Original Article

Prevalence of Osteoporosis in Apparently Healthy Adults above 40 Years of Age in Pune City, India

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Abstract

Purpose: The aim of study was to assess the prevalence of osteoporosis and changes in bone mass with increasing age and compare bone health status of apparently healthy men, premenopausal and postmenopausal women. **Methods:** Data were collected on anthropometric and sociodemographic factors in 421 apparently healthy Indian adults (women = 228), 40–75 years of age, in a cross-sectional study in Pune city, India. Bone mineral density (BMD) was measured by dual-energy X-ray absorptiometry at two sites-lumbar spine (LS) and left femur. Individuals were classified as having osteoporosis or osteopenia based on the World Health Organization criteria of T-scores. **Results:** Mean age of study population was 53.3 ± 8.4 years. Of the total women, 44.3% were postmenopausal with 49.2 ± 3.5 years as mean age at menopause. Postmenopausal women showed a rapid decline in BMD with age till 50 years while men showed a gradual decline. Premenopausal women showed no significant decline in BMD with age ($P > 0.1$). Significantly lower T-scores were observed at LS in men compared to premenopausal ($P < 0.05$). At left femur, T-scores were lower in men compared to premenopausal women ($P < 0.05$) but not postmenopausal women ($P > 0.1$). The prevalence of osteoporosis in men at LS was lower than postmenopausal women but higher than premenopausal women. **Conclusion:** In Indian men, a low T-score compared to women indicates higher susceptibility to osteoporosis. In women, menopause causes a rapid decline in BMD. Therefore, both Indian men and postmenopausal women require adequate measures to prevent osteoporosis during later years in life.

Keywords: Dual-energy X-ray absorptiometry, Indian adults, left femur neck, lumbar spine, osteoporosis, T-score

Introduction

Osteoporosis is defined as a progressive, systemic, skeletal disease characterized by low bone mass and microarchitectural deterioration of bone tissues with a consequent increase in bone fragility and susceptibility to fracture.[1] Studies have shown that bone loss starts from the age of 30–40 years in both men and women. In women, it has been postulated that menopause is followed by an immediate decrease in bone mass and density within a year. This increased rate of bone loss reaches equilibrium approximately 10 years after menopause and then merges into a continuous age-related loss.[2] While type 1 or postmenopausal osteoporosis generally occurs before the age of 65 years and affects women, Type 2 osteoporosis is universal after peak bone mass has been attained and is found in both men and women.[2] While women experience marked increase in bone loss during perimenopause and postmenopause, in men, a small longitudinal bone loss is observed throughout life.[3,4] Thus, women in addition to age-related bone loss also experience menopausal bone loss. Although it is said that bone loss in a universal phenomenon that starts from the time peak bone mass is achieved, most studies have assessed bone health status in postmenopausal women and men above 50 years of age. Further, studies on the effect of increasing age on bone health status are few. Therefore, studies in apparently healthy men and women are required.

Worldwide, it is estimated that 1 in 3 women above the age of 50 will experience osteoporotic fractures, as well as 1 in 5 men.[5] India with a population of 1.2 billion people is the second most populated country in the world with approximately 10% of population (more than 100 million) over 50 years of

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age.[6] In 2013, sources estimate that 50 million people in India are either osteoporotic (T-score lower than-2.5) or have low bone mass (T-score between-1.0 and-2.5).[7] Studies indicate that osteoporosis and osteopenia or low bone mass may occur at a relatively younger age in Indian population.[8,9] Despite being a common cause of morbidity and mortality in males, Indian data on male osteoporosis are few. A study in Delhi estimated the prevalence of osteoporosis as 24.6% in men and 42.5% in women above 50 years of age.[10] Another study by Sharma *et al*. has reported a prevalence of 8.5% in the femoral neck region in men.[11] Even though these estimates suggest that prevalence of osteoporosis in males is lower than in women, mortality in males post hip fracture is high.[12] Further, in older men, the risk of hip fracture or vertebral fracture is 30% higher than in women of the same age.[12] Male osteoporosis largely remains underdiagnosed and untreated and is revealed only after the occurrence of a fracture. Osteoporotic fractures in men are more common than myocardial infarction and prostate cancer, and yet the majority of studies in osteoporosis have a focus on women especially postmenopausal women with little data available in men.[13]

Dual-energy X-ray absorptiometry (DXA) has been established as the reference "gold standard" technique for measuring bone mineral density (BMD).[14] However, inaccessibility and high-cost factor of DXA makes it unavailable to the majority of Indians, resulting in very little population-based research on osteoporosis in India.[15]

Therefore, the aim of the present study was to assess the prevalence of osteoporosis and changes in bone mass with increasing age and to compare bone health status in a cross-sectional cohort of apparently healthy men, premenopausal, and postmenopausal women above 40 years of age from Pune city, India.

