International Journal of Osteoporosis & Metabolic Disorders

ISSN 1994-5442

science alert

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OPEN ACCESS International Journal of Osteoporosis and Metabolic Disorders

ISSN 1994-5442
DOI: 10.3923/ijom.2017.10.16

Research Article
Prevalence of Osteoporosis in Type 2 Diabetes Mellitus Patients Using Dual Energy X-Ray Absorptiometry (DEXA) Scan

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Abstract

Background and Objective: Osteoporosis is a growing health dilemma recognized in both developed and developing countries associated with substantial morbidity worldwide. The present study aimed to determine the prevalence of osteoporosis in type 2 diabetes mellitus patients using Dual energy X-ray absorptiometry (DEXA) scan. **Materials and Methods:** Data were collected from type 2 diabetes mellitus patients attending orthopaedics and diabetes centre who were willing to undergo DEXA Scan. The DEXA was done at hip and spine to assess bone mineral density (BMD). Various other risk factors were evaluated through a questionnaire. T-Scores and Z-Scores have been measured for the presence of osteoporosis based on WHO criteria. Descriptive statistics, t-test and Mean±SD was used as statistical test. Data were entered and analyzed using SPSS. **Results:** A total of 96 type 2 diabetes mellitus patients were studied. The study revealed the prevalence of osteoporosis at the spine 39.6% while at the hip 20.9%. The overall incidence seen was 43.8%. Predominantly, osteoporotic diabetes had lower body weight and lower body mass index with reduced duration of exposure to sunlight. The prevalence of osteoporosis was higher among the group with a positive history of alcohol and smoking. **Conclusion:** The present study indicates that high prevalence of osteoporosis in type 2 diabetes mellitus patients is a cause for concern. Measures such as adequate vitamin D and calcium intake, physical activity and exposure to sunlight will be useful in preventing the occurrence of osteoporosis.

Key words: Skeletal disease, osteoporosis, type 2 diabetes mellitus, DEXA scan, bone mineral density

Citation: Shivank Prakash, Ravi. S. Jatti, Shridhar C. Ghagane, S.M. Jali and M.V. Jali, 2017. Prevalence of osteoporosis in type 2 diabetes mellitus patients using dual energy x-ray absorptiometry (DEXA) scan. Int. J. Osteoporosis Metab. Disorders, 10: 10-16.

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Osteoporosis is a skeletal condition characterized by decreased density (mass/volume) of normally mineralized bone[1]. The incidence of osteoporosis occurs at about 70-80 years of age and in India, it may afflict those 10-20 years younger, at age 50-60[2]. The prevalence of osteoporosis is ticking, with projected global burden of osteoporosis hip fractures expected to exceed six million by 2050[3]. Thirty to fifty% of women and 15-30% of men have a lifetime risk of osteoporosis and osteoporosis-related fractures all over the world[4]. Osteoporosis is defined as "a systemic skeletal disease characterized by low bone mass and micro-architectural deterioration of bone tissue, with a consequent increase in bone fragility and susceptibility to fracture"[5,6]. This definition indicates that measurement of bone mineral density (BMD) is a central component to the diagnosis of the disease[5]. The diagnosis of osteoporosis is based on BMD measurements following the guidelines of World Health Organization (WHO)[6].

The single best technique was used to measure BMD is Dual energy X-ray absorptiometry (DEXA) Scan[3]. Diabetes mellitus is a pandemic metabolic disease with substantial morbidity and mortality. Patients with diabetes mellitus have various skeletal disorders, including osteopenia or osteoporosis, Charcot's arthropathy and the diabetic foot syndrome[7]. Evidence demonstrates a relationship between type 2 diabetes and multiple microvascular (e.g., retinopathy and neuropathy) and macrovascular complications (e.g., coronary heart disease) and more recently; an increased risk of bone fracture has been suggested[8,9]. Osteoporosis is the most significant metabolic bone disease in patients with diabetes mellitus[10,11]. Etiological association studies between diabetes and osteoporosis have reported that bone health is compromised by diabetes. Conversely, studies of patients with T2DM revealed an increased fracture risk due to the risk of falling despite higher BMD. Osteoporosis is the most important metabolic disorder in diabetes mellitus. These two aspects are frequent medical conditions with an increasing prevalence in the aging population[12]. To provide optimal bone health care for the growing number of patients with diabetes mellitus, is awareness of the epidemiology, careful clinical assessment and appropriate prevention or treatment of skeletal diseases. Thus, the study aims to determine the prevalence of osteoporosis in type 2 diabetes mellitus (T2DM) patients using DEXA scan and analysis of the risk factors affecting osteoporosis.

