Effects of Exercise Training on Bone Mineral Density of Different Aged Postmenopausal Women in India

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Abstract:

Introduction: 90 postmenopausal women with low bone mineral density (BMD) were randomized to physical training or control group. After 12 weeks the BMD was significantly higher in the women in the physical training group. The results indicate a positive effect of physical training on BMD in postmenopausal women with low BMD. The aim of the study was to determine the impact of multipurpose exercise training on bone mineral density, in postmenopausal women with low BMD. Also to observe the age wise changes in BMD after the exercise training.

Methods: 90 postmenopausal women 45 to 65 years of age with T-scores were ≤−1 randomized to either a physical training or control group. Training included three fast 30-minute walks and three sessions of one-hour training per week. Bone mineral density (BMD) was measured at baseline and after 12 weeks.

Results: After 12 weeks, significant differences between EG and CG was observed for the BMD. The F-value of BMD (14.564), BMI (16.78), and Weight (23.24) two groups (Exercise and Control) during post-testing. Since the p-value for the F-value was 0.001, 0.001, 0.000 respectively. This study also revealed that the maximum improvement (12.06%) in BMD was observed in 61-65 years of age range of postmenopausal women.

Conclusions: The results indicate that there was a positive effect of physical exercise on BMD in postmenopausal women with low BMD.

Keywords: Bone mineral density, Exercise training, Osteoporosis, Postmenopausal women

Introduction

Fractures due to skeletal fragility in elderly people are an increasing public health issue worldwide, and the already devastating medical and social costs can be expected to increase unless effective prevention and treatment regimens are developed. Hip fracture is the most severe complication of osteoporosis, placing the greatest demand on resources and having the greatest impact on patients because of increased mortality, long-term disability and loss of independence [1, 2]. Exercise has been shown to be essential for maximizing peak bone mass and reducing subsequent bone loss [3]. In premenopausal women, high-impact exercise has been suggested to be the most effective regimen, and it has been suggested that induced gain is maintained after intervention [4]. The prevalence of osteoporosis increases with age. The dramatic increase in hip fractures during the last few decades, however, cannot be fully explained by an increase in the number of elderly in the population alone, but may well be due to an increasingly sedentary lifestyle [5]. The fact that mechanical loading is important for bone mineral density (BMD) has been shown in
animal studies [6–8]. A drastic reduction in the physical activity of an individual will lead to a rapid and substantial decrease in bone mineral density and bone strength. This has been firmly shown in studies on astronauts spending months in zero gravity [9].

Material and methods
The Institutional review board of dept. of physical education, Visva-Bharati approved this prospective randomized controlled study. Screened postmenopausal women 45 to 90 years of age were enrolled in the study.

Questionnaire:
A detailed baseline questionnaire completed by the participants in both the EG and CG combined several parts: 1) overall health status 2) frequency and intensity of pain at various skeletal sites, 3) pre-study physical activity and exercise levels, and 4) osteoporotic risk factors including falls. Menopause was defined as one year after the last menstruation. The women were eligible if they had a BMD T-score of ≤−1 and willing to participate in the training. The women were excluded if they had any disease known to interfere with health risks or were already training at the level of or above that of the intervention. This number defined which group the subject was randomized to, by use of a predefined random number table. There were 45 subjects in the exercise group (EG) and 45 in the control group (CG). Participants in the CG were requested to continue their usual lifestyle, whereas participants in the EG underwent the training outlined below.

Group Exercise Session
The joint exercise session lasted approximately 65–70 min and was subdivided into four sequences: 1) warm-up and endurance, 2) Free hand exercises 3) strength training, and 4) stretching. Warm-up/endurance sequence. The group training session started with 10 min of running, stair climbing and gaming to promote unusual strain distributions under weight-bearing conditions. Then 10 min of aerobic exercises with a progressively increasing amount of high impact concluded this sequence. Heart rate (HRmax) ranged from 60 to 70% during the sequence. Free hand exercise was introduced four sets of different body segments with 15 repetitions were performed. Strength-training sequence. A major emphasis was placed on strength training. Training sessions was carried out using resistance elastic bands. All main muscle groups were trained (13 exercises). At the start of the study, high-volume resistance training with gradually increasing intensity (beginning at 50% one-repetition maximum (1RM) and 20 repetitions) was performed. After 6–7 weeks and exercising at 70% 1RM, this protocol was changed; 12 wk of high-intensity training were performed. A standardized stretching program (8–10 exercises with 1–2 sets and 30s of passive stretching) was performed before the strength complex and during the rest periods of the strength-training sessions.

Baseline and 12 week Measurements
Anthropometric measurements
Height was measured in the upright position to the nearest millimeter (0.1cm) with a stadiometer. Body mass (weight), was measured to the nearest 0.1kg using digital scale.

BMD
BMD was measured by ultrasound bone densitometry at distal radius. Quantitative ultrasound (QUS) was measured (Omnisense) using the standard protocol.