Methods

Participants

A cross-sectional study was carried out in apparently healthy adults (n = 421), aged 40–75 years, attending routine health checks from hospitals, housing societies, and residential areas using random sample method in Pune city, India. The exclusion criteria were (1) Age < 40 years (2) fracture within the past 12 months, (3) prolonged immobilization in the past 12 months, (4) major systemic disease, (5) any condition, or use of any drugs known to affect bone health, for example, diabetes, thyroid disorders. All those individuals who met the inclusion criteria were approached for participation. A total of 193 men and 228 women agreed to take part in the study and gave informed written consent. The study duration was October 2014–September 2016.

Post hoc power analysis for an independent sample t-test was conducted in G-POWER for the sample size of 193 and 228 in men and women, using an alpha of 0.05, an effect size of d = 0.36 (based on available BMD data in Indian men and women[16,17]) and two tails. Based on the aforementioned assumptions, the power of the study was calculated to be 0.96.

Ethical approval and consent

The research protocol was approved by the Institutional Ethics Committee. All the procedures performed in the study were in accordance with the ethical standards of the Ethical Committee and with the Helsinki Declaration of 1975 (revised in 2000) and its later amendments or comparable ethical standards. The purpose and importance of the study were explained, and an informed written consent was obtained from all the participants.

Anthropometric data

Weight and height were measured in the morning with participants in light indoor clothes without shoes. Weight was measured on an electronic digital scale to the nearest 0.1 kg (Libra Industries, Mumbai, India) and standing height was measured using a portable stadiometer (Leicester Height Meter, Child Growth Foundation, London, UK, range 60–207 cm). Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). Participants were categorized as normal, overweight and obese as per the Asian cutoff for BMI in Indians.[18]

Sociodemographic and reproductive factors (in women)

Each participant completed a structured questionnaire on sociodemographic and lifestyle factors such as educational status, occupation, and monthly income. Additionally, in women, data on reproductive factors (menopausal status and years since menopause [YSM]) were also collected.

Women were classified into premenopausal or postmenopausal stage according to the following definition: Premenopause was defined as women above 40 years of age with regular menstruation. Postmenopause was defined as permanent cessation of menstrual periods that occurs naturally or is induced by surgery in accordance with the definition by the World Health Organization (WHO).[19] The period in between premenopause and menopause when women have irregular menstruation but not complete cessation was defined as perimenopause (around menopause). Premature or early menopause was defined as menopause occurring before the age of 45 years either naturally or due to hysterectomy or oophorectomy.[20]

Measurement of bone mineral content and density

Bone mineral content (BMC), bone area (BA), and BMD were measured at two sites: At the anteroposterior lumbar spine (LS) (L1–L4) and left femur-neck (FN) and total, using a Lunar DPX-PRO total body pencil beam Densitometer (GE Healthcare, Wisconsin, USA) using a medium mode scan (software encore 2005 version 9.30.044). The precision of the lunar DPX for repeat measurements in adults is 1.04% for LS BMD and 2.13% for femoral neck BMD.[21]

T-scores were computed by the DXA machine software which uses reference databases The reference cohort for adults consists of a cross-sectional database on BMD of ambulatory

healthy Caucasian men (n = 2880) and women from the USA (n = 3000) and Europe (n = 8000–9000).[22-26] For hip, the lowest T-score between FN and total was considered for classification of osteoporosis at the hip in accordance with the official positions of the International Society for Clinical Densitometry (2013) for adults while at the LS, mean L1–L4 T-score was used.

