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# A Study of Bone Mineral Density in Diabetes Mellitus Patients

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## Abstract

**Background:** In view of the current high prevalence of diabetes mellitus (DM) and osteoporosis, today there is great interest in studying the possible association between these two disorders. The aim of this study was to determine the association between type-2 DM, and Bone mineral density (BMD) in Iranian women.

**Methods:** BMD was determined in the femoral neck and at the L2-L4 level (DEXA) 0f 518 women aged 40-80 years old, referred to bone densitometry unit of Endocrinology and Metabolism Research Center of Tehran University of Medical Sciences (146 patients with type 2 diabetes and 372 normal controls).

**Results:** In diabetics patients, BMD values at the vertebral site were higher than non-diabetic patients but the difference was only significant in postmenopausal subgroup ($P$= 0.045). Besides, BMD values at the hip site were higher when compared with non-diabetes group, but the difference was not significant. Frequency of osteoporosis risk factors (tea consumption, sunlight exposure, late menarche, low physical activity, smoking habits, family history of osteoporosis and inadequate calcium intake) were not significantly different between diabetic and non-diabetic women , but prevalence of early menopause was higher in diabetic women ($P$= 0.046). Prevalence of osteoporosis in premenopausal and postmenopausal was 7% and 41.6% in diabetic and 15% and 36.8% in non-diabetic women, respectively. Prevalence of osteoporosis and osteopenia was not significantly different in diabetic and non-diabetic groups.

**Conclusion:** The present results demonstrate that there is not clear association between BMD and type 2 diabetes mellitus.

**Keyword:** *Diabetes mellitus, Bone mineral density, Osteoporosis, Iran*

## Introduction

There have been conflicting reports on the effects of diabetes and lifestyle on Bone Mineral Density (BMD). In different studies, higher (1-4), lower (5-7) or the same (8, 9) values of BMD have been reported in type 2 diabetic women in comparison with healthy controls. Although the presence of osteopenia in type I Diabetes Mellitus (T1DM) patients, is more clear and has been reported in many studies, mechanism of these changes is poorly explained (10-14).

Biochemical and metabolic studies on bone in diabetic patients indicate a high bone absorption in poor control patients of both types of DM. However, inconsistencies exist in the available reports on biochemical markers of bone metabolism in diabetes. It is suggested that in poorly controlled T1 diabetes, high resorption and low formation (2, 15), as well as low (16) and high bone turnover (17), are involved in the pathogenesis of osteopenia. Few reports are available on bone turnover in T2 DM. Some studies indicate that bone formation in T2 DM is lower than that of healthy subjects (18). Menopausal status has a special effect on the relationship between diabetes and osteoporosis, thus premenopausal and postmenopausal women are studied in separate groups (9, 13, 19).

Different studies indicate that postmenopausal T1 diabetic women have lower BMD in comparison with normal controls and become osteopenic after menopause but not before that (10-14, 20). Since after menopause, bone loss is significant in T1 diabetic women but not in T2,

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some authors have suggested this type of diabetes as a protective factor against bone loss (20). The differences in BMD values between T1 DM and T2 DM patients can be explained by the typical differences in Body Mass Index (BMI). T1 diabetic patients are mostly thin while T2 diabetic cases are usually obese. Obesity can enhance bone metabolism by increasing the load on the bone. It is not clear whether these results are due to increased load on the bones from the higher weight, a subsequently stronger bone, low bone turnover and/or hormone factors, or is due to measurement bias causing falsely high measured BMD in obese patients (20). Some studies have showed that trabecular bone mass is significantly higher in T2 diabetic patients (21). That may be due to metabolic influences of the disease because calcium and phosphorus metabolism changes in diabetes (21). However, consensus on the effects of diabetes on bone metabolism has not been reached yet (20, 21). Lifestyle is one of the well known factors that affect bone mineral density and risk of fracture (22). In both women and men, current and also past physical activity have a positive effect on bone density (23). Also in women, current walking is a protective factor (9, 19). In addition, a balanced diet can prevent osteoporosis by increasing bone density and changing bone turnover. (22). Thus, in studies on the effects of diseases on bone metabolism considering environment factors especially lifestyle is crucial.

