Physiological Effects of Exercise Program on the Bone Mineral Density in Sedentary Saudi Arabian Females
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Summary

Osteoporosis is a widespread disorder, which affects postmenopausal women, causing fractures after simple trauma. The overall expenditure to treat such injuries is draining the economy of the developing world. Earlier studies on Saudi Women have shown that their Bone Mineral Density (BMD) was much lower in comparison to the western standards.

Exercise is long being known to reduce the risk of osteoporosis. A prospective study was carried out at King Faisal University, King Fahd Hospital of the University, Al-Khobar, Saudi Arabia to scientifically to assess the effect of exercise in sedentary Saudi Women.

The study was carried out in 100 women with clearly defined criteria of inclusion in the study. The data of height, weight, abdomen, and thigh girth was measured pre and post exercise. The age range was 28-50 years (mean 39 years). They were randomly divided into groups. Both groups had BMD measurement of the lumbar spine and hip region before the start of the study. One group was subjected to a structured exercise program within the hospital confines, three times a week for two months. At the end of the two months the measurements were repeated.

The results indicate that there was statistical significant gain in the BMD measurement of women who had exercise as compared to the women who did not exercise. We believe it is advisable for Saudi women who are sedentary to participate in some type of exercise so as to reduce the risk of osteoporosis and osteoporosis related fractures.

Keywords: Osteoporosis  Bone Mineral Density  Exercise.
**Introduction:**

Osteoporosis has now become a major health care problem in the world and the World Health Organization (WHO) believes that we are heading for a major epidemic the years to come. Peck (1990) that osteoporosis afflicts over 24 million people in US alone costing them $10 billion and accounts to over 300,000 hip fractures alone. It was estimated that in the years to come 20,000 to 30,000 fresh cases would be added yearly to the existing ones. Researchers and policymakers have long since placed emphasis on preventing or slowing down the process of osteoporosis.

It is long known that regular exercise can be used as a preventive method for osteoporosis. This was suggested because any weight bearing of the bones increase bone turn over thereby increases the bone deposition. Walking is frequently advised as a way to help protect against loss of bone density. Compared to other exercises it is the most safest and beneficial. The impact of walking and how much to do it has not been established with clarity. Preservation of spinal trabecular bone has now been established due to walking (Nelson et al 1991). Exercise as a method of reducing osteoporosis was not given its due importance and other prophylactic interventions were studied at length. The potential ability of exercise to building bone mass and reduction of bone loss had enough appeal but had less optimism among the study groups to study and potentiate the effect of exercise on osteoporosis. It is known since long that the attainment of peak bone mass depend 80% on the genetic factors (Valamaki et al 1994), whereas 20% it depends on the environmental factors such as exercise, other habits and calcium intake (Johnston et al 1992). It was this 20% the researchers have trying to influence by various methods so that maximum peak bone mass can be achieved so that the loss of
bone mass during lifetime is reduced. Chesnut (1993) after his review stated that the controversy which existed then about the role of exercise in the prevention of osteoporosis. Even as early as 1986, Margulies et al showed the affect of exercise on osteoporosis. Marcus (2001) and Chien et al (2000) has conclusively showed the beneficial effect of exercise on osteoporosis. Schapira (1988) after following women with a program of dynamic loading exercises of the distal forearm (tension, torsion, compression and bending) applied three times a week for 5 months in 14 postmenopausal women showed a n increase of around 4% in the mean bone mineral density. Cavanaugh and Cann (1988) did not find any benefit on bone mineral density due to walking.

Studies have shown that Bone Mineral Density (BMD) measurements are an important predictor of skeletal injury (NIH Consensus 2001, Johnell et al 1993, Ross et al 1991). Iwamoto et al (1998) and Silmon et al (1997) came to the conclusion that increased in the physical activity can actually increase the BMD even in postmenopausal osteoporotic women. The exercise needs to be weight bearing as non-weight bearing exercise has no or little benefit and loss of bone mass occurs at the axial and appendicular skeleton (Krolner et al 1993, Drinkwater 1993).

Forwood and Larsen (2000) came to the conclusion along with the dietary calcium exercise does play a major role in the reduction of osteoporotic relation fractures in later life and should be regarded as the part of strategy to reduce osteoporosis. Swezy et al (2000) further went upto confirm that a 10-minute daily isometric progressive resistive
exercise is an adequate stimulus for enhancement of bone formation.