Statistical analysis

Analyses were performed using SPSS software for Windows (version 16.0, SPSS Inc., Chicago, IL, USA). All the variables were tested for normality using one sample Kolmogorov–Smirnov test before any statistical comparisons were made. Data are presented as mean with standard deviation for normally distributed variable. Differences between males and females with respect to anthropometric characteristics were tested using Student's *t*-test for normally distributed variables. Chi-square test was used to test differences between categorical variables with respect to BMI, education, income categories and gender. To test the statistical significance of difference of bone parameters between three groups (men, preenopausal women, and postmenopausal women), analysis of variance model was used with *post hoc* Tukey's test to test the difference between two groups. $P < 0.05$ was considered statistically significant.

Results

Anthropometric and sociodemographic characteristics

Anthropometric variables have been described in Table 1. Men were significantly taller, had higher weight, and BMI than both premenopausal and postmenopausal women ($P < 0.05$). The percentage of obesity (BMI > 28) was significantly higher in women than in men ($P < 0.05$). No significant differences were seen between men and women with respect to their education and income categories indicating that they were at par with respect to these parameters ($P > 0.1$). Majority (63%–71%) of the study cohort had education of graduation and higher and 58%–68% belonged to middle to higher socioeconomic strata.

Gynecological history of women

Of the total women, 44.3% were postmenopausal (natural menopause) with 49.2 ± 3.5 years as mean age at menopause. Percentage of premenopausal women was 15.8, perimenopausal were 21.9 while 18% women had early or premature menopause. Of the total women who had a natural menopause, 70.5% were more than 5 YSM while 29.5% women were <5 YSM.

Bone parameters in the study subjects

Since no significant differences were observed in bone parameters in premenopausal and perimenopausal women and between women who had early menopause and those who had achieved natural menopause, the two respective groups were analyzed together ($P > 0.1$) [Table 1]. At the LS, significant lower T-scores were noted in men compared to premenopausal ($P < 0.05$). For FN and total hip, lower T-scores were noted in men compared to premenopausal women ($P < 0.05$) but not postmenopausal women ($P > 0.1$). No significant differences were seen in BMD between men and premenopausal women at all three sites ($P > 0.1$). However, postmenopausal women had significantly lower BMD compared to both men and premenopausal women at all three sites ($P < 0.05$).

Changes in mean bone mineral density with age in men and women according to menopausal status

To assess the change in BMD with age and menopausal status, mean BMD was plotted against 5 years of age groups for premenopausal women, postmenopausal women, and men [Figure 1a-c]. In the present study cohort, it was observed that premenopausal period may last up to 55 years of age. For the premenopausal women, there was no significant decline in BMD with age even till the age of 55 years. Compared to this, postmenopausal women showed a significant decline in BMD in the 45–50 years group ($P < 0.05$) after which there was no significant decline in BMD in further age groups ($P > 0.1$). For men, at the LS, a gradual but nonsignificant decline in BMD was observed till the 55–60 years age group where the mean BMD was significantly lower than 40–45 years age group ($P < 0.05$).With further increase in age, the BMD was seen to be significantly higher at >65 years age group ($P < 0.05$). On further examination, it was observed, that while the BMC remained similar with increasing age, the BA reduced significantly ($P < 0.05$) which may have led to the increase in BMD seen at the LS in men. At the FN and hip total BMD, no significant change in BMD with age was observed ($P > 0.1$).

To examine the effect of YSM in women, the prevalence of low bone mass was studied by further classifying postmenopausal women according to their YSM.

Prevalence of low bone mass in the study cohort

As WHO definition based on T-score, the overall prevalence of osteoporosis was 14.5% in men and 18% in women at the LS and 5.7% in men and 12.7% in postmenopausal women at the hip. Osteopenia was noted in 39.4% men and 21.6% women at the LS while at the hip it was 56% and 44.8% in men and women, respectively. Since menopause is an important event in the life of women, bone status was assessed in two groups - premenopausal and postmenopausal. Further, the postmenopausal group was divided into postmenopausal <5 years and postmenopausal more than 5 years based on their YSM [Figure 2a and b]. In men, since there was no significant decline in BMD with age, they were divided into two groups based on their median age (52.2 years).