The aim of this study was to investigate the relationship between T2 DM and patients` lifestyle and BMD at lumbar spine and proximal of femur in premenopausal and postmenopausal women.

## Materials and Methods

In this cross-sectional design, 518 T2 diabetic and non-diabetic women, 40 to 80 years old, referred to bone densitometry unit of Endocrinology and Metabolism Research Center of Tehran University of Medical Sciences, Iran were studied. Subjects were grouped as diabetic and non-diabetic. Diabetic women had the disease for at least the past 3 yr. Diabetes was diagnosed by an endocrinologist using ADA criteria (24). None of the subjects had suffered from hormonal and endocrine diseases (such as thyroid and parathyroid disorders), chronic gastrointestinal disorders (such as malabsorption, chronic diarrhea and crohn disease), renal disorders, hepatitis and immobilization for a long time or taken any known supplements or medications likely to affect bone metabolism such as calcium supplements and vitamin D preparations, bisphosphanates, calcitonin, or hormones.

According to menopausal status, all subjects in each diabetic or non-diabetic category were assigned to postmenopausal (absence of menses in past 12 mo) or premenopausal (regular menses in past 12 mo) subgroups.

BMD was assessed by Dual Energy X-ray Absorptiometry (DEXA) technique at the lumbar spine (lumbar vertebrae 2-4) and proximal femur (femoral neck, femoral ward`s triangle, and femoral shaft).

Weight and height was measured by standard methods and BMI was calculated using the formula [weight (kilogram) divided by square height (square meter)]. In each group subjects were matched for age and BMI. A complete questionnaire containing factors reported to affect BMD such as age, physical activity, individual or family history of diseases, sunlight exposure, calcium intake, smoking habits and duration of diabetes was filled for all subjects.

Physical activity level was assessed by asking current and past levels of physical activity, and subjects were divided into two groups of those who exercise more than 30 min daily or those who exercise less. Current calcium intake was assessed by asking the daily amount and frequency of consumption of cheese, yogurt, milk and other dairy products (e.g. ice cream). For sunlight exposure subjects were classified whether as being exposed to sunlight more or less than 15 min per day. According to smoking habits women were grouped as those smoke more than two packs a week and those who smoke less.

All statistical analyses were carried out using SPSS (version 11.5). Unpaired two-sided t-test was used to compare values between groups. In the absence of normal distribution of variables Mann Whitney test was used instead. Frequencies of risk factors in groups were compared using $\chi^2$ test. The relationship between risk factors and BMD variation was evaluated using liner regression and logistic regression. *P* value of less than 0.05 was considered as statistically significant.

## Results

Five hundred eighteen women aged 40-80 yr old were studied. One hundred forty six of subjects were diabetic (126 postmenopausal and 20 premenopausal) and 372 were non-diabetic (315 postmenopausal and 57 premenopausal). A mean (±SD) yr of being diabetic was 6.18±3.03 yr for premenopausal women and 10.68±6.06 yrs for postmenopausal women (Table 1).

Here were no significant differences in age, height, weight, calcium intake, menarche age during postmenopausal and premenopausal ages in both diabetic and non-diabetic groups.

In diabetics patients, BMD values at the vertebral site were higher than non-diabetic patients but the difference was only significant in postmenopausal subgroup ($P$= 0.045). In diabetic patients, BMD values at the hip site were higher when compared with non-diabetes group, but the difference was not significant in subgroups. Fig. 1 and 2 show the BMD values at the vertebral and hip sites in premenopausal and postmenopausal diabetic and non-diabetic women, respectively.

