Bone Mineral Density of Post-Menopausal Diabetic and Non-Diabetic Women from Mumbai City

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Abstract

Objective: To assess the bone mineral density of type 1 and type 2 diabetic and non-diabetic post-menopausal women.

Methods: A cross-sectional study was conducted in 98 post-menopausal women aged 60.5±6.4 years. The participants comprised of 20 type 1 diabetics, 28 type 2 diabetic women and 50 non diabetic women. Anthropometry and dietary intake was assessed for all participants. T score for bone mineral density was measured by DEXA at lumbar spine, femoral neck and total body. This was used to classify women as suffering from osteoporosis and osteopenia.

Results: The mean weight was significantly higher in type 1 and type 2 diabetics as compared to non-diabetics ($p<0.05$). Protein and calcium intake was 52-60% of the RDA in diabetics. There was no significant difference in T score at lumbar spine, femoral neck or total body between the 3 groups ($p>0.05$). After adjusting for weight and nutrient intake, lumbar spine and femoral neck T score was significantly lower in type 1 diabetics ($p<0.05$). Type 2 diabetics also had significantly lower adjusted femoral neck T score as compared to non-diabetics ($p<0.05$). Higher percentage of type 2 diabetics (77.8%) and non-diabetics (77.5%) had low bone density (osteopenia + osteoporosis) at lumbar spine as compared to type 1 diabetics (60%). Higher percentage of type 1 diabetics (75%) and type 2 diabetics (82.1%) had low bone density at femoral neck.

Conclusion: A high percentage of postmenopausal women in Mumbai were observed to be osteopenic and osteoporotic. Dietary and lifestyle Intervention programs need to be developed to prevent onset of osteopenia and osteoporosis especially in diabetic post-menopausal women.

Keywords: Osteoporosis, Osteopenia, Type 1 diabetes, Type 2 diabetes, T Score, dietary intake

Conflict of Interest: None declared.

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Introduction

Osteoporosis is defined as metabolic bone disease characterized by low bone mass and micro-architectural deterioration of bone tissue, leading to enhanced bone fragility and a consequent increase in fracture risk [1,2]. Osteoporosis is caused mainly due to failure to attain sufficient peak bone mass (PBM) during childhood and adolescence or failure to maintain PBM for sufficient period during early adulthood or accelerated loss in later life [3,4]. It is the most common bone disease affecting both gender and all races [5]. Post-menopausal women are at higher risk for osteoporosis and related fractures [6]. As women attain menopause, oestrogen deficiency causes an increase in osteoclastic resorption with a simultaneous decrease in osteoblastic activity, thereby disrupting the normal bone turnover resulting in lower bone mineral density (BMD) [1].

A secular increase in the prevalence of osteoporotic fractures have been observed world over. It is estimated that 1/3rd population at 50-60 years suffer from osteoporosis whereas more than 50% of people over 80 years suffer from osteoporosis [7,8]. Khadilkar and Mandalik (2015) have reported that 8-62% of Indian women of different age groups suffer from osteoporosis. Additionally, it is also estimated that 20% women above the age of 50 years were osteoporotic [9]. Thus, it is essential to measure BMD in post-menopausal Indian women.

Apart from menopause, many other factors influence the risk of osteoporosis including diabetes. Diabetic osteopathy is a significant co-morbidity of both types of diabetes and is characterized by micro architectural changes that cause a decrease in bone quality and an increased risk of fracture [10]. Osteoporosis has different aetiology in both types of diabetes. In patients with type 1 diabetes, long standing hyperglycaemia with absence of insulin and insulin-like growth factor -1, low PBM along with other autoimmune diseases is the primary cause of osteoporosis. On the other hand, a decrease in quality of bone, (i.e. the micro-architecture of the bone, the accumulated microscopic damages, the quality of collagen, the size of mineral crystals, and the rate of bone turnover) also leads to osteoporosis in type 2 diabetes [10].

