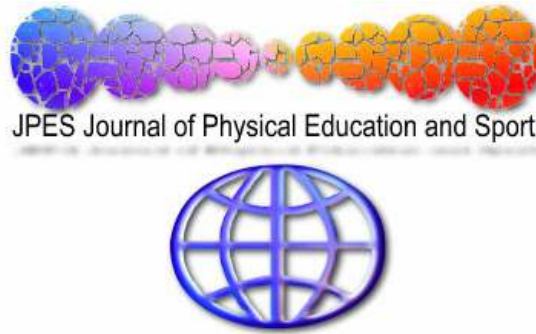




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ORIGINAL RESEARCH

THE ROLE OF HIGH - IMPACTS EXERCISES IN IMPROVE BONE MINERAL DENSITY IN POSTMENOPAUSAL WOMEN WITH OSTEOPENIA OR OSTEOPOROSIS

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ABSTRACT

Purpose - The aim of this study was to examine the effect of high - impacts exercises program based on weight-bearing and strengthening exercises in improve bone mineral density in postmenopausal women with osteopenia or osteoporosis.

Material and Methods – This study included 46 postmenopausal women with osteoporosis or osteopenia whose diagnoses were made by dual energy X-ray absorptiometry (DEXA) showing T-scores of less than -2.5 and in a range of -1 to -2.5, respectively, aged between 43 and 65 years. Subjects were divided into two groups, the experimental group (N=23) and the control group (N=23).

The experimental group followed a multiple therapy based on medication, a diet and exercises program (high - impacts exercises), while the control group was submitted only to diet and medication. Areal bone mineral density (BMD) and T-score was measured on the lumbar spine (L1–L4) with dual-energy X-ray absorptiometry – DEXA (Osteocore Medilink) at baseline and after 12 months of exercise.

Results - After 12 months of high-impact exercise intervention, both groups exhibited significant improvements in T-score (-0,79 vs -0,42 mean variation), and bone mineral density in lumbar spine (0,091g/cm² vs 0,042g/cm² ; p<0.001). But, the exercise group demonstrated a significant gain compared with the control group in T- score (30,3% vs 21,83%;) and Spine BMD (12,56% vs 6,25%).

In terms of changes after the treatment, a significant difference between the two groups was observed (p<0.001). The two groups differ significantly with respect to the differences between the mean (-1,84 vs -2,19; p<0.001 for T score and 0,816 vs 0,748; p<0.001) improvements obtained after the exercise program.

Conclusion - This study indicates that high-impact exercise is safe and effective in improving bone mineral density in the lumbar spine in postmenopausal women with osteopenia or osteoporosis. If done on a regular basis, this type of training may be an efficient, safe, and inexpensive way of preventing osteoporosis later in life.

Keywords: osteoporosis, endurance training, BMD

Introduction

Osteoporosis, the main chronic bone disorder, is determined by the progressive disruption of the microarchitecture of bone tissue, being declared by the OMS as the third issue of public health, coming after cardiovascular diseases and cancer. Osteoporosis is a frequent disease which generates numerous inferences, high costs (for individual, as well as for society) implying an early diagnosis and an efficient prophylactic treatment.

Osteoporosis is considered one of the most common skeletal disorders in elderly. The bone loss process can occur with no symptoms and the individual feels fine until a fracture occurs; therefore the attribute “silent” given to the disease. If untreated, it can lead to suffering, dysfunction, and death in the elderly population (Goldmann and Horowitz, 2000).

Repercussions of this disorder influence the whole body functionality. Due to its considerable complications (bone frailty, skeleton deformity, fractures) and disabilities, the individual's quality of life is seriously affected. The bone mineral density (BMD) is one of the main risk factors for osteoporotic fractures (Nigel Arden, 2006). The diminution of the bone mass generates bone frailty with an increased risk for fractures, but the incidence of fractures is not compulsory.

Strong body of evidence suggests the fact that, besides other therapies, namely, dietary therapy and medication, regular physical exercise may significantly reduce the impairment of the bone mass considering the age, and thus, it may prevent the occurrence of the moment when osteopenia clinically develops into significant osteoporosis (Qin L, et al, 2002, Villareal et al., (2003), Beck and Snow (2003) Hamilton, C.J., 2009). Moreover, physical exercise has an important role in maintaining or, even, increasing the bone mass, registering a more significant influence; physical exercise primarily facilitates the improvement of the muscular mass by enhancing its strength, balance and coordination, and has a major positive impact over stability and walking (Ilinca I, 2008).

