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Research Article

Comparison of Bone Mineral Content and Density in Middle-Aged Women According to Physical Activity Level

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Abstract: Osteoporosis is one of the most common metabolic diseases and is considered a health problem as the average age of the population is rising. Osteoporosis does not have any clinical signs and will progress if not prevented or cured. First symptoms reveal as side effects which are bone fractures. The purpose of the study was to determine the comparison of bone mineral content and density in middle-aged women according to physical activity level**.** The present research is practical regarding the purpose and has a descriptive-comparative design. To this end, the questionnaires of the physical activity level and medical history were distributed among 100 volunteers. 45 were selected by purposeful random sampling and then divided to 3 control, averagely exercised and highly exercised groups. Bone density was measured using bone densitometry (DEXA). In this research ANOVA and Post Hoc Tukey were used. SPSS version 18 at the p_<0.05 level of significance was employed to analyze the data. Obtained results indicate that there is a difference between highly exercised group and control group. Averagely exercised group and highly exercised group have more Bone Mineral Density (BMD) in lumbar vertebrae: There is a significant difference in middle-aged women's lumbar vertebrae BMD according to physical activity level p<0.000. Regular physical activity can be an effective treatment for preventing reduction of bone density. Not only does physical activity improve an individual's wellness, balance and harmony, but also it decreases risk of fracture in one by maintaining body stature. Physical activity can increase density and mass of bone through creating additional weight. The effect of exercise on bone structure depends on the exercise intensity and length. Results of this study showed that there is a significant difference among middle-aged women between density and mineral substances of lumbar spine bones according to physical activity level.
Keywords: Osteoporosis, Bone Mineral Density (BMD), bone mineral content (BMC), Physical activity.

INTRODUCTION

Osteoprosis is one of the most common metabolic diseases and is recognized as a health problem as the average age of the population is increasing. Osteoporosis does not have any clinical symptoms and will progress if not prevented or cured. First symptoms reveal in the form of side effects such as bone fractures [1, 2].

According to World Health Organization, osteoporosis is defined based on the amount of bone mineral substances density, where T-score is less than or equal to 2.5 standard deviations from the mean values of young adults 20 to 29 years old. Accordingly, if a number is between -1 and -2.5, that person has osteoporosis and if it is more than or equal to that number, it indicates normality of the individual's mineral substances density [3].

Osteoporosis is the disease of the third decade of life. After gaining maximum bone mass between the age range of 20 and 30 years old, bone texture gradually worsens after age 30, then the process of bone destruction increases. Since body weight is one of the most effective quality and quantity factors in bone mass, a positive relationship is reported between weight and bone mass in all age groups [4]. By adding to the overload on skeleton, a higher body weight leads to increased osteogenesis stimuli and increased bone mass [5].

Sports activities and exercises which increase power, strength and muscle mass can activate bone building stimulants [6]. Depending on factors such as age, gender and race, osteoporosis may happen to any person. Hereditary and genetic factors are also important in determining maximum bone mass. Although there is still no definite cure for osteoporosis, we can prevent this disease by taking effecting actions such as a following a nutritious diet enriched by calcium and taking vitamins and doing regular exercises and avoiding smoking [7].

Public health plans in majority of European countries are related to how to increase life expectancy and quality of life for older people [8]. According to the instruction published by the study group of World Health Organization (WHO), if one's bone mineral density level is more than 2.5 below the standard deviation of natural bone mineral density in youngsters (T-score<-2.2), that person is affected by osteoporosis. Based on this definition, 30% of menopausal women have osteoporosis. The most common symptoms related to osteoporosis include pain in the spine, movement limitation and psychological trauma which decrease the quality of life [9].

In osteoporosis the fracture mostly occurs in vertebral spine, femoral and wrists. Vertebral fractures may not have any symptoms in 30% of cases and only a third may be diagnosed which need doctor's attention. Even though in some cases fractures do not have any symptoms, they may cause death or illness of patients which happen as a result of their long stay in the hospital bed. Accompanied with occurrence of secondary chronic diseases and inactivity, quality of life and life expectancy of patients are decreased [10].
In Iran, findings of prevention, diagnosis and treatment programs of osteoporosis indicate that more than 70% of men and women aged above 50 have osteopenia or osteoporosis [11]. Moreover, in a comprehensive study on healthy people residing in Tehran conducted inendocrinology and metabolism research center, Tehran University of Medical Sciences, it was discovered that osteoporosis is widespread in 60-69 age group and 32.4% of women [12]. Therefore, this disease is one of the top priorities of the health care system in the country [13].