Frequency of osteoporosis risk factors are shown in Table 2. Frequency of tea consumption, sunlight exposure, late menarche, low physical activity, smoking habits, family history of osteoporosis and inadequate calcium intake was not significantly different between diabetic and non-diabetic women , but prevalence of early menopause was higher in diabetic women ($P$= 0.046) than non-diabetic group ($P$= 0.04). Prevalence of osteoporosis in premenopausal and postmenopausal was 7% and 41.6% in diabetic and 15% and 36.8% in non-diabetic women, respectively. In addition, prevalence of osteopenia during premenopausal and postmenopausal was 35.1% and 40% in diabetic women and 23% and 42.7% in non diabetic women, respectively. Prevalence of osteoporosis and osteopenia was not significantly different in the diabetic and non-diabetic groups.

Regression analysis of the relationship between osteoporosis risk factors and BMD at the vertebral site showed that in premenopausal women, just late menarche was significantly associated with BMD ($P$= 0.04). BMI, calcium intake and diabetes were not correlated with BMD at this site. In postmenopausal women, age, early menopause, calcium intake, BMI, housewifery and diabetes were associated with vertebral BMD ($P$< 0.05). BMD at the hip site showed significant correlation with age, early menopause, BMI and housewifery only in postmenopausal women ($P$< 0.01). Of the studied factors just age, early menopause, housewifery and BMI had significant correlation with osteoporosis in postmenopausal women whereas being diabetic and duration of the disease and also calcium intake were not correlated with osteoporosis. Inadequate sunlight exposure, tea consumption, smoking and low physical activity had no significant correlation with BMD at the vertebral and hip sites. Although significant correlation between calcium intake and osteoporosis was not seen in this study, daily consumption of dairy products was independently associated with osteoporosis in postmenopausal women ($P$= 0.01).

**Table 1:** Baseline characteristics of participants

| variable* | Diabetic | | | Non-diabetic | | |
|---|---|---|---|---|---|---|
| | Pre-menopause | total | Post-menopause | Pre-menopause | total | post menopause |
| Age (yr) | 59.3±8.61 | 61.9±7.56 | 48.37±3.64 | 59.93±9.12 | 61.82±8.23 | 48.05±4.07 |
| Weight (Kg) | 68.09±11.1 | 67.23±10.91 | 72.82±11.07 | 67.71±12.01 | 66.84±11.38 | 73.42±14.64 |
| Height (cm) | 154.99±9.5 | 154.66±5.94 | 156.82±5.31 | 154.5±5.97 | 153.98±5.84 | 157.89±5.82 |
| BMI † | 28.31±4.23 | 28.082±4.141 | 29.63±4.5 | 28.36±4.79 | 28.2±4.68 | 29.37±5.49 |
| Age of menopause | - | 48.25±4.99 | - | - | 47.46±5.75 | - |
| Age of menarche | 13.64±1.43 | 13.69±1.44 | 13.41±1.35 | 13.38±1.49 | 13.47±1.44 | 12.83±1.76 |
| Calcium ‡intake | 465.5±294.65 | 470.98±294.47 | 435.21±296.44 | 504.85±294.23 | 515.35±294.27 | 438.74±292.63 |
| BMD of Spine§ | 0.98±0.18 | ‖ 0 .963±0.173 | 1.123±0.167 | 1.02±0.19 | 0.99±0.18 ‖ | 1.19±0.21 |
| BMD of Hip¶ | 0.87±0.15 | 0.846±0.142 | 0.999±0.142 | 0.862±0.15 | 0.85±0.15 | 0.93±0.14 |

* mean±SD, † Kg/m2, ‡ daily calcium intake (mg), § BMD of L2-L4 (g/cm2), significant different (*P*=0.05), ¶BMD of proximal femur (g/cm2)

**Table 2:** Frequency of osteoporosis risk factors and comparison to studies groups

| variable | Diabetic | | | Non-diabetic | | |
|---|---|---|---|---|---|---|
| | Total (%) | Post- menopause (%) | Pre-menopause (%) | Total (%) | post menopause (%) | Pre -Menopause (%) |
| Osteoporosis family history | 11 | 8.6 | 25 | 12.6 | 10.2 | 26.3 |
| Tea consumption* | 51.8 | 53.2 | 40 | 47 | 47.6 | 43.9 |
| smoking† | 2.1 | 2.4 | - | 4 | 3.2 | 8.8 |
| Early menopause‡ | - | 23.2§ | - | - | 15.4§ | - |
| Late menarche‖ | 0.7 | 0.8 | - | 3.3 | 3.5 | 1.8 |
| inadequate sunlight expose¶ | 29.5 | 28.6 | 35 | 34.7 | 34.6 | 35.1 |
| Low physical activity** | 45.9 | 45.2 | 50 | 54 | 53.7 | 56.1 |
| Adequate calcium intake†† | 86.3 | 86.5 | 85 | 86.6 | 86 | 89.5 |
| Housework | 84.9 | 85.7§ | 80 | 75.3 | 77.1§ | 64.9 |