According to the existing data in the field literature, it results that the recovery or prophylactic kinetic treatment, recommended to individuals already diagnosed with osteoporosis or those at high risk for developing this disease, is generally based on exercise programs meant to enhance strength which promotes bone health and exercises against gravitational forces (Kemmler, 2004).

From a physiological point of view, force training registers an important stimulating effect on a series of hormones in women, as well as in men. An analysis of Kraemer and Ratamess (Kraemer, W.J., Ratamess, N.A., 2005) article indicates the fact that this type of training promotes the release of testosterone and of increasing hormone, encouraging the use of certain variables specific to the exercise. These two hormones have an anabolic effect over the bone, and according to Christiansen, it enforces the valuation of endurance training over BMD (Christiansen, P., 2001).

Material and Methods

The study has been achieved on a group of 46 postmenopausal women diagnosed with osteoporosis or osteopenia based on densitometric criteria, aged between 43 and 65 years. Women presenting orthopedic or neurological disorders could not handle the exercise program. Subjects were divided into two groups, the experimental group (N=23) and the control group (N=23). The experimental group followed a multiple therapy based on medication, a diet and physical exercises, while the control group was submitted only to diet and medication.

The resistance training, undertaken by the experimental group, was performed twice a week and developed on a period of 12 month, under the close surveillance of a physical therapist. Each training session included stretching exercises, for improving joint mobility and trunk stability, and exercises for strengthening and toning paravertebral and abdominal muscles in order to increase the density of the osteoporotic spine and to innervate bone periosteum through physical exercises, which constitutes a stimulus for bone formation. Contraindicated movements, leading to an increased risk for osteoporotic fractures, were avoided, namely, forward excessive leaning of the head and trunk excessive flexion.

The program registered a total span of one hour, from which 10 minutes of warm up, 40 minutes for enhancing strength and 10 minutes of cool-down activities. The warm up exercises included static stretching for the superior part of the body followed by walking breathing exercises and easy running. The effective training part included strength exercises for the superior limbs using slight loads (1kg) from sitting and orthostatism, and calisthenics exercises from decubitus position and orthostatism for the abdominal and paravertebral muscles. Initially, during the adjustment period, under close surveillance, subjects performed each exercise 8 to 10 times with recovery pauses of 1 minute between the exercise sets, and subsequently, they registered an evolution rate which was about 12 to 15 times higher.

During the entire experiment period, all the 46 subjects used the same medication which included Fosamax, calcium supplement and vitamin D, and a diet rich in dairy products and vegetables. Nonexercising controls were asked to maintain their current lifestyle.

Bone loss was assessed through evaluation of the following two bone density parameters: BMD (expressed as g/cm^2); *T*-score (variation in relation to young adults; expressed as mean and standard deviation, SD);

Areal bone mineral density (BMD) and T-score was measured on the lumbar spine (L1–L4) with dual-energy X-ray absorptiometry – DEXA (Osteocore Medilink) at baseline and after 12 months of exercise (Fig. 1)

Results

The data are expressed as mean $\pm$ standard deviation and are presented in Table 1. The statistical analysis was performed using WINKS SDA 6.0.5. statistical package. Paired samples t-test was used to analyze the change from baseline within the groups.

The comparison between the baseline and outcome measurements was made using a paired-samples T-test. In Table 2, the calculate t shows that there are significant differences ($p < 0,001$) between the Experimental group and Control group for all measured parameters.

Characteristic	Experimental Group (N=23)	Control Group (N=23)
Age(years)	58,26 $\pm$ 6,39	59,04 $\pm$ 5,89
Years since menopause (years)	46,47 $\pm$ 6,40	48,13 $\pm$ 5,02
Weight (Kg)	59,21 $\pm$ 9,39	60,52 $\pm$ 8,19
Height (cm)	161,34 $\pm$ 5,54	162,69 $\pm$ 5,62
BMD –Lumbar bone mineral density (g/cm ²)	0,724 $\pm$ 0,06	0,703 $\pm$ 0,05
BMC (g)	37,35 $\pm$ 3,30	38,20 $\pm$ 2,84
T-score	-2,64 $\pm$ 0,06	-2,61 $\pm$ 0,4

Table 1 Characteristics of the Subjects that were included in the training program