Statistics
Descriptive statistics, and Analysis of co-variance test were used. Significance was set at p<0.05 for all tests. Analyses were carried out using SPSS v18.0 (SPSS, 2009).
Results:
Tables 1. showed the baseline characteristics and ANCOVA of age, height, weight, BMI, BMD.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean±SD</th>
<th>SE</th>
<th>F-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exercise Group (n=45)</td>
<td>Control Group (n=45)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age(years)</td>
<td>66.75±9.48</td>
<td>61.2±13.08</td>
<td>0.000</td>
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<tr>
<td>Height(cm)</td>
<td>151.92±7.61</td>
<td>151.25±5.30</td>
<td>0.000</td>
<td>-</td>
</tr>
<tr>
<td>Weight(kg)</td>
<td>56.95±9.12</td>
<td>56.8±12.45</td>
<td>0.104</td>
<td>23.24</td>
</tr>
<tr>
<td>BMI(kg/cm²)</td>
<td>24.67±3.54</td>
<td>24.85±5.23</td>
<td>0.101</td>
<td>16.78</td>
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<tr>
<td>BMD(T-score)</td>
<td>-3.54±0.89</td>
<td>-3.24±0.96</td>
<td>0.015</td>
<td>14.564</td>
</tr>
</tbody>
</table>

Table-1. Showed that the F-value of BMD (14.564), BMI (16.78), and Weight (23.24) for comparing the adjusted means of the two groups (Exercise and Control) during post-testing. Since the p-value for the F-value was 0.001, 0.001, 0.000 respectively which were less than 0.05, thus it was significant.

Critical analysis of improvement (%) of Bone mineral density after 12 weeks of training
As the total improvement of BMD after 12 weeks of training found a significant improvement in BMD for the exercise group, therefore it was important to observe the age wise improvement (%) in BMD of the post menopausal women with osteoporosis.

The subjects were classified into seven groups with five years of difference i.e. 45-50, 51-55, 56-60, 61-65, 66-70, 71-75, and 76-80.

The improvements (%) in BMD were compared among the groups which were shown in the groups.

![Figure 1. Graphical representation of age wise improvement (%) in BMD after 12 weeks of training.](image)
From the Fig. 1 it was observed that the improvement (%) in BMD of the subjects in age range 45-50 years was 6.29%. For the age range of 51-55 years it was 7.11 improvements (%). In the age range of 56-60 years it was 8.47%, in the age range of 61-65 years it was 12.06% which was the peak of the improvements. The improvement in the age range of 66-70 years was 9.68%. In the age range of 71-75 it was 6.65% and in 75-80 years of age ranges it was 2.79%.

These results indicated that the treatment or weight bearing exercises had a significant effect for the improvements in BMD of postmenopausal women with osteoporosis. The striking point in this study revealed that the maximum improvement (12.06%) in BMD was observed in 61-65 years of age range of postmenopausal women.

The study also suggested that after 70 years of age the experimental protocol do not have any significant impact in the improvement of bone mineral density as their improvement (%) in BMD were decreasing subsequently.

**Discussions**

The findings of this study indicate that regular physical activity at a moderate level can help to improve bone density in post-menopausal women. These findings echo those of similar studies that have shown that the benefits from exercise or physical activity. Bolton et al. [10] demonstrated in a recent randomized, controlled trial of post-menopausal women that an increase in regular physical activity can have a positive impact on bone mineral density. In their study, over the course of one year, participants took part in a general exercise program that included 60-minute exercise training three times each week, where control participants continued in their normal daily routine. The exercise training group performed tasks including resistance training, moderately intense exercise and training. The authors found that there was a positive effect on bone density in postmenopausal women. The measured difference in BMD in the current study closely approximates that of the Bolton study. These findings are likely not unexpected, as the benefit gained from resistance or impact exercise relates largely to the effect of loading on the skeleton [11-13].

The results from this study indicate that there was a statistically significant improvement in bone density associated with an increase in the amount of moderate physical activity performed on a regular basis. The relationship between BMI and BMD indicated that increased BMI is associated with a lower risk of osteoporosis. As the total improvement of BMD after 12 weeks of training found a significant improvement in BMD, therefore to observe the age wise improvement (%) in BMD of the post menopausal women with osteoporosis indicated that the treatment or weight bearing exercises had a significant effect for the improvements in BMD of postmenopausal women with osteoporosis. This study revealed that the maximum improvement (12.06%) in BMD was observed in 61-65 years of age range of postmenopausal women. The study also suggested that after 70 years of age the experimental protocol do not have any significant impact in the improvement of bone mineral density as their improvement (%) in BMD were decreased subsequently.

**Conclusions:**

The results of this study indicate that the amount of regular physical activity at a moderate level in which
patients take part each day can have a significant impact on the maintenance of bone density. Furthermore, the evidence to date suggests that physical activity is associated with a reduction in fracture risk. Both weight-bearing endurance exercise and resistance training are important. Larger randomized, controlled studies are needed to further evaluate the effects of physical activity on fall and fracture risk reduction.

Declaration of Conflicting Interests
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