Several studies, also, indicate that sport joined by enough calcium and vitamin D consumption has great impact on slowing the speed of bone mass loss [14].

Regular physical activity helps to the health of bones and by increasing muscle strength creates balance and coordination in body which have a direct impact on body wellness [15]. Sports exercises and physical activities are recommended to youth as a non-medicine intervention for increasing bone density and to middle-aged people for preventing bone mass decrease. In elderly people doing exercises has a key role in bone density increase, preventing falling down and probable fractures [16].

Osteoporosis is a chronic and progressive phenomenon which happens by loss of bone mass per unit volume, disorder in internal bone tissue and bone thinning and porousness. Its most important side effect is bone fracture happening as a result of minimum stress or hit. Osteoporosis is the most common metabolic disease of body skeletal system and is a clinical syndrome which involves all body skeletons [17].

Osteoporosis Clinical symptoms

Osteoporosis fracture mostly happen in those parts of the skeleton which have large amount of trabecular bone. While fracture may happen in any part of the skeleton, the most common fracture parts are spine, femoral neck and wrist [18].

Starting doing exercises from childhood and teenage adolescence is a crucial factor for preventing osteoporosis in middle-age and senescence. Exercising increases bone mass by 5% to 8% and makes it stronger [9]. Weight-bearing exercises are the best kind of exercises to stimulate bone [19].

Amenorrhea in young women may have a negative impact on maximum bone mass. Decrease in bone density among amenorrheic young women is accompanied by increased danger of fracture caused by pressure and other injuries knowing of which is essential for those working with female endurance athletes. The effect of exercises on bone strengthening directly correlates with duration and continuity of exercise. Sports which involve sudden body and limb movements and body parts carry weight in different directions lead to more stimuli in bone making [20]. The five lumbar vertebrae located in the lower part of the spine are the greatest in the spine [21]. These vertebrae are involved in various movements such as bending and turning of the spine in sports skills; for example, in diving and swimming they are used in opening and bending sides [22].

Lee and *et al*. showed that endurance sports increases activity in women after menopause and BMD and BMC of lumbar vertebrae and femoral neck multiplies [23].

However, Gharibdoost conducted a study on the role of inactivity on bone mineral substance mass and declared that bone mass decreases 1% as a result of a week of rest and inactivity. This fall is due to elimination of imposed mechanical pressure on bones which finally results in decline in lumbar vertebrae BMD [12].

Since in Iran osteoporosis threatens a large proportion of society and it usually involves women more, the present research aims at investigating bone mineral substance mass in lumbar vertebrae. It intends to examine if there is any significant difference between spines BMD among middle-aged women based on their physical activity level.

METHODOLOGY

The present research is practical regarding the purpose and has a descriptive-comparative design

because we intend to compare bone mineral substance density among middle-aged women.

After announcing a call for participation in this study, 100 medical record, physical activity and consent forms were distributed among volunteers. Finally, 45 individuals were chosen from middle aged women aging 35 to 45. After they were examined by a doctor and it was made sure that they do not have any disease record, they were assigned to 3 (control, averagely exercised and highly exercised) groups. Research goal was clearly explained to them and they announced their consent in written form. After coordinating with assessment center of Shourideh Hospital in Mashad, samples of density test were collected 5 times a day for almost a week. Bone densitometry tool (DEXA) from Neroland brand made in USA was utilized to assess bone mineral substance density of participants and to measure fat mass and fat free mass of body weight.

Test length was 12 minutes for every participant. They were first asked to take off their shoes, clothes and metal possessions such as watch and ring and then stand on the scale while they were wearing special clothes. In addition to measuring weight, height was measured using stadeometer. First name, last name, age, height and weight of all participants were recorded by the computer operator. Energy source was X-ray in this method which was passed through bones and soft tissue, resistance between incoming and outgoing radiation was calculated by computer. According to this, mineral substance of bone was calculated in grams per square centimeter. Precision of this tool is more reliable than other assessment methods. This issue made investigation of density changes over time best possible. In the present method, time needed for assessing receiving radiation is very little. Participants were asked to lie down on hospital bed so that their body is completely straight and hands are stretched around body. After they were ready, the device was placed over their bodies. Imaging of the lumbar spine was performed with computer. Duration of this test was 5 minutes which was various depending on the amount of soft tissues surrounding abdomen. It means that more time was needed and spent for people who were heavier. At the end, when the test was finished, all required adjustments were performed by operator and results accompanied by a color image were printed in two separate sheets of paper after computer analysis. Each sheet related to bone density included information such as first name, last name, age, height, weight, race, the amount of BMD and BMC with image and normality figure of each participant. This amount is distinct in lumbar vertebrae, femoral neck and entire body.