Few studies have been conducted in the Kingdom the relation of exercise and osteoporosis which can be measured by BMD. The objective of this prospective study is to assess the physiological effects of exercise program on bone mineral density of sedentary people of eastern Saudi Arabia. Secondly to assess the effect of exercise on the total fat content of the body.
Methodology

One-hundred Saudi females who are healthy, married or previously married and living in the eastern Saudi Arabia (Dammam and Al-Khobar) formed the study group. The inclusion criteria as accepted was as follows:

1. Married or previously married women in the age bracket of 35-49 years.
2. Should have no disease or on hormonal therapy.
4. Sedentary life style at least for the last year.
5. Not on a diet.
6. Permanent resident of eastern province of Saudi Arabia.

The study sample of 50 females were subjected to exercise program under the supervision of the investigators twice a week for 12 weeks. Pre and post exercise BMD measurement of the lumbar spine and the hip region before and after the study was completed.

All the members in the study group had the following measurements such as height, weight, body circumference (arm, abdomen, buttock and thigh), blood pressure measurements, serum cholesterol levels, HDL, LDL and fasting blood sugar levels. Obesity status was determined by using Body Mass Index (BMI), calculated using the formula BMI= Weight in Kilograms/height in square meters). All 100 females were subjected to body fat analyzer to measure total fat in kilogram, lean percent, lean in kilogram, basal metabolic rate, water content in liters and the target weight.
The Exercise Schedule:

The exercise program included two main activities; Non-walking activities and walking activities. In the non-walking activity consisted stretching exercises, quadriceps strengthening and breathing exercises. The walking activity included warming-up phase for 5 minutes at normal walking speed at 1.5 km/hour, working-out phase of brisk walk for 20 minutes at 3 km/hour and cooling-down phase for 5 minutes with the return at 1.5 km/hour.

The data was subjected to analysis to achieve Ch-Square, paired t-test for assess the change in body weight, BMI, cholesterol levels, fasting blood sugar levels, HDL, LDL before and after the exercise intervention. Multiple linear regression was used to find the important factors affecting the changes in BMI and Bone mineral density. Comparison among the groups with respect to changes of quantitative variables by ANOVA/Kruskal Wallis test. The final level of significance was accepted as <0.05 throughout the study.
Results

The average age of the subjects studied was 39.0 years (range 27.5 - 50 years). Table 1 give the details of the age distribution. The mean bone mineral density (BMD) of the lumbar spine prior to exercise was 1.15 gm/cm² with a range of 0.94 gm/cm² and 1.50 gm/cm² (Table II) and after exercise the same was 1.2 gm/cm² (range 0.95 and 1.88 gm/cm²) (Table III) with statistical significance of p Value < 0.0001. The BMD of the hip region had increased post exercise from the mean of 1.0653 gm/cm² to 1.1346 gm/cm² with significance of p < 0.0001 (Table IV and V). The exercise made a significant gain in the lumbar spine as compared to the hip region of 1.2364 gm/cm² to 1.1346 gm/cm². The mean BMD of the lumbar spine in women with more than 5 children was 1.2 gm/cm² as compared to the women with less than 5 children was 1.1 gm/cm². There was statistical significance of p Value < 0.05. Similar was the result of BMD of the hip region between both the groups.

The other parameters which were tested and proved significant are given in table VI. The Body Composition Test (BCT) indicated that after exercise the mean body fat reduced by 2.36%, total body water reduced by 0.82 liters, total weight reduced by 1.69 kilograms and the lean body weight increased by 0.43 kilograms.

The overall age and sex matched BMD showed that the Saudi women had significantly lower BMD as compared to the western women of the same age p Value 0.0001.
Discussion:

Osteoporosis is defined as low bone mineral density due to decline in bone mass per unit volume. Osteoporosis results from a complex interaction between the diet, climate, and physical exercise. It appears all these three factors stay neglected among the Saudi Arabian population. In spite of the development in the diagnosis of osteoporosis by measuring bone mineral density still the preventive measures of osteoporosis is neglected. Patients are treated for the condition late rather than preventing osteoporosis in the initial phases itself. The report of Sadat-Ali et al (1993) reported on the basis of plain radiographs that 89 percent of their patients were osteoporotic even though plane radiographs indicate osteoporosis once 30 percent of the body bone is lost. Succeeding reports further confirmed that in fact the BMD of the postmenopausal women was much lower as compared to the international standards (El-Desouki et al 1991, Sadat-Ali et al 1996 and El-Desouki et al 1995).