Several studies have shown that those with Type 1 diabetes had lower BMD and higher prevalence of osteoporosis as compared to non-diabetics [11-13]. On the other hand, patients with type 2 diabetes have shown to have higher or similar BMD as compared to non-diabetics [11,13]. However these patients have higher risk for fractures [11,14]. Many other studies have demonstrated higher prevalence of osteopenia and osteoporosis in type 2 diabetics as compared to non-diabetics [15,16]. The results of studies on prevalence of osteoporosis in type 2 diabetics however have been in-consistent.

Hence, the current study was undertaken to evaluate the prevalence of osteopenia and osteoporosis in post-menopausal women with type 1 and type 2 diabetes in comparison to non-diabetic post-menopausal women.

Methods

A cross-sectional study was conducted in 98 post-menopausal women (50 non-diabetic, 20 type 1 diabetics and 28 type 2 diabetics) with the mean age of 60.5±6.4 years from Mumbai city, India. Women were recruited from bone densitometry centre in a suburban hospital of Mumbai. Study protocol was explained to all participants and informed written consent was obtained. The study protocol was approved by Inter System Bio Medica Ethics Committee, Vile Parle (West), Mumbai, and the research was performed in keeping with the Declaration of Helsinki.

Exclusion criteria:

i) women having any other non-communicable health issues

ii) women on treatment for osteoporosis

iii) women on oestrogen replacement therapy

Anthropometry

Height was measured using a wall-mounted stadiometer to the nearest 1 mm. Weight was measured using a digital weighing scale. BMI was calculated by dividing weight in kg by height in meter square. Women were classified as having normal BMI (<23 kg/m^2), overweight (23-27 kg/m^2) or obese (>27 kg/m^2) using Asian cut-offs [17].

Bone Mineral Density

BMD was measured using GE Prodigy Fan bean DEXA scanner at total body, femoral neck and lumbar spine. All scans were performed by the same operator. All scans were checked for errors and were manually corrected if required. T-score at total body, femoral neck and lumbar spine were noted. Women were classified as having normal bone density (T score <-1), osteopenia (T Score between -1 to -2.5) and osteoporosis (T score > -2.5) [18].

Dietary intake

Dietary intake was assessed by 24-h recall on three days (non-consecutive) of a week, including Sunday.

Each participant was asked about the intake of food items during the day at breakfast, lunch, dinner and snacks, using standard cups and spoons by trained investigators through a face-to-face interview. The recipes of food items were also recorded. Daily nutrient intake was calculated by using nutritive value tables [19]. Percentage recommended dietary allowance (RDA) was calculated in reference to Indian data [Energy – 1900 kcal/d, protein – 55g/d, calcium – 600 mg/d] [20].

Statistical Analysis

Analyses were performed using SPSS software (version 16.0, 2007). Data are presented as Mean ± SD/SE or percentage. One-way ANOVA with post hoc Tukey's test was used to analyse the difference in parameters between 3 groups. ANCOVA with post hoc LSD test was used to analyse the difference in weight and dietary protein and calcium adjusted T scores between 3 groups. Cross tabulations were computed and difference was analysed using chi-square test for categorical data. P-value < 0.05 was considered to be statistically significant.

Results

The mean age of the participants was 60.5±6.4 years.

Anthropometric measurements

Table 1 gives anthropometric characteristics of women when classified according to prevalence and type of diabetes. Weight and height was significantly higher in type 1 and type 2 diabetics as compared to non-diabetics (p<0.05) but no significant differences were observed in BMI (p>.05).

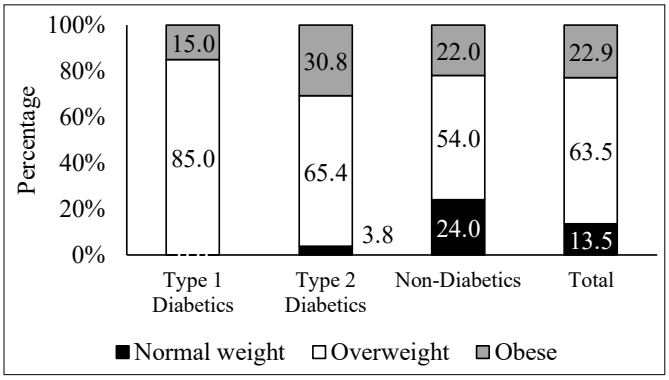
Table 1: Anthropometric parameters the study participants