Descriptive and inferential statistical methods have been used to analyze and interpret data. Means, standard deviations were employed in descriptive statistics and test normal distribution of data, Kolmogrov Smirnov test; it was then followed by parametric tests since data was normally distributed. Since there were three groups, ANOVA was employed to compare research variables. SPSS version 18 at $P<0.05$ level of significance was utilized for analysis purposes.

RESULTS

Means and standard deviations related to age and body mass index (BMI) are represented for each group separately. In the present research, 45 middle-aged women between 35 to 45 years old were assigned to three control, averagely exercised (three sessions a week) and highly exercised (five sessions a week). Age mean of control group, averagely exercised and highly exercised groups were 39.13, 38.42 and 37.13, respectively. BMI mean of these groups were 27.21 for control group and 26.36 and 25.51 for average and highly exercised groups, respectively.

According to Table 2, it can be stated that there is a significant difference between BMD of lumbar vertebrae among middle-aged women based on physical activity level.

In accordance with the obtained result, it was identified that there is a significant difference between the three control, averagely exercised and highly exercised groups in the degree of middle-aged women vertebrae lumbar BMD. Therefore, Tukey test, at 0.05 level of significance, is employed to further compare means. By this test we understand which pair of groups has significant difference in middle-aged women lumbar vertebrae BMD. Tukey test results are depicted in Table 3.

As shown in Table 3, there is a significant difference in middle-aged women lumbar vertebrae BMD between ‘control’ and ‘averagely exercised’ and also between ‘control’ and ‘highly exercised’ groups. However, there was no significant difference between ‘averagely exercised’ and ‘highly exercised’ groups in middle-aged women lumbar vertebrae BMD.

According to Table 4, BMD mean of lumbar vertebrae were 0.92 in control group, 1.06 in averagely exercised group and 1.11 in highly exercised group. Standard deviation of lumbar vertebrae BMD was 0.06 in control group, 0.08 in averagely exercised group and 0.1 in highly exercised group.

Table 1: Demographic characteristics of participants in each group (n= 15 per group)

Index	Group	Mean	Standard deviation
Age (Years)	Control	39.13	4.9
	Averagely exercised	38.42	5.1
	Highly exercised	37.13	4.9
BMI	Control	27.21	4.5
	Averagely exercised	26.36	3.06
	Highly exercised	25.51	3.3

Table 2: One-way variance analysis test result for lumbar vertebra BMD among middle-aged women based on physical activity level

Source of variations	Sum of squares	Mean of squares	F	Level of significance
Between groups	0.298	0.149	11.262	0.000*
Within groups	0.543	0.013		
Total	0.841			

Level of significance is at 0.05

Table 3: Comparison of means using Tukey test

Groups	Mean difference between groups	Level of significance	Result
Control with averagely exercised	-0.143	0.005*	Significant difference
Control with highly exercised	-0.192	0.000*	Significant difference
Averagely exercised with highly exercised	-0.048	0.494	Insignificant difference

*Level of significance is at 0.05

Table 4: Middle-aged women lumbar vertebrae BMD descriptive statistics in three groups

Variable	Group	Mean	SD
Lumbar vertebrae BMD (g/cm^2)	Control	0.92	0.06
	Averagely exercised	1.06	0.08
	Highly exercised	1.11	0.1

DISCUSSION

Research findings revealed that there is a significant difference between lumbar vertebrae of middle-aged women based on physical activity level P<0.000. Several studies with contradictory results have been conducted on the effect of exercising on bone mineral substance density. Many of those pieces of research have shown that BMD and BMC increase as exercise increases and many others have disproved this relationship. Results of the present research are in consonance with Magkos *et al.* [24] and Lee *et al.* [23], however, they are in contradiction with results found in Gharibdoost [12] and Nazarian *et al*. [25].

In a study conducted to investigate the effect of the kind and intensity of exercise activity on bone mineral substance density, Magkos *et al*. [24] found that swimmers have less bone mass density (BMD) than other sports groups and the control group. There was no significant difference between density of speed group and the control group; however, bone density of strength group was significantly higher. Additionally, results confirmed that endurance sportspersons and control group have significantly less bone mineral substance density and athletes in strength sports such as wrestlers have the most mineral substance density in the upper lumbar vertebrae of all other groups.