At the LS, the prevalence of osteoporosis was 10.4% for men in <52.2 years category and 18.6% for men in more than 52.2 years category. In premenopausal women, the prevalence was 3.5%, 18.4% in postmenopausal women <5 YSM and 37.3% in postmenopausal women more than 5 YSM. Osteopenia was seen to be 35.1%–43.8% in men, 31%–34% in premenopausal women and postmenopausal women <5 YSM

Table 1: Anthropometric and bone parameters in the study participants

Bone parameters	Men (n=193)	Pre and permenopausal women (n=86)	Postmenopausal women (n=142)
Age (year)[a,b,c]	53.6±9.0	46.1±3.5	57.5±6.7
Height (cm)[a,b]	168.4±6.6	156.2±5.4	154.3±6.1
Weight (kg)[a,b]	75.3±12.2	67.6±12.5	66.3±12.2
BMI categories (%)			
Normal (BMI <23)	15.2	18.8	17.9
Overweight (BMI 2328)	53.9	36.5	36.4
Obese (BMI>28)	30.9	44.7	45.7
Lumbar spine (L1-L4)			
T-score[a,b,c]	−1.16±1.22	−0.53±1.14	−1.77±1.30
BMD (g/cm^2)[b,c]	1.08±0.15	1.12±1.37	0.97±0.16
BMC (g)[a,b,c]	60.06±10.89	52.29±9.07	44.18±9.63
BA (cm^2)[a,b]	55.39±5.26	46.62±4.12	45.31±4.31
Femoral neck (left)			
T-score[a,c]	−1.19±0.97	−0.64±0.77	−1.39±0.89
BMD (g/cm^2)[b,c]	0.92±0.13	0.95±0.11	0.84±0.12
BMC (g)[a,b,c]	4.59±0.69b	4.19±0.56	3.62±0.60
BA (cm^2)[a,b,c]	5.02±0.40	4.42±0.34	4.29±0.32
Total hip (left)			
T-score[a,c]	−0.87±0.87	−0.12±0.90	−0.88±1.01
BMD (g/cm^2)[b,c]	0.98±0.12	0.99±0.11	0.90±0.13
BMC (g)[a,b,c]	33.14±5.0	28.23±4.00	25.74±4.24
BA (cm^2)[a,b]	33.93±2.34	28.42±2.01	28.67±1.78

All values are mean±SD except BMI categories (%). [a]Significant difference between men and premenopausal women (P<0.05), [b]Significant difference between men and postmenopausal women (P<0.05), [c]Significant difference between premenopausal and postmenopausal women (P<0.05). SD: Standard deviation, BMC: Bone mineral content, BA: Bone area, BMD: Bone mineral density, BMI: Body mass index

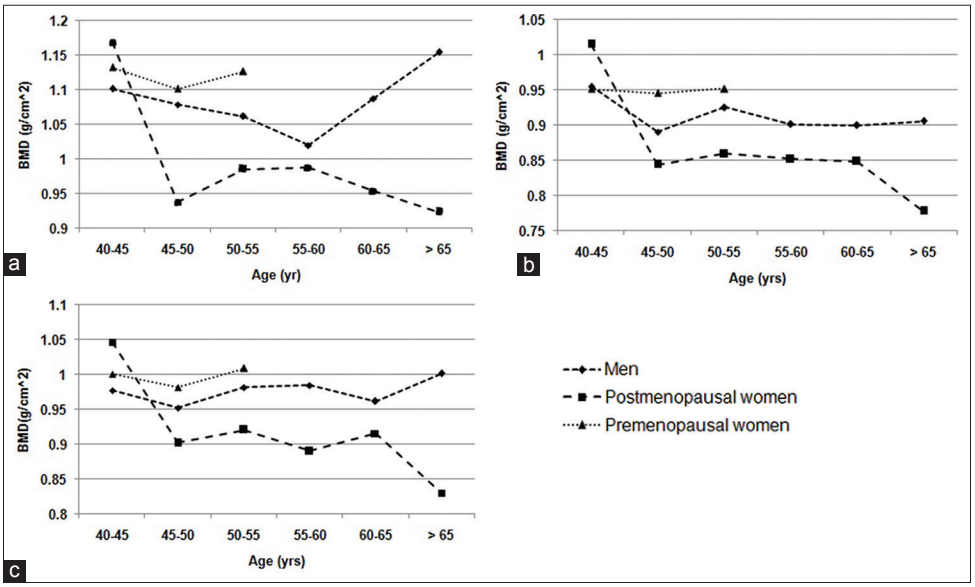

Figure 1: (a) Mean BMD with age at lumbar spine in the study cohort. (b) Mean BMD with age at left femur neck in the study cohort. (c) Mean BMD with age at left hip (total) in the study cohort. BMD: Bone mineral density

and 42.2% in postmenopausal women more than 5 YSM. At the hip, the prevalence of osteoporosis was 5.2%–6.2% in men, 2.6% in postmenopausal women <5 YSM and 16.5% in postmenopausal women more than 5 YSM. Higher prevalence of osteopenia was observed in men (50%–62%) and postmenopausal women (50%–59%) while for premenopausal women it was 32.6%.

