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# Bone mineral density in osteopenic early postmenopausal women practicing Pilates gymnastic for six years

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**Abstract.** Osteoporosis has a negative impact on health and is very frequent in women after menopause. Regular physical activity (PA) is known to reduce the bone loss associated with ageing across the lifespan. Aims: There are two aims of this study: (1) to compare the BMD values of an active female group at the end of the 5-th year with those at the end of 6-th year; (2) to compare the mineral bone density (BMD) in early menopausal women (50-65y), who followed a PA program twice a week, for 6 years with that of a similar group, who have not done any regular PA. Methods: 22 women recently entered menopause (56.53± 6.3 years, BMI 21.11±4.98 kg/m<sup>2</sup>) who have participated for 5 years the Pilates type fitness program, (60 minutes, 2x/week) formed the active group (AG), and the sedentary group (SG) - 25 women (56.98±3.40 years, BMI 22.4±4.8kg/m<sup>2</sup>) with a sedentary lifestyle. Both groups underwent calcaneal ultrasound measurement with OsteoSysSonost 3000 device. Results: The bone parameters of the experimental group were the same, or have not changed significantly in the last year of physical activity. At follow-up (the end of the 6-th year) the bone parameters of AG and SG have generated significant differences favouring the active group (p<0.01). Conclusions: A Pilates fitness program of 12 months had not an impact on the BMD values of women in menopause, but BMD values did not decrease as expected in women of this age. Regular physical activity practiced over a six years period has led to greater BMD values for active early menopausal women than their sedentary peers.

**Keywords:** bone mineral density, physical activity, early postmenopausal women, Pilates, osteoporosis prevention

## **Introduction**

Osteoporosis is one of the greatest challenges for a woman during menopause, and it usually starts after 3 or 5 years from the last menstrual cycle. It affects about 25-44% of women (Czeczuk et al., 2012). Women are most likely to be exposed to osteoporosis especially after menopause. The average age for reaching menopause in Europe is 50 years. Menopause is defined as a natural age-related decrease and, finally loss of ovarian estrogen production and secretion which affects the balance between the osteoclastic and osteoblastic activity. Demineralization happens at the vertebra level regardless of gender (Hăulică, 1999). The absence of estrogen hormones may provoke a rapid degradation of the cardiorespiratory fitness and muscular strength, BMD, weight gain all of which leads to an increased risk of chronic diseases (cardio-vascular, type 2 diabetes, osteoporosis, especially in those leading a sedentary lifestyle (Sowers & La Pietra, 1995).

Therefore, early post menopause (50 to 60 years of age) is an important phase in a woman's life with many risks, especially for physically inactive women.

Regularly physical activity practice represents a stress to the skeletal system and is crucial for reducing chances of osteoporosis especially in older people. Repetitive bone stress increases the bone density and lead to fluid and ion flows inside the bone channels, stimulating the bone mass, and regular moderate physical activity, contribute to increase bone density (Antonescu, 2006).

The strategy of decreasing the bone loss includes increasing and accumulating bone density during growth, optimizing the accumulation of bone density, maintaining the integrity of the skeletal system during adulthood and minimizing the loss of bone density after the age of 50 or post menopause<sup>1</sup>.

There are a lot of correlations between gaining bone density and physical activity (Vella, 2014). Research was also done on athletes practicing volleyball, basketball, gymnastics and an increase in bone density was noticed due to practicing regular physical activity (Nickols-Richardson & O'Connor, 1999). Effects of physical activity on bone density are higher on female athletes who practice gymnastics than on those who practice swimming (Courteix et al., 1998).

There is a direct relation between bone mineral density, fitness and menopause (Hansen & Tucker, 2015). Positive results were noticed in female bones during menopause, especially at hip level, when practicing physical activity, mainly jumps (Zhao et al., 2016). Women with low bone mass at their peak period of bone loss (5 years' post-menopause) who exercised ( $\geq 2$  high intensity exercise sessions per week and  $< 2$  sessions per week) improved their bone strength comparing with sedentary women (Bilek et al., 2016).

Studies have shown that early post-menopausal women are trainable in terms of health related fitness, and they really need exercise for their health (Asikaine et al., 2004; Nurten et al., 2012), and BMD (Cheng et al., 1991), but there is not a lot of research showing the benefits of Pilates physical activity on bone density in this category of women. It was demonstrated that moderate physical activity, at least 30 minutes, five times a week, practiced for a longer period of time, is beneficial for bone health in menopausal women (Wee et al., 2013).

Physical therapy interventions for individuals with osteoporosis, or even osteopenia, should include: weight-bearing exercises, flexibility exercise, strengthening exercise, postural exercise, and balance exercise (Ille, 2011).

Pilates is "a system of exercises using special apparatus, designed to improve physical strength, flexibility, and posture, and enhance mental awareness"<sup>2</sup>. Therefore, because it fulfils all these recommendations for osteoporosis, we choose to use Pilates method in order to prevent the bone demineralization of osteopenic early postmenopausal women.

