifestyle factors. It can be caused secondary to presence of some medical conditions like hyperthyroidism, chronic kidney disease, crohn's disease, RA, due to some lifestyle factors like lack of physical activity, excessive alcohol consumption or smoking, poor nutrition like lack of calcium or Vit D consumption or some prolonged use of medications like steroids, proton pump inhibitors, anticonvulsants, etc. [10] Bone mineral density can be amazing indicator to understand the level of destruction of the bone mass. It is done with Dual Xray Absorptiometry that gives a T score. A T score of -2.5 or less is indicative of presence of Osteoporosis. [11] The bone density is measured from hip or vertebrae that are most susceptible for fractures. Fracture Risk Assessment Tool Model (FRAX) is an important tool that helps to predict the chances of fracture for a period of 10 years. It takes into consideration factors like age, gender, BMD of femoral neck, alcohol consumption or smoking history, low BMI, etc. Higher the FRAX score increased chances of fracture. [12]

Treatment for osteoporosis can be either pharmacological or non-pharmacological. For women the pharmacological treatment is alendronate, risedronate, zoledronic acid, or denosumab depending upon the severity of the disease and T score. For men pharmacological treatment with

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bisphosphonates is recommended. [13] Nonpharmacological management of osteoporosis includes adequate calcium and vitamin D intake, physical therapy, smoking cessation, limitation of alcohol/caffeine consumption. [14] [15] A daily dosage of 600IU of Vitamin D is recommended for both men and women with the ages of 51 to 70 years while 800IU for men and women with the ages above 71 years. A daily calcium intake of 1000mg for men between ages 50 and 70 years while 1200mg of daily calcium for women above 51 years and men above 71 years of age is recommended dosage. [13]

BENEFITS OF PHYSICAL THERAPY FOR OSTEOPOROSIS

Improves Bone strength –

Weight bearing exercises and strengthening (resistance) exercises help to improve the bone strength. These activities create microstresses that stimulate osteoblasts (bone-building cells). Bones adapt to these added stresses by increasing mineral density and structural strength and prepare themselves to handle future stress. Weight-bearing exercise also enhances bone mass and density in weight-loaded areas, such as the spine, hips, and legs. Resistance exercises create a pulling effect on the bone that further triggers creating a response that increases bone density. Weight bearing exercises like walking, jogging, squats, lunges, yoga postures are recommended. While use of weight cuffs, resistance bands, machines are commonly used for resistance workouts.

Enhanced Muscle Strength and Stability –

Enhanced muscle strength and endurance benefit osteoporosis by providing better bone support, reducing fracture risk, and improving mobility. Strong muscles pull on bones, stimulating bone growth and slowing bone loss, while also absorbing impact forces to prevent fractures. [16] Increased endurance helps prevent muscle fatigue, ensuring better balance and coordination, which reduces falls—one of the leading causes of osteoporotic fractures.

Improved Posture and Spinal Alignment –

Improved posture and skeletal alignment are crucial for osteoporosis because they reduce spinal stress, prevent fractures, and enhance balance. Proper posture minimizes excess pressure on the vertebrae, lowering the risk of compression fractures, which are common in osteoporosis. Good alignment also ensures even weight distribution, reducing strain on bones and joints while improving stability and movement efficiency. [17] Additionally, maintaining an upright posture strengthens core and back muscles, further protecting the spine and enhancing overall mobility. By promoting better balance and reducing fall risk, good posture helps prevent fractures, supporting long-term bone health and independence.

Fall Prevention –

Physical therapy reduces falls in osteoporosis by improving balance, strength, coordination, and posture, all of which are essential for stability and fall prevention. Balance training enhances proprioception and reaction time, making it easier to recover from a misstep. Strength **exercises** target key muscle groups, such as the core and legs, to provide better support and prevent sudden weakness-related falls. [16] Gait training helps correct walking patterns, reducing the risk of tripping. Additionally, postural exercises improve spinal alignment, lowering the chance of forward bending that could lead to instability. Physical therapists also teach fall prevention strategies, such as safe movement techniques and home modifications, ensuring individuals with osteoporosis stay mobile and independent while minimizing fracture risk.