	Type 1 diabetics (n=20)	Type 2 diabetics (n=28)	Non-diabetic (n=50)	Total (n=98)	P value
Height (cm)	161.1 ±4.1*	160.2 ±3.9*	157.7 ±7.1	159.1±5.9	0.048
Weight (kg)	67.8 ±4.0*	67.7 ±4.3*	62.2 ±9.3	64.8±7.8	0.002
BMI (kg/m^2)	26.1 ±1.6	26.3 ±1.8	25.0 ±3.3	25.6±2.7	0.072

Data presented as Mean±SD *significantly different than non-diabetic

Figure 1 gives prevalence of overweight and obesity. From the 98 women, 13.5% had normal weight, 63.5% were overweight and 22.9% were obese. Prevalence of obesity was highest in type-2 diabetics whereas prevalence of over-weight was highest in type 1 diabetics. This difference was significant (χ2=11.996, p=0.017).

Figure 1: Prevalence of overweight and obesity



Data presented as percentage

Table 2: T score for bone mineral density for various sites when classified according to prevalence and type of diabetes

	Type 1 diabetics (n=20)	Type 2 diabetics (n=28)	Non- diabetic (n=50)	Total (n=98)	P value
Lumbar T Score	-1.06 ±0.31	-1.75 ±0.25	-1.64 ±0.18	-1.55±0.13	0.163
Femoral Neck T Score	-1.23 ±0.22	-1.66 ±0.21	-1.36 ±0.15	-1.42±0.11	0.320
Total Body T Score	-0.68 ±0.25	-1.11 ±0.26	-0.98 ±0.19	-0.95±0.13	0.512

Data presented as Mean±SE

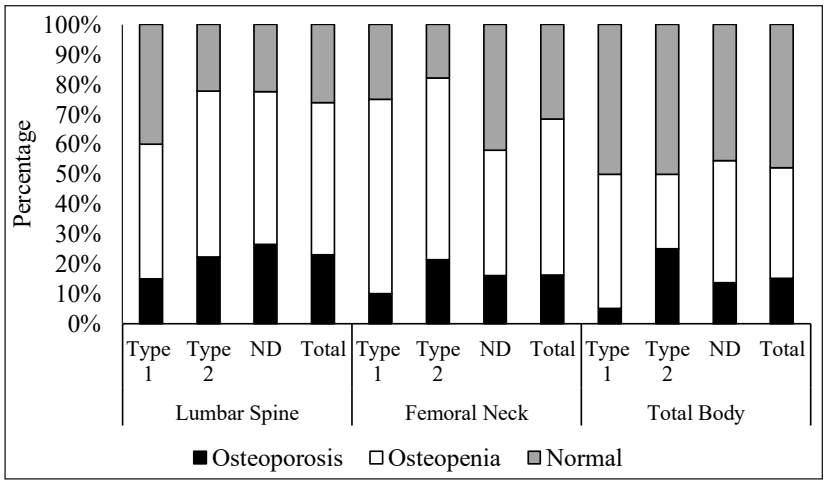
Bone density T Scores

The minimum T score at lumbar spine was -4.6, at femoral neck was -4.2 and total body was -5. The maximum T score at lumbar spine was 1.6, at femoral neck was 1.4 and at total body was 2.1. Table 2 presents T score for various sites when classified according to prevalence and type of diabetes. There was no significant difference in the mean T score of bone density at various sites when classified according to prevalence and type of diabetes (p>0.05).

Figure 2 gives prevalence of osteoporosis and osteopenia as per WHO criteria [18]. For lumbar spine, 60% type 1 diabetics, 77.8% type 2 diabetics and 77.5% non-diabetics had low bone density (osteopenia+osteoporosis). For femoral neck, 75% type 1 diabetics, 82.1% type 2 diabetics and 58% non-diabetics had low bone density (osteopenia+osteoporosis). For total body, 50% diabetics (both type 1 and type 2) and 54.5% non-diabetics had low bone density (osteopenia+osteoporosis).