Discussion

In the present cross-sectional study, in apparently healthy Indian men and women above 40 years, we observed a high prevalence of osteoporosis in postmenopausal women at the LS and a high prevalence of osteopenia in both men and premenopausal women at LS and hip. Even though

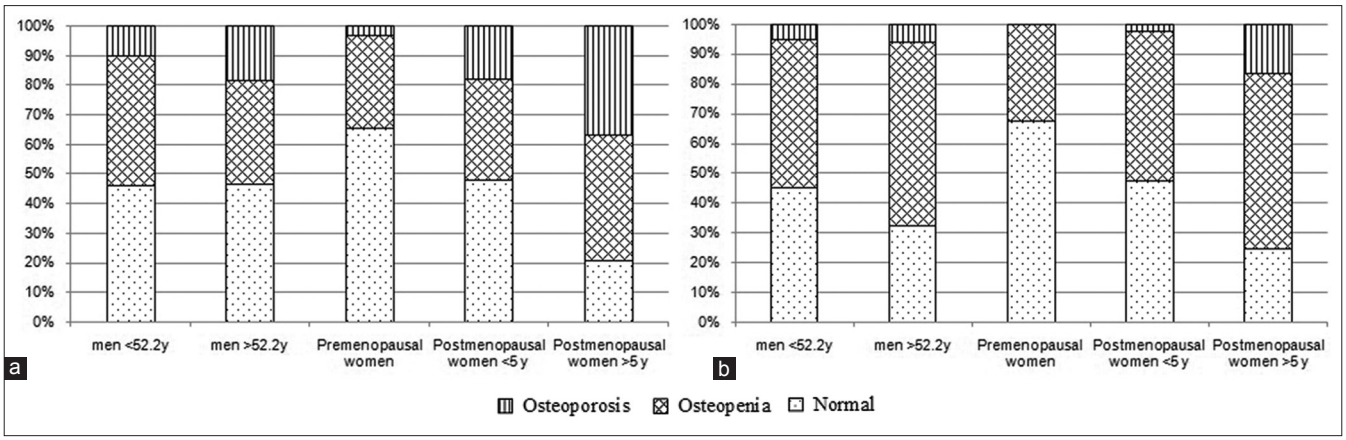

Figure 2: (a) Prevalence of osteoporosis at lumbar spine in women according to menopausal status versus men. (b) Prevalence of osteoporosis at femoral neck in women according to menopausal status versus men

no significant decline in BMD was observed in men, the prevalence of osteoporosis was higher than that observed in premenopausal women. Further, with increasing YSM for postmenopausal women, the prevalence of osteoporosis was seen to increase.

Studies reporting the prevalence of osteoporosis in Indian adults, especially men are few. Our results show the prevalence of osteoporosis in men (40–75 years) to be 14.5% at LS and 4.7% at hip. A study by Lee *et al*. in Korean males found a prevalence of 5.7% at LS and 7.7% at FN[27] while another study in Chinese adults reported a prevalence of 6.4% at LS and 15.5% at FN in men above 50 years of age.[28] Shetty *et al*. reported a prevalence of osteoporosis at LS (15.2%) and FN (10.7%) which is similar to our study findings.[29] In an Indian study based in Delhi, overall osteoporosis prevalence of 24.6% in men was reported at any of the three sites (LS, FN, and forearm).[30] Agrawal and Sharma (2013) have also reported a prevalence of 8.5% osteoporosis at FN in Indian men above 50 years of age.[13] The higher prevalence of osteoporosis at the FN in these studies maybe attributed to the fact that these were men above 50 years of age while the present study includes men above 40 years of age.