### **Aims**

The first aim of our study was to compare BMD values in a group of healthy women, early post-menopausal between 50-65 years old, who followed a Pilates fitness program – 60 minutes, twice a week, for 6 years (AG) measured at baseline (the end of the 5-th year of training) with those measured at follow-up (at the end of the 6-th year of training).

Secondly, we aimed to compare the BMD of the active group (AG) with that of a similar group of women with the same characteristics but who have not practiced regular physical activity for 6 years – sedentary group (SG).

### **Material and methods**

#### **Subjects**

The subjects of our study are 22 healthy women, early post-menopausal (2-10 years), mean age of  $56.53 \pm 6.3$  years, BMI  $21.11 \pm 4.98$  kg/m<sup>2</sup>, who have practiced a Pilates fitness program, for 5 years (60 minutes, 2 times a week). They gave their written consent to undertake the bone quality measurements with the OsteoSysSonost 3000 device. Moreover they were asked to consent to continue their Pilates fitness routine, for the following year, on the same schedule. After one year, the final evaluation took place, but only 15 women have met the criteria of 85% attendance and were included in AG. The sedentary group was formed of 25 women with the same characteristics ( $56.98 \pm 3.40$  years old, BMI  $22.4 \pm 4.8$  kg/m<sup>2</sup>). The selection criterion besides age and BMI was the lack of regular physical activity practice during the last six years and no chronic diseases. During the same week the sedentary women were as well tested with the same device.

#### **Assessments**

Low calcaneal ultrasound measurements (quantitative ultrasound, QUS) were done with the heel QUS ultrasound (Achilles Insight, GE, Lunar Corporation, Madison, WI, USA) (figure 1). The ultrasonometer bone characteristics measured were: Broadband Ultrasound Attenuation (BUA), Speed of Sound (SOS) and Stiffness Index (SI) (Ștef, 2015). Measurements were done on the dominant leg of each participant. Measurement reproducibility was set at 1.6% for BUA and 0.4% for SOS. Calculations were done on 10 subjects with systematic repositioning after every measurement. All ultrasound measurements were performed by the same operator. Identification for every subject was inserted into the machine. Echography gel was applied on the heel of every subject and the leg was placed in the device for accurate testing.



Figure 1. Achilles Insight, GE, Lunar Corporation, Madison, WI, USA  
([http://www3.gehealthcare.com/en/products/categories/bone\\_health/quantitative\\_ultrasound/achilles](http://www3.gehealthcare.com/en/products/categories/bone_health/quantitative_ultrasound/achilles))

**Anthropometric measurements** were taken according to the standard procedures described by the International Society for the Advancement of Kinanthropometry: ISAK (Marfell-Jones, 2006).

Subjects participating in the active group were measured at baseline and follow-up: height, weight, abdomen, and right thigh perimeters. Height was measured with a stadiometer, the vertical pole touching the heels, the butt channel and the spine between the shoulder blades, to the nearest 0.1 cm. The weight was measured with the same analogue scale, to the nearest 0.1 kg. The scale was checked before measurements were taken (at baseline and follow-up). Perimeters were measured with the measuring tape in the following areas: abdomen (in the narrowest area between the lowest part of the ribcage and the highest part of the iliac crest, on the midaxillary line, with a horizontal metric tape); thigh (at the half point between the knee and the inguinal area); shank (in the most voluminous area). BMI was measured using the well known formula  $G/T^2$  ( $\text{kg}/\text{m}^2$ ). Body fatness of participants was classified according to WHO standards: Underweight ( $\text{BMI} < 18.5 \text{ kg}/\text{m}^2$ ;  $\leq 16.00$  Moderate thinness  $< 16.99$ ;  $17.00 \leq$  Mild thinness  $< 18.49$ ), Normal ( $18.5 \text{ kg}/\text{m}^2 \leq \text{BMI} < 25 \text{ kg}/\text{m}^2$ ), Overweight ( $25 \text{ kg}/\text{m}^2 \leq \text{BMI} < 30 \text{ kg}/\text{m}^2$ ;  $25.00 \leq$  Pre-obese  $< 27.49$ ), and Obese ( $\text{BMI} \geq 30 \text{ kg}/\text{m}^2$ )<sup>4</sup>.

**The training program** aimed to increase the muscular strength and endurance of the postural muscles and those of the limbs. It also aimed to improve flexibility, posture and control. The general structure of the lessons followed the classic pattern: warm up, for about 15-20 minutes, with callisthenic exercises, for the major segments and muscle groups, the work-out lasted 30-35 minutes, was based on strengthening exercises focusing on the core muscles of the abdominal-lumbar-pelvic area based on Pilates principles: co-contraction exercises in elongation of the main postural muscles, using the body weight and various objects: large balls, medicinal balls of 2 kg, 1-2 kg weights, elastic bands. The third part, cooling down exercises (5-15 minutes) consisted on stretching exercises for the trained muscular groups.

**Statistic analysis** included descriptive statistics (the average and standard) for all anthropometric parameters. Data was arranged based on initial and final measurements. The statistical analysis of the variation of the bone and anthropometric parameters was done using ANOVA with multiple measurements (initial and after 12 months). The statistical significance was set at  $p < 0.05$ . SPSS 10.1 was used to statistically analyze the data.