There was no significant difference in prevalence of osteoporosis at lumbar spine (χ2=2.973), femoral neck (χ2=6.616) and total body (χ2=0.295) when classified according to prevalence and type of diabetes (p>0.05).

Figure 2: Prevalence of osteoporosis and osteopenia in study participants



Data presented as percentage *Type 1 = 1 diabetics, Type 2 = 2 diabetics, ND = non-diabetics.

Dietary Intake

Table 3 gives dietary intake of the women when classified according to prevalence and type of diabetes. Dietary intake of all nutrients (except carbohydrates) and percentage RDA intake was significantly lower in type 1 and type 2 diabetics as compared to non-diabetics ($p<0.05$). The protein intake for diabetic women was 60% of the RDA. Calcium intake was also very low in diabetic women.

Table 4 gives weight and dietary calcium and protein adjusted T scores for various sites. After adjusting for weight and dietary intake, the mean T score at lumbar spine and femoral neck was significantly lower in type 1 diabetics ($p<0.05$). Type 2 diabetics also had significantly lower adjusted femoral neck T score as compared to non-diabetics ($p<0.05$). No such differences were observed at total body ($p>0.05$)

Discussion

In the present study we assessed prevalence of osteopenia and osteoporosis in type 1, type 2 and non-diabetic post-menopausal women. Diabetic women weighed significantly more than non-diabetic women. Higher percentage of type 2 and non-diabetics had low bone density at lumbar spine (osteoporosis+ osteopenia) as compared to type 1 diabetes whereas at femoral neck higher percentage of diabetics (both type 1 and type 2) had low bone density (osteoporosis + osteopenia).

In the present study, diabetics weighed more than non-diabetics and this difference was significant. Karimifar *et al* (2012) had similar results where type 2 diabetic post-menopausal was significantly higher in weight than non-diabetic post-menopausal women [15]. It has been reported that type 1 diabetic women had higher mean BMI as compared to non-diabetic women and prevalence of overweight and obesity was found to be higher in type 1 diabetic women [21].

In a study conducted in Jammu, 20.25% women were found to have osteoporosis and 36.79% had osteopenia [22]. In Delhi in post-menopausal women, 44.9% had osteopenia and 42.5% had osteoporosis [23]. In another study in Pune, in post-menopausal women, osteopenia was found in 48.4% women and osteoporosis in 25.8% women at lumbar spine; at femoral neck, osteopenia was found in 62% women and osteoporosis in 8.7% wom-

Table 3: Dietary intake of women when classified according to prevalence and type of diabetes

	Type 1 diabetics (n=20)	Type 2 diabetics (n=28)	Non-diabetic (n=50)	Total (n=98)	P value
Energy (kcal/d)	1133±296*	1153±193*	1353±351	5.721	0.005
Proteins (g/d)	38.8±15.8*	38.9±9.9*	51.2±14.9	9.672	0.001
Fats (g/d)	32.7±7.8*	33.6±9.1*	52.1±20.4	16.989	0.001
Carbohydrates (g/d)	179.1± 47.6	181.8±39.6	162.3±47.7	2.009	0.140
Calcium (mg/d)	365±169*	314±158*	679±287	26.283	0.001
RDA energy (%)	59.6±15.6*	60.7±10.2*	71.2±18.4	5.721	0.005
RDA proteins (%)	70.5±28.8*	70.8±17.9*	93.1±27	9.672	0.001
RDA calcium (%)	61±27.5*	52.3±26.3	113.3±47.8	26.283	0.001

Data presented as Mean±SD *significantly different than non-diabetic. [RDA: Energy – 1900 kcal/d, protein – 55g/d, calcium – 600 mg/d] [20]

Table 4: Weight adjusted T scores for various sites when classified according to prevalence and type of diabetes

	Type 1 diabetics (n=20)	Type 2 diabetics (n=28)	Non-diabetic (n=50)	P value
Lumbar T Score	-0.994 ±0.298	-1.913 ±0.271 #	-1.525 ±0.213	0.018
Femoral Neck T Score	-1.254± 0.253	-1.870 ±0.213 #*	-1.210 ±0.166	0.049
Total Body T Score	-0.661 ±0.289	-1.365 ±0.263	-0.788 ±0.221	0.155

Data presented as Mean±SE *significantly different from non-diabetics #significant difference between type 1 and type 2 diabetics

en [24]. The observations of the present study are in line with the national data (Figure 2).