Pain Management –

Physical therapy helps manage pain in osteoporosis by improving posture, mobility, muscle strength, and flexibility, reducing stress on fragile bones and joints. Gentle weight-bearing and resistance exercises strengthen muscles, providing better support to affected areas and alleviating discomfort. Postural training minimizes excessive spinal flexion, preventing compression fractures that cause pain. Stretching and flexibility exercises reduce muscle stiffness and improve mobility, while manual therapy techniques, such as soft tissue massage and joint mobilization, help relieve tension and promote relaxation. Additionally, education on proper body mechanics ensures safe movement, preventing pain flare-ups. By addressing pain at its source, physical therapy enhances overall comfort, function, and quality of life for individuals with osteoporosis. On the other hand physical therapy techniques, such as manual therapy and specific stretching routines, alleviate chronic pain often associated with vertebral fractures.

Aquatic Therapy –

Aquatic therapy is highly beneficial for osteoporosis because it provides a low-impact, weight-supported environment that allows for safe exercise without excessive stress on fragile bones and joints. The buoyancy of water reduces the effects of gravity, minimizing the risk of falls and fractures while still providing resistance for muscle strengthening. Water's natural resistance helps build muscle strength and endurance, which in turn supports bone health and improves balance. Additionally, warm water can relieve pain and stiffness, promoting joint flexibility and ease of movement. Aquatic exercises also enhance cardiovascular fitness, posture, and coordination, all of which are crucial for osteoporosis management. [18] This makes water-based therapy an excellent option for individuals who may struggle with traditional weight-bearing exercises due to pain or fall risk. So for patients with significant frailty or comorbidities, water-based exercises provide a low-impact alternative to maintain mobility and strength without overloading fragile bones.

Mechanisms of Action

Mechanotransduction –

It is the process by which cells sense and respond to mechanical forces or physical changes in their environment. In the context of bone health, it refers to how bone cells (osteocytes, osteoblasts, and osteoclasts) detect mechanical loads or stresses and convert these signals into biological responses that affect bone formation and remodelling. [19] When bones are subjected to mechanical forces, such as during weight-bearing exercises or movement, this creates small deformations in the bone tissue. These deformations are sensed by osteocytes through tiny extensions called canaliculi. The osteocytes then transmit mechanical signals to other bone cells, leading to changes in bone remodelling. Osteoblasts (bone-building cells) increase bone formation in response to these mechanical signals, strengthening the bone. Osteoclasts (bone-resorbing cells) may become less active, reducing bone breakdown. The overall effect is bone adaptation: when bones are subjected to regular mechanical load, they become denser and stronger to withstand future stresses. This process is vital for maintaining bone health and for counteracting osteoporosis.

Muscle-Bone Interaction –

It refers to the relationship between muscle activity and bone health, where the forces generated by muscle contractions influence bone structure and strength. When muscles contract, they pull on bones via tendons, creating mechanical forces that stimulate the bones. These forces activate bone cells, such as osteocytes (bone-sensing cells), which send signals to osteoblasts (bone-building cells) to promote bone formation or to osteoclasts (bone-resorbing cells) to reduce bone breakdown, depending on the load and needs of the bone. This interaction is essential for maintaining bone health throughout life for better bone health and healthy ageing.

Neuromuscular Adaptation –

In osteoporosis, neuromuscular adaptation occurs through physical activity, particularly strength training and balance exercises, which enhance muscle strength**,** coordination, and reaction time. These adaptations help improve postural control**,** balance, and movement efficiency, making individuals more stable and reducing the risk of falls and fractures. [20] The nervous system becomes better at recruiting muscle fibres and coordinating muscle actions, allowing for safer, more controlled movements. Strengthening the core and postural muscles improves spinal alignment, reducing the risk of spinal fractures. Overall, neuromuscular adaptation helps individuals with osteoporosis maintain functional independence and bone health by providing better muscle support and reducing the load on fragile bones.

CONCLUSION

Physical therapy is a cornerstone in the management of osteoporosis, offering safe and effective strategies to slow disease progression, reduce fracture risk, and improve overall quality of life. Through individualized exercise programs and patient education, physical therapists empower patients to take an active role in managing their condition. Future research should continue to refine exercise protocols and explore innovative approaches to optimize outcomes for patients with osteoporosis.

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