MATERIALS AND METHODS

The study was hospital based and data were collected from type 2 diabetes mellitus patients undergoing DEXA scan, attending outpatient department of Orthopaedics and Diabetes Centre, KLES Dr Prabhakar Kore Hospital and Medical Research Centre, Belagavi, during the period from January-December, 2015.

A total of 96 patients suffering from type 2 Diabetes mellitus and who were willing to undergo DEXA scan were selected for the study. They were male and female aged $\geq$30 years. Patients following medication which is known to affect calcium metabolism, long-term steroids, phenytoin, eltroxin, heparin, thiazide diuretics, oestrogen, thiazolidinediones (TZDs) were excluded. Patients with following long-term diseases like chronic liver/kidney diseases, chronic skin disease, malignancy and rheumatoid arthritis were also not considered. The DEXA scan was the gold standard in the assessment of BMD. The DEXA scan (Ge WIPRO 2008 Lunar Model, Belagavi, Karnataka, India) uses X-ray equipment and a computer to measure bone density. Bone mineral density was the most important tool in the diagnosis of osteoporosis. It allows for accurate, precise and reproducible assessment of BMD and enables the detection of osteoporosis before the occurrence of fractures. The variables analyzed were age, time since menopause, diet, socio-economic status, sunlight exposure, smoking, alcoholism, occupation, family history, body mass index and duration of diabetes.

Assessment of data: The bone mineral density (BMD in g cm^{-2}) 'T' and 'Z' scores were determined. The 'T' score compares the BMD result with that of a young adult of the same gender with a peak bone mass while 'Z' score compares the BMD result with people of the same age group size and gender.

Data were analyzed as follows by following the WHO criteria[6]:

Normal BMD = T score not more than 1 SD below the adult mean
Osteopenia = T-score between -1.0 and- 2.5
Osteoporosis = T-score <-2.5 with or without fragility fracture

Data were collected and recorded. Diagnosis based on the BMD score were made. The BMD data were correlated with the data of various risk factors obtained through the questionnaire and correlations were derived.

Statistical analysis: Data were entered and analyzed using IBM SPSS Statistics software Inc., version 20.0 (Armonk, NY: IBM Corp.)[13]. Descriptive statistics, Mean ± SD and t test $p<0.05$ was used as statistical test.

RESULTS

In the present study, out of 96 patients with type 2 diabetes mellitus evaluated with DEXA scan for the presence of osteoporosis and various risk factors, 50 were men and 46 were women. The overall prevalence of osteoporosis in this study were 43.75%, osteopenia 26.05% and normal BMD values were 30.2%. The prevalence of osteoporosis in men was 46% and in women was 41.3%. The study revealed the prevalence of osteoporosis at the spine was 39.6% while at the hip was 20.9%. The overall incidence seen was 43.8% (Fig. 1).

Age of all the patients in this study was above 30 years with the majority of the patients aged >60 years. Highest number of osteoporotic individuals, 27 were above 60 years (Table 1). The mean age of patients was 62 years, ranged from 37-85 years. Highest numbers of osteoporotic diabetics (27) were aged more than 60 years. Similarly, the prevalence rate of patients with BMD and age category are presented in (Table 2). The duration of diabetes was positively correlated with osteoporosis. 46.5% of osteoporotic individuals were suffering from diabetes for 6-10 years (Table 3). The number of osteoporotic diabetic in the lower socio-economic group was highest with 52.7%. A significant correlation was observed between T-score and BMD ($p<0.001$). Gender specific BMD is illustrated in (Fig. 2), the percentage of people with diabetes having normal BMD was highest in the upper socio-economic group (70%). The most common complaint the patients presented with was a backache (56%). Rest had reports of knee pain, sciatica, generalised weakness and diffuse body ache. The prevalence of osteoporosis was highest among patients involved in sedentary work (office work) wherein 30 patients (60%) had osteoporosis. Most of the women in this

Table 1: Total percentage of patients in the respective age category

Age category	No. of patients (%)
35-40	2 (2.10)
41-45	6 (6.25)
46-50	9 (9.40)
51-55	15 (15.60)
56-60	11 (11.50)
>60	53 (55.20)

Table 2: Prevalence of patients categorized with respect to age and body mineral density