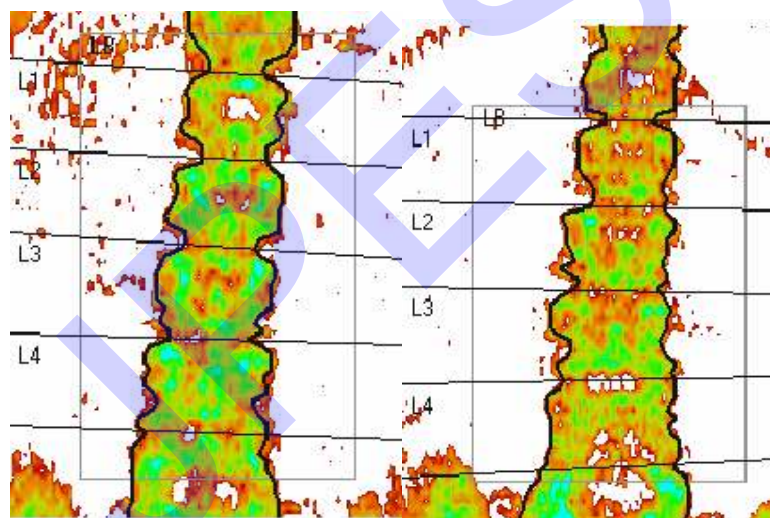


Fig 1. D.E.X.A. Bone Densitometry

	Experimental Group			Control group			P-value
	Baseline	At 12 Months	Variation mean	Baseline	At 12 Months	Variation mean	
T-score	-2,64 $\pm$ 1,1	-1,84 $\pm$ 0,3	-0,79 $\pm$ 1,01	-2,61 $\pm$ 0,4	-2,19 $\pm$ 0,4	-0,42 $\pm$ 0,1	0,001 (t=3,96)
BMD - Lumbar (g/cm²)	0,724 $\pm$ 0,06	0,816 $\pm$ 0,05	-0,091 $\pm$ 0,04	0,703 $\pm$ 0,05	0,748 $\pm$ 0,05	-0,044 $\pm$ 0,03	0,001 (t=5,73)

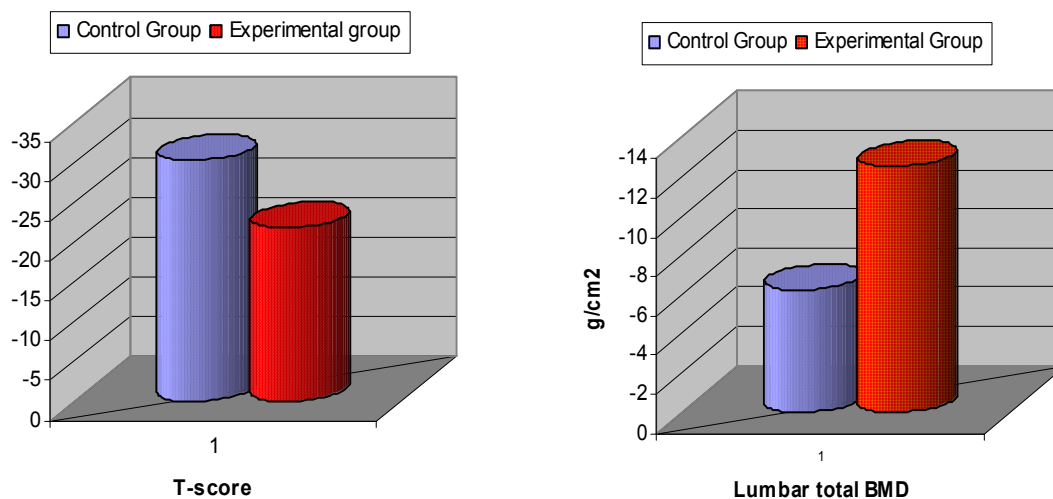
Table 2. Results of initial and final BMD and T-score of control and experimental group

Fig.2. Comparison (percentage) of variation of the *T- score* and *Lumbar total BMD* between the experimental and the control group

We analyzed the characteristics of the nonparticipants and found they did not differ from the study group (Table 1). The mean (SD) T- score for Experimental group at start was $-2,64 (1,10)$ and $0,724 (0,06)\text{g/cm}^2$ in spine BMD, and for control group was $-2,61 (0,04)$ and $0,703 (0,05)\text{g/cm}^2$. After 12 months of high-impact exercise intervention, both groups exhibited significant improvements in T-score ($-0,79$ vs $-0,42$ mean variation), and bone mineral density in lumbar spine ($0,091\text{g/cm}^2$ vs $0,042\text{g/cm}^2$; $p < 0.001$, Table 2). But, the exercise group demonstrated a significant gain compared with the control group in T- score ($30,3\%$ vs $21,83\%$) and Spine BMD ($12,56\%$ vs $6,25\%$) (Fig. 2.).

