

Exercise and Bone Health

By Brianna Martinez and Graduate Student Mentor, Eric Leslie

Introduction

Our bones serve as a framework and helps protect the organs in the body. Bone is a living tissue. It is constantly undergoing remodeling. Bone remodeling is the removal of old bone tissue and is replaced with new bone tissue. When the bones are experiencing daily stress, there is growth occurring. Bone health and exercise are intertwined because bones get stronger with exercise. Exercising regularly will stimulate osteogenesis, which will help them build more bone tissue. The density of bone is correlated with exercise, as exercising regularly will allow for bone to adapt by building more bone tissue that will allow for more density. This will help reduce the risk of fractures and improve quality of life. Resistance training and water exercises are evident categories of how exercise enhances bone health. While exercise plays a major role in bone health, nutrition plays a major role as well. Looking at bone remodeling, the types of exercise, and nutritional considerations demonstrates a clear understanding of how the relationship between exercise and bone health works.

Bone Remodeling:

Bone remodeling is completed by mature bone cells called osteocytes. The remodeling of bone has three phases, which are resorption, reversal, and formation. Osteoclasts break down old bone during resorption. During the reversal phase, mononuclear cells will emerge on the surface of bone. Lastly, in the formation phase, osteoblasts will lay out new bone until the bone that is broken down is utterly replaced. The overall motivation for bone remodeling is to adjust the bone framework to the constant changing of mechanical demands, in addition to restoring small damage in the bone matrix that can prevent the break down of old bone.

Physical activity is practical in the protection and maintenance of bone health. Bone tissue deforms during exercise and the mechanosensors will change their initial process, which will stimulate a signaling process to send a biochemical response to the deformation site (1). Some of these biochemical responses include osteogenesis and bone accretion at the deformed site (1). According to Santos et al. (1), osteocytes are targets for mechanotransduction because of their ability to acknowledge mechanical strains. Osteocytes manage this bone formation and resorption by stimulating osteoprotegerin, an osteoclastogenesis inhibitor. An osteocyte can mediate anabolic actions of a pathway called the Wnt/beta-catenin signalling pathway (1). This

pathway is activated with mechanical loading, specifically exercise, in which allow for the initiation of osteogenesis and bone formation to occur. Physical activity has the ability for parathyroid hormone (PTH) to be generated, thus resulting in the upregulation of fibroblast growth factor-23 (1). Fibroblast growth factor-23 presides over phosphatase homeostasis, along with the metabolism of vitamin D (1). According to Santos et al., bone adaptation to exercise stems from a couple of stimulations, which are the contraction of muscle and ground-reaction forces. The strength and structure of bone is always changing to help the skeletal system bear with the constant loading and injury prevention (1).

Types of Training on Bone Health:

Underdoing daily mechanical loading stimulates osteogenic effects. Planned exercise indicates any organized physical activity that one will take part in. An example of this type of exercise is aerobic exercise. Planned exercise is effective in regulating bone metabolism (2). It is known that exercise protects the bones by preventing bone disorders, such as osteoporosis (1). Engaging in weight-bearing exercises is the best approach for bone density to be enhanced, as well as stimulating bone formation (2). Cellular mechanotransduction mediates the bone's adaptation to exercise (1). Biochemical markers in the bones that will monitor the activities of bone formation, as well as look into the exercise-induced changes that occur within the mass of the bones.

There are specific types of training that have positive effects on bones, such as resistance and water-based exercises. Resistance exercise is valuable in preserving both bone and muscle mass (3). The mechanical load will increase bone strength, that will lead to an increase in bone mass. During resistance exercise, load-induced periosteal apposition will increase the bone's resistance to bending (3). In a study reported by Hong et al. (3), partaking in resistance training for two to three times a week improved the bone mineral density (BMD) in the spine and hip in postmenopausal women. This is ideal for preserving bone loss and increasing BMD in the older population, as well as the younger population. This phenomenon is a doorway for young adults to preserve their bone health and to prevent osteoporosis in the future. It is useful to note that participating in high intensity water-based exercises is beneficial as well(4). Water-based exercises have a lower risk of bone breakage.