Overall prevalence of osteoporosis in women in our study was 18% at LS and 12.7% at hip. In a previous exploratory study on women above 40 years of age, at the LS osteoporosis prevalence of 7.6% and 25.8% in premenopausal and postmenopausal women respectively was reported.[17] However, it did not study the effect of increasing YSM on bone health status. In the present study, we found osteoporosis prevalence of 3.5% in premenopausal women at the LS. Postmenopausal women who were <5 YSM showed osteoporosis prevalence of 18.4% while postmenopausal women who were more than 5 YSM showed a higher prevalence of 37%. Marwaha *et al*. reported an overall prevalence of 42.5% osteoporosis in women above 50 years of age at either of the three sites studied (LS, FN, and forearm).[30] Lu *et al*. have reported a prevalence of 18.4% in Chinese women above 50 years of age[28] while Korean women showed a prevalence of 24.4% at LS.[27] However, none of these studies have accounted for menopausal bone loss and have not classified women based on their menopausal status. A study in Iranian women above 45 years reported a prevalence of 50.7% at the LS[31] while another study by Ejaz *et al*. suggests a higher prevalence of osteoporosis in Pakistani postmenopausal women (49.3%).[32] The high prevalence of osteoporosis in these populations maybe attributable to the high prevalence of Vitamin D deficiency found in them.

The overall prevalence of osteopenia at LS or hip, in both men (39%–56%) and women (36%–71%) in the present study was high. These findings are similar to those reported in Chinese men (34%–55%) and women (42%–55%).[28] Other Indian studies by Marwaha *et al*.,[30] Aggarwal (2011) [33] and Shetty *et al*.[29] have also reported high prevalence of osteopenia in Indian men and women indicating the need to target this population at risk for preventing the progression to osteoporosis in future.

Our results suggest a higher prevalence of osteoporosis for both men and women at the LS than hip. This maybe attributable to the fact that spine contains more trabecular bone than cortical bone. Trabecular bone, which represents 20% of the total bone mass, has an accelerated metabolism and therefore a more rapid and earlier loss than cortical bone.[34] Thus, bone mass in the spine undergoes rapid turnover in the early menopausal period, accounting for the high rate of osteoporosis at the LS.[35] Another explanation could be that weight-bearing causes rise in bone density especially in the femur and hip region.[36]

Our findings show that men had similar BMD values at each age group compared to premenopausal women up to the age of 50 years. Postmenopause, there was a significant decline in BMD noted for women. This decline with age was observed till 50 years of age which coincides with the age at menopause of the present cohort. This indicates that rapid bone loss may occur during menopausal transition. This warrants adequate precaution to be taken during menopausal years to prevent osteoporosis during later years as age-related bone loss is a continuous process throughout life. In men, a gradual decline in BMD was observed at the LS till the 55–60 years age

group indicating that men also undergo bone loss but at a later age than women. This coupled with the high prevalence of osteopenia puts Indian men at risk for osteoporosis in future. After 60 years, the increase seen in BMD at LS for men may be attributable to the decline in BA but no significant change in BMC with age. It has been reported that with increasing age, bones get stiffer and cross-sectional area decreases[37] which may lead to spurious increase in BMD in the absence of a significant bone loss with increasing age.

One of the limitations of our study is that with increasing age, comorbidities increase and the number of apparently healthy adults who do not suffer from any chronic conditions goes down. This may be one of the reasons for less number of individuals in higher age groups which may have further brought down the prevalence of osteoporosis in the present study. Our study indicates no significant bone loss with age in men. Since it is a cross-sectional study, this fact needs be validated through longitudinal studies in men. Further, since our aim was to assess osteoporosis, we did not assess serum parameters such as calcium, phosphorous, and alkaline phosphatase. The present study has been carried out in Pune city, and therefore, the prevalence figures may not be applicable to the whole of India. Thus, large-scale multi-centric studies to establish the burden of osteoporosis in Indian adults are warranted.

To summarize, menopause is an important event in a woman's life cycle which affects bone health with the prevalence of osteoporosis and osteopenia increasing with increasing YSM. Osteoporosis post menopause, in women, is a well-studied and established phenomenon. No similar event that may cause a sudden decline in bone mass has been reported in men. However, in our study population of apparently healthy Indian men and women above 40 years, we observed lower T-scores and a high prevalence of osteoporosis as well as osteopenia in men compared to premenopausal women. This indicates that though Indian men have higher BMD in comparison to women, they may still be at risk for low bone mass and osteoporosis. This warrants intervention strategies aimed at creating awareness about osteoporosis and its risk factors in Indian men.

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Conflicts of interest

There are no conflicts of interest.

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