In terms of changes after the treatment, a significant difference between the two groups was observed ($p < 0.001$; Table 2). The two groups differ significantly with respect to the differences between the mean ($-1,84$ vs $-2,19$; $p < 0.001$ for T score and $0,816$ vs $0,748$; $p < 0.001$) improvements obtained after the exercise program.

Discussion

There is a series of available methods meant to determine the individual's bone density, but presently, the most popular method is called DEXA (Dual Energy X-ray Absorptiometry) which allows the measuring of bone mineral density at the level of the lumbar spine, femur and forearm bones. The achieved values revealed by the measuring are compared to statistical average values of bone density within a population of young healthy individuals of the same sex. The result is expressed as T-score which indicates the difference between the real calculated value and the reference value determined by the population chosen as "witness".

Several researchers have studied the possibilities of improving bone density in osteoporotic women. For example, Crilly and collaborators have analyzed the reaction of bone density to medication for periods of 6 and 12 months, observing an increase of BMD during both periods of time, concluding, thus, the fact that determining the efficiency of the treatment of imaging the lumbar vertebra with DEXA is plenty enough (Crilly RG, et al., 2000). Yamazaki et al has emphasized the effects of exercise program on BMD, using the DEXA after a period of 6 months (Yamazaki S, Ichimura S, 2004).

The present study proposes this method for the evaluation of bone density and calculation of T-score in the case of postmenopausal women with osteopenia or osteoporosis in order to determine the role of high - impact exercises for improving the two parameters already mentioned. BMD rating has been repeated to an interval of 12 months in order to investigate the progress of experimental group.

As a result of the analysis of the evolution registered by the two groups involved, we have noticed that after 12 months of regular high-impact exercise, the experimental group, as well as the control group, have manifested a significant increase of the BMD and T score ($p < 0.001$), although, the progress of the exercise group registered a higher value reflected by a variation mean of $-0,79$ compared to $-0,42$, for T score and a variation mean of $-0,091\text{g/cm}^2$ versus $-0,044\text{g/cm}$ for BMD. The greatest difference in variation between the two groups was found in both T-score ($-1,84$ vs $-2,19$; $p < 0.001$) and BMD ($0,816$ vs $0,748$; $p < 0.001$).

Our research outcomes fit in with previous randomized controlled high-impact exercise interventions in pre and postmenopausal women. According to a recent meta-analysis, having as topics the effects of strength training on BMD of the femur, lumbar spine and radius in women, the resistance training appeared to be an effective means of maintaining BMD in the lumbar spine for women of all age groups (Häkkinen, A., et al, 2000). Sinaki and colleagues reported in their 3-year randomized controlled trial of dose-specific loading and strengthening exercises that lumbar spine BMD improved at 1 year with increased levels of exercise in the subjects who had lower BMD initially (Sinaki, M., et al, 1996).

Other studies oriented on pre and postmenopausal women have revealed the fact that a regular and continuous attendance to strength exercise programs (weight transfer and strengthening exercises), on long term, contributes in a positive manner to the improvement of BMD of lumbar vertebrae, femur neck and trochanter.

Another research including a number of 15 studies has indicated the fact that aerobic exercises, as well as, load-bearing exercises, had a positive impact on the lumbar spine mass in post-menopausal women (1.6% bone loss prevented vs. 1% bone loss prevented respectively) (Wallace, B.,A., Cumming, R.,G., 2000).

As a result of the application of our exercise program, significant progresses have been achieved within the experimental group, as well as the control group. Therefore, we may conclude that, regardless of the osteoporosis stage, the exercises training registers important improvements.

Conclusion

In conclusion, this study indicates that high-impact exercise is safe and effective in improving bone mineral density in the lumbar spine in postmenopausal women with osteopenia or osteoporosis. If done on a regular basis, this type of training may be an efficient, safe, and inexpensive way of preventing osteoporosis later in life. For this reason, the exercise program must be incorporated into a lifestyle change and be lifelong due to the chronic nature of bone loss in older women.

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