Age	Normal n (%)	Osteopenia n (%)	Osteoporosis n (%)	Total
35-40	1 (50.0)	0 (0.0)	1 (50.0)	2
41-45	4 (66.7)	1 (16.6)	1 (16.7)	6
46-50	5 (55.6)	3 (33.3)	1 (11.1)	9
51-55	4 (26.6)	4 (26.7)	7 (46.7)	15
56-60	2 (18.0)	4 (36.6)	5 (45.4)	11
>60	13 (24.5)	13 (24.5)	27 (51.0)	53
Total	29	25	42	96

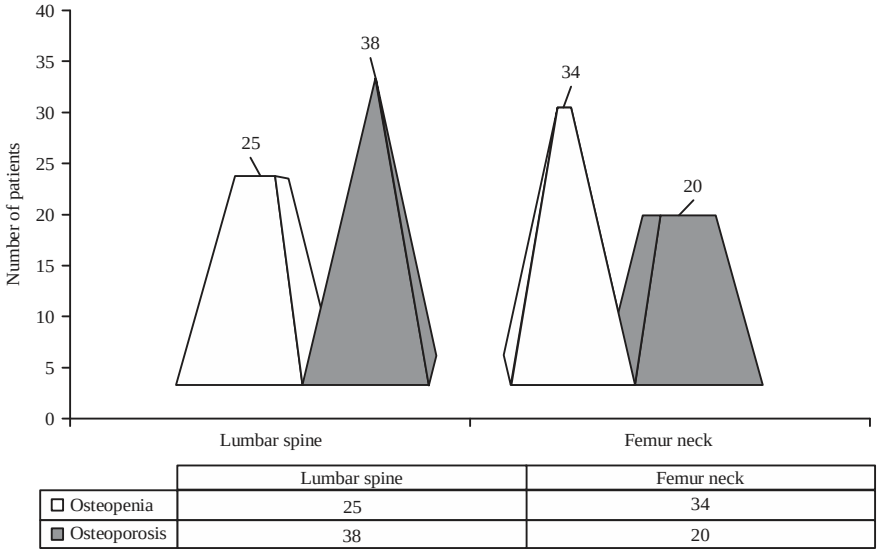

Fig. 1: Patients with osteoporosis and osteopenia at various anatomical sites using DEXA scan