There is limited data on prevalence of osteoporosis in postmenopausal type 1 and type 2 diabetic Indian women. In type 2 post-menopausal women from Jaipur (India), 47.4% and 19.6% women were found to be osteoporotic and 41.2% and 58.8% were found to be osteopenic at lumbar spine and femoral neck respectively [25]. In type 2 diabetics women from Belagavi (India), 19.6% had osteopenia and 41.3% had osteoporosis [26]. In the present study from Mumbai, overall prevalence of low bone density (osteoporosis + osteopenia) in type 1 and type 2 diabetic women was 60-80% (Figure 2).

In most meta-analysis studies, type 1 diabetic postmenopausal women have shown to have higher prevalence of osteoporosis and osteopenia as compared to non-diabetic women [11-13]. In the current study also, type 1 diabetics had higher prevalence of low BMD at femoral neck as compared to non-diabetics (Figure 2).

Few studies in recent years have shown higher prevalence of low BMD T score in type 2 diabetic women as compared to non-diabetic women [15-16]. However, most studies in type 2 diabetics have shown that even though type 2 diabetics have higher fracture risk, they have higher BMD as compared to non-diabetics [11,13-14]. However, in the current study, type 2 diabetic had significantly lower BMD and higher prevalence of osteoporosis and osteopenia as compared to non-diabetics (Table 2, Figure 2).

Increasing evidence has shown that obese individuals have low BMD and higher fracture risk as compared to non-obese individuals [27-28]. This may be one of the reasons for higher prevalence of low BMD in type 2 diabetics as compared to non-diabetics in the current study, as they had more weight and had increased prevalence of obesity as compared to non-diabetics (Table 1, Figure 1).

Another reason for higher prevalence of low bone density in type 2 diabetics as compared to non-diabetics can be diet. Dietary calcium is the building blocks of bone. Even after menopause, adequate calcium is required by the body. Type 2 diabetics only consumed 50% of the RDA for calcium and was much less as compared to non-diabetics. This may be one of the major contributors for low bone density in type 2 diabetics in the current study [29].

Calcium works synergistically with protein to increase bone homeostasis [30]. In orthopaedic patients, protein supplements given in form of casein, attenuates post-fracture bone loss. Dietary protein also enhances IGF-1, a factor that exerts positive activity in skeletal development and bone formation [31]. Hence, low protein intake in type 2 diabetics may be another reason for low bone density in them as compared to non-diabetics.

When bone density was adjusted for weight, dietary calcium and protein intake, no-significant differences were observed in T score at femoral neck and total body between type 2 diabetics and non-diabetics, indicating that these factor do contribute to low T score in type 2 diabetics as compared to non-diabetics (Table 4).

However, there was still a significant difference in adjusted T score at lumbar spine between type 2 diabetics and non-diabetics. Hence, a further study is needed to explore the causative relationship of other factors such as physical activity and serum vitamin D levels in type 2 diabetics as compared to non-diabetics.

The effect of weight and dietary calcium and protein intake is also evident in type 1 diabetics. The adjusted T scores at all sites especially at lumbar spine are better as compared to non-adjusted T scores (Table 2, 4). In fact, type 1 diabetics had significantly higher adjusted T scores as compared to type 2 diabetics further indicating the effect of these on BMD (Table 4).

To conclude, more than 70% women had low bone density at lumbar spine and femoral neck in both diabetic and non-diabetic post-menopausal women. Higher percentage of type 2 diabetics had osteopenia and osteoporosis. Dietary calcium and protein intake was extremely low in diabetics. Intervention programs need to be developed to prevent onset of osteopenia and osteoporosis especially in diabetic post-menopausal women.

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