Lee *et al*. [23] showed that the effect of endurance sports leads to activity progression in women after menopause and BMD and BMC of lumbar vertebrae increases.

Gharibdoost [12] conducted a study on the effect of inactivity on bone mineral substance density (BMD) and found that bone mass decreases 1% as a result of one week rest and inactivity. This decline is due to lack of mechanical pressure on bone which finally causes decrease of femoral neck and lumbar vertebrae.

Nazarian *et al*. [25] compared mineral substance density of dominant and non-dominant leg of footballers with those who were not athlete. They compared bone mineral substance density in neck and trochanter of dominant and non-dominant leg of 15 professional footballersand 14 healthy non-athletes. The results showed that the degree of mineral substance density of dominant leg of footballers is significantly higher than their non-dominant leg, while there was no significant difference between the two legs of non-athletes. Furthermore, the degree of bone mineral density of footballers' dominant leg was significantly more than dominant leg of non-athletes.

These results may be contradictory due to type of exercise, type of participants (athlete, non-athlete, elite ad ordinary), exercise intensity, exercise length, type of supplement consumed.

The present research is also consistent with the following studies.

Rahimian Mashadi [26] explored the effect of long term activity on bone mass density of dominant and non-dominant hand of sportswomen participating in the countries' national teams in table tennis (rocket), swimming and gymnastics (non-rocket). Additionally, they compared that with non-mineral mineral standard density and world non-athletes. It indicated that the slight difference in both hands' radius bone mineral substance of women in rocket sports is significantlt higher than non-rocket sports and non-athletes. Also, mineral substance density is significantly lower in both hands of countries' national team women in most fields recognized by world standard.

Mousavi *et al*. [19] in a study titled 'Comparison of upper and lower extremities bone mineral density in professional women footballers with non-professional footballers' showed that the amount of mineral substance density in lower extreme of soccer players is more than their upper extreme and danger of fracture is less. However, this claim needs further research.

Nordestom [27] conducted a study on 46 boys aged 17 in ice hockey and badminton. Lumbar vertebrae BMD and BMC increased among badminton players.

Physical activity has a positive effect both in prevention and cure of osteoporosis. It is clear that all sports programs do not enjoy these features. Studies on the type of sports activities have shown that exercises which do not involve pressure have less effect than sports such as running and jumping, even they are ineffective [28]. Sports activities as a holder and stimulus of bone making are able to decrease the risk of bone fractures by mineral accumulation, muscle strengthening and balance improvement. Amount of bone density in professional athletes is mostly more than non-athletes. It is more obvious in athletes who need more muscle power [29].

Exercise is essential for building and maintenance of strong bones in life. Best types of exercises to stimulate bone are those which involve carrying body weight and impact all bones [30]. Athletes lose some of their bone mass after quitting sports, however, even after four or five years of quitting sports they have a better bone mass than non-athletes [27].

Risk factors for osteoporosis are already identified by National Osteoporosis Forum NOF which include: non-modifiable factors such as previous fracture experience during adulthood, fracture history in close relatives, old age, females and bad health condition. Factors which are potentially modifiable are: smoking, low weight, Estrogen deficiency, decreased calcium intake, alchoholism, frequent falling down and inactivity.

In studies related to osteoporosis specific risk factors for hip fracture include: age, previous hip fracture in one's mother, weight, height, bad health conditions, history of hyperthyroidism, use of long-taking Benzodiazepines, bone mineral density impaired proprioception [31].

Since lumbar vertebrae BMD increases as a result of exercising, middle-aged women are recommended to continue doing so to enjoy its benefits. It is also suggested to conduct similar research on menopausal women, elite sportspersons in various fields, people with osteoporosis with long term effect, people in different ages, and menopausal women joined with supplement and exercise program. Additionally, although it was attempted to synchronize nutrition programs, it was not controlled exactly by the researcher.

CONCLUSION

Regular physical activity can be an effective treatment for preventing bone mass decrease. Physical activities do not have any side effects, are cost effective and have benefits such as firmness and stability of body condition and preventing falling down. Not only does physical activity improve one's balance and coordination, but also it decreases likelihood of fracture by keeping body stature. Physical activity and exercise stimulate bone making and bone fractures are decrease consequently. It does so by modifying bone making process and increasing bone mineral content density. It can enhance bone density and mass by creating more weight. The effect of exercise on bone tissue depends on exercise intensity and length.

Results of this research demonstrate thatthere is a significant difference between middle-aged women lumbar vertebrae and femoral neck bone density and mineral substance according to physical level activity.

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