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### Exercise for Osteoporosis a Real Necessity?

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#### Introduction

Osteoporosis is a systemic skeletal disorder characterized by low bone mass (amount of bone) and deterioration of the microarchitecture of bone tissue (bone quality), with the consequent increase in bone fragility and greater risk of fractures [1]. It is the most common bone metabolic disease, responsible for most of the fractures occurring in people over 50 years, among which the more frequent are vertebrae fractures, distal end of the forearm and proximal end of the femur [2]. Moreover, osteoporosis is an extraordinarily prevalent disease with serious consequences; from 50 years old, a woman has a risk of almost 40% of suffering some osteoporotic fracture during the rest of her life [3].

It is widely recognised that hip and vertebral fractures are correlated with an increase in mortality [4]. Specifically, in the case of hip fractures most deaths occur in the first 3 - 6 months following that event, with 20 - 30% of them directly relates to the fracture itself [5]. In 2010 the number of deaths causally related to osteoporotic fractures was estimated at 143,000 for the entire European Union, among which 50% of those that occurred in women were due to fractures of the hip, 28% to vertebral fractures and 22% to the remaining locations [6].

Osteoporosis is known as a silent disease because it does not usually present symptoms until the bones become so weak that with an effort, a blow or a fall a fracture occurs. This causes some undesirable situations such as the majority of patients with osteoporosis remain without treatment for this condition. In fact, less than 20% of patients with a bone fragility fracture receive therapy to reduce the risk of future fractures during the year following the fracture [7]. This problem is heightened taking under consideration that once a person develops osteoporosis or suffers a fracture, the complete restoration of bone strength is unlikely due to the irreversible structural loss in the bone microarchitecture [8].

#### Risk Factors

Bone health depends on both the amount of bone and the quality of it, and both factors together give rise to the concept of bone resistance. Consequently, the decline of these are the main causes of the onset of osteoporosis and therefore of the associated fractures. Thus, the interaction of multiple factors contributes to decrease bone health and/or increase the risk of osteoporotic fractures, including clinical, medical, behavioural, nutritional and genetic variables [9-12].

Given that, it can be said that being a woman could be classified as a risk factor itself to suffer osteoporosis and osteoporotic fractures, since the advent of menopause and the consequent decrease in the bioavailability of estrogen will result in a higher rate of bone resorption and therefore to an increase in the fragility of the bone tissue [13-15].

#### Exercise in Osteoporosis

In people with osteoporosis, one of the main objectives must be to carry out potentially osteogenic activities, which are an optimal

stimulus to promote the formation of new bone tissue or at least to stop its loss. Regarding this topic, there is a large literature that has investigated, and in many cases demonstrated, the value of physical activity and physical exercise for the improvement of bone health [16-54].

Although exercise is usually recommended for the prevention and treatment of this disease, general guidelines are often non-specific and do not take into account the individual differences in bone health, risk of fracture and functional capacity.

Regular physical activity that reaches a certain weekly volume and, above all, physical exercise have multiple health benefits, but not all types of activities and exercises are osteogenic. The widespread idea that aerobic training, such as swimming, biking or walking, is beneficial for all body systems is inconsistent with scientific evidence suggesting that none of these activities represent a significant stimulus to the bone [17-19].

On the other hand, other types of activities do have the capacity to improve bone health due to the responses generated by the magnitude, volume and frequency of the applied load or stimulus. In the 80's Lanyon and Rubin [22-24] indicated that the load should 1) be dynamic, not static 2) induce a relatively high bone deformation 3) applied quickly.

In general, randomized control trials and meta-analysis indicate that activities involving certain forms of impact through weight bearing activities, such as jumping or resistance training, alone or in combination with other types of exercise can improve the bone health of children and adolescents [26], premenopausal women [27], postmenopausal women [28] and men [29].

In addition, due to the strong association between falls and osteoporotic fractures, any exercise program designed to prevent fractures should include activities that improve muscle function, balance and gait stability, as these are the main factors to prevent falls in older adults [45,46].

Despite the lack of efficacy, the general guidelines of exercise for people with osteoporosis usually recommend modalities of moderate intensity, due to an apparent risk of fracture as a result of the use of high loads [47]. The evidence has shown the existence of a threshold of intensity that must necessarily be achieved in order for a particular activity to be an osteogenic stimulus. Thus, resistance training carried out with high loads and high-speed execution is a safe and effective stimulus for the improvement of bone health in postmenopausal women [47-49].

Moreover, beside impact and resistance training, whole body vibration seems to be an effective tool for enhancing the bone health of women with osteoporosis [50-53]. Mechanical vibration is a stimulus characterized by an oscillating movement whose intensity is determined by 2 biomechanical parameters, frequency and amplitude. The combination of these parameters determine the magnitude of the acceleration produced [51]. Although the physiological mechanisms that make whole body vibration an effective way to generate osteogenesis are not clear yet, it seems that as in resistance training, the tension caused by the external load (compression) combined with the muscle reactive forces (tension) can induce an effective stimulus to increase bone health [53]. Thus, whole body vibration training can maintain, and in some cases, improve the bone health of people with osteoporosis. Moreover, beside of being osteogenic, whole body vibration training reduce risk of falls and of osteoporotic fractures as it improves strength, functional capacity, and balance [51].

## Conclusion

Given the current scientific evidence, physical exercise can be a safe and effective tool for improving the bone health of people with osteoporosis or those at risk of suffering it. However, not all types of activities are osteogenic. For this population, it is not enough to recommend exercise but the type of exercise. Impact activities, resistance training and whole body vibration are feasible tools to prevent and treat the loss of bone quantity and quality; but it might be taken under consideration that these activities must reach a minimum threshold of frequency and intensity to produce the expected results.

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