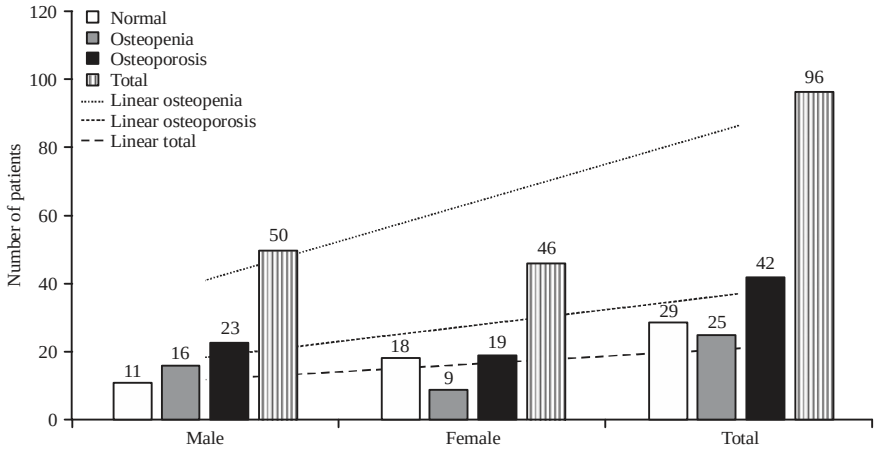

Fig. 2: Gender specific bone mineral index

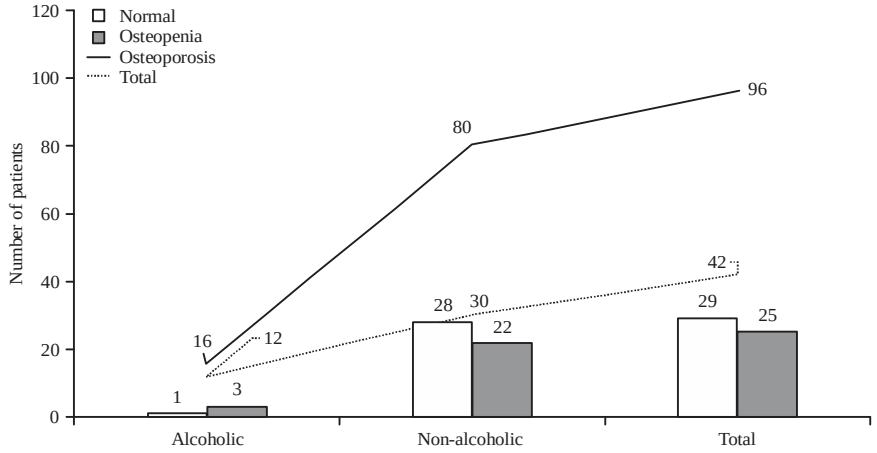

Fig. 3: Patients of bone mineral density with and without alcohol consumption

Table 3: Patients with duration of diabetes mellitus and bone mineral density

Duration of diabetes mellitus (in years)	Normal n (%)	Osteopenia n (%)	Osteoporosis n (%)	Total
0-5	10 (52.7)	5 (26.3)	4 (21.0)	19
6-10	12 (27.9)	11(25.6)	20 (46.5)	43
11-15	6 (20.0)	9 (30.0)	15 (50.0)	30
16-20	1 (25.0)	0 (0.0)	3 (75.0)	4
Total	29	25	42	96

study had attained menopause (91.3%) of which (71.7%) women had reached menopause for more than 10 years. Increase in the time since menopause was associated with increased risk of osteoporosis showing statistically significant with ($p<0.001$). The average age of menopause in this study was 46 years. Body mass index ranged from 17.3-38.5 with a mean BMI of 26.5. People with diabetes with higher body mass index had a lower incidence of osteoporosis, the correlation between BMI and BMD is presented in (Table 4). The total number of diabetics who were vegetarians in the study was 70 and non-vegetarians 26. The maximum percentage of people with diabetes with osteoporosis was in the vegetarian group (48.6%). The number of people with diabetes with an adequate amount of exposure to sunlight (1 ½- 2 h) was 56 and diabetics with little exposure to sunlight (<1 ½ h) was 40. The prevalence of osteoporosis was higher among the group with inadequate exposure to sunlight. The number of people with diabetes with normal BMD was highest among the group with adequate exposure to sunlight. Only 16 (16.7%) patients in this study gave a history of drinking alcoholic beverages of which 12 (75%) were osteoporotic (Fig. 3). Eighteen patients in this study were smokers of which

Table 4: Patients with body mass index ranged and bone mineral index

BMI	Normal n (%)	Osteopenia n (%)	Osteoporosis n (%)	Total
Underweight (≤18.5)	0 (0.0)	0 (0.0)	3 (100.0)	3
Normal (18.5-24.9)	3 (8.3)	10 (27.8)	23 (63.9)	36
Pre-obese (25-29.9)	13 (39.4)	8 (24.2)	12 (36.4)	33
Obese (≥30)	13 (54.1)	7 (29.1)	4 (16.7)	24
Total	29	25	42	96

12 (66.7%) were osteoporotic. Six (6.25%) patients had a positive family history of fracture of the hip and wrist after minor fall and all the six patients had osteoporosis in this study.

DISCUSSION

Diabetes mellitus is a pandemic and chronic metabolic disorder with substantial morbidity and mortality. Osteoporosis is also a silent disease with a harmful impact on morbidity and mortality[12]. In this cross-sectional study, 96 patients with diabetes mellitus were evaluated with a DEXA scan for the presence of osteoporosis and various risk factors were assessed. The overall prevalence of osteoporosis in this study was 43.8%, osteopenia was 26% and with average BMD values were 30.2%[14].

Yaturu's study showed significantly lower BMD values as well as increased incidence of osteoporosis at the hip bone in skilled men with type 2 diabetes compared to age-matched controls[15]. Age of all the patients in this study ranged from 37-85 years. The average age of the patients in this study was 62 years. Highest numbers of osteoporotic diabetics (51%) were above 60 years. Dutta *et al.*[16] prospectively studied the rate of loss of BMD/annum. They concluded that rates of BMD loss at the age of 65 years were 0.91, 0.84, 0.72, 0.78 and 1.66%/annum, respectively for the neck of femur, trochanter, intertrochanteric region, total hip and ward's triangle.

In the study, prevalence of osteoporosis was highest among people with diabetes who were involved in sedentary work (homemakers, office work and retired men) where in 30 patients (60%) had osteoporosis. Cross-sectional studies show weight bearing exercises have a beneficial impact on the bone mass, development of peak bone mass and reduce the bone loss and the mechanical stress[17].