## Results

All final results of the anthropometric parameters have slightly improved, but not significantly compared to the initial measurements in the AG (table 1). In the same group baseline T score (-2.29) indicates osteopenia (table 1). After one year, T score decreased (-2.27) but not significantly (table 2) and still indicates the presence of osteopenia, but none of the subjects has osteoporosis. A BMD measurement made at the same moment for sedentary women indicates the presence of osteoporosis for the whole group (T score = -2.79) (table 2). Bone density in active and sedentary groups measured at the end of the experiment showed significant difference in favour of the group that participated in physical activity for 6 years compared with the sedentary one ( $p < 0.01$ ).

Table 1. Characteristics, anthropometric values and bone mineral density of subjects of the active group, at baseline and follow-up.

Charactristics	Baseline (after 5 y of PA)	Follow-up (after 6 y of PA)	p value
Age ( years)	56.53±6.3	-	-
Height (m)	1.69±0.007	-	-
Weight (kg)	60.5±13.4	60.4±12.7	ns
Thigh circumference (cm)	55.8±5.6	56±7.07	ns
Abdominal circumference (cm)	84.8±5.6	84.6±4.24	ns
Body Mass index (kg/m <sup>2</sup> )	21.11±4.98	21.09±4.73	ns
BMD - T score	-2.29±0.47	-2.27±0.55	ns

Table 2. Bone mineral density measured at the end of the 6 years training – T score of the two groups, active and sedentary and the statistic difference between the two mean values.

Bone parameters	Active Group n=15	Sedentary Group n=25	p value
T score	-2.27±0.55	-2.79±0.55	0.001

## Discussion

There are no significant differences on a morphologic level at the end of the 12 month training program. All the subjects were in the normal weight category. As studies shows, the physical exercise has minimal impact on the form and body composition on women who recently entered menopause (Ready et al., 1996).

*BMD - Active group - initial versus final results*

No BMD evaluation was done for the subjects from active group before the 5-th year of PA training. This first measurement of BMD revealed the presence of osteopenia. The follow-up measurements were done one year later, because it is known that at least 12 months of physical training are necessary in order BMD improvements to appear.

After a year of regular physical activity, there were little improvements of the bone parameters in the active group. But it should be noted when looking in the individual values, that they did not worsen from initial measurements to the final ones. Slight improvements or, at worst, stagnation are encouraging results, considering that the normal decline in people of this age group is of 0.3-0.5% every year (Tanna, 2005). Therefore, we could attribute the slowing down in the bone density loss of the women in EG to the regular participation in physical activity over 12 months. Moreover, it is shown that postmenopausal sedentary women could benefit from 30 minutes of walking every day, and a muscular endurance and strengthening program twice a week, with warming up and cooling down the body through stretching, with weight preservation, maintaining the bone mineral density and increasing muscle strength (Asikainen et al., 2004). Therefore, even though BMI, weight and other anthropometrical measurements did not changed after one year of physical training the results are considered beneficial for the health of these subjects, since worsening would have been expected according to physiological data.

#### *Active group versus sedentary group*

The bone parameters of the group that has been regularly participating in a Pilate's fitness program for over 6 years were significantly higher than those in the sedentary group, even though AG presented with osteopenia and SG with osteoporosis. Moreover, Angin et al., 2015, showed a significant increase in BMD values of menopausal women with osteoporosis who underwent a Pilate's program ( $p < 0.05$ ), while BMD decreased in the control group ( $p < 0.05$ ) who did not Pilates. This is partial true in our study, since the increase of BMD values was not significant in the training group. Anyway, we can conclude that in our study as well, the difference between the active (Pilates) group and sedentary group in terms of bone quality is caused by the first group being involved in a physical activity for over 6 years.

Rianon et al., 2012 concluded in a study made on 2682 women that lifelong physical activity with continuation into old age ( $\geq 65$  years) best maintains better bone health in the elderly. Other 16 years follow-up study (Kemmler et al., 2016) on early-postmenopausal females with osteopenia found that the minimum effective dose of exercise that relevantly addresses BMD averaged around two sessions/week, which indicates that even when applying high impact/high intensity programs, exercise frequency and its maintenance play a key role in bone adaptation. Our results sustain the findings of the two mentioned studies and considering their results, we could conclude that sedentary and active perimenopausal women should be encouraged to engage in-, respective to continue with- regular lifelong PA.

## Conclusions

Regular participation in a physical activity for over 6 years has led to greater BMD values in women who have kept active over the years compared to the sedentary ones.

Participating in Pilates fitness program, for 12 months has not significantly improved the BMD values in early post-menopausal osteopenic women, but they have also not decreased as it would have otherwise been expected at this age.

Regular practice of Pilates Exercises in osteopenic early post-menopausal women over six years is effective to slow down the natural decrease of BMD, and consequently to prevent osteoporosis. Physical educators, fitness trainers, physiotherapist can use Pilates Exercises for preventing osteoporosis in early post-menopausal women, or even earlier.

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