* <daily 5cups, † <2paket per week, ‡>45age, § Significant different (*P*=0.04), ‖ <16yr old, ¶ Daily >15min, ** >30min daily, ††> 800 mg daily

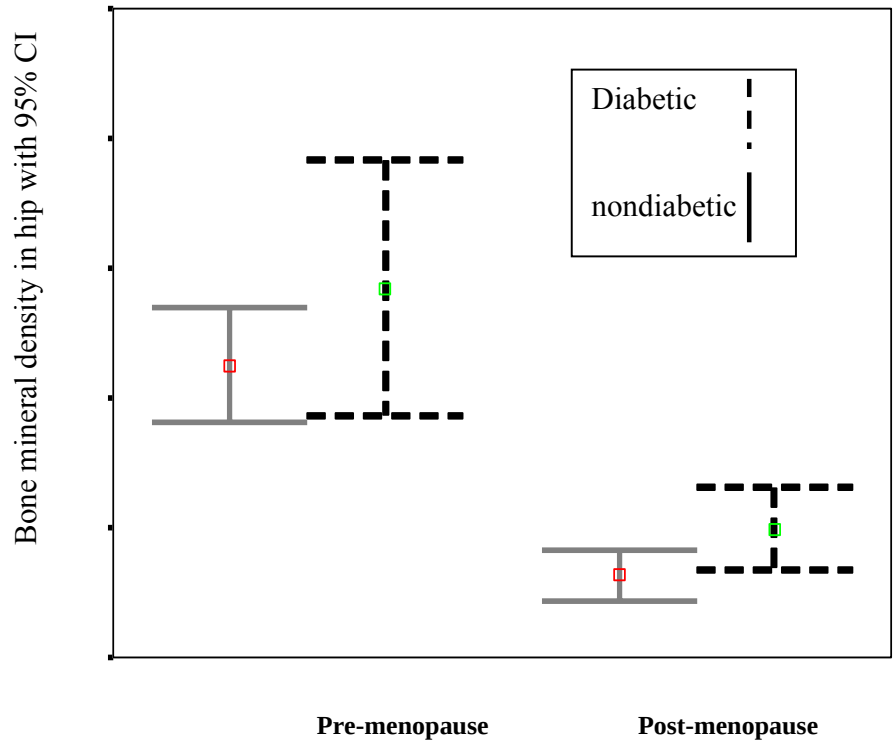


**Fig. 1:** Bone mineral density in lumbar spine in study groups

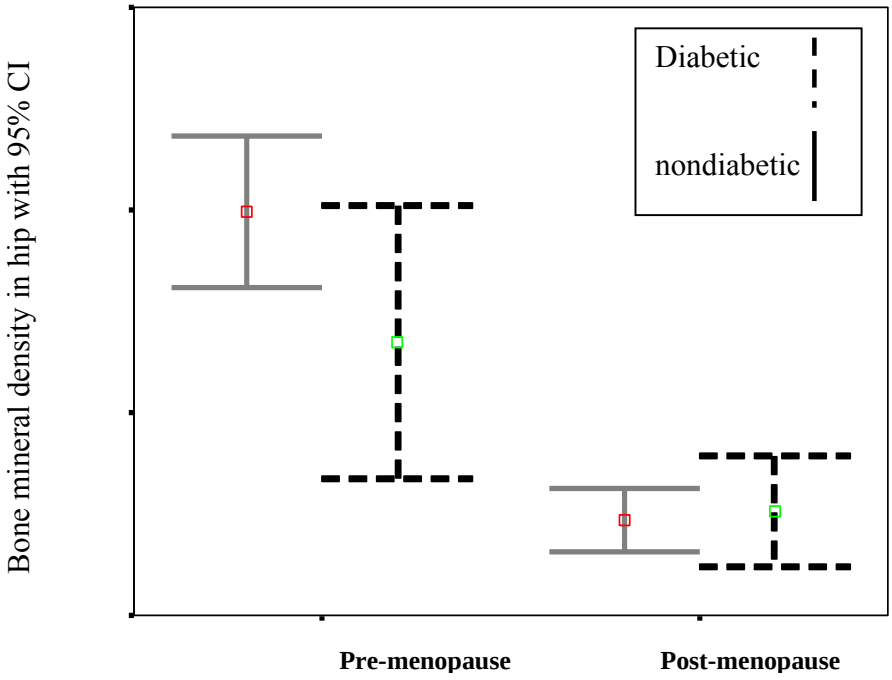


**Fig. 2:** Bone mineral density in hip in study groups

## Discussion

Numerous studies have been done on bone mineral density and metabolism in patients with diabetes mellitus and coexistence of this disease and osteoporosis but controversies still exist (8, 19). Some studies have reported that T2 DM is relatively a protecting factor against postmenopausal bone loss which is consistent with our results at vertebral site (19). Other studies have not showed significant difference in BMD values at the hip site between diabetic women and normal controls (8; 25, 26). In some other studies which have controlled the confounding factors the results are totally different and low bone density is reported in T2 diabetic patients (5, 27- 29). Findings of our study, is similar to these studies which have controlled the confounding factors.

In the most studies that reported increased bone mass at different sites in the T2 diabetic patients correlation between T2 diabetes and osteoporosis is not clearly explained and the increase was not enough to protect patients against osteoporosis. In the present study no significant difference was observed in the prevalence of osteopenia and osteoporosis between T2 diabetic women and non-diabetic subjects. There are some explanations for higher BMD in diabetic women. Prevalence of diffused osteoarthritis at the vertebral site in diabetic women is higher than non-diabetic women and can lead to falsely elevated values of BMD at this site (30). Also, Obesity in T2 DM patients is associated with higher rate of estrogen production from adipose tissue and higher bone mass density so that after adjustment for BMI usually this effect is less clear (31). Meanwhile, in some studies osteoporosis prevalence in diabetic women was not less than healthy controls and also risk of osteoporotic fracture in hip was higher in these people (3).