Many research reports have convincingly shown the effect of exercise is effective in maintaining and increasing the BMD. Prospective studies have shown that the low bone density is an important predictor of fracture risk (Malmors et al 1998). Bone mass in the middle age is determined by peak bone mass at maturity and subsequent age related rate of bone loss. Physical activity is associated with an increased bone mass and thus reducing the risk of fractures. Krall and Dawson-Hughes (1994) showed that walking over 7.5 miles weekly increases the BMD. Previously many retrospective studies confirmed the benefits of physical exercise but this study being a prospective one and in the same subjects have shown beyond doubt that exercise does increase the BMD and slows down the bone loss. Valimaki et al (1994) concluded that regular exercise and non-smoking is important in reaching maximal peak bone mass in young adults. The National Institute of Health Consensus Development Panel on
Osteoporosis, Prevention and Therapy (2001) suggested that regular exercise can contribute to development of high peak bone mass and may reduce fractures in older women.

Exercise if overdone can be harmful hence understanding the relationship between stress and strain is critical in the to get the full potential benefits of the exercise. Kerr et al (2001) studied the effect of exercise and calcium supplementation for 2 years and noted the positive difference of BMD at the hip region. Our study confirms the positive effect on the BMD but it was more pronounced on the lumbar spine than the hip region. It is possible that the younger the study

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All the exercises are not good for the human body. The degree and the extent of any exercise should be adapted to the age, the physical ability and the skeletal condition of the individual. In young people, sporting activities are beneficial in storing up a bone reserve and should be encouraged. Along with the exercise children should be advised to take oral calcium as well to build up the skeletal mass. In young women strenuous exercise could be harmful by causing amenorrhoea, decrease in body weight. It is also noted that in these women low estrogen secretion could reduce the axial bone density.

Zylstra et al (1989) reported that the BMD of the lumbar spine and the femoral neck correlated with hours of physical walk, but some reports on the BMD and lumbar spine were conflicting (Nelson et al 1991, Cavanaugh and Cann 1989). Our study indicates that the gain of BMD at the lumbar spine was much more than the femoral neck. It was recognized that vigorous activity can confer benefit on BMD, but the specific type of the exercise remained controversial. Gutin and Kasper (1992) suggested that the magnitude of the strain produced by strength training and weight bearing aerobic activities, appeared to be critical rather than the number of loading cycles. In our patients a simple 30 minutes exercise of walking at 1.5km/hour was enough to positively change the BMD.

Despite numerous studies and case reports of the changes which occur during pregnancy and lactation, controversy existed whether pregnancy made a positive impact on the BMD. The role of pregnancy and gain of BMD have not been elucidated in depth. Sadat-Ali et al (1996) reported a difference of BMD in women who had borne less than five and more than five
children. Recently Cure-Cure et al (2002) arrived to a conclusion after studying 1855 multiparous women came to the conclusion that the repeated pregnancies appear to have a protective factor against the development of osteoporosis. In this study The BMD of women who had more than 5 children was better than in those less than 5 children.
Conclusions:

This prospective study confirms the following:

1. The average bone mineral density of the Saudi Arabian women is much lower than.

2. The age and sex matched with the group from other countries shows that the BMD is lower as compared to global standards.

3. There was a statistical significance between the post and pre-exercise groups.

4. Apart from the BMD, after the programmed exercises, women reduced weight, increased their metabolic rate and reduced the fat content of the body.

5. Women with more than 5 children had better BMD than those with less than 5 children.
References:


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<tr>
<th>Parameter</th>
<th>Pre-Exercise</th>
<th>Post-Exercise</th>
<th>pValue</th>
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<tr>
<td>Body Fat</td>
<td>26.60</td>
<td>24.24</td>
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<td>Total Body Water</td>
<td>35.72</td>
<td>34.90</td>
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<td>Total Weight</td>
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<td>74.65</td>
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<td>51.25</td>
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<td>BMD Lumbar Spine</td>
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<td>1.24</td>
<td>&lt;0.001</td>
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<tr>
<td>BMD Hip</td>
<td>1.06</td>
<td>1.13</td>
<td>&lt;0.001</td>
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