The most common complaint of the patients selected for this study was backache (56%). Rest had multiple complaints of sciatica, knee pain, generalised weakness and diffuse body ache. The number of osteoporotic diabetics in the lower socio-economic group was highest 19 (52.7%). This high prevalence rate was significant as another study done to assess the bone status of Indian women from a low-income group in 289 women in the 30-60 year age group using DEXA scan showed the prevalence of osteoporosis at the femoral neck was around 29%[18]. Most of the women in this study had attained menopause (91.3%) of which (71.7%) women had reached menopause for more than 10 years. Increase in the time since menopause was associated with increased risk of osteoporosis in this study showing statistically significant ($p<0.001$). Similarly, Kadam *et al.*[19] revealed BMD at all three sites of measurement (Spine, Hip and wrist) was significantly lower in postmenopausal than premenopausal women ($p<0.001$).

Body mass index of the patients in this study ranged from 17.3-38.5. Patients with diabetes with higher body mass index had a lower incidence of osteoporosis. Several studies show low BMI, a measure of body composition, may be associated with number of osteoporotic fractures and osteoporosis. The highest percentage of people with diabetes with osteoporosis were in the vegetarian group (48.6%). Various Indian studies have shown that vegetarians have 50% risk of osteoporosis and 98.82% are osteopenic[20,21]. Critical modifiable risk factors include calcium and vitamin D deficiency, sedentary lifestyle, smoking, excessive alcohol and caffeine intake. Only 16 diabetics in this study gave a history of drinking alcohol of which 12 were osteoporotic. On top 18 people with diabetes who gave a history of smoking 12 had osteoporosis and 4 osteopenia.

In the study, 6 patients with diabetes had a positive family history of fracture of the hip and wrist after trivial fall and all 6 of them had osteoporosis. It is important to distinguish between the diagnostic and prognostic use of bone mineral density measurement. As a diagnostic tool, it gives information concerning the presence or absence of the disease with the cut-off values chosen. Its potential as a prognostic tool is to determine the future probability of osteoporosis[22].

This study recommends the presence of a key risk factor that should alert the physician to the need for further assessment and intervention, pharmacologic as well as non-pharmacologic, to prevent fracture. Like major public health issue of a widespread magnitude, treatment alone cannot help the society or nation to cope with the scourge of osteoporosis[23]. Lifestyle factors form the cornerstone of prevention. These include regular exercise, adequate dietary

calcium (1-1.5 gm/day), adequate vitamin D (800 1.4/day) and cessation of smoking and alcohol intake. Osteoporosis and related fractures have a multi factorial genesis, as a result, their management is involved[24]. The goals of treatment in established disease are to arrest bone loss, maintain the skeletal integrity, to prevent fragility fracture and all these necessitate early intervention.

CONCLUSION AND RECOMMENDATION

The present study indicates that high prevalence of osteoporosis in type 2 diabetes mellitus patients is a cause for concern. Measures such as adequate glycemic control and prevention of diabetic complications are also the main stay of therapy in T2DM. Adequate intake of vitamin D, calcium, physical activity and exposure to sunlight will be useful in preventing the occurrence of osteoporosis. Areas of future research should include assessment of skeletal effects of novel anti-diabetic drugs, subset evaluation of patients with type 2 diabetes mellitus in osteoporosis treatment trials and intervention studies to reduce falls in patients with type 2 diabetes mellitus.

SIGNIFICANCE STATEMENTS

This study helps in establishing a relationship between osteoporosis and type 2 diabetes mellitus, showing type 2 diabetics are associated with an increased risk of non-traumatic fractures. In this study the risk factors were assessed for osteoporosis including age, gender, race, geographical location, diet, lifestyle, hormonal status, bone density, bone quality, body mass index and medical co-morbidities. Considering type 2 diabetes mellitus also has a profound impact on many of the nutritional, cytokine and hormonal factors the consequences on bone remodeling have the potential significant.

ACKNOWLEDGMENTS

The cooperation and support of the staff of Diabetes Centre, Department of Orthopaedics, KLES Dr Prabhakar Kore Hospital and MRC, Belagavi is greatly acknowledged. We thank Mr. Pradeep BK (Biocon) for assistance. The authors wish to acknowledge Dr. P.S. Shankar for reviewing the manuscript. The author's thank Dr. Gurudevi U. Hullepanavarmath Associate Professor of English for editing the English language of the manuscript.

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