Lifestyle has an important role in both diabetes and osteoporosis. Studies indicate that physical activity is associated with higher bone mass density at hip site and walking is a protective factor against osteoporosis (22, 23). In the present study, although we could not show positive relationship between physical activity and osteoporosis, employed women especially at postmenopause ages had higher BMD. This relationship was also significant for housewifery and risk of osteoporosis. The observed difference might be because of the method used to evaluate physical activity and the questionnaire limitations in assessing the actual daily activities.

Some studies have shown benefits of milk consumption before age 50(22, 32). Others indicate that high intake of calcium is associated with reduced risk of vertebral and hip fracture, and also is associated with increased BMD at femoral trochanter and neck (22, 25, 32). In the present study calcium intake was not significantly correlated with osteoporosis but daily consumption of dairy products was significantly associated with osteoporosis in post-menopausal women. This difference might be due to inadequate calcium intake in the study population or better lifestyle of those who regularly consume dairy products. However, some studies have emphasized on the role of dairy products on overall bone health besides calcium intake (22, 32). Because of coexistence of T2 diabetes and osteoporosis, high prevalence of both diseases and also similar age of incidence many authors have investigated the relationship of these diseases but not controlling the confounding factors in many studies which have leaded to in contradictory results.

In conclusion this study indicates that despite higher BMD at the vertebral site, the prevalence of osteoporosis in diabetic women is not different from healthy controls. A healthy lifestyle and regular consumption of dairy products and physical activity is recommended for osteoporosis prevention especially in postmenopausal ages.

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