Nutritional Considerations:

While exercise has a direct relationship with bone health, having a balanced diet with vitamins and minerals is a contributing facet in bone health. When there is a balance between exercise and nutrition, there is optimal bone health and there is a lower chance for injuries, as well as diseases such as osteoporosis (5). Neglecting daily exercise and having a poor diet will lead to an increased rate of bone issues. For example, vitamin D deficiency can lead to an accelerated rate of osteoporosis. When people are not getting enough of these nutrients, their bones are weaker and will not be able to withstand the mechanical stress of everyday life. Vitamin D, calcium, and hormones work together to enhance BMD and framework (6). Calcium aids in the building and maintenance of bone. Vitamin D helps the body absorb calcium effectively. The hormones that help with bone health are parathyroid hormone, calcitriol, and calcitonin. Parathyroid hormone monitors calcium levels, as well as stimulating bone reabsorption and formation. Calcitriol is derived from vitamin D. The last hormone, calcitonin inhibits the breakdown of bones and is used as a protector when there are excessive amounts of calcium in the body (6). Estrogen stimulates the formation of bone as well. Willems et al. (6) stated that these dietary components enhance signaling molecules that are produced by osteocytes, allowing for a better response for mechanical loading and unloading. Essentially, this will result in optimal bone health.

Prevention of Osteoporosis:

Exercise and nutrition help prevent osteoporosis. Osteoporosis is a disease of the bone and occurs when the bone is having trouble keeping up with the loss of bone. Bone angiogenesis occurs when new blood vessels carry oxygen and nutrients, it also serves as a route for inflammatory and bone precursor cells to get to the site that needs healing, in addition to being induced by exercise. Tong et al. (7) discovered that this will increase the blood flow of the bone and influence pressure gradients. The influence on pressure gradients comes from compressive forces in different bone regions, meaning that interstitial fluid will flow from an area of high pressure to an area of low pressure (7). Activating the process of angiogenesis is important in preventing osteoporosis, on account of a disturbance in bone angiogenesis, the result will lead to osteoporosis. Benedetti et al. (7) reported an increase in blood flow in the marrow during physical activity. This proves that exercise regulates the mediators that are needed for angiogenesis, therefore improving bone angiogenesis (7). A study reviewed by Benedetti et al. (8) examined which types of exercise are the most affective in preventing osteoporosis and

fractures in postmenopausal women. Progressive resistance training and weight-bearing aerobic exercise was the most effective route for enhancing BMD and reducing the risk of fractures (8). Resistance training is the sought-after approach for reducing osteoporosis, due to the mechanical stress that it puts on the bones. Of course, safety concerns should be considered in the reduction of fractures.

Conclusion

Overall, there are different ways of how exercise affects bone health. It will enhance mechanisms in bone remodeling, as well as preventing osteoporosis. Instituting the synthesis of bone tissue, in which exercise stimulates will give a rise to healthy bones. It is crucial to put in time for physical activity, as well as maintaining a balanced. Taking time to exercise and maintaining a nutritional diet has a direct relationship in the prevention of osteoporosis. In the long run, exercise is needed for keeping bones healthy and durable.

Applying It All

- Participating in daily exercise will enhance the mechanisms that are important for bone remodeling, which results in exceptional bone health.
- Maintaining a healthy diet that incorporates foods high in calcium and Vitamin D specifically, works hand in hand with exercise to maintain bone health.

Bridging the Gap

As we age, our bone health declines. It is important to take bone health seriously, as bone diseases such as osteoporosis has a higher chance of occurring in weak bones. There is now research that proves how exercising enhances bone health through bone remodeling. It is crucial to know that nutritional considerations should be thought of as well, since Vitamin D and calcium aid in bone health. Making a routine of daily exercise and a healthy diet will result in extraordinary bones.

Summary Statement

To maintain healthy bones, daily exercise such as resistance training is important in terms of amplifying bone rebuilding. Nutrition plays a vital role in the maintenance, in terms of supplying bone with different vitamins and minerals to aid in the rebuilding of bone.

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When people are sedentary, their bones will weaken, and they will become more susceptible to osteoporosis. Exercise, such as resistance training will aid in the rebuilding and

building of new bone tissue, which is healthy. This will give rise to proper bone health and will lower the chance of osteoporosis from occurring.

Bio:

Brianna Martinez is an exercise science undergraduate student at the University of New Mexico. She enjoys dancing, being outdoors, and baking with her mom.

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